A TEXT BOOK
ON
VETERINARY SURGERY AND RADIOLOGY

[FOLLOWING VCI NEW SYLLABUS]

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PREFACE
(SECOND EDITION)

There was a long felt demand from various corners of readers and professionals to upda book covering the new syllabus of "Veterinary Surgery and Radiology" as prescribed by Vete Council of India. Authors feel happy to present his esteemed readers a thoroughly re second edition of this important book as per the guidelines of Veterinary Council of In

Veterinary Surgery is a comprehensive subject involving both sciences and art. unique amalgamation of the knowledge of Anatomy, Physiology, Pathology, Anaesthesi Radiology and many other specialisations. Besides, there are additional problems of d with various species of farm animals, pet animals and birds. As surgery is a clinical sci apart from theoretical knowledge it should imbibe practical demonstrative approach so make the reader a good teacher, surgeon and researcher. There are a lot of books inv Small Animal Surgery, Large Animal Surgery, Radiology, Anaesthesiology, Surgical Path Oncology, Ophthalmology, Cardiology, Avian Surgery, Equine Surgery, Bovine Surgery a on. The students feel at sea when consult these books to have basic information in 'Vete Surgery & Radiology' in under-graduate level. Further, the non-availability of these public and their high cost are the other constrains. Veterinary Surgery has made considerable s in recent years and the student need to be abreast with the latest information in the disc Veterinary Council of India has introduced a uniform pattern of under-graduate course curri in Veterinary and Animal Husbandry throughout the India. Keeping all these points in vie attempted to provide a comprehensive book that covers all the aspects of Veterinary S and Radiology following the Veterinary Council of India (VCI) syllabus presently in throughout the India. Though it is very difficult to include all the minute details of this dis into a single book, we tried to provide the information to the student in a semi outline f point wise especially for under-graduate students of B.V.Sc. & A.H. Besides Post-gra students, teachers and the field practitioners will be able to derive much benefit from this We have tried to describe the text including many key points considering informatio tables and bullet form and illustrating procedures and surgical techniques with many simp drawings. Inclusion of several photographs in different chapters obviously will be help better understanding of the students. We have correlated our own clinical experience information available in literature and provided the useful information in this book. At t of book, addition of a chapter entitled "Glossary of Surgery" will definitely help to unde the terms and definitions related to Surgery.

As ever before, author is thankful to Raj Kumar of M/s Kalyani Publishers for his keen interest for revision of the book. We are striving for continued improvement of the book and welcome any comments or constructive criticism that will help to improve the future edition for betterment of under-graduate students of B.V.Sc. & A.H. in particular and discipline as a whole.

Authors wise to put their appreciation to respective family members for their endurance, constant support and encouragement during writing and acknowledge the facts with love and gratitude.

2014

SAMIT KUMAR NANDI
SAMAR HALDER
MOZAMMEL HOQUE



There are many people who have encouraged and supported us in the course of writing this book and our heartfelt thanks go to all my friends and well wishers. We also acknowledge the help rendered by Dr. A Patil, Assistant Professor, University of Agricultural Sciences, Dharwad, Karnataka by providing a good number of photographs included in this book. We thank to Dr. P. Mukherjee and Dr. S. Roy, Assistant Professor, Teaching Veterinary Clinical Complex, WBUAFS and Subject Matter Specialist, KVK, ICAR who lent their support and help wholeheartedly whenever approached apart from their contribution of two Chapters. We thank to Dr Mohima Dev to collect materials and summarize a small portion of this book.

We are very grateful to the following Authors/Publishers of different text book/articles and very happy to acknowledge their names for their kind permission to adapt or summarize their text in this book like Kirk McKay, Compendium, Veterinary Learning Systems, Yardley, Pennsylvania; Dr. Colin E Harvey, School of Veterinary Medicine, University of Philadelphia, USA and Irma Revah, Editor-in-Chief, International Veterinary Information Service (IVIS) etc.

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S.K. NANDI
S. HALDER
M. HOQUE

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UNIT 1

GENERAL SURGERY

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CHAPTER 1

THE ART OF SURGERY

DEFINITION OF SURGERY

Surgery is a branch of medicine in which manipulative and other modalities are used in treating injuries, deformities and diseases.

Origin of word surgery

The word surgery originated from a Greek word CHEIR meaning HAND, and ERGON meaning WORK, In German language it is called CHIRURGIA.

Other modalities are cryosurgery and hypothermia.

FUNCTIONS OF A SURGEON

A surgeon mainly deals with:

- repair of tissues. *e.g.*: Treating a lacerated wound.
- reconstruction of tissues. *e.g.*: Suturing divided tendons and nerves.
- control of infection. *e.g.*: Post pharyngeal abscess.
- prevent spread of malignancy. *e.g.*: Tumours of lung.
- alter or correct structural and functional disorders. *e.g.* : Correction of knuckling of fetlocks (Structural disorder).
- removal of harmful or useless parts. *e.g.* : Gangrenous limb, gangrenous bowel.

REASONS FOR SURGERY

1. To save life of an animal.
2. To prolong life of an animal
3. To hasten recovery from an injury.
4. For elimination of disease process. *e.g.*: removal of a benign tumour.
5. For cosmetic reasons.
6. For correction of deformities.
7. For replacement of a part by an artificial one.
8. To make an animal socially acceptable. *e.g.*: Castration in a male cat.
9. To aid in diagnosis. *e.g.*: Laparotomy.
10. For investigation in research work.

OBJECTIVES OF SURGERY

1. Restoration of functions to as near normalcy as possible.
2. To eliminate life threaten maladies (choke, intestinal obstruction etc.).
3. Removal of diseased part-gangrenous tail
4. Removal of foreign bodies-rumenotomy
5. To hasten recovery process-wounds and fractures
6. To make the animals to less dangerous-debudding
7. For economic reasons-castration
8. For aesthetic purposes-removal of supernumerary teat
9. To replace the organs
10. For confirming diagnosis.

SURGICAL TERMINOLOGY

Surgeon : A person performing surgery.

Aseptic surgery : Performing an operation in an area free from septic or pyogenic organisms. This is done with sterilized hands, using sterilized instruments to avoid introduction of germs from outside into the wound.

Closed surgery : Surgery in which skin is not incised *e.g.* closed reduction of fracture or dislocation.

Conservative surgery : Surgery in which the diseased or injured part is preserved and its function restored *e.g.* Fracture repair of a limb without amputation. This avoids removal of a part.

Cosmetic surgery: Surgery performed to improve an animal's appearance and to satisfy the sentiments of the owner *e.g.* Tail docking, ear cropping (Trimming), and removal of dew claws.

CLASSIFICATION

I. Nature of Surgery

General Surgery : Is carried out to restore the normal function of the body without substituting or discarding any part of the body (Restorative surgery).

Extirpative Surgery : Involves removal of a part

Plastic Surgery : To restore the destructive part which includes reconstructive surgery (a structure is reconstructed) and cosmetic surgery (which improves appearance).

Replacement Surgery : Replacement of a diseased part either by living material or non-living material.

Exploratory Surgery : To arrive at a diagnosis or for the confirmation of a diagnosis.

Experimental surgery : Systematic investigation of a surgical problem.

Elective surgery: Surgery can be deferred without endangering the life of patient.

Emergency surgery : Surgery is to be performed immediately to save the life of patient or to avoid further complications of the disease process.

Minor surgery : Surgery which is simple to perform and having no risk to the life of patient. This includes procedures ranging from removing skin masses and suturing minor wounds to certain dental procedures.

Major surgery : Surgery which is relatively hard to perform and having risk to the life of patient.

II. Regions/Systems involved

Specialization on particular system

- Thoracic Surgery
- Cardiovascular Surgery
- Orthopaedic Surgery
- Ophthalmic Surgery
- Neurosurgery
- Urogenital Surgery

III. Instruments/appliances used

Micro surgery : Magnification facilities are used for specialized surgical procedures.

Cryosurgery : Involves controlled use of substances like liquid nitrogen that produces freezing temperatures to destroy abnormal tissues.

Electro surgery : Electricity is converted into heat to incise tissue.

Laser surgery : Laser beams are used to cut or destroy diseased tissue.

Ultrasonic surgery : High frequency waves are used to destroy particular tissue or a substance (lithotripsy).

●●●

CHAPTER

2

History and Development of Veterinary Surgery

It is very difficult to squeeze the history of veterinary surgery in a few pages. However, a veterinary surgeon should know the series of events that happened in the past and brought the profession in the present scenario. Initially, medical and veterinary sciences were interlinked. Therefore, to mark the historical perspectives of veterinary surgery, a brief appraisal of the history of veterinary and medical sciences is to be anticipated.

BRIEF SUMMARY OF DEVELOPMENT OF VETERINARY SURGERY

460-370 BC	Hippocrates (Greece) taught surgery.
284 BC	Treatise on dog written in Greece.
13th Century	Jordanus Ruffus-Chief veterinarian of Frederick II (Sicily)—regenerated veterinary art.
14th and 15th Century	Little progress.
16th Century	Veterinary schools established in Spain—Taught castration, spaying and wound repair in dogs—granted license to students for veterinary practice—but the schools didn't last long.
1566	Blundville—first to print English work on veterinary medicine with a scientific basis.
1598	Carlo Ruini—Published 'Anatomy of Horse'.
1673	Michael Harward—described handling of traumatic wound and abdominal hernia in cattle.
18th Century	Surgery considered trade—'barber surgeons' existed.
1762	Claude Bourgelat—established veterinary school at Lyons (France)—taught anatomy and diseases of domestic animals, especially horses.
19th Century	Ether discovered C.P. Long in 1942.
Development of Germ theory of disease transmission (Louis Pasteur)—1849 publication 'On the mode of Communication of Cholera' by John Snow; Aseptic techniques introduced in surgery.	

1924	Society for Prevention of Cruelty to Animals (SPCA) established.
1846	W.T.G. Morton—Public demonstration of ether anaesthesia.
1853	C.P. Jackson (U.S.A.)—Applied ether anaesthesia in veterinary practice.
1854	Dadd—First in USA to begin scientific veterinary practice, used ether regularly.
1862	Joseph Lister—Introduced theory and practice of asepsis.
1967	Pean—Popularised the use of forceps to control haemorrhage
1875	Ore-Reported IV anaesthesia using Chloral hydrate.
1878	Humbert—used chloral hydrate intravenously in horses.
1886	Von Bergmann—Introduced sterilization by boiling.
1887	Glass—Translated and revised Muhler's 'Diseases of the Dog' only definitive reference for small animal practice at that time.
1894	W.S. Halstead—Propagated maintenance of dry operative field and use of rubber gloves by surgeons—Also provided Tenets of Halstead for surgery.
1895	Roentgen—Discovered X rays.
1898 August	Bier (Germany)—Introduced true spinal anaesthesia in animals.
1900	Landsteiner—Discovery of basic blood groups.
1901	Cuile and Sendrail (France)—Induced subarachnoid anaesthesia in horses, cattle and dogs.
1897-1916	R. Eberlein (Germany)—Father of veterinary radiology—Elaborated use of X rays in veterinary practice.
1920s and 1930s	Discovery of barbiturates—General anaesthesia accepted in small animal surgery.
1907	Lane introduced plates in orthopaedics.
1912	Sherman-used bone plantes in orthopaedics.
1915	Hobday—Trumpeted the use of cocaine, chloral hudrate and chloroform as safest anaesthetic for equines.
1920	First advancement in veterinary orthopaedics—Fluoroscopy of skeleton introduced. Hazards of fluoroscopy were later notified to veterinarians.
	Sodium Phenobarbital, newly introduced long lasting anaesthetic was used to carry out reduction procedures under fluoroscopy for as long as an hour. Soon hazards became obvious; unprotected hands of veterinarian under X-ray bean developed permanent radiation skin injury. There was dehydration, irritation and severe ulceration, and even squamous cell carcinoma in some instances.

1920s	Retzgen, Benesch and Brooke—Applied technique of epidural anaesthesia in large animals.
1929	Alexander Fleming—Discovered Penicillin—development of other antibiotics followed, allowing surgeons to undertake surgery with greater success.
1931	Dibbell—Reported the use of small tongs applied to distal fragment of dog's fractured femur, with traction applied by means of cast. Overriding fractures were often corrected, but osteomyelitis developed often where tongs had been inserted.
1933	Schroeder—Adopted splints (Thomas splint) to correct fractures of humerus and femur in horses.
1935-1937	Schnelle—Reported the common occurrence of osteoarthritis in large and giant breed dogs. Hip dysplasia problem was identified in German Shepherds.
1937	Moltzen Neilson (Denmark)—Described ischemic necrosis of femoral head in small and toy breed dogs.
1940	Farquharson and Formston—Applied technique of paralumbar anaesthesia in cattle (Paralumber anaesthesia was introduced in medical sciences by Selheim in 1909).
1940	Principles of asepsis advocated in veterinary practice-courtesy.
	Archibald, Markowitz, Schroeder, Schnelle, Blakely, Leonard, Farquharson etc.
1950	Charpantier (France)—Discovered Phenothiazine derivatives general anaesthesia accepted in large animals.
1950	Jenney—described the use of Kuntschner nain in canine fractures.
1955	Succinylcholine was introduced to equine anaesthesia as a depolarizing neuromuscular blocking agent.
1957	Gorman—First total hip replacement for dogs [Total hip replacement in humans first done by Charnley in late 1950s using PMMA (polymethlmethacrylate)].
Late 1960s	Guaifenesin was introduced to equine anaesthesia as centrally acting muscle relaxant.
1960s and early 1970s	Dr. Hall and E.P. Steffey—Promoted use of halothane and other inhalant anesthetics.
1970s	Introduction and extensive use of Xylazine. Ketamine and Xylazine combination used for short procedures.
1962-1984	Otto Strader—Modified Steinmann pins to suit veterinary needs Anderson—Simplified the Strader splint.
	Ehmer and Olson—Introduced Gordon extender and handpin extender to aid in fracture reduction and stabilization.

1965	Canine Surgery by Archibald published—Promoted application of anatomy and physiology in surgery
1979 and since	Richards II Canine Total Hip Prosthesis is the most commonly used total hip prosthesis.
1980s	Recognition of hypotension and ventilation abnormalities as anaesthetic complications in equines.
Mid 1980s	Arthroscopy common in equine practice.
	Siemering—Described use of arthroscope in dogs.
	Pearson—Use of arthroscopy in the treatment of osteochondritis dissecans (OCD).
1990s	Detomidine started replacing Xylazine
	Diazepam used as adjunct to Xylazine-Ketamine anaesthesia.
	Use of Dobutamine and Ephedrine to stabilize the anaesthetic period Lidocaine and opioids increasingly used as anaesthetic adjuncts.
6000 BC	Vedas enumerated treatment of human and animal ailments Salihotra-treated horses.
	Palakapya—treated elephants
1000 BC	Atharvaveda dealt with medicine
	'Caraka Samhita' written as treatise on medicine.
	'Sushruta Samhita' is the earliest known work on surgery.
322-298 BC	Kautalya (under Chandra Gupta Maurya)—wrote Arthashastra—first organized account of livestock department and practices.
273-232 BC	Emperor Ashoka—Developed organized veterinary hospitals throughout his kingdom.
During foreign rule in India, veterinary profession nearly became extinct. Little progress during British rule.	
[illegible] 1960s	Modern veterinary surgery received a boost-courtesy veterinarians like M.N. Menon, P.D. Wilson, Ratan Singh, Solanki, S.R. Hattangadi and G.R. Singh.
[illegible]	[illegible] Surgery at Hissar.

TENETS (PRINCIPLES) OF HALSTED

William. S. Halsted (1852-1922), late of Johns Hopkins University described certain essential principles of modern surgery. These include:

- Gentle handling of tissues to avoid unnecessary trauma.
- Aseptic procedures to control infection.
- Anatomical dissection of tissues with sharp instruments. Avoid damage to major blood vessels and nerves.

- Control of haemorrhage with fine, non-irritating suture material in small quantities.
- Avoidance of dead spaces to avoid accumulation of blood and exudates which favour pus formation.
- Use of minimum suture material
- Avoidance of suture tension.
- Give rest to the operated part and to the patient (immobilization)

PREOPERATIVE CONSIDERATIONS

A surgeon must keep certain considerations in mind before undertaking surgery. Preoperative considerations may relate to the **owner, patient** and **surgeon.**

I. THE OWNER

- Owner is the custodian and provider of the animals need and therefore he/she has a legal right over his animal.
- A veterinarian is legally answerable to the owner.
- The owner must be well informed about the diseases, proposed surgical treatment and the possible outcome.
- The owner must be convinced that every thing being done is in the interest of the patient.
- Owner—patient—surgeon relationship becomes very important in veterinary profession to maintain a good rapport.
- The whole approach towards the owner should be based on the logic and sound reasoning
- In Eastern countries, the relationship may at times be more influenced by personnel and religious sentiments of the owner, the myths of taboos of the region.
- In certain instances, the owner may strictly forbid the use of a knife or other cutting instrument on the animal.
- A surgeon may be approached for surgery when it is not feasible *e.g.* multiple fracture of pelvis.
- A surgeon must also consider (*a*) economic aspects of the case (*b*) surgical risk involved (*c*) ethics and sentiments of the owner.
- Considering each aspect carefully, the surgeon should make a decision and communicate the same to the owner in a confident and convincing tone. It is the ethical and legal duty of the surgeon to inform the owner about surgical risk in advance.
- An estimate of the immediate and future costs of the surgery should also be informed to the owner.

Surgical risk

The term risk is used to describe the animal's potentiality for surviving anaesthesia and surgery. To reduce the risk to minimum is of surgeons concern and alert to problems that may arise during anaesthesia and surgery.

Classification of physical status

It reflects an attempt to define the condition of the animal and thereby surgeon becomes alert to problems which may occur during anaesthesia and surgery. Physical status may be of :

- good
- fair
- poor
- extremely poor
- emergency good
- emergency poor
- moribund condition

Factors influencing surgical risk

These include :

1. Haemorrhage and shock.
2. Fluid and electrolyte imbalances
3. Acidosis and alkalosis
4. Anaemia and hypovolaemia
5. Malnutrition and hypoproteinemia.
6. Pulmonary and cardiovascular complications.
7. Hepatic insufficiency.
8. Renal and adrenal diseases.
9. Obesity of the patient.
10. Extreme of age- complication in both very old and very young animals.

How surgical risk is determined ?

1. Detailed history of animals.
2. Physical status and condition of animal
3. Individuality
4. Clinical examination of the patient including general, systemic and special examinations.
5. Essential laboratory examination including routine examination of stool, urine and blood (clotting time, bleeding time, total count, differential lecucocytic count, haemoglobin %, packed cell volume)
6. On the basis of magnitude of operation, nature of ailment with foresaid findings, the risk of patient is evaluated.

Adjuncts and safeguards which combine to make the operation safer for the patient,

These are :

- Evaluation of operative risk.
- Recognition and correction of preoperative deficits.
- Prevention of intra-operative and postoperative complications before they develop.
- Resuscitation and after-care of surgical patients.

II. THE PATIENT : IDENTIFICATION, HISTORY, PREPARATION

(A) Identification

- Identification is important due to veterolegal cases.
- Extension of preoperative medication when owner is not available.

- To prepare operative site.
- To avoid chances of wrong animal being operated
- To avoid mixing of radiographs.

(B) History

- Information provided by the owner may prove highly beneficial since an animal cannot describe the ailment.
- A surgeon should have experience and analytical power to extract valuable information as an owner may provide misleading history.
- A simple language without technical terms should be used while extracting information.
- An approach of through questioning with tact and generation without irritating the owner may provide better results.
- Clinical signs recorded by owner, probable duration of the disease, status of pregnancy, date of last parturition and status of milk yield should be recorded.
- Information should also be gained regarding the treatment previously received by the animal and recent treatment (especially anti-inflammatory, antimicrobial and potentially nephrotoxic or hepatotoxic therapy).
- The conflicting points of history should be sorted out logically to gather reliable information.
- Even though, history provided by the owner may be useful, it is not a substitute for careful clinical examination.
- If history and clinical examination are at variance, it is better to depend upon the examination.

(C) Preparation of patient

- Make the patient an indoor one to accustom with the environment of ward.
- In ruminants, rest for couple of hours reduces the stress (travel of animal long distances on feet)
- Emergency case should be attempted immediately
- General physical examinations should be carried to assess prognosis.
  - Severe dehydration
  - Debilitation with prominent ribs

  } Indicate poor prognosis if general anaesthesia or major surgery is indicated
  - Rough and hard coat
  - Sunken eyes
  - Prolonged lateral recumbency
  - Colour of the mucous membrane
  - Capillary refilling time
- Rectal temperature, pulse and respirations should be recorded.
- Palpation, Percussion and Auscultation help to arrive at a diagnosis
- In a febrile state, surgery should be postponed
- Paracentesis of swelling and cavities for differential diagnosis
- Laboratory procedures – Pathological tests and their correction for treatment

- Radiography and ultrasonography
- Fluid therapy particularly in case of dehydrated and worm infected animals.
- With holding of feed and water
  Large Animals : 24-48 Hrs; 12-24 hrs
  Small animals : 6-12 Hrs; 4-6 hrs.
- Administration of laxative, purgative or enema for 2-3 days before operation to evacuate the bowels and fit for general anesthesia (not recommended in Ruminants).

Preparation of operation site

Day before operation

- Clipping of long hairs by scissors or by shaving the site of operation. Before shaving some soapy solution should be used.
- Washing the area by non-irritant antiseptic lotion like Savlon liquid
- Washing by plain water and rubbing gently by cotton or swab gauge
- Again washing by running water
- Evaporative type of antiseptic wash or lotion should be applied locally.
- Covering the site by sterile gauge and bandage for the next day of operation

Day of Operation

- Again wash with antiseptic lotion and shaving
- Application of alcohol
- At the time of operation, the animal should be brought to the operation table

PREPARATION OF THE SURGEON

- Surgeon dresses should be changed in preparation room.
- Infection from the nose and mouth should be prevented by using caps and musk.
- Shoes of surgical team should be changed.
- Hands upto elbow should be scrubbed for at least 5 minutes with soap and running water. Nails should be cut and scrubbed with nail brush or gauge. Hands should be immersed in cetrimide solution or rinse with surgical spirit (70% alcohol).
- While putting on gloves, the outer surface of the gloves should not touch with the hands.

(A) Surgical Judgment

Surgical judgment is something that can be developed only over a period of time, the length of time depending on the surgeon's exposure to many and varied cases. A Surgeon who continuously makes the same errors can never develop sound judgment. When examination and diagnosis favour or indicate for surgical treatment, then decision must be made about:

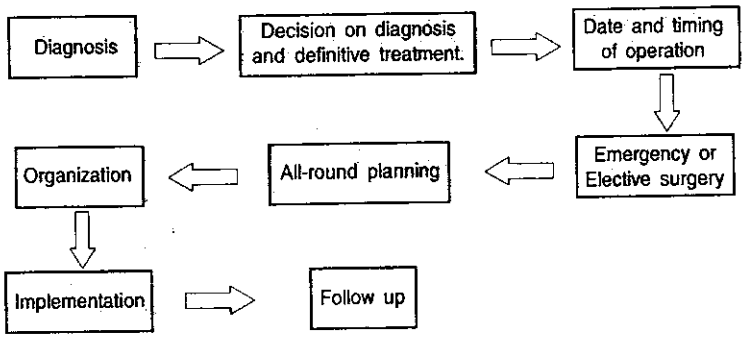
- Feasibility of performing surgery in consideration to the animal's condition.
- When to under take surgery.

Feasibility of performing surgery entirely depends of the evaluation of the patient but the proper timing of operation is more of a problem in clinical judgment than the decision as to performance. The decision must be based on the circumstances and the optimum condition of the patient for surgery. Such type of decision as to wheather and when to undertake surgery is applicable both for emergency and elective surgery.

In elective surgery, certain preoperative schedule should be carefully followed and evaluated.

- Careful recorded history
- Detailed physical examination
- Essential laboratory tests (The **absolute minimum database** for young, healthy animals includes the packed cell volume (PCV) and total plasma protein level.
- Radiographic study where necessary
- Other diagnostic test like ECG, ultrasonography, computed tomography, Doppler study, magnetic resonance imaging etc., wherever required

Emergency surgical operations are those where there is serious injury or massive internal haemorrhage which may endanger the life of the patient. In such cases, the preoperative preparation must be limited to be rare essential. It is never justified to omit the details of a careful recorded history, careful physical examination and treatment of preoperative preparation of emergency cases. Resuscitation, emptying of stomach and empting of bladder by catheterization should be considered as general rule, if necessary.



(B) Location

It is always preferable to perform surgery in an operation theater if feasibility exists where routine professional and manual help in and equally available.

(C) Planning

- A surgeon must know the structure to be incised and handled in any surgical procedure and so be thoroughly familiar with surgical anatomy.
- If doubt exists, available literature should be consulted.
- Anatomical structure should be reviewed on a cadaver (major surgery).
- The surgeon should also ensure that the equipments, instruments, drugs and other items required during an operation have been arranged properly.
- A better approach is to mentally visualize the operation to be done and make a check list of all items required.
- Necessary assistance required for restraint of the animal should be arranged.
- Getting a risk note signed from the owner even for a simple operation is essential.
- A proper planning avoids wastage of time and energy immediately, before and during surgery.

(D) Maintenance of Records

- A surgeon must keep records of each and every aspects of a case.
- The case sheets should be such that can be preserved for future reference and use.
- Description of the patient, identification marks, owners name and address, history of the case, clinical findings, type of surgical and postoperative treatment and the outcome should be recorded.
- Records can be analyzed to work out incidence of various diseases in an area and also to judge the efficacy of the treatment measures adopted.
- Records will help to identity the technical areas of difficulty

(E) Client communication

Full client communication is vital. It is crucial that the prognosis given be realistic and not optimistic. An accurate prognosis can only be given to the owner after thorough evaluation of the animal injuries.

- *Excellent prognosis*—when there is in minimal potential for complications and the animal is expected to return near normalcy after treatment of injuries.
- *Good*—when there is likely for some complications but still with these complications the animal is likely to have good function and a good quality of life.
- *Fair*—if the possibility of complications is high, recovery is likely to be prolonged and there is a chance of considerable long-term disability due to injuries and illness.
- *Poor or Guarded*—if the complication rate is high, recovery very prolonged and the chance of death or very severe disability accompanies the treatment.

POST-OPERATIVE CARE AND MANAGEMENT

1. Shifting of patient in the ward

- Immediately after major operation, the patient should be gently removed from operation table.
- Unconscious patient should be placed in the bed of surgical ward with slightly lowered down the head except in brain surgery operation cases. It prevents cerebral ischemia, vomition and helps to remove tracheobronchial secretion.

2. Post-operative medication

- According to severity of pain, analgesic drugs should be given to alleviate pain which may originate from the operation site.
- Restlessness can be controlled by application of sedative or tranquilizer.
- Routine broad or narrow spectrum antibiotic should be given.
- Antiemetics may be given to prevent vomition.
- Supportive therapy with fluid and vitamins should be resorted too.

3. Post-operative diet

- Oral intake of food and fluid is restricted for 12-24 hours after major operation.
- Liquid diet should be given at second day.
- Semisolid food should be given from fourth day.
- Solid food should be given after 8th day of operation.

Food must be free from fat and some vitamins, enzymes should be added.

4. Post-operative exercise. Exercise means walking which should be accomplished for 2-3 hours per day. The time and distance of walking depend upon the severity of operation.

5. Post-operative dressing. Dressing should be done on every 3rd, 5th and 7th post-operative days to visualize the condition of operative site. The area should be washed with antiseptic lotion and rebandaged for proper healing.

6. Release from the ward. Skin sutures should be removed between 8-10th post-operative days according to the condition. Operative site should be treated with topical antibiotics and covered by light bandages.

7. Followed by check up. The surgeon advised the attendants that the patients must be checked for a certain days.

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CHAPTER

3

Suture Materials and Techniques

HISTORICAL BACKGROUND

Ligatures came into use before sutures. Celsus recommended ligature in the protocol of control of haemorrhage. Gaten in Second Century recommended silk for sutures. Dr. Philip Physick, in 1806, made absorbable suture from kid and buck skin. Lister advocated the chromic acid impregnation of catgut so as to delay its absorption. Twine, flax, strips of cloth were used for ligation around 1890. In 1911, Cushing used silver clips in surgery. Stainless steel suture were manufactured in 1934. Synthetic sutures were introduced in 1940's.

Definition

The term suture may refer to either :

Material used to close the wound *e.g.* gut, silk, PDS, PGA etc.

Method of use *e.g.* interrupted or mattress suture

REASONS FOR SUTURING

- To approximate wound edges.
- To prevent gaping of wound edges.
- To give support to wound edges for healing
- To prevent infection.

PROPERTIES OF IDEAL SUTURE MATERIALS

Suture materials should be :

- Easy to handle
- High in tensile strength : Ability to withstand breakage on stretching it. An ideal suture material should be adequate tensile strength till healing is achieved
- Functional Strength (Tensile strength *in vivo*) : The strength that it maintains in tissue when used as suture.
- Non-capillary : Capillary action of a suture material is the capacity to absorb fluids and spread it along its length like the wick of lamp. This property enables the suture materia to absorb serum, exudates, pus etc.; hence a suture material should be non-capillary.
- Nonreactive in tissues : Should not produce chemical or biological reaction in tissues

- Absorbed/dissolved after having served its purpose
- Easy to sterilize
- High in knot security
- Economical
- Non allergic and non carcinogenic
- Readily available
- Monofilament : Better than multifilament
- Absorbability : Absorbable suture material is suitable for buried suture

"There is no ideal suture material, it does not exist"

Hence surgeon must choose a suture based on the characteristics of the suture and the wound *e.g.* where biological process reduce the strength, we may need a thicker suture material, or where we need less reaction, we may prefer PGA.

GENERAL OBSERVATIONS

- The most important consideration in suturing is not the strength of the suture material, but the holding power of the tissues to be sutured.
- The ability of the tissue to hold sutures depend upon the strength (collagen, elastic, or reticular fibril content) of the tissue, direction of suture pull and orientation of fibers, *e.g.* muscle have little holding power across its fibers and less in direction of its fibers.
- Of the soft tissues, skin and fascia have the greatest suture holding power and fat the least.
- Knotting decreases the strength of a suture strand 40% to 50%. Functional strength is equal to dry strength minus the loss resulting from knotting and wetting.
- A tied suture is about $1/3^{rd}$ stronger than the straight, unknotted strand.
- Functional strength of a suture line increases in direct proportion to the number of sutures, but only to a certain point, *i.e.* when placed approximately 0.5 cm apart.
- Co-efficient of friction closely correlates with knot security. It is highest with monofilament steel and reduces in order in gut, dacron, cotton, nylon and teflon coated materials.
- In buried sutures, the suture end should be cut close to the knot, as long ends are irritating, cause additional separation of tissues and act as foreign material.
- Knots of skin sutures should be placed on one side of the incision to avoid irritation and separation of wound edges.
- Ends of skin suture are left 1/3 cm long to facilitate removal.
- Multifilament and plain gut sutures are unsuitable for use in contaminated wounds.
- Monofilament suture material is superior to multifilament sutures.
- Steel has great strength and can remain in body indefinitely without causing tissue reaction and good for use in infected wounds.
- Interrupted sutures are superior to continuous suture pattern.
- Weakest point in a suture is at the knot
- Chemical byproducts of some materials, *e.g.* nylon, may inhibit bacterial colonization and infection.

- The diameter of suture strands has been described by USP method (15-0 thru 7), metric method (#2 suture is .2 mm) and Brown and sharp method (for wire gauge). Metric method is more rational.
- Medium chromic gut, also called Type C with tensile strength half life of 20 days is the most widely used of all suture materials.
- Suture strength is critical in the early healing period of all surgical wounds.
- Suture is a non-inert foreign body capable of inducing inflammatory response associated with edema and weakening of surgical closure. Hence suture materials that cause least tissue reaction (polypropylene and stainless steel) are desirable.

CLASSIFICATION

It can be classified as absorbable and non absorbable.

Absorbable	Non Absorbable
Catgut	Silk
Collagen	Silkworm gut
Kangaroo tendon	Cotton
Fascialata	Linen
Cargile membrane	Nylon
Poly glycolic acid (PGA)	Stainless steel
Polyglactin 910 (Vicryl)	Umbilical tape
Polydioxanone (PDS)	Vitafil
	Polyester
	Polypropylene
	Polyethylene
	Horse hair
	Aluminum wire

ABSORBABLE SUTURES

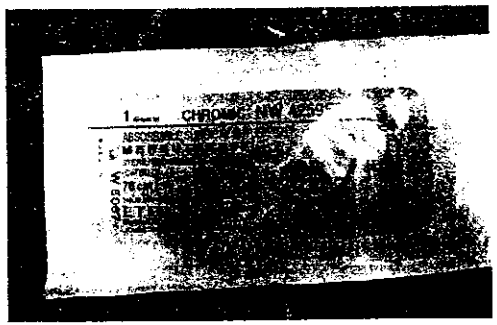
Absorbable sutures get absorbed by the tissues after a visible period of time. This is biodegraded and eliminated from the body within 60 days through phagocytosis and enzymatic action by macrophages.

NATURAL ORIGIN

Surgical Gut (catgut)

Catgut is commonly referred as "**Kitgut**" meaning cord or string on a fiddle. Catgut is comprised of formaldehyde treated fat free strips of collagen harvested from submucosa of sheep or serosal layer of cattle small intestine. Chromic catgut is prepared following chromic acid treatment which helps to lengthen and standardize absorption time and to reduce the intensity of soft tissue reaction to gut. It is a capillary multifilament suture composed of several plies that are slightly twisted, machine ground and polished to yield a relatively smooth surface and diameter that resembles a monofilament. It is sterilized by ionizing radiation because autoclaving denatures the proteins with loss of strength. After *in-vivo* application, loss of tensile strength results from :

(*a*) cleaving of molecular bonds by acid hydrolytic and collagenolytic activity and (*b*) digestion and absorption by proteolytic enzyme in later stages. Premature absorption is seen when gut is exposed to acidic secretions of stomach, infected environment, highly vascularised tissues and protein depleted patients. Increasing suture diameter has very little influence on time of absorption. Commercially it is available in pre-sterilized aluminum foils containing 85% ethyl alcohol. Surgical gut is classified by the degree of chromicization.



Chromic catgut

Four types of gut are available :

Type A—Plain-absorbed in 3-7 days

Type B—Mild chromic-absorbed within 10 days

Type C—Medium chromic-absorbed within 20 days

Type D—Extra chromic-absorbed within 40 days

Rate of loss of strength for B, C, and D type of chromic catgut are 10, 20 and 40 days respectively. Medium chromic, most common in use, loses 88% of its original strength after 7 days and about 67% after 28 days. Advantages of gut are its elasticity, knot security, usage in presence of infection and absorbability. The main disadvantages are its inflammatory response, variable rate of loss of tensile strength, its capillarity and occasional sensitivity reaction.

Catgut is available in different thickness as follows :

Size No.	Diameter	
7/0	0.04	
6/0	0.08	
5/0	0.14	
4/0	0.20	
3/0	0.25	
2/0	0.30	peritoneum, bowel (SA), ligating vessels
1/0	0.40	
1	0.48	Muscles, fascia (SA) ligating large vessels
2	0.50	
3	0.60	
4	0.70	
5	0.80	Rumen, abdomen
6	0.90	
7	1.02	

Collagen

- Sutures are prepared from bovine flexor tendon as homogeneous extrusion of collagen fibers.
- Fibers are treated with formaldehyde or chromium salts or both.
- At present, only five sizes (fine type) for ophthalmic use are being manufactured.
- Incites less tissue reaction than catgut
- Absorption is similar

Miscellaneous

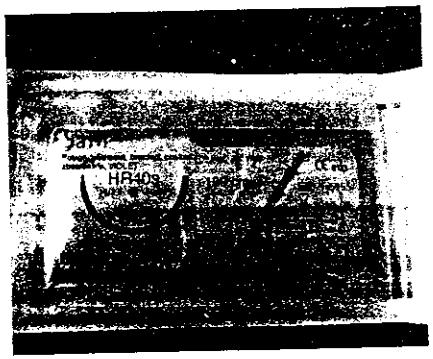
Kangaroo tendon, fascia lata, and dura are other absorbable sutures which are not commonly used in practice.

Synthetic origin

Suture materials were designed to have a standardized absorption and predictable loss of tensile strength.

Polyglycolic Acid (PGA)

- PGA (Dexon) is a braided suture made from fine filamentous threads extracted from Hydroxyacetic acid.
- It is strong, pliable and causes little tissue reaction.
- Has a consistent rate of hydrolysis and hence predictable loss of tensile strength.
- Absorption is minimal until 14 days with complete absorption at 100-120 days.
- Hydrolysis of PGA is quicker in alkaline environment, with complete absorption on 6th day in urine and at 3 day in infected urine
- Loss of tensile strength is 33% during first 7 days and 80% within 14 days.
- PGA tends to saw through tissues and is harder to handle than gut.



Polyglycolic acid suture material

Polyglactin 910 (Vicryl)

- A braided co-polymer of glycolic and lactic acid in a ratio of 9 : 1.
- Its physical properties are same as PGA except it is more hydrophobic and resistant to hydrolysis.
- Coated suture has improved handling characteristics.
- Absorption occurs within 40-90 days.
- It is stronger than PGA at 35 days post implantation
- 50% loss of tensile strength seen at 14 days and 80% at 21 days.
- It has excellent size to strength ratio, is easy to handle, stable in contaminated wounds and elicits minimal tissue reaction.

- Its use in laparotomy of large animal and large breed of small animal is strongly advocated though its cost is an inhibiting factor in veterinary practice.

Polydioxanone (PDS)

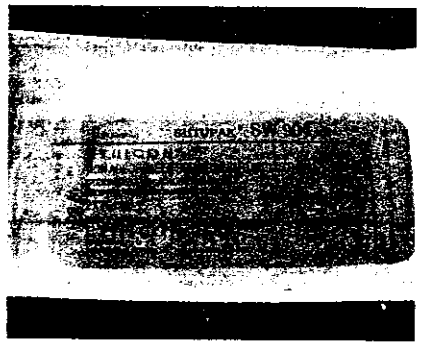
- A Polymer of paradioxanone, available is monofilament suture
- Has greater flexibility than PGA, Polyglactin 910, is extremely strong, incites minimal tissue reaction and is absorbed in a predictable manner.
- PDS retains 74%, 58%, and 41% of its breaking strength at 2, 4, 6 weeks post implantation.

NON-ABSORBABLE SUTURES OF NATURAL ORIGIN

Non absorbable material resists biodegradation and retains its tensile for more than 60 days and thereby necessitates its removal. When used in internal organs/structures, it gets encapsulated by fibrous tissue. Such material is required where long term immobilization of tissue is necessary. When tissues apposed are subjected to movements and heel slowly e.g. tendon, ligaments, house suture material may be proposed from natural fibers, metals, braiding and synthetic polymers.

Silk

- Obtained as silk fibers from silk worm cocoon. Fibers are cleaned of waxes and gums, twisted or braided and dyed black.
- It is coated with wax, silicone, olive oil to reduce its capillary action.
- Silk is used as a standard to compare the handling of other suture materials.
- Silk, a foreign protein, is degraded over time and loosen half of its tensile strength by 1 year.
- It is easy to handle, with low knot security but high inflammatory response.
- Can be sterilized by boiling or autoclave.



Monofilament silk

- May not be used to close mucosal layer of hollow viscera or contaminated wounds.

Non-absorbable synthetic sutures

Polyamide (nylon)

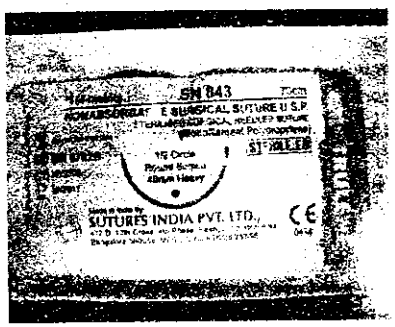
- A synthetic amine-containing plastic polymer, available as mono or multifilament suture.
- Monofilament is relatively stiff and low knot security.
- Tensile strength half life is 6 months when it degenerates into amide by products which are potent antibacterial.
- Can be used in contaminated areas, however not in serous or synovial cavity because ends may cause frictional irritation.



Nylon thread

Polyolefins (polypropylene and polyethylene)

- Polypropylenes (prolene) suture is a monofilament polymer of propylene, a derivative of propane gas, sterilized with ethylene oxide.
- Its material properties are very similar to nylon.
- It is not weakened by tissue enzymes and is least thrombogenic.
- Its strength, inertness, retention of strength after implantation, minimum tissue reactivity and resistance to bacterial contamination are its main advantages. The disadvantage is slippery handling.



Prolene suture material

Polyesters

- It is a braided multifilament suture, available as plain or coated with teflon, silicone or polybutylate to decrease suture drag.
- It maintains its high tensile strength with no loss post-implantation. Hence, is good for slow healing wounds.
- It has poor handling ability; low knot security, high tissue reactivity (equal to catgut) and high coefficient of friction-limits its use in surgery.

Caprolactum (vetafil or Supramid)

- A twisted multifilament polyamide suture with a smooth coating dispensed from spools from containers filled with chemical sterilizing solution. Not very sterile when dispense in this manner, hence not to be used for buried sutures. Ethylene oxide or heat sterilization is necessary prior to implantation in deep tissues.
- It has good tensile strength, poor knot security and variable tissue reactivity.

Metallic suture materials

Stainless steel sutures :

- Monofilament stainless steel, a 816 L (Low Carbon) iron alloy is inert, non corrosive, extremely strong and will not support infection.
- Multifilament steel is easier to handle but is more easily broken if kicked.
- Knots should be tied not twisted, and cut close to the knot to prevent tissue irritation
- It is sold in R and S gauge 40 (smallest) to 10 (Largest) or in USP sizes 10-0 to 7.
- Used to hold slow healing tissues.

Metal clips/Staples/Staplers : Currently used for providing haemostasis, approximate wound edges, anastomosis, ligation etc.

Suture size and suture material selection

Tissue	Type of suture materials	Small animal	Large animal
Skin	Monofilament nylon or polypropylene	0 to 2/0	3 to 1
Subcutis	Synthetic absorbable (PGA, RDS, Polyglactin 910)	0 to 3/0	2 or 1
Fascia	PDS, Nylon, polypropylene	0 to 3/0	0-2/0
Skeletal muscle	Absorbable suture materials	0 to 3/0	3 to1
Tendon	Synthetic non absorbable	0 to 3/0	1 or 0
Ligature	Absorbable suture	2/0-4/0	0-2/0
Castro Intestinal Tract	Catgut Nylon, PDS, Prolene	3/0-4/0	0, 2/0
Urinary Tract	Catgut	2/0-4/0	0-2/0
Uterus	Catgut	3/0-4/0	0, No.1

Suture needles

- Most often suture is made available in sterile single pack with or without needle. The needles when present are swedged on to the thread and are of either cutting or non cutting (taper) type.
- Needles are made out of stainless steel and have varying configuration with straight half curved or varying parts of a circle (1/2 or 3/8 of a circle etc).
- Taper point needles are around in shape with no edge and are used in parenchymatous organs, fat, muscles etc.
- Cutting point needles have an edge to penetrate dense tissues. They are available in conventional cutting (cutting edge on concave side), reverse cutting (cutting edge on convex side) and taper cutting (cutting point and round shaft)

Tissue adhesives

- Most commonly used are cyanoacrylates which take 2 to 60 seconds to set.
- Clinical uses include oral surgery, intestinal anastomosis, corneal ulceration, control of haemorrhage from cut surfaces and skin grafting by using Iso-butyle, Hyoctyle, and fluoro-analogues.
- Problem includes tissue toxicity, granuloma formation, severe wound infections, delayed healing and poor adhesions.

CHAPTER

4

Suture Techniques and Surgical Knots

Contributed by Dr. Prasenjit Mukherjee & Subhasis Roy

The suture patterns are mainly divided into two categories: Interrupted sutures and Continuous sutures. Other types of suture pattern include relaxation sutures, tendon sutures, bone sutures and miscellaneous sutures.

1. Simple Interrupted

Simple; interrupted; appositional. Suture pattern passes through a single point on either side of the incision. Each suture tied separately. For skin—bite is placed 2-3 mm from skin edge; sutures placed 5 mm apart. Surgeon works R to L (right handed).

2. Horizontal Mattress

Mattress; interrupted; everting. Begins with a simple interrupted suture → needle is then placed in the 2nd side and passed back across incision. Suture is tied on original side of incision.

3. Vertical Mattress

Mattress; interrupted; everting. Begins either with a superficial (or deep) simple interrupted suture across incision needle is then placed through the 2nd side & passed back across the incision deep (or superficial) to the 1st bite.

4. Cruciate/X-mattress Suture

Mattress; interrupted; everting. First bite is a simple interrupted suture → needle is then brought to the original side and passed through a second time in the same direction → then the ends are tied creating a cross.

5. Gambee Suture

It starts from serosa of one edge to the serosa of other edge. Sutures prick serosa, then mucous membrane close to edge and come out through mascularis. Then it penetrates through corresponding mascularis of other edge and finally comes out through serosa. Then the two ends are tightened and knot is placed.

6. Connell

Continuous; inverting (mattress). Begin suture beyond incision (gets a good seal at the beginning) → can start as single inverting vertical mattress or a "reverse box" → suture pattern progresses down incision → bites are taken parallel to incision → passing into lumen & back out again → slight overlapping of bites on either side of incision → suture crossed the incision perpendicularly as placing bites but once inverted, should not see suture passing across the incision - suture line goes beyond incision before closure, making sure get good seal at the end of incision- tied by creating a loop from last bite.

(Continuous everting mattress suture: Similar to Connell with the difference that the exposed threads are parallel to the line of incision).

7. Cushing

Similar to Connell suture being the difference is that it does not penetrate the mucous coat and enter the lumen unlike Cushing suture.

(Guard's Suture/Modified Cushing Suture : Similar to Cushing's bur is extended beyond the two commissars of sutures imaging an extended line of incision).

8. Lembert

Continuous; inverting (mattress). Bites are taken perpendicular to incision; taking 2 bites one each side of incision → suture can be tied or used in a continuous pattern → bring the needle back to the 1st side & place the 2nd bites in the same direction as the 1st-the continuous pattern is tied slightly beyond the incision, creating a loop from the last suture

9. Ford Interlocking

Simple; continuous; appositional. Suture begins with simple interrupted → then is essentially a simple continuous suture; however, suture engages a loop of one side of the incision. Suture is ended by passing the needle in the reverse direction for the last bite & tying the long end of the suture to the loop created by this bite.

10. Simple continuous suture

Simple; continuous; appositional. Continuous version of simple interrupted

Suture passes through a single point → perpendicular across incision → then brought back to the first side and the bites start again. Suture end by tying the suture end (long end) to a loop created with the last suture.

11. Parker-Kerr Suture

First passed around the forceps holding the stump forceps is withdrawn suture is tightened and tied.

12. Schmieden's Suture

Suture which comes out through the serous surface of one edge during the closure of placement goes over to the mucous membrane of the other edge and comes out through the serous surface of that edge.

13. Continuous Subcuticular/Sub Epidermal Suture

Bites are taken in the inner layer of the skin (Subcuticular space). If the sutures are not to be removed, absorbable suture materials are used and the beginning and ending knots are buried.

14. Shoe-makers stitch/ Cobbler's stitch

(*a*) Using two needles threaded by a single thread at both the end.

(*b*) Using Shoe-makers needle or Cobbler's needle.

The suture on either side seen from outside, in the completed stage, is parallel to the line of incision

15. Far-Near and Near-Far suture

The sutures enter the tissues first far away from edge and emerge through near end on the opposite side and again reverse back through near side and finally come out far away from the wound edges and finally tied.

(Far-Far and Near-Near suture : The name indicates the course of passage of the suture thread the two edges of the wound successively).

16. Figure of eight

Suture starts from one skin edge → muscular and parietal peritoneal edge of opposite side → corresponding peritoneo-mascular edge of opposite side penetrating from within outward → crosses over diagonally to opposite skin edge and comes out → ends are knotted.

Pattern	Uses	Miscellaneous
	INTERRUPTED SUTURE	
Simple Interrupted	• Skin • SC tissue • Abdominal wall closure • Organ closure (urinary bladder; intestine)	• Maintains suture line even if one fails. • Grossly appears as a single line perpendicular across the incision. • Sutures should be placed 2-3 mm apart from line of incision with 0.6 cm in-between distance.
Horizontal Matterss/ 'U' Suture	Relief of moderate tension in the skin, muscle, fascia, tendon.	• Suture incorporates a portion of tissue in the horizontal plane either side of incision. • Grossly, suture crosses the incision externally; the suture appears as parallel • Advantage of speed; less knots over simpler interrupted. • Disadvantage of causing some eversion.
Vertical mattress	Moderate tension relief for skin, fascia, muscle.	• Incorporates a portion of tissue in the vertical plane either side of the incision. • Causes eversion of tissue but can achieve apposition with superficial bite (and relief of tension with deep bite) → works best if place deep suture first. • Grossly appears as 2 lines perpendicular to incision; opposite each other in the vertical plane.

Cruciate/X-mattress Suture	Relief of minimal tension in skin, fascia, muscle	• Provides some tension relief. • Advantage of fewer knots than simple interrupted; but still advantage of security of an interrupted suture line. • May cause slight eversion of tissue. • Minimize eversion by correct placement of bite.
Interrupted inverted mattress Suture	Hollow organ	• It should not pierce mucous coat, but through muscular coat. • Exposed portion is seen across the line of incision and concealed portion runs parallel to line if incision.
Gambee Suture/ Crushing suture	Intestinal anastomosis suture Continuous sutures	• Slight eversion of mucous edge occurs. • Where lumen of bowel to be united is small, this technique is used
CONTINUOUS SUTURE		
Cushing/Connell		Cushing suture does not penetrate lumen Connell does penetrate lumen
Guard's Suture/ Modified Cushing Suture	Indicated for closing viscera	Better efficiency in preventing the leakage of contents.
Lembert	Indicated for closure of viscera	• Suture will be visible across the incision after the tissue is inverted, crossing the incision in a diagonal pattern • Interrupted "mattress" version of Lembert known as Halstead
Ford Interlocking/ continuous lock stitch/Blanket stitch/Reverdin's continuous suture	Skin closure (long, linear incisions)	• Blanket stitch appearance • Engagement of the loop provides moderate tension relief; also makes suture more difficult to unravel than simple cutaneous • Neater appearance than simple continuous
Simple Continuous	Closure of Skin, SC tissue, abdominal wall, organ	• Suture will cross the incision diagonally. • Skin (not very esthetic; disadvantages—easily removed, caught). • Organ closure (Not the strongest for this vascular compromise).
Parker-Kerr Suture	Closure of Stump	Also be used as temporary suture without knots in intestinal anastomosis.

Schmieden's Suture	Intestine	• Always be covered with a continuous Lembert or Cushing Suture. • Suture partially enters the lumen. • Placement is quick
Continuous Subcuticular/Sub Epidermal Suture	Subcuticular	• Opposing surfaces comes in good apposition. • No need of suture removal. • Suture is not exposed.
Shoe-makers stitch/Cobbler's stitch	• Causes eversion of the wound edges. • Degree of eversion is adjusted by degree of tightening and by the distance from line of incision.	
TENSION/RELAXATION SUTURES		
Quill Suture and stent suture	Skin closure (to relieve tension on wound edges)	• Vertical mattress suture • A piece of quill or gauze is incorporated on either side.
Far-Near and Near-Far suture Far-Far and Near-Near suture	Skin closure	Suture goes very deep into the tissues besides the skin.
BONE SUTURES		
Circlage	Broken fragments of a bone fracture with stainless	Disadvantage is possibilities of bone necrosis
Hemi-Circlage	Steel wire	• Ensues less pressure on periosteum. • One or two holes are drilled into each opposing fragment and suture is passed through and tied.
TENDON SUTURE		
• Suture cutting through the tendon should be prevented. • Two cut ends should appose each other without much tension. • The cutting through of suture through tendon is prevented by 'weaving' the suture through each piece for a variable distance or by passing it through the thickness in one or more "cross-wise" type.		
MISCELLANEOUS SUTURE		
Figure of eight	To close laparotomy wound in large animals	• Single figure of eight suture has outside appearance of simple interrupted suture. • Double figure of eight suture has outside appearance of horizontal mattress suture.

Retension Suture	Retaining gauze packing inside a wound cavity	
Staple type Suture	One edge is placed over the other and sutured	
Overlapping/ Sliding Suture	Closing hernial ring	One edge overlaps the other

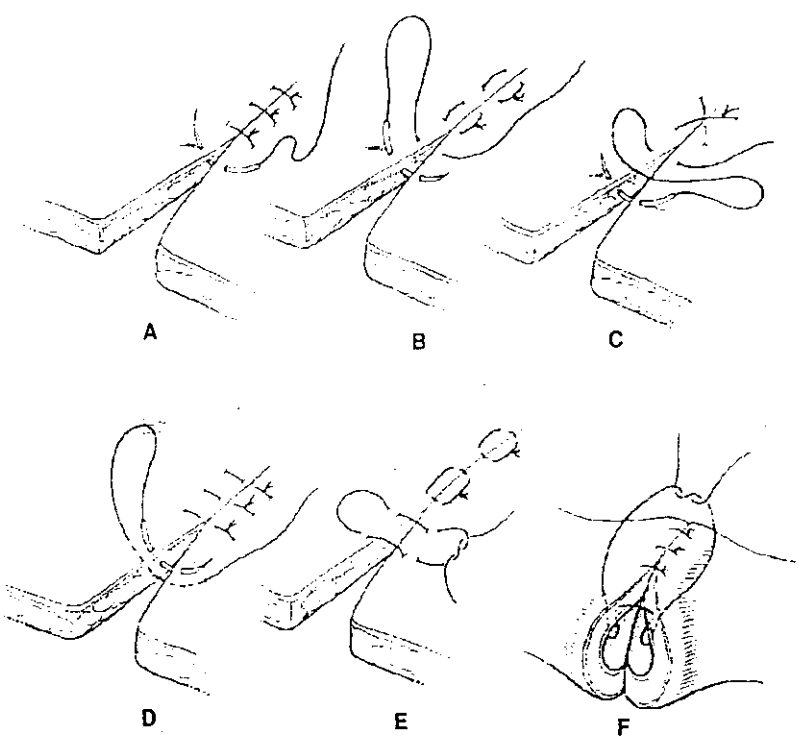
SURGICAL KNOTS

An important part of good suturing technique is correct method in knot tying. A seesaw motion, or the sawing of one strand down over another until the knot is formed, may materially weaken sutures to the point that they may break when the second throw is made or, even worse, in the postoperative period when the suture is further weakened by increased tension or motion.

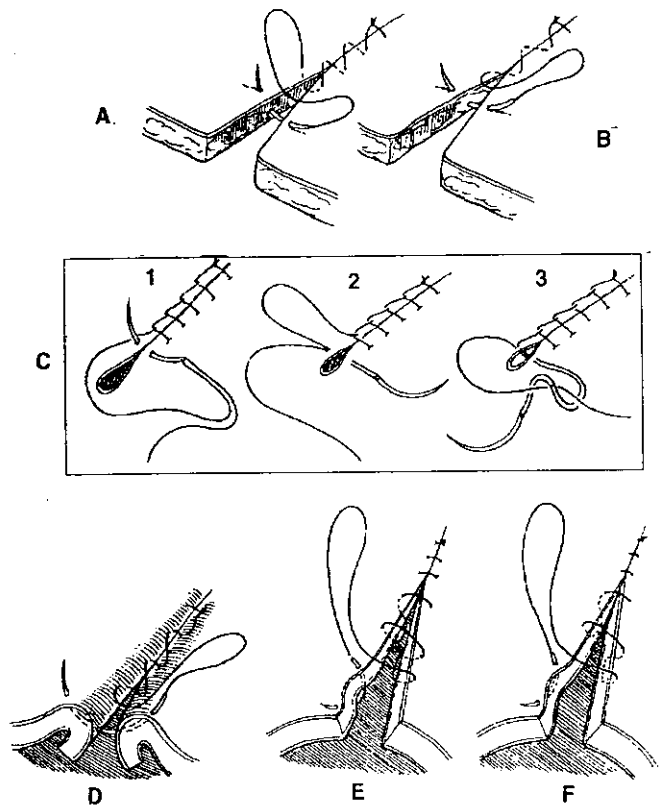
General principles of knot tying

Certain general principles govern the tying of all knots and apply to all suture materials.

- The completed knot must be firm, and so tied that slipping is virtually impossible. The simplest knot for the material is the most desirable.



Interrupted suture patterns. A: Simple interrupted. B: Horizontal mattress. C: Cruciate. D: Vertical mattress. E: Halsted. F: Gambee



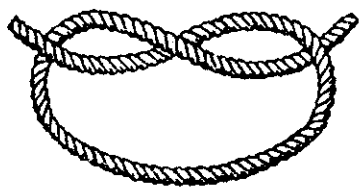
Continuous suture patterns A: Simple continuous. B: Running. C: Ford interlocking (C2 and C3 illustrate how to end the suture line). D: Lembert. E: Connell. F: Cushing.

- The knot must be as small as possible to prevent an excessive amount of tissue reaction when absorbable sutures are used, or to minimize foreign body reaction to nonabsorbable sutures. Ends should be cut as short as possible.
- In tying any knot, friction between strands ("sawing") must be avoided as this can weaken the integrity of the suture.
- Care should be taken to avoid damage to the suture material when handling. Avoid the crushing or crimping application of surgical instruments, such as needle holders and forceps, to the strand except when grasping the free end of the suture during an instrument tie.
- Excessive tension applied by the surgeon will cause breaking of the suture and may cut tissue. Practice in avoiding excessive tension leads to successful use of finer gauge materials.
- Sutures used for approximation should not be tied too tightly, because this may contribute to tissue strangulation.

- After the first loop is tied, it is necessary to maintain traction on one end of the strand to avoid loosening of the throw if being tied under any tension.
- Final tension on final throw should be as nearly horizontal as possible.
- The surgeon should not hesitate to change stance or position in relation to the patient in order to place a knot securely and flat.
- Extra ties do not add to the strength of a properly tied knot. They only contribute to its bulk. With some synthetic materials, knot security requires the standard surgical technique of flat and square ties with additional throws if indicated by surgical circumstance and the experience of the surgeon.

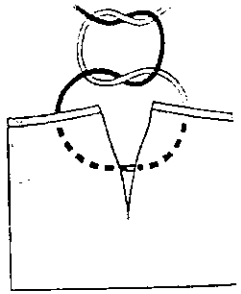
Different knots used in either restraint or surgical operations are:

- **Overhand knot.** This is a simple knot where at first a loop is made, and then one end of the thread is brought under and through the loop. Finally two ends are pulled to tighten. But it has the disadvantage that it is likely to jam tight when the rope has been pulled and the knot may need to be cut off.

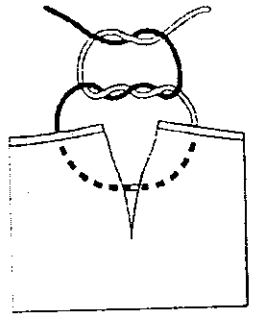


Overhand

- **Square knot.** This is an ideal knot and made with the helps of two hands. At first an "X" is made with the rope or thread ends, keeping the right end on top. Then, an overhand knot is tied, twisting the right end around the left end. With the "new" right and left, the left over the right is put and another overhand knot is tied and pulled tightly. The knot should look very neat-like a square-essentially looking like a loop stuck in another loop.

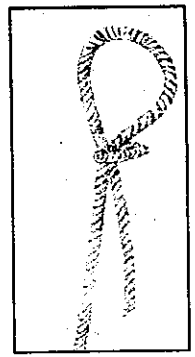


Square

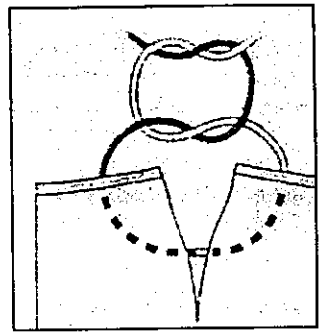


Surgeon's knot

- **Surgeon's knot.** It is same as a square with some modifications and used mostly in surgery. Here the end of one rope is crossed over and around the end of the other rope and another turn of the end is taken around the standing part and again the end is crossed on the right over and around the left and finally pulled to tighten.
- **Slip knot.** A slip knot, also called a running knot, is a broad classification of knots that basically refers to any knot that can "slip" along the rope, and/or can be untied by simply pulling one of the ends. First a length of rope is hold out in front and twisted to form



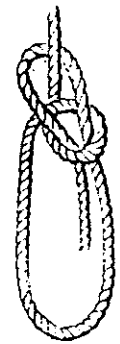
Slip knot



Granny knot

a loop. Reaching through the loop, grasping the hanging right end by the middle it is pulled through the loop, being careful not to let the end come through.

- **Granny knot.** The granny knot is a binding knot, used to secure a rope or line around an object. It is considered inferior to the square knot as it slips under strain, which it superficially resembles. At first the end of the left rope is crossed over and around the end of the right rope, similarly as square knot. Now the "new" left rope is crossed over and then around new right rope and secured tightly.
- **Bowline knot.** At first a small loop is made, with plenty of length remaining to the right of it then the end of the rope is brought up through the loop. Now the end down underneath the main line is brought, to the left of the initial loop and pulled the end to tighten.



Bowline knot

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CHAPTER

5

Asepsis-Antisepsis and Sterilization

COMMON TERMINOLOGIES

Asepsis : being free of disease-producing microorganisms. (A-absence Sepsis-infection)

Contaminated : dirty, unclean, soiled with germs.

Disinfection : the process of destroying most, but not all, pathogenic organisms.

Medical Asepsis : the practice used to remove or destroy pathogens and to prevent their spread from one person or place to another person or place, clean technique.

Microorganism : a living body so small that can only be seen with the aid of a microscope.

Sterilize : to kill all microorganisms including spores.

Antisepsis : is the destruction of micro organisms but not bacterial spores on living tissue.

Antibiotic : A substance derived from mould or bacteria that inhibit the growth of other micro-organisms.

Astringent : Causes contraction of tissues and so arrests haemorrhage.

Styptic : Astringent, haemostatic agent used externally to stop flow of blood.

Haemostatic : Arresting flow of blood within a vessel.

Sterilization : Complete elimination of microbial viability including both the vegetative forms of bacteria and spores *i.e.* process by which an article can be rendered free from all forms of living microbes including bacteria, fungi and their spores and viruses.

STERILIZATION TECHNIQUES FOR SURGICAL MATERIALS AND INSTRUMENTS

Two general categories of sterilization methods can be grouped under.

1. Physical sterilization

- Thermal
- Filtration
- Radiation

2. Chemical sterilization

- Germicidal solutions like Glutraldehyde, Beta propiolactone
- Ethylene oxide

A. THERMAL

Steam sterilization is the most commonly employed method of sterilization of instruments and equipment.

Different types of autoclaves are :

- pressure steam sterilizer
- steam pressure sterilizer
- vacuum steam sterilizer
- dressing sterilizer
- gravity displacement sterilizer

Points to be considered

- Instrument packs are positioned vertically (on edge) and longitudinally in autoclave.
- A 13 minutes sterilizing cycle (exposure to saturated steam at 121°C) is a safe minimum required
- Large linen packs require 30 minutes at 121°C
- Once sterilized, sterile packs should be stored in closed cabinets. All packs should be dated.
- Sharp instruments scissors, needles; surgical instruments can be sterilized by this method.

Dry heat sterilization

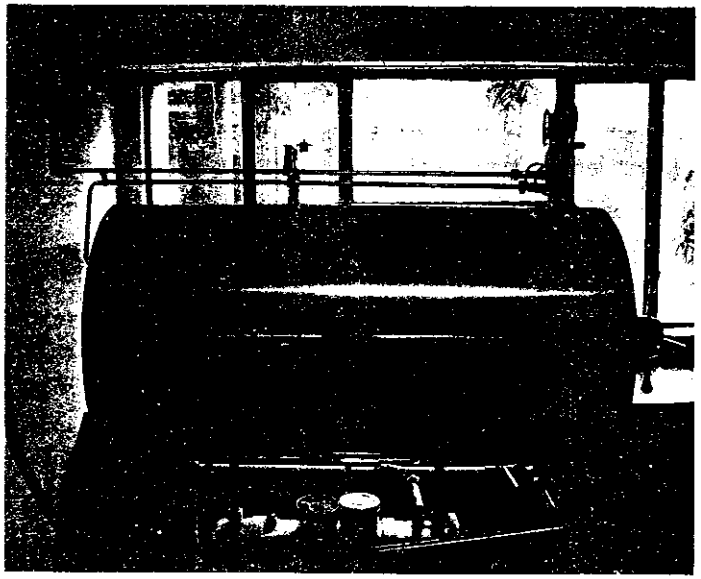
- Dry heat destroys microorganisms primarily by oxidation process.
- It is used to sterilize those materials for which moist heat cannot be used either due to deleterious effects on the material or material being impermeable to steam *e.g.* oils, powders, glass surgicals etc.
- Slow process and long exposure time at a high temperature is required as spores are relatively resistance to dry heat.

Methods

- Direct exposure of instruments to flame—not reliable.
- Hot air oven-most common method.
- An exposure to dry heat at a temperature of 160°C for 60 min. will achieve sterilization equal to that of moist heat at 121°C for 30 min, at 15 lbs pressure.

Temperature time combinations for dry heat sterilization

- 120°C for 8.0 hours
- 140°C for 2.5 hours
- 160°C for 60 minutes
- 170°C for 40 minutes
- Exposure time relates to the time after specific temperature has been achieved and don't include heating lags.
- Clean gowns, paper wrapped material, swabs, Petridis—120°C for 8 hours
- Stainless steel lens and glass ware—160°C for 60 min.



Horizontal autoclave

Filtration is used in air conditioning system to remove particles as small as 0.3 μm in diameter and also used to filter-sterilize heat labile solutions.

Radiation : Ultraviolet light is used for surface sterilization. Ionizing radiations, Beta and cathode rays are used to sterilize heat sensitive prepackaged surgical materials e.g. surgical mask-o produce two fold effects.

2. CHEMICAL AGENT

An ideal chemical agent should have following properties :

- kill all pathogenic microorganism
- work effectively in short period of time
- exert residual action
- not corrode, dry or stain
- be stable, odorless, non toxic
- be effective in presence of organic matter
- not be inactivated by other concurrently used chemicals

(a) Agents in solution form

Alcohol

- Ethyl alcohol (70%). Isopropyl alcohol (90%) are commonly used
- Presence of water easily denatures the protein.
- 70% alcohol is more germicidal than absolute alcohol.
- Isopropyl alcohol is more bacterial than ethyl alcohol
- Sterilization can be done by immensities continuously. *e.g.* Needles.

Aldehyde

Formaldehyde

- Available as formalin 37% solution of formaldehyde and water.
- Used as gas for fumigation.
- Irritant to skin and mucous membranes.
  - ♦ Oxidizing agent *e.g.* Halogens
    - – Inorganic Iodine compounds
    - – Organic Iodine compounds
  - ♦ Surfactants-**Soaps, detergents,**
  - ♦ Phenolic derivatives-carbolic acid

(b) Chemical sterilization by gases

Ethylene oxide acts by inactivating the DNA molecules in the microbial cells thus preventing cell reproduction. Temperature-120° to 140°F

1. E.g. ethylene oxide, formaldehyde and beta propiolatone (generally used)
2. Sharp edged instruments—Scalpel blades, hypodermic needles.

Commonly used disinfectants in veterinary practice

Agent	Disinfectant properties	Antiseptic properties
Alcohol: isopropyl alcohol (50%-70%), ethyl alcohol (70%)	Good	Very good
Iodine compounds : iodophors (7.5%) scrub solution	Good	Good
Chlorine compounds : hypochlorite	Good	Fair
Glutaraldehyde : 2% alkaline solution	Good	None

Commonly used antiseptics in veterinary practice

Antiseptic	Examples
Iodine/iodophors (povidone iodine [PVI])	10% PVI = Betadine
Chlorhexidine (CHG)	4% CHG = Betasept
Alcohol (isopropyl alcohol [IPA])	70% IPA
Alcohol-based solutions	2%CHG+70%IPA = ChloraPrep.

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CHAPTER

6

Inflammation, Abscess, Tumours, Cysts, Hernia etc. and their Treatment

DEFINITION

Inflammation is the complex biological response of vascular tissues to harmful stimuli, such as pathogens, damaged cells, or irritants. It is a protective attempt by the organism to remove the injurious stimuli as well as initiate the healing process for the tissue.

Importance of inflammation

The inflammatory response to tissue damage is of great value by :

- Isolating the damaged area.
- Mobilizing effector cells and molecules to the site, and—in the late stages—inflammation protects the body.
- promoting healing,

The bad side of Inflammation

Often the inflammatory response is out of proportion to the threat it is dealing with. The result can be more damage to the body than the agent itself would have produced.

Allergies and Autoimmune diseases

- All the many types of allergies and
- many of the autoimmune diseases

are examples of inflammation in response to what should have been a harmless, or at least noninfectious, agent. Example: Rheumatism, Allergy, Multiple Sclerosis (MS), Systemic Lupus Erythematosus (SLE). In many of these cases, the problem is made worse by the formation of antibodies against self antigens or persistent antigens from smoldering infections. The antibodies complex with the antigens accelerates the complement system with all its mediators of inflammation. The end result is immune complex disorders.

ETIOLOGY

Inflammation may be caused by any of the following:

- Mechanical injury due to trauma. *e.g.*: blow, sprain, kick.
- Thermal or physical damage due to exposure in excessive cold or heat.
- Chemical injury with corrosive acids and alkalis.
- Pathogenic organisms like bacteria, virus and fungi.

Inflammation due to micro-organisms is more serious due to local and systemic effects o toxin liberated by them.

Cardinal signs

Acute inflammation is characterized by the following quintet :

- Redness (rubor)
- Heat (calor)
- Swelling (tumor)
- Pain (dolor)
- Dysfunction of the tissue involved (functio laesa).

These signs are directly and indirectly attributable to the influx of blood and blood produc into the affected area.

Chronic inflammation is not characterized by the cardinal signs listed above. Instea chronically inflamed tissue is characterized by the infiltration of mononuclear immune ce (monocytes, macrophages, lymphocytes, and plasma cells), tissue destruction, and attempts healing, which include angiogenesis and fibrosis.

PATHO-PHYSIOLOGY OF INFLAMMATION

Inflammation has two main phases *i.e.* **cellular** and **exudative**.

The **cellular component** involves the movement of white blood cells from blood vess into the inflamed tissue. The white blood cells, or leukocytes, play an important role inflammation; they extravasate from the capillaries into tissue, and act as phagocytes, picking bacteria, cellular debris and they may also aid by walling off an infection and preventing spread.

The **exudative component** involves the movement of fluid, usually containing many impor proteins such as fibrin and immunoglobulins (antibodies). Blood vessels are dilated upstrean an infection (causing redness and heat) and constricted downstream while capillary permeab to the affected tissue is increased, resulting in a net loss of blood plasma into the tissue, gi rise to edema or swelling. The swelling distends the tissues, compresses nerve endings, and leads to pain.

If inflammation of the affected site persists, released cytokines IL-1 and TNF will act endothelial cells to upregulate receptors VCAM-1, ICAM-1, E-selectin, and L-selectin for va immune cells. Receptor upregulation increases extravasation of neutrophils, monocytes, activ T-helper and T-cytotoxic, and memory T and B cells to the infected site.

Neutrophils are characteristic of inflammation in the early stages. They are the first to appear in an infected area, and any section of recently inflamed (within a couple of da

so) tissue. They perform many important functions, including phagocytosis and the release of extracellular chemical messengers. Neutrophils only live for a couple of days in these interstitial areas, so if the inflammation persists for a longer duration, then they are gradually replaced by longer lived monocytes.

Various leukocytes are involved in the initiation and maintenance of inflammation. Acute inflammation is mediated by granulocytes or polymorphonuclear leukocytes, while chronic inflammation is mediated by mononuclear cells such as monocytes and macrophages. These cells can be further stimulated to maintain inflammation through the action of an adaptive cascade involving lymphocytes: T cells, B cells, and antibodies. These inflammatory cells are: Mast cells which release histamine and prostaglandin in response to activation of stretch receptors. This is especially important in cases of trauma. Macrophages which release TNF-γ, IL-1 in response to activation of toll-like receptors.

TERMINATION OF INFLAMMATION

The outcome in a particular circumstance will be determined by the tissue in which the injury has occurred and the injurious agent that is causing it.

There are five possible results to inflammation:

- **Delitescence :** Inflammation subsides suddenly when the reaction is slight
- **Resolution :** the complete reconstitution of damaged tissue and the affected part assumes normal function.
- **Connective tissue scarring :** Often healing can not occur completely and a scar will form; for example after laceration to the skin, a connective tissue scar results which does not contain any specialized structures such as hair or sweat glands.
- **Abscess formation** is found primarily in infections by pyogenic organisms.
- **Chronic inflammation :** If the injurious agent continues, chronic inflammation will ensue. This process is marked by inflammation lasting many days, months or even years, may lead to the formation of a chronic wound.

CLASSIFICATION OF INFLAMMATION

Inflammation can be broadly classified as **acute or chronic.**

- **Acute inflammation** is a short term process which results in the classic signs of inflammation due to the infiltration of the tissues by plasma and leukocytes. It occurs as long as the injurious stimuli is present and ceases once the stimuli has been removed, broken down, or walled off by scarring (fibrosis).
- **Chronic inflammation** is a pathological condition characterized by concurrent active inflammation, tissue destruction, and attempts at repair.

The two types of inflammation demonstrate the double-edged nature inherent to the process. Removal of harmful stimuli often involves the production of compounds toxic to the body, and the resultant scarring permanently impairs the original function of the tissue. If left unchecked, a chronic state of inflammation leads to the pathological cycle of destruction and healing by the tissue.

Treatment of Inflammation

1. Acute
2. Sub-acute and chronic.

1. Acute Inflammation is treated on the following lines :

- Remove the cause of inflammation, if possible.
- **Cold and astringent** application at 15°C (60°F) which reduces inflammatory exudation. Cold constricts blood vessels and reduces the blood flow to the area. e.g.: cold compresses, cold water irrigation, cold bath or ice.
- **Warm applications** at 40° to 45° C (104° to 112°F) are mainly used in severe inflammation in which the tissues are likely to undergo gangrenous changes. Warmth promotes circulation; restore blood supply to tissues, prevents gangrene and ultimately resulting relief of tension and pain. *e.g.*: warm water compresses, fomentation, warm water heated sand or bran or salt.
- **Anodyne applications** containing cocainized vaseline are very useful for superficial, painful lesions.
- **Scarification** with strict aseptic precautions is done for severe inflammatory congestion to relieve tension and pain.
- **Septic inflammatory** lesions of foot need antiseptic foot bath. It is given for 30 minutes at a time, and about 2 to 3 times in a day.
- **Massage** for 5 to 10 minutes at a time allows absorption of exudates due to fluid dispersion and reduces pain.
- **Compression** of inflamed parts with bandage following cotton padding produces slight pressure and helps in absorption of exudates by supporting the circulation.

2. Treatment of sub-acute and chronic inflammation

- Application of moist heat.
- Massage and compression, as described earlier.
- **Counter Irritation :** A counter irritant will convert chronic inflammation into acute one which in turn may result in resolution of inflammation. Counter irritation is produced by
  - (*a*) **Rubefacients :** indicated in slight sub-acute inflammation. e.g.: Liniment terebenthinae, liniment saponis and liniment ammoniated camphorae.
  - (*b*) **Blisters:** used in chronic inflammation. *e.g.*: Vaseline or bland oil.
  - (*c*) Application of Pustulents, firing, cauterization or actual cautery.

3. Nonsteroidal anti-inflammatory Drugs (NSAIDs) help in reducing the fever and pain of inflammation.

4. Recombinant DNA and monoclonal antibody technology have produced some new therapies that are being enlisted in the battle against damaging inflammation. e.g.: recombinant **protein C** and infliximab (Remicade®).

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CHAPTER 7

Abscess

Abscesses are circumscribed collections of purulent material (pus) found in several species of animals in a variety of locations. This purulent inflammation is usually caused by one of four pyogenic (pus producing) bacteria: *Corynebacterium, Pseudomonas, Streptococcus* and *Staphylococcus.*

Parts of an Abscess

Abscess consists of a wall, pyogenic membrane and pus (Liquor puris). The pyogenic membrane that lies between the wall and pus, controls spread of infection, and helps in phagocytosis and granulation tissue formation.

Contents of pus and its character

Pus contains necrosed tissue, dead bacteria, leukocytes and proteins of blood and tissues. Pus cells mainly consist of polymorphonuclear leukocytes along with a few mononuclear cells. Pus is alkaline in nature and yellow in colour. Pus serum will not clot, since the fibrin of exudates is digested by the proteolytic enzymes of the leukocytes.

Classification of abscess

Abscess may be classified as:

1. **Acute Abscess**: (Hot abscess): Inflammatory symptoms are more active.
2. **Chronic Abscess** (Cold abscess): Inflammatory symptoms are less active.

Chronic abscess may be:

(*a*) Hard with inspissated pus

(*b*) Soft with liquid pus and thin abscess wall.

3. **Superficial or deep abscess :** Depending on location, (superficially and deep- seated)

Etiology of Abscess

1. Pyogenic organisms like *Staphylococci, Streptococci, Escherichia coli* and *Pseudomonas aeruginosa.*
2. Specific organisms like *Corynebacterium pyogenes, Actinomyces bovis* etc.
3. Chemicals like mercuric chloride, Zinc chloride.

Common seats of abscess formation

Cattle : Yoke, udder and prominences.

Horses : Shoulders, sub-maxillary and post pharyngeal lymph nodes.

Dogs : Anal region, and mammary glands.

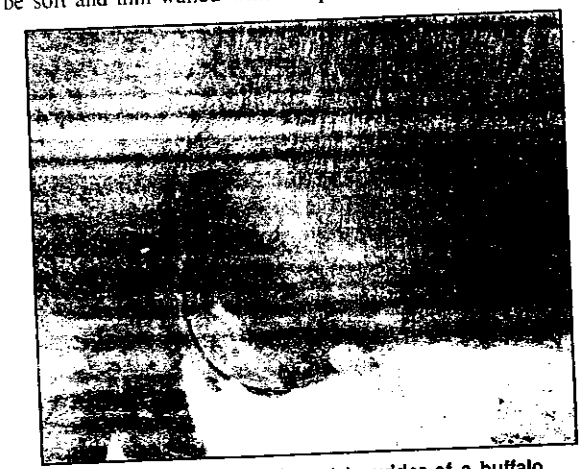
Acute abscess

Acute abscess forms in 3 to 5 days following infection. In long duration abscess, the liquid part is absorbed and the solid part is left. This is called inspissated pus.

Symptoms

Acute superficial abscess appears as a local painful swelling. The dead tissues and dead inflammatory cells are continuously thrown into the cavity which leads to a gradual increase in the amount of pus. Thus the abscess enlarges till it reaches the surface of skin or mucous membrane. The center of abscess becomes soft (pointing) and later ruptures, discharging pus. Local acute inflammatory symptoms without fever are observed in superficial abscess. Deep abscess has no local symptoms, but fever and pain on manipulation of the part are evident.

Chronic Abscess (Cold Abscess) : A chronic abscess develops slowly without any inflammatory symptoms. It may be painless or slightly painful. Primary chronic abscess usually occurs from repeated injuries and observed on the prominences of limbs and ribs due to bed sores. Secondary chronic abscess develops in the course of various local affections. Chronic abscess may be hard in consistency surrounded by fibrous tissue and containing small amount of pus or it may be soft and thin walled with comparatively larger amount of pus.



Large size abscess adjacent to udder of a buffalo

DIFFERENTIAL DIAGNOSIS

An abscess must be differentiated from the following conditions:

Cyst

- Slow in development as compared to an abscess.
- Soft and fluctuates uniformly, but not hard at periphery.

- No inflammatory symptoms.
- No pain sensation.

Haematoma

- Forms due to coagulation of blood or serum caused by rupture of blood vessels.
- Doughy on palpation and forms immediately following an injury.
- Does not point like an abscess.
- No pain sensation.

Hernia

- History of recent injury and swelling.
- Hernial ring can be palpated.

Tumour

- Uniformly hard in consistency.
- Exploratory puncture with needle may reveal blood.
- No pain sensation.
- Does not point like an abscess.

TREATMENT

Treatment should correspond to the stage of development of an abscess. In time, abscesses may become inactive or enclosed (sterile); the body defenses having killed all of the causative bacteria. The accumulated pus, with no route of escape, will slowly become liquefied and be absorbed.

- Measures to accelerate maturation of abscess by using liniments, fomentations and mild blisters.
- Once mature, abscess must be early cleared up of pus by aspiration and subsequent washing of the purulent cavity.
- The abscess should be opened by syme's abscess knife or a scalpel at the place of pointing. The pus should be drained and the cavity is to be irrigated with a mild antiseptic lotion. In cases where the pointing of abscess is not at a dependent part, then drainage will not be perfect. A counter opening is made at the most ventral part (**dependent part**) of the abscess.
- Tincture of Iodine soaked gauge is be packed to keep the openings patent. This should be changed once in 24 hours. The quantity of gauze used to pack the abscess cavity has to be reduced daily as the cavity is being filled up by granulation tissue. Gauze soaked with 0.5% silver nitrate is best against most of the micro-organisms.
- Further therapy is the same as that of a granulating wound.
- A chronic abscess is converted into an acute abscess by applying blisters, and then treated as acute abscess. Sometimes, the chronic abscess is enucleated under local infiltration analgesia, and the skin is sutured.

Cellulitis or Phlegmon is diffuse, suppurative spreading inflammation of loose connective tissue, with predominance of necrotic events over suppurative.

Pustule is a circumscribed cavity with pus, situated in epidermis.

Furuncle or Boil is suppurative inflammation of hair follicle or a sebaceous gland due to *Staphylococcus aureus*. A group of furuncles is called Furunculosis.

Carbuncle is small boil, which drains to outside by multiple small openings. It is caused by *Streptococci* and *Staphylococci*.

Acne is an abscess of sebaceous gland. It appears as single or multiple pustules containing grayish white pus. Antiseptic ointments externally and systemic penicillin gives good relief.

Empyema is collection of pus in a body cavity. *e.g.* Empyema of frontal sinus, empyema of joint.

Antibioma is a clinical condition resulting from improper treatment of an abscess.

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CHAPTER

8

Tumours (Neoplasm)

The term neoplasm is a Greek word used primarily for new formations or new growths.

Tumour may be defined as "an abnormal mass of tissue, the growth of which extends uncontrolled, in comparison to the normal tissue and persists in the same excess even after cessation of the stimuli which evoked the change."

Types of tumour

Benign	Malignant
Grow slowly	Grow rapidly
Locally grow to great size	Create metastases
Don't invade the neighboring tissue	Invade and destroy neighboring tissues
Usually do not return after surgical removal	Recurrence after surgical removal

INCIDENCE

- Tumors are more common in canines.

  Skin—Common in older dogs (often benign) but much less common in cats (malignant).

  Breast—Fifty percent of all breast tumors in dogs and 85% of all breast tumors in cats are malignant.

  Testicles—Testicular tumors are rare in cats and common in dogs, especially those with retained testes.

  Bone—Bone tumors are most commonly observed in large breed dogs and rarely in cats. The most common sites are leg bones and near joints.

  Head and Neck—Cancer of the mouth is common in dogs and less common in cats. A mass on the gums, bleeding, odour, or difficult eating are signs to watch for.

- Horse and cattle are more often affected than sheep, pig and goat.

  Fibropapillomatosis of the skin, mucosa of mouth, esophagus and urogenital organs are often seen in domestic animals. Fibroma is more common in horses, cattle and dogs.

- **Old animals are affected more commonly than young ones.**



Mammary tumour in bitch



Tumour in the traunk of a dog

Varieties of tumors

Tissue of origin	Name of tumour	Cell type
Mesenchymal tumors :	Fibroma	Fibrous connective tissue
	Chondroma	Cartilaginous tissue
	Osteoma	Bony tissue
	Odontoma	Tooth substances
	Myoma	Muscular tissue
	Myxoma	Cardiac skeleton
	Lipoma	Adipose tissue
	Neuroma	Nerve cells and fibers
	Leiomyoma	Smooth muscle
	Rhabdomyoma	Skeletal tissue
	Haemangioma	Blood vessels
	Meningioma	Meninges
	Teratoma	Germ cells
Epithelial tumors	Papilloma	Skin or mucous membrane
	Adenoma	Glandular epithelium
	Basal cell tumour	Basal cell of skin
	Hepatocellur adenoma	Hepatocytes
	Glomus tumour	Melanocytes
Blood cells	Non-Hodgkin lymphoma and Hodgkin lymphoma	Lymphoid cells
	Leukemia	Haematopoietic cells

DIAGNOSIS

- Clinical examination – location, size and consistency
- Radiography – bones and vascular organs.
- Biopsy – exploratory cytology

TREATMENT

1. **Prophylactic treatment** is undertaken either to reduce the anticipated incidence rate of a particular tumor type or the rate of recurrence of a neoplastic disease after therapy.

Mammary tumors in bitch – Spaying between 6 and 12 months of age will greatly reduce the risk of breast cancer. Surgery is the treatment of choice for this type of cancer.

Benign vaginal tumor–ovariotomy

Testicular tumors (Seminoma and sertole cell tumour) - Castration

2. Definitive excision refers to use of surgery as the sole treatment procedure without adjunctive radiotherapy or chemotherapy.

(*a*) **Local *excision***: The removal of a neoplastic mass with the minimal amount of surrounding normal tissue.

(*b*) ***Wide local excision***: Removal of a significant predetermined margin of surrounding tissues together with the primary mass.

(*c*) ***Radical local excision***: Removal of a tumor with anatomically extensive margins of tissue which are undisturbed by the primary growth of the tumor is termed as radical local excision or compartmental excision. *e.g.* sarcomas.

3. Palliative treatment: A procedure that remarkably improves an animal's quality of life by providing pain relief, or relieving poor function, despite the presence of unsolved systemic neoplastic disease *e.g.* Limb amputation–osteosarcoma, Splenectomy–Bleeding haemorrhage of sarcoma.

4. Apart from surgery, **chemotherapy, radiation, cryosurgery** (freezing), **hyperthermia** (heating) or **immunotherapy** can be effectively used to treat cancers. Combination therapy is commonly employed.

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CHAPTER 9

Cyst

A **cyst** is a closed sac having a distinct inner lining of secreting membrane. They may contain air, fluids, or semi-solid material. Cyst may contain a solid structure like tooth (dentigerous cyst) or hair (dermoid cyst). The outer wall of a cyst is called as **'capsule'**. Most of the cysts are benign in nature, but some may produce symptoms due to their size and/or location. Size of a cyst may vary from a small grape to a football.

Cysts can arise anywhere in the body; common examples are listed below :

- Chalazion cyst (eyelid)
- Retention Cyst (gland like salivary cyst)
- Dentigerous Cyst (associated with the crowns of non-erupted teeth)
- Exudation Cyst (Hydrocele).
- Dermoid (misplaced embryonic tissue).
- Encapsulation cyst (around foreign bodies and parasites. *e.g.* Cystecercosis)
- Neoplastic (Cyst adenoma).



Cyst near neck region of a goat

- Ganglion cyst (hand/foot joints and tendons)
- Glial Cyst (in the brain)
- Distension cyst: (Follicular cyst of ovary, cystic distension of a joint bursa)
- Meibomian cyst (eyelid)
- Ovarian cyst (ovaries, functional and pathological)
- Renal cyst (kidneys)
- Sebaceous cyst (sac below skin)

DIAGNOSIS

Cysts are generally non-inflammatory in nature and develop slowly with well defined periphery. On palpation, fluid filled cyst fluctuates uniformly while cysts with solid mass fluctuates en-masse.

TREATMENT

- Puncture and evacuate the contents of cyst and inject an irritant solution like Tr. iodine to destroy the smooth lining membrane and setting up of inflammation.
- Use of setton to drain cyst is a good practice.
- Surgical excision of the cyst is the preferred option. Intact cyst is carefully dissected and removed from the surrounding tissue in possible cases.

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CHAPTER 10

Hernia

Hernia is a protrusion of a tissue, structure, or part of an organ through the muscula tissue or the membrane by which it is normally contained. These contents, usually portions intestine or abdominal fatty tissue, are often enclosed in the thin membrane that naturally lin the inside of the cavity. They are quite similar to sidewall bulges on automobile tires. Some a a minor inconvenience while others are life-threatening conditions. Some are present from birth (congenital) while others are the result of injury.



Hernias by themselves usually are harmless, but nearly all have a potential risk of having their blood supply cut off (becoming strangulated). If the hernia sac contents have their blood supply cut off at the hernia opening in the abdominal wall, it becomes a medical and surgical emergency.

PARTS OF HERNIA

The hernia has three parts:

- Orifice (hernial ring) through which it herniates.
- Hernial sac consists of neck, body and fundus.
- Hernial contents.

ETIOLOGY

- Weakness in the abdominal wall evolves into a localized hole, or "defect", through w abdominal organs covered with peritoneum, may protrude.
- Increase intra-abdominal pressure due to pregnancy, ascites, tympany, constipation
- Direct external violence by falling on a blunt object.
- Imperfect closure of an embryonic defect.
- Increased pressure on the intervertebral discs, as produced by heavy lifting or lifting improper technique, increases the risk of herniation.

CLASSIFICATION OF HERNIA

Since many organs or parts of organs can herniate through many orifices, it is very difficult to give an exhaustive list of hernias, with all synonyms and eponyms. The commonly observed hernias in animals are listed below.

Reducible hernia means when the hernia's contents can be pressed back into normal position.

Irreducible hernia means when the hernial contents cannot be returned to their normal site with simple manipulation. If hernias are irreducible, severe complication can develop.

- **Strangulation :** pressure on the hernial contents may compromise blood supply and cause ischemia, and later necrosis and gangrene, which may become fatal.
- **Obstruction :** when a part of the bowel herniates, bowel contents can no longer pass the obstruction leading to absence of flatus and absence of defecation which requires urgent surgery.

Name of hernia	Characteristics	Incidence
	A. According to anatomical location	
Umbilical hernia	An opening in the abdominal wall, which normally closes before birth, doesn't close completely. Even if the area is closed at birth, umbilical hernias can appear later in life because this spot remains a weaker place in the abdominal wall.	Calves, pups, foals and pigs
Inguinal hernia	Occurs in the groin area in which tissue that belongs in the rear of the abdominal cavity presses out through a weak area surrounding the femoral artery and nerve. Usually the hernial sac contains nothing but fat and can be reduced back into the abdomen with finger pressure.	Bitches, bulls, horses and pigs
Perineal hernia	Herniation of abdominal contents through the pelvic diaphragm and causing swelling on one side of the anus. The hernial sac may contain fat, intestines, or the bladder.	Uncastrated, old male dogs
Diaphragmatic hernia	Protrusion of abdominal organs to the thoracic cavity by tearing of diaphragm.	Buffaloes, horses and dogs
Scrotal hernia	Loop of intestine or the bladder may pass down into the scrotum.	Horse
Ventral hernia	Migration of viscera through a tear in the abdominal wall.	Cattle and horse
Femoral hernia	Protrusion of abdominal viscera through the femoral canal.	Not common in veterinary practice
Hiatus hernia	Normal passageway through which the esophagus meets the stomach serves as a functional "defect", allowing part of the stomach to herniate into the chest.	Not common in veterinary practice

B. According to the hernial contents	
Gastrocele	Stomach
Epiplocele	Omentum
Vesicocele	Bladder
Hepatocele	Liver
Hysterocele	Uterus

SYMPTOMS

External swelling is observed which varies from size and shape and may increase during coughing.

- In reducible hernia-no functional symptoms are observed only there is presence of hernial ring.
- In incarcerated hernia-ring is not flat and difficult to reduce the contents. Colic is seen.
- In strangulated hernia-abdominal pain and fever.

GENERAL PRINCIPLES OF TREATMENT OF HERNIA

Repair of hernias is generally advisable in a timely fashion, in order to minimize complications such as organ dysfunction, gangrene, and multiple organ dysfunction syndromes.

- **Reduction and retention :** The hernial contents are reduced by local manipulation and retention is done by applying bandage or other articles around the abdomen. The bandage is to be kept for two to three weeks until closure occurs. This method is effective in early stages of umbilical hernia.
- **Injection of irritant solutions** close to the hernial ring sometimes may help in closure of hernial ring especially in a small hernia.
- **Surgical remedy :** Most abdominal hernias can be surgically repaired. Uncomplicated hernias are principally repaired by pushing back, or "reducing", the herniated tissue, and then mending the weakness in muscle tissue (an operation called **herniorrhapy**). If complications have occurred, the viability of the herniated organ should be checked and resects it if necessary. Modern muscle reinforcement techniques involve synthetic materials (**mesh prosthesis** like nylon, teflon and stainless steel) that avoid over-stretching of already weakened tissue. The mesh is placed over the defect, and suturing it in borders to keep the mesh in place. The skin edges are also sutured after excising any excess skin.

COMPLICATIONS

Postoperative complications may arise such as:

- Infection and rectocutaneous fistula, anal sac fistula, rectal prolapse especially in perineal hernia.
- Rejection of mesh used for repair of hernia which can be detected by localized swelling and pain around the mesh area.

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CHAPTER

11

Wound Healing

A **wound** is a separation or discontinuity of soft tissues caused by trauma, surgery or noxious physical agents.

CLASSIFICATION OF WOUND

Open or external wound : There is discontinuity in the skin and other covering tissues to a varying depth. In closed or interstitial wound, only deeper tissues, barring the skin or mucous membrane are damaged.

Closed wound/internal wound

Contusion is injury to the skin without any break in the continuity of tissue surface. It is caused by blunt objects and the subcutaneous tissues, muscles; nerves are damaged to a varying degree.

According to the severity and extent of tissue damage it may be of :

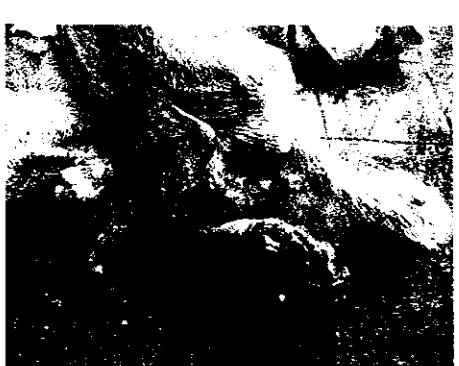
- First degree with rupture of capillary vessels of the skin and subcutaneous tissue.
- Second degree with rupture of larger vessels leading to haematoma formation.
- Third degree with major damage of tissues leading to gangrene formation.

Open wounds

1. Incised wounds are caused by sharp cutting instruments such as knives, scalpels, fragments of glass etc with minimum loss to tissue. edges are regular, bleeds freely and painful.

2. Lacerated wounds are caused by tearing of tissues with torn and uneven edges. Wounds have irregular jagged borders and loss of tissue is limited to skin and subcutaneous tissue e.g. barbed wire.

3. Penetrating wounds are types of deep wounds communicating with cavities like abdomen, thorax, and joints etc. *e.g.* stab wounds.



Maggot wound in paw region of a dog

4. Perforating wound is having two opening, one of entrance and other of exit.

5. Punctured wound are caused by sharp pointed objects like nails relatively with a small opening. There might be presence of infection/foreign particles deep into the wound with inadequate opening for drainage. Ex : Stab wounds.

6. Gunshot wound is produced by various forms of firearms *e.g.* injuries caused by bullet.

7. Abrasions are superficial damage to the skin, generally not deeper than the epidermis.

8. Avulsion occurs when an entire structure or part of it is forcibly pulled away. Explosions, gunshots, and animal bites may cause avulsions.

9. Bite wounds are caused by snake; dog or wild animals bite with significant degree of tissue damage.

10. Virulent wounds are caused by bacteria or virus leading to formation of pustules or vesicles *e.g.*: FMD, anthrax.

11. Granulating wound is one in which there is a tendency to heal within expected time.

12. Aseptic wound is surgical wound made under aseptic conditions where chances of bacterial contamination are negligible.

13. Contaminated wound is one where there is presence of microorganisms.

14. Infected/ septic wound : A contaminated wound may become infected after a period of 6-8 hours where bacterial multiplication may occur and liberation of their toxin.

Symptoms of wound

- Localized pain and bleeding.
- Gaping of the lips of wound.
- Weakness, paralysis or a loss of function in a dependent portion.
- Febrile disturbances in severe septic wound.
- Neuritis extending along the course of the nerve involved in the wound.

PHASES OF WOUND HEALING

Wound healing involves a complex series of interactions between different cell types, cytokine mediators, and the extracellular matrix. The phases of normal wound healing include haemostasis, inflammation, proliferation, and remodelling. Each phase of wound healing is distinct, although the wound healing process is continuous, with each phase overlapping the next. Before the advent of modern veterinary practice, many soft tissue injuries healed with time. The difference that the modern veterinary practice has made is that the more severe injuries that would have killed the animal are now manageable; the deformity and infection that often accompanies natural unaided tissue healing can be avoided or minimized.

The four phases of wound healing :

A. Haemostasis

Tissue injury initiates a response that first clears the wound of devitalized tissue and foreign material, setting the stage for subsequent tissue healing and regeneration. The initial vascular response involves a brief and transient period of vasoconstriction and haemostasis. A 5-10 minute period of intense vasoconstriction is followed by active vasodilatation accompanied by an increase

in capillary permeability. Platelets aggregated within a fibrin clot secrete a variety of growth factors and cytokines that set the stage for an orderly series of events leading to tissue repair.

B. Inflammatory phase

The second phase of wound healing *i.e.* the inflammatory phase lasts for 1-3 days in uninfected wounds.

1. Classic signs include the following:

(*a*) Redness (**rubor**)
(*b*) Swelling (**tumor**)
(*c*) Pain (**dolor**)
(*d*) Heat (**calor**)
(*e*) Loss of function (**function laesa**)

2. Process

(*a*) The inflammatory response increases vascular permeability, resulting in migration of neutrophils and monocytes into the surrounding tissue. The neutrophils engulf debris and microorganisms, providing the first line of defense against infection. Neutrophil migration ceases after the first few days post-injury if the wound is not contaminated. If this acute inflammatory phase persists, due to wound hypoxia, infection, nutritional deficiencies, medication use, or other factors related to the patient's immune response, it can interfere with the late inflammatory phase.

(*b*) In the late inflammatory phase, monocytes converted in the tissue to macrophages, which digest and kill bacterial pathogens, scavenge tissue debris and destroy remaining neutrophils. Macrophages begin the transition from wound inflammation to wound repair by secreting a variety of chemotactic and growth factors that stimulate cell migration, proliferation, and formation of the tissue matrix.

C. Proliferative phase

1. The subsequent proliferative phase is dominated by the formation of **granulation tissue and epithelialization.** Its duration is dependent on the size of the wound. Chemotactic and growth factors released from platelets and macrophages stimulate the migration and activation of wound fibroblasts that produce a variety of substances essential to wound repair, including glycosaminoglycans (mainly hyaluronic acid, chondroitin-4-sulfate, dermatan sulfate, and heparan sulfate) and collagen. These form an amorphous, gel-like connective tissue matrix necessary for cell migration.
2. **New capillary growth** must accompany the advancing fibroblasts into the wound to provide metabolic needs. Collagen synthesis and cross-linkage is responsible for vascular integrity and strength of new capillary beds. Improper cross-linkage of collagen fibers has been responsible for nonspecific post-operative bleeding in patients with normal coagulation parameters. Early in the proliferation phase fibroblast activity is limited to cellular replication and migration. Around the third day after wounding, the growing mass of fibroblast cells begins to synthesize and secrete measurable amounts of collagen. Collagen levels rise continually for approximately three weeks. The amount of collagen secreted during this period determines the tensile strength of the wound.

WOUND REMODELLING

The final phase of wound healing *i.e.* remodelling develops 3 weeks following injury and continues up to two years, achieving 40-70 percent of the strength of undamaged tissue at four weeks.

1. This phase is characterized by reorganization of new collagen fibers, forming a more organized lattice structure that progressively continues to increase wound tensile strength.
2. The strength of scar tissue formed in this phase is less than the surrounding normal tissue.

COMPLICATIONS OF WOUND HEALING

1. Wound dehiscence is the splitting and separation of previously closed wound layers. **Evisceration** is protrusion of viscera through the wound. **Eventration** is protrusion of the bowels from the abdomen. The main causes responsible for these conditions include improper surgical technique and the local and systemic factors described below. Dehiscence usually occurs 3-5 days after surgery before collagen deposition. The characteristics features include incisional swelling, discolouration, necrosis and unusual exudation.

2. Haemorrhage due to rupture of blood vessels can lead to development of haemorrhagic shock and ultimately death.

3. Traumatic neuralgia is the pain perceived at or around the vicinity of wound. Primary traumatic neuralgia persist for prolong period whereas secondary one appear during cicatrisation.

4. Septicemia and pyemia are the common complications of wound healing caused by the bacterial toxins due to massive infection and may lead to endotoxic shock.

5. Traumatic fever is the resultant of pyrogen release from neutrophils and injured body tissue.

6. Haematoma (accumulation of blood in the subcutis) **or seroma** (accumulation of serum in the dead space) may occur due to rupture of blood vessels following injury.

7. Sinus (draining tract from a suppurative cavity to the surface) may develop due to presence of necrotic tissue debris and foreign bodies.

8. Fistula (abnormal passage between two internal organs) may develop due to paucity of drainage from a purulent cavity.

9. Cellulitis is inflammation of the connective tissues presenting as oedema, redness, pain and heat often with hardness.

10. Exuberant granulation tissue (proud flesh) is granulation tissue which grows above the level of the surrounding skin (overgranulation), preventing epithelial cells from growing across the wound.

11. Tetanus may develop due to *Clostridium tetani* infection particularly in deep penetrating and punctured wound. Caprine, equine and camalidae are more susceptible to tetanus.

12. Adhesions are the major post-operative complication following abdominal surgery due to rough handling of viscera.

13. Traumatic emphysema arises due to punctured wounds of the respiratory or gastrointestinal tract where gas or air accumulate in and around the wound area.

14. Venous thrombosis and embolism may occur when fat tissue accidentally entered in the circulation.

15. Gas gangrene may develop.

FACTORS AFFECTING WOUND HEALING

A. Local factors

1. Good surgical technique is warranted for proper wound healing if Halsted's principles are followed. The principles include :

- Gentle handling of tissue.
- Aseptic surgical technique.
- Perfect haemostasis and preservation of blood supply to the wound area.
- Close tissue approximation and obliteration of dead space.
- Removal of necrotic and devitalized tissue.

2. Tissue vascularity ensures oxygenation and nutrients which is essential for wound healing. Oxygen influences angiogenesis, epithelialization and resistance to infection.

3. Infection is one of the major factors which retard the wound healing significantly as it prolongs the inflammatory phase, disrupts the normal clotting mechanisms, promotes disordered leukocyte function and ultimately prevents the development of new blood vessels and formation of granulation tissue.

4. Topical medications promote wound healing by minimizing bacterial infection. However, certain antimicrobial agents and local anaesthetics delay the healing process by destroying cellular elements of wound.

5. Lavage and Dressings accelerate wound healing by protecting healing tissue. Lavage with sterile isotonic solutions like normal saline decreases the concentration of the microorganisms mechanically and aids in healing process. Nonadherent, moist dressing triggers epithelisation whereas adherent gauge dressing mechanically debride the contaminated wound.

6. Presence of **foreign bodies** such as tissue debris, dirt, soil, sequestrum, or nonabsorbable braided suture materials delay the healing process by exacerbating the inflammatory response and inciting infection.

7. Obliteration of **dead space** and prevention of **fluid accumulation** promote migration of reparative cells and minimizing the risk of infection during wound healing.

8. Ionizing radiation retards wound healing by decreasing fibroblast formation, collagen synthesis and neovascularisation within fortnight of surgery.

9. Movement of the wound site prolongs the healing process as movement can disrupt cell migration, neovascularisation and formation of early ground substances of the wound.

10. Mutilation of the wound not only disturbs the healing but also complicate by creating evisceration like condition.

B. Systemic factors

1. Advanced age retards healing because of reduced skin elasticity and collagen replacement. The immune system also declines with age making patients more susceptible to infection. Older animals are also susceptible to other chronic diseases, which affect their circulation and oxygenation to the wound bed as compared to young.

2. Nutrition plays a pivotal role in wound healing process.

- **Protein** is required for all the phases of wound healing, particularly important for collagen synthesis. Hypoproteinemia slows healing by decreasing wound tensile strength, delaying fibroplasia and producing edema.
- **Glucose** balance is essential for wound healing. Hyperglycemia delay wound healing.
- **Iron** is required to transport oxygen.
- **Minerals like zinc, copper** are important for enzyme systems and immune systems. Zinc deficiency contributes to delay epithelisation and disruption in granulation tissue formation by inhibiting fibroblastic cellular proliferation.
- **Vitamins A and B complex** are responsible for supporting epithelialization and collagen formation. It is also important for the inflammatory phase of wound healing.
- **Vitamin C** is essential for formation of intercellular cementing substances as it is needed for hydroxylation of the lysine and proline moieties of collagen.
- **Carbohydrates and fats.** These provide the energy required for cell function. When the patient does not have enough, the body breaks down protein to meet the energy needs. Fatty acids are essential for wound healing.

3. Medication like anti-inflammatory, cytotoxic, immunosuppressive and anticoagulant drugs all reduce healing rates.

(*a*) **Anti-inflammatory** drugs like corticosteroids if used in long term and at higher doses impair the inflammatory phase, decrease fibroplasia, collagen synthesis and neovascularisation.

(*b*) **Chemotherapeutic agents** like methotrexate, doxorubicin and cyclophosphamide delay the wound healing process by inhibiting cell division or collagen synthesis. In addition, healing process is adversely affected by depressing immune function, epithelialization and contraction.

(*c*) **Anticoagulant drugs** retard the healing by interrupting clotting mechanism and thus making a wound more prone to infection due to presence of blood clots.

(*d*) Most **NSAIDs** lower resistance to infection and ultimately delay healing.

4. Systemic diseases like malignancy, uncontrolled diabetes, renal and hepatic disturbances delay healing process.

(*a*) A malignancy in the body retards wound healing by altering metabolism, producing chachexia, and minimizing inflammatory cell division.

(*b*) Uremia delays fibroblastic proliferation, granulation tissue formation, epithelial proliferation and subsequently strength of healing wound.

(*c*) In patients with uncontrolled diabetes, there is delayed healing as hyperglycemia impairs collagen formation, neovascularisation, granulocytes cell functions and ultimately leading to wound dehiscence.

Clinical signs of infection

- Local pain/tenderness

- Local swelling/oedema
- Increased exudate
- Frank pus
- Wound breakdown
- Pyrexia
- Delayed healing
- Change in appearance of granulation tissue
- Bridging of epithelial tissue
- Abnormal smell

MANAGEMENT OF WOUNDS

Humans have always been faced with the dilemma of how to treat wounds. Many diverse and interesting approaches to wound management have been applied throughout medical history. Thirty years ago, physicians believed pus in a wound was laudable and anxiously awaited its arrival; surgeons today attempt every conceivable means to prevent its presence.

1. Contusions : are treated with cold and astringent applications to minimize extravasation.

2. Haematoma : when small get absorbed otherwise they may have to be opened and treated.

3. Open wounds : surgical or aseptic wound, contaminated and septic wound or infected wounds.

SURGICAL OR ASEPTIC WOUNDS

- A surgical wound made with all aseptic precautions in a non infected tissue is an aseptic wound.
- Surgeon should avoid drying of the tissue, excessive trauma and haemorrhage-lower the wound infection.
- Prophylaxis against tetanus.
- Dependent drainage should be provided if haematoma or seroma formation is expected.
- Suture should be supported upto healing time 8-14 days.
- Systemic use of specific antibiotics as a therapeutic or prophylactic measure.
- Local application of fly repellents – hot summer months.
- The patient and the affected injured part should be kept at rest.

Contaminated wound

A fresh wound gets contaminated when it is more than 4-5 days old. The principal therapeutic strategies of the open and contaminated wound are to convert it into a clean closed wound.

Wound cleansing protocol

Wound cleansing is a clean-not sterile—procedure. Not all wounds require cleaning.

Reasons to clean a wound

Presence of :

- Foreign bodies

- Debris *e.g.* slough, residue from hydrocolloid dressings
- Purulent exudate *i.e.* infection

EQUIPMENT

1. Clean basin-basin for this purpose must be washed with soapy water, rinsed and dried before use.

2. Warm tap water is required otherwise cold water may reduce the temperature of the wound surface to a degree where cell mitosis will not recommence for up to 4 hours.

3. Gauze/soft wash cloth : Contaminated wound, where possible, immerse and clean. Otherwise, the soaked wash cloth must be squeezed over it allowing the water to wash over it. Non-fiber shedding gauze should be used where foreign bodies remain. This is not a routine practice as it redistributes bacteria, is painful and causes trauma to healing cells.

4. Disposable gloves (clean but not sterile).

The following procedures should be meticulously adhered :

- A sterile gauze pad should be placed over the wound followed by shaving the surrounding skin and finally, cleaning the edges of wound with a detergent soap and water.
- The surrounding area should be draped with a sterile one.
- The wound area should be prepared for surgical debridement by gentle irrigation with lukewarm isotonic saline solution.
- Devitalized and ragged skin edges, nonviable and heavily contaminated tissues should be removed.
- Again the wound area should be exposed by gentle traction and carefully irrigated.
- After cleansing, surrounding skin should be dried but not the wound itself.
- The operative field should be again prepared by placing sterile gauze over the wound and redraping the surrounding area.
- Capillary and venous oozing should be controlled by gentle pressure and ligating blood vessels if necessary.
- Wound closure should be done either by suture without drainage or placing a small rubber drain into the depths of the wound and other end in the skin margin.
- The wound may be loosely packed with petrolatum-impregnated gauze and sutured at a later date (delayed primary closure).

SEPTIC WOUND OR INFECTED WOUND

Basic principles of infected wound treatment strategies are as follows:

1. Debridement : Thorough debridement is most essential to manage septic wounds which will provide easy access to the wound depth.

(*a*) All necrotic tissue debris and foreign materials should be removed until clean, healthy tissue margin of the wound are achieved.

(*b*) Infected wound should not be plugged or closed unless infection is well controlled for primary healing but should be left to heal by secondary healing.

2. Lavage : After removal of the necrotic debris, the wound and its periphery should be copiously irrigated with like warm normal saline or water and or 2% hydrogen per oxide.

(*a*) **Volume** and **nature** of lavage fluid depend on the degree of gross contamination and size of the wound.

(*b*) **Addition of antibiotics or antiseptics** is not required when large volume of fluid is used as improper concentrations of such drugs may have deleterious effect to the wound healing process.

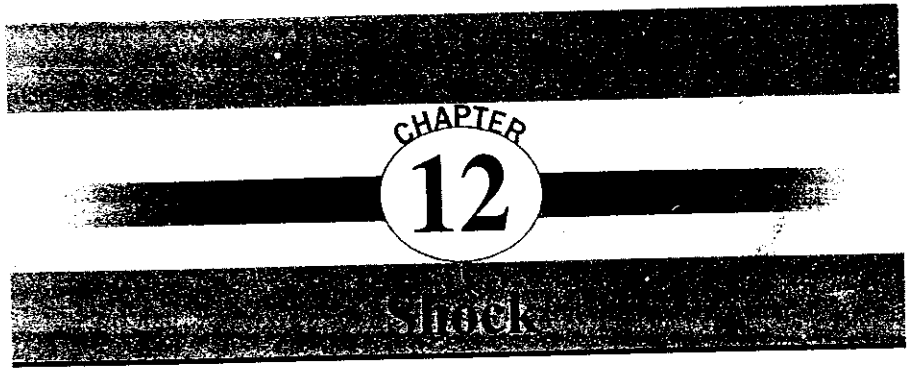
3. Wound drainage can be achieved by using penrose drains, plastic or rubber tubes or open drainage with bandage support. The aim is to reduce fluid accumulation, dead space, haematoma and seroma. The following guidelines should be observed :

- **Dependent drainage** of wound exudate should be provided if possible so that gravity will aid drainage of the exudate.
- The incision for drainage should be placed in the most **direct route possible and away from anastomotic sites, tendon** and **major vessels**. They may cause pressure necrosis.
- Soft, petrolatum based antiseptic gauze should be used to keep the wound edges apart.
- Incision to place the drain should be made **within the zone of reaction**; avoid cutting into non-infected areas. The drain exit site should be **prepared in an aseptic manner** and should be covered with sterile bandages to prevent premature removal or loss of the drain and to access the nature of the exudate.
- Through and through drainage should not be used.
- Usually drain should be removed after 24-48 hrs.

4. Antimicrobial therapy : Selection of the antimicrobial agent should be based on culture and antibiotic sensitivity test. However, empirical antimicrobial agents should be advocated in life–threatening infections that exists or develops while awaiting culture and sensitivity results (48-72 hrs). In most cases, animals with existing wound infection are treated initially with loading dose of intravenous medication. Antimicrobial therapy should be continued for 10-14 days.

5. Sterile protective bandaging is a good practice to avoid hospital infection, colonization of the wound by opportunistic organisms and to prevent environmental contamination with the infective agent.

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A recent veterinary textbook defines shock as "the clinical state resulting from an inadequate supply of oxygen to the tissues or an inability of the tissues to properly use oxygen." This deprives the organs and tissues of oxygen (carried in the blood) and allows the buildup of waste products. Shock can result in serious of damage or even death. Many attempts have been made to define shock, but because it is such a complex disorder, no single definition has been successful.

CLASSIFICATION

There are four general categories of shock: hypovolaemic, cardiogenic, septic and vasogenic shock.

1. Hypovolaemic shock is the result of inadequate intravascular circulatory volume commonly resulting from haemorrhage, fluid loss in excess of intake, or third spacing of body fluids.

A. Acute blood loss : Major laceration, ruptured abdominal or thoracic organs, surgical procedures.

B. Fluid loss : Severe vomiting, diarrhea, burns

C. Fluid sequestration : Massive tissue trauma, especially crushing injuries.

2. Cardiogenic shock occurs from cardiac insufficiency with lowered cardiac output. It may result from:

- Inherent heart diseases such as arrhythmias, myocardial trauma etc.
- Extracardiac diseases such as cardiac tamponade, tension pneumothorax.

The circulatory failure is central in origin.

3. Septic or endotoxic shock occurs from massive infection caused by gram negative microbes. Various diseases which can cause this type of shock are peritonitis, pyometra, haemorrhagic gastroenteritis, intestinal strangulation, or volvulus, pericarditis, mastitis, osteomyelitis etc.

4. Vasogenic shock occurs either due to extensive vasoconstriction or extensive vasodilatation. Direct action of toxic substance on blood vessels produces dilatation of blood vessels. It leads to decreased resistance and increased capacity of vascular bed.

Pain or extensive handling and traction of the viscera—massive vasoconstriction.

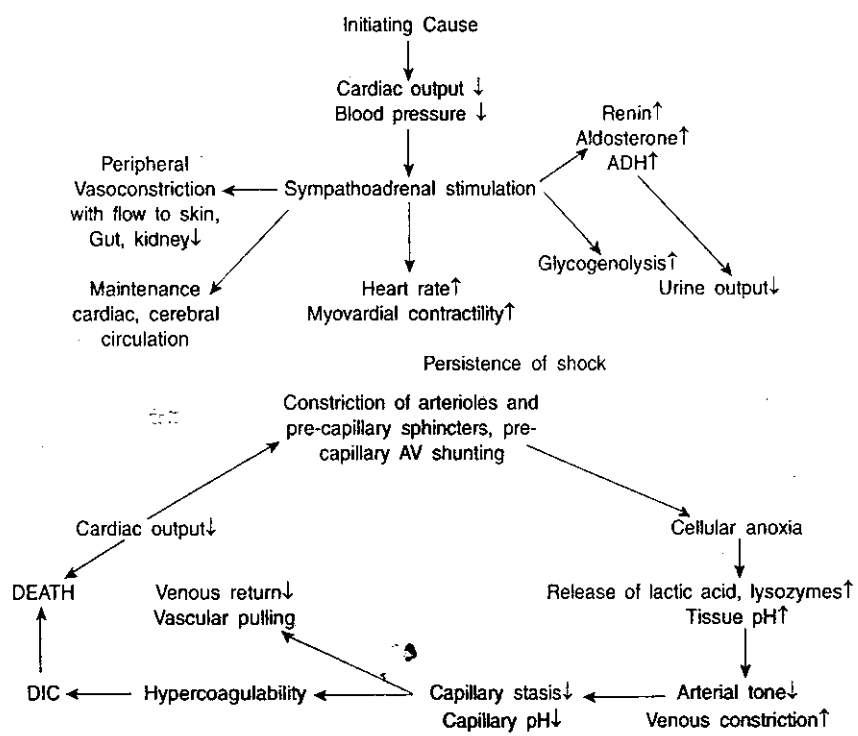
Deep anaesthesia or spinal injury—extensive vasodilatation.

5. Anaphylactic shock occurs due to antigen-antibody reaction and resultant histamine release. Histamine leads to increased permeability and massive vasodilatation.

PATHOPHYSIOLOGY OF SHOCK

I. Although the nature of shock vary, the fundamental sequence of events is essentially the same in all forms of shock:

- Some precipitating cause decreases cardiac output and blood pressure.
- Stimulation of sympathoadrenal system leads to peripheral vasoconstriction and shunting of blood away from the skin and intestinal viscera.
- Heart rate and myocardial contractility increases, leading to cardiac output.
- Simultaneously there is increased release of ADH, activation of rennin-angiotensin system and release of aldosterone which ultimately helps to conserve water and sodium through the kidneys.



Flow diagram of the pathophysiology of shock (Morgan, 1981) [With permission]

II. In microvascular level, certain compensatory changes become less reversible as shock persists and provide a positive feedback.

- There is lowered oxygen delivery to tissue due to sympathetic constriction of arteriole and pre-capillary sphincters.
- Development of cellular anoxia with release of lactic acid.
- Permeability of cell membrane increases with release of lysozymes.
- Capillary stasis and decreased capillary pH triggers vascular pulling and decreased venous return to heart.
- Hypercoagulability also occurs, which may leads to disseminated intravascular coagulopathy (DIC).

III. The end result in all forms of shock is cardiac failure ultimately leading to death.

SYMPTOMS OF SHOCK

It is easy to recognize fully established shock; but it is difficult in early or compensated shock. Shock is dynamic and not a static process. Physical examination findings associated with hypovolemic and cardiogenic shock include :

- Tachycardia
- Tachypnea
- Pallor of mucous membrane
- Prolongation of the capillary refill time and decrease pulse quality
- Heart murmurs or arrhythmias (not absolute)

Laboratory findings during shock shows lowered red blood cells, haematocrit and plasma proteins; and elevated blood urea nitrogen (BUN). Other signs include weakness, restlessness, and depression, reduced urine output, coma and dilation of pupils.

TREATMENT

The most important goals in the treatment of shock include: quickly diagnosing the patient's state of shock; quickly intervening to halt the underlying condition (stopping bleeding, re-starting the heart, giving antibiotics to combat an infection, etc.); treating the effects of shock (low oxygen, increased acid in the blood, activation of the blood clotting system); and supporting vital functions (blood pressure, urine flow, heart function).

Treatment protocol for shock

- Maintenance of parent airway, O_2
- Insert I.V. catheter; check PCV, TP, BUN
- Ensure haemostasis
- Rapid intravenous infusion of multiple electrolyte solution/dextrose
- Administration of sodium bicarbonate, antibiotics, corticosteriods
- Maintenance of body temperature

- Monitor urine output
- Note visible mucous membrane colour, CRT, RR, pulse rate and CVP
- Over enthusiastic fluid therapy is avoided

1. Patent airway should be ensured by intubating animal if collapsed or comatose. Oxygen should be delivered via musk, cannula or endotracheal tube.

2. Haemorrhage, if any, should be controlled by direct pressure, bandages, tourniquet or ligation.

3. Fluid therapy : A multi electrolyte, sodium containing crystalloid replacement solution is usually the fluid of choice; plasma and whole blood have obvious advantages.

Types of Intravenous Fluids

- *Crystalloid* : Dextrose or electrolyte solutions increase intravascular and interstitial fluid volume : Isotonic 0.9% NaCl, lactated Ringers hypotonic (5% dextrose in water, 45% NaCl).
- *Colloids* : Do not diffuse easily through capillary walls, fluids stay in vascular compartment; increase osmotic pressure: albumin, plasma protein and dextran.
- *Blood and Blood products* : Treatment of haemorrhage restores coagulation properties.

4. Glucocorticoid : The role of glucocorticoid in shock state has remained debatable even in man and small animal. Beneficial effects (dexamethasone @10 mg/kg, prednisolone @ 30 mg/kg) include: increase in cardiac output, decrease in peripheral resistance, increase in metabolism of lactic acid, improved efficiency of glycolytic enzymes, stabilization of lysosomal enzymes and interference with endotoxin- induced immune reaction.

5. Vasoactive drugs are used to modify sympathetic and adrenal responses. Dopamine is most popular vasoactive drugs used in shock.

6. Sodium bicarbonate is indicated to counteract metabolic acidosis caused by accumulation of lactic acid in shock state.

7. Broad spectrum antibiotics are indicated to combat wide-ranging secondary bacterial infection and **diuretics** for over dehydration or poor urine output.

8. Drugs acting on cardiovascular system are also indicated to improve blood pressure and to stimulate blood flow. Digitalis and adrenaline are drug of choice in this case.

9. The animal should be kept in a **warm** and **well ventilated room** without exposing direct heat.

10. Thrombolytic therapy (drugs that dissolve clots as they form) may be considered in the case of myocardial infarction or pulmonary embolism.

11. Treatment with **antioxidants** that help rid the body of free radicals (harmful by-products of the oxidative process) may protect against some types of shock.

- **Carnitine** may be helpful in treating cardiogenic, septic, and hypovolaemic shock.
- **Coenzyme** Q10 (CoQ10), an antioxidant, may be beneficial in treating hypovolaemic and septic shock.

- **Glutamine** added to parenteral nutrition may protect the intestines and prevent complications from septic shock.
- **N-acetylcysteine** (NAC) improved the immune system response in septic shock caused by endotoxins (toxins released from bacterial cells).
- **Omega-3 fatty acids** compared with omega-6 fatty acids may protect against the harmful effects of septic shock.
- **Vitamins B_3 and B_{12}-nicotinamide** (a form of vitamin B_3) may help protect against bacterial endotoxin that causes septic shock.

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CHAPTER 13

Haemorrhage and Haemostasis

Haemorrhage means escape of blood from an artery, vein or capillary to extravascular space. The complete loss of blood is referred to as exsanguination.

CLASSIFICATION

1. External haemorrhage occurs from open wounds or cut wounds that is visible on the outside of the body

E.g. : Epistaxis—bleeding from nose.
Haematuria : Blood in urine.
Haematemesis—vomiting fresh blood.
Haemoptysis—coughing up blood from the lungs.
Melena—presence of blood in faeces.

2. Internal haemorrhage is bleeding occurring inside the body. It may be caused by high blood pressure (by causing blood vessel rupture) or other forms of injury, especially high speed deceleration occurring during an automobile accident, which can cause organ rupture. When blood is collected in a newly formed cavity called as **haematoma**.

Example :

Haemometra	— haemorrhage into uterus
Haemopleura	— haemorrhage into pleural cavity
Haemoperitoneum	— haemorrhage into peritoneal cavity
Haematocele	— haemorrhage into tunica vaginalis
Haemarthrosis	— haemorrhage into a joint
Haematomyelia	— haemorrhage into spinal cord
Petechiae	— Pinpoint haemorrhages on skin and subcutis
Ecchymosis	— haemorrhagic spots on skin and subcutis.

3. Depending on the time of occurrence

- **Primary haemorrhage** occurs immediately after injury.
- **Reactionary haemorrhage** occurs within 24 hours after the primary bleeding has been arrested due to mechanical disturbance of clot in vessel or due to slipping of the ligature.

- **Secondary haemorrhage** occurs after about a week or more due to septic disintegration of clot or due to sloughing of portion of vessel because of a septic or gangrenous lesion.

4. Depending on the source of haemorrhage : Arterial, Venous and Capillary

Characteristics	Arterial	Venous	Capillary
Colour	Bright red	Dark red	Red
Flow	Jets (Jerks) Spurting/pulsating	Continuous flows freely	Slow and steady oozing
Of force	Cardiac side	peripheral side distal	wound

ETIOLOGY

1. Trauma-blunt trauma (*e.g.* fall, motor vehicle accident), laceration, or penetrating trauma (*e.g.* knife or gun).
2. Necrosis and ulcerations of blood vessel wall
3. Infection and subsequent release of toxins of microorganism
4. Aneurysm (weaknesses in blood vessels)
5. Increased blood pressure
6. Lack of oxygen and nutrition.
7. Anaphylactic shock
8. Deficiencies of coagulation factors.
9. Deficiency diseases
   Haemophilia
   Thrombocytopenia
   Deficiency of vitamin C, vitamin K
   Plant toxins (sweat Clover)

Symptoms

- Bleeding from injured blood vessel
- Skin and mucous membrane become pale, cold and moist
- Patient feels thirsty
- Air hunger
- Thready pulse
- Hypotension
- Low haemoglobin and red blood cells
- Severe bleeding leads to shock

HAEMOSTASIS

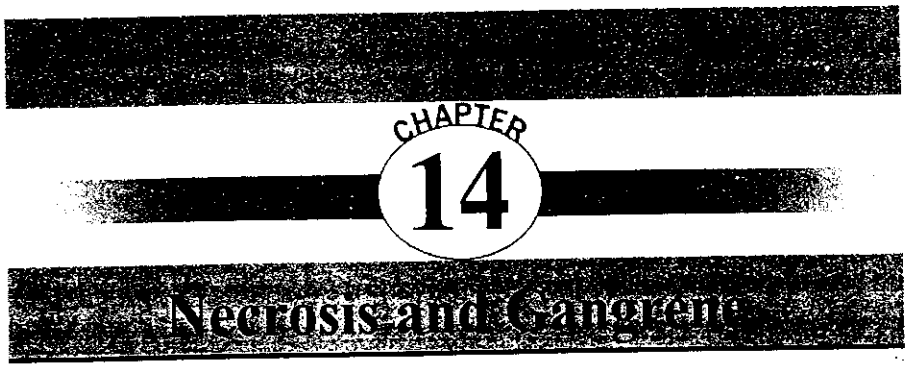
Haemostasis may be defined as complex interaction between vessels, platelets, coagulation factors, coagulation inhibitors and fibrinolytic proteins to maintain the blood within the vascular compartment in a fluid state.

Methods of haemostasis

Bleeding should be addressed in calm and controlled manner. Gentle digital pressure on the point of haemorrhage provides an extremely effective temporary haemostasis in minor bleeding.

1. **Pressure haemostasis :** A dressing, typically made of gauze, should be applied. The tissue should be gently blotted rather than wiped (Wiping causes abrasion and dislodges blood clots that have formed).
2. **Haemostatic forceps :** Crushing of tissues at the point of application leads to clot formation inside the vessel adjoining the ruptured ends of the inner coats. This can be done using artery forceps.
3. **Diathermy :** Cauterization of vessel is usually performed by monopolar coagulation and bipolar coagulation. Arteries less than 1mm and veins 2mm diameter causes vessel wall to shrink and lumen occlude by thrombosis.
4. **Ligation** is the ideal method of controlling bleeding from a vessel which can be accomplished first by grasping the vessel followed by putting a ligature. Vascular clips made of titanium or stainless steel is also used for ligation.
5. **Tourniquet :** A cord should be tied around an extremity (limb, tail, penis etc.) and proximal to bleeding area to control bleeding (not more than one hour 20 to 60 minutes). The use of a tourniquet is not advised in most cases, as it can lead to unnecessary necrosis or even loss of a limb.
6. **Topical agents** like fibrin adhesives, oxidized cellulose (regenerated), absorbable collagen fibrils, and gelatin sponge with or without thrombus are also helpful for arresting bleeding from small vessels. Bleeding from drilled cut or chipped edges of bone can be controlled by using bone wax plugs physically.
7. Application of Tr. Benzoin, Liq. Ferri perchlor, collodion, ice, cold water etc. can be successfully used for controlling bleeding from small vessels.
8. Bleeding from unidentified points of vessels in a wound cavity can be controlled by **packing or plugging** the cavity with sterilized gauze pieces (**tampon**). Tamponing favours coagulation of blood by exerting pressure in the area.
9. **Adrenalin,** a vasoconstrictor agent when applied topically controls bleeding especially from a small bleeding vessel.
10. Administration of **vitamin K** (Kapillin), **calcium** and other coagulation factors may have remarkable effect in controlling haemorrhage.

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NECROSIS

Necrosis means death of tissue in the body. This occurs when enough blood is not supplied to the tissue, whether from injury, radiation, or chemicals. Necrosis is not reversible.

Classification

1. **Avascular necrosis** is a disease resulting from the temporary or permanent loss of the blood supply to the bones. Without blood, the bone tissue dies and causes the bone to collapse. This disease is also known as osteonecrosis, aseptic necrosis, and ischemic bone necrosis.
2. **Coagulative necrosis** is typically seen in hypoxic environments (*e.g.* myocardial infarction, infarct of the spleen).
3. **Liquefactive necrosis** is usually associated with cellular destruction and pus formation (*e.g.* pneumonia).
4. **Haemorrhagic necrosis** is due to blockage of the venous drainage of an organ or tissue (*e.g.* in testicular torsion).
5. **Caseous necrosis** is a specific form of coagulation necrosis typically caused by mycobacteria (*e.g.* tuberculosis).
6. **Fatty necrosis** results from the action of lipases on fatty tissues (*e.g.* acute pancreatitis, mammary tissue necrosis).
7. **Fibrinoid necrosis** is caused by immune-mediated vascular damage. It is marked by deposition of fibrin-like proteinaceous material in arterial walls.

Etiology

There are many causes of necrosis including injury, infection, cancer, infarction, toxins and inflammation. Severe damage to one essential system in the cell leads to secondary damage to other systems, a so-called "cascade of effects". Necrosis can arise from lack of proper care to a wound site.

- Physical agents like excessive heat or cold.
- Mechanical injuries that crush or cut off blood supply.

- Loss of blood supply cuts off oxygen, may be due to passive hyperemia with sluggish flow of nutrients and deficient oxygenation (volvulus, strangulated hernia) and ischemia (decreased blood supply to a part) due to thrombus or embolism; compression of an artery, and ergot poisoning.

GANGRENE

Gangrene is necrosis and subsequent decay of body tissues caused by infection or thrombosis or lack of blood flow. It is usually the result of critically insufficient blood supply sometimes caused by injury and subsequent contamination with bacteria. This condition is most common in the extremities.

Etiology

The main factors in gangrene are loss of blood supply, and later invasion of the part by micro-organisms.

Gangrene may be caused by :

Direct damage to tissues which include :

(*a*) Mechanical compression or interference with blood and nerve supply to a part of the body or an organ while lying on a hard floor. Example: bed-sores; sit-fast.

(*b*) Physical agents like application of heat and cold. Example: burns, frost-bite.

(*c*) Action of acids, alkali and other chemicals producing dry gangrene and moist gangrene.

(*d*) Impaction of intestine in the hernial ring and infestation with pathogenic microbes especially with anaerobic infection.

Indirect changes in tissues due to cardiac, venous, arterial or nervous affections like:

(*a*) Ergot intoxication, which causes spasmodic narrowing of arterioles and leads to dry gangrene of extremities. It is commonly seen in feet of cattle.

(*b*) Diabetic gangrene narrows arteries and sugar in tissues, favours bacterial growth.

(*c*) Senile gangrene *i.e.* arteriosclerosis in old age, which narrows lumen of blood vessels.

Common sites of affection

1. Extremities like legs, ears, tail, wattle and combs. It is mostly due to freezing or ergot poisoning.
2. Mammary gland: Staphylococcal mastitis produces necrosis due to toxins or thrombosis of mammary vessels.
3. Involvement of lung due to wrong drenching of medicines, improper passage of stomach tube or severe lung infection.
4. Intestines in equines are commonly involved either with infarction due to verminous thrombosis of anterior mesenteric artery; or due to acute, local passive hyperemia produced by intestinal torsion, volvulus or intussusceptions.

Classification, etiology and signs of gangrene

Type	Etiology	Characteristic Signs
Wet gangrene, or moist gangrene	Sudden interruption of blood flow such as due to burns, freezing, injury or blood clot. Wet gangrene spreads very quickly and can be fatal.	• Affected tissue may appear badly bruised, swollen or blistered. • May also become infected. • No clear line between healthy and affected tissue.
Dry gangrene	Insufficient blood flow through the arteries such as due to atherosclerosis or blood clots. It usually doesn't involve bacterial infection.	• Affected tissue becomes shriveled, dry and blackish or greenish colour. • Cold to touch
Gas gangrene	Infection with certain types of bacteria, such as Clostridium. It typically occurs at the site of a recent injury or surgery. The bacteria rapidly destroy muscle and surrounding tissue.	• Swelling around skin due to exudates and gas formation. • Skin initially looks pale and then turns dark red or purple in colour. • Offensive odour of exudates.

Diagnosis

Diagnosis of gangrene will be based on a combination of

- History (recent trauma, surgery, cancer, or chronic disease).
- Physical examination.
- Results of blood and other laboratory tests (presence and extent of infection).

Treatment

Treatment should be directed to :

- Prevention of cause and extension of gangrene.
- **Debridement :** Removal of dead, damaged, or infected tissue to improve the healing potential of the remaining healthy tissue.
- Application of **warm antiseptic fomentations** to relieve pain.
- **Surgical excision** or amputation of a limb or organ.
- **Antibiotics** alone are not effective because they do not penetrate ischemic muscles sufficiently. However, penicillin is given as an adjuvant treatment to surgery.
- In addition to surgery and antibiotics, **hyperbaric oxygen therapy (HBOT)** is used that inhibit the growth and kill the anaerobic organisms.

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CHAPTER

15

Ulcer

An **ulcer** is a localized defect in the continuity of an epithelial surface without any tendency to heal. It is usually associated with an inflammed base of granulation tissue with or without necrotic slough. The majority is chronically inflammed; the slough at their base represents inadequate drainage. Acutely inflammed ulcers may have an outer rim of cellulitis. Ulcer must be differentiated from erosion which is an epithelial defect with loss of superficial layers, but the basal layers are intact.

Classification

- **Iatrogenic ulcers :** wound breakdown post-operatively and in irritant fluid extravasating.
- **Non-specific ulcers :** *e.g.* Traumatic ulcers including secondary stress ulcers.
- **Specific Ulcers :** as observed in tuberculosis, ulcerative lymphangitis, and glanders.
- **Malignant ulcers** observed in skin and gastrointestinal tract.
- **Ischemic ulcers or Decubitus ulcers :** These are due to continuous pressure which interferes with supply of nutrition to local tissues leading to pressure or bed sores.
- **Infective ulcers**: primary *e.g.* viral, tuberculosis, and secondary *e.g.* due to drainage of deep focus.
- **Neuropathic ulcer** *e.g.* in diabetes.

Etiology

- Repeated and continuous irritation of wound. *e.g.* Traumatic ulcer, bed sore.
- Secondary infection of the site by bacteria, fungus or virus with which the tissues cannot effectively combat.
- Insufficiency of nerve and blood supply to the part.
- Presence of necrotic tissue or foreign body in a wound.
- Specific diseases like tuberculosis, glanders, and ulcerative lymphangitis.
- Presence of neoplasm. *e.g.* Rodent ulcer.

Common sites of ulceration

Cattle : yoke

Horse : saddle place, elbow, limbs.

Dog : root of tail, tip of ears, and cornea of eye.

Symptoms

- The edge of ulcer may be raised or in level with the surrounding skin and rugged.
- The center of the lesion may be flat or concave, and may show necrotic spots.
- Granulations are pale or blue in colour depending upon the form.
- The discharge may be serous, purulent or grayish.

Treatment

The specific treatment of an ulcer is dependent on the subtype.

- Elimination of the cause adversely affecting the course of ulcerative disease and stimulation of regenerative processes at the affected site.
- Astringent or caustic applications for ulcers with excessive or unhealthy granulations. *e.g.* copper sulphate, silver nitrate, carbolic acid.
- Thermo-cautery with red hot iron to destroy unhealthy tissue which promotes granulation and cicatrisation.
- Bier's hyperaemic treatment.
- Antibiotics are only indicated for infected ulcers in which there is evidence of spread around the margin *e.g.* a cellulitic rim and there may be ongoing systemic infection *e.g.* tuberculosis.
- Exposure to ultra—violet rays to stimulate circulation and to destroy micro-organisms.
- For large deficits or prolonged ulcers with little evidence of healing, further surgical intervention may be indicated *e.g.* skin grafts and rotational flaps.

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CHAPTER

16

Burn and Scald

Burn is an injury of integuments and underlying tissues, occurring due to high temperature or chemical substances. Burn may be defined as tissue changes that occur on excessive absorption of heat by skin.

A **scald** is an injury caused by hot liquids or stream. Scald is likely to be more injurious than burn because the hot liquid may penetrate into the deeper part of tissues.



Burn in a cow

Classification

A. According to the depth and severity of burn :

- **First Degree** (Superficial) : Epidermis is affected and transient erythema, sometimes vesicle formation and desquamation of the epidermis occurs. Epidermal burns look red, are painful and heal rapidly.
- **Second degree burn** (partial thickness burn) : Here, depth extends to the mid dermis. Loss of epidermis is complete. Capillaries and venules in the dermis is dilated, congested and exude plasma. There is erythema, coagulative necrosis of epidermal cells and vesicle formation. Healing is rapid and complete by the regeneration of epithelium unless there is involvement of secondary infection.
- **Third degree burn** (Full thickness) : It is characterized by coagulation of epidermis and dermis. Severe edema of the subcutis develops and dry gangrene of the damaged tissue occurs. The epidermis is desiccated and charred with presence of black layer in skin. Permanent scarring occurs due to healing by granulation. Full thickness burn is insensitive to pain because of damage of cutaneous nerve endings.
- **Fourth Degree** : Here, subcutaneous fascia and deeper tissue like muscles, bones etc are involved. The clinical features are similar to those described in third degree burn. Repair is by scar formation preceded by sloughing of the necrotic tissue.

Etiology

The following may cause burn :

A. Thermal injuries

1. Direct heat
2. Flame
3. Scalding

B. **Electrical burns**

1. Electrical cord exposure
2. Lightning

C. Chemical burns

Injuries caused by chemicals like strong acids and alkalis, solvents, petroleum distillates and hot tars are referred to as chemical burns. The chemical produces localized necrosis of skin and deeper tissues with which it comes in contact. The degree of tissue destruction depends on the strength of the chemical and the duration of contact. Chemical causes local coagulation of proteins and necrosis.

Clinical Signs

Thermal burns

- Superficial-hyperemia, desquamation and pain.
- Partial thickness-exudation, pain, decreased sensitivity.
- Full thickness-White, black or brown, leathery escher, subcutaneous edema and little or no pain.

Electrical burns

- No pain.
- Well-circumscribed cold, blood less, pale yellow lesion.

Chemical burns

- Line of demarcation between dead and healthy tissue.
- Devitalized tissues may get infected.
- Formation of ulcer which heals gradually.

Treatment

The therapeutic measures must be aimed at

- termination of painful stimuli and improvement of the nervous system function for avoiding shock;
- reduction of autointoxication;
- Prevention of infection;
- promotion of rejection of coagulated skin and tissues and
- creation of favourable conditions for regeneration of skin.

Anti-shock measures are to be provided to prevent shock that may arise as burn complication. Burn may lead to renal failure and fatty infiltration of liver thus appropriate care should be extended to combat the complication.

Local treatment of burns should include :

- Application of **ice (3-17°C) pack** wrapped in a soft towel and cold water for 30 minutes or covers it with wet towels. This also helps to remove caustic substances (acid or alkali) if these are the cause.

- Hair should be removed and gently clean from the site. Necrotic tissue should be debrided. The area should be swabbed with weak vinegar (half water, half vinegar) using cotton wool or cloth.
- **Topical antibacterial ointments** may be applied to prevent the animal from post burn sepsis. Several topical commercial products like Aloevera cream, Silver sulphadiazine cream (Indo-Pharma), Silver nitrate 0.5% solution, chlorhexidine 0.5% Solution, gentamycin sulphate 0.1% cream, povidone iodine cream can be used. Soothing and protective preparations like Badional gel (Bayer), Caladryl cream (Park Davis), Burnol (Knoll) may be used as burn dressing.
- **Drugs** like gentian violet, picric acid, acriflavin and tannic acid should not be used as far as possible as they delay the healing process by damaging the living cells.
- **Analgesic** should be given to reduce pain.
- Hypovolemic shock and acidosis are to be prevented by supplementation of large quantities of **fluid** (Dextrose 5%) including 4% sodium bicarbonate.
- The treatment in chemical burns should include washing with lots of plain water and **neutralization** of the offending chemicals. Acids can be neutralized with 2-3% solution of sodium carbonate or milk, while alkali with 2% vinegar, citric or boric acid. Finally soothing ointment like olive oil may be applied. If shock occurs, keep the animal warm with heating pads or hot water bottles and a blanket of heavy coat. A burn patient (pet) should be provided with ample warm fluids to drink and this may be given in the form of milk or glucose water.

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CHAPTER 17

Frost Bite

Frost bite is injury of tissues due to the action of a low temperature on them. The condition is rare in animals because they can withstand cold temperature due to their hairy coats and will instinctively seek shelter from inclement weather. Udder and teats are commonly frozen in cows during exercise on frosty winter days. Besides the prepuce, penis and scrotum in horses, snout of pig, comb and wattles of birds, tip of the ear and scrotum of dogs, tail and distal extremities in other animals are commonly affected. It usually occurs in a low temperature but it can also ensue in prolonged action of wet moderate above zero temperature (3-7°C) since heat conductance of the skin is increased and heat emission is intensified by it.

Causes

- Exposure to cold or chilling environment.
- Contact with cold metal, glass, and liquids.
- Iatrogenic freezing with cryogens like liquid nitrogen and nitrous oxide etc.

Classification and Pathophysiology

Various degrees of frost bite recognized are:

1. Mild : Contraction of blood vessels (parts appear white) ⟶ paralytic dilatation of blood vessels ⟶ engorgement of vessels ⟶ parts appear red and swollen ⟶ thawing ⟶ severe pain

2. Moderately severe : Below 0°C temperature for longer period than mild ⟶ injury of Blood vessels ⟶ inflammation of the tissues ⟶ redness of epidermis together with certain amount of necrosis and blister formation ⟶ desquamation.

3. Severe : Temperature falls for lower than freezing point ⟶ impaired circulation of blood and lymph ⟶ parts undergoes necrosis and gangrene may ensue.

Clinical Signs

- Loss of sensation in the affected part.
- Cyanotic or pale appearance of frozen part.
- Moderate edemas, pain and very cold to touch.
- Shivering.
- In neglected cases, necrosis and sloughing of skin.

Treatment

- Withdrawal from cold
- **Warming** of frost bitten extremities, and restoration of blood and lymph circulation : Frozen animals must be immediately put in a warm housing to restore body core temperature. Hot water bag or hot pad may be used for warming; frozen parts should be bathed in increasingly warm water until pink colour is restored.

Drugs

- Prevention of infection with systemic **antibiotics.**
- **Fluid therapy** with dextrose should be considered.
- **Analgesics** may be provided to prevent self-trauma.
- **Artificial respiration** should be provided to frozen animals.
- The frozen tissue should not be massaged.
- Necrosed tissue if there, should be removed. **Amputation** of frozen part if necessary, should be carried out.
- **Diet :** High protein, high caloric diet and vitamins should be instituted.

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CHAPTER

18

Principles of Fluid Therapy in Surgical Patients

Fluid and electrolyte therapy is used (1) to replace dehydration deficits, (2) to maintain normal hydration, (3) to replace essential electrolytes and nutrients, and (4) to serve as a vehicle for the infusions of certain intravenous medications. It is an invaluable aid in management of surgical patients. Surgical patients require a normal fluid balance before surgery to prevent hypotension caused by peripheral vasodilation during surgery, and or to protect against excessive loss of fluid during surgery through bleeding or tissue drying. Healthy animals also show cardiovascular changes associated with anaesthesia and surgery. Anaesthesia alters vascular volume, depresses cardiac output and blood pressure and decreases compensatory responses to blood loss. In addition, concurrently administered drugs (antibiotics, corticosteroids) can depress vascular tone and blood pressure, some surgical procedures depress venous return, cardiac output and blood pressure, and evaporation from exposed tissue decreases vascular volume. In the compromised patient, there are additional problems of ongoing fluid losses (haemorrhage, sequestration etc) and incomplete therapy of hypovolemia, dehydration, electrolyte and acid-base abnormalities.

Volume of fluid needed

Volume resuscitation is the key to restoring perfusion, correcting tissue oxygen debt, and minimizing end-organ insult. The **volume of fluids administered** is the sum of the **replacement needs, maintenance requirements** and **estimated future losses.** Rapid replacement of existing deficits is best accomplished by **intravenous administration.** Replacement of intravenous fluid volume must be made based on physical findings (e.g. heart rate, pulse quality), central venous pressure and mean arterial pressure, PCV and TS, electrolyte and acid-base parameters and urine output.

Replacement needs can be calculated as follows:

Need (L) = % dehydration × body weight (kg) × 1 L + losses from vomiting, diarrhoea.

Maintenance requirements : In case of canine and feline, the normal maintenance requirement is approximately 50-70 ml/kg/day which may increase proportionately with the increment of metabolic requirements.

Rate of fluids administered varies with the condition of the animal especially on the severity of the dehydration. As a rule, the entire fluid deficit should be corrected and maintenance fluids should be administered before surgery takes place.

In hypovolemic patients that do not have cardiovascular disease, fluids may be administered at a rate of upto 100 ml/kg/hour. A satisfactory rate in cow is about 2-3 litre/hour and in horse 8-10 litre/hour. In small animals, the rate of fluid infusion can be determined by the following formulae :

Drops/minute × drop factor = ml/hour

Drop factor is obtained by dividing 60 by numbers of drop that are needed to deliver 1 ml.

Choice of fluids

The choice of fluids depends on the electrolyte status of the animal and concentration of the fluid loss.

- **Isotonic saline** solution when administered intravenously, remain within the extracellular fluid compartment and helps in increasing intravascular fluid volume.
- **Hypertonic saline solution** (> 0.9%) if administered intravenously, there is rapid rearrangement of fluids from the interstial to the intravascular space.
- **Lactated Ringer solution** helps to maintain acid base balance and is the choice of any unknown or emergency situation due to close resembles of electrolyte composition to plasma.
- **Hypotonic saline solution** like 5% dextrose supply free water.

In brief

ECF replacements : RL, NS

Plasma volume expander : Bovine gelatine, Dextran

ECF acidifiers : NS

ECF alkanisers : Bicarbonate or its precursors

ECF diluents : 5% dextrose solution

Estimating the Degree of dehydration

Percentage of Dehydration	Physical Examination Findings
<5	History of vomiting or diarrhoea but no physical examination abnormalities
5	Dry oral mucous membranes.
6-8	Mild to moderate degree of decreased skin turgor, dry oral mucous membranes.
10-12	Marked degree of decreased skin turgor, dry mucous membranes, weak and rapid pulse, slow capillary refill time, moderate to marked mental depression

Conditions requiring fluid therapy in surgical patients

- Healthy patients with no underlying pathology
- A balanced electrolyte solution (BES) such as Lacted Ringer's solution should be administered rapidly into the intravascular compartment throughout the anaesthesia which provides electrolyte in about same concentration as that found in blood.

- Dehydration prior to anaesthesia should be treated to ensure that patient stability is optimal.
- Well hydrated animals should provide free access to water for upto about 2 hours before induction of anaesthesia.
- Hypovolaemic animals should not be anaesthetized as irreversible tissue damage may occur with the added insult of cardiovascular depression induced by anaesthetic agents and surgery.

The compromised patient

Requirements of fluid during surgery depend on the underlying cause and the procedure. Compromised patients should not be anaesthetized before the cardiovascular system has been stabilized. The choice of fluid in compromised patients is balanced electrolyte solution (BES) at 10-15 ml/Kg/hour. Other fluids like plasma, colloid, blood or related blood substitutes may be used.

Haemorrhage during surgery

There are certain surgical conditions like tumour excision, amputation, mandibulectomy, nasal and sinus surgery, maxillectomy where bleeding may be expected. The resultant blood loss may lead to decreased tissue oxygen delivery.

To re-establish normovolaemia, Lactated Ringer solution (LRS) is the most commonly used replacement fluids because they are usually effective, readily available, easily administered, and relatively inexpensive. This results further haemodilution, but decreases blood viscosity without adversely affecting tissue oxygen delivery. Hypertonic saline solution @2-4 ml/Kg may be used as an alternative source of LRS. If PCV actually falls, blood or oxyhaemoglobin are needed to maintain tissue oxygen delivery.

Gastric Dilatation-Volvulus (GDV)

The GDV complex causes hypovolemic shock as well as gastric sequestration of fluids and electrolytes. Although the hypovolemia may lead to tissue hypoxia and eventually metabolic acidosis, there are several instances in which the gastric hydrogen and chloride ion sequestration can offset the acidosis and perhaps even cause a metabolic alkalosis.

GDV complex in canine are initially treated with LRS to re-establish normovolaemia, their acid-base parameters should be monitored if possible in order to detect any need for a change in fluid type.

Fluids for the patients with Anaemia

Intravenous fluids are sometimes used excessively in the anaemic patient when the decrease in red blood cell mass is misinterpreted as total blood volume depletion. Anaesthetic drugs during surgery reduce PCV mildly to severely depending upon the agents used and volume administered.

The dehydration deficit and maintenance fluid volumes should be gradually replaced over a 24-hour period with an isotonic crystalloid solution, while fresh whole blood is used to replace the red blood cells before anaesthesia. The volume of whole blood infused should be considered when calculating the volume of crystalloid for infusion.

Blood substitutes

There are several problems associated with administering blood which include limited availability, incompatibility and disease spread. Moreover, crossmatching and blood-typing, collection, and storage procedures restrict the use of blood products in an emergency situation.

An ideal characteristic of blood substitutes should be nontoxic, free of pathogens, capable of transporting oxygen and carbon dioxide, have a long shelf life, and be available at a reasonable cost.

A haemoglobin-based oxygen carrying solutions has recently been derived from bovine haemoglobin (**Oxyglobin**). Oxyglobin is a dark purple, sterile, polyionic colloidal fluid, pH 7.8, based on glutaraldehyde-polymerized, ultrapurified bovine haemoglobin formulated in a modified Lactated Ringer's solution that requires no cross-match prior to infusion due to lack the antigenic red cell stroma present in whole blood. Oxyglobin can potentially improve overall oxygen carrying capacity, not only by increasing total haemoglobin concentration in excess of that found in circulating erythrocytes, but also through facilitative transport of oxygen between erythrocytes and tissue and the "near wall excess" phenomenon where plasma containing cell-free haemoglobin is concentrated at the walls of blood vessels. It is metabolized and eliminated via the reticuloendothelial system. Approximately 90% of the administered dose is eliminated from the body 5 to 7 days after infusion. The recommended one time dose is 30 mL/kg administered intravenously at a rate of up to 10 mL/kg/h but may overload the vascular volume.

Summary of fluid therapy for surgical patient

- The volume and type of fluid are dependent on the patient's physical status, the acid-base, fluid and electrolyte status; the surgical procedure; and the expected losses occurring during the procedure.
- No one fluid schedule is perfect for all patients.
- A brief minor surgical procedure in a healthy surgical patient needs little or no fluid therapy.
- Extensive surgical procedures involving invasion of the abdomen or the chest as well as in cases with trauma and expected major blood loss, much more volume and a specific balanced replacement of fluid are needed.
- Based on the severity of the surgical case, administration rates of 5 to 15 mL/kg/h or greater of crystalloid may be required to maintain perfusion.
- Blood loss of 20% to 25% of the calculated blood volume is indications for colloids or blood replacement at the ratio of 1 : 1.
- A better approach in fluid therapy is combination of crystalloids as well as natural and synthetic colloids, to obtain and maintain perfusion and oxygenation to the tissues.

●●●

CHAPTER 19

Surgical Infections

An **infection** is the detrimental colonization of a host organism by a foreign species. In an infection, the infecting organism seeks to utilize the host's resources in order to multiply (usually at the expense of the host). The infecting organism, or pathogen, interferes with the normal functioning of the host and can lead to chronic wounds, gangrene, pain and discomfort and even death especially in veterinary surgery.

Classification

- Incisional
  - ♦ superficial (skin and subcutaneous tissue)
  - ♦ deep (deep soft tissue muscle and fascia)
- Organ/space manipulated during an operation.

Deep incisional and organ/space are the types of surgical site infections that cause the most morbidity.

Etiology

1. Endogenous (*e.g.*, bacteria on the patient's skin): Most surgical site infections are caused by the patient's own bacterial flora.
2. Exogenous sources (*e.g.*, personnel, the environment or materials used for surgery).

The most common microorganisms causing surgical site infection are *Staphylococcus aureus*, *Coagulase negative staphylococcus* and *Enterococcus*.

Microbes most likely to cause acute infection at different body sites

Traumatic and surgical wounds	*Staphylococcus aureus*, Group A hemolytic Streptococcus (*Streptococcus pyogenes*), Gram negative bacilli, Clostridia, Anaerobic streptococci, Enterococcus
Abscess	Anaerobic Streptococci, *B. frugilis*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Streptococcus pneumoniae*, Fungi, Actinomyces, Norcardia, *Pseudomonas aeruginosa*.
Joints (septic arthritis)	*Staphylococcus aureus*, Group A haemolytic Streptococcus (*Streptococcus pyogenes*), *Streptococcus pneumoniae*, Gram

	negative bacilli, *Haemophilus influenzae*, *Mycobacterium tuberculosis*, Fungi
Bone (osteomyelitis)	*Staphylococcus aureus*, Group A haemolytic Streptococcus (*Streptococcus pyogenes*), *Salmonella*, *Mycobacterium tuberculosis*, *Pseudomonas aeruginosa*

Factors that increased risk include diabetes, steroid use, obesity, malnutrition etc. Other preoperative and intraoperative risk factors are:

- Asepsis
- Inappropriate use of antimicrobial prophylaxis
- Infection at remote site not treated prior to surgery
- Shaving the site vs. clipping
- Long duration of surgery
- Improper skin preparation
- Improper surgical team hand preparation
- Environment of the operating room (ventilation, sterilization)
- Surgical dress and drapes
- Surgical technique: haemostasis, sterile field, foreign bodies
- Operating room traffic
- Administration of supplemental perioperative oxygen may decrease surgical site infections rates.

Optimization of antimicrobial prophylaxis

It is one of the most important interventions in preventing surgical site infections. It provides a brief course of an antimicrobial agent in order to reduce the microbial burden of intraoperative contamination to a level that cannot overwhelm host defenses. It is critically timed adjunct to other surgical site infections prevention measures but not an attempt to sterilize tissues.

Following factors are to be taken into considerations while practicing optimal surgical antimicrobial prophylaxis :

- Appropriate choice of antimicrobial agent.
- Proper timing of the antibimicrobial prior to the incision.
- Limiting the duration of antimicrobial administration after surgery.

Appropriate Antimicrobial agent

Clinical efficacy, safety, cost and spectrum should be the guideline for selection of antimicrobial agents. It should be "active against the pathogens most commonly associated with wound infections following a specific procedure and against the pathogens endogenous to the region of the body being operated on." In clean contaminated procedures, it is generally recommended that a single dose of cephalosporin be administered intravenously by anaesthesia personnel just before the incision.

Proper timing of Antimicrobial administration

Timing of administration should be selected so that optimal concentration in the serum/tissue at the time of the incision can be achieved. It is equally important to maintain that

therapeutic level in the serum/tissue throughout the operation. If the surgical procedure is longer than the half-life of the drug, the drug must be re-dosed during the procedure. Preferably, the drug should be given no more than 30 minutes before the skin is incised.

Limiting the duration of antimicrobial administration

Discontinuation of the antibiotic within 24 hours after surgery is recommended in medical practice for two reasons:

1. Use of the surgical prophylaxis antimicrobial agent past this time frame has not been shown to improve surgical site infections rates and increases the cost of care unnecessarily.
2. Indiscriminate use of antimicrobials can lead to the development of antibiotic resistant microorganisms.

Treatment of surgical infection

A fundamental prerequisite for successful management of bacterial infections is the availability of a therapy effective against the offending microorganisms. The immune system of the host is well equipped to combat bacterial infection. Antimicrobials include the antibiotics as well as the semi-synthetic compounds used against microorganisms. Apparently the most justified use of antibiotics in small animals is the therapeutic application against specific diseases, although a judicious strategy is warranted in therapeutic use.

Qualities of an ideal antimicrobial agent

The desirable qualities of an antibacterial agent include :

- Should be broad spectrum in action.
- Should preferably be bactericidal in nature.
- Should not produce supra infection.
- Should be stable at room temperature.
- Should not produce cross resistance within group.
- MEC should be maintained for long duration.
- Should have good distribution in various body fluids and tissues.
- Protein binding should not affect its clinical effect.
- Should have a high therapeutic index (more than 4).

Selection of antibiotic

The factors for selection of antibiotic include :

- Identification of the infecting organism based on culture.
- Identification of the anatomic and pathologic sites of infection.
- Sensitivity of the pathogen to the antibiotic.
- Cost effectiveness.
- Route of administration, therapeutic dose, duration of therapy and clinical pharmacology.
- Age, sex and species of animal.
- State of body defence.
- Indications for combination therapy.

Empirical antimicrobial selection is indicated in life-threatening maladies that exist or develop while awaiting culture and sensitivity results and in minor infections where culture and sensitivity testing are not cost effective.

Duration of antimicrobial therapy is based on clinical and laboratory findings. Generally in veterinary surgical patients, with wound infections are treated for 10-14 days. Animals with existing wound infections are treated initially with intravenous medication followed by hospitalization.

Empirical Antibiotic therapy

Source of infection	Possible Organism	Perferred Antibiotics
Skin, urogenital tract, osteomyelitis	Staphylococcus	Amoxicillin-clavulanate, Gentamycin, cephalosporin, oxacillin, clindamycin, trimethoprim-su;phamethoxazole.
Traumatic wounds and alimentary or urogenital tracts	*E. coli*	Amoxicillin-clavulanate, Gentamicin, cefazolin, enrofloxacin, amikacin
Burns, urinary tract	Pseudomonas	Ciprofloxacin,
Abscesses, respiratory tract	*Bacterioides fragilis*	Amoxicillin-clavulanate
Nosocomial, alimentary tracts	Klebsiella	Amikacin, enrofloxacin, cefazolin.
Soft-tissue infection and respiratory tract	Pasturella	Amoxicillin, ampicillin cefazolin.

Reasons for failure of antimicrobial therapy

- Improper diagnosis of the offending microbial agents.
- Development of resistance during the course of therapy.
- Suprainfection by a resistant opportunist pathogen.
- Reinfection on withdrawal of treatment.
- Antibiotic not sufficient to kill multiple pathogens.
- Presence of foreign body at the site.
- Inappropriate route of administration and insufficient dose of drug used.
- Reduced body defence and drug interactions.

Nosocomial infections are infections that are not present or incubating at the time of ad[illegible]tance but develop during hospitalization. Common nosocomial pathogens are *Chlamydia, M[illegible]plasma, Klebsiella, salmonella, clostridium perfringens, Pseudomonas aeruginosa, Pasturella mu[illegible]cida, E. coli, Staphylococcus, Sreptococcus* etc. In veterinary practice nosocomial infections [illegible] respiratory tract infections, urinary tract infections, surgical wound infections and bacteremia [illegible]ated with intravenous catheterization.

[illegible]ontrol of these [illegible]fections includes eliminating the source of infection, interrupting spread [illegible] and modifying risk factors.

- [illegible] before and after contact with each animal.
- Isolation of anim[illegible] with nosocomial infections only and reservoirs of said infections.
- Surveillance routines should be established by periodic and random microbial sampling and hospital equipment.
- Maintenance of proper surgical technique.

CHAPTER

20

Affections of Muscles, Arteries, Veins and Nerves

AFFECTIONS OF MUSCLES

Muscle lacerations

Any muscle may be injured along with fracture of the adjacent bones. Muscles lacerations are common in domestic animals mainly in cattle, buffaloes, goats and rare in sheep due to presence of thick layer of wool.

Etiology

Muscle lacerations are generally occurred as a result of:

- Violent muscular contractions
- Overextension of joints while kicking
- Wire cuts, dog bites, hoof and horn injuries
- Overstraining by body weight during rearing up
- Car accidents

Clinical signs

- Impairment of posture and gait accompanied by lameness if [illegible]scles of extremities are lacerated.
- Prolapse or hernia of internal viscera in lac[illegible]rations of abdominal muscles.
- Marked sagging of chest area with difficulty in movement in bilateral lacerations of [illegible]scle ventral [illegible]
- Feeling of depress[illegible] or fluctuation in [illegible]

Treatment

- [illegible]
- Haemorrhag[illegible] must be [illegible] using tourniquet. Larger vessels if still [illegible]
- In severe blood loss, fluid [illegible]ations [illegible]

- Wound should be thoroughly cleaned and debrided with warm isotonic saline solutions followed by application of antiseptic lotions. Presence of foreign body if any, should be removed. Wound closure may be accomplished as per the standard protocol of wound management.
- Topical and systemic antibiotic therapy should be considered in contaminated and infected wound.
- Finally, immobilizing dressing should be applied where it is needed.

Muscle rupture

Muscle rupture either partial or complete is generally observed in younger animals as compared to tendon ruptures in older animals.

Etiology

- Powerful active contraction of a flexor motor unit at the same time forced passive extension occurs.
- Direct injury from slipping, struggling while casting, falling from a height etc.
- Necrosis of muscle resulting from eosinophilic myositis may also lead to rupture of muscle.
- Rupture of ventral abdominal muscle may occur due to paucity of thick layer of wool in sheep.

Signs

- Local tenderness, subcutaneous ecchymosis, swelling and lameness are the main signs in muscle rupture.
- Rupture of gastrocnemius muscle : inability to maintain the normal support at hock.
- Rupture of peroneus tertius muscle : dragging of hind foot and looseness of achillis tendon. Hock-extended, stifle-flexed.
- Rupture of adductor muscle : recumbency.
- Rupture of biceps femoris muscle : signs resembling to intermittent upward fixation of the patella in ruminant.

Treatment

Incomplete rupture

- Immobilization with cold packing in acute cases.
- Rest with pressure bandage to alleviate pain.
- Immobilization of affected limb followed by restricted activity for two or three more weeks.

Complete rupture

- Reparative surgery may be considered of the affected muscle.
- Physical therapy and active and passive movement after four to six weeks are considered.

MYOSITIS

Inflammation of a muscle is called **myositis** occurred mainly due to traumatic injury or infection.

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Classification

Myositis can be broadly classified into:

1. **Traumatic Myositis** results from contusions, sprains and lacerations of mus Lameness is observed if limb muscles are affected. Acute symptoms of inflamm are observed. The inflamed muscles are enlarged, painful and tense at site of in Palpable fluctuation is observed in partial and complete lacerations.
2. **Infective Myositis** is caused by bacterial infections that have invaded the muscle t through the injured skin. Elevation of general body temperature and impairme muscle function are noted.
3. **Fibrous Myositis** is accompanied by overgrowth of interstitial connective tissue atrophy of muscular fibers with scar formation. This type of myositis is a resulta purulent, rheumatic and traumatic myositis. There is cord-like consolidation enlargement of muscle with absence of tenderness. Contracture of joint may ens there is involvement of muscle or shortening of it.
4. **Rheumatic myositis** is accompanied by neurodystrophic processes in the system c connective tissue, caused by prolonged action of an infectious-toxic irritant alth the exact etiology of this condition remains unclear. The characteristic signs note rise in body temperature, tenderness of muscles, stiff gait and pain. Animals pre lie for a longer time and stand up with great difficulty. During movement, lam appears in alternate limbs, then disappears for a while and again reappears.

Treatment

- Rest is integral part of all form of myositis.
- Local application of antiphlogistic drugs followed by massage of a counter irritant
- Systemic administration of broad spectrum antibiotic is considered wherever infect suspected.
- In rheumatic myositis, administration of antipyretic, analgesic and anti-inflamm agents is considered until favourable response is achieved.
- Various physiotherapeutic procedures like diathermy, light irradiations, vibration ma and ultrasound may be used topically especially for rheumatic and fibrous myos

MUSCULAR ATROPHY

Muscular atrophy is characterized by reduction in muscle size and volume.

Etiology

- Generalized muscle atrophy-old age, impairment of nutrition supply and certain cl diseases (arthritis *i.e.* osteoarthritis, osteomyelitis, ankylosis of joints etc).
- Localized muscle atrophy-paralysis of peripheral and spinal nerves, muscle in (laceration and compression), presence of neoplasm.
- Deficiencies of vitamin E, B and starvation.
- Thrombosis of major vessels and resultant diminution of nutrient supply leads to isc atrophy.
- Genetic predisposition.

Symptoms

- Asymmetrical muscle mass in comparison to other side of body.
- Bony prominences are pronounced against the background of atrophied muscles.
- Paralysis and absence of sensation in muscle are observed in neurogenic muscle atrophy.

Treatment

- Identification of underlying cause of disease and its elimination.
- Local massage combined with active or passive movements for restoring muscle function.
- Rubbing with a counter-irritant ointments and liniments.
- Injections of vitamin E, B group are indicated.
- Electrotherapy with galvanic current prevents atrophic events.

MUSCLE HYPERTROPHY

Muscular hypertrophy is an increase in muscle mass and cross-sectional area. The increase in dimension is due to an increase in the size (not length) of individual muscle fibers, Muscle hypertrophy can be induced by a number of stimuli in which the most familiar is abnormal exercise. However, genetic predisposition may be the factor that has been reported in bovine. There is excessive muscular development with presence of intermuscular septa.

MUSCULAR DYSTROPHY

Muscular dystrophy is a slowly progressive, degenerative and atrophic change affecting a variety of muscles. It occurs as an inherited disease affecting sheep, cattle, dogs, cats, pigs etc. Progressive stiffness of the limbs and neck are observed on 6 months of age.

Symptoms

- In dogs, there is muscular weakness, dysphagia, stiffness in gait, exercise intolerance and muscular atrophy.
- In ruminants, swollen, painful muscles; stiffness and weakness due to involvement of skeletal muscles.
- Muscle contracture and scoliosis.

Treatment

There is no specific known treatment for any of the forms of muscular dystrophy. Physical therapy to prevent contractures, orthoses (orthopedic appliances used for support) and corrective orthopedic surgery may be needed to improve the quality of life in some cases.

FIBROTIC MYOPATHY

Fibrotic myopathy is a chronic, progressive, idiopathic, degenerative disorder primarily observed in dogs. In riding horses, it is also called as **ossifying myopathy** affecting semimembranosus, semitendinosus, and biceps femoris muscles. There is progressive fibrosis with local adhesions of the affected muscle which subsequently ossify. Although the exact etiology in dog is not known, in horses trauma may be the main reason.

Symptoms

- Nonpainful muscle atrophy may be seen.
- There is normal neurological function.

- In horses, gait is fairly characteristic: forward phase of stride is jerky and foot is jerked back of foot for a short distance before placing on the ground.

Treatment

- Surgical management of affected tissues by tenotomy, myotenotomy, Z-plasty or complete resection.
- Surgical resection of the medial ligament of semitendinosus at the stifle in equine.

CONGENITAL MUSCLE CONTRACTURE

Muscle contracture occurring from congenital factors, are due to damage of muscle fibers, nerve and vessels. These changes are irreversible and often lead to lameness resulting from minor changes in gait to complete loss of limb function.

Chondrodysplasia syndrome is observed mostly in calves characterized by unabling to stand properly due to permanent flexure of one or both forelimbs along with abnormal chondral ossification.



Chondrodysplasia in calf



Arthrogryposis in calf

Doubling muscling is an overdevelopment of the musculature especially in shoulder, back, rump and inner quarters. It is supposed to be caused by a pair of incompletely recessive genes.

Arthrogryposis is ankylosis of the limbs with other growth deformities. It occurs in all breeds of cattle. Although arthrogryposis has more than one etiology, the noticeable muscle changes observed are thought to be due to fetal stress. The affected animals are usually unable to stand.

AFFECTIONS OF VEINS

Phlebitis

Phlebitis is defined as inflammation of vein. Inflammation of adventitia of a vessel is called **periphlebitis** and in intima is **endophlebitis**. If a thrombus is formed in vein inflammation, the

process is called **thrombophlebitis**. These conditions are mostly seen in animals in large veins mostly used for blood collection and intravenous medications.

Etiology

- Improper puncture of a vein without asepsis and antisepsis rules.
- Puncture of vein with blunt needles with the animals being excited.
- Too rapid administration and very high concentration of irritant drugs lead to chemical burn of vascular wall.
- Extension of purulent foci outside the vein.
- Presence of infection.

Clinical signs

- Moderate inflammation and pain reaction at the affected site.
- Marked oedema of the dependant region due to venous flow interferences.
- In chronic cases, inflamed vessel appears like a fibrous cord.
- Abscess formation along the course of vein in purulent phlebitis.
- Repeated haemorrhage in haemorrhagic phlebitis.

Treatment

- Elimination of causes of disease and prevention of infection by suitable antibiotics and clot formation.
- Drugs that help to clot resorption should be used.
- Counterirritants may be used in dependent portion to stimulate collateral circulation.
- In purulent phlebitis, surgical excision of the affected segment of vein is advisable at the early stage of inflammation.

VARICOSE VEINS

Varicose veins refer to the marked dilatation as well as elongation of vein. Although, this condition in animal is low as compared to human subject, still most cases are reported in cattle and buffalo mainly involving radial, saphenous, cephalic, mammary or coccygeal veins.

Etiology

- Trauma or proximal occlusion or insufficiency of the valves resulting to become dilate, tortuous and elongate and loose the elastic property of vein.
- Other predisposing factors are local hypoxia, malnutrition and pain.
- Repeated vascular trauma results to thinning of blood vessel wall.

Treatment

Exact location may be ascertained by contrast radiography.

- In early stages- ligation of arteriovenous shunt.
- In advanced stages- ligation is not recommended for the same.
- Compression bandage may provide temporary relief from pain.
- Injection of sclerosant substances at the site is advisable.

ARTERITIS

Arteritis means inflammation of artery. It is very rare in domestic animals as a sole dise and may develop at the site of cellulitis, osteomyelitis, sepsis and ulcerative conditions.

In purulent arteritis, initially the canal is obstructed with a thrombus which is soon ly and forms various purulent emboli. This purulent embolus is then transmitted in various part body resulting to the onset of infection. The inner coat of artery is thickened causing constric of canal. The peripheral blood supply is impaired resulting to necrosis or gangrene of tissue the area.

Treatment

- Elimination of local inflammatory factors causing this condition.
- Intra-arterial injection of suitable antibiotic in infectious endoarteritis.
- Measures to be taken to dilate a constricted vessel canal to improve peripheral bl circulation.

LYMPHANGITIS

Lymphangitis is the inflammation of lymph vessels due to invasion of pathoge microorganisms from local infection site and absorption of their toxins. This condition has b reported in camels and horses. Enzootic lymphangitis observed in horses is caused by *Cryptococ farciminosus* and is characterized by inflammation of lymph vessels of the skin and subcutane fat. Traumatic lymphangitis is caused by *Streptococci* or *Staphylococci* where infection is ente through a wound in skin.

Signs

- In purulent lymphangitis, lymph vessels protrude more on the skin, well noticeable hairless skin (scrotum, udder) and appear as solid cards and painful at palpation.
- Enlargement of respective regional lymph node.
- In severe purulent lymphangitis in cattle, solid nodes are seen along lymph vessels after a few days, it converted in a small abscess, often self-rupturing.
- In deep purulent lymphangitis, there is inflammatory oedema in areas of traver lymph vessels with pain reaction on palpation.
- In camel lameness, oedematous swelling and fever are seen.

Treatment

- Treatment should be directed at preventing toxin absorption and eradication of infec from the primary septic focus.
- Application of liniments and massage to the area is indicated to reduce swelling stimulating the circulation.
- Control of infection by parenteral administration of suitable antibiotics is advisabl
- For absorption of oedematous fluids, five percent lugol's solution @ 70-100 ml per by slow intravenous administration is indicated.
- Extirpation of nodes and abscesses is considered in enzootic lymphangitis.

AFFECTIONS OF NERVES

Spastic paresis

Spastic paresis was reported in cattle in 1922 and has been referred to as **"Contraction of the achilles tendon", "Elso heel"** and **"Straight hock".** In calves, the condition appears 1 week to 1 year of age of either sexes and is characterized by extension of the stifle and tarsus and by spastic contracture of the muscles of one or both hind limbs. In adult cattle, the condition appears between 3-7 years of age and is characterized by extension of muscles of the back and hind limbs, causing lumber lordosis and caudal extension of the limbs. The condition is thought to be inherited by autosomal recessive genes.

Clinical signs

- In calves, there is progressive lameness, the leg is usually held in extension behind and the toe fails to touch the ground. At a later stage, the limb appears shorter than normal and swings like a pendulum.
- In severe cases (after a period of months), the animals fails to maintain body balance and may fall while turning.
- In advanced stages, the animal feels difficulty in getting up and stands on three limbs with arched back.

Treatment

Four surgical techniques may be approached to relieve the spastic paresis.

- Neurectomy of the tibial nerve *i.e.* severing of the tibial nerve supplying the lateral and medial heads of gastrocnemius.
- Complete severing of gastrocnemius tendon and partial severing of superficial digital flexor tendon.
- Achilles tenotomy leaving the fascial sheaths intact.
- Partial or complete severance of gastrocnemius and superficial flexor tendons.

PERIPHERAL NERVE INJURIES

Peripheral nerve injuries are common in veterinary practice that may occur due to trauma or other lesions near the nerve. The common affected nerves and their clinical manifestations due to injury are summarized below:

Nerve injured	Characteristic signs
Olfactory nerve	Loss of smell (anosmia)
Optic nerve	Blindness
Loss of motor function	Impairment of prehension and mastication and clinically manifested by dropped jaw and protrusion of the tongue
Glossopharyngeal nerve	Difficulty in swallowing, abnormal vocal sounds and interference in respiration
Abducent nerve	Protrusion and medial deviation of the eye globe
Hypoglossal nerve	Difficulty in prehension and protrusion of tongue

Facial nerve	Dropping of ear and eyelid, accumulation of food in the vestibule on the affected side
Spinal nerves	Atrophy of the associated muscle
Suprascapular nerve	Abduction of the forelimb
Brachial plexus	Paresis of the affected limb
Radial nerve	Affected limb appears longer than the normal, flexed fetlock and dragging of limb during progression
Sciatic nerve	The animal may bear weight, but the stifle does not flex
Tibial nerve	The animal stands knucked over and drags the limb during progression
Peroneal nerve	Dragging of affected limb and hock joint in overextended position
Obturator nerve	Pelvic limb ataxia, total abduction of both the hind limbs in bilateral affection

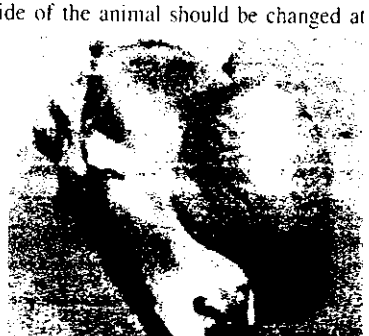
Treatment

In all the above cases, prognosis depends upon the character of nerve injury. Contused, stressed and compressed nerve fibres can restore normalcy gradually. However, in severe affections and lacerations, recovery is hopeless. In cases, where motor and sensory functions are partially lost, prognosis is favourable where; reinnervation of nerve is expected within the passage of time. The following steps are to be undertaken for management of the conditions:

- Rest is an integral part in recent injuries.
- Soft bedding materials and clean floor condition is imperative.
- To abolish pain and reduce inflammation, administration of anti-inflammatory drugs and immobilization of the affected part are indicated.
- Physiotherapy in the form of slight massage, moderate thermal procedures and passive movements are helpful from fourth-fifth day to prevent muscle atrophy.
- To avoid bed sores in recumbent animals, the side of the animal should be changed at regular intervals.
- Administration of nerve tonics (Vitamin B complex injection) may be helpful in some cases.

HYDROCEPHALUS

Hydrocephalus is a neurological disease in which there is excessive accumulation of cerebrospinal fluid (CSF) within the ventricular system of the brain. The resulting increased pressure on the brain causes the clinical signs that occur with this condition. It may be observed in young animals (less than 18-months age) or older animals (greater than 6 years old) and either sex are equally affected.



Hydrocephalus in a calf
Courtesy Dr. A Patil

Etiology

- In young animals, it is mostly congenital in origin (born with this condition), intrauterine or perinatal infections and perinatal trauma.
- In older animals, the condition is acquired later in life due to some disease process that blocks normal drainage of CSF. The outward signs are not as evident since the bones of the skull are already fused.
- Deficiencies of vitamin A lead to acquired hypothalamus where absorption of fluid is impaired.
- Presence of tumour, cyst, and haematoma etc. cause mechanical obstruction of impaired drainage of CSF and may lead to acquired hypothalamus.

Clinical signs

Symptoms of hydrocephalus vary with the cause, the age of occurrence, the brain tissue being compromised and the degree of tissue damage. The following signs are generally seen in animals:

- A domed skull (which gradually become more pronounced).
- Abnormal movement behaviours (restlessness, aimless walking, unable to stand of its own etc.).
- Head pressing, tilting and circling.
- Problems with vision (blindness) and auditory impairment.
- Paddling and seizures.

Treatment

The aim of treatment is to minimize or prevent brain damage by improving CSF flow. Treatment mostly depends on the severity of the clinical manifestations and recognizing the ongoing medical problems.

- Drugs that either decrease the production of CSF or increase CSF absorption are considered. Corticosteroid may be helpful for this situation. Short term diuretics may be given.
- Prevention of trauma such as falling or rapid changes in pressure.
- Phenobarbitone may be indicated in dogs that experience convulsions.
- Surgical treatment of severe cases of hydrocephalus is placement of a permanent shunt outside of the brain to drain the fluid.



Gid in a goat

GID (COENUROSIS)

Gid is a localized, space occupying metacestodal disease occurring in brain caused by the invasion of intermediate stages of Taenia multiceps (*Coenurus cerebralis*). This condition is commonly seen in sheep, goat and ox although incidence is relatively higher in goat and sheep.

Clinical signs

- There is increased intracranial pressure
- Ataxia
- Varying degree of blindness
- Head deviation on the affected side and pressing on a hard object, circling movemen
- Occasional muscle tremors
- Anorexia

Treatment

Simple aspiration of the cystic fluid through the softened skull bones can be done bu chances of recurrence is common. **Surgical management** of gid is to be performed if cyst i located superficially. For this infiltration anaesthesia with 2% lignocaine hydrochloride is performe to minimize the pain sensation. A cross incision or C-shaped incision with convexity directe rostrally is given and the bone is exposed. If there is no softening of the skull bone, triphenin is done to remove a small disc of bone. The cyst is then removed carefully without making an tear of cyst. There after, the area of operation is painted with mild antiseptic solution. The ski incision is closed by routine standard procedure. Broad spectrum antibiotic for seven days an dressing of the wound are recommended.

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UNIT 2

ANAESTHESIOLOGY

CHAPTER

1

Development of Veterinary Anaesthesia and Its Importance in Veterinary Surgery

The first recorded use of anaesthesia goes back to the ancient Incas; shamans got coked-up chewing cocoa leaves and drilled holes in the heads of their patients (to let the bad spirits escape) while spitting into the wounds they'd inflicted. The use of anaesthesia dates back to 300 B.C. in the Alexandrian period when the juice from the mandrake plant was used. At the same time, unconsciousness was induced by compression of the carotid artery (by Egyptians). The first herbal anaesthesia was observed in pre-history. Opium poppy capsules were collected in 4200 BC and opium poppies were framed in Sumeria and subsequent empires. Opium was not introduced to India and China until 330BC and 600-1200 AD, but these nations pioneered the use of cannabis incense and aconitum. Through Europe, Asia and the America, a variety of Solanum species containing potent tropane alkaloids were used, such as mandrake, henbane, *Datura metel* and *Datura inoxia*. Anaesthetics were sometimes administered in the *Spongia somnifera*, a sponge into which a large quantity of drug was allowed to dry, from which a saturated solution could be trickled into the nose of the patient.

Name of Scientist	Year	Important development
Theodoric of Lucca	1298	Used sponges soaked with opium and mandragora for surgical pain relief.
Paracelsus	1540	Administered ether to chicken.
Humphrey Davy	1800	Introduced to his classic work, Researches, Chemical and Philosophical : Chiefly Concerning Nitrous Oxide, or Dephlogisticated Nitrous Air, and its Respiration.
Henry Hill Hickman	1824	Introduced painless surgery on animals using carbon dioxide as an anaesthetic.
William E. Clarke	1842	Administered ether from a towel to a Miss Hobbie prior to the removal of a tooth by dentist Elijah Pope.

William T.G. Morton	1844	Used sulphuric ether as a local anaesthetic agent in his Boston Dental practice.
Horace Wells	1844	Described the use of nitrous oxide for dentistry.
Flourens	1847	Described the use of chloroform for anaesthesia in animals.
Pirogoff	1847	Rectal anaesthesia was introduced in animals using chloral hydrate.
John Snow	1853	Administered chloroform to Queen Victoria for the birth of Prince Leopold.
Dr. C.T. Jackson	1853	Extensively used ether in animals.
Dadd	1854	Used ether and chloroform for general anaesthesia in animals.
Ore	1875	Monograph on IV anaesthesia was published using chloral hydrate.
Vassily von Anrep	1884	Published first extensive account of the clinical use of cocaine in a Russian journal.
Dr. August Bier	1897	Administered the first spinal anaesthetic in animals.
Cuillie and Sendrail	1901	Described subarachnoid anaesthesia in cattle and horse.
Cathelin	1901	Epidural anaesthesia was described in dogs.
Selheim	1909	Paralumbar anaesthesia was described in man.
Retzgen, Benesch & Brook	1920	Epidural anaesthesia was described in large animals.
	1930	Barbiturates was introduced in animals.
Farquharson and Formston	1940	Described paralumbar anaesthesia in cattle.
Charpentier	1950	Introduced phenothiazine as tranquilizer in large animals
	1956	First time halothane was used clinically in veterinary practice.
	1971	Introduced xylazine and ketamine.
	1985	Introduced isoflurane for veterinary clinical use.
	1989	Introduced propofol.
	1993	Released Desflurane for veterinary clinical use.
	1999	Introduced sevoflurane.

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CHAPTER 2

Preanaesthetic Considerations

GENERAL CONSIDERATIONS

1. Species : Species difference plays a vital role in anaesthesia that may prevent the use of certain drugs.

A. **Ruminants:** Generally, ruminants are not good subjects for general anaesthesia unless endotracheal intubation is done. Regional anaesthesia has gained popularity nowadays in these animals. Major abdominal surgery can be done by paravertebral or lumbar epidural anaesthesia. Caudal epidural anaesthesia is routinely used for obstetrical operations.

B. **Equines :** Restraint is of paramount importance even in simple handling as may cause excitement. Casting may lead to fracture in a conscious animal unless an experienced team is available. Besides, casting is necessary for the safety of the operator as well as for the animal. During the use of general anaesthesia, care should be taken so that induction should be rapid without excitement, prompt recovery from anaesthesia and animal may stand early without falling.

C. **Pig :** Restraint and handling of pig produces struggling and continuous squealing. Pig is a good subject for general anaesthesia with sedatives followed by inhalation or intravenous anaesthetics. Local anaesthetics are sufficient for piglets.

D. **Dog and cat :** General anaesthesia is successfully used in dog for all types of operation except in brachycephalic breeds with nasal bone depression as relaxed jaw muscles cause obstruction. Morphine in higher doses causes excitation in cat.

2. Age : Anaesthesia in the very young patient is subjected to higher risk due to limited size, limited muscular and adipose tissue in which anaesthetic may be redistributed and underdeveloped metabolic and excretory mechanisms.

3. Breed : Breed predisposition plays a role in anaesthesia. Brachycephalic dogs need a patent airway via endotracheal intubation due to their pendulous soft palate and restricted respiratory passages. Short-lasting anaesthetics (e.g. Propofol) may be chosen for rapid elimination from the body and avoidance of prolonged recovery period. Anaesthetics in large animals such as cattle and horse should be selected to provide rapid recovery with minimal emergence struggling (more in horse). The potential hazards of general anaesthesia in ruminant are tympany, regurgitation and aspiration, so regional anaesthesia is preferred.

4. Disease conditions : General anaesthesia is contraindicated in certain disease conditions like renal failure, heart worm infestation and congenital heart disorders. Wasting disease produces tachycardia and a soft, friable myocardium. Such animals may develop cardiac failure due to anaesthetic stress.

5. Nature of operation; its magnitude, site and duration : Local anaesthesia is sufficient to incise a haematoma or suturing a wound. On the other hand, for equine capped knee, a simple operation can not be made with local anaesthesia since the drug will not be absorbed by the indurated tissue. General anaesthesia is needed in such a situation.

Factors affecting anaesthesia and selection of anaesthetic technique

1. Size of the patient : Smaller animal has higher metabolic rate than large size of animal, hence larger doses of anaesthetics are required.

2. Sex : In male, the basal metabolic rate (BMR) is higher by approximately 7% than in female. In female, BMR rises during pregnancy due to metabolic activity of fetus.

3. Physical condition of animal : Obese animals have lower basal metabolic rate per unit of body weight and need less anaesthetic than lean muscular animal in good condition.

4. Temperament, activity and biological rhythm : Generally, active animals have higher basal metabolic rate and accordingly, require higher dose of anaesthetics.

5. Genetic differences : Genetic variation in dose response to anaesthetics has been reported.

TYPES OF ANAESTHESIA

Anaesthesia is often classified based on the method or route of administration and the drugs used.

A. General anaesthesia

1. Injectable anaesthesia: Anaesthesia is achieved by subcutaneous, intramuscular and intravenous administration of anaesthetics. Other routes include intrathoracic and intraperitoneal, although not generally used.

2. Inhalation anaesthesia: Anaesthesia is achieved by inhalation of anaesthetic gases or vapours in combination with oxygen.

B. Local anaesthesia

Anaesthetic solution is applied topically in the form of gel, solution or aerosol on the eye and mucous membrane of penis, vagina, rectum, urethra etc. (**Topical**) or injected locally in surgical site (**Field block**). Besides, anaesthetics are injected around a large nerve trunk (**Regional nerve block**) or in the epidural or subarachnoid space (**Epidural**) or in distal to the site of a tourniquet intravenously (**Regional intravenous**).

C. Other routes

1. Electronarcosis : Anaesthesia is achieved by passing an electric current through the cerebrum to induce deep narcosis although the method is rarely used in veterinary practice.

2. Acupuncture : An ancient Chinese system that involves insertion of specially designed needles at specific points and their stimulation by various means to produce analgesia.

3. Hypothermia : The procedure involves decreasing the body temperature either locally or generally to minimize the anaesthetic doses.

DEFINITIONS

Analgesia refers to loss of sensibility to pain without unconsciousness or sleep.

Tranquilization is a state of calmness and quiet. The patient is awake, relaxed and indifferent to surroundings and minor pain.

Sedation is mild degree of CNS depression in which the patient is awake but calm, and unaware of its surroundings.

Hypnosis is an artificially induced sleep or a trance resembling sleep resulting from moderate depression of CNS.

Narcosis is a drug-induced state of deep sleep, may or may not be accompanied by analgesia.

General anaesthesia is a state of unconsciousness produced by a process of controlled, reversible, intoxication of the central nervous system in which this is a lowered sensibility to stimuli from the environment and a diminished motor response to such stimuli.

Surgical anaesthesia is a stage of general anaesthesia that provides unconsciousness, adequate muscular relaxation and analgesia to enable surgery painlessly.

Balanced anaesthesia is produced by a combination of two or more drugs or anaesthetic techniques each contributing its own pharmacological effects to produce unconsciousness, muscle relaxation, analgesia and attenuation of undesirable side effects of a single drug

Dissociative anaesthesia is drug induced loss of sensation of whole body due to dissociation of the thalamocortic and limbic systems. It is generally characterized by cataleptoid state in which eyes remain open with functional swallowing reflex.

Neuroleptanalgesia is defined as a state of CNS depression produced by a neuroleptic and analgesic drug.

Local analgesia (anaesthesia) is a temporary loss of sensation in a prescribed body area without loss of consciousness.

Regional anaesthesia/analgesia involves injection of a local analgesic solution into connective tissue around a sensory nerve trunk or intravenous injection distal to a tourniquet.

Basal anaesthesia is a state of light level of anaesthesia produced primarily by preanaesthetic agents (tranquillizers, sedatives) and serves as a basis for general anaesthesia.

Neuroleptanalgesia refers to a surgical pain relief using combination of a neuroleptic agent (tranquillizers/sedatives) and analgesic agents (acepromazine + morphine).

Induction refers to transition from unconscious state to a state of anaesthesia.

Pain has been defined as an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage.

Agonist refers to a drug that has affinity for and stimulates physiologic activity at cell receptors normally stimulated by naturally occurring substances.

Antagonist refers to a substance that reverses the action of another drug that binds to a cell receptor without eliciting a biological response.

Selection of anaesthetic agent

The ideal anaesthetic is one that

- permits rapid induction, quick alteration in depth and rapid recovery,

- does not depend on the body for detoxification,
- is non-irritant to tissues,
- is non-inflammable, non-explosive, inexpensive and clinically stable,
- causes no or minimal depression of vital functions,
- requires no expensive equipment for administration, and
- produces good muscle relaxation and analgesia.

Indications for anaesthesia

- During surgical procedures
- Cervical, pelvic or spinal radiographs
- During application of cast
- During obstetrical procedures
- For special diagnostic procedures
- Others

PREPARATION OF PATIENT FOR ANAESTHESIA

- **Fasting :** With most types of general anaesthesia, it is wise to have the patient off feed for 12 hours previously. Induction of anaesthesia in an animal having a full stomach should be avoided if at all possible, because of the hazards of aspiration although some species are adversely affected by fasting. Small mammals and birds and neonates may become hypoglycemic with but a few hrs of starvation and mobilization of glycogen stores may alter the rate of drug metabolism and clearance. Distention of rumen in ruminants affects ventilation and some other associated respiratory problems (with consequent hypoxemia and hypercapnia). In the horse, a full stomach may rupture during induction and casting. The possibility of the regurgitation is perhaps reduced if water is withheld for 12-24 hrs prior to induction.
- **Water :** In most species, especially in the young and the aged, water should be provided up to the time that preanaesthetic agents are given. To withhold water from the animals suffering from nephritis, even for the short period may prove dangerous. In non ruminant's, free access to water should be allowed right up to the time when premedication is given, but in ruminants there is controversy 6 hrs, 12-24hrs.
- **Fluid administration :** In any case it is a good anaesthetic practice to administer I/V fluids during anaesthesia to correct the dehydration and electrolyte imbalance if any, and to help maintain adequate blood pressure, urine production and to provide an available route for drug administration.
- **Antibiotics :** Systemic administration of antibiotics preoperatively as a prophylactic measure is indicated prior to major surgery or if contamination of the operative site is anticipated. Oral antibiotic is preferred prior to elective surgery of the G.I. tract. Preoperative enemas should be done a day or two prior to surgery of the colon, rectum and anus which remove fecal materials and facilitate manipulation. An enema just prior to surgery is contraindicated since faeces will be fluid and operative site may become contaminated.
- **Anemia and hypovolemia** should be corrected by administration of whole blood or blood components and balanced electrolyte solutions. Plasma or plasma expanders are

indicated in patients either in shock state (without blood loss) or suffering from nutritional deficiency.

- Preanaesthetic **corticosteroids** may be indicated in certain geriatric or debilitated patients and those undergoing extensive surgery.
- **Oxygen administration** by nasal catheter or mask or tracheotomy under local anaesthesia is indicated in upper air way obstruction and patient accepts it.
- Animals having **lung infection** should receive specific therapy prior to anaesthesia. Local and regional anaesthesia should be strongly considered in such cases.
- General anaesthesia is contraindicated for **decompensated heart disease.** If **ascites** is present, the fluid should be aspirated to reduce excessive pressure on the diaphragm. In cases of hepatic or renal insufficiency inhalation anaesthesia is preferred.
- To encourage defecation and urination, it is best to give the animal access to a run or exercise. Catheterization or bladder compression may be necessary in unsuccessful attempts.
- **Positioning of animal:** During anaesthesia, the patient should, if possible, be restrained in a physiologic position. Compression of the chest, acute angulations of the neck, over extension or compression of limbs should be avoided as it may lead to serious problems. In all species, the head should be extended to provide a free airway and to prevent leaking of the endotracheal tube.

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CHAPTER

3

Preanaesthetics

Preanaesthetic drugs are used to prepare the patient for induction and contribute to the maintenance and smooth recovery from anaesthesia.

Indications

- Reduces the amount of anaesthetic required, so reducing side-effects (and cost).
- Reduces anxiety and improves induction quality.
- Reduces salivary and bronchial secretion.
- Decreases the minimum alveolar concentration for inhalation agents.
- Provides sedation, analgesia and relaxes muscles.
- May help to make the animal easier to handle.
- Promotes smoother recovery from anaesthesia (fewer tremors and less vocalizing).

There are no preanaesthetic drug combinations that can be safely and routinely administered to all patients.

Preanaesthetic drugs should be selected according to patient's needs rather than routine administration

Factors to be considered during selection of preanaesthetic drugs

- Patient's age, breed and species
- Physical status
- Surgical procedure and duration
- Inpatient and outpatient
- Elective and emergency surgery
- Familiarity of the anaesthetist with the drugs

Premedicant drugs

A. Anticholinergic agents : Atropine and glycopyrolate.

B. Tranquilizers or neuroleptics :

1. Phenothizine derivatives.
2. Butyrophenons : Droperidol, azaperone.
3. Benzodiazepines : Diazepam, midazolam, zolazepam.

C. Sedatives :

1. Alpha-2-agonists : Xylazine, detomidine, medetomidine.
2. Chloral hydrate.

D. Opoid Analgesic agents

1. Agonists : Meperidine, morphine, oxymorphone.
2. Agonists/Antagonists : Pentazocine, butorphenol.

ATROPINE SULPHATE



Atropine sulphate

Mechanism of action : It blocks acetyl choline at pre-ganglionic termination of choligenic fibre in the autonomic nervous systems. (Competitive antagonism of ACH).

- Oral, pharyngeal and respiratory tract secretion are decreased and bronchi dilated.
- Motor and secretory activity in the gastrointestinal tract is decreased.
- Vagal influence on the heart is suppressed resulting in increase of heart rate.
- Dilates pupils (mydriasis) and decreases tear formation.
- It can prolong thiobarbiturate anaesthesia when using intravenously during recovery.

Dose : Adult cattle @ 0.04-0.06 mg/kg s/c, i/m, i/v
Swine @ 0.06-0.08 mg/kg
Sheep@ 0.7 mg/kg
Dog @ 0.04 mg/kg
Horse@ 0.02-0.04 mg/kg

Duration of action : 60-90 min.

GLYCOPYRROLATE



Glycopyrrolate

It is a synthetic quaternary ammonium anticholinergic drug. It is five times more potent than atropine sulphate. Its duration of action is longer than atropine sulphate. It is used to decrease salivary tracheo-bronchial and pharyngeal secretion and the volume and acidity of gastric secretions. Because of the increased pH of the gastric secretions and decreased intestinal motility, regurgitation is decreased.

- Respiration, arterial blood pressure and heart rate are essentially unaffected. It decreases bradycardia, hypertension and intestinal hyperactivity of vagal origin.
- As glycopyrrolate is a large polar molecule, diffusion across lipid membranes such as blood brain barrier (BBB) and placenta is limited.
- It has little central action whereas atropine sulphate can cross the blood brain barrier, it has some central action.

- Its onset of action is within one minute, peak effect—30-45 minute, vagal inhibition—2-3 hours and antisialogogue effect—7 hours.

Dose : Dog—0.01-0.02 mg/kg
Horse—0.0015- 0.003 mg/kg
Pig—0.0015 mg/lb

Route of administration is I/V, I/M and S/C.

TRANQUILIZERS

Tranquilizers commonly used in veterinary practice are **phenothiazine, butyrophenone and benzodiazepines.**

Uses

- Their primary use is to relieve anxiety.
- They may be used to quite a patient for physical examination or transport.
- They are sometimes used to avoid post-operative complications i.e. to prevent animals from licking the wounds or chewing the bandages and splints.
- Used as an antiemetic.
- When tranquilizers are given as a preanaesthetic, induction of the anaesthesia is easier, the dose of anaesthetic required is decreased, the incidence of vomiting is decreased and recovery from anaesthesia is usually smoother and free from struggling and vocalization.

Phenothiazine derivatives includes

- Chlorpromazine HCL
- Triflupromazine HCL
- Promethazine HCL
- Propiopromazine HCL
- Piperacetamine
- Ethyl isobutrazine
- Acepromazine maleate

Chlorpromazine hydrochloride

- It has antiemetic, central depressant and vagolytic properties and enhances the activity of analgesics, anaesthetics and sedatives.
- Cattle should not be given chlorpromazine before the administration of a general anaesthetic since it produces a most inconvenient delayed recovery. It is, however, of some use when an operation is to be performed under some type of local analgesia. Cattle may be given @ 1mg/kg by I/M about 1 hour before the injection of the local analgesic.
- Chlorpromazine was used extensively for premedication in dogs. Chlorpromazine premedication prevents excitement during recovery from barbiturate anaesthesia. It may be used in obstetrical cases as it does not depress the respiratory centre of the puppy or suppress labour in the bitch.
- In cats, chlorpromazine is an effective tranquilizing agent.

- It is not preferred in horses as it decreases blood pressure, giving rise to state of panic due to muscle weakness when dose exceeds 0.4 mg/kg by I/M injection and the animal's response may be alarming and difficult to control.

Dose : Dog/cat-0.5-1.0mg/kg I/M or I/V
Horse-0.4 mg/kg I/M
Cattle-0.5-1.0 mg/kg I/M
Pig-1.0 mg/kg I/M
Sheep/goat-1.0-1.5 mg/kg I/M

Triflupromazine hydrochloride

Triflupromazine has about 10 times antiemetic effect than chlorpromazine and 3-5 times the tranquilizing potency. When it is used as preanaesthetic, the doses of barbiturates is generally 1/2-2/3rd than that usually required.

Dose : Dog – 1.0-2.0 mg/kg IV, 2.0- 3.0 mg/kg IM
Cat – 3.0-5.0 mg/kg IM
Cattle- 0.1-0.2 mg/kg IV or IM maximum dose of 40 mg
Horse- 0.2-0.3 mg/kg IV or IM maximum dose of 100 mg

Promethazine hydrochloride

The solution of promethazine is irritant to the tissues; therefore it should be injected deep into the muscle. The drug can be given after dilution with isotonic saline by slow IV injection as rapid IV injection causes profound fall in blood pressure which may be fatal in shock animals. It has a potent antihistaminic activity.

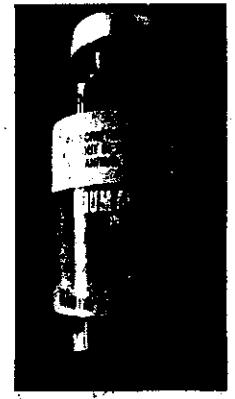
Its actions are similar to those of chlorpromazine. The hypotensive and other circulatory effects of promazine are less than those of chlorpromazine. The IV dose of promazine in dogs is 2.0-6.0 mg/kg. The amount of barbiturate necessary for anaesthesia is reduced to 1/3-1/2 and no foetal depression is reported. The antihistaminic effect is $1/5^{th}$ of that of chlorpromazine. Horses under influence of promazine appear to be hypersensitive to noise.

Dose : Horse- 1.0 mg/kg IM or IV

Acepromazine maleate

- Acepromazine is a potent neuroleptic drug with relatively low toxicity. This drug is particularly valuable in dogs, horses and cats and has been given to a wide variety of wild animals.
- Acepromazine induces the tranquilization, muscle relaxation and decrease in spontaneous activity. In greater dose, it produces sedation.
- Acepromazine causes antiemetic, anticonvulsant, antispasmodic, hypotensive and hypothermic properties.
- Acepromazine premedication is observed to reduce halothane requirement in dogs by about 20%.

Dose : Dog 0.01-0.1 mg/kg body wt, not to exceed total dose of 3 mg.



Acepromazine maleate

Cat- 0.03-0.1 mg/kg
Cattle and horse- 0.02-0.05 mg/kg IV, 0.2 mg/kg IM

Butyrophenone include haloperidol, droperidol and azaperone.

Droperidol

- It is about 20 times more potent than haloperidol and 1000 times greater than that of chlorpromazine and its duration of action is also much longer. It is one of the most potent known antiemetics.
- In the dog, it induces calmness with decreased motor activity and tranquilization similar to that induced by acepromazine. Tremors, muscle spastisity and hyperirritability occur when high doses are administered IV (5-10 mg/lb).
- Droperidol potentiates the actions of barbiturates and decreases the anaesthetic dose. The principle use of droperidol has been as a component of innovar-vet (neuroleptic analgesic agent) in a mixer with fentanyl because of its sedative effects and antiemetic action.

Dose : Dog-0.1-0.4 mg/kg IM or IV

Innovar-vet (20 ml vial)-droperidol-20 mg/ml, fentanyl-0.4mg/ml

Azaperone

- It is primarily used in swine for sedation, as a premedication and to decrease aggression (to prevent fighting tendencies).
- At the normal dose, it may provide insufficient tranquilization for minor surgical procedures as awakening and movement following stimulation may occur.
- A higher dose is necessary for restraint but side effects like salivation, chewing, irritability, hyperesthesia and twitching may occur.
- The drug may be used prior to general anaesthesia but will potentiate cardiopulmonary depression.
- It may cause transitory excitement following intramuscular use and should not be administered intravenously.

Dose : Swine-2.2 mg/kg IM, higher doses @ 8.0 mg/kg may be used.

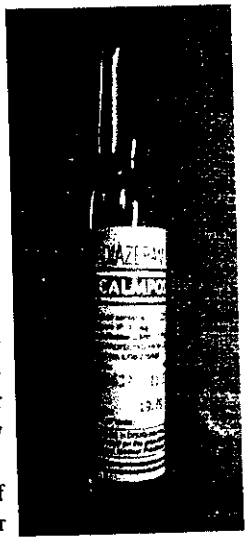
Benzodiazepines

Benzodiazepine compounds exert their main sedative effects through depression of the limbic system and their muscle relaxing properties through inhibition of the poly sympathetic reflex. The primary use of benzodiazepine in anaesthetic practice is as angiolytics, for premedication and for induction of anaesthesia but still there is a question whether it is possible to induce anesthesia alone or not. Answer is benzodiazepine cause anaesthesia while sedation is predictable, benzodiazepine can be used in combination with some other CNS depression including opioid to induce anesthesia. It can be used as a anticonvulsants.

Benzodiazepine has the properties to stimulate appetite in a variety of animals. It has been particularly used in cats showing anorexia following illness and doses up to 1 mg/kg claimed to be successful in restoring normal feeding habits in these animals. However, in debilitated cats intravenous doses of 0.05-0.1 mg/kg are usually adequate and doses of 0.4 mg/kg should not be exceeded. Benzodiazepine drugs like diazepam, midazolam, and zolazepam have been mostly used in veterinary anesthesia.

Diazepam

Diazepam has not been widely used in large animals and horses; its muscle relaxation properties may be associated with induced panic. It is mostly used in small animals alone or in combination in pre-anaesthetic period, during anaesthesia or post-operatively.



Calmpose

- Diazepam may be administered orally, I/M or I/V.
- It is water insoluble and solution for injection contains solvent such as propylene glycol, ethanol and sodium benzoate. Rapid intravenous injection may lead to thrombophlebitis and this is thought to be due to solvents rather than diazepam itself.
- Because of the problems of solubility, diazepam should not be diluted with water or mixed with solutions of the other drugs.
- Diazepam is not recommended to administer in intramuscular route. The absorption from intramuscular injection sites may be unreliable, erratic and very painful.
- Premedication with diazepam increases the length of action of other anaesthetic agent and the drug is useful particularly prior to ketamine anaesthesia to prevent seizures and during anaesthesia to abolish ketamine induced convulsion in cats.
- At clinical dose rates, diazepam has minimal cardiopulmonary depressant effects and bradycardia. Cardiac arrest has occurred after rapid intravenous administration due to propylene glycol's effect and so diazepam should be injected slowly.
- Diazepam produces skeletal muscle relaxation and may be useful as preanaesthetics in old or debilitated patients.
- In dogs and cats, the drug has been used both for premedication as a preventive measure and postoperatively to control convulsions. It has been proved to be useful for postoperative sedation in dogs, especially when sedation has to be maintained for prolonged periods.

Diazepam dose :

Species	Route	Dose(mg/kg)
Dog and cat	I/V	0.1-0.5
	I/M	0.3-1.0
Horse	I/V	0.05-0.02
Cattle	I/M	0.5-1.0
Sheep and goat	I/M	0.5-1.0
Pig	I/M	0.5-1.0
Chicken	I/M	5-10
Turkey	I/M	5-10
Deer	Oral	5

Midazolam


Midazolam

- Midazolam is another member of benzodiazepine group with greater potency in humans.
- It is less irritant to tissues than diazepam and unlikely to cause tissue damage if extravasation occurs during IV administration.
- It is shorter-acting than diazepam, but when used in combination with acepromazine or ketamine, it seems to provide a deeper sedation.
- It may cause excitement if given alone in small animals, particularly in high doses.
- As with diazepam, there is little or no analgesic action.

Doses : Dogs/cats: 0.06- 0.3mg/kg IV, IM, SC.

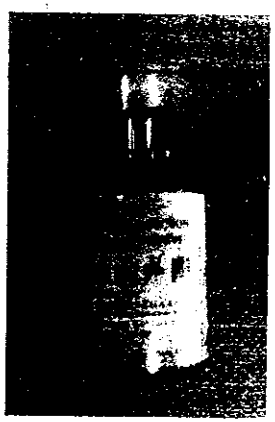
Zolazepam

- General effects are similar to those of diazepam although it is more potent.
- The drug is usually used in combination with tilatamine to produce anaesthesia in a variety of species.

SEDATIVES

Alpha-2-agonists : The drugs in this group include Xylazine, detomidine, medetomidine and romifidine.

Xylazine hydrochloride


Xylaxin

- Xylazine was the first alpha$_2$ agonist to be used as a sedative and analgesic in veterinary medicine.
- It causes decreased cardiac contractibility, cardiac output and bradycardia in small animals.
- It depresses gastrointestinal, ruminal motility and thermoregulation in cats, dogs and cattle.
- In cattle, there is increased intrauterine pressure and may lead to abortion in last trimester of pregnancy.
- Xylazine should be used with extreme caution or not used at all in debilitated patients and in patients with cardiovascular, respiratory, hepatic or renal dysfunction.
- Half-life of elimination after IV administration of a single dose is 45.5 minutes in the horse, 36.5 minutes in cattle, 23 minutes in sheep and 30 minutes in dogs.
- Emesis is a side effect of xylazine administration in dog and cat.

Dose :

Species	Intravenous(mg/kg)	Intramuscular(mg/kg)
Horse	0.4-1.1	1.0- 2.0
Cattle	0.03-0.1	0.1-0.2
Sheep	0.025-0.1	0.1-0.3
Goat	0.05-0.1	0.1-0.3
Pig	1.0-2.0	2.0-4.0
Dog	0.25-0.5	0.5-1.0
Cat	0.25-0.5	0.5-1.0

Antidote of xylazine

Species	Yohimbine (mg/kg)	Tolazoline (mg/kg)	Idazoxan (mg/kg)	Atipamezole (mg/kg)
Cattle	100-200	2000-3000	30-100	10-30 (1/10 the X dose)
Horse	75-150	4000	NA	150 µg (ponies)
Pig	50	2000	NA	NA
Dog	100-150	500-1000	NA	200
Cat	100-200	2000	NA	200

Medetomidine

- Medetomidine is one of the newest a_2-adrenergic agonists and provides good muscle relaxation, sedation and analgesia.
- The analgesic property is more potent against visceral than skeletal pain and is reversed by the antagonist (atipamezole).
- Sedation is generally very good and can be reversed by administration of atipamezole, making it a very popular drug for quick procedures, especially in minor surgical procedures.
- There is dose-dependent reduction in arterial pressure and unsuitable for use in animals with cardiac dysfunction.
- It is contraindicated in dogs that are debilitated, in shock, or stressed due to extreme cold, heat or fatigue.

Dose : Dogs: 0.01-0.08 mg/kg IV, IM, SC

Cats: 0.05-0.15 mg/kg IV, IM, SC

Detomidine

- It is a relatively new drug with greater potency and longer duration of action than xylazine.
- The drug induces dose dependent sedation, onset of action following intravenous injection takes 2-3 minutes and 15-20 minutes after intramuscular injection.

- It has wide margin of safety and is effective in all domestic ruminants for chemical restraint of animal.
- Side effects of the drug include ataxia (in 80% cases), local muscle tremors in horses, bradycardia and abortion in pregnant animals.

Dose : Horse: 10-30 mg/kg IV, 20-50 mg/kg IM
Cattle and buffalo : 15-40 mg/kg
Sheep : 30-60 Goat : 10-40 IV

●●●

CHAPTER 4

Local and Regional Analgesia/ Anaesthesia

LOCAL ANAESTHESIA

Local anaesthetics are used to anaesthetize a region of the body by applying directly at the target site. Absorption and distribution of local anaesthetics by the systemic circulation are not necessary to achieve the intended application. Cocaine was the first local anaesthetic discovered by Niemann in 1860. The next milestone in the development of lidocaine was made by Lofgren in 1943.

Advantages of local anaesthetics

- Simple, safe technique, economical and do not require sophisticated equipments.
- Geriatric and poor surgical risk patients can withstand local anaesthesia without major complications.
- Useful when general anaesthesia is contraindicated.

Disadvantages of local anaesthetics

- Local or systemic reactions to local anaesthetic agents can crop up.
- There may be chances of patient movement during the procedure.
- Increased risk of injury to the surgeon.
- Some species may not tolerate certain techniques *e.g.* lumbosacral injection of local anaesthetic agents in conscious horse.

Local anaesthetic agents

Local anaesthetic agents are materials that interfere with conduction of nerve impulses along the nerve trunk by preventing generation and conduction of the nerve impulse. Vasoconstrictor substances may be added with local anaesthetic agents to increase the duration of action by delaying absorption of the agents from the site.

Ideal characteristics of local anaesthetic agents

- Should be freely soluble in water and heat stable.
- Should have near normal pH so as to cause least tissue reaction.

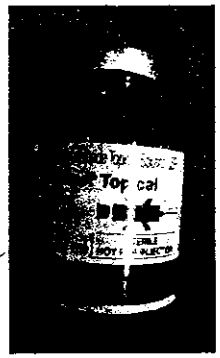
- Should have rapid onset of action and have good penetration power so as to produce uniform analgesia.
- Should cause specific nerve action and not generalized sedation.
- Should produce low systemic toxicity.
- Should produce reversible analgesic action.
- Should be easily available and economical.

COMMONLY USED LOCAL ANAESTHETICS

Procaine hydrochloride (Novocaine®)

- It is an ester-type agent available as 2% solution for local anaesthesia.
- It is non-irritant in action.
- Onset of action is very fast from the site, so producing shorter duration of action. Adrenaline is generally used to increase the duration of action.
- It is used for specific nerve block, local infiltration and epidural anaesthesia (less commonly in horses and cattle).

Lignocaine/lidocaine hydrochloride (Xylocaine®)



Xylocaine (2%)

- It is an amide-type local anaesthetic agent, available in aqueous form (0.5% to 5%) with or without adrenaline.
- A 2% solution with 1: 100,000 adrenaline is commonly employed for peripheral nerve blocks, infiltration and epidural anaesthesia in horses and cattle. A 4% solution is mostly used for surface anaesthesia.
- It is approximately twice as potent as procaine because of rapid onset of action, higher penetrating power and extreme stability.
- Onset of action is approximately 10 minutes and duration of action is approximately 60 minutes.

Mepivacaine hydrochloride (Carbocaine®)

- It is an amide-type local anaesthetic agent mostly used for peripheral nerve blocks, infiltration and epidural anaesthesia in horses.
- Similar to lignocaine, it is twice as potent as procaine and is less toxic than lignocaine.
- Onset of action is rapid and has longer duration of action.
- It is available in concentrations from 1-2%.

Bupivacaine hydrochloride (Sensorcaine®, Marcaine®)



Sensorcaine (0.5%)

- It is an amide-type, long acting local anaesthetic agent and highly stable.
- More rapid onset (10 minutes), longer duration (2-3 times that of lignocaine) and more potent than lignocaine.
- It is available in concentrations of 0.25, 0.5, 0.75 and 1.0% solutions with or without adrenaline.

- Mostly used in conditions where prolonged analgesia is required *e.g.* for caudal epidural anaesthesia in recurrent prolapse of uterus/vagina in cattle, goat and sheep.

Infiltration anaesthesia

Infiltration of local anaesthetic solution at or around the incision site can provide adequate analgesia for most minor surgical procedures. This technique involves infiltration with 2% lignocaine hydrochloride anaesthesia using a line block or an inverted-L or-7 pattern by making multiple subcutaneous (1 cm deep) and deeper muscle (2-7 cm deep) injections along a proposed incision site. The quantity of the solution used will depend upon the required incision size, thickness of body wall, species of animal and concentration of agent.

REGIONAL ANAESTHESIA

Regional anaesthesia involves the injection of local anaesthetic solution around a sensory nerve trunk or intravenous injection distal to a tourniquet. Absorption of drug by the main nerve trunk causes temporary loss of function, resulting in the desensitization of those parts from which it receives a sensory impulse. Many surgical techniques like abdominal exploratory, umbilical surgery, perineal surgery, caesarean section, castration, dehorning or enucleation can be performed with regional anaesthetic technique. Regional nerve blocks are always carried out in aseptic condition as injections are frequently carried out quite deep to the skin surface. The possible toxic effects of local anaesthetic solutions can be avoided by using optimum concentration of solution and volume. Nerves located superficially (*e.g.* digital) require little volume of analgesic solution and deeply located (*e.g.* lumbar or internal pudendal) need much larger volumes. Rubbing of the site where applicable on completion of injection will further disperse the solution and may overcome the minor inaccuracies in placing the needle.

Advantages of regional anaesthesia

Regional anaesthesia is preferred over local or general anaesthesia because of:

- Less quantity of local anaesthetic solution is required as compared to infiltration anaesthesia.
- No distortion of the tissues at the surgical site or any toxic effect on the tissues.
- Standing position is a prerequisite for a number of surgical procedures which reduces complications associated with bloat, salivation, recumbency-associated regurgitation and nerve and muscle damage.
- Safe, reliable, economical, reversible loss of pain to a limited body area.

Analgesic solutions used for regional anaesthesia

Majority of local analgesic solutions are used routinely in regional anaesthetic blocks. These drugs provide reversible anaesthesia with acceptable onset times and predictable durations.

- Lignocaine or lidocaine hydrochloride (2%) is three times more potent than procaine and diffuses more widely in the tissues. The drug has an intermediate duration of action of 90 to 180 minutes which is more than adequate for most operations.
- **A vasoconstrictor, such as** epinephrine (1 : 200,000 or 1 : 50,000) can be added to increase the intensity, prolong the anaesthetic activity and reduce the potential toxicity although tissue necrosis may ensue in thin-skinned animals.

- Recently, opiates and alpha$_2$-agonists, either alone or in combination with local anaesthetic solutions have been incorporated for epidural anaesthesia.
- **Hyaluronidase** has been added to shorten onset time and improve anaesthetic dissipation into adjacent tissues, thereby reducing the amount of lidocaine hydrochloride especially for ocular nerve blocks.

NERVE BLOCKS

Brachial Plexus Block

Anatomical consideration : The brachial plexus is formed by the ventral branches of the cervical spinal (C6, C7, C8) and the first thoracic (T1) nerves. After they have passed through the intervertebral foramina and intertransversus musculature, they emerge through and cross the ventral border of the scalenus muscle where they spread out over a fairly large area and extend to the thoracic limb by traversing the axillary space. Specific nerves like suprascapular, subscapular, musculocutaneous, radial, median, ulnar and axillary nerves exit the plexus. The axillary artery and vein lie ventromedial to the caudal portion of the brachial plexus.

Technique : The animal should be placed in lateral recumbency with the limb to be blocked uppermost. Landmarks include the scapulo-humeral joint, trachea, jugular vein and the axillary artery. The puncture point is located at the level of the scapulo-humeral joint in a plane medial to the scapula. The pulse of the axillary artery can be palpated. Care should be taken to protect the external jugular vein, which is to be found in this region. The direction of insertion of the stimulating needle should be caudal, with a discrete dorsal orientation relative to the body axis. After a few centimeters, the musculocutaneous nerve is reached which becomes evident by contractions of the biceps brachii muscle and flexion of the elbow. A test injection of 1 ml of the solution should cause the motor response to cease thus indicating that the nerve has been displaced away from the needle by the injectate; this rules out the possibility of making an intra-neural injection. Due to the high vascularity of the area and potential for inadvertent intravascular injection, the local anaesthetic solution should be injected slowly, with frequent aspiration. No resistance should be noted during injection.

Corneal nerve block

Indications : The block is indicated for dehorning of adult cattle and disbudding of young calves.

Anatomical considerations : The corneal branch of the lacrimal (zygomaticotemporal) nerve which is part of the ophthalmic division of the trigeminal nerve passes through the periorbital tissue dorsally to run along the lateral border of the frontal crest to the base of the horn. Initially it lies deep, but on the upper third of the lateral temporal ridge it lies relatively superficially covered only by skin and thin layer of temporalis muscle.



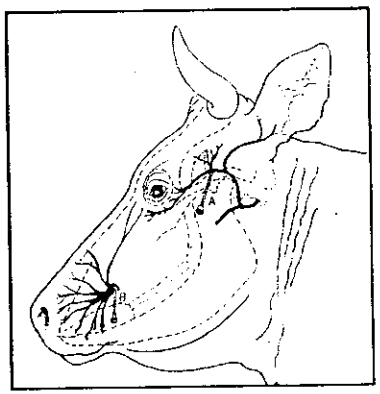
Corneal nerve block. The site of the injection is slightly closure to the base of the horn than midway along the frontal ridge. *Redrawn from Sharder* (1996)

Method : A 20 gauge needle is inserted ventromedially close to the frontal bone approximately 2 to 3 cm in front of the base of the horn. The depth of needle penetration depends on the animal i.e. 1 cm in small cattle, 1 to 1.5 cm in goat and 2.5 cm in large bulls. Attention must be paid during insertion of needle as corneal artery and vein lie in close proximity to the nerve. Five to 10 ml of 2 per cent lignocaine solution in cattle and buffaloes, 2 to 3 ml in goat is injected, depending upon the size of the animal. In goat and buffaloes, the corneal branch of the infratrochlear nerve also supplies the horns and as such this nerve is also to be blocked at the dorsomedial margin of the orbit. Satisfactory anaesthesia is achieved characterized by blink response during infiltration and an ipsilateral ptosis. In older cattle and bulls with well developed horns need extensive infiltration of the caudal aspect of the horn to desensitize subcutaneous branches of the second cervical nerve.

Auriculo palpebral block

Indications

- Motor paralysis of the eye lids (without analgesia) can be achieved with this block which facilitates examinations of the eye by abolishing the strong tone in the eyelid.
- This block in combination with topical anesthesia is useful for removing foreign bodies from the cornea and conjunctival sac or for injecting medication into the bulbar subconjunctiva.



Auriculopalpebral block. *Redrawn from Skarder* (1996)

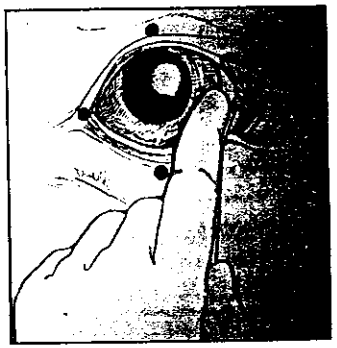
Method. The auriculopalpebral branch of the facial nerve is sometimes palpable in a notch on the zygomatic arch anterior to the base of the auricular muscles in bovine and 1.5 cm depth in camel. A 2.5 cm 20 gauge needle is placed subcutaneously at this site and 5-10 ml of 2% lignocaine is injected, thus anesthesia (not analgesia) of the eyelids. If necessary, 10 ml of 2% lignocaine can be infiltrated approximately 1 cm from the edges of the dorsal and ventral lids.

Retrobulbar block

Indications

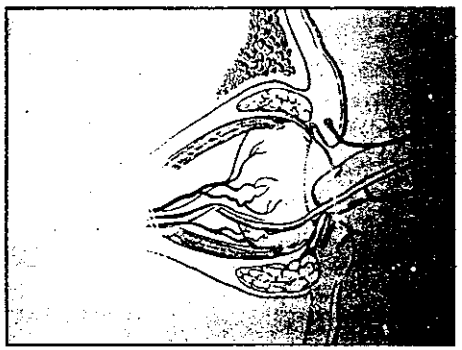
- For enucleation of the eye.
- To facilitate surgery in cattle with a squamous cell carcinoma of the cornea.

Method. In large animals, the procedure may be carried out under sedation either in standing or casting position. Adequate restraint of head is essential. Injections are made using a 15 cm, 18 gauge needle with a large curve on it. The eyelids are penetrated at the dorsal, ventral, medial or lateral orbital rims. The needle is inserted at the medial and lateral canthus while using the finger to reflect the globe away from the needle. A total of 15-20 ml of 2%



Injection site (black dots) for retrobulbar deposition of local anaesthetics

lignocaine is slowly injected as the needle is withdrawn from the orbit. When the retrobulbar block is complete, the following structures like optic nerve, oculomotor nerve, trochlear nerve, trigeminal nerve, abducent nerve and facial nerve will be desensitized.



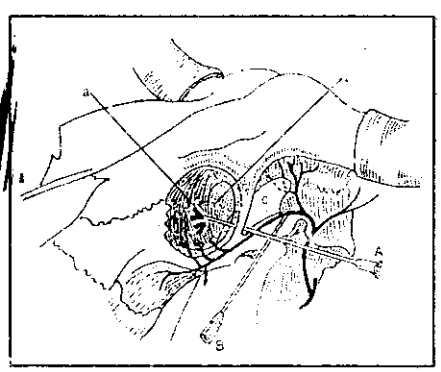
Curved needle used for retrobulbar deposition of local anaesthetics

Possible adverse effects of this procedure

- Damage of globe
- Retrobulbar haemorrhage.
- Damage of optic nerve.
- Intraneural or meningeal injection. (rare but causes death)
- Initiation of oculocardiac reflex.

Peterson eye block

Potential risk associated with the retrobulbar block can be minimized with Peterson block. The technique is safe and more effective if performed properly but requires more skill as compared to retrobulbar block



Peterson (A) and Auriculopalpebral block (B) for enucleation of the eye or surgery on the globe. (*a*) Orbital foramen, (*b*) Pterygoid crest, (c) Coronoid process of the mandible. *Redrawn from Skarder* (1996)

Method : The initial landmark of this block is the angle formed by the supra orbital process cranially, the zygomatic arch ventrally and the coronoid process of the mandible caudally. The needle (straight or only slightly curved, 3 to 4 inch, 18-gauge) is introduced into the most rostral aspect of the notch formed by the supraorbital process and zygomatic arch. The needle is then advanced medially until the coronoid process of the mandible is encountered. It is redirected rostrally until it passes medial to the coronoid process and reaches the solid bony plate in the region of the foramen orbitorotumdum. At this site, 15-20 ml of 2% lignocaine is slowly injected. When the block is complete, the entire globe and its associated structures are desensitized.

Anaesthesia of the eyelid is accomplished by blocking the auriculopalpebral branch of the facial nerve. To achieve this, the 18 gauge needle is withdrawn to the subcutaneous tissue and then redirected caudally and laterally as an additional 5 to 10 ml of solution is injected at the site.

Infraorbital nerve block

Indication. An infraorbital nerve block is used for the repair of nasal lacerations, surgery of the incisors, gums and insertion of a nose ring in mature, ill-tempered bulls.

Anatomical considerations : The infraorbital nerve is the continuation of the maxillary division of the fifth cranial nerve, after it crosses the pharyngopalatine fossa and enters the infraorbital canal. The nerve immerges on the face through the infraorbital foramen where it is covered by levator nasolabialis muscle.

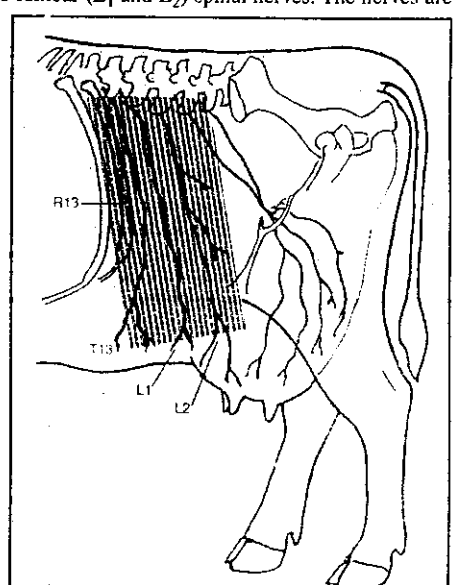
Method : The infraorbital nerve is blocked where it emerges from the infraorbital canal. The foramen is located rostral to the facial tuberosity, dorsal to the first molar tooth. A 4 cm long, 18 gauge needle is inserted deep into the levator nasolabialis muscles and 10 to 20 ml of 2% lignocaine is injected to block the nerve.

Paravertebral anaesthesia

Indications : Paravertebral anaesthesia involves the perineural injection of local analgesic solution around the spinal nerves soon after they emerge from the intervertebral foramina. The technique was first used in cattle in 1940 by Farquharson and Formston and is now widely used to access the abdominal cavity via the flank region for abdominal displacements, rumenotomy, caesarean section, or intestinal surgery.

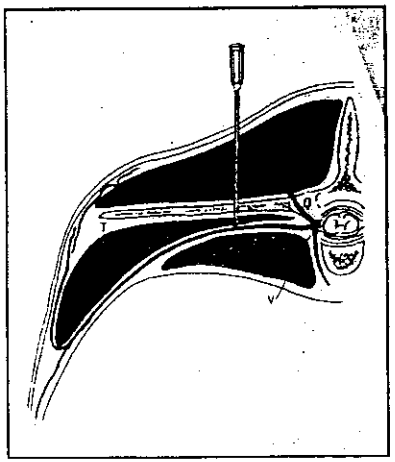
Proximal paravertebral anaesthesia (Farquharson, Hall or Cambridge technique)

In proximal paravertebral anaesthesia, the entire flank region can be anaesthetized through blockade of the last thoracic (T_{13}) and first two lumbar (L_1 and L_2) spinal nerves. The nerves are approached from the dorsal aspect of the transverse processes of the lumbar vertebrae. The transverse process is directed outwards and slightly forwards so that the caudal border is slight behind the lateral extremity. The ideal site is about 5 cm from the midline, for T_{13} just cranial to the transverse process of the L_1, for L_1 just cranial to the transverse process of the L_2 and for L_2 just cranial to the transverse process of the L_3. The transverse process of L_1 is harder-to-palpate and so other nerves are blocked first. The skin over the site should be clipped, surgically scrubbed and disinfected and anaesthetized with 2 to 3 ml of 2% lignocaine using a 2 cm long 23 gauge needle. A 5-inch, 18 gauge spinal needle is introduced through the desensitized skin and advanced through the underlying muscle until it strikes the lumber transverse process. The needle is then walked off the cranial edge of the process and passed ventrally to penetrate the transverse ligament and fascia. The penetration of the ligament can be recognized as a loss of resistance to the needle. Ten to 15 ml of 2% lignocaine is injected slightly varying depths and directions below the ligament in order to block the ventral branch of the nerve. The needle is then withdrawn 1 to 2 cm so that the tip of the needle is above the fascia, where an additional 5-10 ml of lignocaine is injected to desensitize



Paravertebral block showing the area of the flank desensitized when the T_{13}, L_1 and L_2 nerves are blocked. R_{13} last rib.

the dorsal branch of the respective nerve. An additional 2-3 ml of lignocaine is injected continuously while the needle is being repositioned. Camels have 12 pairs of ribs and hence in addition to T_{12}, L_1 and L_2, L_3 nerves are also to be blocked to get satisfactory results.



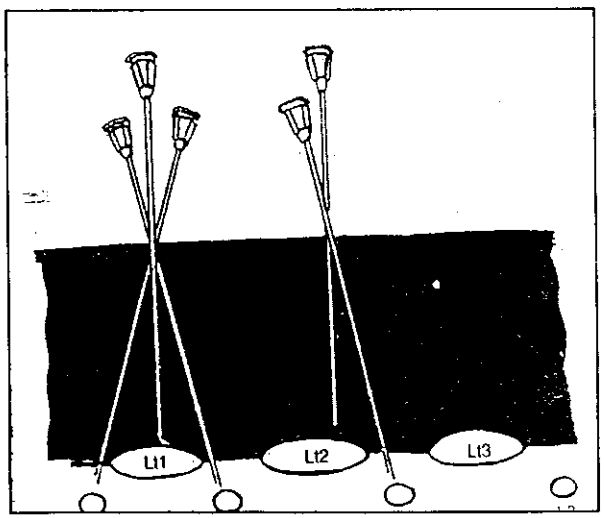
Paravertebral block. Location of the needle for blocking the ventral branch

Advantages of this technique

- It requires a significantly smaller amount of local anaesthetic.
- It produces a relatively large area of desensitization.
- Onset of local anaesthesia is rapid.
- The procedure can be carried out quickly and in a more professional manner.
- Satisfactory muscle relaxation is produced and intra-abdominal pressure is decreased.
- If required, the length of incision can be extended intraoperatively.

Disadvantages of this technique include :

- Difficulty in finding landmarks in obese and heavily muscled animals.
- Scoliosis and moderate ataxia.
- Risk of penetrating spinal canal or the major blood vessels and thereby chances of haemorrhage.



Paravertebral block. Insertion of the spinal needles to block the ventral branches of the T_{13} L_1 and L_2 nerves.

Distal paravertebral anaesthesia (Cornell technique)

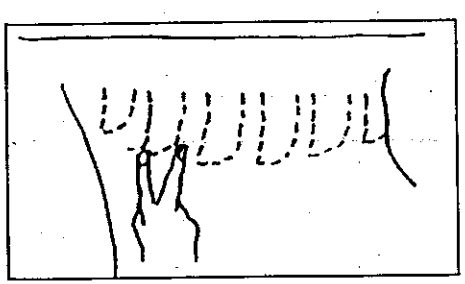
Distal paravertebral anaesthesia provides satisfactory anaesthesia of the entire flank region through blockade of T_{13}, L_1 and L_2 at the tip of the transverse process of the lumber vertebrae. The local anaesthetic solution is injected with an 18 gauge, 1.5 inch needle parallel to the tips of the process of L_1, L_2 and L_4. About 10-20 ml of 2% lignocaine is infiltrated in a fan-shaped fashion dorsal to the tip of the process. The needle is then withdrawn and redirected ventral to the process and infiltration is repeated with 10 to 20 ml of lignocaine solution.

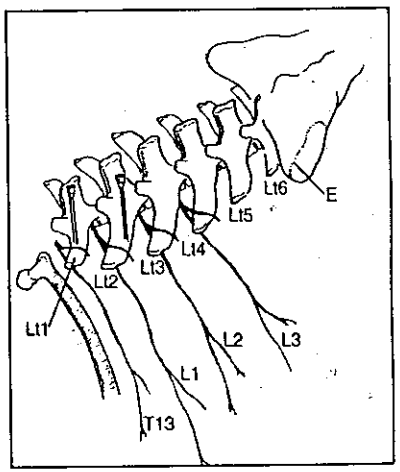
Advantages

- Risk of penetrating nerves or large blood vessels is less.
- Lack of scoliosis and ataxia.

Disadvantages

- Incomplete or inadequate anaesthesia due to variable position of the nerves.
- Significantly large volume of lignocaine is required.
- Difficulty in locating the transverse process in obese animals.





Paravertebral block. (A) Identification of the second lumber transverse process. (B) Course of the nerve and position of the needles. T_{13} Thirteenth thoracic nerve, L_1-L_3 first to third lumber nerves, Lt1-Lt6 Lumber transverse processes, E External angle of the ilium.

Epidural anaesthesia

Indication : Epidural anaesthesia is used

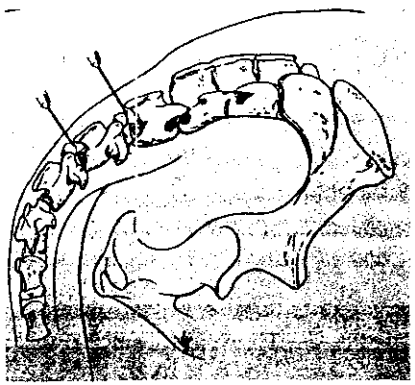
- For surgeries of areas such as vagina, vulva, anus, tail and rectum.
- Repair of prolapsed rectum or vagina; difficult parturition; foetal manipulation during dystocia.
- Perineal urethrotomy.
- To control tenesmus and uterine contractions.

Epidural anaesthesia is commonly performed in farm animals and less frequently in pet animals. The block is carried out at the sacrococcygeal region (caudal or low epidural) or the lumbosacral region ("high" epidural).

Caudal Epidural Anaesthesia

Caudal epidural anaesthesia is commonly performed in farm animals to block the coccygeal and sacral nerves. It is technically easy to perform and requires no special equipment.

Site of anaesthesia is sacrococcygeal (S_5-Cx1) or first coccygeal (Cx1-Cx2) space. Sacrococcygeal space is the ideal site in buffalo (due to downward inclination of sacral ridge, anaesthetic solution may not reach to uppermost part when first intercoccygeal space is selected) and camel (due to wider sacrococcygeal space than the first intercoccygeal space). In cows, the intercoccygeal space is larger thus making it easier to penetrate this interspace. The correct position is palpated by moving the tail up and down with one hand while simultaneously palpating the dorsal spinous processes of the sacrum and coccygeal vertebrae with the other hand.



Injection sites for caudal epidural anaesthesia in cattle

Choice of anaesthetics

- 2% lignocaine hydrochloride (routine practice)
- 0.75 % bupivacaine with adrenaline @ 0.1 ml/ Kg in cow (longer duration upto 2 hours).
- Xylazine alone or in combination with lignocaine (Xylazine @0.03 mg/kg diluted with 5 ml of lignocaine for an adult cow.
- Xylazine (0.05 mg /Kg) diluted in 5 ml sterile water (longer duration upto 3 hours).

Method : In cattle and buffaloes, an 18-gauge, 1.5 inch needle is inserted slightly cranially with the bevel in a lateral or cranial orientation. The needle is inserted until a "pop" is felt, thus indicating entrance into the epidural space. Before injecting local anaesthetic solution to the epidural space, it is necessary to check the presence of blood by aspiration in a syringe filled with anaesthetic solution. Injection of 8 to 10 ml of 2% lignocaine hydrochloride is recommended in adult cattle which should be easy and without resistance. The needle should be slightly withdrawn and redirected if resistance is felt. Larger doses are not recommended as they may paralyze the spinal nerves to the hind limbs of smaller cattle thus causing recumbency. Time of onset is usually 10-20 minutes with a 30 to 150 minutes duration range with the signs of flaccidity of the tail.

In small ruminants like sheep and goat, the technique is similar except a 2 inch, 18 to 20-gauze needle is used and 1 to 2 ml of 2% lignocaine is injected.

Cranial epidural anaesthesia

This procedure is carried out as far cranial as the diaphragm, depending upon the amount of local anaesthetic used.

Site of anaesthesia : At the sacrococcygeal space or the first intercoccygeal space with administering larger volume of lignocaine but usually may cause ataxia and recumbency. The ideal site is lumbosacral space (L_6-S_1).

Dose of local anaesthetic : – 0.5 to 1 ml of 2% lignocaine per 4.5 Kg body weight for cattle i.e. 40-150 ml (average 80 ml) for adult cattle and 5-25 ml (average 15 ml) in calves.

Method : Technique of insertion of needle, testing of the location and injection are similar to the caudal epidural anaesthesia. The volume of lignocaine injected is determined by the animal's response to the injection and desensitization area size. The position of the animal also affects distribution of local anaesthetic. High volume infusions need extensive care because improper positioning of the animal (elevated hind quarters) may lead to respiratory paralysis and death.

Intravenous regional anaesthesia

Indication : Intravenous regional anaesthesia produces effective lower limb anaesthesia for debridement of severe foot abscess, corn removal, digit amputation and laceration repair.

Method : At first, the animal is secured in lateral recumbency with the limb to be anaesthetized in lower most position. A rubber tourniquet is placed in the mid metacarpus or metatarsus and upto 30 ml of 2% lignocaine is injected into any prominent superficial vein (dorsal metacarpal or metatarsal vein, palmar or planter digital vein or lateral saphenous vein). Anaesthetic action is achieved within 10 minutes and remains as long as the tourniquet is in place. A tourniquet can be safely kept in place upto 90 minutes without loosening. The tourniquet should be released slowly to overcome the signs of lignocaine toxicity from rapid spreading of the lignocaine into the systemic circulation.

Advantages of this anaesthesia include complete anaesthesia of lower limbs and feet, reduce chance of bleeding, single injection and smaller amount of lignocaine required and rapid onset of anaesthesia.

Disadvantages include the need of thorough knowledge of vessel anatomy in the limb/foot, failure of nerve block despite accurate penetration of the vessel.

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CHAPTER

5

NARCOTIC ANALGESICS

Morphine

- Morphine (morphine sulfate) is a narcotic agonist derived from the milky exudates of the unripe seed capsules of the opium poppy (*Papaver somniferum*).
- Its primary effect is to produce some degree of sedation, analgesia and as a preanaesthetic agent (limited to dog).
- It binds to both m- and kappa-receptors although it acts on other receptors.
- It depresses respiratory centre but does not affect myocardial contractibility or cardiac output.
- Rapid intravenous administration may lead to hypotension caused by histamine release and subsequent vasodilation.
- It causes mania and tonic convulsions in the cat in higher doses.

Dose : Dog – 0.5-2.0 mg/kg IV, duration for 2-4 hours

Cat – 0.1 mg/kg SC duration of analgesia for 4 hours

Ponies – 0.66 mg/kg IM (good analgesia for superficial pain for 2 hours)

Meperidine

- Meperidine is the synthetic narcotic agonist that has one tenth analgesic potency of morphine.
- It decreases the amount of general anaesthetics required and intra- and post-operative pain when used alone.
- At therapeutic doses, it causes less cardiovascular and respiratory depression as compared to morphine.
- Rapid intravenous administration may lead to hypotension excitement caused by histamine release and convulsion and hence is not recommended.

Dose : Dog and cat-5-10 mg/kg SC

Horse-1.0-4.0 mg/kg (for analgesic and spasmolytic actions)

कृपया रेषा मारुन पुस्तक खराब करु नये.

Fentanyl

- Fentanyl (Sublimaze) is a synthetic narcotic agonist with greater potency (approximately 250 times) than morphine and faster onset of action (within 3-8 minutes).
- It has a shorter duration of action but does not cause histamine release and lasts approximately 30-60 minutes because of its rapid redistribution to peripheral compartments.
- It should be administered by continuous intravenous infusion when long-term pain control is required.
- It has minimal effects on blood pressure and cardiac output but there is hypoventilation and bradycardia (counteracted by atropine).
- Fentanyl, unlike morphine, usually does not induce vomition in dogs; however, the anal sphincter relaxes and frequently defecation occurs.
- Fentanyl is combined with droperidol under the trade name of Innovar-Vet.

Dose : Dog- 0.005-0.02 mg/kg IV duration for 0.5-1.0 hours

Ponies and horse- A combination of fentanyl (0.055 mg/kg) and xylazine (1.1 mg/kg) for analgesia.

Oxymorphone

- Oxymorphone is a semisynthetic opioid that is 10 times more potent than morphine and has a longer duration of action (2-4 hours).
- Oxymorphone appears to induce more sedation and less hypnosis than morphine.
- When combined with a tranquilizer (*e.g.* acepromazine), it produces neuroleptanalgesia.
- It also does not cause the same degree of vomiting and defecation as that caused by morphine.
- It can be administered intravenously, intraoperatively, and epidurally to enhance analgesia during surgery and the postoperative period.
- Respiratory depression is not noticeable as compared to morphine.

Dose : Dog and cat-0.05-0.2 mg/kg IV.

Pentazocine lactate (Fortwin®)

- It is an opioid analgesic with both agonist and antagonist properties having one third potency of morphine.
- It has minimal effects on the central nervous system, cardiovascular system and is a mild respiratory depressant.
- Onset of action by intramuscular route occurs within 15 minutes and lasts for approximately 2 hours.
- It is an effective analgesic in horse, dogs, pigs, rabbits and primates.

Dose : Horse- 0.5-3.0 mg/kg IV and 0.5-6.0 mg/kg IM

Dogs-2.0 mg/kg IM, Pigs-2.0 mg/kg IM

Buprenorphine

- It is a partial m-agonist with high receptor affinity and 30 times more potent than that of morphine.
- It has a slow onset, may take up to 45 minutes for the complete clinical effects to become evident and lasts up to 6 hours.

- It can produce moderate levels of analgesia with less respiratory depression.
- It can be given intravenously with little effect on the cardiovascular system and does not result in respiratory depression at clinical doses.

Dose : Dogs and cats-0.006-0.010 mg/kg

Horse-0.004-0.006 mg/kg IV

Butorphanol

- It is a semisynthetic opioid approximately five times more potent than morphine.
- Its degree of analgesia is not as profound as that of a pure agonist, and it should be used in patients in mild pain.
- It exhibits a "ceiling" for inducing respiratory depression; greater doses do not result in a corresponding increase in respiratory depression nor do they result in greater analgesia.
- It is rapidly absorbed after intramuscular injection, with peak level occurring in 15-30 minutes and duration of effect lasts for 1-4 hours.

Dose : Dog- 0.1-0.4 mg/kg IV,

Horse-0.022-0.066 mg/kg IV as preanaesthetic, 0.022-0.11 mg/kg IV as

Postoperative pain, a combination of xylazine (0.33-0.55 mg/kg IV) and butorphanol (0.022-0.066 IV) for chemical restraint.

Bovine-0.022-0.05 mg/kg IV as preanaesthetic, a combination of xylazine (0.03 mg/kg IV) and butorphanol (0.33-0.55 mg/kg IV).

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CHAPTER

6

General Anaesthesia

It is the unconsciousness of a subject with analgesia and muscular relaxation caused by controlled, reversible intoxication of the central nervous system using drugs or other means.

Stages of general anaesthesia

1. Preanaesthetic stage
2. Induction of anaesthesia
3. Maintenance of anaesthesia
4. Recovery from anaesthesia

Preanaesthetic stage : It refers to a period before actual anaesthesia is induced and can be achieved by preanaesthetic drugs. The preanaesthetic examination is also needed in this stage and it varies as per the species, the procedure, the individual animal and circumstances. The examination may be a complete physical examination alone, or may include laboratory investigations such as haematology, medical imaging, and electrocardiography. Animals should be kept off fed and water as necessary, equipment and drugs are prepared. Preanaesthetic drugs are administered to enter into induction stage.

Induction of anaesthesia : It refers to transition from a state of consciousness to unconsciousness using injectable or inhalation agent with intubation of the animal. This stage is again sub-divided into four stages as described below.

Stage I (Stage of voluntary movements) : This stage is characterized by voluntary excitement marked by struggling and breath holding if the induction is slow and by inhalation. There is increased pulse and respiration rate and dilatation of pupil. Occasional urination and defaecation may occur. Consciousness is not completely lost but is just preserved. Central perception of pain is greatly abridged or abolished. This stage is very concise with rapidly acting thiopentone.

Stage II (Stage of involuntary movements) : This stage is characterized by loss of consciousness and involuntary excitement. There is irregular ventilation and increased muscle tone. The chances of complications are more during this stage.

Stage III (Stage of tolerance or surgical anaesthesia) : This stage is characterized by unconsciousness, abolition of sensation and is further divided into three planes based on progressive depression of cardiopulmonary functions and response to stimuli.

Plane 1 : It is characterized by presence of pedal and palpebral reflex (possibly nystagmus). Painful stimuli can increase the heart rate, blood pressure and respiratory rate. Lacrimation is not suppressed leading to shiny cornea. The eye ball is centrally placed in dog and cat. **Minor surgical and most diagnostic procedures can be done in this stage.**

Plane 2 : It is characterized by abolishment of palpebral, pedal and laryngeal reflex. There is no response to painful stimuli and further depression of cardiovascular functions. The eye remains central in horse and eye ball rotates down in dogs and cats under halothane, barbiturate and propofol anaesthesia. **This plane is adequate and safe for nearly all the surgical operations to be accomplished.**

Plane 3 : It is characterized by reduced respiratory functions, lowered blood pressure and the breathing pattern becomes diaphragmatic in dogs and cats. The eyeballs become central with no palpebral reflex. Lacrimation ceases and the cornea appears dry. **This plane gives caution that the animal received too much anaesthetic and this plane is not to be crossed.**

Stage IV (Progressive medullary paralysis *i.e.* Overdose) : This stage is characterized by weak pulse, dilated pupil and dry cornea. There is paralysis of intercostal respiratory muscles leading to cardiopulmonary collapse and death may occur due to paralysis of medulla of the brain. Recovery is only possible if inhalation anaesthetic is withdrawn, specific antagonistic agents are used and artificial respiration is instituted before profound cardiovascular depression occurs.

Maintenance of anaesthesia : It refers to prolongation of anaesthesia by administration of either inhalation agents (ether, enflurane or halothane-best option) or injectable drugs (thiopentone, pentobarbitone or ketamine). This stage provides desired depth of anaesthesia and the animal can tolerate surgery without any resistance. Therefore, this stage is also called as ***surgical anaesthesia.***

Recovery from anaesthesia : It refers to gradual revival from anaesthetic stage to normalcy. Supportive therapy in the form of fluid and supplementation of oxygen are desirable to reduce hypoxemia. Attempt should be taken to stand ruminant patient as early as possible after operation and at least, the animal should be placed in sternal recumbency to avoid tympany, internal suffocation and hypoxemia. Proper selection of anaesthetic agent and techniques may also reduce the recovery period. Besides, ambient temperature in the zone of comfort is also advantageous in the recovery period.

Anaesthetic methods

The common methods to induce general anaesthesia in animals are by using inhalation and intravenous anaesthesia. Other methods not commonly used are oral, per rectal, intramuscular and intra peritoneal etc. However, in veterinary practice, the common method adopted is intravenous anaesthesia.

1. **Injectable anaesthesia :** Intravenous administration of the agent results in loss of consciousness of the patient for a period. Depending on the agent, repeated injections may be given to maintain anaesthesia, or else it may be continued by the addition of an inhalant (volatile) agent. Intravenous anaesthesia in veterinary practice is primarily used for the induction of anaesthesia which is subsequently maintained by inhalation anaesthesia in small animals. However, in large animals, intravenous anaesthesia is mostly used for both induction as well as maintenance.

2. **Inhalant anaesthetic :** Inhalant anaesthetic can be administered via lung using a volatile anapestic agent alone or in combination with injectable anaesthetics.

Anaesthetic monitoring aids

- ***Oesophagial stethoscopes***—cheap and useful, allowing auscultation without having to risk disturbing drapes.
- ***Thermometers***—measuring the core and surface temperature over a period of time may give an indication of peripheral perfusion and hence cardiac output.
- ***Electrocardiogram***—It gives us valuable information other than heart rate and rhythm.
- ***Pulse oximeter***—this gives relative concentration of oxygenated and deoxygenated haemoglobin by measuring the relative transmission of red and infrared light.
- ***Respiratory gas analyzer***—This can give us information about CO_2, O_2, N_2O and anaesthetic gas levels in inspired and expired gas.
- ***Arterial blood pressure***—This is a very useful measure of cardiovascular function, and it is becoming easier to perform as better instrumentation has become available.
- ***Central venous pressure (CVP)***—It gives us a good indication of hydration status and integrity of the cardiovascular system.
- ***Blood-gas analyzer***—Measurement of pH, CO_2 and O_2 tension, plasma bicarbonate, haemoglobin saturation and base excess gives us a lot of information about the health status of an anaesthetized patient.

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CHAPTER 7

Intravenous Anaesthesia

Advantages

- They are simple to use, requiring little special instruments.
- Produces surgical anaesthesia with speed and pleasantness.
- They are not irritating to airways.
- Good for short surgical and diagnostic procedures.
- Economical

Disadvantages

- Once administered, they cannot be withdrawn.
- Any untoward effects or overdose must be controlled until the agent is metabolized or redistributed.
- Some agents (such as thiopental) are extremely irritant if administered perivascularly.
- Recovery period may be longer depending upon the health status of the animal and drug used.
- Most injectable anaesthetics result in temporary hypotension or respiratory depression.
- Oxygen and equipment for assisted or controlled ventilation may not be available.

COMMONLY USED INJECTABLE ANAESTHETICS

Barbiturates

Barbiturates include phenobarbital, pentobarbitone, thiopental and methohexitone and are still a popular choice for anaesthetic agents in veterinary practice. Only thiopental and methohexitone are routinely used for general anaesthesia in small animals. Barbiturates have little or no anaesthetic effect.

Classification (based on length of action)

- **Long-acting**-phenobarbital, barbital sodium
- **Medium-acting**-amobarbitol
- **Short-acting**-pentobarbital, secobarbitol
- **Ultra- short-acting**-thiopental, thiamylal and methohexital

Pentobarbital sodium

- This drug is available in solutions containing 50 mg/ml or 65 mg/ml and its use restricted to small animals and swine.
- The drug is slow in crossing the blood-brain barrier and onset of action is slow. If administered slowly then anaesthetic induction excitement may occur.
- The drug is non irritant if injected perivascularly and is metabolized in the liver. In very low doses the drug will act as a sedative without causing excitement.

Dose : *Dogs and cats*-20 mg/kg for light surgical anaesthesia to 30 mg/kg for deep surgical anaesthesia (without premedication). With premedication-10-20 mg/kg body weight.

Two-thirds of the calculated dose should be administered through rapid intravenous route to overcome the initial excitement followed by the remainder dose for a period of 2-5 minutes.

Horse and cattle : It is not used alone in horse and cattle as recovery is slow and accompanied by excitement.

Thiopental sodium

- Thiopental is one of the older injectable anaesthetics, is still very popular due to its low cost and the small volume required to induce anaesthetic in large dogs.
- It is highly lipid soluble, resulting in quick transfer across the blood-brain barrier and hence, quick acting. Besides, the drug is highly irritant and results in pain and local tissue damage if injected perivascularly.
- Thiopental crosses the placenta well and may result in respiratory depression of the foetus. As a result it is not recommended for caesarean section.
- It should not be used in animals in shock, animal with arrhythmias or with severely impaired cardiovascular functions. Rapid intravenous administration produces a fall in blood pressure.
- Muscle relaxation and analgesic property are poor in light anaesthesia.
- This drug is most commonly used as induction agents prior to inhalation anaesthesia as a sole agent for short procedures. In small animals a 2.5% solution and in lar animals a 5% solution of thiopental is used. The drug is preferably administered throu intravenous route because, by this route the dose can be controlled and the drug is giv "to effect".



Thiopental sodium

Dose : *Dogs and cats*—6-8 mg/kg for rapid induction of shorter duration. 20-30 mg/kg effect" for surgical anaesthesia without any preanaesthetics.

Horse and ruminants—6-15 mg/kg with preanaesthetics "to effect".

Small ruminants—8-30 mg/kg with preanaesthetics "to effect".

Swine—2.5-5 mg/kg with preanaesthetics "to effect".

In all the animals, 1/3rd of the calculated dose should be administered rapidly as bolus and remainder of the dose should be given slowly "to effect" as per the requirement.

NON-BARBITURATE INTRAVENOUS ANAESTHETICS

Chloral hydrate

- Chloral hydrate is commonly used in horses, cattle and buffaloes as hypnotics/ narcotic agents without any analgesia.
- During administration, locomotory incoordination in the early stages occurs followed by deep sleep in later stages.
- It causes hypotension and tachycardia in large animals but within safe limits and the drug also crosses the placental barrier.
- The drug is contraindicated in animals suffering from hepatic, renal diseases or in animals under one month of age.

Dose : The solution should always be prepared before administration. The effect is produced within 20-30 minutes and remains for 2-3 hours.

Horse—6-10 g/50 kg per os, 5-6.5 g/ 50 kg as 6-8% solution as intravenous in adult.

Cattle and buffaloes—40-60 g per os, 5 g/ 50 kg as 6% solution intravenous in adult and 140 mg/kg. 6% solution in calf.

Camels—100 mg/ kg 10% solution intravenous.

Chloromag

- It is a mixture of chloral hydrate and magnesium sulphate in 1 : 1, 2 : 1 or 3 : 1 ratio used as 10% solution for horses, cattle, buffaloes and camels.
- Irritant effect of chloral hydrate is reduced by addition of magnesium sulphate.
- It produces excellent muscle relaxation due to presence of neuromuscular blocking action of magnesium sulphate.

Dose : 5g/ 50 kg intravenous "to effect".

Chloral-mag-pentoparbitone (Equithesin)

- It is a good anaesthetic combination for horses due to its low toxicity and negligible excitement during induction.
- It produces excellent muscular relaxation and recovery is fast.
- Composition : Chloral hydrate-28 g; magnesium sulphate-14 g; pentobarbitone- 6.5 g. All dissolved in sterile distilled water to make the solution 1000 ml and add few drops of ethyl alcohol to make it stable. The solution should always be prepared in fresh.

Dose : 670 ml/450 kg intravenous.

Propofol

- It has become one of the most popular injectable anaesthetics due to its properties and is of use in many species.
- It is ultra-fast acting especially for dogs and cats and cleared rapidly from the body and recovery is smooth. As it is cleared so rapidly, it is suitable as a maintenance anaesthetic and may be given by constant infusion over prolonged periods of time without apparent untoward effects.
- Propofol is very mildly analgesic and is non-irritant to tissues but has little or no effect unless given IV-ly.
- First half of the dose is given rapidly and the last half at a slow rate "to effect". Anaesthesia is mostly observed within 8-13 minutes.
- Rapid IV injection often leads to temporary apnoea and dose related reduction in blood pressure and cardiac output. It is suitable for use in animals with liver failure.

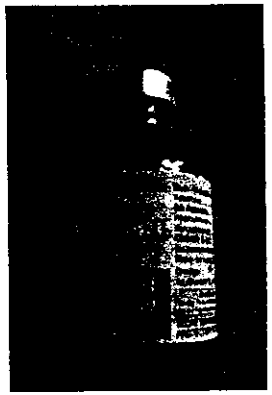
Dose : Horse-2 mg/kg IV, dogs- 4-6 mg/kg IV with premedication and 6.5 mg/kg without premedication.

DISSOCIATIVE ANAESTHESIA

Dissociative anaesthesia is characterized by profound amnesia, superficial analgesia, catalepsy, involuntary spontaneous movements, and persistence of reflexes like swallowing, pharyngeal, palpebral, and corneal. Ketamine hydrochloride and tilatamine are the generally used dissociative anaesthetics in veterinary practice. Phencyclidine is another group in this category but not used because of drug abuse.

Ketamine

- Ketamine is a rapidly acting dissociative anaesthetic without excitement and with a duration of action that allows induction of anaesthesia to proceed slowly.
- It has excellent analgesic property even at sub-anaesthetic doses and in combination with diazepam; it is the cheapest injectable anaesthetic agent.
- It has less respiratory depression effect than thiopental or propofol and respiratory responses to hypoxaemia and hypercarbia are better maintained.
- Ketamine is the suitable induction agent in patients with cardiac tamponade, asthma and with reactive airways.
- It is effective if administered by any route (IV, SC, IM, oral), making it especially useful for fractious cats.
- Disadvantages include profuse salivation and lacrimation, increase intraocular pressure, susceptible to corneal abrasion (as eye remains open) and postanaesthetic delirium.
- Recovery from anaesthesia may be accompanied by excitement, hyperthermia and even convulsions.



Ketamine hydrochloride

Dose : *Dog* 10 mg/kg in non-premedicated together with diazepam 0.5 mg/kg. 5 mg/kg in premedicated together with diazepam 0.5 mg/kg.

Cat 11-33 mg/kg IM

Tiletamine (Telazol)

- Tiletamine is presently available only as Telazol, a combination of equal parts of tiletamine and zolazepam.
- The drug provides good analgesia and is more potent than ketamine.
- Cardiovascular effects of the drug vary markedly among species but are similar to those of ketamine.

- It causes respiratory depression, primarily a decrease in rate, resulting in hypercarbia.
- Onset of anaesthesia occurs within 5-8 minutes in intramuscular injection and within 30-60 seconds following intravenous administration. Duration of anaesthesia following intramuscular injection is 20-40 minutes.
- Poor muscle relaxation occurs and recovery may be characterized by emergence delirium when used alone in some species.

Dose: Dog- 6.6-13.2 mg/kg IM, Cat-8.8-15.4 mg/kg IM
Bovine—4.0 mg/kg IV
Sheep—4.0 mg/kg IM in combination with xylazine (0.1 mg/kg IM)

Commonly used anaesthetica/sedatives and their antagonists with does

Anaesthetics/sedatives	Antagonsit	Dog (10 kg)	Cat (4 kg)
Acepromazine	4-aminopyridine, 0.5 mg/kg	5 mg	2 mg
Barbiturates	Doxapram, 5.5 mg/kg	1-2.5 ml IV	0.4 ml-1 ml IV
Diazepam, Midazolam	Flumazenil, 0.02-0.12 mg/kg IV	2.12 ml IV	0.2-4.8 ml IV
Ketamine	4-aminopyridine, 0.5 mg/kg	5 mg	2 mg
Morphine, Pethidine, Fentanyl	Naloxone, 0.015-0.04 mg/kg IV, IM, SC	0.37-1 ml IV	0.15-0.4 ml IV
Propofol	Doxapram	1-2.5 ml IV	0.4 ml-1 ml IV

*Doxapram is not a true antagonist to any of these agents; it has been included as a respiratory stimulant (thus antagonizing apnoea).

NEUROLEPTANALGESIA

Neuroleptanalgesia is the condition or state of hypnosis and analgesia produced by the combined administration of neuroleptic drug (*e.g.* droperidol, acepromazine) and an opioid analgesic (fentanyl, buterphanol, oxymorphone). However, in a broader sense, a combination of opioid with sedative or tranquilizers like alpha-2 agonist or benzodiazepine also produces a state of neuroleptanalgesia. Though, Neuroleptic drugs traditionally include the phenothiazines (*e.g.*, chlorpromazine) and the butyrophenones (*e.g.*, haloperidol and droperidol). E.g. Innovar vet (Droperidol + Fentanyl).

Neuroleptanalgesia is more commonly used in high risk (*e.g.* cardiac patients) and geriatric patients and not much useful in very young healthy dogs. It is not recommended in cats as opioids can produce excitement. Neuroleptanalgesia is not suitable in patients receiving monoamine oxidase inhibitors (MAOI).

Method of administration

- Preanaesthetic (anticholinergic) followed by tranquilizer, waits approximately for 15 minutes and then administers opioid till effect.
- No premedication, slow intravenous administration of opioid followed by tranquilizer.
- No premedication, followed by slow intravenous administration of tranquilizer and then opioid till effect.

ELECTRO ANAESTHESIA

Electro anaesthesia is produced by passing an electric current through the brain from electrodes placed at the head and tail. Direct, pulsating direct and alternating current have been used to produce electronarcosis (AC 700 cycles, 35 to 50 mA and approximate 40 volts). Continuous electrode contact is important to maintain anaesthesia.

- It is characterized by convulsions on induction unless a muscle relaxant is first administered.
- During induction, profuse salivation develops and continues throughout and can be counteracted by administration of atropine.
- Hyperthermia may be seen.
- Disadvantages include severe stress (increased blood cortisol levels) and sharp rise of blood pressure followed by gradual fall to near normalcy.
- Muscle relaxation varies from adequate to poor and analgesia persists for several minutes following removal of the current and the animal often appears hypnotized.
- Advantages include economical, immediate recovery and useful in experiments where no drug is supposed to be given.

ACUPUNCTURE

Acupuncture is the part of Chinese medicine to diagnose and treatment of chronic diseases of patients. In veterinary acupuncture, animals are considered as a whole unit consisting of body, mind, diet, spirit and environment. Generally, holistic approach of the medicine helps to explain this ancient medical approach. In the acupuncture therapy, the needles are pierced in certain points that are called as **accupoints**. This piercing stimulates those points and the stimulation cures the diseases. The word '**ACUS**' means **needle** in Latin. Acupuncture therapy is one of the most ancient forms of therapy practiced by the Chinese for over 600 years. This therapy has been introduced in India for anaesthesia and therapy in man and animals.

Applications of acupuncture therapy

- Pain relief in animals.
- Acupuncture analgesia in non-premedicated animals, as part of balanced anaesthesia and in anaesthetic practice.
- Management of respiratory depression and arrest.
- Management of paralysis and shock.
- Stimulation of body defense functions.
- Cardiovascular support in the course of general anaesthesia.
- Antipyretic and immunological actions.

Acupuncture points

Acupuncture points are located on imaginary horizontal lines known as meridians, which in turn have internal connections to the organs from which the meridian or the channel gets its name. There are over 360 points on these meridians and many non meridian points and all

together are 14 meridians. The Chinese believe that the vital energy, Ch'i flows these pathways (energy pathway).

Organ Meridians	Maximum pathways of energy flow	Direction
Lung (Lu)	11 points 3-5 AM	Chest to fore leg
Heart (H)	9 points 11-13 PM	Chest to fore leg
Stomach (St)	46 points 7-9 AM	Head to hind leg
Spleen (Sp)	21 points 9-11 AM	Hind leg to chest
Large intestine (LI)	20 points 5-7 AM	Fore leg Head
Urinary bladder (BI)	67 points 17-19 PM	Hind leg to chest
Kidney (K)	27 points 19-21 PM	Chest to fore leg

HYPOTHERMIA

Hypothermia means lowering of body temperature below 35°C. Hypothermic anaesthesia is a form of general anaesthesia. The combination of hypothermia and anaesthesia is used to achieve :

- Loss of consciousness
- Loss of sensory response
- Depressing the motor activity
- Loss of reflex response

Methods of whole-body cooling

- **Surface cooling** is usually accomplished by directly immersing the unprotected body in ice water or by placing the body on a mattress through which ice water is circulated.
- **Body cavity cooling** is usually accomplished by pouring cold saline solution into the open thoracic cavity.
- **Extra corporeal cooling** is accomplished by running blood from a cannulated artery through a heat exchanger using cold tap water as the cooling medium.

Effect of hypothermia

- Cardiovascular system effect—Blood pressure falls due to decreased cardiac output and bradycardia.
- Respiratory system—Depression of respiratory centre.
- Central nervous system effect—decreased blood flow to cerebrum.
- Blood—prolongation of clotting time, decreased platelets, decreased eosinophils and leukocyte counts and haemoconcentration.
- Severe damage to the liver, kidneys and adrenal glands (25°C temperature for hours).

Protocol for induction of hypothermia in a dog

Phenothiazine tranquilizer is given as intravenously

↓

Thiobarbiturate is injected as general anaesthesia followed by endotracheal intubation and administration of inhalant anaesthetics as maintenance

↓

Slow intravenous drip of Ringer's lactate or 5% dextrose is started and a muscle relaxant is given in the drip to abolish respirations followed by controlled respiration

↓

The animal is put in a sink, bath tube or other container with its head above the water

↓

Ice water is used for rapid cooling and the dog should be removed from the bath before the desired body temperature is reached

↓

The dog is dried with towels and placed on a inactive heating pad during the operative period

↓

Rewarming can then be started as soon as skin closure is started

↓

Rewarming can also be made in a water bath along with administration of atropine and neostigmine to reverse the muscle relaxant

MUSCLE RELAXANTS (NEUROMUSCULAR BLOCKING AGENTS)

Anesthetic drugs causes a degree of dose dependent muscle relaxation, but to achieve a profound muscle relaxation (especially to perform orthopedic surgery) such a higher dose can cause severe compromise in cardiopulmonary functions. Therefore, to increase the different level of muscle relaxation during surgery, muscle relaxants are required to be added in anaesthetic regime. Such drugs can produce complete relaxation of skeletal muscle.

Indications

- To achieve desirable level of skeletal muscle relaxation particularly for orthopedic operation and for easy access to deep into the abdomen.
- For easy close reduction of dislocated joints.
- For easing ophthalmic procedures by relaxing extra-ocular muscles, hence allowing control positioning of the eye and also to prevent coughing and moving of patients.
- For easy endotracheal intubation of cats.
- To facilitate intrathoracic surgery by allowing smooth respiration during manual ventilation.

Precautions

- Muscle relaxants not only relax skeletal muscle but also diaphragmatic and intercostal muscles. Therefore, facilities for endotracheal intubation and intermittent positive pressure ventilation (IPVV) must be required.

- When muscle relaxants are used in combinations with other anesthetic drugs, during recovery even after the patient is breathing spontaneously, if extubated, airway obstruction may happen. Because relative sensitivity of the pharyngeal muscles to the small amounts of muscle relaxants which are still present in neuromuscular junctions.

Mechanism of action

Block transmission at the level of the neuromuscular junction at nicotinic receptors, thus decreasing skeletal muscle tone.

Types

A. Non-depolarizing :

- Bind to receptors and prevent acetylcholine (Ach) from stimulating receptors (competitive), hence muscle paralysis occurs gradually.
- Drugs include in this category are tubocurarine, metocurine (dimethyltubocurarine), gallamine, pancuronium, atracurium, vecuronium, mivacurium, rocuronium, alcuronium, cisatracurium and fazadinium.
- These groups of drugs are often referred to as curare because of their relationships with the curare alkaloids that were first used clinically.
- Being water soluble, none of the drugs cross the blood-brain barrier, polar molecules and therefore have no effect on the central nervous system. Thus, unless an anesthetic agent is administered concurrently, animals are fully conscious throughout the period of immobilization.
- Minimal cardiovasuclar effects except atracurium.

Atracurium

- short-acting relaxant.
- Few cardiovascular effect but bradycardia during anaesthesia is a common feature due to absence of vagal blocking activity).
- Bronchospasm is rare in proper dose, if so may be due to secondary to histamine release.
- Con not cross placental barrier.
- Dose : 0.3-0.6 mg/kg I.V.
- Duration of action : 20-40 minutes.
- Atracurium precipitates in alkaline pH.
- Atracurium should not be mixed with thiopentone or should not be administered immediately after thiopentone, if it is required to be administer, always flush the vein with saline.

Vecuronium

- short-acting relaxant
- Cardiovascular effect is like that of atracurium
- Dose : 0.08-0.1 mg/kg IV
- Duration of relaxation : 15-30 minutes.

Rocuronium

- Minimal **Cardiovascular effects**
- Bronchospasm is uncommon because of non-significant histamine release.

- Does not trigger malignant hyperthermia.
- Dose : 0.6 mg/kg (For E.T tube placement), incremental dose if required: $1/4^{th}$ of initial dose.

B. Depolarizing:

- Causes brief depolarisation of post-junctional membrane skeletal muscle, thus causing contraction, fasciculations.
- Repolarisation is inhibited by mimicking the effect of acetyl choline but without being rapidly hydrolysed by acetyl cholinesterase.
- Propagation of an action potential is prevented by the area of inexcitability that occurs around the acetyl choline receptors.
- After the drug has been present for a period of time, the motor end plate loses its sensitivity and depolarisation cannot occur; desensitisation continues for several minutes, even after drug is no longer present.
- Drugs under this category are succinylcholine (suxamethonium) and decamethonium

C. Suxamethonium, a short-acting muscle relaxant, is used.

- For smooth and quick endotracheal intubation and neuromuscular blockade for a short period.
- For immediate management of seizure.

D. Dose: Intravenous 1-2 mg/kg; Intramuscular 3 mg/kg.

E. Rapid onset of action: 30-60 seconds after I.V use.

F. Duration of action: 5-10 mins. Intermittent bolus dose can be used to prolong the action.

G. may be used in intramuscular route, but the onset of action is slower and less predictable

H. Adverse effects :

- bradycardia on repeat doses
- Potassium level in the serum will rise (by about 0.2-0.4 mmol/L) in healthy patients and by much more in patients with recent burns, paraplegias or severe muscle trauma.
- can trigger the onset of malignant hyperthermia.
- increase post-operative muscle pain.
- increase intracranial and intraocular pressure.

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CHAPTER

8

Inhalation Anaesthesia

Inhalant anaesthetics are extensively used to provide general anaesthesia in both human and veterinary patients. Unique among general anaesthetics, inhalants are eliminated from the body primarily through the lungs; hepatic inactivation and renal elimination are not strictly necessary to permit a patient to regain consciousness from inhalant anaesthesia. The ability to induce and maintain general anaesthesia without being totally dependent upon hepatic function to permit the patient to recover consciousness is a tremendous advantage. To deliver predictable concentrations, liquid inhalant anaesthetics are usually first vaporized in a vaporizer and then administered in an enriched concentration of oxygen to a patient via a breathing circuit.

Advantages

- Anaesthetist has better control over the level of anaesthesia.
- Safe anaesthesia for longer surgical operations.
- Recovery from anaesthesia is fast and primarily not dependent upon the body detoxification mechanisms.
- Increased patient safety by enriched oxygen concentration and controlled ventilation.

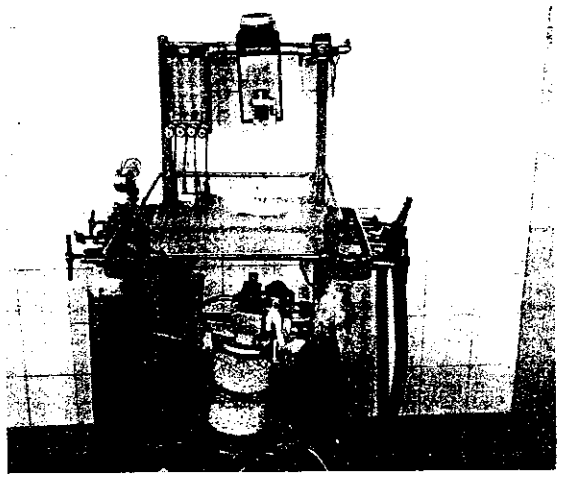
Disadvantages

- The equipment is heavy, bulky and not easily portable and become problematic in field conditions.
- Constant surveillance by the anaesthetist is needed.
- The anaesthetic agents may be inflammable, explosive and irritant to the body tissue.
- The pungent smell of isoflurane or halothane may force the animal to hold their breath during induction and as a result, slow the speed of induction.
- Severe physiological changes may occur in long standing procedure.

Methods of administration

1. **Open insufflations :** The anaesthetic gas or vapour together with air and /or oxygen is delivered to the mouth or trachea by a mask catheter.
2. **Semi open systems without nonbreathing valves** include semi open drop, anaesthetic boxes and chambers, and Macgills apparatus.
3. Semi open systems with nonbreathing valves
4. Semi closed and closed systems.

Inhalant anaesthetics : Volatile or gaseous



Boyle's apparatus

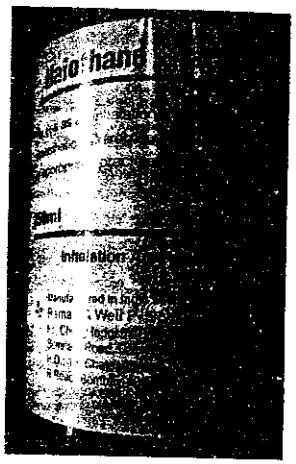
Ether

- It is a colourless with pungent smell, highly volatile liquid that is highly inflammable, explosive and irritant in nature.
- It is available at low cost and is safe for operating-room personnel.
- It has a very wide safety margin and high level of analgesia (but is irritant to mucous membrane).
- Induction and recovery by ether are fairly slow.
- There is good muscular relaxation. It also causes excessive salivation and increase in respiratory tract mucous recreations which interferes with respiration. Sometimes it may lead to paralysis of respiratory tract due to sudden inhalation of higher concentration.
- Ether may also lead to oliguria, post anaesthetic nausea and cardiac arrhythmias.

Methoxyflurane

- Methoxyflurane is a fairly soluble and stable volatile inhalant anaesthetic agent resulting in slow induction and recovery, so it is not recommended for induction.
- It has a very low minimum alveolar concentration (MAC) as compared to halothane, so it is highly potent.
- Low concentrations (0.4-1%) are required to induce and maintain anaesthesia.
- It produces excellent muscular relaxation and analgesia.
- It is not hepatotoxic, although it should not be used in patients with liver diseases.
- It is very difficult to monitor the levels of anaesthesia as palpebral and pedal reflexes are abolished at an early stage.
- Disadvantages include dose dependant depression of the cardiopulmonary system and reduced motility and tone of gastrointestinal tract.

Halothane



Halothane

- Halothane is non inflammable, nonirritant and non explosive.
- Halothane is less soluble than ether or methoxyflurane; it is thus faster-acting and recovery is quicker, making it a suitable agent for induction, although it is odd-smelling and tends to cause unpleasant inductions.
- Recovery is very rapid and free from excitement. The MAC value is higher than methoxyflurane- 0.87% in dogs and 1.19% in cats.
- Analgesic property of halothane is reasonable.
- There is negligible direct effect on the liver and kidney functions.
- It can cause arrhythmias, has a marked dose-dependant cardiac-depression activity and so is not suitable for patients with cardiac disease.
- Other untoward effects include depressed respiration, bradycardia, hypotension and post-anaesthetic shivering.
- **Concentrations** of 2-4% can produce stage-III in dogs and small animals, 4-10% in large animals. The maintenance concentration is 0.8-2.3% in the inhalant mixture and should be **administered** by closed system using precision vaporizers.

Isoflurane

- Isoflurane is a newer agent becoming more popular than halothane in recent years, slightly less potent than halothane with a MAC value of 1.31% in dogs and 1.61% in cats and is non inflammable and non explosive in clinically useful concentrations.
- The solubility of isoflurane is lower than that of halothane and inductions into and recoveries from anaesthesia occur more rapidly than with halothane.
- There is good muscle relaxation like halothane but there is a similar lack of analgesia.
- Advantages include good cardiovascular stability, low blood solubility and resistance to hepatic metabolism (suitable for patients with compromised hepatic functions).
- Disadvantages include depression of cardiovascular system, CNS and ventilation.
- **Concentrations** of 2-4% can be used for induction and 1-2% for maintenance of anaesthesia in small animals and **administered** in a precision vaporizer.

Sevoflurane

- It is the newest inhalant anaesthetic that has been approved for use in veterinary anaesthesia.
- It is non inflammable and non explosive in clinical concentrations and it has a MAC value of 2.36% in dogs and 2.58% in cats making it both less potent and less soluble in blood than either halothane or isoflurane.
- The lower blood solubility of this agent compared with isoflurane results in more rapid inductions and recoveries and a more rapid change in anaesthetic depth in response to a change in inspired concentration.

- Analgesic property is minimal.
- Cardiovascular effects of sevoflurane are comparable to those of isoflurane. Respiratory depression effect and CNS effects appear to be similar to that of isoflurane.
- The greater price of this agent is a hindrance for clinical use in veterinary patients.
- **Concentration** of 4-5% for induction and 2.5-4.0% for maintenance are required in typical vaporizer settings.

Desflurane

- Desflurane is the newest of the inhalant anaesthetic introduced into human anaesthesia practice and being popular in dogs.
- The MAC value in dog is between 7-10% and variation seems to be due to several factors including temperament of the animal.
- It is even less soluble, highly volatile than sevoflurane with a quicker induction, recovery and rapid changes in anaesthetic depth.
- It boils at close to room temperature, so it can not be used in conventional vaporizers and it requires electronically controlled vaporizers.
- The cardiovascular effects, respiratory effects and CNS effects are similar to those associated with isoflurane.
- **Concentrations** of 12-18% for induction and 8-10% for maintenance are required in typical vaporizer settings.

Nitrous oxide

Nitrous oxide is the oldest inhalant still in use in anaesthesia practice, although technically a vapour nitrous oxide is often referred to as gaseous anaesthetic. In veterinary anaesthesia the use of nitrous oxide has four main indications.

- A MAC-sparing effect when used in combination with other "potent" inhalants.
- To supplement analgesia during a surgical procedure.
- To speed induction of inhalant anaesthesia via the "second gas effect".
- As the sole anaesthetic in extremely debilitated patients.
- It is an inert, nonirritant, non inflammable and non explosive gaseous anaesthetic.
- Its high MAC value (around 200% in dogs and cats) makes it impossible to use as a sole anaesthetic agent. However, at sub anaesthetic doses N_2O is a very good analgesic. It is usually administered with other anaesthetic gasses to increase analgesia and decrease the amount of volatile anaesthetic agent required to maintain anaesthesia.
- It should not be used in patients with respiratory compromise (especially with pneumothorax or pneumoperitoneum).
- **Administration :** by semi close or closed method with oxygen. Mostly used with volatile anaesthetic in 50-70% concentration. Minimum of 30% oxygen should be there in the inhalant mixture.

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CHAPTER 9

Anaesthetic Emergencies and Remedies

INDICATIONS FOR ANAESTHETIC EMERGENCIES

- *Equipment problem :* It includes failure to deliver oxygen, empty cylinders, misconnected gas lines and kinked or plugged endotracheal tubes.
- *Human error :* It includes unfamiliarity with the equipment, anaesthetic drug and its action, miscalculation of dose, incorrect route of administration and wrong medication.
- *Ventilatory problems :* hypoventilation due to anaesthetic over dose, hyper ventilation due to inadequate anaesthesia and ventilatory depression.
- *Circulatory problems :* It includes hypotension, bradycardia, tachycardia and shock.

Some common anaesthetic emergencies and accidents which may be encountered during anaesthesia are listed below with a brief description of the problem and recommended remedies.

1. Hypotension—Hypotension may occur due to excessive blood loss during anaesthesia which may be sudden or in prolonged operations. Such complications may occur during surgerics such as caesarean in cattle, buffalo and other animals or due to sudden pressure on liver or spleen in dogs and cats.

Remedies—Blood loss can be substituted with appropriate fluid therapy, compatible blood or plasma expanders therapy, before, during and after operation. In sudden hypotension, the operation should be stopped and wait until blood pressure comes to normalcy.

2. Shock—Shock generally develops due to overdosing of anaesthetic or excessive fluid loss during surgery. It may be hypovolaemic, cardiogenic or vasculogenic.

Remedies—Treatment of specific shock can be made in the general principles of the management of shock. Normally, it can be prevented by administering preoperative steroids along with compatible intravenous fluids before and during the surgery.

3. Bradycardia—It is generally seen in deep anaesthesia, hypothermia, hypoxia and vagal reflexes.

Remedies—This can be managed by administering an anticholinergic drug like atropine. If atropine does not correct the problem, dopamine may be considered as an infusion at a rate of 2-10 mg/kg/min in fluid.

4. Tachycardia—Tachycardia means increase in heart rate that can be occurred from pain, hypercarbia, hypoxemia and hypovolemia. It is also observed in young animals or during shock or in patients premedicated with atropine.

Remedies—Lignocaine hydrochloride 2% without adrenaline may be considered intravenously if the heart rate is increased too much.

5. Cardiopulmonary arrest—Cardiopulmonary arrest is really a true emergency condition where immediate treatment is mandatory within 2-3 minutes. The clinical signs of this condition are no auscultable heart sound, no palpable pulse, dilated pupil, cyanotic mucous membrane and unconsciousness.

Remedies—The basic line of treatment in cardiopulmonary resuscitation (CPR) is A-Air way B-breathing, and C-circulation. It is otherwise termed as the ABC of CPR.

A-Airway

- Head should be extended and intubate the animal immediately.
- Examine for the possible obstruction of the airway with food material or kinked endotracheal tube.
- Perform tracheostomy immediately to maintain patent airway.
- Aminophyline may be injected to treat bronchospasm.

B-Breathing

- Artificial respiration may be instituted using rebreathing bag or mechanical ventilators and supply of 100% oxygen.
- Use of Ambu type resuscitation bag or mouth to mouth respiration to maintain breathing.
- **Drugs like doxapram (1mg/kg IV) may be given.**

C-Circulation

- External cardiac massage by chest compression should be made at the rate of 60-90/ minute in small animals with hands on either side of the chest and 30-40/ minute in large animals with foot or knee.
- Direct cardiac massage by thoracotomy (in 6th intercostals space).
- Defibrillation by means of internal or external paddles of cardiac defibrillators.

Other drugs in cardiopulmonary resuscitation include administration of calcium solution, dopamine (2.5-20 mg/ kg/ min in small animals and 1.0-5.0 mg/ kg/ min in large animals), epinephrine (5 ml of 1 : 1000 solution for a 450 kg horse), doxapram (0.55 mg/kg IV), picrotoxin (1mg/kg IV), nikethamide (10-25 ml IV in large animals and 1-3 ml IV in dogs and cats), corticosteroids, lignocaine, sodium bicarbonate and appropriate fluids.

6. Other complications that may occur during anaesthesia include hypothermia, hepatitis, renal failure, corneal abrasions, vomition and regurgitations.

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CHAPTER

10

Postoperative Pain Management

Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage.

Types of pain

A. Physiologic pain : Pain that occurs after most types of noxious stimulation is usually protective and quite distinct from the pain resulting from overt damage to tissues or nerves. It is characterized by high stimulus threshold, is well localized and is transient and demonstrates a stimulus-response relationship similar to those of the other somatosensations.

B. Pathologic pain : The noxious stimulus is not transient and may be associated with significant tissue inflammation and nerve injury. It may manifest in several ways: spontaneous pain that may be dull, burning or stabling (Causalgia); exaggerated pain in response to a noxious stimulus (hyperalgesia); and pain produced by a stimulus that is not normally noxious (allodynia). This type of pain is also called clinical pain. Pathologic pain is often further classified into :

Visceral pain : Pain emanating from deep visceral structures.

Neuropathic pain : Pain produced as a consequence of damage to the nervous system.

Clinical pain is further classified as :

(a) ***Acute pain*** : Recently occurring pain typically arise from soft tissue trauma or inflammation, with the most common example being postoperative surgical pain.

(b) ***Chronic Pain*** : Pain persists beyond the expected time frame for a given disease process or injury.

Management

Analgesic Medications : Analgesic medications have traditionally been administered on an "as-needed" basis and should be administered on a continuous or scheduled intermittent basis, with supplemental bolus doses as required. The following analgesics may be administered to dogs :

(a) **Opioid pure agonists** (Oxymorphone, hydromorphone, morphine, fentanyl, Fentanyl patch).

Partial agonists (Buprenorphine) or agonists-antagonists (Butorphanol).

(b) **NSAIDs** (Caprofen, Ketoprofen, Meloxicam, Tolfenamic acid, Etodolac, flunixin meglumine).

(c) **Local anesthetics** (Lidocaine, Bupivacaine, Mepivacaine)

(d) **Adjunctive methods**

(e) **Ketamine hydrochloride**

(f) **Alpha-2 agonists** (Xylazine, Medetomidine)

***(a)* Opioid pure agonists:** Opioid analgesics provide the most consistent and effective analgesia and are still the best drugs available for pain control in small animals especially in canine. Opioid agonists, either exogenous or endogenous, produce analgesia and other central effects by binding to specific opioid receptors in the brain and spinal cord. The μ and κ opioid receptors then mediate these analgesic effects. The selection of which opioid to be used depends on the degree of pain that the animal is perceived to be experiencing. The perioperative doses of the opioids in canine pain management are given bellow.

Drug	Dose	Route	Duration of action
Morphine	0.5-1.0 mg/kg 0.5 mg/kg + 0.1-1.0 mg/kg/h	I/M, S/C I/V	3-4 hrs As long as infusion lasts
Oxymorphone	0.05-0.1 mg/kg	I/M, I/V, S/C	3-4 hrs
Hydromorphone	0.1-0.2 mg/kg	I/M, I/V, S/C	2-4 hrs
Fentanyl	5 mg/kg+3-6 μg/kg/h	I/V	Infusion
Butorphanol	0.1-0.2 mg/kg	I/M, I/V, S/C	3-4 hrs
Buprenorphine	5-20 μg/kg	I/M, I/V, S/C	8-12 hrs
Fentanyl patch	10-20 kg-50 μg/h	Transdermal	

***(b)* Nonsteroidal anti-inflammatory agents :** NSAIDs have the potential to control moderate to severe acute or chronic pain in veterinary practice. These drugs provide analgesia via the non-selective competitive inhibition of cyclo-oxygenase (cox-1) and (cox-2) which ultimately reduces the production of prostaglandins. The main indications for these drugs in pain management are post-operative pain, different inflammatory conditions and pain associated with osteoarthritis. NSAIDs must be used with caution because there is potential for stomach and intestinal problems and prolonged blood clotting time.

Commonly usaed NSAIDs and dosing regiment in canine practice are given below

Drug	Dose	Route	Duration of action
Ketoprofen	Surgical pain ≤ 2.0 mg/kg. ≤ 1.0 mg/kg Chronic pain ≤ 2.0mg/kg, PO ≤ 1.0 mg/kg, PO	I/V, S/C,I/M, PO I/V, S/C, I/M 	Once Repeat every 24 hr Once Repeat every 24 hr
Meloxicam	Surgical pain ≤ 0.2 mg/kg ≤ 0.1 mg/kg Chronic pain ≤ 0.2 mg/kg, PO ≤ 0.1 mg/kg, PO	I/V, S/C I/V, S/C, PO 	Once Repeat every 24hr Once Repeat every 24 hr

Caprofen	Surgical pain ≤ 4.0 mg/kg ≤ 2.2 mg/kg, PO Chronic pain ≤ 2.2 mg/kg, PO	I/V, I/M, S/C	Once on induction Repeat every 24 hr Every 12-24 hrs
Flunixin Meglumine	Surgical pain ≤ 1.0 mg/kg	I/V, S/C, I/M	Once
Tolfenamic Acid	Acute chronic pain ≤ 4 mg/kg, PO	S/C	Once daily for 3 days and 4 days off; repeat the cycle

(c) Local analgesia. Local anaesthesia can increase patient comfort and facilitate patient co-operation during painful procedures. Techniques for the administration of local anesthetics include topical application, local infiltration and peripheral nerve block. The type of local anesthetics used determines the duration of analgesia resulting from the blockade.

Topical anaesthesia **:** Eutectic mixture of local anesthetics (EMLA) cream is a 1 : 1 mixture of two anesthetics (Lidocaine and Prilocaine). This combination has excellent dermal penetration and because the total amount of anesthetics used is decreased, local irritation and toxic effects is reduced.

Intercostal nerve block **:** This block is used to diminish sensation from a thoracotomy, placement of a chest tube or rib fracture-related pain.

Epidural **:** Epidural analgesia is frequently used to prevent, reduce or treat pain in dog. It can provide good postoperative pain relief and pain control in patients with pancreatitis, an abdomen open and draining because of peritonitis, post-traumatic but pre-operative fracture pain.

(d) Adjunct agents. Sedatives are common adjuncts to analgesics used to decrease the anxiety and agitation that may be seen in the critical care patients. Sedatives such as acepromazine (in young stable patient) or diazepam or midazolam (in the geriatric or cardiovuscularly compromised animal) may be useful in calming the anxious patient. Sedatives have no analgesic properties when used alone.

Drug (Sedatives combined with opioids)	Dose	Route	Dosing interval
Midazolam	0.1-0.5 mg/kg	I/V, I/M	Upto 6 hrs
Diazepam	0.1-0.5 mg/kg	I/V	Upto 6 hrs
Acepromazine	0.01-0.05 mg/kg	I/V	1-2 hrs
Medotomidine	0.002-0.004 mg/kg	I/M, S/C	2-6 hrs

(e) Ketamine hydrochloride : Although ketamine is a dissociative anaesthetic, there is a clinical belief that ketamine can provide a significant degree of analgesia through blocking the phencyclidine site in the ion channel associated with the N-Methyle-D-asparate (NDMA) receptor. The NDMA site is thought to be essential in evoking a hyperalgesic state in response to repetitive small afferent (C-fibre) input. Ketamine has been found to be a useful agent for analgesia in dogs with burn wounds at a dose rate of 10 mg/kg orally every 8 hours and 2-4 mg/kg I/V, may be an alternative to control pain quickly if opioids are not available.

(f) Alpha-2 agonists: α_2 agonists (xylazine, medetomidine) when administered systemically, binds with α_2 adrenoreceptors that are situated in several areas within the spinal cord and brain stem concerned with analgesia. It can also produce analgesia when given epidurally or intrathecally with a decreased incidence of untoward side effects.

(g) Non-Medicinal Management of Pain : The use of tools and techniques outside the drugs and medications to enhance comfort and recovery.

Cryotheray **:** Indicated for acute attacks of arthritis or to relieve pain and prevent inflammation and application by massage with ice (5 to 10 minutes) for 3 to 6 times a day.

Thermotherapy **:** Analgesia for distal joints and superficial heat should be applied for 15 to 20 minutes, one to three times a day by hot water bottles or hot-packs.

Actinotherapy **:** Applied in joints affected with arthritis by Infrared rays and duration of exposure should be 15 minutes to 1 hour.

Ultrasound Therapy **:** High & low-frequency ultrasound waves to treat hip and shoulder joints and to reduce muscular spasm for 5 to 10 minutes for two to three times a week.

Transcutaneous Electrical Neuro-Stimulation (TENS) **:** For sub-acute and chronic pain in arthritic animals and a TENS current should be applied for a minimum of 20 to 30 minutes.

Extra-corporeal shock wave therapy (ESWT) **:** Indicated in rheumato-orthopaedic disorders in horses (desmitis of the suspensor ligament of the fetlock) and arthritic dogs.

Acupuncture **:** To treat acute as well as subacute and chronic attacks of arthritis. In acute inflammatory attack, one session every two to three days is necessary until clinical signs resolve whereas for chronic pain, several sessions are required.

Low Level Laser Therapy **(LLLT) :** Pain reductions by restoring nerve cell action potential back to its normal value.

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CHAPTER

11

Chemical Restraint of Wild/Zoo Animlas

With the advent and understanding of new drugs and new delivery systems, chemical restraint has become a practical procedure in the last few years. Tranquilizing or sedation of animal is only resorted to, when physical or mechanical means are not feasible or become difficult. A variety of agents are available in the market but each has its own limitations and indications. Precise knowledge of pharmacology of the agents is utmost essential before restraining.

Advantages

- Immobilization causes little disturbance and physical damage is negligible.
- Selected individuals can be captured.
- Specific time of capture can be selected.
- Rapid shifting of portable equipment to field conditions.

Disadvantages

- Procurement of drug from foreign countries is expensive and cumbersome.
- Undesirable side effect may occur.
- Careless use of drug leads to danger to operator.
- Sometimes death of darted animals may happen.

Properties of ideal chemical immobilization drug

- Should not cause tissue irritation.
- Should be rapidly eliminated from the body.
- The recovery and induction periods should be calm.
- Should have a wide margin of safety.
- Should have rapid absorption in systemic circulation and onset of action.
- Should have availability of reliable antidote.
- Should have no permanent damage to the wild animal.
- Should have no drastic effect on the pregnant animals.
- Should have suitable stability.
- Should have less risk to wild life veterinarians handling the drug.

Monitoring anaesthesia

Anaesthetic monitoring in wild and zoo animals is of paramount importance to determine any complications that require treatment. This can be achieved by monitoring different reflexes as cited below.

- ***Palpebral reflex :*** Animals under a light plane of anaesthesia will blink the eyelid in response to the touch.
- ***Nystagmus:*** The eye flicks rapidly from side to side with xylazine-ketamine and medetomidine-ketamine.
- ***Movement :*** Movements of the limbs or the head or neck often depicts that the animals is waking up and additional drug will be needed.
- ***Body temperature :*** A temperature for which animal is cause for concern and the animal should be cooled if possible.
- ***Heart rate :*** It varies between species and drug administered and can be measured by auscultation with a stethoscope or a pulse can be measured from the femoral arteries.
- ***Respiratory rate :*** It will also vary among species and is usually monitored by observing chest movement.
- ***Mucous membrane colour :*** The colour of mucous membrane is generally pink. White mucous membrane indicates shock state and blue or purple indicate a lack of oxygen.

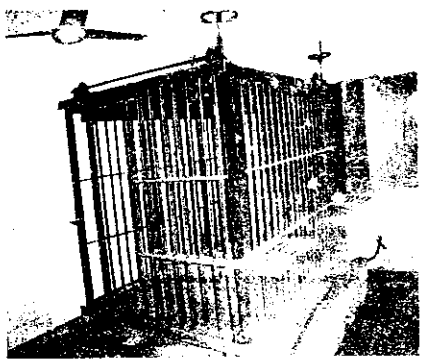
ANAESTHESIA OF WILD RUMINANTS

Special considerations

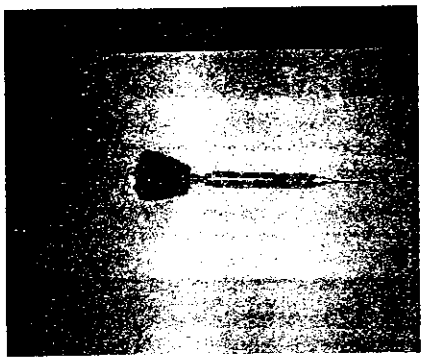
- ***Tympany :*** Ruminal tympany may develop due to gas formation and decreased rumen motility. If bloat is severe, it can impair breathing and blood flow resulting in hypoxemia and shock. This can be relieved by passage of a stomach tube or rumen trocharization.
- ***Regurgitation :*** Regurgitation is a common sequel of bloat in anaesthetized ruminants and ultimately leads to risk of aspiration pneumonia.
- ***Hypoxemia :*** Hypoxemia is also a common complication of ruminant anaesthesia that requires close monitoring of oxygenation.
- ***Position :*** It is preferable to maintain a ruminant in strenal recumbency if possible so that it might decreases the risk of tympany.
- ***Myopathy :*** Myopathy may develop in ruminants after anaesthesia.
- ***Hyperthermia :*** Hyperthermia may develop in ruminants and so immobilization should be avoided during the warm hours of the day if possible.
- ***Trauma :*** During induction of anaesthesia every care should be taken as small ruminants are very flighty and may traumatize themselves.

Delivery Systems

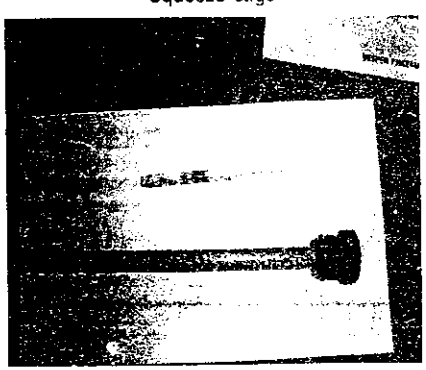
Chemical immobilization has become a routine operation carried out by veterinarians engaged in zoo as well as in sanctuaries. Though some level of expertise has been gained in drug immobilization and translocation procedures, the procedure is still fraught with potential dangers like mechanical injuries to the animal. Veterinarians have often been blamed for any capture related deaths. For successful immobilization, the operator should have a thorough knowledge of selection of appropriate equipment and familiarity of its use. Besides, a high degree of accuracy



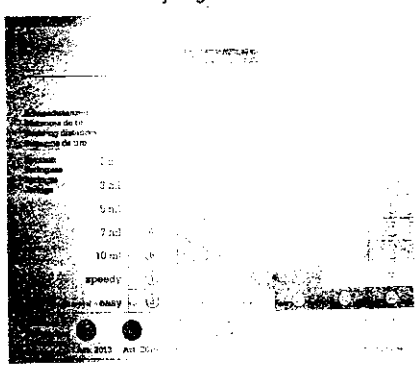
Squeeze cage



Dart Syringe with feathers



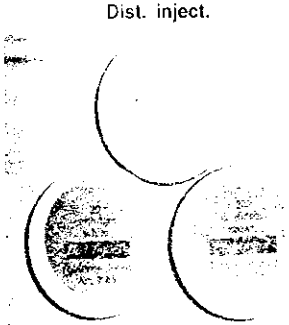
Blow pipe with dart syringe



Dist. inject.



Cartidges



Cartidge box



Dart Gun

in darting aims, shooting range and in dose estimation in relation to body weight of the animal is of great importance before capture operation. The immobilization equipments are the projector blowpipe, rifle, pistol and the projectile-dart or flying syringe with needle (short range, long range and extra long range).

Doses of Chemical Immoblizing Agent

Species	Anaesthetic agents	Reversal
Deer	Xylazine—2-8.0 mg/kg body weight Ketamine 10-20 mg/kg body weight	Yohimbine
Primates	Ketamine—10-25 mg/kg intramuscular Xylazine 2 mg/kg—intramuscular	
Chimpanzee	Ketamine 10-15 mg/kg body weight Xylazine 2 mg/kg	
Kangaroo	Xylazine 8 mg/kg body weight and Ketamine 3 mg/kg—Combination, Thiopentone less than 20 mg/kg body weight	
Antelope	Xylazine 0.23 mg/kg and Ketamine 11.54 mg/kg body weight (Combination)	
Camels	Xylazine 0.27-0.51 mg/kg intramuscular	
Bears	Xylazine 2-4 mg/kg and Ketamine 4.5-9 mg/kg (Combination) Ketamine 15-18 mg/kg I.M with atropine	
Bison	Chloral hydrate 250 mg/kg body weight	
Elephants	Asian Elephants 100-175 mg-Xylazine (Total dose) Etophine-Acepromazine combination (2.4 mg/ml of Acepromazine per ml) Dose 1 ml/4 feet of shoulder height	
Reptiles	Ketamine—20 mg/kg intramuscular Xylazine—1 mg/kg	
Snakes	Ketamine—50-130 mg/kg intramuscular Tiletamine—10-20 mg/kg intramuscular	

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CHAPTER 12

Anaesthesia of Laboratory Animals

Anaesthesia of laboratory animals is challenging and often more difficult than the actual diagnostic or surgical procedure. Because of the small size of these patients, sedation or anaesthesia is often required for the most simple of diagnostic or treatment procedures including proper positioning during imaging, blood collection, physical examination, etc. There is not one perfect anaesthesia protocol as there are many species of animals of vastly different sizes and with variable responses to the wide variety of drugs available for anaesthesia. These animals present specific anatomic and physiologic characteristics that will influence the use of drugs and the outcome of anaesthesia.

Pre-anaesthetic preparation

- Ideally all patients should be stabilized prior to anaesthesia. However, vascular access can be very difficult, but even in patients difficult to catheterize, intraosseous (into the femur) catheterization is possible.
- Pre-anesthetic preparation will vary depending on whether anaesthesia is for an emergency or routine procedure. However, even in an emergency situation, obtaining the maximum amount of information prior to anaesthetizing the animal is recommended.
- A thorough history and physical examination should be performed prior to inducing general anaesthesia. An emphasis should be made on the respiratory tract for two reasons: most small mammals are primarily necessitate nasal breathers (rodents, lagomorphs), and upper respiratory tract infections are common. Assessment of the patency of both nares is important and can be accomplished by placing a small mirror or dental mirror immediately in front of each naris and looking for fogging.
- Critically ill ferrets often present with poor cardiovascular function. An accurate body weight is obligatory, and if possible basic laboratory tests should be obtained. However, blood work may not be available until after the animal is anaesthetized. Minimal basic blood parameter includes packed cell volume, total proteins, blood urea nitrogen (BUN), glucose, and urinalysis.
- The use of sedatives and analgesics are highly recommended to compensate the risks associated with stress and pain. The safety of the handler and the animal during the procedure should be taken into account when establishing the anaesthesia protocol.

- The use of cedar shavings for bedding is controversial. The oils from such bedding may induce hepatic microsomal enzyme activity and may significantly affect drug metabolism.

Pre-anaesthetic fasting

For each patient, the advantages and disadvantages of fasting should be evaluated. Fasting has been advocated in order to reduce the volume of contents in the gastrointestinal tract which can mechanically compress the diaphragm and lungs, a particular problem in large breeds of rabbits and obese animals. Fasting appears to reduce (but not eliminate) regurgitation in Guinea pigs. However, fasting exhausts glycogen stores resulting in hypoglycemia and may significantly contribute to peri-anaesthesia ileus, especially in rabbits and Guinea pig. Fasting is contraindicated in a chronically anorexic animal, those with an insulinoma such as ferrets, hepatic dysfunction, or in late pregnancy. Current fasting recommendations vary from 0 - 4 hours prior to anaesthesia.

Pre-medication

Pre -medication of small mammals is recommended. Tranquilizers and sedatives reduce anxiety, reduce MAC, and provide smooth induction and recovery. As for domestic mammals, pre-emptive analgesia should be administered.

Commonly used drugs

1. Parasympatholytics : Anticholinergic drugs reduce respiratory and salivary secretions. They may, however, thicken secretions and cause airway obstruction. These drugs are used to treat vagally mediated bradyarrhythmias. Rabbits have circulating atropine esterases and, therefore, require higher doses of atropine which also increase the risk of toxicosis; a better alternative drug is glycopyrrolate.

2. Phenothiazines : Acepromazine and other related drugs are not used routinely in small mammals. These drugs block alpha-1 adrenergic receptors thus producing vasodilation and hypotension. They have also been associated with prolonged recovery from anaesthesia. Peak effect occurs 30-45 min after injection. Acepromazine should be used only in healthy animals.

3. Benzodiazepines : Diazepam and midazolam are anxiolytics, sedatives, anticonvulsants, and centrally acting muscle relaxants; they cause minimal cardiopulmonary effects and are useful adjuncts in drug combinations used for induction. Diazepam can be administered per os (PO) or intravenously (IV); but if used IV, the animals must be monitored for hypotension caused by the propylene glycol used in preparations of diazepam; intramuscular absorption of diazepam is unpredictable because of the propylene glycol. Midazolam is water soluble and can be administered IM, IV or PO.

4. Alpha-2 adrenergic agonists : These sedative -hypnotics are often used in combination with ketamine because of their analgesic and muscle relaxant properties and sedative effects. They will prolong anaesthesia if not reversed. Bradycardia and respiratory depression are often reported. These effects may be antagonized by using partial doses (10-20%) of atipamezole without reversing their anaesthetic and analgesic effects. The alpha-2 agonists, in order of increasing potencies, are xylazine, detomidine and medetomidine.

5. Pre-emptive analgesics : Analgesia should be considered for any painful procedure and the choice of analgesic drugs includes opioids and non-steroidal anti-inflammatory drugs. Local blocks and low doses of ketamine can also be used. These drugs can be combined or used alone. Pre-emptive analgesia is still most advantageous. Opioids are often used as pre-anesthetics to potentiate sedation and provide analgesia.

6. General anaesthesia

- Injectable anaesthetic agents : These are the drugs that can be administered IV, IM, SQ, IP, or intraosseously (IO) that will induce anaesthesia or heavy sedation. The ideal injectable anaesthetic agent should have a wide therapeutic index, a rapid onset of effect, and a short duration of effect; it should be safe for the cardiovascular and pulmonary systems and ideally should be reversible. In reality, there are no such drugs and each species reacts differently to drugs used in anaesthesia. Following pre-medication, anaesthesia can be induced with ketamine (in combination with a benzodiazepine, opioid, or an alpha-2 adrenergic agonist), Telazol ® (tiletamine + zolazepam), or propofol (IV or IO only). These drugs are effective for short procedures. Telazol is more potent than the combination of ketamine and a benzodiazepine such as midazolam, and can cause prolonged recovery. Both ketamine and Telazol can be irritating and lead to self-mutilation or shock from pain. In rabbits, high doses (32 or 64 mg/kg) of Telazol produce renal tubular necrosis within 7 days after injection, and doses as low as 7.5 mg/kg produce nephrosis; the use of Telazol in rabbits is not recommended. There are also species specific differences in the rapidity with which zolazepam and tiletamine are metabolized. Propofol is a rapidly acting, non-cumulative anesthetic drug for intravenous (or intraosseous) use exclusively. It causes a dose dependent cardiopulmonary depression that may result in apnea and hypotension. Used alone it produces inadequate analgesia.
- Inhalant anaesthetic agents : Inhalant anaesthetic agents, such as isoflurane, are versatile and relatively safe to use in all species. They produce rapid induction, changes of anaesthetic depth, and recovery from anaesthesia. Termination of their effects can be obtained rapidly. They can be used alone or following pre-medication, or induction with parenteral agents. They do require the use of precision vaporizers and the bulkiness of the equipment may complicate access to the patient. Induction with inhalants can be accomplished by placing the animal in an induction chamber or in a mask. An involuntary excitement phase (seen in rabbits and ferrets) can precede induction. Maintenance of anaesthesia can be achieved following endotracheal intubation or administration of the agents via mask.

Lagomorphs

- Stress is the most important factor to counteract during the pre-and post-anesthetic period. In addition, rabbits have a small thoracic cavity that can be compressed easily by dilation of abdominal viscera (gas accumulation from any source) or inappropriate positioning.
- At least, two conditions are routinely seen that may significantly compromise the outcome of anaesthesia. Rabbits may have sub-clinical or overt upper respiratory infection (pasteurellosis). These animals have compromised respiratory function that may lead to poor gas exchange during anaesthesia, inability to breathe, and death.
- Renal function may be compromised by infection (although silent) with the microsporidian *Encephalitozoon cuniculi*. These animals often recover well from anaesthesia but present a few days later in renal failure.
- Routine pre-anesthetic blood work will detect this condition; when detected, elective procedures must be postponed until the animal is stabilized.

- Intubation is challenging but not impossible. However, repeated attempts and the resulting laryngeal trauma during intubation attempts often result in swelling and respiratory obstruction during the peri-anaesthesia period.
- Self-inflicted injuries may occur if physical restraint is poor, and the most common complication is fracture of the lumbar spine. Because at least 50% of rabbits possess circulating atropine esterases, atropine has variable effects and glycopyrrolate is recommended if an anticholinergic is required.

Pre-medication

Protocols for healthy rabbits include the following combinations:

1. Ketamine (5 mg/kg), midazolam (0.5-1 mg/kg), butorphanol (0.2-0.5 mg/kg), and glycopyrrolate (0.01 mg/kg), all given IM.
2. Midazolam (0.5 mg/kg), butorphanol (0.2-0.5 mg/kg) and glycopyrrolate (0.01 mg/kg), all given IM.

Induction is then achieved by masking the animal to anaesthesia with isoflurane in oxygen. It is important to keep the induction area quiet and the lights dimmed. Depending on the size and the condition of the animal, general anaesthesia is maintained with a mask or tracheal intubation is attempted. An intravenous catheter is placed and the monitoring equipment applied as soon as induction is completed.

Guinea Pigs and Chinchillas

- Guinea pigs are easily frightened and are prone to stress-related complications; they will store food or chewed paper in their cheeks which if it becomes dislodged, may obstruct the glottis.
- Guinea pigs often regurgitate during induction and active monitoring of airway patency is important. They also produce profuse amounts of bronchial secretions that may partially obstruct the bronchi or trachea.
- The lack of readily available peripheral veins makes IV access difficult in an emergency.
- Underlying vitamin C deficiency and concurrent diseases are also potential problems that can complicate anaesthesia.
- Intubation is difficult and complicated by the fusion of the soft palate to the base of the tongue creating only a small opening called the palatal ostium, an anatomic feature common to both chinchillas and Guinea pigs. This tissue is vascular, fragile, and will bleed if traumatized. In the absence of intubation, inhalant anaesthesia can be maintained with a mask.

Anaesthetic protocol

The combination that is frequently used for premedicating Guinea pigs is glycopyrrolate (0.01mg/kg), butorphanol (0.2-0.5 mg/kg) and midazolam (0.5-1 mg/kg), all given IM. Induction and maintenance is achieved with isoflurane in oxygen delivered via a mask. It is important to monitor for signs of upper airway obstruction throughout the entire procedure; a stethoscope may be low-tech, but it is a very effective means of monitoring the airway and lungs, especially when it has a pediatric head. In Guinea pigs, an intravenous catheter may be placed in the cephalic vein which is located along the lateral aspect of the forearm.

Small Rodents

- Because of their small size, pre -anaesthetic preparation of these animals may be difficult if not impossible. Routine procedures are rare and often have a compromised and high risk animal to anaesthetize.
- Peripheral IV access is rarely available and intubation is very difficult.
- Their small muscle masses must be taken into account when giving intramuscularly proportionally large volumes of drugs; irritating drugs, such as those with a low pH or that which include an irritating solubilizing agent, often result in self-mutilation.
- Pain and fear may cause aggression and other defensive behaviors.
- Because of their small body mass, hypothermia occurs rapidly under anaesthesia.

Anaesthetic protocol. Pre-medication can include the use of midazolam, butorphanol and glycopyrrolate singly or in combination. For short procedures in a healthy animal, masking with isoflurane can be done without pre-medication (may be more stressful). Anaesthesia is maintained with isoflurane in oxygen delivered via mask or in larger species after endotracheal intubation.

Ferrets

- Ferrets often present with severe underlying diseases such as insulinoma, hyperadrenocorticism, foreign body ingestion, etc. Stabilizing these patients prior to anaesthesia is very important.
- Prolonged fasting or ongoing diseases may result in hypoglycemia.
- Because of their small size, hypothermia is also a common complication that must be prevented or corrected aggressively.
- Although they have small peripheral veins, catheterization of the cephalic, saphenous or jugular is relatively easy and should be attempted.
- Hypotension is commonly seen in ferrets under general anaesthesia: this condition results from poor cardiovascular function (pre-anaesthesia), compression of the vena cava by the viscera when the animal is in dorsal recumbency and/or a direct effect of the drugs.
- Ferrets are sensitive to the sedative effects of butorphanol and doses commonly used in domestic animals are recommended : 0.05-0.1 mg/kg, rarely 0.2 mg/kg.

Anaesthetic protocol. To avoid hypoglycemia, healthy ferrets should not be fasted for more than 4-6 hours. Ferrets with insulinoma can be fed up to 2-3 hours prior to surgery. Monitoring of blood glucose should be performed every 30-60 minutes while the animal is under anaesthesia and frequently during recovery. Glycopyrrolate (0.01 mg/kg) and butorphanol (0.05-0.1 mg/kg) combined with midazolam (0.4 mg/kg) or diazepam (0.4 mg/kg) is a good combination for pre-medication. The animal can then be masked with isoflurane in oxygen, intubated and maintained with inhalant anaesthetic agents. For short procedures, healthy animals can be induced with a combination of ketamine (15-20 mg/kg) and midazolam (0.4 mg/kg), both given IM; diazepam may be substituted for midazolam. This combination allows for short surgical procedures (10-20 min) and, if necessary, anaesthesia can be prolonged with inhalant agents. Complete recovery occurs in 2-3 hours.

Marsupials and Insectivores

- Sugar gliders and hedgehogs may require anaesthesia in order to perform a simple physical examination or radiography.

- Their small size including small airway diameter and limited access to peripheral veins, limit our abilities to provide life support during anaesthesia.
- As is true of other mammals, these animals are prone to hypothermia.

Anaesthetic protocol. Sugar gliders and hedgehogs are often masked to anaesthesia without pre-medication. The combination of midazolam, butorphanol and glycopyrrolate will reduce the stress of induction and decrease the Minimum Alveolar Concentration (MAC) of the inhalant agent. These animals have small muscle masses and only small volumes should be administered IM. Anaesthesia can be maintained via mask or if possible after endotracheal intubation.

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UNIT 3

DIAGNOSTIC IMAGING

CHAPTER

1

Introduction of Veterinary Radiology

GENERAL TERMINOLOGY

X-RAYS : X-rays are a form of electromagnetic radiation with high energy, very short wavelength, no charge or mass and travel at the speed of light through space as a combination of electric and magnetic fields.

Radiograph (Skiagram, Roentgenogram) : It is a composite shadow of structures and objects in the path of an X-ray beam recorded on the film. **Radiography** is the processes involved in getting a radiograph whereas the procedure of looking at a radiograph is called radiology.

Radiologist : Any person in medical or veterinary Sciences and Radiological Physics to use radiant energy in the diagnostic, therapeutic and research fields of medicine.

Radiographer : A technically trained person who can obtain quality radiographs for use by a radiologist.

Radiation : Energy emitted and transferred or propagated through the matter is used radiant energy as Radiation.

Ionization : Any type of energy or matter energy combination capable of removing one or more orbital electrons from the atom after interaction is known as ionizing radiation. The process is called ionization.

Kilovolt : The presence due to the forcing electrons along their ions is called potential difference and is measured in units called Volts. In radiography, kilovolt is used for the unit. 1 KV = 1000 Volts.

Kv (kilo voltage) : The potential difference between cathode and anode

KvP : Indicates maximum energy available at that kilo voltage setting.

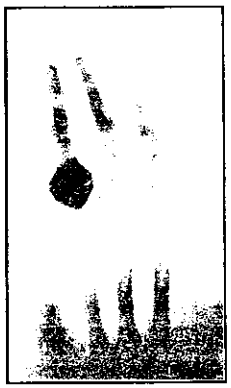
Part Film Distance : It is the distance between the object to be radiographed and the x-ray film.

HISTORICAL PERSPECTIVES

Among all, medical historians are unanimous in listing the discovery of X-rays among the milestones that punctuate the onward march of medical science. This happened in the end of 19th



W.C. Roentgen



Radiograph of hand of Mrs. Roentgen with wedding ring

century, German Physicist Professor Wilhelm Conrad Roentgen (1845-1923) at the University of Wurgburg on the evening of 8th November 1895 discovered X-rays, was an accidental product of the work on Crooks type tubes. Towards the end of 1895, Roentgen began his research using an induction coil connected with Crooks type of tube. Roentgen observed the effects of penetrating rays of a previously unknown and to them he given the name **'X Rays'**. Roentgen subsequently replaced the fluorescent paper with photographic film on which he produced a radiograph of his wives hand with their wedding ring and he exhibited that in a conference where he read the first paper on the discovery of X rays to the society of Physics and Medical Science at Wurgberg University on 28th December 1895. In recognition to his outstanding contribution Roentgen was awarded First Nobel Prize in the year 1901 in Physics.

Milestone of Veterinary Radiology

08-11-1895	W.C. Roentgen	Discovered X-Rays (Father of Radiology)
1896	A.A. Campbell and J. C. Stanton	First Medical Radiograph
	Trowbridge	First oil immersion X-ray
	Pupin	Used Intensifying screen
	Wright	First photographic paper developed for reaction of X-ray
	Paton and Duncan	1st Veterinary radiography of an equine foot
	R. Ebaerlin	**Described the use of X –Rays in veterinary practice (Father of Veterinary Radiology)**
1897	A.H. Becquerel	Discovered radio activity of Uranium

1898	Cannon	Used X- Rays in the form of Contrast studies using Barium meal to investigate Gastrointestinal tract physiology
1901	W. C. Roentgen	Received Noble Prize in Physics for discovery of X-rays
1903	Becquel	Discovered Uranium
	Mary Cuerie	Discovered Radium
1905	First Radiological Congress held at Berlin where veterinarian R. Ebaerlin acted as chairman	
Early 1920	Moving grid	Dr. Hollis Polts
1928	International recommendations on radiation safety were proposed	
1972	Computerized axial tomography (CT scan) developed by G.N. Hounsefild in England	

Scope of Veterinary Radiology

Though the cost of equipment for CT scan, MRI and Ultrasound has limited the scope of these machines in veterinary practice, radiology is still widely accepted and a bit accessible to veterinary patients. Most radiography is used as a good aid in diagnosis. In practice, radiographic studies are carried out only when it is expected to provide more significant information.

Use of radiography in veterinary practice

- As diagnostic aid for survey radiography and to detect previously unrecognized lesions.
- To select methods or techniques of treatment.
- To monitor efficacy of treatment schedule.
- To screen the normal animals for morphological evaluation.
- Determination of the age of animal.
- For non destruction examination of archaeological specimens of animal origin.
- As a teaching aid in the subject of applied anatomy.
- In veterinary research.

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CHAPTER

2

Production and Properties of X-rays

PRODUCTION OF X-RAYS

The production of a radiograph involves the use of complicated apparatus and a sequence of complex physical processes. A basic understanding of radiological physics will allow the radiographer to make the best use of the equipment available.

The production of X-Rays

X-Rays are produced whenever charged particles are slowed down or stopped. **Continuous spectrum** is formed if the electron is slowed by passing near to the positively charged nucleus of an atom; energy is lost as an X-Ray, The X-Ray photon has a variable amount of energy depending on the degree of slowing of the electron.

Characteristic spectrum is formed when the electron of sufficient energy collides with another electron in an atom, then the bound electron may be ejected from the atom. The vacancy in the electron shell is filled by an electron in an outer orbital. X-Rays of only a few characteristic energies are produced. depending on the energy levels of the electron shells.

The X-Ray tube

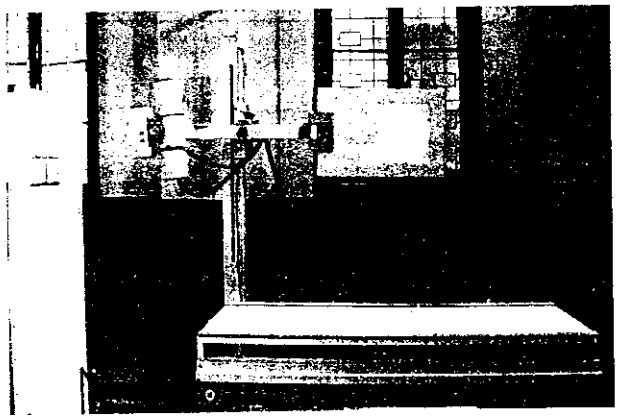
Basic components of an X-ray tube:

1. Air evacuated glass envelope : A vacuum is necessary to prevent accelerated electrons from colliding with air molecules.

There are three basic requirements for X-Ray production in an X-Ray tube :

2. Cathode : The cathode is a wire filament (usually tungsten, metallic point 3400°C) which is the source of the electrons. Electrons are produced by heating a filament by thermionic emission. The number of electrons which pass from the cathode to the anode represents the tube current and is measured in milliamperes (mA)

3. Anode : The anode is a tungsten disc that acts as the target for the electrons that come from the cathode. X-Rays are produced at the anode when it is struck by electrons; but only 1% of the incident energy is converted to X-Rays. The remainder is converted into heat, and must be dissipated. A fixed anode relies on conduction of the heat away from the target by mounting it on a copper stem while a rotating anode allows X-Rays to be produced over a greater area of the target by rotating it during the exposure.



X-ray machine

The Rotating Anode : As the anode spins, the electron beam interacts with a new part of the anode. Again, a rotating anode spreads the x-ray formation and heat over a larger area. If it did not spin, the electron beam would hit the same part of the anode at all times which would damage the anode. The area where the electron beam hits the anode is called the *focal spot.*

4. Others : There are a few other components such as cooling mechanisms, the window of the tube etc.

Other parts of an X-Ray machine

1. The filament circuit to heat the filament.
2. The high voltage circuit to provide the high potential difference across the tube.
3. A timer to control the duration of the exposure.

How x-rays are produced or what goes on in the tube ?

Step 1 : The cathode filament is heated thus electrons to be emitted form the filament and form a cloud around the filament. A focusing cup keeps the electrons in a tight cloud.

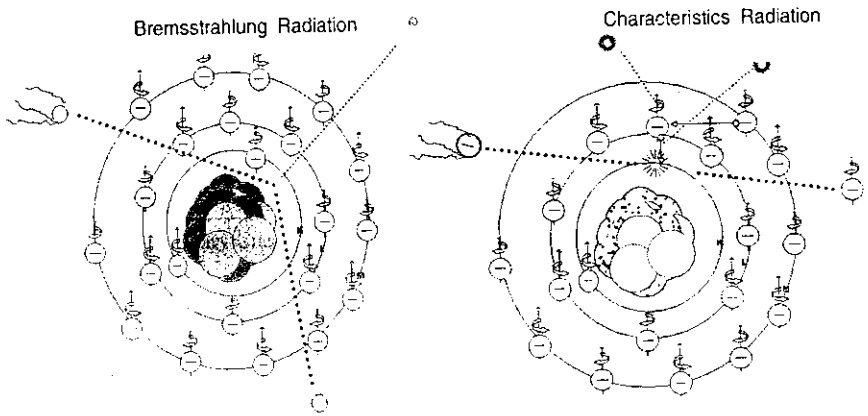
Step 2 : At this point, voltage is applied to the tube, which causes the electrons that are waiting in the cloud on the filament to accelerate toward the anode.

Step 3 : Electrons collide with the anode and two things happen: 99% of the energy is released as heat and 1% energy converse to X-ray.

When the electrons from the cathode hit the tungsten anode, give up their energy in two ways:

1. ***Bremsstrahlung Radiation*** : This word stands for "**braking radiation.**" As the electron hits the anode, it passes near the nucleus of the tungsten atom. The attractive force of the nucleus causes the path of the electron to bend around the nucleus. Kinetic energy is lost as the electron path bends. This energy is given off as heat (99%) and X-rays (1%).

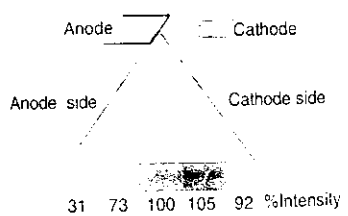
2. Characteristic Radiation is formed when electron smash directly and eject an electron in an inner shell of the tungsten atom. The vacancy is filled by an electron from a higher shell. As the new electron drops into the lower shell, energy is released in the form of an X-ray. This



is called characteristic radiation because there are only a few discrete or specific energies of the X-rays produced which is "characteristic" of the element from which it is produced. The energy of the released X-ray is equal to the difference between the binding energy of the two electron shells involved.

The heel effect is the resultant of a portion of the X-ray beam being absorbed by the anode, which results in an X-ray beam that is less intense on the anode side and more intense on the cathode side. The heel effect is more pronounced with steeper anode angles. Since the X-ray beam will be more powerful on the cathode side, always it is necessary to place thicker body parts under the cathode side to give a uniform exposure across the radiograph.

X-ray generators



An X-ray generator is the device that supplies electric power to the X-ray tube. An X-ray generator begins with a source of electrical energy. An X-ray tube cannot use simple alternating current. If an alternating current is applied to an X-ray tube electrons would first go toward the anode, then they would reverse and go toward the cathode. This would only happen one time because the cathode would be destroyed. To keep electrons going in one direction, the generator must first convert the **alternating current** into **direct current.** A **rectifier** performs this function. A rectifier is a device that allows current to flow in only one direction. There are two ways to rectify alternating current and make it flow in only one direction:

Half-wave rectification: In this form of rectification the negative part of the sine wave is simply chopped off.



Full-wave rectification : In this form of rectification, the negative part of the sine wave is inverted. This allows X-rays to be formed during the whole cycle of current.

High frequency generator : convert the 60 Hz current to produce a whopping 100 kHz output, produce a near constant beam of X-rays.

A *line voltage compensator* adjusts the incoming line voltage to keep it at a level needed to produce a constant beam of X-rays of the energy. Some machines do it automatically but some (portable units) require to do it manually.

Care of the x-ray machine

- Be particularly careful with portable units, do not drop or hit the X-ray tube as it is made of glass and is quite fragile.
- Do not keep X-ray machine on continuously. Turning it off when not in use and that's how prolong the life of X-ray machine.
- Do not hold down the rotor button prior to making a radiograph for any longer than have to. When the rotor is on, the filament is heating. Since the filament has a finite life, heat it as little as practical.
- Do not make too many high KV/mA exposures too rapidly in succession. Most machines have a circuit that will not permit to overheat the tube for any given exposure. However, these circuits do a poor job when the tube is getting too hot after repeat exposures. Always allow the tube to cool for an appropriate amount of time after "big" exposures.

Properties of X-Rays

1. Fluorescence : X-rays cause certain substances to fluoresce, i.e. to emit light in the visible spectrum after absorbing X-rays, such substances include calcium tungsten or rare-earth phosphors, both found in intensifying screens.

2. Photographic effect : X-rays produce a 'latent image' (invisible to the eye) on photographic film. This image is made visible by processing the film.

3. Penetration : X-rays can penetrate substances or tissues that are opaque to visible light. They are gradually absorbed further they pass through an object. The amount of absorption depends on the atomic number and density of the object and on the energy of the X-rays.

4. Excitation and ionization : X-rays produce excitation (process of raising an electron to a higher energy level) and ionization (process in which an electron is completely removed from an atom) of the atoms and molecule of the substances through which they pass.

5. Biological effect : X-rays interacts with living tissue and can cause biological changes. These changes are mediated directly by excitation or ionization of atoms or indirectly because of chemical changes, occurring near the cells. Affected cells may be damaged or killed. **Genetic effects** involve chromosomal damage or mutation in the reproductive cells. **Somatic effects** involve damage to the other tissues and result in changes within the individual's lifetime (*e.g.* radiation burns, leukemia). Radiation is a particular hazard because its effects are painless, latent and cumulative.

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CHAPTER

3

Quality of Radiograph

Quality of radiograph is directly influenced by the quality of the beam. As the proportion of high-energy photons increases, quality is also improved. Intensity is a measure of the amount of radiation produced.

Various **factors** affect the quality and intensity of the beam.

These include:

A. RADIOGRAPHIC FACTORS

1. Exposure factors

- *kV*—the greater the potential difference across the tube, the faster the electrons move and the higher the energy of the X-ray photons. Thus the quality and intensity are increased.
- *mA*—the higher the tube current, the greater the intensities of all the photon energies and the intensity of the beam is increased.
- *Time*—the longer the exposure, the greater the time during which X-rays are produced, and the greater the beam intensity. The time (seconds) and mA are generally considered together as the composite factor mAs.

2. Focal Film Distance (FFD) : Increasing distance from the source of radiation results in a decrease in the intensity of the beam, according to the inverse square law. Hence, doubling the distance from the tube head will result in a beam of one quarter its original intensity.

3. Movement of the patients or Motion unsharpness : Motion unsharpness is the loss of radiographic quality due to the movement of either the patient or the X-ray tube or the film during X-ray exposure. In veterinary radiology, movement of the patient is the problem. Shortest possible exposure time and appropriate reasoning measures can reduce this problem.

4. **Beam restricting devices :** Small fields of exposure may result in less scatter. Less scatter means a better image. Common devices used to accomplish this task of decreasing the size of the X-ray field are cones, cylinders, and aperture diaphragms. Currently, the standard technology is the collimator.

Collimators allow use of lead shutters to restrict the size of the area to be radiographed. Collimators do not focus the X-ray beam; they merely shape it by cutting off the edges of the beam, simply exclude the part of the beam that is not in use. Since X-rays do not have a mass or charge, they can not be focused.

B. GEOMETRIC FACTORS

(*a*) Image magnification : Shorter the distance between light source and object greater the magnification. Magnification of some degree is usually present in every clinical radiograph because the image formed is the dimensions representation of a three dimensional structure. However, magnification has to be kept as lower as possible except in vascular radiography.

The magnitude of image magnification is expressed either by magnification factor (MF) or by percentage magnification of image.

$$\text{Magnification factor (MF)} = \frac{\text{Film Focal Distance (FFD)}}{\text{Part Film Distance (PFD)}}$$

$$\text{Magnification \%} = \frac{(\text{Image width} - \text{Object width})}{\text{Object width}} \times 100$$

Key points

- Short FFD increases the magnification and longer FFD decreases the magnification.
- Short PFD results less magnification and distortion and increased PFD cause more magnification.

(*b*) Image Distortion : Shape and size of the object being examined when altered on radiograph due to unequal magnification of different portions distortion of the image is evidenced. It depends on shape of the object.

Shape of the object	Possible distortion
Oval opaque object	Circular
Rectangular object	square
Disc	circular
Sphere	circular

Position of the patient. Correct positioning (parallel to the film) minimize or rule out distortion. **Foreshortening of the image** (smaller image) is obvious for inclined object, which increases as the angle of inclination of the object increases.

(*c*) Image unsharpness (Penumbra). It refers to the region of partial illumination that surrounds the complete umbra (true shadow) causing undesirable blurred region on the radiograph. Maximum sharpness of image is achieved by placing the thicker body parts under the cathode side to give a uniform exposure across the radiograph (**Hill Effect**).

Image unsharpness is determined by :

- Large effective focal spot size
- Short focus-film distance
- Long object-film distance

Penumbra becomes smaller when the object to be radiographed is placed as nearer to film as possible.

$$\text{Penumbra} = (\text{Effective focal spot}) \times \frac{\text{Objective Film Distance (OFD)}}{\text{Focus Objective Distance (FOD)}}$$

When, Focal spot size is small, OFD is minimal and FOD is large, then penumbra will be small.

Motion unsharpness : discussed earlier under movement of the patient.

Absorption unsharpness : When a beam of X-rays passes through matter, its intensity is reduced as the energy is absorbed or scattered. The degree of attenuation depends on the atomic number and physical density of the tissue and the energy of the X-rays. The differential absorption of X-rays by the various tissues of the patient allows a radiographic image to be made. This will lead to the unsharp edges.

Screen unsharpness is caused by light diffusion in screen phosphors layer, which is possible to minimize by maintaining a good film screen contact and use of intensifying screens with high intensification factor.

(B) PHOTOGRAPHIC FACTORS

General information

- X-rays will produce a pattern of varying depths of blackness on the film.
- The incident photons are attenuated to varying degrees by the patient's tissues.
- The emerging pattern of photons of differing energies affect the film emulsion to produce the latent image.
- Developing the film allows this image to become visible.
- The film emulsion consists of gelatin containing finely dispersed grains of silver bromide.
- Silver bromide grains which have been exposed to X-rays, will be turned black by the developer.
- Unexposed grains are dissolved and removed and leave a white area on the film.

Effect of the exposure factors on the film

1. kV governs the penetrating power of the photons.

- Films taken with a low kV have high contrast, *i.e.* tissues appear black or white with very little grey.
- Films taken with a high kV have low contrast, *i.e.* the film is more uniformly grey.

2. mAs governs the amount of X-rays reaching the film.

- mAs too low (underexposure) results in a pale film.
- mAs too high (overexposure) results in a dark film.

3. Distance affects the amount of X-rays reaching the film by the inverse square law. This will only affect the film if the distance is changed without altering the mAs

4. In essence, the kV controls the number of shades of grey, and the mAs controls how dark they are

Cassettes and intensifying screens

1. A cassette is a light-tight, robust container, which holds the film, and intensifying screens in close contact, protect the film from visible light and from damage during use.

2. Two intensifying screens are present within the cassette, either side of the film. Screens contain materials, which fluoresce when bombarded by X-rays. The radiographic film is sensitive

to this visible light emitted by the screens as well as the X-rays themselves. The use of both visible light and X-ray photons allows the reduction of exposure times. However, cassette without screens is used when very fine detail is required.

Qualities of a good diagnostic radiograph

- An accurate portrayal of the structures under examination, which requires good positioning with the minimum of geometric distortion (the region of interest should be under the central ray, parallel to and close to the cassette).
- Easy perception of the relevant structures with good contrast and detail.
- No misleading artifacts.

Objective qualities of a good radiograph

Three main visible requirements of a good radiograph are

- Excellent detail
- Correct density
- Proper scale of contrast.

Detail

The **details** of a radiograph depend for their perceptibility upon their contrast with the background and upon their definition or sharpness. It is important to note that very small details require high contrast if they are to be easily seen. When opacity merges gradually into another, the eye will find it difficult to perceive the difference. If two densities are separated by a firm line of demarcation, the difference can easily be seen.

Definition is **poor** if there is a blurred image, which may be caused by

- factors inherent in the tube head and film/screen combination
- movement of the machine, animal or film during exposure

Following factors influence detail

- Focal Spot Film Distance : Short FFD- ↑ magnification
  Longer FFD - ↓ magnification.
- Part Film Distance : The closer an object to the film, there will be less magnification and distortion of the image. So, affected part or side of the animal is placed nearest to the film.
- Intensifying screens : These are used to reduce the exposure time. Cassettes with intensifying screen reduce the detail of a radiograph.
- Differential absorption of X-rays
- Motion of the patient, cassette or X-ray tube : Cause less detail as multiple images, one upon the other, is formed
- Double emulsion of the film : Since film is loaded with film emulsion on both sides an image is formed on both sides. Thus, detail o radiograph is decreased.

- Exposure factor used : **Over exposure** (too dark image), **under exposure** (too light image) will affect the detail of a radiograph.
- Film processing : To obtain excellent detail the developing process should be shade dried for each and every reading taken. A film may develop at Temperature = 68°F.
- Scatter radiation and fog (Radiographic mottle) : Scattered radiation, faulty dark room technique will cause fogging. Fogging of the radiographs reduces the detail.
- Film Screen contact : If the X-ray film is not in direct contact with the entire surface of both screen above and below, fluorescence of energified crystals on the screen will came a most lager reflection on the radiograph, this coming image to be blurred.

Radiographic Density

Radiographic density is the measure of blackness on a processed film and is directly related to the number of X-rays reaching the film. More the number of X-rays that reach the film, higher is the radiographic density. Radiographic density is primary influenced by subject density and its thickness. Radiographic density is inversely proportional to subject density.

Factors affecting radiographic density

1. **Milli amperage (mA) :** As mA increases, more X-rays are able to reaches the film. Radiographic density is directly proportional to mA provided that all the factors remain constant.
2. **Exposure Time :** Radiographic density is directly proportional to exposure time if all other factors remain constant, as total production of X-rays is increased.
3. **Kilo Voltage :** kVp controls quality of X-rays, higher kVp producing high energy X-rays with higher penetrability.
4. **Focal Film Distance (FFD) :** Due to change of FFD, variations in density are inversely proportional to the square of distances. If FFD is reduced to half, radiographic density will increase by a factor of four.
5. Speed of the film intensifying screens affects radiographic density.
6. **Developing Time and temperature :** Over-development of the films increase radiographic density.
7. **Grid Ratio :** Higher grid ratio allows more absorption of scatter radiation to affect radiographic density.

Radiographic contrast

Contrast is the opacity difference between adjacent areas on radiograph. The **scale of contrast** refers to the number of density gradations between the lightest radiograph shadow and the darkest radiographic shadow.

Short scale of contrast : An image with a lot of contrast is having a short scale of contrast. A high contrast image only has a few shades of gray between the lightest and darkest areas of

the radiograph. High mAs and low kVp exposure factors are one method of achieving a short scale of contrast. A short scale of contrast is often times preferable for bone examinations.

Long scale of contrast (latitude) represents an image with a little contrast. A low contrast image has many shades of gray between the lightest and darkest areas of the radiograph. Low mAs and high kVp exposure factors are one method of achieving a long scale of contrast. Radiographs with a long scale of contrast often times preferable for abdominal examinations.

Factors affecting radiographic contrast

1. Subject contrast : When thickness and physical composition of the subject affect the opacity of a radiograph is called subject contrast. It can be controlled.

2. Film contrast : Different scales of contrast for the same exposure factors are evidenced in different types of film. **Long latitude film** results in decreased contrast with many shades of gray. **Short latitude film** produces radiographs with more contrast and only a few shades of gray.

3. Development time : Extended development time and more temperature will result in loss of contrast. Underdevelopment will also decrease contrast. Old developer will also result in decreased contrast.

4. KvP : Increased KvP will decrease contrast; high kVp creates a radiographic beam with a variety of energies of X-ray photons. These photons will be absorbed by different tissues in different amounts, thus long scale of contrast will be produced. A very low kVp beam will have X-ray photons that will either go through the patient or not. It is an all or none phenomenon that produces black or white with no shades of gray.

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CHAPTER

4

X-ray Accessories

X-ray machine accessories include accessories required for positioning of the animal, recording of the image, radiation safety procedures, processing of the film and interpretation of the film

Positioning

- X-ray table
- Wooden block
- Foam block
- Abdominal belt
- Positional aids
- Sand bag
- Cassette holder

Recording

- X-ray Machine
- Intensifying screen
- Beam restricting devices
- Lead blocker
- Florescent screen
- X-ray film
- Cassette
- Collimator, Cone, Grid
- Lead letters
- Image intensifier

Radiation Safety

- Lead apron
- Lead goggles
- Warning signals
- Lead gloves
- Radiation safety badge
- Lead shield

Processing

- Processing solutions
- Film holder
- Floating thermometer
- Dry and wet thermometer
- Wet bench
- Processing tanks
- Film clipper
- Safe light
- Dry bench
- Film hangers

Interpretation

- Viewer
- Magnifying glass
- Spot film viewer
- Viewing lobby
- Black chart

Filters

It is placed between the patient and X-ray table to remove soft (less energetic) X-ray from the primary beam. Advantages of filter use include increase radiographic detail, decrease exposure dose and scatter radiation. Filtration of the X-ray beam is the summation of inherent filtration and adjunct filtration devices. Inherent filtration devices are glass envelop of the X-ray tube, insulating oil surrounding the tube, backlite window in tube housing. Whereas placing an absorber (metal filter) in the path of X-ray beam act as an adjunctive to inherent filtration. Aluminum (atomic number-13) and copper (atomic number-29) alone or in combination are most commonly used material for most diagnostic X-ray tubes.

X-ray beam restricting devices

It was important to limit the size of the X-ray field because (*i*) Smaller fields mean less scatter. Less scatter means a better image (*ii*) smaller fields mean less exposure for the patient. Thus, reduce the amount of ionizing radiation that our patients receive.

There are many devices used to restrict the size of the X-ray field which include **Cones, cylinders, aperture diaphragms and variable aperture collimator.**

- **Cones and Cylinders** are metal tubes (conical or cylindrical) that direct the X-rays to the specified field size. Base of the cone or cylinder is made of lead to absorb undesirable X-rays but cannot prevent penumbra.
- An **aperture diaphragm** is a lead sheet with a circular, square or rectangular hole in the centre that permits X-ray beam to pass through. Disadvantages include a fairly large penumbra formation at the periphery and separate size of diaphragm is required for each size of the film.
- **Variable aperture Collimator** allows a variety of X-ray field sizes to be selected by using a series of lead shutters and a light beam that shows the size of the field. There are two sets of adjustable diaphragms placed one above the other to work in pair. Mirror is used to align the light field. Some portable systems use a laser to center the field. Collimators do not focus the X-ray beam; they merely shape it by cutting off the edges of the beam. Again, collimators simply exclude the part of the beam which need not wan to use.

Grid

Good collimation reduces scatter, anytime scatter hits the film, image quality degrades. A **grid** is used to reduce scatter from hitting the film. Grids do not decrease scatter formation, they just stop scatter from hitting the film. Grids improve detail and contrast in a radiograph by preventing scatter from hitting the film. However, grids necessitate an increase in technique, which increases patient and personnel exposure. Grids should be used w[illegible] body part to be radiographed is thicker than 10 cm.

Composition : Grids are composed of hundreds of alternating thin lead st[illegible]n fiber or aluminum interspacers. X-rays can pass through the interspacers without in[illegible]. However, the grid absorbs X-rays that hit the lead strips. These strips are encased in a protective cover for protection so the soft, thin lead strips will not bend.

Types of Grid

1. Parallel grids (linear grid) : Grids are composed of parallel lines of lead strips. Parallel strips absorb oblique scatter radiation while interspaces allow X-rays, perpendicular to the surface of the grid to pass through to expose the film.

2. Focused grid : Here, lead strips, may be paralleled or crossed, but are angled in alignment with the primary X-ray beam.

3. Cross-hatched grids : Here, grids are composed of parallel lines of lead strips and have two sets of grid lines running perpendicular to each other.

4. Potter-Bucky diaphragm (Bucky diaphragm/Bucky grid) **:** Grid is moved back and forth during the radiographic exposure. By moving the grid back and forth, the grid lines are blurred over the resulting radiograph and can not be seen. This type of system is also called a **moving grid system**.

Grid, again, may be described as :

1. Grid frequency (Lines per inch) **:** The more lead lines per inch, the better the grid is at scatter reduction. However, it absorbs more of the primary X-ray beam, which necessitates a larger increase in exposure. Most grids have frequencies in the range of 60-110 lines per inch.

2. Grid Ratio : The grid ratio is the height of the lead strips divides by the distance between the strips. The higher the ratio, the more efficient a grid is. In general grid ratio ranges from 4:1 to 16:1.

3. Type of inter-space material : Aluminum is better but more expensive. Fiber is cheaper but may result in an inhomogeneous image pattern. Stationary grids should be aluminum while fiber grids are acceptable for a moving grid system.

Basics

- Primary beam is the part of the beam that is used to expose the radiographic film. **Scatter,** however. will not be aligned with the spaces in the grid and will be absorbed by the lead strips. Thus, scatter photons cannot hit the film because the grid absorbs them.
- Some of the primary X-ray beam inevitably hit the lead strips and get absorbed. Therefore, this reduction in intensity of the primary X-ray beam is adjusted by increasing the exposure factors. The amount to increase the exposure depends on the type of grid.
- Focused grids must be used at a precise distance from the X-ray tube to work properly. If they are used outside (too far away or too close) of the focal distance the **grid cutoff** occurs.
- Grid **cutoff** results in greater than normal absorption of the primary X-ray beam. The resulting radiograph will be very light or underexposed. The worst possible type of grid cutoff occurs when the grid is placed upside down.

When grids are used properly, subtle images of the alternating lead strips and spacers are seen in the resulting radiograph. These lines are called **grid lines**, which are an unfortunate consequence of using a grid. With modern grids, these lines are very fine and only slightly distracting.

- Grids are fragile, if the lead strips become bent or the grid gets warped, a number of grid artifacts will be produced that will degrade image quality. Grids should be stored lying flat and handled in a gentle manner.

Cassettes : Radiographic cassettes are rigid, light-tight containers that hold the X-ray film and screens. The screens are permanently mounted in the cassettes.

Safe light : Safe lights are only safe if they are used properly. The safelight filter (like the intensifying screen) must be matched to the film to use. An inappropriate safelight color will fog radiograph just like any other light. Also, the safelight must be of the correct wattage (usually 6.5-10 watts) and be located at the correct distance from the counter top. If the light is too strong or too close to the film, run the risk of exposing the film.

X-ray Film

Radiographic film consists of a **polyester base** that provides support. This base gives radiographs their blue tint and **Film Emulsion** (actually records the image.), **which** is a thin layer of stuff on both sides of the polyester base. **Film Emulsion** is again, composed of two main ingredients. These are **Silver halide Crystals** and **gelatin.** Silver halide is the light sensitive material in the emulsion. Gelatin keeps the silver halide grains evenly dispersed and prevents clumping of the grains.

Size, shape, composition, and number of particles of silver halide affect the characteristics of the radiographic film. The major effects that alter the emulsion on film are film latitude, film contrast, film speed, film detail, and light color (spectral) sensitivity.

These parameters of film response alter the type of the film in the following ways:

- ***Film Latitude***: **Film latitude** refers to the amount of error when exposing a film and still gets a good image. High latitude film means that pretty bad mistake still have a reasonably exposed film. High latitude film has low radiographic contrast.
- ***Film Speed***: A faster film appears grainier and has less fine detail. Faster film is used to make faster exposures that reduce the chance of motion unsharpness and less exposure to the patient and personnel. Accordingly, film speed films are classified as standard, fast and ultra fast.
- ***Film Detail***: Higher detail film is always slower.
- ***Light Color Sensitivity***: Radiographic film must compliment screens. If screens emit blue light, film too must be sensitive to blue light.

Types of X-ray films : Two types screen and Non Screen :

- **Screen Films** are more sensitive the UV light, blue light or green light (orthochromatic film) which originates from calcium tungsten crystals of intensifying screens. Screen films require less exposure to produce an image compared to non-screen film because of intensifying screen.
- **Non-screen Films** are used for direct X-ray without intensifying screen. More thickness of emulsion and prolonged processing time and more exposure factor are required. This type of screen is used to detect hairline fracture and in dental radiography to obtain better detail.

FILM SIZES : 5 × 7, 6 × 12, 6 × 15, 8 × 10, 10 × 12, 12 × 12, 12 × 15, 14 × 14, 14 × 17 Inches

Lead blocker
Lead letters
Lead apron
Lead gloves
Lead goggles
Radiation safety badge

Film Processing

Unexposed silver halide within the emulsion is green or purple in colour. When the emulsion is exposed to light from the intensifying screen, portions of the silver halide are converted to metallic silver. Metallic silver is black. At this point, the exposed, metallic silver halide is called a "sensitivity speck". Prior to development, the pattern of exposed sensitivity specks is known as the "latent image" which can not be seen until it is developed. When it is developed the entire silver halide crystal containing the sensitivity speck is converted to metallic silver. The remaining, unexposed, silver halide grains are removed during processing. After processing, it is the pattern of metallic silver crystals that remain on the emulsion, are responsible for the radiographic image.

Four tanks are required for manual film processing namely, **developer tank, Rinser tank, Fixer tank** and **Washing tank** These vertical tanks are available in 9, 13, 22 liters capacity.

Processing is composed of four separate steps:

1. Development : The first step is placing the film in a developing solution. Developer consists of reducing agents that convert silver halide crystal into metallic silver to convert latent image to visible image. Developing time should be guided as per manufacturer's recommendation. Usually it is 4-5 minutes at 20°C temperature of developing solution. However, higher temperature requires less developing time. When exposure factors are not accurate, an intermediate step is to take the film out of developer and view in safe light. Films with density are then rinsed and placed in the fixer tank in order to retrieve some information from the film.

Composition of developing solutions

1. Reducing agent	Hydroquinone	• Convert exposed silver halide crystals to metallic silver. • Provides contrast in image
2. Activator	Sodium carbonate	• Soften and swell film emulsion so reducing agent can act on the film. • Provides alkaline medium for reducing agent.
3. Restrainer	Potassium bromide	• Controls the activities of the reducing agent so that fogging of the film does not occur
4. Preservative	sodium sulphide	• Controls rapid oxidation of developing agents
5. Solvent	Water	• Used as solvent for this chemicals.

2. Rinsing : To prevent mixing of developing solution with fixing solution, the developed exposed film is rinsed in a running water tank by agitating the film for 10 -30 seconds. Water need to drip down the film before being transferred to fixer. If running water is not available, use 128 ml glacial acetic acid in one liter water (stop bath) for the same purpose.

3. Fixer : The next step is the placing the film in a fixer solution to remove the unexposed silver crystals, to stop development of the film by neutralization of developing agents and hardening of film emulsion. Fixing time is usually double the period of development. However, films need to keep for another 10 minutes in the fixing solution for hardening of the emulsion. As silver gets dissolved in fixer, strength of the fixing solution reduces.

Fixing solution contains: fixing agent, acidifier, and hardener, preservative and solvent.

Composition of fixing solutions

1. Fixing agent	Sodium thiosulphate Or ammonium thiosulphate	• Acts to remove unexposed silver crystals
2. Acidifier	Acetic acid Or sulphuric acid	• To neutralize developing solution
3. Hardner	Ammonium chloride Or ammonium sulphide	• Shrinks and hardens film emulsion
4. Preservative	Sodium sulphide	• Maintain chemical balance of the fixing solution
5. Solvent	Water	• Used as solvent for this chemicals.

Replenisher (strong solutions of original developer or fixer, available with manufacturer) is used @ 4 liters/fifty 14" × 17" film size or equivalent area developed to replace volumes lost during developing process. Replenishers restore or maintain chemical activity of the developing or fixing solution. When quantities of replanisher used equal to that of original volume, solution should made fresh.

3. Wash : The final step is the washing of the film to remove excess fixing agents and residual silver. Washing is carried out in a larger tank with running water. If fixer is left on the film, it will turn brown and hazy.

4. Drying : After washing, water is allowed to drain and film is either air or machine dried. Film should not come in contact with each other. Dust free room with proper air circulation is preferable for air-drying. Drying cabinet with electric heater quicken the drying process.

POINTS TO BE REMEMBERED

- The whole developing process must take place at a specific temperature. The temperature is monitored and regulated in an automatic processor. Ice or warm water can be added to water around the developing tank to maintain the required temperature of the developing solution.

- If the temperature is too hot, film will look overexposed and too low will look underexposed. If film is allowed to develop for too long, it will become over exposed and turn black.
- Once solution is made, it should not use more than 3 months because oxidation degrades the solution unsuitable for quality X-ray.
- Do not discard the used fixer solution; it is sold in the market. Used fixer solution contains silver (washed out unexposed silver) which is recovered by using electrolytic or chemical precipitation technique.
- 90% of all technical errors occur in film processing.

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CHAPTER 5

Intensifying Screens and Fluoroscopy

An intensifying screen consists of four distinct layers with a total thickness of about 0.4mm. These layers are:

- Super coat or the Protective layer (5-10 mm)
- Fluorescent layer (100-200 mm)
- Substratum Layer (10-20 mm)
- Base layer (200-400 mm)

1. Supercoat or the Protective layer : It is a strong smooth protective layer of cellulose acetate, which encapsulate and seal the whole screen with minimal thickness. It is resistant to abrasion and moisture.

2. Fluorescent layer : It is an active layer of intensifying screens and its main function is to convert X-ray energy into visible light. An even coating of microscopic phosphor dispersed and suspended in a binding material *e.g.* Cellulose acetate, nylon or polyurethane.

Desirable features of phosphors

- High X-ray absorption efficiency
- High X-ray to light efficiency
- Emission spectra matched to film sensitivity
- Fast light emission
- Absence of afterglow
- Uniform light output *i.e.* uniform dispersion in suspension media.

Types of phosphor

Calcium Tungstate, Silver Zinc Sulphide. Barium lead sulphate is mostly used as it provides good detail. The "rare earth" (difficult to isolate from earth) phosphors are also gaining importance. The rare earth elements (or rare earth metals) include the elements with atomic numbers 57 to 71.

Rare earth Phosphors

Three principal elements have been explored, these are Gadolinium (Gd), Yttrium (Y) and Lanthanum (La) and the most used compounds are their oxy-sulphides (O_2S) with activators Terbium and Europium with Terbium. The function of the activator is to enhance the light output both in speed and the wavelength of the light to match the application of the screens use.

X-ray exposure factors may be reduced upto 50% in rare earth screen-film combination due to its increased X-ray absorption efficiency (Gadolinium : 51%, Lanthanum : 24% Yttrium : 12% and Calcium Tungstate : 13% @ 60 Kv)

Increasing the thickness of the phosphor layer upto a point increases speed but also increases halation hence unsharpness, pigmentation of the suspension medium. The substratum can help to reduce halation. Recent advances include double phosphor and multiple layers.

3. Substratum Layer : Two types of substratum layers are used. In some cases, substratum layer is not used but the function is incorporated into the phosphor layer.

Reflective layer. In order to maximize the amount of light emitted by the phosphor layer, a bright white reflective layer (titanium dioxide/manganese oxide) is placed between the base and the phosphor layer to reflect as much of the light produced towards the film.

Absorptive layer. In order to minimize the halation effect hence minimize unsharpness caused by halation, sometimes an inert light absorptive dye is placed between the base and the phosphor to minimize internal reflections within the screen. It is used mostly in specialist applications such as multi-section tomography.

4. Base layer acts as a support for the other layers and common materials that include card. polyester and plastic which is chemically inert and moisture resistant. Radiation should not able to damage and do not discolor with age. All layers are designed or treated to adhere strongly together.

Advantages

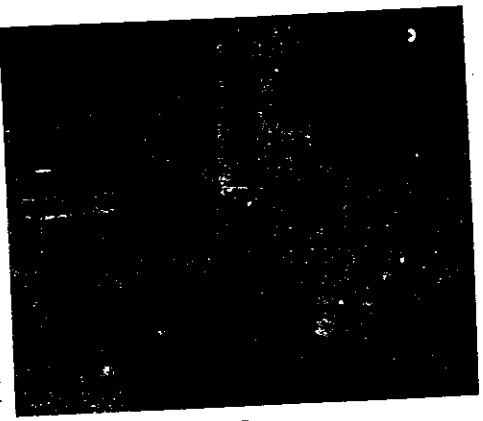
The efficiency of X-ray film to absorb X-ray photons is only about 1%. Intensifying screens thus used to amplify the film blackening effect on the film by the conversion of X-ray photons to light photons to which the film emulsion is sensitive. The conversion depends on the efficiency of the screen phosphor to absorb X-ray photons and convert it to ultra violet and visible light to which the film emulsion is optimally sensitive. The screens thus allow reduction in the factors required to obtain a diagnostic radiograph, which is very important in veterinary practice to avoid motion unsharpness.

Care of Screens

Screens are expensive objects. Damaged screen creates artifact in the processed film. Screens should be cleaned as per the manufactures recommendations.

- In general, any dust and particles should be blown out, cassette should be brushed out with a soft paintbrush, and then a lightly moistened cotton wool ball should be wiped gently across the surface and the same with a dry one. Finally, the cassette should be left open on its edge to dry in a convenient place.
- Do not scratch at any surface.
- Do not make the screen wet.

- Do not use unproved solvents.
- Ensure that the screen is fully dry before reloading the cassette.
- Record the date of cleaning.
- Be alert to avoid processing liquid to splash over screen.
- Do not touch protective screen unnecessary.



C-arm

Fluoroscopy

In fluoroscopy, continuous X-ray beam is passed through the body part being examined, and is visualized in the screen or on a monitor so that the body part and its motion can be seen in detail. Fluoroscopy may be performed to evaluate specific areas of the body, including the bones, muscles, and joints, as well as organs such as the heart, lung, or kidneys.

Use : Fluoroscopy may be used alone as a diagnostic procedure, or may be used in conjunction with other diagnostic or therapeutic media or procedures which includes

- Contrast radiography
- Cardiac catheterization
- Arthrography
- Lumbar puncture
- Placement of intravenous catheters
- Intravenous pyelogram
- Hysterosalpingogram
- Biopsies
- Locating foreign bodies
- Percutaneous vertebroplasty—a minimally invasive procedure used to treat compression fractures of the vertebrae of the spine

Limitations

- Fluoroscopic procedures (particularly prolonged interventional procedures) involve high patient radiation doses.
- The radiation dose depends on the type of examination, the patient size, the equipment, the technique, and many other factors.
- Doses may be reduced by using intermittent exposures, grid removal, last image hold, dose spreading, beam filtration, pulsed fluoroscopy, and other dose reduction techniques.
- Proper training of fluoroscopic operators, understanding the factors that influence radiation dose, and use of various dose reduction techniques may allow effective management of patient dose.

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CHAPTER

6

Radiographic Interpretation

Radiographic interpretation is based on the visualization and analysis of opacities on a radiograph. Absorption of X-rays depends on the atomic number and thickness of the tissues/objects to be radiographed. Tissues/objects with a higher atomic number will absorb more radiation than tissues with a lower atomic number. Thicker tissue/objects will absorb more X-rays than thinner tissue of similar composition The greater the amount of tissue absorption, the fewer X-ray photons reach the film, and the whiter the image on the film The radiograph will display a range of densities from white, through various shades of grey, to black. **Radiopaque tissues/objects** appear whiter. **Radiolucent** tissues/objects appear blacker. The resultant pattern of opacities forms an image on the radiograph, which is recognizable in form, and which can be interpreted.

Following points are to be remembered while viewing and interpreting radiographs :

1. Radiopacity : Radiopaque tissues/objects result in a whiter image; less radiopaque objects result in a blacker image. The radiopacity depends on:

- ***Atomic number :*** The higher the atomic number, the more radiopaque the tissue/object.
- ***Physical opacity :*** Air, fluid and soft tissue have approximately the same atomic number, but the specific gravity of air is only 0.001, whereas that of fluid and soft tissue is 1. Therefore, air will appear black on a radiograph, compared with fluid and soft tissue, which appear greyer.
- ***Thickness :*** The thicker the tissue/object, the greater the attenuation of X-rays and the image will be whiter. When two tissues/objects are superimposed, the composite shadow formed by these will appear more opaque than either of the two separate tissues/objects (e.g. the area where the two kidneys overlap appears more radiopaque than either kidney itself).

Tissue/Object	Effective Atomic Number	Specific Gravity
Gas	1-2	0.001
Fat	6-7	0.9
Soft tissue/fluid	7-8	1
Bone	14	1.8
Lead	82	11.3

2. Basic tissue radiographic opacities

- **Mineral opacity :** Calcium and phosphorus is the principal composition of bone. Differences of radiopacity within the same bone and between bones are evident because of the difference in radiopacity of compact vs spongy bone; trabecular bone vs. intertrabecular spaces; cortical bone vs medullary canal; diseased bone may be more (sclerotic) or less (porotic) opaque than normal bone.
- **Soft tissue/fluid opacity :** Both soft tissues and fluids have the almost same radiopacity. Thus, radiopacity of normal soft tissue and fluid-filled organs (heart, liver, spleen, urinary bladder) can be differentiated by variation in volume, thickness and degree of compactness of soft tissue.
- **Fat opacity :** Fat is more radiolucent than soft tissue or bone, but is more opaque than gas. Presence of fat actually helps to differentiate many organs and structures radiographically because radiographic contrast in fat surrounding an organ or structure will allow it to be delineated. In immature and thin animals, the lack of fat results in poorer contrast in the radiograph thus differentiation of different structures are little difficult job for radiologists.
- **Gas/air opacity :** Most radiolucent material visible on a film is gas or air. This lucency provides contrast to allow visualization of various structures like heart and great vessels outlined against the air-filled lungs in the chest.
- **Metal opacity :** This is the most opaque shadow seen on radiographic films. Thus, it is used for contrast studies of barium, water-soluble iodine media, implants for orthopaedic use, metallic foreign bodies and metal on collar and lead chain (artefacts) are easily visible in the radiograph.
- **The appearance of these opacities is relative :** As for example, a small cystic calculus may be difficult to identify in a bladder full of urine, but will be more readily apparent in a pneumocystogram. On the other hand, in positive contrast cystogram, the calculus will appear relatively radiolucent as it is less opaque than the iodine-containing contrast medium.

Interpretation of X-ray films

Interpretation of radiographs **is to be performed in a systemic manner without hurry.**

The following steps are to be followed for accurate interpretation:

1. Perform routine assessment of radiographs

- Be sure that the radiograph is the one of the patient being examined
- Check the date of exposure
- Ensure two orthogonal projections are available
- Identify the position of the patient during exposure and left/right markers
- The radiograph should be of high technical quality in respect to positioning, centering, collimation, exposure and development, and should be free from artifacts.

2. View the radiograph in appropriate environment: This procedure should be performed in a quiet, darkened room.

Requirements

- At least two good, evenly lit viewing boxes.
- While studying the film, bright edges around the film should be masked.
- A bright light illuminator for relatively over-exposed areas.

3. Three-dimensional concept: The radiographic image is two-dimensional shadowgram of the object. Thus, to reconstruct the third dimension mentally, two radiographic projections at right angles (orthogonal projections) to each other is need to made. Oblique projections may be required to assess anatomically complicated areas.

4. Evaluate every visible shadow : Radiograph must be evaluated to determine whether it is

- A feature of normal anatomy.
- A composite structure formed by superimposition of structures.
- An artifact produced by inaccurate positioning.
- A pathologic lesion.

5. Evaluate the radiographs :

A. ***Determine whether an abnormality exists.*** This is often the most difficult part.

- There is a wide range of normal anatomic variants.
- It is not possible to even see, in a lifetime all the normal variations.
- Textbooks, normal radiographs, tissue specimens or the contralateral limbs should be made as reference.

B. Define the anatomic location of the abnormality :

- A minimum of two orthogonal projections are required.
- More views may be required in certain areas.

C. Make a list of differential diagnoses by considering what diseases could cause the observed roentgen signs.

D. If a number of abnormal roentgen signs are identified, then those gamuts common to all lists are more likely (assuming only one problem is present).

6. Describe differential radiographic abnormalities of tissues/organs/objects (roentgen signs)

1. Changes in size of an organ or structure.
   - Increase in size *e.g.* diffuse neoplasia within the spleen.
   - Decrease in size *e.g.* poor development of the liver with a portosystemic shunt.
2. Variation in contour or shape
   - This may be local or diffuse e.g. hypertrophy of chambers of the heart in cardiomyopathy
   - Irregularity of mucosal border seen on positive contrast study with intestinal lymphosarcoma.
3. Variation in number of organs
   - Many organs or structures may be present in increased or decreased number or absent completely (*e.g.* supernumerary teeth and ribs, absence of a kidney).

4. Change in position of an organ or structure.
   - Presence of abdominal organs in chest in diaphragmatic rupture.
   - Ventral deviation of descending colon by enlarged sub-lumbar lymph nodes.
5. Alteration in opacity of an organ or structure
   - Increased radiopacity.
   - increased opacity in air-filled space *e.g.* fluid-filled tympanic bulla.
   - calcification within soft tissues.
   - radiopaque foreign body.
   - gas in abnormal sites *e.g.* subcutaneous emphysema.
   - bone may appear more lucent with osteoporosis, osteomyelitis and neoplasia.
6. Alteration in the architectural pattern of an organ or structure
   - Change in normal bone trabeculation, or bronchovascular markings in the lungs.
7. Alteration in the normal function of an organ
   - Secretory contrast studies *e.g.* excretory intravenous urogram.
   - Transit contrast studies *e.g.* Barium series.
   - Physiologic phases *e.g.* inspiratory and expiratory chest films.
   - Moving picture image intensification contrast studies of pharynx and oesophagus.

7. Other clues

1. *Summation effects* : If the two objects are separated along the axis of the primary beam, then a summation shadow will be formed. Summation image representing the degree of X-ray absorption by all the superimposed objects.

- ***Radiolucent summation shadows***—The more cavities that overlap, the greater the number of X-rays that reach the film.
- ***Radiopaque summation shadows***—A radiograph of a single small object may not be readily visible. However, the areas where many such objects overlap will absorb more X-rays e.g. miliary pulmonary metastases are visible, though the individual size of the metastases is very small.

2. *Silhouette effect* : Two structures of the same radiopacity when stays in contact, their individual margins at the point of contact cannot be distinguished radiographically. This is called **Silhouette effect.** It can be termed as 'border effacement'.

- As for example, liver and stomach generally stay in close contact and radiographically a composite shadow represents both structures.
- Coronary artery is not visible since it has the same radiopacity as the heart, and there is no intervening tissue of a different radiopacity.

3. *Importance of a contrasting substance* : The presence of a contrasting substance allows some structures to become visible. For example, in many patients, nipples and the prepuce are clearly visible in ventrodorsal projections of the abdomen as these structures are surrounded by air, and their margins are parallel to the axis of the central ray.

4. *Perception* : the eyes and brain do not always perceive appearances accurately, and optical illusions may occur. The shadow which appears as concrete visual evidence is not always

such, and perception is an important part of radiographic interpretation. What appears to be an obvious finding to inexperienced radiologists may be an incorrect assessment because of perception.

8. Make a radiographic diagnosis: Radiographic diagnosis should make in light of clinical history and physical examination findings. It must incorporate all of the radiographic abnormalities identified and should try to conclude into clinical disease entity.

9. Make a recommendation or suggest the next step of patient management. This might include advice for additional imaging studies, special oblique radiographs, and special advance techniques.

Pitfalls in interpretation

1. Searching or scanning errors ('satisfaction of search' error): This happens due to failure to adopt a systematic approach.

- An obvious abnormality present in the radiograph may distract the evaluator from systematic evaluation of the rest of the radiograph.
- Sudden 'Discovery of a lesion' that answers the clinical question, prompted the radiographic examination, thereby distract the evaluator.
- Tunnel vision (preconception of what will be found) ends viewing of the radiograph

2. Recognition errors : Here, abnormalities is seen but not perceived as an abnormalities due to lack of experiences.

3. Decision-making errors : it involves how we interpret radiographic abnormalities and which radiographic abnormalities we decided are important.

4. Egocentric errors : overestimation of our own grasp of truth or misapplication of information that we know leads to such errors.

All of the above pitfalls may be nullified by avoiding reviewing radiographs in single-person environment to seek second opinion.

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CHAPTER

7

Contrast Radiography

A **contrast medium** is a either highly radiolucent or highly radiopaque substance, which is administered to a patient to increase radiographic contrast within an organ or system. **Contrast radiography** is a special radiographic procedure using contrast media. Contrast studies are used to supplement or confirm information gained from routine survey radiographs.

CLASSIFICATION

There are two categories of contrast media :

Positive contrast media (elements of high atomic number) absorb more X-rays than do soft tissues or bones. *e.g.* barium (atomic no. 56) or iodine compounds (atomic no.53). These are radiopaque and appear white on radiographs.

Negative contrast media (agents with low specific gravity)—are gases like air, oxygen and carbon dioxide appear black on a radiograph. An ideal negative contrast media should be inert, quickly dissolved in the body fluids and quickly eliminated from the body.

Ideal characteristics of ideal positive contrast media

- Should be of high atomic number (preferably more than 50).
- Should be either inert or its metabolic byproducts should not be toxic.
- Should retain in the organ to be radiographed only for a desirable period.
- Contrast agents used for excretory organs must specifically be excreted through that in sufficient concentration for diagnostic quality of radiograph.

Contrast radiography is classified as

- ***Positive contrast radiography :*** Positive contrast media is used to fill or outline a hollow organ (*e.g.* G.I. tract, urinary bladder), or can be administered intravenously for immediate visualization of the vascular supply or for subsequent excretion evaluation. appear white.
- ***Negative contrast radiography*** **:** Negative contrast media is used to fill or outline a hollow organ like urinary bladder, which is appeared black on a radiograph.
- ***Double-contrast study*** **:** Here both positive and negative contrast agents are used (double contrast). A double-contrast study provides optimal mucosal detail and avoids the masking of small anomalies by large volumes of positive contrast agent.

Classification of Positive contrast media

1. Barium Sulphate preparations : Barium Sulphate is insoluble and is not absorbed in the body. Barium Sulphate is restricted for outlining alimentary tract. Its use is avoided if perforations are suspected. If it enters peritoneal or pleural cavity, may provoke granulamatous reaction. Barium Sulphate is available as powder, suspension or paste.

2. Water-soluble iodine preparations : These are low osmolarity contrast media, which dissociate in solution. It may be ionic or non- ionic. Common agents are the sodium meglumine salts of iothlamic, diatrizoic or metrizoic acids, iohexol, iopamidol.

3. Viscous and oily preparations : Viscous (Propyliodine) and oily (iodized oil and iophendylate) preparations are not suitable for intravascular use. Their use in veterinary practice is limited to lymphangiography, dacrocystorhinography and hysterosalpingography.

4. Preparations excreted through biliary system (Cholycystopaques) : These water-soluble organic iodine preparations are exclusively used for outlining biliary systems and gall bladder. Intravenous preparations (Meglumine iodoxamate, ioglycamate or iotroxate) are preferred then oral preparations (Sodium iopodate) as absorption through oral route is variable.

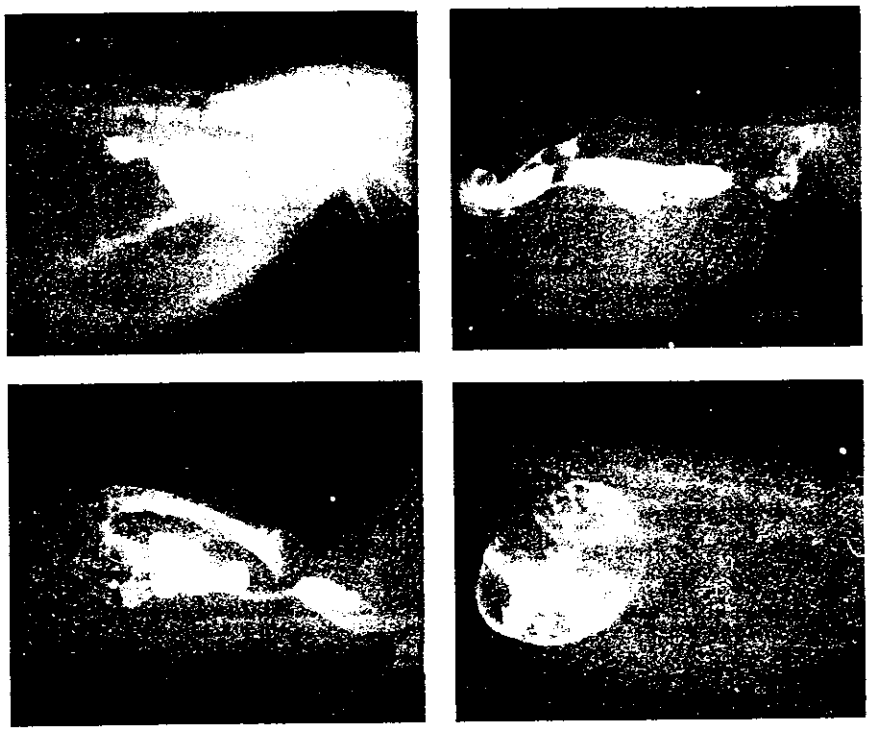
Indications

It is used in certain cases to delineate internal structures, which allows the visualization of soft tissue structures and evaluation of size, shape and position. It is also possible to assess the physiological condition.

Contrast techniques

Barium series : Gastrointestinal tract is studied in this technique. Contrast studies may be positive, negative or double contrast.

- ***Positive contrast study*** **:** barium or water–soluble iodide preparation may be used. Micro pulverized barium suspension @ 2 to 5 ml/kg body weight is administered slowly into the buccal pouch. Stomach tube may also be used to administer the contrast agent directly into the stomach.
- ***Double contrast study*** **:** Here either air through a stomach tube or a carbonated beverage (50 to 60 ml) may be given before or after the use of barium. Water-soluble iodine compound @ 7 ml/kg body weight by using stomach tube (as these agents are very bitter test) should be used when perforation of the esophagus, stomach, or intestine is suspected. As the stomach usually contains some gas or swelled air, virtually all contrast studies are double contrast studies. Double contrast studies are particularly valuable in studying the gastric mucosa.
- ***Negative contrast study*** **:** Room air is given by a stomach tube @ 6 to 12 ml/kg body weight, or a carbonated beverage (30 to 60 ml) may be given. Negative contrast study is useful to locate radiolucent foreign body.
- ***Barium Enema*** **:** Barium enema is used to outline the colon and rectum in suspected cases of intra-luminal or extra-luminal obstructions. This technique is not indicated if perforation is suspected. Ten to 24 hours fasting prior to this procedure is advisable. Laxative is needed to be administered 12 hrs before the study. Warm soap water enema is administered about 2hrs before. Deep sedation or general anesthesia is desirable to eliminate straining. Barium suspension of about 15 to 20% (W/V) concentration @ 20 to 30 ml/kg body weight is administered slowly through a cuffed rectal catheter by gravity flow from a large container or by using syringe.



Positive contrast radiography of G.I. tract

OESOPHAGOGRAPHY

Oesophagography is the contrast radiographic study of oesophagus. This technique is used to evaluate both structural and functional status of the oesophagus. Oesophagography is useful to diagnose esophageal obstruction, stenosis, diverticulum and mucosal diseases. Barium sulphate suspension (micro pulverized barium sulphate suspension) is usually used as a contrast agent.

A barium paste is useful to study the mucosa of oesophagus since it adheres better to the oesophageal folds. If rupture of the esophagus is suspected, it is preferable to use water – soluble contrast agent instead of barium. Dose of barium suspension is 5 ml/kg body weight through the buccual pouch. Radiographs are taken as soon as the last of the barium is being swallowed. If the oesophagus is grossly dilated, additional amounts of barium will be required to outline its lumen fully. Normally, longitudinal folds of the mucous membrane is observed in dog while in cat, longitudinal folds in the proximal ¾ of the oesophagus and the distal ¼th has oblique mucosal folds, giving a herringbone pattern.

GASTROGRAPHY

Gastrography reveals stomach rugae with barium contrast studies of stomach. Barium meal study of descending duodenum shows lymphatic craters on the anti-mesenteric border of the duodenum, visualized as depressions, which may be mistaken for ulcers, and it is called as pseudo-ulcers.

Indications

- Acute or chronic vomiting.
- Hematemesis.
- Anorexia and acute abdominal pain.
- Small intestinal diarrhea or melena.
- Doubt of complete or partial obstruction (intraluminal or mural lesions) and linear foreign body.
- Cranial abdominal mass lesion.
- Necessity to determine size, shape, and position of stomach or small intestine.
- Suspect intestinal perforation (**iodinated contrast to be safest**).

Contra-indications

- If obstructive ileus is found on survey radiographs, an upper GI series will only delay surgery and increase client cost.
- High doubt of bowel perforation (barium sulfate is contraindicated as it can cause severe granulomatous peritonitis).
- Prior use of drugs that affect intestinal transit time.

Contrast media used and dose

- Barium sulphate suspension (30% weight/weight).
- The dose of barium sulphate suspension is **12 ml/kg** for both dogs and cats.
- If intestinal perforation is suspected, iodinated contrast (Gastrografin) should be initial contrast of choice with a dose of **2-4 ml/kg.**
- The dose of iodinated contrast should be decreased to dilute with water to obtain a volume of 12 ml/kg.

Preparation

- In elective study, the patient should be fasted for 12-24 hours to keep the stomach empty.
- For emptying the colon, an enema should be given the evening prior to, and the morning of the study as food and faecal material can cause delay in emptying and transit times.

Technique

- Survey radiographs of the abdomen must be performed before contrast radiography.



Positive contrast gastrography

- Sedation generally should not be used, especially if the study is to be of a functional nature. A mild dose of acepromazine (0.1-3.0 mg) may be given to the dog and a combination of of ketamine (12 mg/kg) and diazepam (0.4 mg/kg) may be given to the cat.
- The suitable dose of contrast material should be administered via an orogastric or nasogastric tube.
- Lateral, DV and VD views should be taken immediately following administration of the contrast material.
- In general, lateral and VD views should be taken in dog at 15, 30, 60 minutes and then hourly until the majority of the contrast material has reached the distal small intestine and the colon. In the cat, lateral and VD views to be taken at 15, 30, 45, 60 minutes, and then every 30-60 minutes until the majority of the contrast material has reached the distal small intestine and the colon. Transmit time with iodinated contrast will be faster.
- In double-contrast study of the stomach, the stomach may be distended with air after the majority of the positive contrast has emptied and then opposite lateral, VD, and DV views of the stomach may be taken.

Dacrocystorhinography is the study of the nasolacrimal ducts where contrast agents are administered into the ducts by means of cannula inserted into the superior puncta lacrimata. Radiographs are taken in quick succession just after administration of contrast agents. The procedure is indicated in cases of suspected partial or complete obstruction, atresia, inflammation, deviation or distortion of the nasolacrimal duct.

Sialography is the contrast radiographic study of the salivary glands and ducts. It is performed to locate the site of obstruction in the stenson's duct and leakage of saliva in cases of sialocele. Sialograph is also done to diagnose space-occupying lesions of the parotid gland.

Under sedation and local anaesthesia salivary ducts through its opening in the oral cavity is exteriorized, cannulated and 0.1 to 0.3 ml of oily material or upto 2 ml of aqueous contrast medium is administered into the salivary duct. Latero-lateral radiographs are made immediately after the injection.

Bronchography is the contrast radiography of the bronchial tree. The patient is anesthetized and intubated. The contrast material is then administered by means of a catheter through the endotracheal tube. The catheter is placed at the point just cranial to its bifurcation and the contrast agent is deposited. One lung is studied at a time. The lung to be radiographed is positioned in lateral recumbency so that gravity carries the contrast materials *i.e.* for bronchography of left lung left lateral recumbency is the correct positioning. Selective bronchography can de done under fluoroscopic control. Two ml of contrast agents are adequate for each lung. A 50 to 60 % w/v 1 ml per bronchus has been recommended. Bronchography should be done cautiously in patients with cardiopulmonary disease.

Angiocardiography (Contrast studies of the heart): A cannula is inserted into the external jugular vein and contrast medium is administered in a bolus form and the radiograph taken.

Reticulography is the contrast radiographic study designated to diagnose cases of reticular hernia in cattle and buffaloes by feeding barium sulphate suspension.

Peritoneography is the contrast radiographic study of the peritoneal cavity and its contents by injecting negative contrast agent like air (pneumoperitoneography) or a mixture of a negative

and a positive contrast agent (double contrast peritoneography). The technique is indicated to determine the locations of various abdominal organs and suspected abdominal mass if any but should not be used in suspected diaphragmatic hernia because of danger of pneumothorax.

Angiography (Arteriography) is the contrast radiographic examination of lumen of blood vessels and organs of the body, with particular interest in the arteries, veins and the heart chambers to study the normal arterial pattern and also to diagnose abnormal arterial situation like occlusion. This can be done by injecting a radio-opaque contrast agent into the blood vessel and imaging using X-ray.

Fasciagraphy is the contrast radiographic study of tendons and associated structures to diagnose adhesion, calcification and rupture of tendons and muscle.

Pneumocolonography is a study of the large intestine utilizing air as a negative contrast agent to determine position of the colon relative to the small intestine and other organs or suspected masses, stricture, ileo-colic intussusception, or cecal inversion.

Intravenous pyelography (IVP) (excretory urography) is the contrast radiographic study of the kidneys, bladder and ureters by injecting positive contrast medium to diagnose abnormalities of urinary tract. This technique is unsuitable in severely dehydrated patients because of risk of fatal anuria.

Arthrography is the contrast radiographic technique of diarthrodial joints by injecting either positive contrast or negative contrast or a combination of both. This technique is helpful to detect various joint abnormalities but should not be used if infection is suspected. The main advantage of this technique is the visualization of articular cartilage and intra-articular tendons/ ligaments which cannot be differentiated on survey radiographs.

Myelography is the contrast radiographic demonstration of the structures within the spinal canal by introducing contrast media into the subarachnoid space.

Technique : Flex the head ventrally and palpate the wings of the atlas, spine of the axis, and the occipital protuberance. Draw a line between the wings and a line from the occipital protuberance to the spine of the axis. Place the needle on the midline ½ inch in front of the line between the wings. Go roughly parallel to the caudal wall of the skull and feel for the "pop" of resistance as the needle passes through the dorsal atlanto-occipital ligament. Stop when through the ligament. Positive contrast medium (non-ionic and of low osmolarity) is injected into the spinal subarachnoid space and radiograph is taken at different time interval. The subarachnoid space becomes visible as two white lines are separated by a space (spinal cord). Normal radiograph shows smooth contrast lines. Two bulging site one at cervical and another at lumbar area are normal due to brachial plexus and lumbar intumescence. Any deviations in the contrast lines, therefore in the cord is to be looked. Discontinuity or thinning in the subarachnoid space indicates swelling of the spinal cord. Contrast



Myelography in dig

line appearing to be pushed inward could be due to a mass outside the meninges (herniation of a disc). Contrast medium is heavier than CSF, so gravity can be used to mov it up or down the subarachnoid space.

Cystography

Cystography is a radiographic study performed to help in evaluation of the urinary bladder for extramural, mural, or intraluminal lesions. Cystography is easy to perform with relatively few complications. Different types of cystography (positive versus negative contrast) may be used depending on the type of information that the clinician anticipates to obtain.



Normal pneumocystograpm, enabling the bladder wall, mucosal margin and lumen to be visualized

Negative contrast cystography (Pneumocystography) : Simply catheterize the bladder (using sterile technique) → drain all the urine from the bladder → through a three way stop cock, instill air or gas into the bladder until it becomes slightly turgid → take lateral and ventrodorsal radiographs.

Positive contrast cystography : Drain the air out of the bladder in pneumocystography and replace it with approximately 50 mL of positive contrast medium turgid → take lateral and ventrodorsal radiographs. The positive contrast media can be diluted with 50% with sterile water as large volumes are excessively opaque and expensive. This positive contrast cystogram will provide more acute detail of the mucosa and the bladder wall as compared to negative contrast study.



Negative (a) and double contrast (b) images of the bladder, demonstrating a mass infiltrating the ventral bladder wall

Double contrast cystography : Drain the positive contrast from the bladder and re-insti air until the bladder is again turgid → Take the radiographs which will help to identify sma calculi not visualized previously on the negative or positive contrast studies.

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CHAPTER

8

Radiation

Radiation exposure may results from both therapeutic and diagnostic radiation devices. Radiologist, radiographer, technician and assistant personnel may be affected by radiation hazards. Thus, it is expected that proper radiation safety measure for radiology unit is to be followed and educate the persons involved in this procedure about the potential hazards of radiation.

Biological effects of radiation

The X-ray beam while traversing the tissue, X-ray photon forces the electrons to be ejected from the atomic lattice. Thus, the atom left with surplus positive electrical charge. Hence, the cells with in the tissue come to a state of high chemical reactivity and initiate biological effects. This results in cellular damage which leads to pathological and physiological changes leading to **"radiation sickness"**

Radiation insult may be somatic (harmful to person in his lifetime) and/or genetic effects (affect several generations). Leukemia (blood cancer) and malignant tumors are common somatic effect while atomic explosion are examples for genetic effects.

After the transfer of radiant energy to the atoms and molecules of the living tissue of the body in the form of excitation and ionization, direct and indirect effects of radiation can produce the resultant chemical changes in the molecules.

Direct effects appear due to absorption of energy by the molecules.

Indirect effects are caused by the products of radiation decomposition (radiolysis) of water and other solutes of the body.

Mechanism of action: Radiolysis stimulates formation of free radicals with unpaired electrons. These free radicals and H_2O_2 formed by them are highly reactive and mutagenic. These free radicals with high energy readily break chemical bonds in vitally important macro molecules of the body such as proteins, nuclide acids and lipids.

Radiation sensitivity of different body cells

Radiation affects the reproductive ability of proliferating cells by damaging the mitotic linked. Thus, regularly proliferating cells seem to be most radiosensitive. Cells, which do not proliferate (neryes and muscles), are generally radio-resistant.

Order of decreasing sensitivity of body tissues

- Lymphoid cells,
- Epithelial cells of small intestine,
- Haemopoietic cells,
- Germinal cells,,
- Epithelium of skin,
- Connective tissue cells,
- Cartilage and growing bone cells,
- Cells of brain and spinal cord,
- Cells of skeletal muscle and mature bone.

Radiation injury may be acute or chronic.

Acute effects : Acute effects are seen within a few days to weeks following whole body radiation. Diagnostic radiology can not produce acute effects. Acute biological effects may be seen with whole body therapeutic radiation administered to treat some tumors. However, they are generally associated with atomic bombs and nuclear meltdowns.

These effects include :

- *Pancytopenia-* results in haemorrhage and infection.
- *Vomiting, diarrhea, dehydration* due to death and sloughing of the intestinal lining cells
- *Neurological symptoms* resulting from cerebral edema, vasculitis and meningitis.
- A much higher dose is required to cause neurologic problems than bone marrow and GI injury.

Chronic effects : Chronic effects may be seen months to years after radiation exposure. The possible effects of radiation include:

- *Genetic effects* such as radiation induced mutation.
- *Increased risk of cancer* with a higher incidence of skin tumors, thyroid tumors, and leukemia.
- *Increased fetal abnormalities*—growth retardation, congenital malformation, embryonic or fetal death, childhood leukemia.
- *Shortened life span with premature aging.*
- *Cataract formation.*

Exposures to less radiation are always better. This is not meant to scare or prevent from performing the job rather, it is meant to alert to the potential hazards and to insist following good radiation safety and protection procedures.

Measurement of radiation

Units of exposure, this unit represents the amount of exposure a person gets.

- ***Roentgen(R)* :** Roentgens measure the quantity of ionization of air produced by an X-ray or gamma ray. The unit is coulombs/kg of air.
- **Units of absorbed dose :** these units represent the amount of energy that is deposited within an absorber (patient or personnel engaged in the procedure).

- *Rad* **(Radiation absorbed dose).** It stands for the radiation-absorbed dose. The unit is ergs/gram. It is the traditional unit.
- *Gray (Gy)*—The SI unit. Expressed in joules/kilogram.
- Some useful conversions:

1 Gy = 100 rad , 1 cgy = 1 rad, 1 rad = 0.01 Gy

Units of dose equivalents : These units represent difference in tissue damage resulting from different types of radiation. In order to compare different types of radiation, each type of radiation is assigned a quality factor (QF). Radiations that cause more damage, such as neutrons, have a higher quality factor than those that cause less damage (like X-rays). The quality factor is multiplied by the absorbed dose to give the dose equivalent.

Dose equivalent (rem or Sv) = absorbed dose (Gy or rad) × quality factor

- *REM* **(Roentgen Equivalent Man).** The traditional unit
- *Sievert* **(Sv)**-the SI unit.
- Some useful conversions:

1 Sv = 100 rem, 1 rem = 0.01 Sv

These units are important because exposure badge that the personnel engaged in the radiography wear when taking radiographs are reported in rem or Sv.

Radiation hazards and their prevention by adoption of safety measures

All radiation is potentially harmful.

Radiation Injury : Keeping radiation exposure to an absolute minimum is warranted because radiation damages cells by the ionization of vital molecules in cells. The specific effects of radiation depend on a number of factors:

1. **The rate of delivery**: Massive radiation in a single dose could kill a patient *e.g.* 650 rads administered in a single dose could kill a person, however, 650 rads administered over 50 years would be unlikely to result in detectable damage to anyone because our bodies can repair tissues injured by radiation. Thus, work with radiation with a low levels exposure each month and do not show any untoward effects.
2. **The amount of the body exposed**: Body can tolerate a high level of exposure if administered to a small portion of the body, while the same exposure would cause death if administered to the whole animal.
3. **The sensitivity of the individual and the variation of sensitivity of body cells**: Lymphocytes and all immature germ cells are highly sensitive to radiation injury. The cells lining the gastrointestinal tract are also very sensitive. Other sensitive tissues include the thyroid gland, and the lens in the eye.

Extremities can withstand much higher doses of radiation than the blood forming organs because of the decreased sensitivity of epithelial, muscle, and nerve tissue.

Radiation safety

The fundamental principles of radiation safety depend on time, distance, shielding.

Time

- Minimize 'time of exposure' to ionizing radiation is advised.
- Follow technique charts to decrease repeat examinations.
- Use of personnel associated with radiographic procedure on rotational so that no worker spends a disproportionate amount of time producing radiographs.
- Use tape, sandbags, sedation, and restraint devices for positioning of animals.
- Plan the radiographic procedure carefully in order to avoid repeat films.

Distance

- Maximize the distance between the worker and the primary X-ray beam.
- To put **inverse square law** (The radiation exposure is inversely proportional to the distance from the X-ray machine *e.g.* if double the distance away from a radiation source will decrease exposure by a factor of four) into practice.
- Remove all essential personnel from the radiology room during exposure.
- Use cassette holders, do not hand hold cassettes.
- If personnel must hold a patient, advice them to extend arms and move head and trunk away from the primary beam and source of scatter.
- Rotate the personnel restraining the animal manually or holding the cassette holder so same person is not repeatedly exposed.
- Care should be taken during fluoroscopy to avoid scatter radiation.
- Operator should be in a shielding booth or behind a shielding screen at least 6 feet away from X-ray source.

Shielding (prevents the radiation from hitting the body and results less exposure.)

- Never allow any part of the workers body to be in the primary beam.
- Use beam-limiting devices (filters) and collimate to the appropriate field size.
- Always wear protective a full body lead apron (minimum of 0.25 mm lead equivalent up to 100 KV).
- Always wear protective lead gloves(not less than 0.33 mm for 100 KV) *Lead apron and gloves protect only against scatter radiation NOT the primary beam.*
- Always wear a thyroid shield
- Use protective Goggles are a good option, however, at least do not look at the x-ray tube during an exposure and avert eyes form the patient. More useful during fluoroscopy.

X-ray room and equipment :

- X-ray unit should be located away from flow of traffic
- X-ray equipment should be periodically checked for possible leakage
- Proper warning notice must be displayed near the location of the X-ray units regarding radiation hazards.
- Walls should be 22 cm thick with lead linings and witched between plywood.

Note : 1. Proper care and use of lead aprons and gloves is essential for radiation protection. Aprons and gloves should be periodically checked for cracks and defects. The apron should be hung and not folded. Folding causes cracks to form in the lead. In order

to test for any cracks in the lead, simply radiograph your equipment. Cracks will show up as black areas on the film.

2. The walls of radiography room should be lead lined or thick enough to block all stray radiation.

Common Sense

- Avoid the primary beam.
- Never hold a portable X-ray machine during the exposure.
- Do not allow pregnant women or personnel younger than 18 years old in the radiology room.
- Wear a film badge outside lead apron at neck level to monitor radiation dose.
- Look away during exposures to protect the lens of the eye.

Maximum Permissible Dose (MPD) :

At present time of the *maximum whole body dose equivalents* are :

Category of person	:	*Maximum Whole Body Dose Equivalents*
Occupational workers Whole body, gonads, bone marrow, lens of the eye	:	5 rems/year (50 msv)(5000 m rem)
• Hands of arm	:	75000 m rem (one year)
General public Whole body, gonads, bone marrow, lens of the eye	:	0.1 rem/year (1 mSv)
An embryo or fetus any given month	:	0.5 rem/9 months (5 mSv) with 0.05 rem in

- The maximum accumulated whole body dose equivalent (lifetime dose) for occupational workers is 5(n–18) where "n" is in the age in years.

Personnel monitoring devices

Personnel monitoring devices are used in long-term monitoring of low levels of radiation that the people working in your practice are exposed to.

Film badge : It is the most widely used personnel monitor. Here, the nuclear emulsion monitor consists of a piece of film that is inserted in a special plastic holder. This badge is needed to be clipped in clothes outside the lead apron. The badge should be worn on the collar on the outside of the lead apron. Film badges are sent to a company to be read and report the results on a periodic basis. The length of time between evaluations depends on the amount of radiation to which the worker is probably exposed but quarterly readings are the most common.

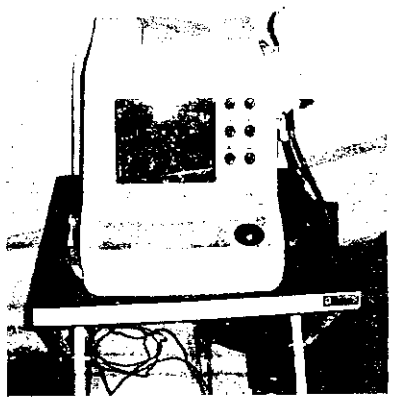
The film badge should be worn any time whenever radiographs are obtained or are in the area of hospital in which radiographs are obtained.

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CHAPTER 9

Ultrasonography in Veterinary Practice

Ultrasound is defined as high frequency sound wave greater than audible sounds (more than 20.000 Hz). For diagnostic applications, frequencies of 1-10 MHz are used. Pulse-echo principle is followed in ultrasound imaging i.e. when a sound wave travels in a pulse and is reflected back it becomes an echo.



Ultrasound machine

Properties of ultrasound

- Ultrasound cannot propagate through vacuumed area and transmission through gas is poor.
- A higher frequency penetrates less far but provides better resolution.
- The axial resolution of the ultrasound system is limited by the pulse length and so to get high resolution, short pulse is to be generated.
- Transducer : Transducer is composed of one or more piezoelectric crystals. Upon stimulation of these crystals electrically, shape is changed and sound waves of a particular frequency is generated. The frequency of a transducer is calculated by the times the crystal expands and contracts per second.
- Three main types of transducers available are **linear array, convex and sector.**
- Linear array : Linear array transducers are composed of thin rectangular clips lined up side by side, each of it produce sound waves. Thus, the produced beam is rectangular and permits a good visualization of superficial structures with an easy analysis of the anatomical relationship.
- **Convex :** Here, crystals are placed in curvilinear fashion. Hence, imaging of a greater area is achieved with the same contact area.

- **Sector :** This is most modern transducer that contains a single crystal, which oscillates or rotates to produce a fan shaped beam. This small size transducer is better in terms of maneuverability and access to thoracic and abdominal organs through a small contact area. This type of transducer more readily visualizes deeper structures whereas superficial structures are not well visualized.
- It is expected that a transducer emits a single frequency sound wave, but in reality, it emits ultrasound waves of many frequencies on either side of main frequency (bandwidth of transducer). Narrowest bandwidth is always desirable.
- The distance between the transducer (which emits and receives ultrasound signals) and the patient must be bridged by a suitably coupling agent.
- Ultrasound can be propagated and when transducer is placed in close contact with the body surface through coupling medium, continuous modification takes place through absorption, reflection, and scattering.
- **Absorption :** Sound wave when hit the tissues, part of it converts to heat and absorbed by the tissues. This conversion to heat and absorption by tissues depends upon the atomic number of the tissue. Differential absorption forms the basis of therapeutic ultrasound.
- **Reflection :** A portion of ultrasound beam gets reflected (rest continues through the tissues) and redirected by the tissues depending upon the interfaces between tissues of different acoustic impedance. Thus, different forms of echoes are formed which converts into electric signals and displayed onto an oscilloscope monitor. Amplitude of the echo (echo quantification) depends on the amount of sound that is reflected at an interface. Different amplitude of echoes formed by the two different acoustic impedances forms the basis of ultrasound scanning.
- **Scattering :** Scattering at different directions is resultant of interaction of ultrasound beam and irregular smaller (than beam size) structures.
- Common cause of artifact formation is refraction.
- Modes of display in diagnostic ultrasound are Amplitude (A) Mode, Brightness (B) Mode and Motion (M) Mode.
- **Amplitude (A) Mode**—It is the simplest form where two parameters of the echoes *i.e.* distance from the transducer and amplitude is displayed. Horizontal lines in the monitor represent distance and vertical lines are amplitude.
- **Brightness (B) Mode**—In this mode, the image represents a slice through which ultrasound beam is passed and brightness of the dots of the screen is made proportional to the amplitude of the echoes.

  In **real time B-mode scanner**, sound beam automatically and rapidly moves in the scan plane and image is continuously updated to allow movement to be seen. This is very popular mode in use in veterinary practice.
- **Motion (M) Mode**—It is a revision of real time scanning and records position and motion of the echo and resembles A-mode except that A-mode also records the amplitude in addition to the position. Each spike is replaced with dot on the display. Images are moved along a horizontal axis.

- **Coupling agents:** Coupling agent is required to bridge the gap between the transducer face and the patient because ultrasound travels poorly through air. Mineral oils, liquid paraffin, aqueous ultrasonic gel (mostly used) can be used as coupling agents.

SCANNING PROCEDURE

(*i*). **Preparation of patient.** Patient should be prepared by clipping, shaving and cleaning the hair and skin. Coupling agents are placed in the area of interest liberally to keep good contact of the transducer and skin without the presence of air. Air blocks the ultrasound completely. Close contact requires having minimum attenuation of the sound beam. Ultrasound scanning warrants considerable co-operation from the patient. In highly temperamental animals, tranquillizer/sedative may be advocated before examination. Overnight fasting of the animal is advised. Laxative may be given on the previous day to clear bowel of faeces and gas.

(*ii*) **Patient positioning.** It is important to position the animal to get acoustic window for proper image. Scanning may be performed by placing the animal on dorsal, right/lateral recumbency or in standing position depending upon the organ to be scanned and availability of good acoustic window. Acoustic window is an area may be natural or artificial through which ultrasound beam can pass avoiding gas and bone. Full urinary bladder acts as good acoustic window for scanning of pelvic organs, like wise through spleen left kidney can be examined better. The organs or tissues are need to be examined in orthogonal view (at least in two planes) one in transverse and other one in longitudinal/sagittal. Oblique views are also advised in few occasions.

(*iii*) **Image interpretations.** Echo patterns are generally described in contrast to the adjacent tissues or organs.

Terminology used for interpretation of images is :

1. **Hyperechoic/echogenic :** Echo pattern appearance over the screen is brighter. *e.g.* bone or air.

2. **Hypoechoic** : Echo pattern appearance over the screen is grey or dark and is given by interfaces of moderate reflection such as soft tissues.

3. **Anechoic/echo-free** : In absence of any echo, image will be black in screen. Fluids give an anechoic image as the sound beam passes uninterruptedly.

4. **Acoustic enhancement** : A normal bright area immediately deep to fluid.

5. **Artifacts:**

   1. ***Acoustic shadowing*** : This phenomenon is caused by attenuation or reflection of the sound beam at an acoustic interface. Here, bright image with no visible structure beneath a soft tissue/fluid filled cavity is seen due to presence of bone, minerals or gas inside the cavity. This phenomenon helps in detection of cystic, renal and biliary calculi.
   2. ***Reverberation*** : it is the largest source of positive artifact. When sound beam is returned back to the transducer, a portion of sound beam is absorbed by crystals which form electrical impulse and image is shown in the screen. Rest portion of beam is reflected back into the patient and again to the transducer. This phenomenon is called *Reverberation.*
   3. ***Mirror image*** : Occurs at high reflected surface, creating a second image behind the anatomical mirror of the structure. One such mirror reflector is the diaphragm which

can make replicas of anterior anatomy appears behind it.

4. ***Comet tail*** **:** it is caused by a highly reflective interface most commonly the air fluid interface.

Control panel of ultrasound massage

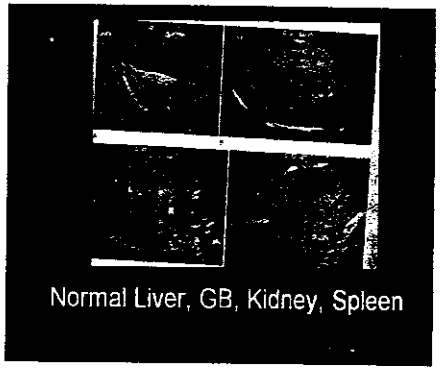
1. **Transpose :** use to change the image presentation from left to right or right to left.
2. **Invert :** change the displayed image from white on black and black on white.
3. **Scale zoom/ near far switch :** switching up increases and switching down decreases scale size. Near far switch is used to move up the ultrasound image so that the lower part of the image can be reviewed.
4. **Freeze/focus :** this switch have two functions, if the switch is pressed down, freezing of the frame will take place and if the switch is pushed up four zone, focus will be initiated and frame rate per second will reduce to 4-6.
5. **Depth compensation :** This is regulated to remove strong echoes in the near field.
6. **The gain and TCG control :** Continuous monitoring and adjustments of the gain and TCG (Time compensated gain) improves image quality. The gain adjusts the overall density of the image to receive echoes from all organs and tissues. TCG controls allow equal acoustic interfaces to return equal echoes regardless of the depth. Scan beam is diminished in intensity by one decibel (approximately) per am per MHz. thus unequal echoes are returned by equal acoustic interfaces located at different distances from the contact point of transducer.

Maintenance of machine

- The room for ultrasound machine should be dust free and dust proof. When not in use, the machine should always be kept under cover.
- The room temperature must be maintained between the 15-25 °C by using A.C./ room heater. High temperature do damage of the piezo-electric crystal.
- Use constant voltage stabilizer for more precise electrical protection.

Abdominal Ultrasonography

- Hepatobiliary scanning-Hepatic size, abscess, cyst, tumour, cirrhosis, calculi, obstruction, infection of gall bladder and bile duct and porto-systemic shunts.
- Spleen- Abscess, tumour, infarction and splenic size.
- Pancreas- Infection and tumour.
- Gastro-intestinal tract- Foreign body, obstruction, tumours, mucosal pattern, peristalsis, gastric and intestinal emptying time can be well appreciated by ultrasonography.
- Renal hemodynamics, renal and urinary bladder volume and urine formation can be measured with morhpometric parameters. Calculi in kidney and urinary bladder, hydronephrosis, bladder tumour are well detected by sonography.



Normal Liver, GB, Kidney, Spleen

Reproductive Ultrasonography:

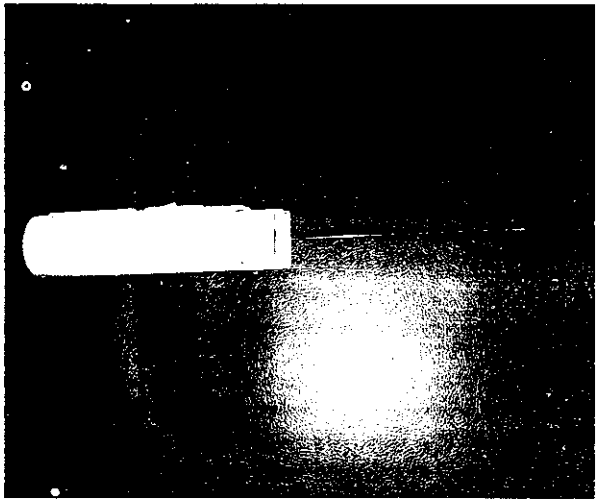
- Ultrasonography is used to study ovarian follicular dynamics, pregnancy detection, fetal well being and for fetal sexing and ovum pick-up technology (OPU).
- Diseases of female reproductive tract like pyometra, mucometra, hydrometra, fetal mummification, and ovarian tumour can be detected by ultrasonography.
- Physiological blood flow pattern of canine testis and prostate gland is documented sonographically. Testicular hypoplasia, Benign Prostatic hyperplasis in canine are frequently diagnoses by ultrasonography.

Limb Ultrasonography

- Evaluation of tendons and ligaments of both fore and hind limbs is extensively used in racehorses to certify their fitness.
- It has been proved to be a superior imaging modality to detect adhesions, tearing and inflammation of these structures.
- Besides, ultrasonography is being used for evaluation of endocrine glands, salivary glands, eyes, tissue healing, teat and udder.

Ultrasound- guided biopsy:

- Percutaneous biopsy of abdominal organs like liver, spleen, kidney, prostrate, abdominal mass, lesions etc under ultrasound guidance is well documented.



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CHAPTER

10

Radiotherapy and Isotopes

Radiation therapy (also called radiotherapy, X-ray therapy or irradiation) is the use of a certain type of energy (called ionizing radiation) to destroy cancer cells and shrink tumors.

Principles of radiation therapy

- Depending upon the clinical circumstances, radiation therapy may be used alone or in combination with surgical and/or chemotherapeutic modalities.
- Radiation therapy injures or destroys cells in the area being treated (the "target tissue") by damaging their genetic material, making it impossible for these cells to continue to grow and divide.
- It does not work as well on cells that are in the resting phase (G0) or are dividing slowly. Radiation therapy attacks cancer cells that are dividing, but it can also affect dividing cells of normal tissues. The damage to normal cells causes side effects.
- Although radiation damages both cancer cells and normal cells, most normal cells can recover from the effects of radiation and function properly. The aim of radiation therapy is to damage as many cancer cells as possible, while limiting harm to nearby healthy tissue.
- Radiation can change the genes (DNA) and some of the molecules of a cell. These genes control how cells in the body grow and divide.
- Some types of radiation can be very finely controlled to treat only a small area without damaging nearby tissues and organs. Other types of radiation are better for treating larger areas.
- In some cases, the goal of radiation treatment is the complete destruction of an entire tumor. In other cases, the aim is to shrink a tumor and relieve symptoms. In either case, doctors plan treatment to spare as much healthy tissue as possible.
- Radiation therapy may be used alone or in combination with other cancer treatments, such as chemotherapy or surgery. In some cases, a patient may receive more than one type of radiation therapy.
- Radiation therapy may be used to treat almost every type of solid tumour, including cancers of the brain, breast, cervix, larynx, lung, pancreas, prostate, skin, spine, stomach, uterus or soft tissue sarcomas. Radiation can also be used to treat leukemia and lymphoma.

- **Prophylactic radiation therapy :** Radiation may be given to areas that do not ha evidence of cancer. This is done to prevent cancer cells from growing in the area receivi the radiation.
- **Palliative radiation therapy :** Radiation therapy also can be given to help redu symptoms such as pain from cancer that has spread to the bones or other parts of t body. It is the most accepted therapy for veterinary patients.
- Radiation dose to each site depends on a number of factors, including the type of can and whether there are tissues and organs nearby that may be damaged by radiati **Radiation dose** or exposure is measured in units of absorbed radiation per unit of tiss The Gray (Gy) represents 1 J/kg of tissue. Older literature uses the rad, which is equival to 0.01 Gy. The exposure and dose rate of radiation decrease according to an inve square law, such that the exposure decreases by 4 when the distance increases by

TYPES OF RADIATION THERAPY

There are two main types of radiation therapy: external beam radiation (teletherapy) internal radiation therapy (brachytherapy).

External Beam Radiation Therapy (Teletherapy)

- Here, radiation delivered from a distant source, from outside the body. External be therapy is used for most cancer patients.
- Different types of radiation for external beam therapy include orthovoltage X-ray machi Cobalt-60 machines, linear accelerators, proton beam machines, and neutron be machines.
- It is used to treat many types of tumors including cancers of the head and neck a
- Depending upon tumor location, different levels of radiation are used for external be therapy.
- Low-energy radiation does not penetrate very deeply into the body and is used ma to treat surface tumors such as skin cancer.
- High-energy radiation is used to treat other deeper cancers.
- **Stereotactic radiation therapy:** In this type of therapy, radiation beam focused small area and deliver very high doses. Thus, the ideal amount of radiation neede destroy tumor cells is delivered directly to the tumor growth, while the amoun exposure to the area surrounding the tumor is minimized. Stereotactic radiation the is very effective in treating small tumors such as those in the head and brain.
- External beam therapy is painless. Most patients do not need to stay in the hospital they are having external beam therapy.

Internal Radiation Therapy (Brachytherapy)

- In Brachytherapy, radiation sources are placed as close as possible to the tumor Sometimes, they may be inserted directly into the tumor.
- The radioactive sources or isotopes are in the form of wires or rods.
- This technique is very effective in treating malignant tumours of the cervix, u vagina, rectum, eye, and certain head and neck cancers. It is also occasionally us treat tumour of the breast, brain, skin, anus, esophagus, lung, bladder, and prosta

- Brachytherapy may be used in conjunction with teletherapy. When both forms are employed, the external beam radiation is intended to destroy cancerous cells in a large area surrounding the tumor, while the brachytherapy delivers a boost, or higher dose of radiation, to help destroy the main concentrated mass of tumor cells.

Types of Brachytherapy (based on different methods of placing radiation inside the body):

- *Interstitial Brachytherapy*
- *Intracavitary Brachytherapy*
- *Intraluminal Radiation Therapy*
- Radioactively *tagged molecules given intravenously.*

Interstitial Brachytherapy: Here, radioactive needles or wires are implanted in the tumor area. The radioactive sources may be put in and taken out on the same day; removed from the body after several days; or may stay in the patient permanently.

Intracavitary Brachytherapy: Radioactive sources are placed by using a metal or plastic device (applicator), in body cavities such as the vagina, uterus, or larynx to irradiate the walls of the cavity or nearby tissues. The oncologists monitor the dose and when the specified dose of radiation has been delivered to the tumor, the applicator containing the radioactive isotope is removed.

Intraluminal radiation therapy delivers radiation to hollow organs. Oncologist inserts a specially designed tube or applicator into the lumen, or opening, *e.g.* esophagus to treat cancer.

Radioactive particles can be attached to small molecules and given intravenously. For example, I-131 is used intravenously to treat bony metastases.

Isotopes and their uses

A medical isotope is a very small quantity of radioactive substance used in safe, cost-effective imaging and treatment of disease. Medical isotopes can be delivered directly to the site of diseased cells. This is different from external beam radiation treatment where radiation is directed from outside of the body. Medical isotopes are isolated in either accelerators or nuclear reactors.

Commonly used medical isotopes are :

Isotope	Half-life	Applications
Ra-226	1600 y	Target isotope to make Ac-227, Th-228, Th-229 (Parents of alpha emitters used for RIT).
Co-60	5.27y	Teletherapy (destroy cancer cells), disinfect surgical equipment and medicines, *external radiation cancer therapy* (E).
Cs-137	30.2y	Blood irradiators, PET imaging, tumor treatment.
Ir-192	73.8d	Implants or "seeds" for treatment of cancers of the prostate, brain, breast, gynecological cancers.
I-125	59.9d	Osteoporosis detection, diagnostic imaging, tracer for drugs, monoclonal antibodies, brain cancer treatment (I-131 replacement), SPECT imaging, radiolabelling, tumor imaging, *mapping of receptors in the brain (A); interstitial radiation therapy (brachytherapy) for treatment of prostate cancer (E).*

Diagnostic value of medical isotopes

- Medical isotope diagnostic procedures often facilitate an earlier and more complete disease diagnosis and therefore more rapid and effective treatment.
- Radioisotopes in small quantity are administered into the body and imaging equipment tracks their location and movement. As radioisotopes give off energy that can be detected by the equipment, this enables the technologists to learn more about the diseased tissues than a diagnostic procedure that just takes a picture from the outside.
- When radioisotopes are delivered straight to the cancer cells, healthy tissues are spare while cancer cells are eliminated.
- Medical isotopes are proving very helpful in treating cardiovascular disease. They effectively prevent re-clogging of arteries (restenosis) when used in conjunction with balloon angioplasty.
- Rheumatoid arthritis is commonly treated in Europe with injections of medical isotopes.

Different types of medical isotope treatments

Brachytherapy is a form of cancer treatment where tiny "seeds" containing medical isotopes are accurately placed within and near a tumor. Brachytherapy is used for localized prostate cancer, liver cancer, head and neck cancers, gynecological cancers and others.

Radioimmunotherapy is a type of treatment where technologists inject antibodies that have isotopes (monoclonal antibodies) attached. The antibodies then flow through the blood stream and attach themselves to the cancerous cells. The energy from the medical isotopes is thus targeted straight to the cancer. This type of treatment is showing great promise for blood cancers such as leukemia, lymphoma, and multiple myeloma. This technique is still in clinical trials.

Medical isotopes can also be directed to cancerous cells by a carrier that has an attraction to a certain part of the body. Chemical phosphonates can be paired with medical isotopes and sent to the bone, since phosphonate is a natural building block of bone matrix. The medical isotope Iodine has been used for thyroid treatment for years because the isotope itself is naturally attracted to the thyroid.

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CHAPTER 11

Diathermy and Ultrasonic Therapy

DIATHERMY

Techniques and application of diathermy

Radiant sources of heating (ultraviolet and infrared) as well as conducting heating (Fomentations) are used mostly for superficial heating. In this method, it is practically impossible to heat the deeper tissues without overheating the superficial structures like skin and fascia. Thus, use of high frequency current for heating the deeper structure of body is an important physical medicine modality. A high frequency current is defined as an alternative current consisting of a million or more oscillations per second.

Classification of diathermy unit

1. Long wave Diathermy-It is the oldest type and now a day is not in use. In long wave diathermy machine, oscillations of a frequency of about million per second are applied through bare metal electrodes placed in direct contact with the skin or mucus membrane.

2. Shortwave Diathermy is most commonly used method. Here, oscillations varies from 10 to 100 million per second and can be applied from a distance through a spacing of air or rubber.

3. Microwave Diathermy: Oscillations of 3000 millions per second, which are used by focusing single beam of electro magnetic energy from some distance to the region to be created. This can be produced by magnetron oscillator.

Effects of Diathermy

As diathermy is applied, an increase in blood flow may occur locally as a result of changes in the tissue temperature.

Methods of applications

1. Heating in the electrical field : Tissue when placed in between two electrodes, part of the electric charge will pass. The conduction current will be converted to heat. This high frequency oscillation can therefore be conveyed to the body through a layer or air, insulating pad or an insulated cable.

2. Heating in the electromagnetic field : Here, a flexible heat insulated cable in the form of the coil or loop is placed over the area of interest of the body. The high frequency current

traversing such a coil creates a magnetic field and in conducting substance placed inside this induced currents known as eddy currents and these flow in a direction opposite to tha changing current in the coil. Meeting in an electro magnetic field is especially effectiv vascular tissue.

3. Microwave heating : This is eradiated electromagnetic field, the energy is deemed an antenna or radiator and no contact is required for its transmission.

Clinical effects

1. Effects on circulation

(a) Local Effects **:** The local application of diathermy results in an active arterial hyperem in increased flow of lymph—an increase in the volume of the part thus effected.

(b) General Effects **:** Rapid dilatation of peripheral blood vessels—visa in blood temper an increase in the pulse rate and respiration and perspiration—an increase in the general metabolism.

2. Effects on nervous tissue : Diathermy exerts a marked sedative effect on the irrig conditions of sensory nerves (spasms and cramps)

Indications

- It promotes disintegration of inflammatory exudates and assists in their resort fro decreasing the swelling, relief of pain and restoration of the function clinically.
- The pain and spasm relieving effect of diathermy makes its used indicated in irrit of sensory and motor nerves.
- In traumatic and inflammatory conditions of bursas, bones and joints after the stage.
- In painful and exuberant callus formation and fibrous ankylosis, joint injuries.
- In post operative adhesions in extremities.

Spastic conditions of the stomach.

- In the treatment of neuritis and certain conditions of neuralgia or myalgia.
- In the treatment of chronic infections.

Contraindications

- In acute inflammatory process accompanied by fever and suppuration.
- In tendency to hemorrhage recent haemoptysis.
- In malignant tumors.

Technique of short wave diathermy

- Each of the forms of short wave diathermy application involves the use of different electrodes.
- Electric or condenser field meeting—flexible condenser pads, air spaced plate, singl double cuffs.
- Electromagnetic field heating—Inductance cable wound around part or placed body in from of loop paheaka col of treatment drum.

- Electric or condenser field heating—Electric field heating consists of supplying two space metal electrode condenser pads and cuffs or air space electrodes on either surfaces or the same body surfaces to heat the interposed parts.

(*a*) Condenser pads are held in place by elastic bandaging or perforated rubber band—the advantages of the pad is this pliability, which allows bending or shaping them to conform to the surfaces to be treated.

(*b*) **Double Cuffs :** Consists of a pair of long or narrow condenser pads that are applied along lymph flow at suitable distance from each other. They should be so placed that they include only or the part to be heated and the skin electrodes distance under both cuffs should be equal.

(*c*) **Air spaced condenser plates :** Consists of circular metal plates or disks covered with insulating material.

(*d*) **Inductance Coil :** For coil fill heating, 2 or 4 thickness of Turkish toweling should be placed between the cable and skin. There should be 2 or 4 turns of the cable spaced one inch or more apart. In all inductance cable treatment the ends of the cable leading to the apparatus should be of equal length and should be supplied by at least the distance of the outlets of the apparatus.

Technique of microwave diathermy

The minimum spacing with any director is 1-2 inches. In applying microwave diathermy, one should see that the surfaces treated are dry and no toweling should be placed over the skin, equip mental moisture can be wiped off from time to time. The director should not be used without their protective coverings. The directory should never be placed with an open side against the metal surface of a table. Special care is advised in treating the region of the head specially the eyes.

ULTRASOUND THERAPY

Therapeutic heating agents are of two types.

1. Superficial tissue heating agents produce temperature changes in the skin and subcutaneous tissue to a depth of approximately 10 mm. *e.g.* Hot packs and warm water baths.

2. Deeper tissue heating agents cause temperature elevations in tissues to depths of 3 cm or more, without over heating the superficial tissues. *e.g.* ultrasound therapy, short wave and microwave diathermy.

Ultrasound can be used for scanning of internal structures (**diagnostic ultrasound**) and for treating certain diseases (**therapeutic ultrasound**). Therapeutic Ultrasound is used for tissue destruction surgery for tumour irradiation, lithotripsy and physical therapy to promote deep tissue healing and restores function. The various properties of ultrasounds are listed below.

1. Physical properties

- Therapeutic frequencies of 1 MHz penetrate as deep as 4-6 cm into the tissues.
- Tissues with a high fluid content, such as blood and muscle, will absorb sound waves better than less hydrated tissues.
- Nerve tissue has a high coefficient of ultrasound absorption. Thus, use of ultrasound in treating peripheral nervous systems is encouraging.

2. Thermal effects

- Skin and subcutaneous fat cannot absorb ultrasound well, absorption takes place on the molecular level and protein molecules are the major absorbers. So the skin surfaces may remain cool while underlying structures are heated. This unique characteristic of ultrasound made an ideal therapeutic option for treating sports insures, that occur at the nerves, ligaments, tendons, joint capsules, muscles and all tissues with a high protein component and high coefficients of ultrasound absorption.
- Blood vessels in the path of the interacting waves could also suffer thermal damage. When periosteum is overheated, pain results.
- Thermal damage can be avoided by using low intensities and by steadily moving the sound head over an area close to the skin surface.

3. Chemical effects

- Ultrasound waves result alternating cycles of compression and rarefaction in the area through which it passes.
- Rarefaction (areas of decreased density and pressure) forms air bubbles in the blood or tissues fluids and expand because of the decrease in pressure. During expansion, gas enters into the bubble.
- In compression phase (increased density and pressure), gas is flown out of the bubbles.
- Rarefaction and compression phase results in the gaseous exchange, which exerts mechanical stress on the surrounding called cavitations.
- Ultrasound therapy with the therapeutic range produces stable cavitations. Stable cavitations has multifactorial benefits:
  - (*i*) It increases cell permeability
  - (*ii*) It has electrolytic effect
  - (*iii*) Useful in the breaking up of calcified deposits
  - (*iv*) Increasing in the extensibility of fibrous capsule.
- Ultrasound of higher frequencies produces unstable cavitations, which causes collapse of bubbles under the influence of changing pressures. Thus, high temperature and pressure is created which can damage the cell and produce free radicals.
- **Acoustic streaming/micro streaming/micro massage:** Another important mechanism of ultrasound which is therapeutically valuable. Ultrasound when passes through, liquid flow along the cell membranes pushed by the pressures of the sound wave. Thus, diffusion of ions and metabolites across the membrane improves. Change in membrane permeability to sodium ions could be involved in the altered electrical activity in nerves, resulting in pain relief. Exchange of sodium and calcium probably helps in reduction of muscle spasm.

4. Indications

- Ultrasound is very useful to get rid of stiffness and a decrease in flexibility of skeletal muscle.
- It improves range of motion of the joint- ultrasound has more affinity towards collagen tissues. Joint capsule is rich in collagen. Because ultrasound selectively heats this type of tissue, it is the ideal modality for pre-stretch heating.

- Ultrasound also improves circulation to the scar tissue as it is rich in collagen
- Ultrasound therapy decreases pain and muscle spasm. It is reported that ultrasound therapy can be used successfully on painful neuromas, in back pain and herniated intervertebral disc syndrome.
- Ultrasound therapy stimulates the resorption of calcium deposits (*e.g.* splints, spondylosis).
- Ultrasound stimulates tissue repair by acoustic streaming and promoting the healing of pressure sores by increasing the rate of protein synthesis by fibroblasts and increased lysosomal activity.

Technique : The area to be treated should be clipped/shaved and cleaned. Ultrasound gels (coupling agents) are applied liberally and sound head is placed over the skin. After setting required frequency and time, sound head must keep on moving slowly over the target area.

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CHAPTER

12

Advanced Imaging Techniques

COMPUTED TOMOGRAPHY (CT) SCAN

Computed Tomography (CT) scan or Computer **Axial Tomography** (CAT) scan utilizes rotating X-rays around the part to be examined to make cross-sectional. Both two and three-dimensional images are reconstructed from the acquired CT data around a single axis of rotation. The first clinical CT scanner was built and installed at Atkinson-Morley Hospital in England in September 1971. General anesthesia or deep sedation in small animal patients is utilized along with various foam positioning devices for proper positioning. In CT, the source/detector makes a complete 360-degree rotation about the subject obtaining a complete set of data from which images may be reconstructed.

Advantages

- CT has become an important tool in medical imaging to supplement X-rays and medical ultrasonography. CT completely eliminates the superimposition of images of structures outside the area of interest.
- CT scanning is very useful as it can construct a detailed 3-D image of parts to be examine in contrast conventional radiography suffers from the collapsing of 3D structures onto a 2D image. Scan can be viewed as images in the axial, coronal, or sagittal planes, depending on the diagnostic task. This is referred to as multiplanar reformatted imaging.
- Soft tissues, blood vessels, the lungs, the brain, abdomen, and bones are well visualized by CT scanning. Although resolution is lower in CT, it has extremely good low contrast resolution, enabling the detection of very small changes tissue type.
- Although it is still quite expensive, it is the gold standard in the diagnosis of a large number of different disease entities.

A CT scan can also provide valuable data on the patient's vascular condition.

Development of CT scan

1st generation (1971; single beam, translate-rotate)

- Cranial side of the body was placed via a rubber membrane into a water-filled box.
- In this device, the water-filled box rotated (in 1° increments) along with the single-narrow-beam, single-detector assembly, resulting in a fixed path length through patient plus water for all rays and transmission measurements.

2nd generation (1974; multiple beam, translate rotate)

- Basic design is same as first-generation design, with scan times of 5–6 min.
- As in the first generation, used rotate–translate motion but second-generation CT used multiple narrow beams and multiple detectors.
- Artifacts were severe because of Translation motion. Even small deviations (because of vibrations or other misalignments) of scanner hardware position relative to reconstruction matrix voxels would cause data to be back projected through the wrong voxels.

3rd generation (late 1975)

- 3rd generation CT is characterized by linked tube–detector arrays undergoing only rotational motion, is known as third-generation geometry.
- Scan in less than 5 seconds.
- Uses an array of detectors and accomplished by widening the X-ray beam into a fanbeam encompassing the entire patient width and to intercept the beam.
- The detector array is rigidly linked to the X-ray tube, so that both the tube and the detectors rotate together around the part of interest.
- Numerous detectors are used (~250 for the initial models and 750 or more in later designs) to allow a sufficient number of measurements to be made across the scan circle.
- ring artifacts in third-generation CT images are minimized by high-quality detector design and daily maintenance (calibration).

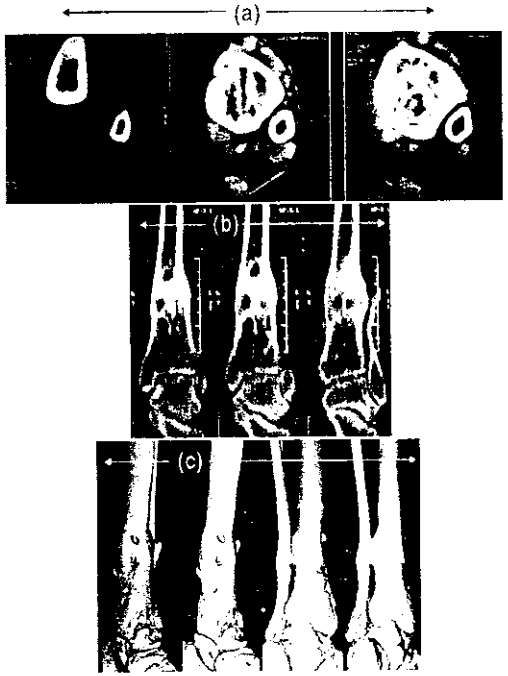
4th generation (1976)

- A large stationary ring of detectors, with the X-ray tube alone rotating around the patient.
- Unlike third-generation detectors, each fourth-generation detector can measure rays at any distance from the center of rotation and can be dynamically calibrated before it passes into the patient's shadow, so that ring artifacts are not a problem.

MULTISLICE CT (MSCT)

Multislice CT may be 4-slice, 16-slice, 32 or 64 slice CT scanner. Multislice CT is very fast and with increased speed (with more volume coverage) excellent opportunities for dedicated 2D and 3D visualisation, and post-processing is achieved. However, specific artefacts (multislice artefacts, cone-beam artefacts) and increased contribution to patient dose due to reduced geometric efficiency and more prominent impact of the additional tube rotations necessary before and after data acquisition over the planned scan range are few disadvantages of it. Survey exams in oncologic or trauma patients and the characterization of focal lung and liver lesions through the creation of thin sections retrospectively is now reality with the advent of MSCT.





However, the greatest impact has been on CT angiography, cardiac imaging, virtual endoscopy, and high resolution imaging. In recent advances, MSCT capable of acquiring four channels of helical data simultaneously, thus greatest incremental gain in scan speed since the development of helical CT and have profound implications for clinical CT scanning is achieved. Fundamental advantages of MSCT include shorter acquisition times, retrospective creation of thinner or thicker sections from the same raw data, and improved three-dimensional rendering with diminished helical artifacts.



MAGNETIC RESONANCE IMAGING

Magnetic Resonance Imaging (MRI), nuclear magnetic resonance imaging (NMRI), or magnetic resonance tomography (MRT) is a medical imaging technique to visualize internal structures of the body by using the property of nuclear magnetic resonance to image nuclei of atoms inside the body.

Basics : It is a device in which the patient is placed within the magnetic field of very large and powerful magnet which in turn align some atomic nuclei in the body by magnetization and radio frequency(RF) magnetic fields are applied systematically to alter the alignment of this magnetization. Thus nuclei produce a rotating magnetic field detectable by the scanner and which (information) is

recorded to construct an image of the area of interest (scanned area of the body). In different body parts, variable magnetic field gradients are created and Fourier analysis of the measured signal draws spatial information. By using this variable magnetic field gradients in different directions, 2D images or 3D volumes are constructed.

Advantages

- MRI provides good contrast between the different soft tissues of the body, which makes it especially useful in imaging the brain, muscles, the heart, and cancers compared with other medical imaging techniques such as computed tomography (CT) or X-rays.
- Unlike CT scans or traditional X-rays, MRI systems do not use ionizing radiation
- MRI can image in any plane. In contrast CT scans are limited to one plane, the axial plane.

Disadvantages

- Pets with pacemakers cannot have MRIs.
- The machine makes a tremendous amount of noise (continual, rapid hammering) during a scan.
- Noise arises due to electrical current in the wires of the gradient magnets being opposed by the main magnetic field.
- MRI scans require longer time of about 20 minutes to 90 minutes or more.
- Even very slight movement of the part being scanned cause motion unsharpness like images which means the scanning will need to be repeated.
- Metallic orthopaedic implants like plates. Screws, wires, prosthetic joints in the area of a scan can cause distortions of the images.
- MRI is expensive.

ECHOCARDIOGRAPHY

- Echocardiography or cardiac ultrasound has added a new dimension in the evaluation of cardiac function and diseases.
- It is useful in hemodynamic assessment and diagnosis of many anatomic and functional disorders of the heart like congenital disorders of the heart valves, various shunts and complex malformation, acquired diseases and congestive heart failure including valvular disease, cardiomyopathy, endocarditis, pericardial diseases, cardiac neoplasia and cor pulmonale.
- Occult or unsuspected heart disease is occasionally detected during scanning even when physical diagnosis or other laboratory tests are negative or equivocal.
- The modern echocardiographic examination includes not only transthoracic two-dimensional and M-mode imaging, but also various Doppler studies.
- The modality has largely supplanted cardiac catheterization, angiocardiography and other invasive studies of cardiac disease and function.

TWO—DIMENSIONAL ELECTROCARDIOGRAM (REAL-TIME B-MODE)

- Commonly used to examine the heart, blood vessels, soft tissues and thoracic viscera.

- It offers substantial anatomic information while serving as the template used to guide M-mode, saline contrast and Doppler studies.
- The technique is simple, easy to learn and the cost of the instrument is within the reach. However, it is unable to detect abnormal blood flow and other functional cardiac abnormality.
- It can estimate hemodynamic overload (dilatation of hypertrophy) indirectly from detection of chamber enlargement, hypertrophy, abnormal valve movements or altered ventricular septal motion.
- Dilatation of the great vessels can also be detected.
- Besides, it can detect ventricular ejection fraction from volume estimates.

M-MODE ECHOCARDIOGRAM

- This is a less intuitive imaging modality generated by a single line of B-mode ultrasound.
- Its interpretation requires a preconceived knowledge of this graphical imaging technology.
- It is valuable for quantifying heart size and left ventricular function, imaging moving structures using a high sampling rate and, when combined with color-coded Doppler, accurately timing flow events.
- Most B-mode sector scanners either contain M-mode hardware and software or can be adapted to perform this study.
- An electrocardiography (ECG) module also is important whenever such graphic formats are to be recorded or interpreted.
- Like B-mode, it can detect hemodynamic overload indirectly and unable to detect abnormal blood flow. Assessment of ventricular function can be done on the basis of left ventricular shortening fraction; velocity of circumferential fiber shortening; systolic time intervals: mitral valve E-point to septal separation.

DOPPLER ECHOCARDIOGRAPHY

- This modality is most advanced as well as expensive one.
- Based on the theory of Christian Doppler (1842) that the frequency of a wave changes between a moving wave source and the target.
- Doppler effect, occur usually between a stationary transducer transmitting and receiving sound and the blood cells as moving reflectors.
- It offered the clinician with quantitative information about pathologic changes and homodynamic parameters and is complementary to data provided by M-mode and B-mode real time studies.
- Doppler works on Doppler principle to the processing of reflected ultrasound waves.
- The principal value of these studies is the delineation of the direction and velocity of blood flow in the heart and great vessels.
- Position and angle of the transducer has to be adjusted in order to keep the Doppler angle below 60°.
- Different types of Doppler scans include pulse wave, continuous wave, high-pulse repetition frequency (HPRF) pulse wave, Duplex Doppler, power Doppler and color-coded Doppler.

- Doppler instruments also are programmed to identify turbulent flow. Because most cardiovascular lesions cause abnormalities in blood flow direction or velocity, the Doppler study can be used to demonstrate the cause of a heart murmur, assess systolic and diastolic cardiac function and quantify the severity of the condition.

Pulsed wave Doppler

- Sound is transmitted in short pulses and received by the same crystal during the time interval between emissions of pulses.
- Detects hemodynamic overload indirectly from abnormal blood flow patterns and has the limitation of inability to quantify high velocity signals.

Continuous wave Doppler

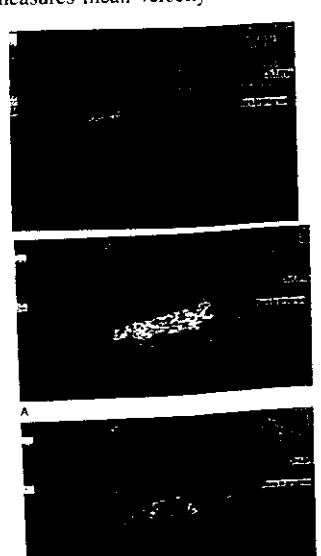
- Here one crystal transmits and the other receives sound continuously.
- Excellent for recording high velocity flow and estimating pressure gradients.

Duplex Doppler

- Phased array and linear array transducers allow the cursor and sample volume to be placed using B-mode image as a guide and also to record a B-mode image simultaneously with Doppler spectrum.

Color Doppler

- Doppler mean shift frequencies in a specific area are measured, colour coded and superimposed over the 2-D gray scale image.
- Direction and velocities of flow in a large area can be displayed using various colours for the direction and velocity of flow, e.g. red, orange, yellow for flow towards the transducer, blue and green for flow away from the transducer.
- Colour Doppler only measures mean velocity.



Power Doppler

- Used mainly in abdominal or small part imaging where low blood velocity is encountered.

Scanning approaches

- Clip the area of chest wall over the heart and apply gel.
- Locate left and right cardiac windows just caudal to elbow.
- Pull forward the forelimb on the side to be imaged for better exposure.
- Put a pillow, rolled up towel or sponge wedge beneath the patient for better transducer placement.
- Direct the transducer downward toward the chest wall, which is on the upper side of the patient.
- Approach from the dependent side by directing the transducer upward from beneath the table level may be done.
- Imaging of a patient in sternal or in standing position may also be done in large animal.
- Standard views are obtained in both long-axis and short-axis direction.

CONTRAST ECHOCARDIOGRAPHY

- Injection of an echocontrast (microbubbles based on albumin microcapsulated particles or galactose microparticles) into a peripheral vein, appearance of the bubbles on 2-D image as small echogenic dots is the basis of the technique.
- Most sensitive method for detecting even small right-to-left cardiac shunts.
- Safe method.

NUCLEAR MEDICINE (SCINTIGRAPHY)

- A highly sensitive imaging procedure in which radioisotopes are used to detect functional status of the body systems.
- The principle of Nuclear Medicine is based on the use of a pharmaceutical labeled with an isotope that after entry into the blood stream gets localized in a particular tissue or organ.
- The localization of the isotope can then be detected by using a detector or gamma camera (scintillation camera) due to emission of gamma rays from the area of interest.
- Sodium iodide crystal is used which absorbs gamma rays emitted by the radioisotope from the organ and converts it into light flushes.
- A computer system is usually attached to the camera for gathering data and its display and quantification.
- Many pharmaceuticals are available for organ imaging (e.g. pyrophosphate or methylene diphosphate for bone; macro aggregated albumen for lung perfusion.)
- Most commonly used radioisotope is Technetium-99 m. This isotope has the advantage of a short half-life of 6 hrs and thus animal can be discharged next day after the scan. Additionally radiation exposure to the animal and attending personnel is minimal.
- A scan appears as an image formed of dot. The interpretation is based on the appearance of increased (hot spots) decreased (cold spot) radioactivity regions.

- Scintigraphy has been used to detect functional status of kidney, liver, G.I. Tract, lung, thyroid, bone, brain etc.
- Scanning of bone is most commonly used by this modality.
- The limitations are high cost, safety measures, etiological non-specificity and difficulty in interpretation especially in skeletal system.
- Radiation safety measures are to be adopted to minimize the potential hazards of radiation.

GAMMA CAMERA

The **gamma camera**, also called a scintillation camera or Anger camera is a huge radiation detector, like a Geiger counter and is used in nuclear imaging. It detects radioactive areas of the body and outlines an image or picture of the pattern of radioactivity on X-ray film. The picture looks like a shadow outline of the pet with a bright area where radioactive activity is detected. When a radioactive substance is taken up by a certain type of tissue either by injection or introduction into the body, it travels to the selected organ and then can be detected by the camera.

A gamma camera consists of one or more flat crystal planes (or detectors) optically attached to an array of photomultiplier tubes (called "head"), mounted on a gantry. The gantry is connected to a computer system that both controls the operation of the camera as well as acquisition and storage of acquired images.

Use of camera

- Used frequently in horses to detect tendon, ligament and bone injuries. Injured tissue that is inflamed and has a greater blood flow. Radioactive substances if given intravenously are used by these tissues and will appear in greater amounts in inflamed tissue enabling pinpoint diagnosis of lameness vis-à-vis its subsequent treatment.
- Another use of this technology is in the detection of portocaval shunts i.e. abnormal vessels that are small and difficult to detect by ultrasound and other means.

Gamma camera imaging needs small amount of radioactive substance, making this technology no more dangerous than an X-ray, which also uses radiation. It is a very safe and simple way to diagnose otherwise difficult to diagnose conditions.

XERORADIOGRAPHY

Xeroradiography ('xero' means dry in Greek) is another form of electronic radiography in which image of the part to be radiographed is recorded on paper rather than on film. In this technique, a plate of selenium, which rests on a thin layer of aluminium oxide, is charged uniformly by passing it in front of a 'scorotron'. As X-ray photon impinges on this amorphous coat of selenium, charges diffuse out, in proportion to energy content of the X-ray. This occurs as a result of photoconduction. The resulting imprint, in the form of charge distribution on the plate, attracts toner particles, which is then transferred to reusable paper plates. In contrast to conventional X-rays, photographic developers are not needed. No special skills are required for xeroradiographic process. Dark room requirements are unnecessary, and the entire process are very short, may be completed within 60 seconds. The process also allows multiple copies simultaneously.

Advantages

- Elimination of accidental film exposure- Because large light intensity is required for photoconduction.
- High resolution.
- Higher latitude of exposure factors with chances of incorrect exposure are highly less because little image quality change in xeroradiography require large kilo-voltage variations. no need to make multiple exposures as tissues of different densities and thicknesses can be recorded in one exposure.
- Better ease and speed of production.
- Economic benefit—Xeroradiograph is the most cost effective compared to either automat processing or manual processing.
- Wide applications—apart from routine applications it can be used for specialized applications like management of neoplasm of laryngopharyngeal area, mammary and joint region, as well as an aid in cephalometric analysis.

Disadvantages

- Technical difficulties.
- Fragile selenium coat-The selenium photoconductor layer is a highly electrically stable but the layer is quite easily scratched.
- Transient Image Retention xeroradiographic process involves residual charge patterns and therefore, the imaging process should be completed as soon as possible.
- Technical limitations-low density of the selenium plate which requires increased doses of the X-rays administered make the technique not to be considered as a total substitute for halide radiograph.

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UNIT 4

HEAD AND NECK

CHAPTER 1

Affections of the Lips and Cheek and Their Treatment

Hare lip (Chiloschisis)

Hare lip is a congenital disorder, rarely observed in domestic and pet animals. This condition is associated with running of cleft in upper lip into the nostril. This may be unilateral or bilateral and may exist alone or be accompanied by cleft plate or split jaw. There is difficulty in feeding and if the nostril and hard palate are affected, the milk may run through the nostrils.

Treatment of this condition is not promising and only may attempt to satisfy the sentiments of owners. Surgical operation involves incising a thin slice of tissue from lip edges and subsequent suturing of both skin edges with non-absorbable suture materials.

Ulceration of the lip

Ulceration of the lip is occasionally encountered in cat where a considerable portion of the lip is damaged exposing the teeth and gums. It starts at the free border, in the centre or to one side of the middle line. This condition causes pain and toxaemia followed by emaciation and death.

Treatment of this condition is directed to isolate the animal and application of tincture iodine or the stick of lunar caustic at the ulcerated site.

Retraction of the lip

Retraction of the lip generally develops due to cicatrical contraction caused by injury and subsequent development of much fibrous tissue between the lip and gum that prevents its meeting the other one.

Treatment of this condition includes:

- Surgical incision between the gum and lip for greater mobility of lip and allow it to move down or up.
- Some new tissues may be removed by making two parallel incision transversely between the lip and jaw and finally excising the intervening portion.

Tumours

Papilloma or warts are the commonly encountered neoplasm on the lip of horse and dog. Multiple papillomas are formed in the buccal mucous membranes and gums in dog, which is contagious in nature. Besides, malignant tumour like epithelioma frequently develops on the lip of the dogs. It starts as a small swelling, which soon ulcerates and extends rapidly into the surrounding area involving bone also. The neighbouring lymphatic glands are also affected. There is salivation and usually an offensive foul smell comes from the mouth due to decomposition of food adhered to the affected area and discharges from the tumourous mass.

Treatment of this condition includes:

- Surgical excision of large warts and subsequent application of astringent mouth wash.
- Small epithelioma confined to the lip only may be excised by a V-shaped incision.
- Well-developed epithelioma should not be excised as there is a chance of recurrence. Radiotherapy may be tried for such situation with promising results in localized tumours.

Traumatic lesions

Trauma in cheek occurs most commonly in cattle, dog, and horse but is also found in other animals. The cheek, jowl and lip may be wounded by the sharp molars or incisor teeth, fragments of fractured bone of jaw, bits, foreign bodies accidentally ingested with the food such as nails, fish-hooks, needles etc. The wounds may be complicated when important vessel or nerve is injured.

Signs

- The animals feel difficulty in taking feed.
- Trickles of saliva from the mouth.
- The dogs rub his paws against the jaw to dislodge the foreign object.

Treatment

- Mostly, ordinary wounds heal rapidly and spontaneously, only to clean the mouth after feeding is necessary.
- A foreign body must be removed and discontinue the offending bit.
- Food requiring little mastication should be provided.
- Haemorrhage, if any from artery must be ligated.

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CHAPTER

2

Affections of Tongue and Their Treatment

Strangulation

Strangulation of the free portion of the tongue has been made to control vicious horse by tying a string round it or by fixing it in cord round the lower jaw. The free portion of tongue in front of ligature becomes swollen and cyanotic from venous engorgement. If the ligature is not removed within 24 hours, the portion will undergo necrosis due to arrest of blood supply to the area.

Treatment of this condition includes:

- To remove ligature and scarify the swelling on the dorsal part to prevent pressure necrosis.
- To control venous bleeding due to incision, application of a thick layer of flour on the dorsal linguae is necessary and subsequently keeping the jaws strapped together by a tight nose-band for a few hours.

Smooth tongue

Smooth tongue is a congenital anomaly and occasional cases are reported in Holstein-Friesian and Brown Swiss cattle. This condition is associated with either presence of small or absence of horne papillae on the dorsal surface of tongue, leading to smooth appearance. The calves feel difficulty in prehension particularly when they are put to grazing field. As a result, the animal gradually looses body condition and growth is retarded.

Treatment of this condition is not promising and hence not indicated.

Tumours of tongue

Tumours of tongue are rarely observed in ruminants and pet animals. In rare instances, fibroma, angioma and lipoma may affect the tongue. Epithelioma usually also affects the tongue and in dog, contagious papilloma of the mouth appear in the tongue.

Clinical signs include difficulty in mastication, salivation, dysphagia, and quidding (partially chewed food materials mixed with saliva, drop out from mouth). On inspection of the mouth, blood stained discharge from the ulcerated tumour is a usual feature.

Treatment of malignant tumours should not be interfered as there is a chance of recurrence. If the tumour involves the anterior portion of the tongue, amputation of free portion of tongue is indicated.

Ranula

Ranula is a mucocele occurring on the floor of the mouth alongside the tongue close to frenum linguae. This is frequently seen in dogs, less frequently in other animals in association with a cervical mucocele. It originates from the ducts of the sublingual salivary gland. The presence of cyst interferes with mastication and swallowing. The cyst is non-inflammatory and there is salivation.

Treatment of this condition is directed to incise the cyst and place a drain in the area of mucocele to allow fluid to escape from the area until it has a chance to heal. Tincture iodine may be touched in the cyst wall to destroy its lining and to prevent further accumulation of cystic fluid.



Ranula in a buffalo
Courtsey by Dr. A. Patil

Snake bite

Snake bites are commonly encountered in animals. All snakes are not poisonous, only a very few of them are poisonous like cobra, krait and viper. Snake venoms are of two types : **neurotoxins** acts on the nervous system *e.g.* venom of cobra and krait and **cytolysin and haemorrhagin** acts on the cardiovascular system. In all cases the severity of the bite depends on the location and amount of toxin injected, the size of the animal bitten, and the specific toxicity of the venom. Depth of venom penetration is dependent on the length of the snake's fangs and the presence of "spreading factors". Mortality in horses bitten by rattlesnakes has been reported at 10-30% and often occurs 5-7 days past envenomation due to secondary complications, *e.g.*, myopathy and hepatopathy.

Clinical signs

- When venom (pit viper) is injected into the tissues, pain, erythema, and edema develop as a result of the activation of bradykinins, histamine, and other inflammatory mediators. Swelling may become extensive and may be accompanied by paetechia, ecchymosis, and haematomas.
- If signs of erythema and edema do not occur within 20 minutes, envenomation has probably not occurred; however, it is possible in a minority of cases to have systemic signs without local involvement.
- Systemic signs (in dogs) are noted as the clinical course continues; these include hypotension with tachycardia, pulmonary edema, salivation, diarrhoea, renal failure, and shock. Cardiac arrhythmias include premature ventricular contractions and ventricular tachycardia has been commonly reported. After a few hours hemolytic anemia often develops. In advanced cases, lethargy and paralysis develop. Death is due to respiratory and circulatory collapse.
- If strikes occur in the head and neck region, local swelling with secondary respiratory distress may be noted.
- Clinical signs in horses include initial excitement, anxiety, and pain. May act colicky. Lameness in all animals may be an early clinical sign.

Neurotoxic signs include lethargy, tremors and incoordination.

Treatment. Snake bite is an urgent emergency. In some cases, it is lethal; in many it c cause prolonged and disfiguring injury. The **objectives** of therapy are to neutralize the veno prevent shock, and prevent secondary infections; and sometimes to prevent the further spread toxins, and remove the venom. The use of alcohol to clean the wound is contraindicated becau of its vasodilatory effect, which would promote uptake and spread of venom.

- The rational treatment is to administer **antivenin** slowly, mixed in fluid, as a dr Antihistamines (such as diphenhydramine) may be used to offset allergic reactions.
- **Antibiotics**: The prophylactic use of antibiotics is indicated. Broad spectrum antibioti are commonly chosen.
- **Respiratory assistance** (ventilator) may be needed for 48-72 hours for animals wi coral snake poisoning.
- **Fluid therapy:** Generally indicated in small animals. Hypotension is a common presenti sign.
- **Corticosteroids**: Use is controversial. Useful in treating shock but increases in mortali have been reported with their use. It is generally used for prevention of shock a hypotension but may not affect local swelling.
- **Transfusions**: Commonly indicated in dogs, if necessary, to treat anemia and haemorrhag
- **Supportive**: The maintenance of a patent airway is critical. Large diameter tubing opened syringe cases are commonly placed in the nostrils of horses bitten on the fa to keep the airways open. Emergency tracheotomy may be required. Tranquilization horses may be required.
- **Tetanus antitoxin** should **always** be given to the horse.

Trauma

Trauma to the tongue usually occurs in cattle, buffaloes and dogs caused by thorns, barbe wire, sharp teeth and accidental ingestion of certain foreign bodies. The affected animals feel pa and reluctant to eat. There is excessive salivation which is often mixed with blood.

Treatment of this condition includes through washing of the mouth with light potassiu permanganate solution and consequent application of local antimicrobial solutions. Soft liqui diet at least for a week is recommended.

Gangrene

Gangrene of the tongue is sometimes seen in animals especially in dogs accompanyin with gangrenous stomatitis. **Clinical signs** include offensive odour from mouth, greenis and shriveled appearance of tongue. In general, it is restricted to the anterior portion of th tongue.

Treatment includes frequent irrigation of the mouth with hydrogen peroxide or potassiu permanganate solution until the dead part is separated.

Sublingual abscess

Sublingual abscess is occasionally seen beneath the tongue. There is a swelling on the floo of the mouth in the intermaxillary space. **Clinical signs** include salivation and difficulty in eating

Treatment consists of opening the abscess in the intermaxillary space and draining the pu material by washing the mouth with light anti-septic solutions.

Glossoplegia

Glossoplegia or paralysis of the tongue may occur due to involvement of hypoglossal nerve, but is a rare incidence. The condition may develop during the course of an infectious disease, such as distemper, chronic pleuropneumonia or in association with acute pharyngitis. Besides, it may occur due to trauma resulting from a wound or excessive traction of tongue. The prognosis in deplegia cases is grave.

Signs

- The tongue becomes flaccid and hangs out of the mouth.
- In unilateral paralysis, the tongue is deviated towards the non-affected side.

Treatment

- In true glossoplegia, treatment should be made as for paralysis in general. The response of treatment in this case will take longer time.

If it is due to acute pharyngitis, systemic administration of antibiotics and corticosteroid produces promising recovery within a few days.

Actinobacillosis

Actinobacillosis is the most common clinical condition in cattle and buffaloes and occasionai in sheep, goat and other domestic animals. This condition is characterized by one or more swellings in the submandibular region along with inflammation of the affected tissue. There may be involvement of tongue in cattle, rarely in other ruminants.



Actinobacillosis in a heifer

Signs

- In advanced cases, there is difficulty in mastication and swallowing.
- In more advanced cases, there is swelling of entire throat region along with inflammation of pharyngeal lymph node leading to dysphagia and dyspnoea.
- Discharge of yellowish pus material from the ruptured swelling.

Treatment

- Maturation of hard abscess with counter-irritant and hot fomentations is indicated followed by draining of matured abscess.
- Systemic administration of potassium iodide is still considered effective therapeutic protocol of this condition. In bovine @ 6-10 grams orally for 7-10 days or 10% sodium iodine (1 gm/12 kg) as single intravenous injection is routinely used.
- Surgical excision of large tumorous growth is indicated.
- A course of antibiotic like Streptopenicillin for 7-10 days should be administered.
- Iodized glycerin or boroglycerin may be smeared in involvement of gum, lips and tongue.

Milk suckling (surgical treatment)

Milk suckling is the interference with the ability to suckle milk and may enter the nasal cavity due to involvement of lip and premaxilla (primary cleft palate).

Surgical treatment

Position of animal : The animal should be placed in ventral recumbency and the head elevated on a cushion under the mandible which provides good surgical access to the lips. Oral speculum may be used in involvement of premaxilla.

Operation technique : The hair on the muzzle is clipped and the skin is prepared for surgery. The edges of the cleft defect are incised to a depth of 2 to 3 mm along the entire margin of the defect to create an inner mucosal layer and outer cutaneous layer. The mucosal edges are apposed starting from the most dorsal point with interrupted absorbable sutures. Attempt should be made to appose the tissue without tension. Skin should be closed starting from the lip margin to avoid step deformity using non-absorbable suture material in interrupted fashion. In case of involvement of premaxilla, closure is troublesome. Mucosal flaps based on nasal or oral mucosa are elevated from each side of the defect and are sutured together with fine absorbable suture material. Generally two layer closures are preferred but due to insufficient tissue, one layer closure is performed. In one layer closure, the nasal epithelial side should be reconstructed and the oral mucosal side is allowed to heal by second intension. Finally lip closure should be performed as per the method described earlier.

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CHAPTER

3

Affections of Palate and Treatment

Lampas

Lampas is an inflammatory thickening of the mucous membrane of the hard palate appearing as a ridge immediately behind the upper incisors. This condition is commonly observed in horses when the incisors are erupting. Pain is evidenced when biting hard feedstuffs.

Treatment of this condition is directed to scarify the mucous membrane. Soft foods should be offered to minimize pain during chewing.

Cleft palate

Cleft palate, a congenital disorder occurs in all species and perhaps most commonly observed in brachycephalic breeds of canine. It is a rare condition to find in a weanling or yearling, as usually the accompanying problems of chronic nasal discharge and pneumonia lead its diagnosis as a neonate or young foal. The animal with cleft palate condition should not be used for future breeding purposes.



Cleft palate in a dog

Etiology

- Nutritional, hormonal and mechanical factors are responsible as incrinating cause but these factors are not the cause. likely affect the severity of the cleft in predisposed animals.
- Genetic and stress factors are also responsible for this condition.
- Intrauterine infection and exposure to toxins at specific periods of gestation may also lead to this situation.

Signs

- Food material passes to the nostrils on expiration and to the pharynx on inspiration.
- In early stages of life, rhinitis or pneumonia occurs.
- Milk or food in the nasal cavity frequently causes sneezing or gaggling.

- In some cases, the animal is unable to create a negative pressure in the mouth and may lead to death by starvation.

Treatment : Surgical reconstruction of cleft palate condition is indicated by pedicle flaps of palatine mucosa.

Palatine tumours

Palatine tumours like malignant melanoma, squamous cell carcinoma and fibrosarcoma are commonly encountered neoplasms in dog and cat although melanoma and fibrosarcoma are rare in cat. Malignant melanomas arise from the gingival and palatine epithelium (hard palate) and infiltrate the underlying bone. The tumour is usually ulcerated and may bulge into the oral cavity. Incidence of fibrosarcoma of palate is higher in larger breed dogs and in male as compared to female. Squamous cell carcinoma is locally invasive and cause lysis of bone.



Palatine tumour in a dog

Clinical signs

- Slow progressive facial swelling.
- Abnormal salivation.
- Oral haemorrhage.
- Difficulty in eating.

Treatment. Early detection, diagnosis and treatment are essential in the management of oral tumors. Surgery is the most effective mode of therapy for treating most oral neoplasms. Sharp dissection rather than electrocautery should be utilized when incising palatal mucosa to minimize postoperative dehiscence. Fibrosarcoma is a better candidate to radical surgical excision because of its lower metastatic rates. Local recurrence is very common if excision is not performed in a radical manner. Cryosurgery is a good therapeutic option because the ice ball can reach areas of alveolar bone and destroy malignant cells that could not be found using other methods and could be the cause of local recurrence.

Protrusion and strangulation of soft palate in camel

Protrusion of well developed soft palate from the oral cavity occurs in male camel while creating oral sounds. Sometimes, there may be injury of this distended and protruded soft palate due to sharp molars or canine teeth of the same animal and external violence due to fighting between two animals. As a consequence of injury, the walls of soft palate may perforate, cause rupture of blood vessels and ultimately leading to submucosal haematoma. Soft palate becomes infected due to entry of microbes. If the soft palate still protruded outside, blood supply is seriously compromised leading to necrosis and gangrene.

Treatment of this condition consists of surgical excision of the affected part of the soft palate. Under sedation with xylazine hydrochloride and restraining in sternal recumbency, the mouth of the animal is opened. The soft palate is taken out by pulling the tongue and dissected laterally from both sides beginning from the rostral dorsal attachment. Postoperatively, the oral cavity is flushed with warm normal saline solution followed by light antiseptic solution like potassium permanganate. A course of antibiotic for 5 to 7 days is indicated. The animal should be offered succulent type of feed at least for 2 weeks.

CHAPTER 4

Affections of Nose and Treatment

Atheroma

Atheroma *i.e.* epidermal inclusion cyst is an uncommon abnormality that is most frequently observed in the nasal passage of yearling. This is a small fluctuant mass that occurs unilaterally (rarely bilaterally) at the caudal aspect of false nostril. It is observed externally as a small swelling in this area. In general, this does not obstruct the airway but sometimes causes partial encroachment of the nasal passage resulting to nasal respiratory noise.

Treatment of this condition is directed to incise the cystic swelling, evacuate its contents and swabbing its lining with Tincture of iodine or any irritating solutions. Care should be taken that the irritant does not come in contact with the mucous membrane of the nose. Complete removal of the cyst by surgical operation provides permanent cure of this condition.

Nasal polyps

Nasal polyps, the commonly encountered neoplasms of this region are found in horse, cattle and dog. Polyp is fibrous and benign in nature, mainly composed of inflammatory cells. Polyps arise due to a chronic inflammatory process associated with chronic irritation due to certain infectious diseases. Besides, focal accumulation of oedema fluid in nose mucosa with hyperplasia of the associated submucosal connective tissue is another causative factor. The growths are commonly attached to the lateral wall and rarely to the nasal septum. Apart from nasal polyps, various tumours like papilloma, lipoma, myxoma, sarcoma etc. may affect the nasal chambers in the domesticated animals.

Signs

- Mucoid or mucopurulent nasal discharge may come from nose.
- Bleeding from nose (Epistaxis).
- There may be frequent sneezing, restlessness and may rub its nostrils against the ground.
- Occasionally more or less complete obstruction of bilateral nasal passage resulting to respiratory difficulty and exhibits mouth breathing.
- Deformity of face due to bulging of the nasal bones and atrophy of the turbinates.

Treatment

- Polyps can be excised by sharp dissection or by electrocautery. Haemorrhage is controlled by plugging the nasal cavity with adrenalin soaked gauze. The gauze may be changed after 24 hours.

- But removed after 48 hours. Complete surgical removal is very unlikely, should be so chances of recurrence are common. Prognosis of such cases is guarded.
- When the polyps extend up to the caudal aspect of the nasal septum, trephining of the nasal bones is indicated.
- Complete surgical removal of malignant tumour is impossible, so chemotherapy or radiation therapy must be considered.
- In case of bilateral and multiple benign tumours, surgical removal is impracticable. Tracheotomy should be performed in such cases to increase the usefulness of the animal.

Resection of the nasal septum

The nasal cavity is separated into two halves by the **nasal septum** which is mostly cartilaginous, but has bony and membranous portion. Diseases of the nasal septum are rare and are caused by abnormalities, traumatic injury or "cystic" degeneration and squamous cell carcinoma. Deformity of the nasal septum usually as part of the "wry nose" syndrome, can cause an airflow obstruction.

The animal is placed in dorsal recumbency. An incision is made in the skin and continued through the nasal cartilages, bone and turbinates. The entire diseased portion of the septum can be removed most effectively and quickly by using obstetrical wire to make the dorsal, ventral and caudal cuts. Copious haemorrhage is to be controlled by packing the nasal passage with sterile gauge soaked in saline or in 1:100,000 epinephrine solution. Finally, closure of the wound should be done in routine standard manner. A tracheotomy is generally indicated for proper respiration.

After-care includes parenteral antibiotics and non-steroidal anti-inflammatory drugs. The gauge packing and tracheotomy tube should be removed 48-72 hour after surgery. Healing of the wound generally occurs by second intention within 3 week.

Necrosis of the turbinates

Necrosis of the turbinated bones is occasionally encountered in horse and rarely in other animals. There is accumulation of pus in the folds of the bones as a result of strangles. It may also develop as result of wound caused by injury and consequent localization of infection or may be a complication of disease of the root of a molar tooth in its surroundings.

Signs

- There is foetid purulent discharge from nose.
- Interference in respiration manifested by a roaring noise.
- Swelling in nasal chambers and submaxillary lymphatic glands.
- Finally, there is ulceration and discolouration of the turbinate bone.

Treatment of this condition is directed to remove the necrotic bone by surgical operation. The turbinate is to be severed above and below the affected part with a strong sharp scissors and remove it. Antiseptic powder may be applied once daily into the affected region for healing of the wound area.

Parasites in the nasal chambers

Parasites mainly *Linguatula taenioides* is of frequent occurrence in dog but is rarely observed in horse, sheep and goat. The parasite may lodge in any part of the cavity but most

commonly in the convolutions of the ethmoid and in the cul-de-sac of the middle meatus. Larvae of the parasites usually remained in sheep and rabbit. The dog may become infested by ingestion of the viscera of sheep and rabbit. The parasite may remain for months in the nose, eventually die or expelled out.

Signs

- Presence of numerous parasites in nasal chambers may cause agitation of animals.
- There is sneezing and scratching of nose with paws.
- Mucoid blood tinged discharge may come out of the nose.

Treatment

- Attempts may be made to remove the parasites from the nasal cavity either by forceful sneezing or by triphening.
- Mild irritating solutions like ammonia or benzene may be introduced through the nostrils to dislodge or destroy the parasites.

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CHAPTER

5

Affections and Treatment of Guttural Pouch

Anatomical considerations

The **guttural pouches** are paired extensions of the **Eustachian tubes** that are in co a thin membrane (rostral portion), and through the longus capitis and rectus capitis v muscles (caudal portion). They are covered by a respiratory mucosal tissue, comprising of epithelium, mucus glands, sero-mucosal glands and lymphoid structures. Each guttural p divided ventrally and caudally by the stylohyoid bone into a lateral and a larger medial comp

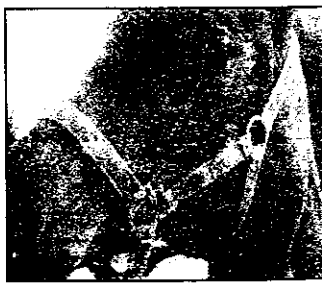
Major nervous structures in close contact with the surfaces of the guttural pouches caudal wall of the medial compartment, the cranial cervical ganglion, the cervical sym trunk, the vagus (X), the accessory (XI), the glossopharyngeal (IX) and its pharyngeal bra hypoglossal nerves.

Empyema

Empyema is a uni-or bilateral accumulation of purulent exudates within the guttura This condition may occurs at any age in horses but usually occurs in young animals.

Etiology

- Consequence of a respiratory tract bacterial infection (*Streptococcus sp, Pasterulla spp*) or the result from the rupture of abscessed retropharyngeal lymph nodes.
- Infection caused by *Pasterulla multocida* is also described.
- It may accompany in cases of guttural pouch tympany, developed after fracture of the base of the cranium or after penetration of a foreign body.



Guttural pouch empyema in h

Clinical signs

- Nasal discharge with discrete packets of blood tinged yellow or whitish muco

- Pus may be of fluid to thick in consistency, with occasional formation of concretions.
- Secondary pharyngitis, coughing and respiratory distress are observed.
- Dorsal displacement of the soft palate, exercise intolerance and dysphagia may be encountered.

Treatment

- Tracheotomy may be necessary with major respiratory distress.
- In acute and mild cases of empyema may resolve in a couple of weeks with systemic administration of antibiotics.
- In other cases, local therapy to provide drainage and lavage is advocated. In clinical situations, two liters of saline solution mixed with povidone iodine and antibiotic may be used. Higher concentration of iodine solutions and topical application of irritating solutions should not be used. The lavage should be done intermittently through indwelling catheters placed into the pouch for a period of one week or more.
- To help drainage, the animal should be sedated during lavage and feed at the ground level.
- In chronic cases, when the exudate is inspissated or concretions have formed, surgical excision through the Viborg's triangle or a Whitehouse approach is indicated.

Chondritis

Chondritis is a progressive inflammatory disease of the laminar portion of arytenoid cartilage that results in exercise intolerance and inspiratory noise produced during exercise. The condition is most often unilateral in nature.

Signs

- Signs of this condition are similar to laryngeal hemiplegia. There is reduced range of abduction of the involved arytenoid cartilage.
- Dyspnoea in resting horse is seen.
- Marked distortion of the rima glottis and laryngeal stenosis in bilateral involvement may occur.

Treatment of this condition depends on the extent of the disease.

- In mild cases, surgical intervention may be delayed that do not require extended exercise capacity.
- In severe cases, [illegible] removal of [illegible] is usually recommended.

Tympanitis

Tympany of guttural pouches is infrequently observed in horses, although it is reported in foals showing [illegible] up to 3 months of age. It is usually unilateral but can be bilateral. The condition is characterized by excessive accumulation of air within one or both guttural pouches. The etiology of this condition is not clearly known but the most likely cause is malfunctioning of structurally abnormal pharyngeal orifice acting as a one way valve, with the flap trapping air inside the guttural pouches.

Clinical signs

- Diffuse, cool to touch and non-painful tympanic swelling of the parotid region.
- Resonance on percussion at the level of the pouch.
- Respiratory noise, dyspnoea, dysphagia, milk in nostril or aspiration pneumonia is observed.
- Escaping of air or gas due to pressure on the pouch produces whistling sound.

Treatment

- ***Conservative therapy*** : This approach provides a temporary relief by introducing percutaneously with a 14G catheter or performing catheterization through the pharyngeal orifice of the guttural pouch to allow air to escape.
- ***Surgical therapy*** : Surgical therapy that allows air to move freely in and out provides permanent and definitive relief of this condition. This can be achieved by making communication between pouches by fenestration of the medial septum in unilateral condition but resection of the medial lamina or pharyngeal fistulation should be combined in bilateral involvement. The fenestration of the medial septum can be performed via a skin approach or a transendoscopical cauterization approach. Modified Whitehouse approach can be followed for permanent external fistula formation. The prognosis of surgery is usually good except in presence of pneumonia.

Sinusitis

Sinusitis refers to the inflammation of paranasal sinus mainly. It is relatively uncommon in horses and usually unilateral but bilateral disease has been reported. In bovines, mostly the frontal sinus and rarely the maxillary sinus are affected. Frontal sinusitis may be a common complication in cattle to dehorning because the sinus communicates with the horn core. In sheep, both frontal and maxillary sinuses are infected.

Etiology

- Due to primary bacterial or mycotic infections.
- Secondary to dental diseases, Actinomyces or Actinobacillus organisms, facial trauma, [illegible] cysts and sinonasal neoplasia.
- Anaerobic bacteria and parasites (*Oestrus ovis* in sheep) may be other factors.

Clinical signs

- [illegible] lymph node enlargement [illegible].
- [illegible] exophthalmos, abnormal respiratory [illegible].
- Pyrexia may or may not [illegible].
- Percussion of the [illegible] produced hollow sound.
- The animal appears [illegible] pressure in the brain.

Treatment

- Acute cases of primary sinusitis may spontaneously resolve or may respond to parenteral antimicrobial drug administration based on the sensitivity test isolated from sinusitis.

- In chronic sinusitis, lavage of the paranasal sinuses with 5-10 lit. of water, saline or dilute disinfectants such as 0.05% povidine-iodine solution, once to twice daily for 5-10 days may be performed via a catheter sutured into an osteotomy in the frontal sinus (for lavage of the frontal and caudal maxillary sinuses).
- If sinusitis is accompanied by cellulites, application of hot pack is indicated.
- Cases with gross thickening of the sinus mucosa or with accumulation of inspissated pus in the sinus cavity may require surgical debridement, removal of inspissated exudate or sinonasal fistulation and drainage.
- Sinusitis secondary to maxillary dental apical infections necessitates removal of the affected cheek tooth before resolution of the sinusitis will occur.

Pus in the sinus

Etiology

- It is usually secondary to an acute pharyngitis, presence of neoplasm on its walls, infectious parotiditis or a subparotid or retropharyngeal abscess.
- Suppurative inflammation may develop due to entry of food material in guttural pouch through the eustachian tube.
- Paucity of complete dependent drainage of the inflammatory products.

Signs

- Intermittent discharge may appear during feeding or lowering of head to eat from the ground or during exercise.
- Swelling of the submaxillary lymphatic glands and parotid region.
- Holding the head towards the sound site.
- Interference in swallowing and respiration.
- During exercise, a rattling noise in the pouch may be produced.

Treatment

- Fluid contents from the cavity should be removed and thoroughly irrigated with an antiseptic lotion through a Gunther's catheter. Irrigation requires frequent repetition owing to re-accumulation of the fluid.
- Antiseptic inhalations may be done but little beneficial effects are observed if pus has already accumulated in the guttural pouch.
- Opening the guttural pouch by surgical operation should be done to evacuate the accumulated pus material or inflammatory exudate and ultimately relieving the trouble caused by its distension.

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CHAPTER 6

Affections of Horn and Their Treatment

Anatomical considerations



Normal horn in cattle

Horn is one of the hard, usually permanent structures projecting from the head of certain mammals, such as cattle, sheep, goats, antelopes, etc. consisting of *horn process*, a **bony core** covered with a sheath of keratinous material. The hard smooth keratinous material forms the outer covering of the horns of cattle or related animals. The **corium** at the base of the horn is thick at its joining with skin proper. The **horn papillae** are shorter and more sparse towards the apex of the horn. The **horn tubules** extend from the base of the horn towards the apex of the horn. Growth of horn depends on the nutritional supply to the animal resulting presence of a series of rings on the horn.

Avulsion of horn

Avulsion of horn refers to the separation of horny covering from the bony core. There may be profuse bleeding which arrested spontaneously.

Etiology

- Direct violence such as by fighting or by blow or striking the head against a hard obje
- In working bullocks, repeated injury by the yoke sets a chronic inflammation of t keratigenous membrane and subsequently detachment occurs by striking it against fixed object.

Treatment

- Before treatment, cornual nerve block should be done to alleviate pain.
- The exposed horn bony core should be cleaned and disinfected with an antiseptic dressin
- Fly repellent ointment should be applied to prevent maggot infestation.



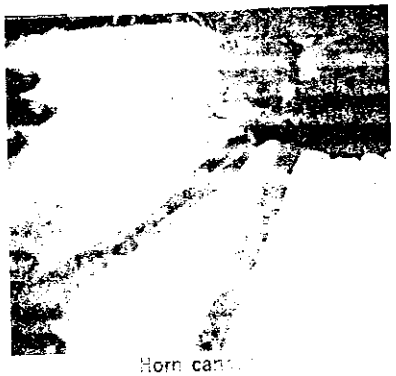
Avulsion of horn in cattle
Courtesy Dr. A. Patil



Avulsion of horn in buffalo

Horn cancer

Horn cancer, a squamous cell carcinoma of the horn is the most common condition affecting mostly bullocks, less in cows and rarely in bulls. It has been reported that this condition is more prevalent in working bullocks and very less in buffaloes. The disease is restricted to older animals in comparison to young cattle. Generally, animals of 5-10 years of age group are found to be mostly affected. The tumour is seen more commonly in long horned, white coat breeds of cattle.



Horn can[illegible]

Etiology

[illegible] horn cancer [illegible] not [illegible] cancer [illegible]

- Trauma [illegible] to the horn [illegible] lead to this condition.
- [illegible] use of the liver by worms [illegible] etc.
- Appl[illegible] of [illegible] coal tar used for making the horn black.
- Solar radiation.
- Reproductive hormonal imbalance may play an important role for this condition. Castrated bullocks are more prone for this condition.

- Genetic predisposition is another factor.
- According to some researchers, viral infection may also be responsible.

Clinical signs

- Constant shaking of head, rubbing of the horn on some hard object and striking with limbs.
- Pain is manifested by keeping a little low or inclined towards the affected side.
- A foul-smelling discharge is seen from the nostrils or base of the affected horn.
- In advanced stages, tilting of the horn to one side.
- The exposed growth looks typically like a cauliflower and bleeds easily and profusely.

Treatment

- In general, treatment of horn cancer is very difficult and sometimes impossible. However, attempts are to be made for treating such condition.
- Hormonal therapy with oestrogen and testosterone may be tried with varying success.
- Autogenous vaccine derived from cancerous tissue of amputed horn (in a 5% solution of formaldehyde) has been advocated to use and clinical recovery was observed in few cases.
- Surgical removal of the growth by amputation is the only possible remedy for this condition. Amputation should be performed from its base. In certain cases, if the cut surface is unaffected with cancerous tissue, normal wound healing occurs otherwise, the prognosis is grave.

Fracture of horn

Fracture of horn generally occurs due to fighting or by striking the horn against a hard object. Fracture may usually occur obliquely at the base of the horn, in its middle part or near the point of horn. There may be haemorrhages into the frontal sinus leading to sinusitis. Bleeding from the nostril is also seen.



Horn fracture management

Treatment

- [illegible] fracture involving its distal portion may be set by applying sleeve of oasis bandage taped or with [illegible] wooden splints) as [illegible] splint.
- Complete fracture requires amputation of horn by flap method proximal to the fracture site.
- Fracture of the [illegible] tip of the horn is [illegible] protective dressing is needed.

In all cases, the wound should be protected with an antiseptic pad and bandage which should be secured by fixing to the other normal horn.

Sinusitis

Sinusitis is a common sequel to dehorning in all species of animals. During amputation of horn, bone sawdust and rain can enter into the sinus through the opening. Sometimes, the animal may rub its head on the ground due to severe irritation leading to entry of more debris into the sinus tract. The **clinical sign** includes discharge run from the sinus opening when the animal lowers the head. Occasionally, the sinus will become heavily infected leading to profuse and purulent discharge.

Treatment comprises draining by opening the dehorning site, flushing it copiously with a disinfectant, and tipping the head to drain it on a daily basis until it dries up and drainage ceases. Occasionally, systemic antibiotics are also required. Chronic sinusitis is best treated by trephination and lavage, administration of topical and systemic antibiotics and analgesics. If drainage persists, osteomyelitis may develop which can be best treated by surgical curettage.

Horn fissures

A **fissure** involving the horn or horn core may develop as a result of direct injury and appear as its parallel to its long axis.

Signs

- Inflammation of the affected part.
- Oozing of blood from the fissure part.
- Pus formation in the area if it gets infected.

Treatment

- Application of cooling (ice pack), astringent and antiseptic lotion.
- In septic cases (presence of pus), horn should be cut and dress it aseptically.

Disbudding or debudding

Disbudding or debudding of calves and kids means removing the very early developing horn base to prevent horn growth. The procedure is carried out routinely in cow and buffalo calves, lambs, kids for management reasons.

Indication

- To minimize the risk of animals causing injury to each other.
- Easy and safe restraint of the animals.
- To reduce the risk of injury to stock holders.
- Aesthetic purposes in show animals (not in buffalo).

Useable age of debudding

Debudding should be carried out while the buds are still very small, well before they become too large for a disbudding iron to fit over. The useable age for debudding in calves is 3 to 6 weeks of age. However, goat horns often appear earlier than calf horns and grow faster, so special checking of kids daily from birth is essential.

Procedure of debudding

Debudding is painful and stressful procedures and effective anaesthesia is essential. Cornual nerve block with local anaesthetic solution is sufficient for the same. Debudding can be performed either by thermal cauterization or chemical means.

Thermal cauterization involves the use of a custom-made circular hot iron to cauterize the tissue around the base of the horn. The procedure should take only a few seconds, but it's painful, skill is required and firm restraint of the animal is necessary. After removing the hair away from around the bud of the horn, the hot iron should be put over the bud and twist it around for about 10 seconds. Care should be taken not to use too much pressure or forceful use especially with goat kids because of the small sized thinner skull; they may prone to injury from excess or deep burns.

Chemical cauterization : Debudding of calves may be carried out in the first seven days of life by chemical cauterization without an anaesthetic. There are caustic chemicals on the market for this purpose. These are applied to the horn bud to cause chemical burns to permanently damage the horn-producing area. The chemicals are easily rubbed onto sensitive skin. In general, using a hot iron is better than using caustic soda to remove the buds.

Hair and skin will eventually grow over the burned area and will after a few days, cause the animals no further discomfort.

Amputation of horn

Amputation of horn is indicated in adult animals following horn cancer or irreparable injuries and misdirected or overgrown situation. This procedure is not only painful, but it can also impede milk productivity which is certainly not in the farmer's interest. It is infact a rather unpleasant affair, even when a local anaesthetic is used to deaden the pain.

Many techniques have been developed for amputating affected horn. Amongst various techniques, Flap method of amputation of horn described by Angelo and Das (1970) is simplified and superior because of less haemorrhage, pain and a short healing period. The procedure requires cornual nerve block with 2% lignocaine hydrochloride to reduce pain and ligation of cornual artery for bloodless operation. The hairs around the base of horn should be clipped and cleaned. An elliptical incision is given around the base of horn and skin on both sides of incision is reflected to form a flap. The exposed horn is now cut at its bottom with a wire saw. Haemorrhage is controlled by point firing or using potassium permanganate crystals. The wire saw also produces appreciable heat as a result of friction which results further haemostasis. The skin flaps are apposed together with mattress suture. A protective bandage is then applied after covering the wound. On follow-up, the ligature is removed on the next day and aseptic dressing is employed. The post operative treatment period is comparatively shorter. Appropriate measures are to be taken if there is wound dehiscence and maggot infestation.

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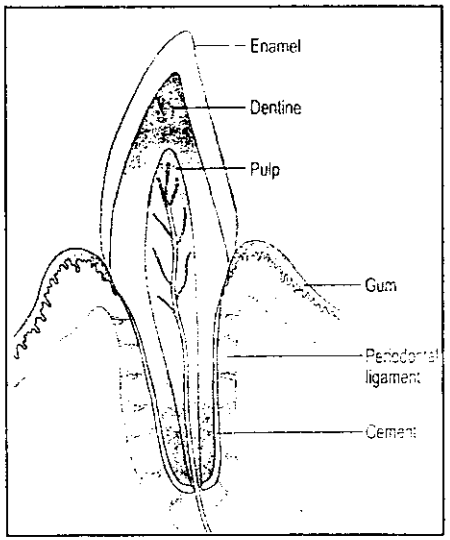
CHAPTER

7

Affections of the Teeth and Their Treatment

Anatomical considerations

The tooth is hard, white or yellowish white structures located in the alveoli of bones of the jaw. In animals, tooth is the masticatory organ and is of two types: temporary or deciduous tooth and permanent tooth. The temporary or deciduous tooth appears or erupts at birth while permanent tooth is the replacement of primary tooth during growth of the animals. A tooth is composed of a portion above the gum line called ***crown*** and a section below the gum line called the ***root***. Enamel, the hardest mineralized tissue found in the body covers the crown and is formed by ameloblasts. Cementum, which is attached to the periodontal ligament, covers the root. **Dentin**, softer than enamel, makes up the bulk of the teeth and is formed by odontoblasts that line the hollow chamber in the center of the tooth. The ***pulp*** extends into the crown of the tooth and takes the same general form of the tooth crown. The ***endodontic system*** is called the ***pulp chamber*** in the crown of the tooth. In the tooth root, the endodontic system is called the ***root canal***. Inside the pulp is composed of live tissue, which contains nerves, blood vessels and lymphatics. The dental formula in different ruminants and pet animals are given below :



Structure of a permanent tooth



Species	Type	Formula	Total
Cattle : Buffalo, Sheep	Deciduous	$2(DI\ \frac{0}{4}\ DC\ \frac{0}{0}\ DP\ \frac{3}{3})$	20
Goat	Permanent	$2(I\ \frac{0}{4}\ C\ \frac{0}{0}\ P\ \frac{3}{3}\ M\ \frac{3}{3})$	32
Dog	Deciduous	$2(DI\ \frac{3}{4}\ DC\ \frac{1}{1}\ DP\ \frac{3}{3})$	28
	Permanent	$2\ (I\ \frac{3}{3}\ C\ \frac{1}{1}\ P\ \frac{4}{4}\ M\ \frac{2}{3})$	42
Cat	Deciduous	$2(DI\ \frac{3}{3}\ DC\ \frac{1}{1}\ DP\ \frac{3}{2})$	
	Permanent	$2(I\ \frac{3}{3}\ C\ \frac{1}{1}\ P\ \frac{3}{2}\ M\ \frac{1}{1})$	
Pig	Deciduous	$2(DI\ \frac{3}{3}\ DC\ \frac{1}{1}\ DP\ \frac{3}{3}$ or $\frac{4}{4})$	
	Permanent	$2(I\ \frac{3}{3}\ C\ \frac{1}{1}\ P\ \frac{3}{3}$ or $\frac{4}{4}\ M\ \frac{3}{3})$	

In general incisor teeth are used for shearing and grooming. The canines are designed to grasp and tear with great pressure. Premolar teeth have sharp edges used for shearing. Molar have a flat surface used for grinding.

CONGENITAL AND DEVELOPMENTAL ANOMALIES

Various congenital and developmental anomalies of teeth may occur in animals which are as follows :

Malocclusion

Malocclusion refers to an abnormal tooth alignment.

1. **Over bite (parrot mouth or brachygnathism)** occurs when the lower jaw is shorter than the upper. There may a gap between the upper and lower incisors when the mouth is closed. This type of malocclusion is never considered normal in any breed and is a genetic fault. Generally elongated muzzles types of breed are mostly affected.
2. **Under bite (Prognathism or Hog mouth)** occurs when the lower teeth protrude in front of the upper jaw teeth. The most commonly affected breeds are those with short muzzles although, in medium muzzled breeds it is abnormal.
3. **Even or level bite** occurs when the upper and lower incisor teeth meet each other edge to edge. This condition is considered normal in some breeds, although it is actually an expression of under bite.
4. **Anterior cross bite** is one of the common malocclusions observed in veterinary



Prognathism in rabbit

dentistry which is not considered a genetic or inherited defect. This condition occurs when canine and premolar teeth on both sides of the mouth occlude normally but one or more of the lower incisors are positioned in front of the upper incisors. It can be caused by tug-of-war games, retained primary teeth, or impacted roots.

5. **Posterior cross bite** occurs when one or more of the premolar lower jaw teeth overlap the upper jaw teeth. This is a rare condition that occurs in the longer-nosed dog breeds. Heavy amounts of calculus will accumulate on the buccal surfaces of the lower premolar and molar teeth. Regular tooth brushing is necessary.
6. **Wry mouth** or **wry bite** occurs when one side of the jaw grows more than the other. Wry bites show as triangular defects in the incisor area where some of the incisors will meet their opposing counterparts, while others will not. Minor abnormalities may be seen in the midline of the rugae of the hard palate. Wry bite is a severe inherited defect.
7. **Open bite** occurs when some incisors are displaced vertically and do not touch. Often, the tongue will protrude.
8. **Rotated teeth** are seen mostly in short muzzled breeds and commonly affect the upper third premolar. The rotated tooth root closest to the palate is prone to periodontal disease which need regular tooth brushing to save a rotated tooth but frequently, the tooth cannot be saved.

Supernumerary teeth (Polyodontia) create alignment problems and the development of hooks and ramps. The extra teeth are usually premolars or incisors although a supernumerary canine tooth may be seen. Extra teeth can cause periodontal disease from over crowding. It has been reported that 9% of dogs have supernumerary teeth.

Missing teeth (Hypodontia) usually occurs in the premolar area, but any tooth in the mouth may not erupt and are considered genetic faults. There may be feed packing in the empty socket if it is still open which subsequently get infected. Sometimes the missing tooth is trapped below the gum line. A dental x-ray can be taken to determine the presence of unerupted tooth.

Dental interlock occurs when deciduous teeth erupt during an accelerated growth phase of one jaw that places the upper deciduous canine teeth rostral to the lower deciduous canine teeth, preventing forward growth. It has been seen that genetically normal dogs can occasionally develop abnormal bites due to the interlock of primary teeth.

Treatment is directed to remove the primary teeth from the shorter jaw that interfere with forward growth, may allow the upper jaw to lengthen unimpeded. About 50% of minor jaw length malocclusions can be corrected by the time permanent teeth erupt.

Shear mouth

This condition is also known as overlapping molars where the angle of the occlusal surfaces is extremely steap. The borders may be as sharp as may cause injury to the opposite gums. Restriction in movement of the jaws, abnormal chewing pattern and anatomical factors plays a role in the development of this wear pattern.

Treatment of this condition is directed to periodical rasping of the sharp edges of teeth.

Sharp teeth

In sharp teeth condition, the upper jaw is broader than the lower jaw and there are razor sharp rows of enamel points especially on the outside of the upper molar rows and the inside of

the lower. The pain can cause a number of symptoms and the high point and rows can physically prevent the jaw from moving side ways to chew properly. The sharp borders of teeth cause injury to the cheek and tongue.

Clinical signs

- Due to injury of cheek and tongue by the sharp borders, there is pain.
- Due to restriction in movement of jaws, food is not properly grinded.
- Inclination of head to one side and foamy saliva at the borders of mouth are seen during chewing.
- Quidding *i.e.* partially chewed food materials mixed with saliva may drop out from the mouth.
- Development of wound on the tongue and cheek due to injury caused by sharp borders of teeth.
- Finally, the animal starts to loose body weight due to improper feeding.

Treatment. After opening the mouth with mouth speculum, the sharp border of the teeth should be rasped and polished.

Waveform mouth

In this condition, the whole molar row becomes uneven, certain teeth being very short and their opposing teeth in opposite jaw are too long. It often develops secondary to other conditions such as caps, missing teeth, big hooks and rams, and old age where some of the teeth are running out of enamel. Generally, the fourth cheek teeth are affected. The result can be problems with the normal movement of the jaw and thereby chewing the food properly.

Treatment

- Remove the sharp points and edges of the long tooth and extraction of the affected tooth.
- A soft diet may be given to overcome the difficulty in chewing.

Step formed mouth

A step is the result of an overgrowth within a molar table, caused by lack of occlusion. In this condition, the irregularity seen is much more as compared to "wave formed mouth".

Treatment should be directed as that of "wave-formed mouth."

Smooth mouth

Smooth mouth is caused by an excessive wear of teeth leading to smooth surfaces instead of having the normal grinding surface. This condition is mostly observed in cattle with increased difficulty to masticate grasses or grains properly, to chew their cud well or to glean proper nutrition from their feed. Due to interference of feeding, the animal gradually loses his body condition.

Dental tartar

Tartar is a mixture of food, cellular debris, mineral salts and bacteria which is deposited on and around the teeth. Prolonged accumulation of the tartar ultimately causes gum recession, tooth root exposure, gingivitis, tooth loosening and eventual loss of teeth. This condition is commonly seen in dog and cat and uncommon to other animals. Offensive odour **(halitosis)** may come out from the mouth.

Recommendations for treatment

- In early stages, tartar should be removed by putting fingers in mouth and rubbing the gums a couple of times per day.
- The next step is to use a dog tooth brush and gently run it inside the cheek pouch next to the molars and around the sharp 'spiky' canine teeth.
- Companion animal tooth paste with enzymatic base may be used along with a suitable sized brush.
- Other options include use of a logic oral gel with a brush inside the cheek daily after the main meal. It helps to kill bacteria, reduce plaque and tartar in the mouth and reduce bad breath.
- Dental treats and toys are a very useful aid in controlling dental tartar.
- Dental scalers may be used to remove tartar from the affected tooth.

Dental caries

Caries occasionally occur, most often as scooped out lesions on the occlusal surfaces of molar teeth in dogs. This condition is uncommon in cattle and occasional in buffalo and camels. The explorer tip will catch or stick in the soft tissue of a decayed tooth. Subgingival carries may also be present at or underneath the gingival margin in dogs. Likewise, resorption of tooth roots can occur within periodontal pockets. A slab fracture into an open pulp chamber of an upper fourth premolar could be mistaken for caries; a portion of the crown of the tooth will be missing.

Clinical signs

- Salivation, difficulty in mastication and simple indigestion.
- Offensive smell from mouth.
- In late stage, feeling of pain.

Treatment consists of :

- Extraction of the affected tooth under local anaesthesia may be the treatment of choice.
- Post extraction oral cleaning with light potassium permanganate (1: 1000) is recommended.

DENTAL TUMOUR

Odontoma

Odontomas are tumours that evolve from the tooth bud and fortunately are benign in nature. An odontoma may be considered as harmatoma rather than a well-differentiated neoplasm. It is generally observed in pet's and occasionally observed in cattle, buffalo and sheep. The tumour may affect either the mandible or maxilla but mostly occurrence is observed in lower jaw. In advanced stages, loose incisors are often embedded in the tumourous lesions. The radiographic picture shows a sharply defined mass of calcified material surrounded by a narrow radiolucent band or a variable number of tooth-like



Odontoma in cattle
Courtesy Dr. A. Patil

structures. If the tumour is properly excised by a specialist, will not recur and the prognosis is excellent. However, if left in the mouth, they can grow and become locally damaging.

The **treatment** of the condition is directed to:

- Surgical enucleation of the tumourous growth as well as fibrovascular stroma from which they are growing by curetting or chiseling out under general anaesthesia.
- Extensive bleeding that may occur during extraction can be checked by cauterization.
- Post-operatively, washing the mouth cavity with light potassium permanganate solution and analgesic for few days is recommended.
- Soft liquid diet should be offered for one to two weeks.

Ameloblastoma

Ameloblastoma is one of the most common odontogenic tumours, occasionally incorrectly referred to as **Adamantinoma.** This tumour usually occurs in canine and sporadically in cattle, sheep and buffaloes. It is a locally invasive benign neoplasm with osteolysis around the tooth roots and cystic changes. The canine acanthomatous ameloblastoma is a benign odontogenic tumour with similar histologic characteristics like that of centrally located ameloblastoma but appearing in the gingiva and mucosa of the tooth bearing area of the jaws. In most cases, infiltration in the underlying bone is evident. The radiographic picture shows alveolar bone resorption and tooth displacement.

Clinical signs

- There is difficulty in mastication and deglutition due to pain.
- In advanced stages, incisor teeth are displaced and firmly embedded.

Treatment Treatment of this condition is same like that of odontoma. Local recurrence is common after marginal excision, and wide or radical excision is therefore recommended.

PERIODONTAL DISEASE

Periodontal disease is a very slow, insidious disease that affects all of the supporting structures of the teeth: the free gingival margin, attached gingiva, periodontal ligaments, and alveolus or bony socket. Periodontal disease starts with the formation of plaque, a transparent adhesive fluid composed of mucin, sloughed epithelial cells and aerobic, and gram positive cocci. Plaque forming starts 12 hours after dental cleaning and can mineralize into calculus in as little as 48 to 72 hours if not removed. The calculus mechanically irritates the gingiva, changes the pH of the mouth allowing pathogenic aerobic gram negative bacteria to survive subgingivally. The by-products of bacterial metabolism "eat away" at the tooth's support structures eventually causing the tooth to be lost.

There are two active phases of periodontal disease namely gingivitis and periodontitis.

Gingivitis

Gingivitis refers to the inflammation of gums caused by bacterial infection. The bacterial population generally consists of non-motile, gram-positive, aerobic cocci. The condition is reversible to tissue surrounding the teeth.

Clinical signs

- Swollen and inflamed gums.
- Bad breath (halitosis) and bleeding red gums.

- Plaque on the teeth perhaps with some calculus.
- The animal may drop food and rub its mouth as well.



Gingivitis in a dog

Gingivitis may turn into chronic due to negligence of owner, fibrosis of the gingival tissue may develop and the inflamed gingival margin disappears.

The **treatment** of this condition is directed to :

- Removing the plaque and calculus that have accumulated on the tooth.
- Gingival pockets if develop may resolve after treatment of gingivitis.
- Gingivectomy is considered if fibrosis is present and the pocket does not resolve.

Periodontitis



Periodontis in a dog

Periodontitis develops if gingivitis is not treated properly and in time. The time span for development of periodontitis from gingivitis is variable and usually may take as few as 2 weeks. The organism responsible for gingivitis may form into motile, gram negative, anaerobic rods that cause periodontitis. The condition is generally irreversible and can start in 4-6 years of age. The anaerobic bacteria penetrate the gingival sulcus and marginal tissue and endotoxins ultimately migrate toward the root tip of the tooth. As the disease progresses, periodontal ligaments that hold the tooth to the jaw bone and the bone itself becomes damaged. Deep periodontal pockets begin to form. Periodontitis can exist around one or more teeth for years. Due to the advanced destruction of the jaw bone, the teeth are lost.

Clinical signs

- The animals are more reluctant to chew on hard food.
- There is formation of abscess in the gum and jaw bone.
- There may be bleeding and pain sensation.
- There may be sneezing episodes and nasal bleeding.
- In advanced stages, permanent oro-nasal fistula may develop if upper fang teeth are affected.
- The animals start to loose weight and avoid having its face or head touched.

Treatment. Treatment is preceded by dental radiographs not only to determine the degree of bone destruction and disease but also in establishing an appropriate treatment protocol to save the animal's teeth.

The following plans may be adopted for successful treatment.

- Subgingival calculus is to be removed with powered scalers or a hand curette.
- The root surface should be smoothed by root planning until it is glassy smooth and ha
- In case of periodontal pocket of more than 4 to 5 mm deep, a periodontal flap procedu should be performed for adequate visualization of tooth row. Subsequently, the cav should be thoroughly cleaned and a long-acting sustained release antibiotic (doxycycli polymer may be placed.
- Finally, flap surgery is the most appropriate procedure to expose the pathology a render care in periodontal disease especially in small animal dentistry.

Epulis



Epulis in a dog

This tumour generally develops at the dental border or in interdental spaces. The term 'epulis' is subjected too much confusion. It is probably best referred to now as a basal cell carcinoma, which describes its biological behavior much better (locally invasive, like carcinomas). Epulis is also often used wrongly to describe the gingival hyperplasia seen in breeds such as the boxer.

Clinical signs include inapetance, weight loss, drooling, gagging/retching, bleeding from the mouth, oral pain, halitosis etc. clinical examination may reveal an obvious mass on the gums.

The growth is best treated by through **surgical excision** under general anaesthesia. The diffuse bleeding can be controlled by packing or cauterization with surgical diathermy.

Bishoping

One of the first objectives in a pre-purchase examination is determining the age of horse. If the horse is supposed to be seven and the teeth say the horse is eleven, often buyers right there. **Bishoping** is tampering with cups to make the horse appear younger than it is. artificial infundibulum marks are made by staining with silver nitrate. The normal infundib marks disappear from centrals by six years, laterals by seven years and corners by eight e The artificial marks are made deeper on lateral in comparison to centrals but less de p corners.

[illegible] can be easily detected by observing the shape of the surface of the tooth [illegible] is roughly oval side ways. In aged horse, it is triangular and in [illegible] it is oval, antero-posteriorly or circular in shape.

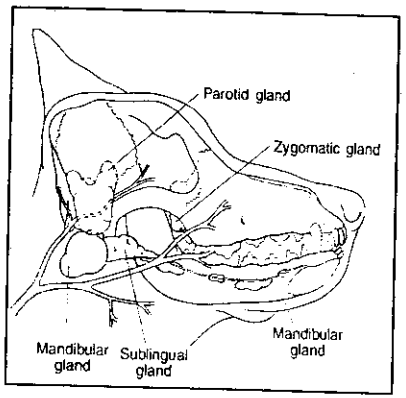
CHAPTER

8

Affections of Salivary Glands and Their Treatment

Anatomical considerations

The salivary glands like consists of three pairs of well-defined glands namely **parotid, mandibular** and **sublingual** as well as scattered lobules of salivary tissue.



Anatomy of salivary gland

The parotid salivary gland is situated ventral to the ear in relation to the caudal border of the mandible. The parotid salivary duct along with the fascial vessels passes ventrally and cranially on the deep face of the caudal part of the mandible and crosses the check superficially just cranial to the masseter muscle and ultimately penetrates the cheek near the upper third of fourth cheek tooth.

The mandibular (submaxillary) salivary gland is located ventral to the parotid gland just caudal to the mandible. The mandibular salivary duct passes forward medial to the mandible to open ventral to the tongue located slightly anterolateral to the *frenulum linguae.*

The sublingual salivary gland is located deep to the mucous membrane along the ventral side of the lateral surface of the tongue near the floor of the mouth.

The salivary gland also contains secretary glands like serous, mucous or mixed.

Trauma

Trauma from lacerations or penetrating wounds to the parotid duct or gland is the most common affections associated with the salivary glands. Since the parotid gland and duct is the most superficial, damage to this salivary gland is more commonly seen than to the other salivary glands. If the integrity of the salivary duct or gland is disrupted, there will be increased secretion of saliva from the wound especially during eating.

Treatment

Wounds heal spontaneously as with any other wound. Treatment of this condition includes :

- Cleaning and debridement of necrotic tissue.
- Fresh wounds can be surgically treated by suturing the parotid duct or suturing the fibrous capsule of the damaged parotid gland or healing by second intention.
- Provision of liquid diet and avoid noise to reduce salivary secretions.
- Application of Vaseline to the affected part to prevent excoriation.
- In horse, nasogastric tube may be used for feeding several days after injury to the paroti gland to prevent stimulation of salivation by eating.

Sialoliths

Sialoliths or salivary calculi may form in the salivary glands or salivary ducts of the animals. The occurrence of sialoliths or salivary calculi has been reported in different kinds of animals such as dog, cattle, buffaloes, monkey, donkey, horse, camel, chimpanzee etc. These are seen more often in horses than in other species. **Sialoliths** are hard, non-painful, generally smooth and oval in shape, yellowish-grey in colour and moveable swellings that can obstruct usually in rostral portion of the parotid salivary duct in older horses. They are composed of calcium carbonate (80-90%) and organic matter (9-10%). There appears to be no gender or age predisposition to sialolith formation. However, sialolithiasis is reported to occur more commonly in animals living in more arid environments.

Etiopathogenesis. The exact etiopathogenesis of sialolithiasis is not clear, but it is believed that organic matter acts as a nidus around which calcium salts are deposited. The organic matter may be a foreign body, such as grain or grass, entering the parotid duct through the salivary (parotid) papilla, or it may be cellular debris and bacteria as a result of sialodenitis. In the horse, sialoliths may grow to over 10 cm in length and parotid salivary duct obstruction may occur with large stones, which, in turn, may lead to retention of saliva, stasis, and proximal movement of bacteria, resulting in acute sialodenitis. Salivary gland dysfunction and oral mucosal ulceration caused by sialolithiasis may occasionally result in discomfort, dysphagia, and possible atrophy of the gland.

Diagnosis. The diagnosis of sialolithiasis is based on the followings :

- Clinical signs and palpation.
- Radiographic examination.
- Differential diagnosis includes sialodenitis, tooth abscesses, and buccal tumours and metaplasia or dystrophic calcification.

Treatment. The early surgical intervention is required to save the affected salivary gland from atrophy. **Surgical removal** of sialoliths by an external approach is traditionally practiced; however, it may cause complications, such as salivary fistula formation if duct closure fails. Consequently, it is recommended to remove them by transoral approach. The incision is made through the buccal mucosa directly over the sialolith. Complications are few with incisions allowed to heal by second intention. Secondary sialodenitis may be a complication of simple sialolith extraction and require postoperative lavage and antimicrobial therapy.

Salivary cyst

Salivary cyst is a collection of saliva that has leaked from a damaged salivary gland or salivary duct, and has accumulated in the tissues. In some instances, the duct may have been broken or it may have been bruised with the resultant swelling closing of the duct. **Ranula** is a mucocele of the sublingual salivary gland and a **salivary cyst** is aberrant salivary tissue. The large fluid filled swelling will appear similar to a haematoma or seroma. Paracentesis of the swelling yields thick mucoid saliva often mixed with a purulent discharge and rumen card. This condition is almost exclusively seen in dogs, very rarely in cats and occasionally in cattle and buffaloes. Retrograde sialography can confirm diagnosis.

Etiology

- Trauma such as from choke collars, bite wound or chewing on foreign materials is generally initiating event.
- Saliva leaking from the torn salivary gland or duct accumulates in the tissue and initiates an intense inflammatory reaction. A connective tissue capsule gradually develops around the saliva to prevent it from migrating further.

Signs

- In Ranula, there may have some problems in eating and drinking. The animal may limit normal movement of the tongue during drinking and chewing food.
- In pharyngeal salivary cyst, there may have respiratory difficulty and dysphagia (difficulty in swallowing).

Treatment

- Sublingual mucocele (Ranula) may be treated with **marsupialization** (in addition to removal of mandibular and sublingual glands) to facilitate drainage into the mouth.
- **Dissection and removal** of the salivary gland or glands can also be attempted. Continued aspiration of a salivary cyst will not permanently eliminate the problem and sometimes invading bacteria into the cyst can cause an abscess.
- **Chemical ablation** of the parotid gland should stop saliva from draining into the cyst.
- **Complete excision** of cyst is indicated in high grade infection.
- **Stenson's duct ligation** caudal to the placement of the cyst is advocated.

Salivary fistula

Salivary fistula develops from a wound in the region of a salivary duct due to salivary secretion preventing the healing process. A salivary fistula affecting the gland heals in due course of time but in duct involvement, healing will not occur due to continuous flow of saliva through it.

Etiology

- Direct trauma from outside to the duct.
- [illegible] in the region leads to rupture of the duct alongwith communication to [illegible] wound.

Signs

- Dribbling of saliva causing excoriations of the wound.
- In ruminants, heavy looses of saliva leads to dehydration and indigestion.
- In few chronic cases, high grade infection of the parotid gland develops.

Treatment

- Salivary fistulas resulting from damaged parotid gland can be treated by reconstr the duct, duct transposition or chemical involution of the gland.
- **Surgical repair** consists of dissecting over fistula, passing polyethylene catheter ca towards the glandular part and rostrally through the parotid papilla. A ligature is around the duct and brought out this stent through the cheek and keep it in pla several weeks.
- **Chemical ablation** of the gland and duct is accompanied to destroy their func Sclerosing agents like 10% formalin, 2% iodine, 2% chlorhexidine and 2% silver may be used for this purpose. The chemical agent especially 10% formalin (becau causing least necrosis and suppurative inflammation) is injected via a canula place the parotid duct followed by suturing the canula and duct to prevent leakage infusion.

Neoplasms

Neoplasms of salivary gland are infrequently encountered in animals. In ho adenocarcinoma, acinar cell tumours, melanomas and mixed cell tumours have all are repo In canine, a 17 year survey of salivary gland neoplasms in USA revealed that most adenocarcinoma or carcinomas. Osteosarcoma of the mandibular salivary gland is also repo

- **Clinical signs** are parotid welling and pain.

Treatment of circumscribed and benign neoplasms, **excision** of the mass is carried without injuring important nerves and vessels in the vicinity. **Surgical excision** of mixed tumour or acinar cell tumours as well as with melanomas is usually not successful becau chances of recurrence. Adenocarcinomas often metastasize and it is better not to intervene altho variable success was obtained with surgical excision followed by **chemotherapy** cyclophosmamide in dog.

Sub-parotid abscess

Sub-parotid abscess generally occurs as a result of strangles in horse and tuberculos cattle. A diffuse inflammatory swelling develops which may burst inside or outside if not op within eight to fourteen days of course. Sometimes, pus materials enter into the larynx bronchi and results to septic pneumonia or as a fistula of the pharynx may ensue.

Treatment of this condition is directed to opening the abscess like that of a deep se abscess without causing injury to important vessels and nerves. Finally, draining of pus mat is to be done as per routine procedure. A course of antibiotic for 7 days is indicated.

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CHAPTER 9

Congenital Affections of Lower Jaw and Treatment

Paralysis of lower jaw

Paralysis of lower jaw is fairly common complication in dog, rare in the horse and ox and may be of unilateral or bilateral, partial or complete and central or peripheral in origin.

Etiology

- Affection of nerve in the point of origin in brain due to pressure by extravasated blood, inflammatory exudate or a tumour.
- Affection of peripheral nerve due to pressure by tumours, extravasated blood or direct injury or toxin of infectious disease like distemper in dog.

Signs

- In unilateral paralysis
  - (*a*) Prehension and movements of the tongue are normal but mastication is interfered.
  - (*b*) The animal holds the head low and towards the sound site so that food material is passed towards the corresponding molars.
- In bilateral paralysis
  - (*a*) Slow intermittent masticatory movements in incomplete paralysis.
  - (*b*) In complete paralysis, loss of masticatory movements on both sides, drooping of lower jaw, dry tongue protruded from the mouth.
  - (*c*) The dog is able to swallow liquid diet and solid food when placed in its mouth.

Treatment. Treatment of this condition is same like that of general treatment of paralysis.

Gnathitis

Gnathitis is an inflammatory condition of the interdental space in horse due to injury caused by bits. The inflammation in mucous membrane is mild in nature and may affect the underlying tissues like periosteum and bone. The animal feels severe pain when the bit is moved. There is pus formation and may also affect the underlying bone.

Treatment of this condition includes :

- To discontinue the use of bit for certain periods till normal healing is achieved.
- Drainage of pus material if suppuration develops.
- Removal of necrosed piece of bone (sequestrum) is indicated if bone is involved.

Lymphadenitis of jaw

Lymphadenitis refers to inflammation of lymphatic gland. The condition is mostly encountered in goats, sheep and horses. The main etiology of this condition is infection *i.e. Streptococcus, Staphylococcus* and *Corynebacterium pseudotuberculosis.* In horses, disease like strangles may lead to this condition.

The **clinical signs** include enlargement of lymph gland, presence of external abscess beneath the jaw (more common in goat), internal abscess (more common in sheep) and chronic weight loss.

Treatment of this condition includes:

- In simple inflammation of gland, **blistering ointments** are helpful as counterirritant.
- Administration of **potassium iodide** and **antibiotics** (based on causal organism).
- If there is **abscess** formation in jaw area, use a disposable scalpel to cut the surface of the abscess and **drain** it before it ruptures on its own in the field. The abscess is about to rupture when it has lost hair.
- In chronic lymphadenitis, **extirpation** of the affected **gland** is recommended.

Injuries and fracture of hyoid bone

Injuries and fracture of hyoid bone are infrequently observed in animals.

Etiology

- In dog, this may occur due to rough seizure by the throat during securing stray animals.
- In horses and cattle, kicking, violent traction on the tongue and horn thrusts may be main reason.

Signs

- Salivation.
- Difficulty in eating and especially in swallowing (dysphagia).
- Prolapse of tongue.
- Accumulation of food in the mouth and swelling in the throat.
- Bleeding from mouth due to tearing of hypoglossal artery or other vessels.

Treatment

- Semi liquid diet may be offered in simple fracture.
- Through cleaning of wound in the mucous membrane after each meal.
- Fragments of bone should be removed if there any.

Crib biting

Crib biting is where horses use their teeth to grasp onto objects, such as their manger, or the top of their stable door, then arch their necks and swallow air called **wind sucking**. This

behaviour has always been regarded as a 'vice' of the horse, and has been linked to various forms of ill-health including worn teeth, colic, stomach ulcers, hypertrophy of the muscles of the ventral neck, and a failure to maintain body weight. Although a nutritional deficiency may be an underlying cause, if the horse is being fed a balanced diet and has free access to a mineralized salt block, this should not be the case. The researchers also proposed that crib-biting may be a way for horses to produce saliva. Saliva buffers excess stomach acid, but saliva production in the horse is a physical process that depends on pressure being exerted on the parotid salivary gland. So, these horses may actually have a biological need to crib-bite. A chronic crib-biter will develop abnormal wear of the incisor teeth which could lead to digestive problems.

Control of this condition is directed to horse owners need to reappraise their management practices and use alternative and humane methods to prevent the development of crib-biting. The problem can be controlled by :

- Minimizing the number of surfaces which the horse has available to chew: for example, removing the manger, placing a strip of metal over the top of the door or placing a grille on the door.
- The surfaces should not make unpleasant to taste as this is only likely to make the horse more frustrated. It is better to allow horse to crib bite on a suitable surface, such as a hard rubber board, than to try to physically prevent the behaviour with straps or collars.
- Some horses are helped if they have a companion—a small pony, a sheep or a goat. Others are improved if a solid object, such as a rubber ball, is hung from the ceiling.
- The horse has to provide lots of roughage in diet and plenty to chew on during the day.

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CHAPTER

10

Affections of Ear and Treatment

Anatomical considerations

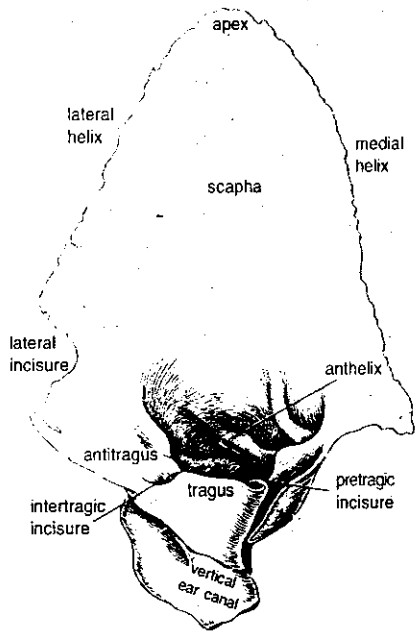
The ear has three parts: the external, middle and inner ear.

A. The **external ear** is composed of the pinna and the external canal.

1. The **pinna** may be upright, pendulous or funnel like structures, depending on the shape and size of **the auricular cartilage.**
2. The **external canal** is composed of the **vertical (lateral)** and **horizontal (medial)** regions and ends at **the tympanic membrane.**

B. The **middle ear** comprises the **tympanic cavity** and **auditory tubes** lined by mucous membrane. The tympanic cavity, located between the tympanic membrane and internal ear, consists of three parts: the atrium, the epitympanic recess—which contains most of the **auditory ossicles** and the large **tympanic bulla.**

C. The internal ear consists of two cavities namely **membranous** and **osseous labyrinth**. The osseous labyrinth, immediately medial to the tympanic cavity, has three parts: the cochlea, vestibule and semicircular canals. The membranous labyrinth lies within the osseous labyrinth containing supporting cells and hair cells.



Anatomical structure of ear

Functions of ear

A. Hearing

- The external ear gathers and transmits sound waves to the tympanic membrane.
- The middle ear transmits sound waves that reach the tympanic membrane through the auditory ossicles of the internal ear.

B. Balance. Movement of fluid within the semicircular ducts stimulates cells, sending impulses to brain via the vestibular nerve. Simultaneously, efferent signals are sent to the spinal cord to stimulate and inhibit muscles in the extremities and thereby maintaining equilibrium.

Examination of ear

Clinical examination of ear is essential to locate various surgical and medicinal affections. The external ear can be examined without the use of any special device. The cattle may require manual head restraint, twitch in horse and muzzle in dog. The auditory canal can be examined with the use of aural speculum or **otoscope** (handheld or video). Various surgical and medical affections like swelling at the base of ear, haematoma and otorrhoea should be examined for prompt treatment.

Haematoma of ear

Aural haematoma is most frequently occurred in dogs with pendulous ears and rarely in cats and ruminants. It is an excessive collection of blood in the inner or the outer aspect (very rare) of the ear flap, between the skin and cartilage.



Aural haemotoma in a dog

Etiology

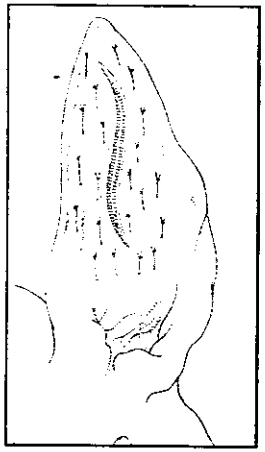
- Auricular vessel trauma related to head shaking, scratching or rubbing the ear due to otic pruritis.
- Discomfort from otitis may be a predisposing cause.
- Results from an autoimmune disease of the pinnal tissue.

Clinical signs include soft, fluctuating swelling on the concave surface of the pinna and accompanied by pain. In chronic cases, the lesions become firm and fibrotic.

Treatment of this condition is based on identifying the cause of the initial trauma to prevent recurrence and evacuates the contents.

- **Needle aspiration** and consequent bandaging of the haematoma lead to recurrence; hence surgical correction is recommended.
- **Surgical treatment** consists of incisional drainage combined with suturing to obliterate dead space. The pinna (both sides) is surgically prepared and incised longitudinally in inner side. The coagulated blood is removed and the cavity is curetted and flushed with saline.

The horizontal mattress sutures are placed in rows parallel to the skin incision. To promote wound drainage, the skin incision is not sutured. A light protective bandage is applied



Aural haematoma repair. Suture should be placed vertically rather than horizontally

to protect and immobilize the ear (pendulous ear-bandaged over head or neck and erect ear-bandaged in erect position). Routine postoperative dressing should be followed and sutures are removed in 3 weeks. An Elizabethan collar is recommended to prevent scratching for few days.

Complications

- Cosmetic alterations and recurrence may occur.
- Necrosis of pinna may also occur due to improper suture placement.

Ear cropping

Ear cropping refers to the practice of reshaping a dog's ears by surgically removing the pinna, or "floppy part" of the ear. It is more of an art than a surgical technique and is usually performed on young puppies for aesthetic purposes. Because ear cropping is a surgery and a general anaesthetic is required, the procedure is generally performed by a veterinarian, although breeders and dog owners often undertake amateur attempts of the ear cropping procedure. Ear cropping is practiced widely but considered inhumane and an unethical procedure.

Age of cropping. Great Dane, Doberman pinscher and Boxer-10-11 weeks.

- Bostons, Bull terriers and toy Manchesters and others 4-6 months.

Length of cropping. The type and length of ear crop varies with the standard for the breed and the prevailing fashion. Generally, a long, narrow head requires a longer ear, while a short, broad head needs a shorter ear and approximately one-half of the ear is removed.

Surgical technique. After applying cropping clamps (act as a template) from the upper to lower points of a flattened ear flap in a desired shape, lateral portion is excised. The raw, bloody edges are then closed with stitches from the bottom to the tip of the ear with 3-0 catgut. Bleeding on the top of ear flap is controlled with sponges and pressure. The upper portion of ear flap (skin to skin) is closed with simple continuous sutures of 3-0 or 4-0 silk and lower portion with simple interrupted sutures.

Aftercare : Postoperatively, the ears are generally supported over the head and the bandages are not disturbed for 48 hours. The anterior border of cropped ear is covered with adhesive tape and the tips of the ears are attached to the frames to keep it stretched. Sutures should be removed on 8th to 10th postoperative day or after complete healing.

Necrosis of conchal cartilage

Necrosis of cartilage is the sequlae of deeper wounds involving the auricular cartilage especially seen in horse. The condition is caused either by fight wounds or chronic flea or mite infestation.

Clinical signs include gradual destruction of cartilage and deformity of ear.

Treatment consists of partial resection of necrotic cartilage and suturing of fresh wounds. Extensive necrosis of cartilage may need complete surgical excision of concha.

Drooping ears

In most species of animals, the ears are held slightly raised or upright due to contribution from facial nerve and auricular muscles. Drooping ear means inability to maintain its normal direction (upright) in which that is the norm. It may be a congenital abnormality, due to injury that has damaged the cartilage, or a sign of neurological deficit.

Etiology

- The weight of a haematoma or paralysis of the facial nerve may lead to droop.
- Due to ingestion of some poisons and also following severe cerebral disorders and lesions affecting the acoustic nerve.

Ulceration of conchal cartilage

Ulceration of conchal cartilage is commonly encountered in dogs with pendulous ears.

Cause : The condition occurs due to an open wound of the ear or repeated shaking of ear as a result of canker.

Clinical signs include small wound with bleeding surface (covered by scab), tender on manipulation, pruritis and scratching or rubbing the ear.

Treatment comprises cleaning and disinfecting the wound, cauterization, freshening and suturing of the affected area and keeping the ear in fixed position by bandaging.

Conchal fistula

Conchal fistula is also known as periauricular cysts, ear fistula or ear tooth. They occur in the horse, and are thought to represent developmental defects. Lesions are solitary and occur at or near the base of the ear or in relationship to the zygomatic process. They may discharge a grayish mucoid material. Histologically, they may be epidermoid, dermoid, or dentigerous (containing a tooth or teeth). Clinical and surgical management is often difficult because these anomalies have a variable relationship to the facial nerves. **Surgical excision** of the sinus and its tract is required. Incomplete excision is believed to be the cause of recurrence of the condition.

Otitis externa

Otitis externa is an acute or chronic inflammation of the epithelium of the external auditory meatus characterized by an increased production of ceruminous and sebaceous material, pruritis and pain.

Etiology

- **Primary causes** include foreign bodies, parasites (Otodectes), neoplasia, trauma, allergy, climate and endocrine disorders (especially hypothyroidism) and use of irritating cleaners in the ear.
- **Predisposing causes** include conformation of ear canal and that of pinna (floppy ear, excessive hair), treatment errors, maceration of ear canal and ear diseases.
- **Perpetuating causes** include bacteria (*Staphylococcus aureus, Pseudomonas, Proteus, E. coli* etc.), yeasts, otitis media and progressive pathologic changes.
- **Moisture, temperature and humidity** in the ear canal are believed to play a major role in otitis externa.

Clinical signs include head shaking, rubbing and/or scratching of the affected ear, discomfort, head shaking, anorexia and swelling at the base of ear (in chronic cases).

Diagnosis of this condition can be done by:

- Complete otoscopic examination including visualization of the tympanum.
- Cytologic smears and microbial cultures examination provide immediate diagnostic information.

- Radiography of the osseous bulla for adequate visualization of tympanic membrane (in proliferative tissues in canal and otitis media).

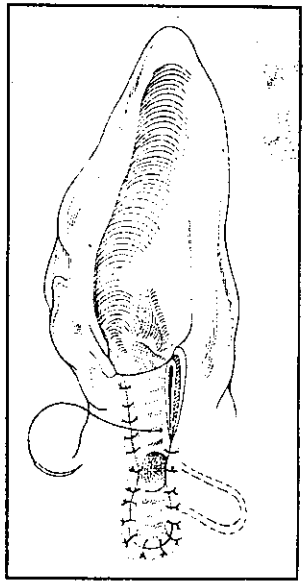
Treatment is based on identifying the underlying primary, predisposing and perpetuating causes and their necessary correction.

Medical management

(*a*) **Medical management** of otitis externa includes irrigation and cleansing the external ear canal with non-irritant solution, use of ceruminolytic agents and antibiotics (aqueous solution) locally or parenterally based on culture and sensitivity test, anti-fungal or parasiticides locally and pH alteration.

(*b*) **Ventilation** of the ear canal by bandaging the ears over the top of the animal's head and clipping of hair from the inside of the pinna and around the external auditory meatus should be done.

(*c*) Application of **least potent corticosteroid** to reduce exudation, pain, swelling and glandular secretions.



Lateral ear resection (Zepp's procedure).

Surgical management is indicated when otitis externa becomes unresponsive to medical therapy. This can be accomplished by lateral ear canal resection (**Zepp's operation**).

Otitis media

Otitis media is the inflammation and infection of the middle ear and is one of the most common causes for relapsing otitis externa, yet often it goes unrecognized. The condition is developed in three ways:

- Extension of infection from the external ear (common in dog).
- Ascending infection via the auditory tube (common in cat).
- Haematogenous spread (rare in veterinary medicine).

Clinical signs

- Headshaking, rubbing or scratching of the pinna with resulting inflammation.
- Purulent discharge within the ear canal.
- Pain on palpation of the base of the ear or upon opening the mouth.
- Behavioural changes and intermittent alteration of the head carriage with the head carried lower on the affected side with unilateral disease.
- Facial nerve palsy (facial and aural drooping) and Horner's syndrome (enopthalmus, ptosis, miosis).

Diagnosis

- Otoscopic examination and evaluation of tympanum.
- In chronic otitis media, radiographs of the skull and tympanic bulla (thickening of

tympanic bulla, fluid or soft-tissue density within the bulla) may be helpful to diagnose the lesion.

- Advanced diagnostic imaging techniques like CT and MRI can also be helpful.
- Myringotomy is the most accurate diagnostic test (in intact tympanic membrane).
- Cytological and microbiological examination of samples taken from tympanic membrane.

Treatment

- **Medical management** of otitis media includes both topical and systemic antibiotic therapies for 4-6 weeks based on the culture and sensitivity results along with removal of debris within the external meatus.
- **Surgical management** is indicated where medical management is no longer effective. This can be achieved by **lateral bulla osteotomy** combined with **total ear canal ablation.**

Chronic otoria

Chronic otoria usually develops because the primary cause is a chronic condition or because perpetuating factors occur and alter the normal anatomy and physiology of the ear canal. The problem most often encountered due to failure to recognize, inadequate treatment or lack of treatment and improper drainage of exudate from external ear canal. The condition can permanently change the size and character of the external ear canal. The epithelium of the canal becomes thickened, fibrous and can become ulcerated. The ear canal can become stenotic if the epithelium becomes excessively scarred or undergoes metaplastic proliferation.

Treatment. ***Medical management*** must be instituted vigorously. Application of "swimmer's solution" (three parts of 70% isopropyl alcohol and one part white vinegar) may be beneficial for long term therapy; it helps to lowers the pH of the ear canal and provides a cleaning-drying action.

Surgical therapy is indicated for this condition which can be accomplished by lateral ear canal resection (**Zepp's operation).**

Procedure of Zepp's operation

Site of operation: From the tragus to a level below the horizontal portion of the canal.

Technique: Two long clamps are applied in the conchal portion at an angle to each other to form a "V" shaped area of the concha; the apex of the "V" should be towards the external auditory meatus. Skin incisions are made close to the jaws of clamps but should not coincide to each other and the incisions are then extended a little downward. A third incision is made at the terminal part to connect them. Skin, subcutaneous tissue and cartilage are then resected. A ventral flap of cartilage attached distally and the skin is sutured to the epithelium of the lateral wall to create permanent exposure of the external ear canal.

Aftercare includes treatment with appropriate systemic antibiotics and management of self-trauma and ear movement.

Total ear canal ablation

Procedure : This procedure is the continuation of the vertical ear canal resection where the horizontal part is also exposed and the horizontal canal is resected at its junction with the ossified part of the canal before its entry to the bulla.

- Care should be taken not to damage the tympanic membrane. Other vascular structure and nerve structure should be protected during the surgery.

- **Facial nerve** runs very close to the ventral aspect of the bulla hence should be taken care to prevent postoperative facial paralysis or paresis.
- **All diseased tissue debris must be removed** to prevent recurrence and fistulation from infection.
- To reduce infection and accumulation of exudate, a **temporary drain** (*e.g.* Penrose drain or rubber tubing) is placed in the deep subcutaneous tissue.
- **Prognosis** following surgery is fair because it alleviates persistent signs of otitis and recurrence after unsuccessful Zepp's surgery is successfully corrected. The major drawback of this procedure is loss of hearing, formation of fistulous tract and facial palsy.

Bulla osteotomy

Bulla osteotomy is indicated for **otitis media** resulting from chronic inflammatory, infectious and neoplastic lesions.

- **Lateral bulla osteotomy** is usually performed in combination with total ear canal ablation in animals with severe and protracted otitis externa and media.
- **Ventral bulla osteotomy** is indicated for diagnosis and treatment of bacterial infection and carcinomas of bulla.

Lateral bulla osteotomy

- **Lateral bulla osteotomy** is performed following removal of the external ear canal.
- Bulla is opened using ronguers, burr, and intramedullary pin using hand chuck.
- The contents of bulla are collected for histologic diagnosis and culture and sensitivity testing prior to curettage and flushing of the cavity.
- Drainage tube is fixed from the bulla to the exterior skin incision for continuous drainage and promoting healing.

Ventral bulla osteotomy

- This procedure allows increased exposure of the tympanic cavity and can be performed alone or in conjunction with lateral ear resection.
- Incise the platysna muscle and deepen the incision by bluntly dissecting the diagastricus muscle.
- Confirm the location of bulla and bluntly dissect tissues from the ventral surface of the bulla and use a Steinmann pin to make a hole in its ventral aspect.
- Enlarge the opening with a small rongeur and examine the interior of the bulla for any lesions and obtain sample for culture, sensitivity and histopathological examination.
- Flushing the cavity with warm saline and placing of a small fenestrated drain tube in the cavity and exit it through a separate stab incision if infection is anticipated.
- Suture the fenestrated portion of the drain tube to the bulla with catgut (4-0 or 6-0).

Tumour in the ear

Aural neoplasms are relatively uncommon compared to the overall incidence of integumentary tumors. Neoplasms of the ear in various animals comprise adenomas and adenocarcinoma, basal cell carcinoma, mast cell tumours, histiocytomas, squamous cell carcinoma, sebaceous gland adenomas, sarcomas and ceruminous gland adenomas. These tumours are likely to arise in the

external ear canal and auditory meatus than in middle and inner ear cavities. In general, tumors external ear are more common than tumors middle and inner ear.



Tumor in front of ear canal of a dog

Clinical signs include swelling, malodorous e or abscess around the ear, deafness and ilt, ataxia, pruritis, local pain, nystagmus or er's syndrome (middle and inner ear vement).

Treatment involves early wide surgical excision to prevent recurrence (benign tumour). Malignant tumours also need to complete resection although recurrence may occur. Because of the invasive nature of most of these tumors, total resection is difficult but radiotherapy or chemotherapy may be beneficial in some animals.

Foreign body tympanitis

The most common foreign body associated with tympanitis is the grass awn (especially during late spring/summer), foxtails, dirt, sand that can migrate to the tympanic membrane of middle ear. Tympanic membrane alterations occur in response to the accumulation of inflammatory debris and adjacent infection as well as in response to the build up of exudate and debris that no longer can migrate out or pass through the occluded lumen. The tympanic membrane may dilate and extend into the tympanic cavity. The pocket, or diverticulum, results in a false form of otitis media. A pocket would form that still allowed for the impaction and sequestering of material from topical therapy. Rupturing or tears in the tympanic membrane in the presence of otitis externa will usually lead to otitis media.

Clinical signs include scratching at the ear, head shaking and suppurative inflammation (in chronic cases).

Diagnosis can be made on otoscopy after flushing the ear canal as severe edema of the epithelial lining of the ear canal can prevent visualization of foreign bodies.

Treatment includes removal of the foreign body with special forceps. Antibiotics and corticosteroids ointments can be necessary to reduce the edema before a foreign body can be detected and removed or after removal to treat secondary infection and inflammation.

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CHAPTER

11

Surgical Affections of the Eye

Anatomical considerations of eye

Orbit : Orbital structure is of two types : open or closed orbital rim. Adjacent to th wall of the orbit is modified connective tissue known as the periorbita, which is continuo the periosteum of the bones. Foramina through which pass the nerves and blood vessels eye and peribulbar structures are present.

Dog, cat, pig, birds have an open orbit with discontinuous bony orbital rim later thick, dense fibrous ligament (orbital ligament) spans the gap between the frontal and zyg bones, which is an important landmark, especially for the administration of retrobulbar medi Horse, cattle, sheep, and goat have a continuous bony orbital rim. Humans and primate completely enclosed orbits, which do not communicate with other portions of the head ex way of the various foramina.

The Anterior Chamber is the space between the cornea and the iris; filled with a humor.

The Choroid is the vascular shell or tunic of the posterior segment of the eye, pr nutrition to the retina.

The Ciliary Body is the vascular tissue where the aqueous fluid is pro The ciliary muscles are the smooth muscles which attach the ciliary body to the lens zonular ligaments.

The Conjunctiva is a fine tissue which lines the inner surface of the eyelids, both s of the third eyelid, and reflects onto the globe where it attaches at the limbus. **The Corne** clear tissue in front of the eye. It is the "window" of the eye. The cornea consists of a layer called the epithelium, the stroma which makes up most of the corneal tissue, a toug called Descemet's membrane, and the endothelium on the inner surface.

The Gland of the Third Eyelid : A tear secreting gland located on the inner surface third eyelid. It is responsible for the production of approximately 30% of the aqueous por the tear film.

The iris is the coloured part of the eye. It consists of dilator and constrictor muscl vascular tissue. The pupil is the opening in the centre of the iris, and is the diaphragm of t When the pupil dilates, more light enters the eye.

The lens is the structure within the eye which allows the image to focus on the retina.

The Lens Capsule is a fibrous covering of the lens.

The Lids: The upper and lower eyelids provide protection for the eye, and the glands within the eyelid margin (meibomian glands) secrete an oily substance which helps stabilize the tear film.

The Limbus is where the cornea meets the sclera.

The Nictitans also called the third eyelid, the nictitating membrane helps protect the eye, helps spread the tearfilm over the cornea, and is involved in tear production.

The Non-Tapetal Fundus is the part of the retina lacking a tapetal layer

The Optic Disk is the structure in the fundus where all the nerve fibres from the retina meet to form the optic nerve.

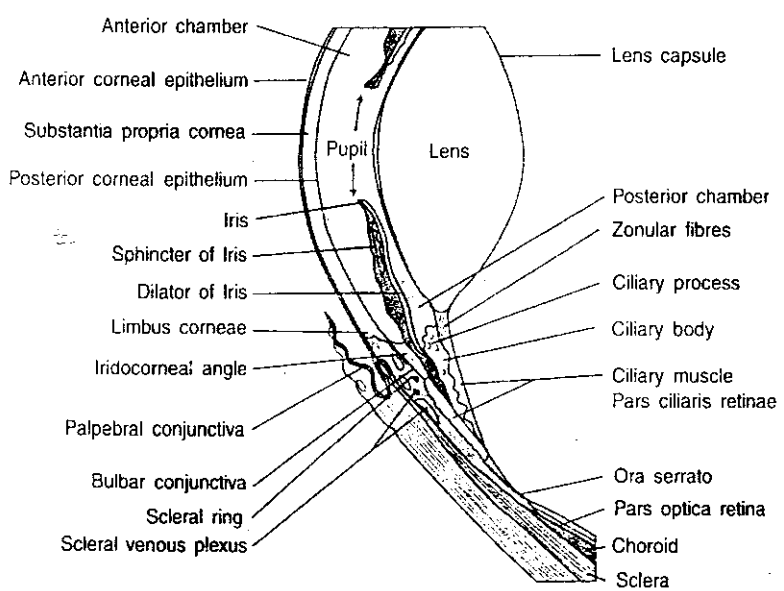
The Optic Nerve is the main sensory nerve running from the eye to the brain.

Posterior Chamber is the space between the iris and the lens, filed with aqueous fluid.

The Retina: The nervous tissue in the eye, upon which the image is cast, and converted to an bio-electrical signal. The rods and cones are involved in this biochemical transformation, and the generated signal travels via the ganglion cells and the nerve fibre layer to the optic nerve and onto the visual centers in the brain.

The Sclera is the fibrous shell or tunic of the eye.

The Tapetal Fundus is the part of the retina bearing a tapetum, a mirror like structure just behind the retina which acts as a light amplifier.



Anatomical structure of eye

The Vitreous is a jelly like material which fills the posterior segment of the eye.

The Zonular Ligaments connect the ciliary muscle to the perimeter of the lens and stabilizing the position of the lens.

Examination of eye

The examination of the eye and periocular structures is essential for the complete evaluation of the patient.

Vision evaluation

- The animal should be observed walking into the examination room with the client, or in its own environment.
- A blind animal may exhibit high stepping, collision with objects, a stare-like expression, or reluctance to move in a strange environment. The owner's impression that the animal "sees" well at home must be interpreted cautiously.
- Animals can "memorize" their own environment. The animal is permitted a few minutes to adjust to the room and observed as the history is obtained.
- The patient's vision can be further evaluated by noting the response to hand movements, bright lights or to cotton balls tossed into the visual field.
- The menace response and the visual placement reaction can also be performed to evaluate the vision.
- In certain circumstances, each eye should be evaluated separately by patching one eye with a bandage or by covering it with one hand.
- The vision examination should be performed in normal light, then in dim light.
- Cats generally do not menace test well, but respond well to bright light stimulation, laser lights, and cotton ball testing.

Ocular examination

- An orderly sequence of diagnostic tests must be followed based on the special requirements of each test.
- Evaluation of the tear film (**Schirmer tear test**) must be done before the eye is manipulated or any drugs are instilled.
- Cultures of the external ocular structures must be done before extensive cleaning is done and before drugs are instilled.
- The use of mydriatics is necessary for examination of the lens and posterior segment, but should not be given prior to measuring the intraocular pressure (IOP).
- The intraocular pressure evaluation requires topical anaesthetic and must be recorded before excessive manipulation or before the patient becomes restless and excited.

Periocular examination: Orbit and adnexa

- Orbits are evaluated for symmetry, eye-orbit relationship, deformities or enlargements.
- The eyelid position may be helpful in determining relative globe size. Looking from over the top of the animal's head helps to estimate globe position. Additional evaluation of the orbit consists of examination of the mouth (floor of the orbit), palpation of orbital rim, retropulsion of the globe, and evaluation of nasal patency, if necessary.

- The presence or absence of strabismus and nystagmus is noted.
- Esotropia (crossed-eyes) is inherited in Siamese cats
- Nystagmus occurs frequently in Siamese, apparently not always associated with clinically detectable vision defects, but in dogs may result from congenital intraocular diseases, or acquired vestibular or cerebellar diseases.
- Special examinations such as standard skull radiography, orbital angiography, ultrasonography, CT and MRI, and surgical exploration may be necessary for a thorough evaluation.

Eyelids

- The eyelids are examined for abnormalities of position, function and structure such as lagophthalmos, ptosis, trichiasis, ectropion, entropion, blepharitis, lid neoplasms, etc.
- The blink reflex should be evaluated. The efferent limb of this reflex requires the integrity of the facial nerve (CN VII) and the orbicularis oculi muscle. The afferent limb may be a menace (CN II), corneal sensation (CN V) or touch sensation to the periorbital skin (CN V). Rapidity and completeness of the blink should be evaluated.
- The lower and upper eyelids should touch the globe. Lower lid-globe contact is important to prevent accumulation of tears and debris. The lower "lacrimal lake" may be grossly distorted by anesthetics and tranquilizers.
- Cilia or eyelashes occur mainly on the dog's upper lid in three irregular rows.
- The lower eyelids of dogs and both eyelids of cats are usually void of cilia.
- The eyelid contours are regular and gently curved, partially exposing the openings of the tarsal or Meibomian glands (gray line). The duct orifices are frequently raised and nonpigmented.

The Conjunctiva and the Nictitating membrane

- The palpebral conjunctiva is examined by manual eversion of the upper and lower eyelids. Excessive lymphoid follicles, increased vascularity, foreign bodies, ectopic cilia, obstructed tarsal glands, hemorrhage, lacerations, abnormal growths and edema (chemosis) may be abnormalities observed.
- Coloration of the conjunctiva can be used to assess the presence of anaemia and icterus. Because the palpebral conjunctiva is transparent, chalazia or impacted Meibomian glands appear as slightly raised yellow masses.
- Examination of the palpebral and bulbar surfaces of the nictitans is important for diagnosis of several common external ocular conditions. Frequent abnormalities are eversion of the cartilage of the nictitans, prolapse of the gland (cherry eye), foreign bodies, follicular conjunctivitis, enlargement of the secretory gland, foreign bodies, follicular conjunctivitis, and enlargement of the bulbar lymphoid tissue.



Cherry eye in dog

The Sclera

- Look for change in colour, abnormal masses, and tears or lacerations.
- Small vessels in the episclera are usually visible and occasionally a large vortex vein (especially the dorsolateral vein) can be seen.
- Enlargement and congestion of the episcleral veins occur commonly with *glaucoma*. This venous enlargement remains even after the glaucoma is controlled.
- Hyperemia of the episcleral vessels is evident in inflammatory conditions. The limbal hyperemia from *iridocyclitis* is usually less affected by topical phenylephrine while that associated with the conjunctivitis will usually blanch.

The Cornea

- Corneal reflex is tested prior to topical anaesthetic instillation by a small wisp of cotton gently touched to the cornea. If the animal sees the stimulation, false positive result is obvious.
- The cornea is normally transparent, avascular, moist, and unpigmented with a smooth, even contour. It should be carefully examined for loss of transparency (edema or infiltrates), opacity, vascularization, pigmentation, dryness, growths, foreign bodies, lacerations, changes of contour, and ulceration.
- Two types of vascularization occur in the cornea: superficial and deep.
- In external corneal diseases, superficial vessels in the anterior one-half of the corneal stroma are usually continuous with visible conjunctival vessels ("tree-like").
- Deep vessels appear as small, fine vessels in the corneal stroma that extend from the anterior sclera or deeper limbal vessels and are associated with intraocular inflammation.
- **Fluorescein test** is used to demonstrate the presence or absence of corneal ulcers. Fluorescein impregnated paper strips are touched to the cornea, a faint green may occur on the corneal surface. The corneal epithelium is lipid-selective and prevents any appreciable corneal penetration by fluorescein. The dye rapidly diffuses into the corneal stroma in presence of corneal epithelial defect. Fluorescein retention by corneal stroma is indicative of an epithelial defect (a corneal ulcer/erosion).
- **Rose Bengal stain** is very useful to study the health of the corneal and conjunctival epithelium. It produces a brilliant red coloration of any dead or degenerating cells, and indicates defects in the mucin layer of the tear film. Rose Bengal is retained by the cornea and conjunctiva in early fungal keratitis, keratoconjunctivitis sicca, pigmentary keratitis, exposure keratitis, viral keratitis, and certain other corneal ulcers.

The Anterior chamber

- In uveitis, aqueous flare is noticed.
- Compare the depth of the anterior chamber between the two eyes.
- The iris is examined with a focused beam of light and magnification for colour, shape, pupil size, surface, and movement.
- In acute iritis, the iris may appear congested and swollen with loss of detail, and it may become darker in appearance with chronicity.

The Lens

- The lens, which is normally a transparent avascular structure, should be examined for opacities (cataracts), position, presence, and size.
- Focal cataracts should be localized within the various parts of the lens as prognosis and etiology may be suggested by location.
- Nuclear cataracts are usually stationary while those affecting the equator or posterior cortex are often progressive.
- By slit lamp biomicroscopy, the canine lens may contain focal imperfections that are not "cataractous."
- Early cataract formation, evidenced usually as focal crystallization, vacuoles and water clefts, can be detected long before visual disturbances occur.
- Localization of focal cataracts can be performed using the tapetal reflex to highlight the opacity and then observing which direction it moves as the animal's eye moves.
- For practical purposes, in the dog and cat, the center of axis of rotation of the eye is the center of the lens. Thus if a cataract is in front of the lens, it will move with the eye movement. If a cataract is in the back of the lens, it will move in the opposite direction of the eye movement. Location of a cataract may give clues about its cause i.e. inherited or associated with PRA (Progressive Retinal Atropy).
- Nuclear sclerosis of the lens begins to develop in dogs around 6 years. Biomicroscopic examinations can detect refractive changes between the lens nucleus and cortex as early as three years of age in dogs.
- Advanced nuclear sclerosis is clinically evident as a blue zone limited to the lens nucleus that does not impair ophthalmoscopic visualization of the fundus and does not impair vision.
- This is frequently mistaken for cataract formation in older animals.

The Vitreous

- Ophthalmoscopy or the slit lamp biomicroscopy with added lenses is required to study the posterior aspect of the vitreous.
- Frequently seen vitreous abnormalities include vitreous strands, asteroid hyalosis, haemorrhage and infiltration with inflammatory cells. Small remnants of the hyaloid vasculature (seen as white strands) are frequently encountered behind the central posterior lens capsule in the vitreous immediately posterior to the lens.
- Liquefaction of the vitreous is called syneresis, and opacities that occur in the liquefied state are called "synchysis scintillans". These opacities often rise and fall in the vitreous as the eye moves.
- Vitreous opacities tend to move slightly or oscillate within the gel vitreous after eye movement ceases.

The Fundus

- The ocular fundus is examined last and requires direct and/or indirect ophthalmoscopy.
- Although the fundus can be viewed without drug-induced mydriasis, dilation of the pupil greatly facilitates examination of the complete ocular fundus.

- The ocular fundus is examined for changes in the normal appearance, detachment of the retina, chorioretinal hypoplasia or dysplasia, vascular patterns, attenuation, congestion, haemorrhage, colobomas, scars, alteration in coloration, changes in pigmentation and foci of inflammation.
- The optic disc should also be examined for size, shape, color, masses, and pits or colobomas.
- Swelling and inflammation of the optic disc occurs with optic neuritis, which is characterized by blindness.

SPECIAL DIAGNOSTIC PROCEDURES

Pupillary light reflexes (PLRs)

- The size of the pupils is evaluated and the direct and consensual pupillary light reflexes are tested.
- This should be done with a bright light in a dimly lit room.
- The pupillary light reflexes are affected by the psychic state of the animal, room illumination, age, many topical and systemic drugs and the intensity of the light stimulus.
- Older animals may exhibit slow and incomplete pupillary light reflexes resulting from atrophy of the iris sphincter muscle. This is common in small dogs, especially poodles.
- The pupillary margin may have an irregular or scalloped appearance. Incomplete iris atrophy may give an irregular pupil shape.
- The rapidity of pupillary light response, extent of miosis and ability to maintain miosis to constant light stimulation are evaluated.
- The consensual pupillary reflex is normally equal to the direct. The pupillary light reflexes require integrity of retinal neural cells, optic nerves, optic chiasm, optic tracts, midbrain (Edinger-Westphal nuclei), and parasympathetic fibers via the oculomotor nerve, ciliary ganglia and the iridal sphincter musculature. The reflex is subcortical and should be considered an evaluation of the retina and optic tracts, not of vision.
- Drug induced mydriasis is not used indiscriminately. The instillation of mydriatics is avoided in animals with predisposition to, or overt glaucoma, and lens luxation. Young puppies dilate slowly, often incompletely, and may require multiple drops. Mydriasis produced by darkening the room may permit a cursory but not complete examination of the ocular fundus.

Corneo-conjunctival cultures and cytology

- Corneo-conjunctival cultures and cytology are helpful in the diagnosis and classification of corneal and conjunctival diseases. The procedures are especially valuable in chronic, severe and non-responsive external ocular conditions.
- The cultures should be done before any administration of drops, since many of the drugs contain bacteriostatic agents.
- Sterile swabs are used to collect material for culture. The swab should be moistened. The moistened swab is rubbed over the area to be cultured taking care to avoid skin, hair and other nearby structures. Bacterial identification and disc sensitivity tests aid in the choice of antimicrobial therapy.

- To obtain a specimen for cytologic examination topical anaesthetic is instilled 2-3 times over a few minutes and the animal's head and muzzle are held firmly by the assistant.
- To obtain a conjunctival scraping, the lower eyelid is everted and the ventral conjunctival surfaces are vigorously rubbed with a stainless steel or platinum spatula. The collected material is distributed onto glass slides. Ideally, conjunctiva should be scraped vigorously enough to obtain basilar cells without inducing hemorrhage. To obtain a smear of exfoliated cells, a moistened dacron tipped applicator is rubbed along the conjunctival *cul-de-sac* and then rolled on glass slides.
- The specimens are stained with new methylene blue, Gram's, Wright's, Giemsa's, or modified Sani's methods.

Schirmer Tear Test (STT)



Schirmer tear test

- It is the qualitative examination (aqueous tear production) of the tear-producing system.
- Excessive manipulation of the eyelids, topical anaesthesia and exposure to other topical and systemic drugs (such as tranquilizers and atropine) are avoided before the test.
- Increased tear production because of corneal irritation during the test appears to be of little significance in the dog and the cat.
- The round end of the test paper is bent while still in the envelope and positioned without contamination in the lacrimal lake at the junction of the lateral and middle thirds of the lower eyelid. The animal usually closes its eyelids during the test.
- The STT strip should be left in position for one minute. After one minute, the paper is removed and measured on a millimeter scale on the paper envelope.

Schirmer values :

Dog : 21.9 +/ 4.0 mm wetting/minute

Rabbit : 5.3 +/ 2.9 mm wetting/minute

Cat : 20.2 +/ 4.5 mm wetting/minute

Phenol Red Thread (PRT)

- The Phenol Red Thread Test is a new, fast and equally accurate method to assess tear production.
- In the PRT tear test, the thread is 75 mm long and is impregnated with phenol red, a pH-sensitive indicator. A 3 mm indentation at the end of the thread is inserted into the inferior conjunctival sac for 15 seconds. The alkaline tears turn the pale yellow thread red. A test time of 15 seconds is required compared to the 5 minutes needed for the STT in humans or the 1 minute in dogs.
- Anaesthesia is not necessary for the PRT tear test because the subject has little or no sensation from the thread.

PRT values

Cats : 23.0 mm ± 2.2 mm/15 seconds.

Dogs : 29.7 to 38.6 mm/15 seconds.

Test for tear drainage

- The excretory component of the nasolacrymal system is evaluated by the presence or absence of medial canthal tearing; passage of fluorescein instilled onto the eye; nasolacrymal flush; catheterization of the entire system, and by dacryocystorhinography.
- **Passage of fluorescein** from the eye to the external nares is a reasonable test for patency of the nasolacrymal system. A strip of fluorescein is moistened with a few drops of sterile eyewash and touched to the upper bulbar conjunctiva. The dye usually appears at the external nares in 3 to 5 minutes. Both sides should be performed at the same time to compare passage times. Ultraviolet light enhances detection of the dye.
- Fluorescein passage in brachycephalic dogs is not reliable as the dye may exit more readily into the nasopharynx. The animal's tongue and saliva should be examined with a UV light in these cases.
- The **nasolacrymal flush** determines patency of the system and the treatment of many of its disorders. The upper punctum is cannulated with a 22-23 g blunt lacrimal needle or 22-24 gauge teflon catheter under topical anesthesia. Tranquilization or general anesthesia is seldom necessary for the dog but often necessary for the cat. A 2 to 3 ml plastic syringe with sterile saline is used to inject the solution through the upper punctum, canaliculus, nasolacrimal sac, lower canaliculus and out the lower punctum. Once this "arc" is established, the lower punctum is compressed digitally and the solution is forced through the nasolacrymal duct and out the external nares.

EXTERNAL OPHTHALMIC STAINS

Fluorescein

Examination of the cornea is incomplete without utilization of topical ophthalmic stains. Fluorescein is used to demonstrate the presence or absence of corneal ulcers. For topical use, fluorescein impregnated paper strips are preferred to fluorescein solution to insure sterility.

Rose Bengal

Rose Bengal is retained by the cornea and conjunctiva in keratoconjunctivitis sicca, early fungal keratitis, pigmentary keratitis, exposure keratitis, viral keratitis, and certain other corneal ulcers.

Intraocular pressure measurement (Tonometry)

- Intraocular pressure (IOP) can be estimated by digitally, Schiotz tonometry or applanation tonometry. Subtle elevations in intraocular pressure, repeated measurements of glaucomatous eyes under medical treatment, or after surgical intervention require instrument tonometry.



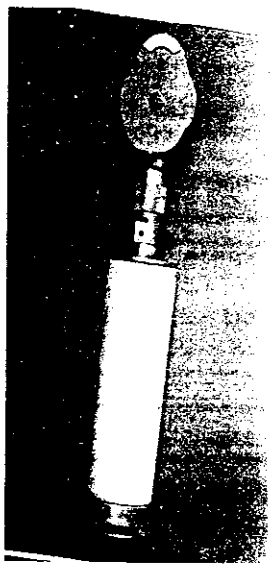
Intraocular pressure measurement (Tonometry) in dog

- Applanation tonometers (especially the Tonopen type) are very accurate and easy to use. Applanation tonometers are becoming more common in practices. The Tonopen applanation tonometer has made it much easier to diagnose and treat the animal glaucoma.

IOP is 16.8 ± 4.0 mm Hg in dogs; 20.2 ± 5.5 in cats; and 23.2 ± 6.9 in horses.

OPHTHALMOSCOPY

Direct Ophthalmoscopy



Ophthalmoscope

- Direct ophthalmoscopy is used more frequently by practitioners than indirect ophthalmoscopy. However, both techniques have advantages that complement each other when used together.
- The method is termed "direct" because a condensing lens is not interpositioned between the ophthalmoscope and the patient's eye. The examiner has a direct optical image of the patient's eye. The fundus image is real, upright and approximately about 17 to 19 times magnified in dogs and cats. The fundus area visualized is about 10 degrees or approximately 2 disc diameters.
- In performing ophthalmoscopy, the patient's body and head are minimally restrained by an assistant. The examiner holds the muzzle and/or lids with one hand and with the other hand holds the ophthalmoscope to make the necessary diopter changes. It is preferred to view the tapetal fundus several inches from the patient and then move to 1 to 2 inches from the patient's eye when the optimum focus is achieved and the animal has adapted to the restraint. The diopter setting is usually started at "0" and adjusted to between +3 to −3 diopters to provide the sharpest image possible. By using more positive lenses the lens can be seen at +8 to +12 diopters and the cornea at +20 diopters.

Indirect ophthalmoscopy

- Indirect ophthalmoscopy complements direct ophthalmoscopy.
- To perform indirect ophthalmoscopy, a fairly bright light source is directed into the eye. A condensing lens is interposed between the light source and the eye. Incident light is condensed to illuminate the fundus. The reflected light then is condensed by the same lens to form a virtual, inverted, and reversed image between the lens and the light source.
- The **advantages** of binocular indirect ophthalmoscopy are penetration of cloudy media, large field of view, examination of the peripheral fundus, ease of compensation of refractive errors and eye movements, stereopsis, greater distance between examiner and patient, two to three simultaneous observers and the ability to readily examine the more intractable patients with fewer hazards to the examiner. The **disadvantages** include less magnification for studying particular areas, and the need for drug-induced mydriasis.
- Indirect ophthalmoscopy can be employed with only a light source and a lens. The indirect ophthalmoscope is adjusted so the light is slightly off center of the examiner's visual field (to reduce glare). The patient's muzzle is held gently and the lens is positioned 3 to 5 cm from the cornea and the upper eyelid retracted. The lens is usually held close to the cornea initially to permit observation of the ocular fundus and then moved away from the eye until the image is maximum size. When the hand lens is interposed between the light source and the eye, the fundus is visualized. Image magnification (2X to 4X) is dependent on the dioptric power of the hand lens. The +20 lens is the most versatile. Occasionally, an annoying light reflection occurs and is remedied by slightly tilting the hand lens.
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Dacryocystorhinography

- It is **contrast radiographic study** of the **entire nasolacrymal drainage apparatus.**
- This is used to identify obstructive lesions of nasolacrymal duct in the dog.
- Under general anesthesia, the nasolacrymal duct is first flushed with 0.9% sterile saline to clear loose debris and to determine patency.
- 0.5-1 ml contrast agent is injected in the upper punctum after canulation until it emerges from lower punctum and external nares.
- Lateral, dorsoventral and oblique radiographs are taken. This helps in outlining the nasolacrimal drainage apparatus, thereby revealing dilatation, osteolysis associated with chronic inflammation and exposing both the site and extent of nasolacrimal obstructions.
- Nasal neoplasms that obstruct or deviate the duct can be delineated with this procedure, whereas those that invade the nasolacrimal duct may lead to spillage of contrast material into nasal cavity.

Fluorescein angiography

- Animal is sedated and pupils dilated, eye and fundus or video camera is aligned and control photographs are taken.
- Fluorescein is then injected as a rapid bolus via an IV catheter and photography is initiated @ 1 every 2 seconds after the injection. After 20 seconds photographs are taken 1, 5 and 10 minutes following injection. Phases of fluorescein angiogram includes prefilling, choroidal, retinal capillary, retinal venous and recirculation.

Slit-lamp biomicroscopy



Slit-lamp

- It enables the examiner to identify and localize even the more subtle lesions of cornea, anterior chamber, lens and anterior vitreous.
- When combined with special lenses the slit–lamp biomicroscope can be used to evaluate the iridocorneal angle and ciliary cleft.

- Following instillation of 1% tropicamide initially, diffuse illumination is used to locate the eye and to inspect the surface of eyelids, cornea, conjunctiva and iris.

Gonioscopy

Gonioscope is special contact goniolens is placed on the cornea to evaluate iridocorneal angle (for detection of glaucoma) and ciliary cleft. Other uses of gonioscopy include evaluation of peripheral anterior synechiae, peripheral iris cysts, neoplasm, foreign body, granuloma and anterior segment colobomas.



Gonioscope

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CHAPTER 12

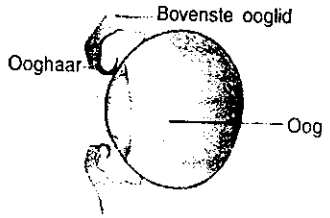
ENTROPION

Entropion is defined as inversion of the eyelid margin which results secondary trichiasis (misdirected hairs of the eyelids). The lower lateral eyelid is usually involved but depending on the breed, any part of the eyelid margin can be involved.

Clinical signs vary from epiphora to corneal perforation.

Classification:

- primary (anatomical)
- spastic (physiological)
- cicatricial (scarring)



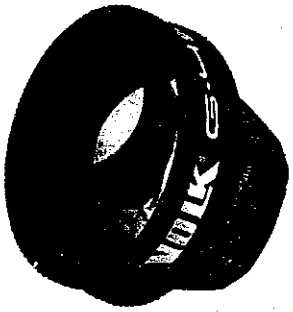
Primary (anatomical) :

- Primary entropion results from a structural abnormality of the eyelid/tarsal plate.
- Primary entropion is differentiated from secondary entropion by response to topical anaesthetic. After instillation of topical anaesthetic if entropion persists, there is no spastic component.
- When entropion occurs in immature animals, temporary "tacking sutures" by placing several vertical mattress sutures at the haired-nonhaired junction (approximately 3 mm from the eyelid margin) at partial-thickness depth in the lid and apposing to the skin overlying the bony orbital margin result in eversion of the eyelid margins. Tissue adhesives or staples have also been used to tack eyelids.
- Placement of tacking sutures often eliminates the need for surgical correction of entropion later in life.
- In mature animals, **blepharoplastic surgical technique** is followed to correct entropion. The shape, size, and location of the surgical incision vary with the breed, age, severity, and location of entropion. Silk sutures are recommended in this purpose.
- Medial canthus entropion is a common cause of epiphora in brachycephalic canine and feline breeds, and also occurs in canine breeds with tense eyelid-to-globe conformations (Toy and Miniature Poodles, Bichon Frise, Maltese, etc.). The lesion may

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Gonioscope

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CHAPTER

12

Surgical Affections of Eye

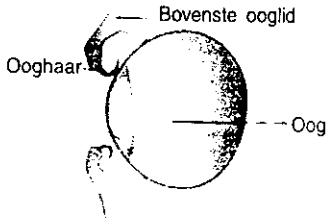
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be subtle and is often overlooked as a cause of epiphora. **Medial canthoplasty** surgery is required.

- Care should be taken to avoid accidental incision at the canaliculi.
- Use of Elizabethan collar is recommended post-operatively to prevent self-excoriation of the surgical area.

Spastic (physiological)

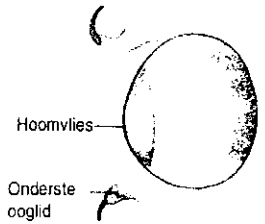
- Spasm of the orbicularis oculi muscle in response to ocular pain or irritation results in spastic entropion. Secondary trichiasis may result, which causes further ocular pain, additional blepharospasm, and more pronounced entropion.
- Topical anaesthesia relieves the spasticity of the ocular muscles and confirms the condition. In chronic condition, spastic entropion may become cicatricial secondary to tarsal fibrosis.
- Treatment is aimed at removing the cause of ocular pain and placement of temporary tacking sutures.

Cicatricial

Cicatricial entropion results from trauma or faulty eyelid surgery or from chronic spastic entropion. Cicatricial entropion is less common and surgical correction is more difficult to achieve.

ECTROPION

Ectropion is eversion of the eyelid margin. This may result in exposure of the conjunctiva (usually lower) but is usually less serious than entropion. Ectropion may also notice secondary to instability of the lateral canthus and is misdiagnosed as primary ectropion.



Classification

- *Conformational ectropion* : It is the most common cause of ectropion commonly seen in Spaniel and hound breeds
- *Neuroparalytic ectropion* : Facial nerve damage may result in this condition.

Clinical signs of ectropion include visualization of the lower conjunctiva, and may include conjunctival hyperemia, keratitis, and mucus accumulation in the lower conjunctival cul-de-sac.

Surgical maneuver : Correction of ectropion is indicated only when the ability of eyelid to blink is intact and abnormalities of the cornea are evident. Surgical correction by full-thickness wedge resection is simple and effective. A "V to Y" blepharoplasty can also be used for cicatricial ectropion. This elevates skin overlying scar tissue and allows the eyelid margin to retract to a more normal position.

GROWTHS AND TUMOURS OF EYELID

Neoplastic eyelid diseases

- Canine eyelid neoplasms generally have a benign biological behavior and can usually be differentiated based on clinical appearance.

- In stark contrast to eyelid neoplasms of dogs, those of cats have a malignant biological behavior and can not be differentiated from each other based solely on clinical appearance.
- Feline eyelid neoplasms may all be raised, alopecic, and eventually ulcerate. Cytological examination of fine needle aspiration and biopsy samples of feline eyelid masses may reveal specific type of neoplasm. Feline eyelid neoplasms should always be submitted for histological identification.

Eyelid neoplasms

Meibomian (Sebaceous) adenoma : It is the most common eyelid neoplasm of dogs and is observed at the eyelid margin, near the Meibomian orifice. Surgical maneuver includes debulking and adjuvant cryosurgery or full-thickness eyelid resection.

Melanoma : Lid melanomas are usually benign and most frequently recorded in older dogs of heavily pigmented breeds. This tumour is usually slow growing, may be multiple, and is cryosensitive.

Papilloma : Papilloma is usually seen in young dogs. Surgical removal is recommended if a rapid increase in size or irritation to the cornea is evident. Papilloma may spontaneously regress in young dogs. It is very cryosensitive.

Adenocarcinoma : Adenocarcinoma and Meibomian gland adenoma can not be differentiated based on clinical appearance. Adenocarcinoma is histologically malignant but benign biological behavior is the rule. It is also cryosensitive.

Histiocytoma : Histiocytoma is mostly observed in young growing dogs. Histiocytoma is always raised, less than 1 cm in diameter, pink in color, hairless, and has a characteristic rapid growth pattern. Histiocytoma can regress spontaneously between 3 and 5 weeks after it appears.

Squamous cell carcinoma : Squamous cell carcinoma is the most common eyelid neoplasm of cats which is characterized by very rapid growth, highly invasive locally, with a tendency to ulcerate early and occasionally late metastasis to regional lymph nodes or organs.

Treatment options include wide surgical excision and adjuvant radiation, cryosurgery, interstitial brachytherapy, or hyperthermia.

Basal cell carcinoma : Basal cell carcinoma is another common eyelid tumour of cat. This looks like a discrete circular nodule that develops an ulcerated surface. Eyelid basal cell carcinoma in cats ulcerates with equal frequency as other eyelid neoplasms, unlike those located elsewhere on the body.

Fibrosarcoma : Fibrosarcoma is a firm, raised, alopecic, mass that also may ulcerate. It may be associated with FeLV (Feline Lukemia Virus) infection.

Mast cell tumor : Characteristics of this tumour is similar to that of Fibrosarcoma but generally has the best prognosis of all eyelid neoplasms in the cat. Local excision with appropriate surgical margins may be curative.



Tumour in eye in a monkey

Affections of conjunctiva

Nonspecific conjunctival responses to disease

1. **Conjunctival hyperemia** may result in response to a variety of local and systemic diseases. Conjunctival hyperemia should not be used synonymously with conjunctivitis until and unless other criteria for inflammation are fulfilled,
2. **Conjunctival haemorrhage:** Rupture of the conjunctival capillaries due to external trauma may result in haemorrhage which usually occurs into the subconjunctival tissue. Generally, treatment is not required and the haemorrhage will spontaneously resolve in several days. However, conjunctival haemorrhage should warrant to perform a complete ophthalmic examination to determine if concurrent intraocular damage has occurred.
3. **Chemosis:** It is the condition where there will be edema of the conjunctiva. It may result from local allergic reactions, irritating/traumatic stimuli, in presence with infectious (upper respiratory) disease (chlamydiosis in cats), or obstruction of orbital venous drainage. Affected part appears pale or dark and swollen. Underlying cause should be removed to cure the disease.
4. **Lymphoid Follicle formation** is generally seen on the bulbar surface of the nictitating membrane. Chronic physical irritation (*e.g.*, entropion, trichiasis) or antigenic stimulation (*e.g.*, allergies) is the most common cause.
5. **Pigmentation:** Chronic irritation (trichiasis, ectopic cilia, keratoconjunctivitis sicca or inflammation may result in hyperpigmentation of the conjunctival epithelium.

Conjunctival Neoplasms

Melanomas, squamous cell carcinomas, angioendotheliomatosis, mast cell tumors, haemangiomas, haemangiosarcomas, angiokeratomas, papillomas, lymphosarcomas and histiocytomas are some of the neoplasm of the conjunctiva. Combined excision and cryotherapy are advised treatment.

Non-neoplastic conjunctival masses

- Informatory modules.
- Displaced orbital fat.
- Cyst.
- Conjunctival dermoid.
- Parasitic granuloma.
- Onchocerciasis due to *Onchocerca liennalis* causes granuloma of conjunctiva. Manual removal of the worm is curative method.

Conjunctival manifestations of systemic diseases

1. Leishmaniasis.
2. Listeriasis.
3. Hepato zonosis.
4. Tyrosinemia.

A. Conjunctivitis

Primary conjunctivitis attributable to infectious pathogens is exceedingly rare in dogs whereas feline conjunctivitis is almost always primary and attributable to infectious pathogens (viral, chlamydial, or bacterial). Bacterial conjunctivitis in dogs occurs mostly secondary to an underlying disease that alters normal resident conjunctival flora and favors bacterial proliferation. **Allergy/ hypersensitivity** is the common causes of conjunctivitis in the dog.

Affections of conjunctiva can be classified as :

1. Infectious affections.
2. Non-infectious affections.

Infectious Conjunctivitis : Infection is by specific pathogens. Secondary conjunctivitis is more common leading to keratoconjunctivitis.

(*a*) **Bacterial conjunctivitis :** Bacterial conjunctivitis develops secondary to eyelid abnormalities or keratoconjunctivitis. Causative organism is *Staphylococcus* sp and other gram positive organisms.

(*b*) **Viral conjunctivitis :** Canine distemper virus is one of the cause. It produces mucopurulent discharge.

(*c*) **Fungal conjunctivitis :** Infection with Blastomyces dermatitis causes nodule formation. Itraconazole is drug of choice.

(*d*) **Rickettsial conjunctivitis :** *Rickettsia rickettsii* causes vascular lesions of conjunctiva, uvea and retina. Canine Ehrlichiosis causes serous ocular discharge and conjunctival haemorrhage, anterior uveitis and retinal haemorrhage.

(*e*) **Parasitic conjunctivitis :** Thelazia spp. infects the conjunctival sac causing chronic conjunctivitis. The worms are susceptible to Tetramisole as 0.5% solution.

Non infectious conjunctivitis

(*a*) **Allergic conjunctivitis :** It occurs in combination with Atopic dermatitis. Pollen grains, dust, bacterial toxins are some allergens. Chemosis (edema of conjunctiva), hyphemia, serous ocular discharge is noticed in this conjunctivitis. Corticosteroids are administered to treat this condition.

(*b*) **Follicular conjunctivitis** results due to chronic antigenic stimulation (entropion, allergy) and is characterized by clear vesicles in the ventral conjunctival cul-de-sac of young, large-breed dogs. In severe, acute onset, allergic conjunctivitis may cause serous ocular discharge and profound chemosis. In chronic cases, hyperemia and mucoid discharge are more typical. Topical application of corticosteroids resolves follicular conjunctivitis.

(*c*) **Plasma cell conjunctivitis** is manifested by thickened, "cobblestone" appearance to the surface of the nictitating membrane. It may be associated with sub-epithelial corneal infiltration (**pannus**). Topical corticosteroids and/or topical cyclosporine application can control the conditions.

(*d*) **Conjunctivitis associated with tear deficiencies :** Keratoconjunctivitis sicca is a result of frequent development of secondary bacterial conjunctivitis in the dog.

(*e*) **Ligneous conjunctivitis :** Thickened, hyperaemic palpebral conjunctiva with proliferation of opaque membranes is observed in Ligneous conjunctivitis. Immunosuppressant drugs are good option to cure this condition.

Conjunctivitis due to anatomical abnormalities. Anatomical abnormalities cause conjunctivitis.

(*a*) **Medial canthal pocket syndrome :** Enopthalmia, deep orbits, narrow skull slight entropion and inadequate tear discharge cause conjunctival affection.

(*b*) **Medial Aberrant Dermis (Carunular Trichiasis) :** It occurs in brachycephalic breeds of dogs. Surgical removal of the aberrant dermis and cryotherapy resolve the problem.

Conjunctivitis caused by trauma. Grass awns and other plant materials cause blepharospasm, mucoid discharge, hyperemia and corneal ulcers. Mechanical removal of the irritating agents relieves the condition.

Common causes of conjunctivitis in the cat include : **Herpes virus** (FHV-1), **Chlamydia, Mycoplasma, Calicivirus,** and **Eosinophilic conjunctivitis.**

Occlusion of nasolacrymal duct

Etiology

- Congenital absence of inferior canaliculus.
- Inflammatory condition of the nasolacrymal apparatus (*e.g.* dacryocystitis).
- Presence of foreign body.
- Secondary to scarring—traumatic, inflammatory.



Occlusion of naso-lacrimal duct in dog

Signs. Depends on cause.

(*i*) ***Inflammatory/foreign body***

- Epiphora—mucopurulent discharge.
- Conjunctivitis.
- Pain on palpation of medial canthus region.
- Abscessation in severe cases.

(*ii*) ***Congenital/scarring/neoplastic***

- Epiphora.

Imperforate puncta or punctal membranes are most commonly seen in American cocker spaniel, toy and miniature poodle.

Diagnosis

(*a*) Negative fluorescein passage.

(*b*) Flushing duct to recover material.

(*c*) Dacryocystorhinography.

Treatment

- Systemic antibiotics (topical and /or systemic)—to control infections.
- Anti-Inflammatory drugs (topical and /or systemic).
- Corticosteroids (Topical)—in non-infectious origin. It should not use if concurrent corneal ulcer is present.

Squint (Strabismus)

Abnormal deviation in the position of the eyeball is termed as **squint** or strabismus.

Classification : On the basis of the direction of deviation of the eyeball it can be grouped as :

- **Horizontal squint :** Deviation is along a horizontal plane. Further it may be lateral (divergent) squint and medial (convergent) squint.
- **Vertical squint :** Deviation is in the vertical plane. It may be in the form of an upward deviation of the eyeball or a downward deviation of eyeball.
- **Oblique squint :** Deviation is in a direction other than the horizontal or vertical plane.

Etiology

- Congenital.
- Infection in the middle ear, brain tumours, meningitis etc.

Treatment

Surgical treatment is indicated when the condition is not associated with any apparent disease. The principle of treatment is to severe the offending eye muscle to correct the position of the eye ball.

Technique

- Keep the eyelids well dilated with a speculum.
- Lift the conjunctiva with a conjunctival forceps in the level of the muscle to be divided and incised.
- Introduce a strabismus hook to locate the muscle to be divided.
- Severe the muscle close to its scleral attachment with a narrow, thin bladed knife introduced through the conjunctival wound.
- The eyeball may rotate to the normal position as soon as the muscle is severed.
- Release the eye speculum.
- Apply a suitable antibiotic eye ointment and protective bandaging daily till the healing is complete.

Prognosis : Guarded.

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CHAPTER

13

KERATITIS

Keratitis is inflammation of the cornea. Keratitis has numerous causes, some specific, others incidental or secondary. A diagnosis of keratitis usually must be qualified by stating the predisposing or actual cause because the use of keratitis alone is non-specific.

General signs

- **Pain**-The more superficial the lesion, the more painful condition due to presence of the nerve endings.
- **Iridocyclospasm** followed by **photophobia** and **blepharospasm**. All these may cause self-mutilation.
- **Lacrimation** leads to **epiphora**. The discharge may become mucopurulent especially if bacterial infection occurs.
- **Conjunctival hyperemia.**
- **Loss of corneal transparency** due to edema, cellular infiltration, vascular in growths.
- **Impaired vision**—If severe and bilateral.
- If bilateral severe **blepharospasm** is associated with the disease, this also would cause temporary loss of vision because of the closed eyelids.

Classification

Superficial keratitis—It is characterized by corneal vascularization and opacification, which may be due to edema, cellular infiltrates, pigmentation, or fibroplasia.

Etiology : Traumatic, Mechanical factors, such as lid conformational defects and foreign bodies, secondary invasion by bacteria and, in horses, by saprophytic fungi. Bilateral superficial keratitis may be immune-mediated or associated with a lack of tears, eyelid conformational defects, or infectious agents

Interstitial keratitis is a deep involvement of the corneal stroma with all chronic and many acute cases of anterior uveitis. The corneal vascularization is less branching, finer, and deeper than in superficial keratitis; if the endothelium has been disrupted, corneal edema is often marked.

Etiology : Systemic diseases, such as infectious canine hepatitis, malignant catarrhal fever, systemic mycoses, and septicemias that localize in the eye, can cause bilateral or unilateral interstitial keratitis.

Therapy is directed at the treatment of anterior uveitis, the systemic infection, or both.

Ulcerative keratitis may be superficial, deep with or without descemetocele, or perforating. Pain (more in superficial ulcer), corneal irregularity, edema, and vascularization are signs of ulceration. A dense, white infiltrate at the margin of the ulcer bed indicates strong leukotaxis and bacterial involvement.

Small ulcers may be diagnosed by application of topical fluorescein.

Etiology :

1. Infections:

Bacterial : *Pseudomonas*; *Moraxella* (cattle)

Viral : canine distemper, herpes virus, infectious bovine rhinotracheitis.

Mycotic : *Chlamydophila* among numerous species, horse most commonly affected.

2. Neurotrophic : Non-function of ophthalmic branch of trigeminal nerve with the history of recent trauma to head. The ulcer does not arise simply due to lack of innervation, but may be associated with trauma to an eye which has lost an important defense mechanism against corneal irritation, the blink reflex.

3. Metabolic disturbances : Hypoestrogenism (*e.g.*, in ovariohysterectomized dogs) probably may cause some spontaneous ulcerations.

- Dogs and horses : mechanical in origin.
- Cattle, sheep, and reindeer : mechanical causes and infectious agents.
- Cats and horses : herpes virus infection is a frequent cause.
- All ulcers have the potential for secondary bacterial contamination or endogenous enzymatic "melting" of the stroma.

Mechanical: Abrasions by clippers, whips; eyelash abnormalities; foreign bodies; exposure of cornea in proptosis or prominent-eyed breeds; eyelid diseases such as entropion.

Diagnosis

- Thorough examination of the eye to find a cause for the ulcer.
- Use fluorescein dye to outline limits of ulcer.

Treatment : Should be continued until the ulcer is healed.

- Correct the cause if known.
- **Topical medical treatment for most ulcers :**

  Bacterial : broad spectrum antibiotic 4 times a day. For ulcers caused by *Streptococcus* in the horse, penicillin usually is the drug of choice.

  Viral : idoxuridine or vidarabine.

  Mycotic : topical miconazole, nystatin or amphotericin B. **Absolutely no corticosteroids should be used.**

  Chlamydophila: Chloramphenicol or tetracycline traditionally used; erythromycin may be beneficial.

- To relieve pain caused by iridal and ciliary spasm 1% atropine (iridocycloplegic) 3 or 4 times a day for 2-3 days, then once or twice a day.

- Anticollagenase agents : Acetylcysteine/serum from the patient. Use only if the ulcer shows signs of rapid progression.
- **Protect the cornea :**
  - **Soft contact lens**: not extensively use in veterinary practice.
  - **Third eyelid flaps**: The third eyelid may be sutured to the bulbar conjunctiva or to the upper eyelid under general anesthesia.
  - **Do not do in birds because this will damage the third eyelid, and the third eyelid is critical for corneal health in birds.**
  - Tarsorrhaphies.
  - Conjunctival flaps.
- **Cauterization :** Cotton tipped applicators are lightly soaked in cauterizing solution (2% tincture of iodine) and the edges of the ulcer are gently rubbed to remove the epithelium under topical anesthesia. Superficial ulcers which are refractory to topical medication or which re-epithelialize only to break down again may need to be cauterized. Rinse the eye with artificial tears when done and treat medically.
- **Osmotic agents :** Topical 5% NaCl ointment 3-4 times a day may be helpful in cases where the epithelium fails to become adherent to the underlying stroma.
- **Systemic medication :** In case of deep ulcers with concurrent uveitis, systemic administration of broad spectrum antibiotics for several days is indicated.
- **Granulation tissue associated with deep ulcers :** Once the ulcer is filled with granulation tissue, topical corticosteroids should be used 3-6 times a day to reduce scar formation.

Drops may be better than ointment because of less interference with healing.

Eosinophilic keratitis

This is an uncommon condition in cats, and rarely seen in the dog and horse. It is characterized by corneal infiltration with eosinophils, mast cells, or both with granulomatous inflammatory response. Although often unilateral, both eyes can be involved, especially if treatment is ineffective. In the eye of a patient with eosinophilic keratitis, the conjunctiva will initially be reddened initially. Next, a few white "cottage cheese" deposits will develop on the cornea and/or on the conjunctiva immediately adjacent to the cornea. Finally, the cornea will become pink to red and a white plaque will develop on the cornea. **Diagnosis** is done by cytologic examination of scrapings of the corneal lesion, or by superficial corneal biopsy.

Treatment

- Topical strong steroids several times a day.
- Oral megestrol acetate @ 5 mg every 24 hrs for five days, followed by 5 mg every other day for 10 days, tapering off as the lesion regresses. Topical steroids and megestrol acetate should not be used simultaneously because this may exacerbate adrenal suppression.
- Prognosis : guarded.

Corneal stromal abscesses in horses are generally the sequelae of healing corneal ulcers or defects and the trapping of bacteria or fungal organisms (or both) within the stroma after re-epithelialization. A variable, white to yellow, stromal infiltrate is surrounded by an intense stromal

keratitis and vascularization. Treatment with intensive topical and occasional systemic antibiotics (and if indicated, antifungal), iridocycloplegics, nonsteroidal anti-inflammatory drugs, and surgical drainage of the abscess is the common practice.

Pannus (chronic superficial keratitis)

Subepithelial infiltration of the cornea by fibrovascular tissue and mononuclear inflammatory cells in any chronic, superficial keratitis is termed as pannus. It is mostly seen in German shepherd dog. Causes are unknown, may be related to autoimmune problems. Irritation (ultraviolet light, dust, wind or infection) can aggravate the lesion.

Signs and natural history. It is mostly bilateral, occurs in dogs those are older than 9 months with highest frequency during 2 to 5 years of age. It characteristically begins in the ventrolateral limbal region of the cornea as a zone of granulation tissue (pink) invading the cornea. From here it continues to grow inward; as this continues, a lesion may begin in the medial limbal area and grow towards the original lesion. Lesions may then arise from dorsal and ventral limbal areas. Eventually, the entire corneal surface may become involved. Soon after the fibrovascular infiltration begins, melanin is deposited in the affected corneal epithelium and stroma. When enough of the corneal tissue is opacified, the dog may lose vision in that eye; if this occurs bilaterally, the dog may become blind. The progression of changes usually is slow, but can develop within several weeks.

Treatment : Topical corticosteroids (0.1% dexamethasone or 1% prednisolone acetate) @1 drop in each eye 6-8 times a day for at least 2 weeks are the most effective form of treatment.

- ***Subconjunctival injection*** of corticosteroid (triamcinolone) is useful in moderately advanced lesions or lesions where topical treatment is becoming ineffective in the patients with lesions which progress in spite of corticosteroid treatment requires Beta radiation @ 5000 to 7500 rads/area in conjunction with systemic and topical steroid injection.
- Advanced lesions causing temporary vision loss due to severe scarring or melanosis warrant superficial keratectomy.

Descemetocele

It is the condition where Descemet's membrane to protrude through the wound of cornea in the form of a small, transparent vesicle. Treatment is aimed at supporting and protecting this



Descemetocele in dog

lesion until the cornea can heal. Various surgical procedures including conjunctival or third eyelid flap are performed. However, anterior chamber paracentesis to lower intraocular pressure as part of the therapy is not so effective.

Feline Corneal Sequestrum (corneal mummification, the 'isolated black lesion', corneal nigrum, keratitis nigrum, focal degeneration of the cornea, corneal necrosis, primary necrotizing keratitis) is a condition peculiar to the cat in which the corneal stroma dies and then degenerates. The dead stroma becomes pigmented with corneal edema and white blood cell infiltration as a 'foreign body' reaction to the necrotic tissue occurs.

Corneal Dystrophy

Corneal degeneration and dystrophies occur in dogs, cats, and horses. Corneal degenerations are often unilateral and usually secondary to ocular or systemic diseases. The corneal dystrophies are bilateral; appear inherited or breed-predisposed in dogs; and often consist of the deposit of triglycerides, cholesterol, and calcium within the corneal stroma. In the patient with painful lesion, steroids can be tried initially to suppress the inflammation. Subsequently, then surgery needs to be performed. The surgery entails surgically removing layers of the cornea until the cholesterol has been completely removed and subsequent use of steroids to prevent return of the lipid.

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CHAPTER 14

Affections of the Lens and Other Lesions

The lens is an important component of the refractory mechanism of the eye. Any condition that alters the state of the lens from normal vision is interfered. It is to be remembered that lens being an avascular structure, as a limited capacity for pathological responses.

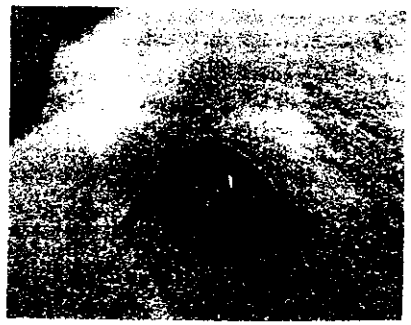
Congenital abnormalities

Aphakia is the lack of a lens. True aphakia is extremely rare and usually is associated with severe arrest in ocular development so that severe microphthalmia or congenital cystic eye is the result.

Coloboma of the lens is a rare condition, which often is accompanied by coloboma of the uveal tract. Clinically the lens will appear notched or may be abnormal in shape, due to uneven tension on the lens capsule in the area of the uveal coloboma during development.

Microphakia : The lens is smaller than normal. It may be an isolated lesion or occur as part of a syndrome of multiple ocular anomalies. If not already cataractous at birth, it often will opacify later in life.

Lenticonus : In this condition, the surface of the lens protrudes at the anterior or posterior pole in conical form. The defect in the lens capsule often appears as a circular defect of the lens and the protruding material may be opaque. The lens capsule in these defective areas often is weak and may spontaneously rupture. Posterior lenticonus may be associated with persistent hyperplastic primary vitreous. Lenticonus internum describes an abnormally shaped lens nucleus which extends into the posterior cortex.



Cataract in dog

Acquired Abnormalities

Cataract is opacity of the lens (including the capsule) which results in loss of transparency of the lens and, therefore, interferes with vision (or visualization of the ocular fundus). It may be focal,

thus not preventing vision through clear portions of the lens, or diffuse, thus severely diminishing visual capability or even blinding. Cataract is the most common disease of the lens, simply because the lens reacts to most insults by opacifying. Although it can be an isolated condition, it often is seen associated with ocular abnormalities.

The pathogenesis of cataract development is not fully understood. Lens fiber transparency is affected by swelling and coagulation of protein. Opacification due to the imbibition of water may be reversible if the pathologic process is corrected. Opacification due to chemical changes in the proteins is irreversible. On a cellular level, it is associated with intra- and extracellular vacuolation and local precipitation of protein, loss of epithelial cells, aberrant epithelial cell differentiation or epithelial cell metaplasia.

Classification

Classification based on the degree of opacification or maturity of cataracts is :

1. ***Incipient cataracts*** : These are the first evidence of opacification. Vision is not affected. The opacity may or may not progress.
2. ***Immature/Incomplete cataracts*** : Lens is largely, but not completely, opaque. Clinical vision may have present in dog or cat with the presence of tapetal reflex. Slightly enlarged lens are seen due to imbibition of water.
3. ***Mature/Complete cataracts*** : Lens is totally opaque preventing vision in that eye. Intumescent (enlarged due to imbibition of water) of the lens may be noticed.
4. ***Hypermature cataracts/Complete with shrinkage*** : Break down of the lens proteins and subsequent dissolution of the opacified lens material and the escape of the broken down proteins through the capsule results shrinkage and clearing of the lens.
5. ***Morgagnian*** : Cortex is liquefied, but nucleus is not and floats in the cortex (settles with gravity).

In dogs less than one year of age, resorbing type cataract is sometime noticed in which the cataractous material gets resorbed leaving the anterior and posterior capsules in contact with each other. Clinical vision may return with the resorption of the cataractous material.

Classification on the basis of age

1. ***Congenital*** : present at birth.
2. ***Developmental or 'juvenile' cataracts*** : develops sometime after birth, but generally before adulthood - many of the heritable and nutritional cataracts fall into this category.
3. ***Degenerative*** : cataract formation after normal development. This includes cataracts which occur as a result of senescence ('senile' cataracts).

Cataracts as clinical entities

Hyaloid cataract : Opacity is posterior subcapsular and capsular, and ranges in size from pinpoint to a large, white plaque containing blood vessels. It is caused by a defect in the resorptive process of the hyaloid vessels and is congenital. Usually not progressive; mydriatics may be helpful if vision is affected. Small hyaloid remnants (without lens opacity) commonly are found in all animals and are of no concern.

Y-suture cataract : Granular clumping along the arms of the Y-sutures. It may represent as a variable expression of a heritable cataract seen in golden retrievers.

Persistent pupillary membrane cataract : These are anterior capsular and usually non-progressive. It may range in size from pinpoint to large plaque. Relatively few patients with persistent pupillary membrane will have cataract. Mydriatics if vision is affected may be tried. Surgical therapy is not advocated.

Metabolic cataract : Here, metabolic diseases like **diabetes mellitus** result in defective lens nourishment which in turn leads to cataract. Lesions first begin in the equatorial cortical or posterior subcapsular regions and often progress rapidly. Once they begin, they may advance to completeness regardless of treatment. Cataract extraction may be successfully performed if the patient is being well-controlled for the systemic disease.

In the case of diabetes mellitus, abnormally elevated blood glucose concentration leads to an increase in glucose within the lens. This overloads the normal glucose pathways and leads to increased sorbitol which cannot escape the lens and results in imbibition of fluid by the lens (opacification results).

Toxic cataract : Drugs like **Disophenol**, used in treating hookworm infection, can cause lenticular opacities at doses not much higher than used clinically, but these opacities usually are reversible after the drug is discontinued.

Heritable: Few species and breeds are more predisposed for cataractogenesis. In some breeds of dogs, cataract formation is heritable. In others, the heritable nature of the disease is suspected, but not yet proven. Generally, heritable cataracts are manifested within the first few years of life, but can be congenital.

Complicated or secondary cataracts may result as a sequel of ocular injury, uveitis or other intraocular inflammation and some systemic illnesses. If there is minor damage to the lens and the cause is ameliorated, the opacity formed probably will be stationary. If there is recurrent uveitis or if the original injury severely damaged the lens, the opacity may enlarge and eventually involve the entire lens. Treatment is aimed at eliminating the cause. Mydriatics may be helpful for incomplete cataracts.

General comments on cataracts

- ***Pupillary responses to light*** are normal *unless there are other problems.*
- Two different areas of medical management in the dog are in obtaining a reasonably dilated pupil during and after surgery and controlling the anterior uveal inflammation post operatively.
- Myoriasis is essential for cataract surgery. Atropine sulphate (1%) is administered frequently topically 3 to 4 times daily for 1 to 2 days prior to surgery.
- Topical and systemic antiprostaglandins may be used in maintaining a large pupil. Release of prostaglandin results papillary miosis during and following surgery.
- Topical Antibiotic instillation on 1 to 3 days prior to surgery is recommended.

Methods of cataract removal

There are four basic types of cataract extraction practices in Veterinary ophthalmology today :

1. ***Extracapsulsar extraction*** : removal of the lens after removing the anterior capsule. The posterior capsule usually is left in place.

2. ***Intracapsular extraction*** : removal of the lens without rupturing the capsule. Difficult in most non-human animals due to firm attachment of zonules and adherence to the anterior vitreous face.
3. Cryoextraction.
4. Phacoemulsification.
5. Discisssion and Aspiration.

Extracapsulsar extraction

- ***Corneal Incision*** : The corneal incision is made 1 to 2 mm anterior to the limbal margin. Disadvantage of this technique is the increased incidence of corneal optical opacification along the incision line.
- ***Removal of anterior lens capsule*** : Anterior lens capsule is grasped with the extra capsular forceps and open them widely. The teeth are pressed against the anterior lens capsule and compressed slowly. This procedure can tear the capsule in the weaker equatorial region of the lens. The extra capsular forceps can be rotated slowly to free any remaining attachment of the anterior capsule. Gentle irrigation of the anterior chamber with a balanced salted solution is done to remove remaining pieces of cortical material.
- ***Closure of anterior chamber*** : Absorbable (polyglactin 910 and polyglycolic acid) or non-absorbable (6-0 and 7-0 nylon and prolene) suture material with swaged on spstula or reverse cutting needles may be used.

Intracapsular lens extraction

The surgical approach and wound closure are same as that in extracapsular extraction. The difference is that the lens material is removed within an intact lens capsule.

1. ***Enzymatic zonulolysis :*** Though alpha chymotrypsin (1 : 5000) given good results in intracapsular lens extraction in human beings, even higher concentration of 1 : 2500 to 1 : 500 give poor results in dogs. Also, there has been post operative complication following this dose.

2. ***Forceps delivery :*** Two methods are used tumbling and sliding.

Cryoextraction

The cryoprobe (Carbon dioxide, Nitrous oxide or liquid nitrogen) is activated and placed in the anterior lens capsule in the superior quadrant. An ice ball adhering the probe to the lens forms in approximately 4 to 6 seconds. Once both combined with a forward motion of the lens are used to break the zonular attachments and the lens is removed.

Phacoemulsification

In this method, high frequency ultrasonic vibrations are used to fragment the lens into fine particles, which can be aspirated from the anterior chamber. The anterior lens capsule is then lacerated near the equator and the ultrasonic tip placed into the lens cortex. Care must be taken to maintain the anterior chamber depth with the irrigating fluid and to keep the ultrasound tip within the capsule throughout the procedure. The anterior lens capsule and the remaining lens epithelium are removed with intraocular scissors. The second incision is closed first with a 9-0 absorbable suture material in a simple interrupted fashion. The chamber is reformed as the injection canula is removed and the first incision closed in a similar manner. After phacoemulsification and aspiration of the cataract, if an intraocular lens has to be implanted and

limbal incision has to be enlarged using corneal scissors according to the width of the IOL. The advantages of this technique include smaller incision, the surgery time is less, and there is less of postoperative uveitis and improved overall surgical result when done properly.

Discission and Aspiration

This is possible in dogs lesser than one year of age as the entire lens is soft enough to permit discission and aspiration. A small incision is made and the anterior lens capsule is incised and as much as possible removed. The lens cortex and nucleus are broken into small pieces by discission and the lens material is removed by aspiration.

Intraocular lens implantation

Although aphakic canine patients function reasonably well, postoperative vision can be improved by inserting an artificial intraocular lens after cataract removal. Because of the sensitivity of the canine uvea to contact with intraocular lenses, a posterior chamber implant inserted within the capsular bag is the best location.

The prosthetic lens has two parts—an optic and two haptics. The optical portion is made of polymethacrylate and measures about 7.5mm in diameter, the haptics measure about 16mm from tip to tip. There are different types of intraocular lenses available. Silicone lenses are also available, which require only a small part of entry into the anterior chamber for introduction. Although there is some individual variability in refractive need, an implant of about 40 dioptres brings the majority of canine patients acceptably close to emmetrpia.

Needle or scissor capsulotomy is preferred if an intraocular lens is to be inserted because of the desirability of having a controlled capsusular tear with large anterior flaps. After cataract extraction, the incision is closed, except for an 8mm superior wound (or extended to 8mm if phacoemulsification is used). The anterior chamber and capsular bag are reformed with viscoelastic solution (hyaluronic acid, methyl cellulose, chondroitin sulphate alone or in combination). and the implant is inserted into the capsular bag. The lower haptic is inserted directly and the superior haptic either dialed with a hooked 30-gauge needle or otherwise manipulated into place. Dialing however ensures capsular placement of both haptics with minimal capsular stress.

Post operative care

All patients may develop some degree of post operative anterior uveitis, which may lead to serious complication like glaucoma.

- Systemic and topical broad spectrum antibiotics are given for 7 to 10 days.
- Mydriatics, corticosteroids and antiprostaglandins are administered to reduce anterior uveitis and maintain mydriasis.
- Atropine (1%) is applied topically every 4 to 6 hours until the pupil is dilated and is continued as needed to maintain mydriasis.
- Topical prednisolone (1%) is used every 4 to 6 hours and topical flurbiprofen every 6 hours, for the first 7 to 10 days and then as needed to control uveitis.
- A systemic antiprostaglandin (aspirin 10 mg/kg) is given twice daily for the first week following surgery.
- Minimal activity and frequent follow up examination during the first few post operative weeks are also essential.

Lens displacement/luxation and subluxation/ectopia lentis

Partial or complete breakdown of the zonular attachments results in displacement of the lens. If the lens remains in the patellar fossa it is considered subluxated; if the lens moves into the anterior chamber or vitreous, it is luxated.

Causes include congenital, traumatic, spontaneous, and secondary to other diseases, especially those leading to increased globe size, such as glaucoma.

Signs and diagnosis

- **Iridodonesis** (vibration or fluttering of iris)—pathognomonic for ectopia lentis.
- Anterior chamber may be more shallow than normal—assessed by gonioscopy.
- Aphakic crescent (the area of the pupil where there is no lens).
- **Anterior luxation.** The lens may go through the pupil and lie in the anterior chamber, where it may rub against the cornea and cause corneal edema. In many cases, the lens may be mobile while still attached to the anterior vitreous face.
- **Posterior luxation.** The movement of the lens may cause vitreous liquefaction (syneresis). The lens then may luxate into the vitreous cavity. This usually results in a deeper than normal anterior chamber, with a flattened iris profile. The lens usually settles down to the ventral aspect of the vitreous cavity.

Treatment

- Lens removal-spontaneous luxation or subluxation.
- The earlier the disease is diagnosed and treated, the greater the chance of saving vision.
- Luxation secondary to glaucoma should not be treated surgically because the displacement is secondary.
- If glaucoma is present along with the displacement, or if there is vitreous degeneration, the prognosis is more guarded. If the glaucoma is chronic, it may persist after lens removal.
- Traumatic lens displacements usually have a poor prognosis due to the severity of ocular damage.

TRAUMATIC AFFECTIONS OF THE EYE

Traumatic lesions in conjunctiva

- **Lacerations:** Laceration of bulbar conjunctiva may expose the sclera. If clean, recent (within 6 hours) and large, suture with 6-0 or 7-0 absorbable suture will heal within few days. Small non-gaping wounds should not be sutured. Dirty, old wounds should be cleaned and allowed to heal by second intention. Fornix wounds may be associated with protrusion of orbital fat. Remove the fat before suturing Palpebral conjunctival wounds usually need no suturing, but if part of a full thickness eyelid laceration occurs, suturing is needed to add strength to the eyelid skin suture.



Laceration of eye in a kitten

- **Subconjunctival haemorrhage** is associated with trauma to the eye and is also seen in clotting disorders or secondary to strangling (e.g., choke collars).

Treatment is directed to eliminate the cause, if still present. Topical 1-2% epinephrine for active bleeding and topical corticosteroids are needed if there appears to be irritation.

TRAUMATIC LESIONS IN SCLERA

Lacerations and perforations

Horse : The peri-limbal sclera apparently is weak in the horse and severe blows to the eye cause rupture. Ciliary body and iris usually prolapse through the wound and there is marked haemorrhage into the eye. Sometimes the lens may protrude through the wound. If the wound is clean or occurred within the last 6 hours, it can be flushed with saline and the uveal tissue is reposited followed by suturing of the sclera (The technique is similar to any intraocular surgery). If the wound is dirty, old, or the uveal tissue is necrotic, the protruding uveal tissue should be excised before closing the wound. In most cases, there may be little chance of saving vision.

Other animals : Automobile accidents, fights, or other injuries account for scleral trauma. The tear in the sclera can be anywhere and may even be posterior, beyond view; in these latter cases, the eye may not appear particularly traumatized but will be very soft.

Treatment is similar to that for the horse and the prognosis is similar. A posterior perforation carries a poor prognosis for saving the globe.

Prolapse of orbital fat in cattle : Retrobulbar fat occasionally can dissect anteriorly between the sclera and Tenon's capsule to prolapse into the anterior episcleral space. It may be seen in young animals that apparently are normal. Fat may extend close to the limbus. Eye movements during examination may result in temporary prolapse of fat. Besides, space occupying lesions in the orbit may also lead to this situation.

Treatment : No treatment usually is indicated because vision is not affected and the patient apparently is not uncomfortable. A thorough examination should be done to rule out more serious orbital disease. If there is excessive prolapse, the fat could be removed followed by close suturing of the conjunctiva to the sclera; nevertheless may re-occur.

Traumatic lesions of cornea

Corneal lacerations : Although these are common, the toughness of the cornea prevents perforation in most cases. Cat scratches are a common cause especially when pups encounter their first cat. Fights, car accidents, contact with pointed objects and various other situations may also lead to corneal laceration. There is lack of pupillary response in the opposite eye in severe laceration. Stimulation of the affected eye with strong light may indicate severe posterior segment disease such as retinal separation (detachment) or dense vitreous haemorrhage.

Superficial wounds without excessive gaping of the edges heal rapidly, but should be treated with a topical antibiotic solution four times a day to prevent bacterial growth in the exposed stroma.

Deep wounds with gaping of the edges or production of a flap of cornea: If the wound is fresh and the edges can be apposed, 6-0 or smaller absorbable or non-absorbable suture in a simple interrupted pattern can be used. Non-absorbable sutures should be removed in 10-14 days.

Punctures without iris prolapse : These usually are sealed by fibrin-rich secondary aqueous and may require fluorescein dye for demarcation of the wound. These eyes usually are soft,

painful and have a pinpoint pupil and aqueous flare. These should be treated with a combination of systemic and topical antibiotics, a topical iridocycloplegic and cautious use of a topical corticosteroid.

Cat scratches in dogs and others

This lesion is described separately because of its greater potential for severe consequences. The cat's claw often perforates the cornea and contaminates the anterior chamber. However, the wound is small in diameter and quickly seals; by the time the patient is brought to you, there may be re-epithelialization so that there is no fluorescein staining. The patient usually is comfortable and the eye appears quiet. Do not be misled by the benign appearance! Many of these develop a fulminating endophthalmitis in 3-4 or more days due to growth of inoculated bacteria. This often leads to glaucoma and eventual loss of the eye.

All patients having cat scratch trauma must be treated vigorously, both with topical and systemic antibiotics. Atropine should be used topically. Topical corticosteroids also are indicated unless the wound is a large laceration and retains fluorescein.

Corneal foreign bodies

Non-penetrating : This is foreign material which is adherent to the surface of the cornea. but has not entered the tissue. Small seeds or plant fragments are seen most commonly. Affected individuals often will have blepharospasm and epiphora; the client may see the foreign body. If the condition has been present for several weeks, there may be some epithelial changes or minor vascularization.

The foreign body may be dislodged with a stream of saline from a syringe with a blunted cannula and to remove the dislodged object from the cul-de-sac with a forceps followed by application of topical anaesthetic. Medical therapy following removal of the foreign body in either case consists of topical antibiotic-steroid drops for several days.

Chemical burns

These are unusual in domestic animals, but when they occur, proper management will prevent serious damage. The types of corneal chemical burns may be divided into those caused by alkalis or acids.

Alkalis are the most serious agents because topical alkali results in immediate death of the corneal (and conjunctival) cells and some denaturation of the stromal collagen. The initial treatment of these includes copious and continual flushing of the eye with saline. Specific treatment includes frequent antibiotic and anti-collagenase drops. These must be continued for several weeks. **Corticosteroids are absolutely contraindicated in alkali burns** because they potentiate collagenase activity.

Acids usually are not as serious as alkali burns because their initial effect is to precipitate protein which then prevents further penetration by the agent. Treatment would include moderate flushing of the eye with saline followed by frequent application of antibiotic drops until healing occurs.

Hydrophthalmia

This is not a common affection in the canine. In this condition eye globe greatly extend with superabundance of the humours occasioned by over-secretion. Old dogs are more apt to

suffer from this disease than young dogs. As the disease progresses, the eyeball become harder and tender, the sight is greatly impaired, and ultimately, if not arrested, the eye bursts, discharges its contents and total blindness ensues.

Treatment

- Medical management includes Mercurial ointment, rubbed over the eyebrow, will assist in stimulating the absorbents.
- In chronic advance condition, arthrocentesis or placement of setons along the spine would have a good effect.

GLAUCOMA

Glaucoma is the elevation of intraocular pressure (IOP) beyond a specific point with compromised vision. Normal flow of intraocular fluid (aqueous humor) maintains normal intraocular pressure. The aqueous humor is produced and drains from the eye at approximately the same rate, resulting in a stable pressure inside the eye of 15 to 20 mm Hg. Glaucoma occurs because of inadequate outflow of aqueous humor and a subsequent buildup of pressure inside the eye. The resulting high pressure damages the optic nerve and results in blindness.



Glaucoma in a dog

Glaucoma is **classified** as either primary or secondary in animals.

Primary glaucoma is an inherited condition. Inherited open angle glaucoma is an autosomal recessive trait in beagles. Narrow angle glaucoma is inherited as an autosomal dominant trait in spaniel. Primary glaucoma occurs in many breeds, especially American Cocker Spaniels, Basset Hounds, Chow Chows, Labrador Retrievers etc. It is rare in cats. Primary Glaucoma usually begins in one eye, but almost always eventually involves both eyes, leading to complete blindness.

Primary glaucoma may again be classified as:

- Narrow angle glaucoma.
- Open angle glaucoma.
- Narrow/closed angle glaucoma.

Secondary glaucoma is the result of some intraocular condition that interferes with the natural flow of ocular fluid. Diseases that commonly cause secondary glaucoma include ocular inflammation (uveitis), lens dislocation, intraocular tumours and injury to the eye.

Pigmentary glaucoma, the obstruction to fluid drainage is caused by an abundance of pigmented cells within the iridocorneal angle and sclera. The increase in IOP is progressive and often results in blindness.

Clinical signs

- A reddened eye.
- An eye that suddenly looks blue.
- Dilated pupil with loss of pupillary reflex.

- Enlarged eye ball.
- Excessive tearing.
- A green or yellow eye discharge.

Diagnosis

- History and clinical signs.
- **Tonometry** (Schiotz tonometry and Applanation tonometry) is the measurement of pressure within the eye. Dogs, cats, and humans have normal intraocular pressures between 10 and 20 mm Hg. Glaucoma often results in pressures of 20-28 mm Hg in humans, but pressures of 45-65 mm Hg are common in dogs and cats. Thus, glaucoma in pets is more painful than glaucoma in humans.
- **Gonioscopy** is a technique used to evaluate the drainage angle by placing a goniolens on the corneal surface. This lens allows directly visualizing the drainage angle. To perform Gonioscopy occasionally requires sedation but in most pets, it can be performed under topical anesthetics only. The technique is essential to evaluate the non-glaucomatous eye for risk of a future attack of glaucoma.

Treatment

Preserving vision in an eye with glaucoma is difficult and requires aggressive medical and surgical therapy. Treatment depends on several factors-the type of glaucoma present, the degree of elevation of IOP, and the extent of visual impairment. Primary open angle glaucoma tends to be slower in onset and may, at least initially, be controlled by medical therapy (drugs) alone. With closed angle glaucoma, which is much more common, there is usually a sudden, rapid elevation in IOP. Ultimately, most forms of glaucoma require surgery.

If vision is present or has just recently been lost, a combination of medical and surgical therapy will be used to try and maintain the sight. Aggressive medical therapy (anti-glaucoma drugs) with close monitoring is used to reduce IOP prior to surgery to prevent further damage to the eye. Some of these drugs will be used as well for additional minor IOP reductions following surgery. The aim of surgery in an eye that is still visual (or potentially visual) is to decrease the production of fluid within the eye, and to improve the drainage from the eye.

Medical management

The most frequently used medical therapies include :

Ophthalmic Beta-Blockers- lower pressure by reducing aqueous production.

- Nonselective beta-blockers (timolol, levobunolol, metipranolol, carteolol)
- Beta 1 selective blocker (betaxolol).

Carbonic Anhydrase Inhibitors also lower pressure in the eye by decreasing aqueous production.

- Topical Carbonic Anhydrase Inhibitors—dorzolamide and brinzolamide.
- Oral Carbonic Anhydrase Inhibitors—acetazolamide, methazolamide. The topical forms are associated with fewer systemic side effects than the oral forms and are better tolerated by many patients.
- When using carbonic anhydrase inhibitors on a chronic basis, be sure patient is receiving adequate nourishment because potassium can become depleted.

Alphas-agonists lower the pressure primarily by reducing the aqueous production and probably increase the rate drainage of aqueous humour. Alpha 2 agonists (apraclonidine, brimonidine) are commonly used.

Miotics decrease IOP by increasing aqueous outflow through the trabecular meshwork. However, because of their ocular adverse effects (increased myopia, eye and brow pain, decreased vision and retinal problems), the use of miotics is declining. *e.g.*— pilocarpine (1%—@ 2 drops 3-4 times a day) and carbachol.

Prostaglandin analogs (latanoprost) increase the uveoscleral outflow.

Hyperosmotic agents may be used for quick reduction of intraocular pressure. It is generally use as immediate therapy while waiting for other treatments to take effect or prior to intraocular surgery must have intact blood-ocular barrier for osmotic agents to have effect. Intravenous **Mannitol** @ 1-2 gm/kg body weight given over 5-10 minutes; oral **Glycerol** (50%) @ 2 ½ cc/kg body weight initially, then the same dose divided into three equal amounts three times a day for maintenance may be used.

Epinephrine preparations are useful in open angle glaucoma; often used in conjunction with miotics; causes decrease in aqueous production and increase in outflow facility; when used chronically may cause brown-black deposits in eyelids, conjunctiva and cornea. **Dipivefrin HCl** @ one drop twice a day is a prodrug; it breaks down into epinephrine after absorption.

Surgical management

A. Treatment for an eye with glaucoma where vision is still present.

I. ***Laser Cyclophotocoagulation:*** Laser surgery is the treatment of choice in pets with primary glaucoma that can still see. Under anaesthesia, the laser burns are used selectively to kills small areas of the ciliary body in an effort to reduce the production of aqueous fluid to create a balance with the poor drainage. Occasionally the ciliary body will not be damaged enough and a second procedure is needed to restore normal intraocular pressure. This procedure may also be recommended as a preventative in the other eye.

II. ***Cyclocryothermy*** involves freezing the ciliary body with a small probe placed on the outside of the eye under anesthesia to kill the cells that produce the aqueous humor. Disadvantages include swelling and redness sclera, retinal detachments, severe intraocular inflammation, high intraocular pressure immediately following the freezing that may lead to permanent blindness, shrinkage of the eye or cataract formation.

III. ***Anterior Chamber Shunts:*** Small valve like device is implanted just under sclera and a small tube is placed through a tiny incision in the anterior chamber. This tube provides an alternate drainage pathway for the aqueous fluid to leave the eye. Disadvantages include the blockage of tube with fibrin, or the functioning of the valve may be compromised by scarring.

IV. ***Trabeculectomy***

B. Treatment for an eye with glaucoma where vision is lost.

I. ***Evisceration and implantation of intrascleral silicon prosthesis.*** Intraocular prosthesis involves surgical removal of the contents of the eye, leaving the outer shell or sclera, and implanting a silicone implant within the walls of the eye. The shape of the eye is maintained and the eye moves normally. Following surgery, minimal care is needed and

the eye is maintained in a relatively normal cosmetic appearance while being free of pain. Complications of this technique are that corneal ulceration may occasionally occur following surgery. In some cases scarring of the cornea results in a gray appearance.

II. ***Ciliary ablation by intravitreal injection of gentamycin.*** Gentamycin is injected into the inside of the eye in high concentrations which result in a killing effect on the ciliary body resulting in the reduction or cessation of the aqueous humor production under chemical restraint. Complications of this technique are generalized shrinking of the eye, return of the glaucoma at a later time and occasionally chronic pain. This technique is generally only recommended in quite elderly pets where the other choices are not acceptable to the client.

III. ***Enucleation.*** The blind, painful eye is enucleated.

Neoplasm of eye

Dermoid : More common in the dog particularly in St. Bernard and Dalmatian dogs. Also seen as a heritable trait (autosomal recessive and polygenic) in Hereford cattle.



Dermoid in a dog

Site of involvement usually the lateral canthus or limbus in dogs. Additional sites in cattle include third eyelid, medial canthus and eyelid.

Appearance-*Dogs and Cattle* : Usually thick with all the characteristics of skin including hair and causes epiphora. If the hair is short and stiff, there may be considerable irritation; this usually is associated with dermoids which are thin and flat.

Horses : Usually flat with a rough surface; hairs usually are short, stiff and not always easily appreciated.

Treatment

Surgical excision : Follow similar techniques as if a neoplasm; small conjunctival incisions do not need suturing; large incisions should be closed with fine, absorbable suture.

Neoplasm of conjunctiva

Cattle : Squamous cell carcinoma ('cancer eye') is most frequently encountered and often begins as hyperplastic plaque, progresses to keratoma, papilloma and, finally squamous cell carcinoma. Usually, this is seen in individuals over 4 years old with a peak at 8 years. Most begin at lateral limbal area. Most do not metastasize.



Neoplasms in a dog

Horses : Squamous cell carcinoma ('cancer eye') is most commonly seen and lesions begin at limbal region or leading edge of third eyelid. Early lesions may appear simply as conjunctivitis. Angiosarcomas have been reported and are particularly aggressive and usually fatal.

Dogs : Primary conjunctival neoplasms are uncommon, but haemangiomas, virus induced warts, melanomas or histiocytomas may be seen.

Cats : Primary conjunctival neoplasms are rare, but squamous cell carcinoma may be seen.

Neoplasia of sclera

- Primary neoplasms of the sclera are rare.
- *One neoplasm, the origin of which is not clear but is believed to be episcleral or scleral tissue, is the* epibulbar melanoma. *It is benign in behavior even though it may grow sufficiently large to cause exposure problems.*

Neoplasms of uvea

Melanoma: This is the most common primary intraocular neoplasm in most species. It occurs usually in the anterior uvea of middle-aged and older animals. ***Be aware that uveal melanomas do not behave like skin melanomas.*** It is rare to metastasize, grow slowly and is effectively cured by excision (enucleation).

Adenoma and adenocarcinoma : Adenomas usually occur in elderly animals and are best left alone unless they enlarge to become a problem. If there is intractable uveitis and pain, the eye should be removed; if the eye appears comfortable, leave it alone.

Medulloepithelioma : This is the tumour of young animals which is embryonic or neonatal in onset and is derived from the primitive ciliary epithelium. These tumors may be composed of immature retina, brain tissue, glandular spaces, striated muscle fibers, cartilage and bone. Enucleation or exenteration usually is sufficient, but they can be aggressive and metastasize.

Metastatic neoplasms to the uvea : Because the uveal tract is rich with blood vessels, haematogenous spread of remote neoplasms is not uncommon. Mammary or other adenocarcinoma, transmissible venereal sarcoma and lymphosarcoma are most commonly seen. The presence of metastases in the eye always is a poor sign and no treatment is available in most cases. However, removal of the eye and histological examination may be important in establishing a diagnosis and prognosis.

Panopthalmia

Panopthalmia **refers to accumulation of septic pus in the eyeball.**

The common **causes** of this condition are injury and infection of the eye following accidental and operation wounds of the organ. Besides, it may occur as a sequel to ulceration of the cornea.

The **clinical signs** include intense inflammation of the eye and presence of perforation of the cornea, discharging pus.

Treatment includes draining of pus by incising the cornea and washing with luke antiseptic solution. Removal of eyeball is often indicated as infection may enter into the optic nerve leading to meningo-encephalitis.

Retinal detachment/separation

Retinal detachment occurs at the site of discontinuity is between the retinal epithelial cells and the photoreceptor outer segments. If the retinal epithelium were to lose continuity with the choriocapillaris, this would be a true detachment; this is a rare occurrence. Because retinal separation usually is secondary to other ocular or systemic disease or idiopathic, it should not be considered a specific entity in itself. Some of the conditions in which retinal separation may

include: Collie eye anomaly; retinal dysplasia; any abnormal ocular development; trauma to the head; exudation from choroid through retinal epithelium due to inflammation or bleeding; renal disease; hypertension; and vitreous inflammation with formation of contraction bands.

Clinical signs. If bilateral and complete, the patient will be blind; if unilateral, the patient will be blind on affected side. The retina may be in apposition to the lens thus creating a leukocoria. If the sensory retina still is attached at the optic disk and ora serrata, the separation is described as funnel-shaped or 'morning glory.' If the sensory retina is torn from the optic disk or ora serrata, it is said to be dialyzed as well as separated. *Ophthalmoscopic findings.*

- With complete separation, the retina easily is visible through the pupil, using a penlight after pupillary dilatation.
- Incomplete separations appear as zones out-of-focus with their surroundings; if a vessel courses through the affected zone, it will appear elevated.
- Tears may be associated with the separated tissue or there may be disinsertion from the strong attachments, called dialysis. In the latter, if the disinsertion is at the ora serrate, it is termed peripheral dialysis; if at the optic disk, it is termed central dialysis.
- Pupillary responses to light-may be normal, but there often is dilatation with incomplete response.

Diagnosis. Ophthalmoscopic findings are diagnostic.

Treatment and prognosis

- Treat the specific cause.
- Corticosteroids at higher dose for at least 7-10 days.
- Carbonic anhydrase inhibitors for at least 7 days.
- Patient should have minimal exercise; sedate if necessary to keep calm.

The **prognosis** in purely idiopathic cases often is better because the retinal layers may reunite, but this depends on length of time of separation. Prognosis depends on cause and length of time retina has been separated (after a couple of weeks, degeneration in the outer retinal layers may not be reversible).

AFFECTIONS OF THE ANTERIOR AND POSTERIOR CHAMBER

Congenital abnormalities

Waardenburg's syndrome. This is a condition in which there is white fur, blue eyes and deafness seen in mice, cats and dogs as well as in humans. The eyes are not abnormal; the blue eye may not have a tapetum.

Hypermelanosis

- **Freckle.** This is an increase in melanin content of individual cells. It is not a pathologic condition.
- **Nevus.** This is a localized increase in the number of melanocytes usually with slight protrusion above the surface. It is not a pathologic condition, but could be precursor to melanoma.

Persistent pupillary membrane

In the fetus, the pupil is closed by a thin, vascular membrane that is mostly resorbed before birth. Normally, any strands remaining at birth are necessarily resorbed by 4-5 weeks of age. In

this pathologic condition, strands persist beyond several months of age with or without associated changes in the lens or cornea. This heritable condition is seen in basenji, collie and Australian shepherd dog. The pupillary membrane arises from the iris collarette; this is important in differentiating persistent pupillary membrane from iridal synechiae which usually arise from the pupillary border of the iris.

Signs. If the strands attach to cornea or lens, a white, gray or brown opacity may be present. Most of these opacities are minor and have no significant effect on vision. Occasionally there will be extensive corneal edema due to endothelial cell destruction, or cataract may notice.

Treatment

- Surgical intervention is neither desirable nor necessary; some of these strands contain patent blood vessels and would bleed profusely if cut.
- In patients with extensive corneal or lenticular disease, a mydriatic may improve vision.
- Basenjis and other individuals affected with persistent pupillary membrane should not be used for breeding.

Iris hypoplasia

- Mostly color dilute animals (Siamese cat, Welsh ponies) whose irides are hypomelanotic are suffered from this condition.
- The individual may be photophobic. Various degrees of choroidal hypoplasia also may be present. Hypoplastic region may bulge forward due to aqueous humor pressure from behind. This may be mistaken for a cyst of the iris stroma, or worse, with a neoplasm.
- Retroillumination the iris cause transillumination of the hypoplastic regions.
- No treatment is necessary. If there is concurrent choroidal hypoplasia and it is substantial, there may be loss of vision, but this is rare.

Anterior uveal cysts

Microscopically Tiny cysts of the iris or ciliary body epithelium are common in young animals. Sometimes these cysts are large enough to be seen clinically: in the anterior chamber, at the pupillary border, or in the posterior chamber. Occasionally the cysts break off and float free in the anterior chamber or vitreous cavity. Clinically detectible anterior uveal cysts are most commonly seen in golden retrievers, Labrador retrievers and Boston terriers.

Most of these cysts are innocuous and do not require any treatment. Occasionally a free-floating cyst may become adherent to the cornea and cause edema or melanosis. Treatment options include surgical excision, aspiration of the cyst.

ACQUIRED ABNORMALITIES

Uveitis

Uveitis is the inflammation of the vascular coat of the eye seen both in dog and cat. Inflammation of the anterior uvea breaks down the blood-aqueous barrier so that protein escapes into the aqueous humor resulting in flare. Blood and other cellular infiltrates also may be present.

Classification

- Anterior (inflammation of iris and ciliary body) uveitis.
- Intermediate (ciliary body, pars plana) uveitis.
- Posterior (choroids) uveitis.

Causes of Canine Anterior Uveitis

- Unknown—Idiopathic.
- Trauma (accidental and surgical).
- **Viral :** Hepatitis, Distemper.
- ***Bacterial :*** Corneal wounds, Bacterial Sepsis (*e.g.* pyometra, dental disease), *Leptosporsis, Botteliosis, Brucellosis, Tuberculosis.*
- **Protozoal :** Leishmaniasis, Neosporosis, Toxoplasmosis.
- **Parasitic :** Dirofilariosis, Angiostrongylosis, Toxocariasis.
- **Rickettsial :** RMSF, Ehrlichiosis.
- **Fungal/Algal :** Blastomycosis, Histoplasmosis, Coccidioidomycosis, Cryptococcus.
- **Immune mediated:** Lens induced uveitis, uveodermatologic syndrome.
- **Metabolic :** Hyperlipidemia, Diabetes Mellitus.
- **Genetic :** Uveitis in Golden Retrievers associated with iridocialary cysts.
- Neoplasia.

Clinical signs

- Redness (episcleral reddening).
- Ocular pain (watery discharge, blepharospasm, photophobia, enophthalmos).
- Corneal changes (edema, deep vascularization).
- Anterior chamber changes Aqueous flare, keratic precipitates, hyphema (pus in the anterior chamber), hypopion (blood in anterior chamber).
- Iris changes (in color, swelling, granulomas).
- Myosis.
- Low intra ocular pressure.
- Lens anomalies (deposits, cataract).
- Vitreous flare.
- Fundus anomalies.

Diagnosis

- History—age, vaccination, environment, trauma, travels combined with epidemiological considerations.
- Ophthalmic and physical examination.
- Clinical signs.
- Imaging : head radiographs are indicated in cases of unilateral uveitis.
- Ocular Ultrasound is useful in cases of media opacity.
- Blood samples: blood count, protein electrophoresis (hyperglobulinaemia in chronic "parasitic" diseases and FIP, FIV), a biochemical profile and serological screening tests when available.
- Aqueous humor samples are useful to demonstrate local antibody production, for cytology and Polymerase Chain Reaction (PCR).
- Conjunctival samples are useful for cytology, cultures, direct parasite observation and PCR.

Differential diagnosis. Differential diagnosis must include consideration of other acquired ocular conditions (conjunctivitis, corneal diseases, glaucoma, tumors) and of developmental conditions (aniridia, heterochromia, persistent pupillary membrane, cysts).

Item	Conjunctivitis	Iritis	Glaucoma
Congestion	Conjunctival vessels	Deep ciliary vessels	Scleral venous outflow .
Effect of 1 : 1000 epinephrine	Blanches vessels	No effect	No effect
Pupil	Normal response to light	Miotic	Often dilated; may not respond to light.
Cornea	Clear	Edematous	Opacification due to edema and structural changes.
Intraocular pressure	Normal	Low	High.
Anterior chamber	Clear	Aqueous flare and sometimes cells	Usually clear, may have some aqueous flare.

Treatment

- *Iridocycloplegic drug* (to relieve iris sphincter and ciliary spasm): Atropine 1% solution every 2-3 hours until the pupil starts to dilate, then frequently enough to keep pupil dilated.
- Anti-inflammatory medication.
- Corticosteroids.
  - Topical—Initially every 2-3 hours, then three times a day.
  - Subconjunctival—Use only if condition is severe and systemic therapy is not possible; triamcinolone is good.
  - Systemic corticosteroids—but also used concurrently with systemic administration in severe cases.
- **Non Steroidal drug (NSAIDS)**
  - Topical : Flurbiprofen sodium or suprofen could be used (topically), but usually not necessary if corticosteroids are being used.
  - Systemic: Flunixin Meglumine@1 mg/kg body weight IV, or orally in horse. Phenylbutazone may also be used in horses.
- **Immuno-suppressive drugs** Topical cyclosporine has been used with some success
- **Specific treatment for specific cause.**

Complications

- Synechiae (adhesion of the iris to contiguous structures).
- Secondary glaucoma (hypertensive uveitis).
- Iris atrophy.
- Corneal edema (secondary to endothelial damage).

- Lens subluxation/ luxation, cataract (in cats).
- Fundus changes.
- Anophthalmitis.
- Phtisis bulbi.

Equine recurrent uveitis/moon blindness

This disease is a panuveitis (entire uveal tract is affected) which is characterized by repeated recrudescence. Recurrent iridocyclitis is seen at the interval between one week to greater than a year. Each attack causes further ocular damage until eventually the eye may become blind due to cataract, retinal degeneration, or phthisis bulbi. Attacks may subside spontaneously without treatment (but treatment reduces the course and damage).

Cause

- ***Bacteria***: *Leptospira* infection.
- ***Parasites***: *Onchocerca cervicalis* infection.
- ***Metabolite deficiencies***: Deficiencies in vitamins A, B_2 (riboflavin) and C have been suggested, but not proven.

Signs

- Posterior synechiae, occlusion or seclusion of the pupil.
- Cataract or corneal scarring.
- Secondary retinal inflammation and degeneration.
- Peripapillary choroiditis or chorioretinal atrophy.
- There may be fibrosis or separation of the retina in chronic or relapsing cases.

Treatment

- Treat symptomatically as for any other uveitis.
- Treatment of each attack must be vigorous; subconjunctival injections of steroids may be indicated.
- *Onchocerca* infection-Diethylcarbamazine at 11 mg/kg.

Prognosis : Prognosis must be considered guarded to poor because of the recurrent nature of the disease.

Uveodermatologic syndrome

It is characterized by moderate to severe uveitis (anterior and posterior), secondary retinal separation, poliosis (whitening of hair), vitiligo (loss of cutaneous melanin), dysacousia and meningitis. The cause of this syndrome is unknown. It is hypothesized that there may be an immune response mediated against the patient's melanin. Prognosis is poor. The uveitis tends to recur and may result in permanent blindness due to cataract and retinal degeneration after long term separation or inflammation. Even vigorous therapy may not control the situation. In patients in whom inflammation is controlled, useful vision may be retained and melanosis of the skin may recur.

Worm in the eye

Eye worms (*Thelazia* spp.) are common parasites of horses, cattle and also found in pigs, sheep, goats, deer, water buffalo, hares, dogs, cats, and birds. Horses are infected primarily by

Thelazia lacrymalis; cattle mainly by *Thelazia gulosa*, *T skrjabini*, and *T rhodesii*. Eye worms be found in the tear gland and its ducts, less commonly in the third eyelid and the nasal tear d and also on the cornea, in the conjunctival sac, and under the eyelids. Irritation and inflamma of the eye is likely due to the rough outer layer of the worms. Inflammation of the tear ducts sac has also been reported in horses. Mild to severe inflammation of the conjunctiva inflammation of affected eyelids are common. Inflammation and swelling of the cornea, inclu the development of an opaque film, slow-healing sores, holes, and permanent fibrous tissue develop in severe cases.

Clinical signs include mild conjunctivitis, excessive lacrimation, localized edema, cor clouding, and occasionally, subconjunctival cysts. Sometimes severe clinical manifestations conjunctivitis, photophobia, and keratitis may occur. Typically, there is chronic conjuncti with lymphoid hyperplasia and a seromucoid exudate.

Treatment

- Mechanical removal with forceps after instillation of a local anesthetic is useful.
- Flushing the eyes with an iodine solution or applying an iodine ointment may also effective.
- Concurrent use of an antibiotic-steroid ointment to treat the inflammation and any bacte infection is often recommended.
- Certain whole-body drugs that destroy or flush out parasitic worms have been shown work against eye worms.
- Control of thelaziasis in both cattle and horses may be done by fly control measu especially against the face fly.

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CHAPTER 15

Affections of Neck

YOKE GALL

This is a chronic injury to the **ligamentum nuchae** on the dorsal region of neck and gradually develops into a large sized abscess. The pressure of yoke combined with movement induces friction and leading to separation of the layers of the skin and subcutaneous tissue. There will be infiltration of serum and inflammatory exudate and ultimately resulting to a small or large football size swelling formation. Yolk gall is the most common ailment of working bullocks and buffalo bulls.



Yoke gall in a bullock

Etiology

This is caused by the continuous pressure of the yolk on the neck due to indiscriminate use of buffalo, bullocks for traction of loaded carts. The main incriminating factors include:

- Putting to young animal to yoke, since skin is tender.
- Putting to old animals to yoke, since the skin is inelastic.
- Rough yoke surface.
- Putting animals to prolonged work with heavy loads.
- Improper selection of pair of animals. The short height animal receives more weight.
- Ploughing in rocky soils.
- Uneven roads.
- Too early or too late castration of an animal.

Classification

Depending on duration and symptoms, yoke gall may be acute (hot) or chronic (cold).

Symptoms

1. Symptoms of acute inflammation in acute stage.
2. Fibrosis in chronic case.

Yoke abscess : When yoke gall become infected by any infection, there is pus formation within the cavity and is commonly called as yoke abscess. The abscess may be acute (hot) and a chronic (cold) abscess.

Yoke tumour : The yoke gall swelling may persist and in course of time is encapsulated by fibrous tissue. This is commonly called yoke tumour or **tumour neck**. Sometimes, there is presence of pus within the fibrous mass and is actually chronic (cold) abscess.

Treatment

- Application of **fomentation** with magnesium sulphate in initial stages to reduce the swelling and maturation. Counter irritant like Iodine ointment may be rubbed over the swelling to facilitate re-absorption of exudates.
- **Surgical draining** of pus is indicated if an abscess has developed. The cavity should be thoroughly irrigated and dressed with antiseptics till healing occurs.
- Administration of **systemic antibiotics** based on the sensitivity test is also indicated for few days.
- **Extirpation** of well-developed and hard, encapsulated mass (yoke tumour) may be done under strict asepsis and local infiltration anaesthesia.
- The animal should be put to work with minimum load gradually with lubrication of yoke.

TORTICOLIS

Torticolis refers to twisting or distortion of neck. The condition has been commonly encountered in calves, adult cattle and rarely in horses.

Etiology



- Musculoskeletal causes have included fracture/subluxation of cervical vertebrae, unilateral cicatrical muscle contracture, unilateral muscle rupture, unilateral paralysis subsequent to cervical spinal nerve damage and nutritional dystrophic myodegeneration.
- Neurogenic causes include cervical nerve damage or dorsal grey column chronic myelitis.
- Recently, parasitic (verminous) sensory myelitis by *Parelaphostrongylus tenuis* in horse was also implicated as a cause for the problem.
- In buffaloes, involvement of brain in certain diseases like polyencephalomalacia, rabies etc. may be the possible cause of the disease.

Treatment

Early therapeutic measures should be considered in acquired cervical torticolis of non-neurogenic or skeletal origin although most cases do not respond to therapy due to poor prognosis. Following approaches may be made for curing of this condition.

- The dorsal cervical plexus nerve block with local analgesic mepivacaine HCl 2% releases the spasticity of the involved muscles of the neck and provides the requested analgesia for free mobility which helps the remodelling of the affected cervical muscles.
- The action of the vasoconstrictor levonordefrin 1 : 20000 is to prolong the duration of the analgesic effect which is very necessary to maintain relaxation of the muscles.
- Potent steroidal anti-inflammatory drug like Triamcinolone acetonide is very important to alleviate myositis in the affected region.
- In horse, to straighten the curvature of the neck of the affected horse by applying a counteraction forcible pressure on the involved cervical vertebrae after general anaesthesia may lead to dramatic results.

SIT FAST

Sit fast is an area of dry gangrene due to arrest of blood supply by pressure of the saddle. There is involvement of skin which may be extended into the subcutaneous tissue. The necrosed tissue is cone shaped with the base of the cone above. There is sloughing of dead tissue which takes a longer time to heal.

Treatment

- Discontinue the use of collar or saddle.
- The superficial dead tissue is removed and salicylic acid powder is packed to accelerate the sloughing of deeper part of tissue.
- Following removal of dead tissue, ordinary wound dressing preferably dry dressing is indicated for normal healing.
- A fly-repellant ointment or lotion may be applied to prevent maggot infestations.

FISTULOUS WITHERS

Fistulous withers denote a sinus or blind purulent fistula in the region of the withers mostly observed in horse. The most tissues commonly affected are ligamentum nuchae, supraspinous ligament, cartilages of dorsal spines, cartilage of scapula, bone itself and the ribs.

Etiology

- Traumatic injury resulting from an ill-fitting saddle.
- Infections due to *Bacillus abortus, Actinomycosis* and filarial parasite like *Onchocerca reticulata*.
- Deficiencies of certain vitamins like vitamin E.

Signs

- There is localized inflammatory swelling.
- Enlarged bursa may rupture and the pus escapes through one or more orifices of the skin in the area of withers.
- Due to spreading of pus material through the intermuscular spaces, a soft, abscess like swelling may develop in front of the shoulder or behind the shoulder.
- In long standing cases, necrosis of ligamentum nuchae occurs and leads to fistula of neck.

Treatment

- Discontinue the use of saddle that causes this condition.
- Enlarge the sinus openings to provide drainage for easy escaping of pus and necrotic tissue.
- Local application of anti-septic and antibiotic solution is indicated.
- In necrosis or caries of spines, removal of the affected part is advocated.
- A course of antibiotic is indicated to control infection.

SADDLE GALL

Saddle gall is a sore or oedematous swelling caused by an ill-fitting saddle and is commonly encountered in horse. Constant friction or pressure by saddle produces localized acute inflammation of skin and subcutaneous tissues. It may develop into abscess, wherein the infection may extend to the rib below the saddle place. The condition is characterized by circular swelling, varying in size.

Management of this condition is directed to avoid ill fitting saddle, keeping its lining clean and evenly stuffed, equal and balanced distribution of weight on the back and avoiding long journeys with young horses. The saddle should be kept in place for half an hour after work to prevent the formation of galls. The explanation is that the arterioles in the skin and subcutaneous tissues are deprived of blood due to pressure of saddle and if the pressure is suddenly withdrawn, the paralyzed vessels dilate excessively and rupture leading to infiltration of exudate and blood in the area. If the saddle is kept for sometime, the circulation in the affected vessels will be gradually restored.

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CHAPTER 16

Affection of Oesophagus

Anatomical considerations

The **oesophagus** is a muscular tube extending from the pharynx to the cardia of the stomach just caudal to the diaphragm. It is divided into cervical, thoracic and a very small abdominal part. From the pharynx, the oesophagus passes dorsal to the trachea and enters into the thorax. It continues posteriorly between the trachea and the aorta to the diaphragm. The oesophagus then enters through the ***hiatus oesophagus*** and joints the stomach within the abdominal cavity termed as ***cardia***. In general, cervical oesophageal part is thicker as compared to the thoracic part. The muscular wall of the oesophagus consists of two layers *i.e.* inner circular and outer longitudinal layer. In dog and ruminants, muscles are striated through out its entire length, striated to smooth muscle in caudal 1/3rd of oesophagus in horse and in front of diaphragm in pig.

OESOPHAGIAL ULCER

An **oesophagial ulcer** is a hole in the lining of the oesophagus corroded by the acidic digestive juices secreted by the stomach cells. It is usually located in the lower section of oesophagus and is often associated with chronic gastroesophageal reflux disease. The common causes of oesophageal ulcers are chronic use of anti-inflammatory medications and presence of bacteria in stomach. Possible **clinical features** include dyspepsia, dysphagia, vomition, haemetemesis and melaena. The common complications of oesophageal ulcer noted are bleeding and perforation of the oesophagus. **Diagnosis** of this condition in small animal is made by barium X-ray and endoscopy.

Treatment comprises elimination of underlying cause, antibiotic to eradicate bacteria if involved, anti-reflux medication, elimination of risk factors and prevention of complications.

OESOPHAGIAL STENOSIS

Oesophageal stenosis or stricture is a pathologic narrowing/constriction of the lumen of oesophagus occurring sporadically in dog, cat, cattle and buffaloes. It may occur at any point along the oesophagus. In most of the cases, thoracic portion of oesophagus is involved.

Etiology

- Trauma or injury (foreign body, caustic substances, faulty introduction of probang).
- Oesophagitis.

- Gastroesophageal reflux.
- Oesophageal sarcomas due to *Spirocerca lupi* infection.
- As a complication of oesophagotomy.

Clinical signs depend on the location and the diameter of the stenosis. The following signs are generally observed:

- Regurgitation.
- Dysphagia.
- Ptyalism.
- Pain.
- Hypersalivation.
- Weight loss.
- Respiratory signs (coughing, tachypnoea etc.).

Treatment of this condition comprises:

- Balloon catheter dilation in small animal has been the most successful method.
- **Surgical resection** of a single stricture and end to end anastomosis is another option. However, it is also less successful as these therapeutic protocols are likely to induce some degree of oesophagitis which needs further treatment to reduce the chance of stricture reformation. The use of corticosteroids either systemically or intra-lesionally may be tried although there is no existence of clear data regarding the success of this therapy.

DILATATION AND DIVERTICULUM OF OESOPHAGUS

Dilatation of oesophagus (megaoesophagus) is seen cranial to an oesophageal lesion such as stricture, foreign body, and tumour or extraoesophageal compression. It may be of congenital defect or an adult-onset. The factors for congenital defect of dilatation of oesophagus include vascular ring anomalies and oesophageal diverticulum. Adult-onset megaoesophagus may be primary (idiopathic) or secondary to systemic disease (myasthenia gravis, polymyositis, lead toxicity, CNS disorders etc.).



Oesophagial diverticulum of a dog

Diverticulum is a sack like protrusion of the oesophageal mucosa through a rupture of the outer muscular coats, similar to a hernia. This is called an **oesophagocele (jabot).** It generally develops in one side of oesophagus. Diverticulum may occur due to local injury during careless use of probang. Besides, increased intraluminal pressure due to presence of foreign body obstructing the oesophagus may sometimes rupture the muscle fibres in a localized area. Middle and distal cervical portion is commonly affected.

Incidence

Megaoesophagus and diverticulum are observed in all species of animals although incidence is higher in cattle, buffaloes and horses.

Clinical signs

- Accumulation of food materials in the dilated portion of oesophagus.
- Regurgitation through mouth and nose.
- Aspiration pneumonia with associated signs of cough, fever and nasal discharge.
- Liquids may be taken normally.
- Ballooning of the oesophagus at the thoracic inlet if pressure is applied to the abdomen.

Treatment

- Medical management of dilatation of oesophagus is indicated.
- The consistency of diet should be semi-liquid type that best prevents regurgitation.
- Surgical exposure of the oesophagus followed by resection of the diverticulum is the alternative way of treatment. After exposure, the excess mucous membrane of protruding sac is trimmed and sutured. Care should be taken not to resect excess part of oesophagus otherwise stricture may develop. Routine postoperative care should be taken and provide only semi-liquid diet until complete healing is occurred.

CHOKING

Obstruction of oesophagus is commonly called **choke**, frequently met in cattle, buffalo, pig, and small ruminants like sheep and goat and pet animals. It may be acute or chronic depending on the onset of occlusion.

Etiology

- **Intra luminal :** Intra luminal obstruction may occur due to accidental ingestion of potato, large size lemon and apples, mango seed. Besides, ingestion of rubber sheets, leather piece, stone, piece of metal, wood, glass etc. may also cause choking in animals. In dog, solid food, sharp bone, fish hook, rubber ball, toys, large block of meat may struck within the oesophagus.
- **Extra luminal :** Extra luminal obstruction includes pressure of oesophagus by space occupying lesions like tumor or enlarged mediastinal lymph node and oesophagial hiatus hernia.

Incidence

Obstruction commonly occurs in cervical region in cattle, horse and distal cervical region in buffaloes. On the other hand, in dog and cat the foreign objects like sharp bone, solid food, fishhook, needle, toys, large block of meat or fish etc. frequently lodge in the thoracic inlet, base of heart region or diaphragmatic region.



Choke in esophagus with fish bone of a dog

Clinical signs

Early signs

- Salivation.
- Restlessness.
- Difficulty in breathing.
- Anxious look.
- Pawing in the mouth.
- Stretching of neck region.
- Refusal of food.
- Protrusion of tongue.
- Vomiting attempts.

Late signs

- Severe tympany (ruminants)—if the obstruction is complete.
- Dyspnoea.

The cardinal signs in choking in cattle are lowering of head and salivation, horse- anxious look and arching of the neck, dog-anxious expression on the face and vomiting attempts.

Diagnosis

- History and clinical signs.
- Palpation of cervical oesophagus for foreign bodies.
- Passing of probang or stomach tube if there is involvement of thoracic esophagus to judge nature and location of obstruction.
- Radiographic examination of full length of esophagus.
- Contrast radiography with barium swallow depending of the size of the animal.
- Exploratory diagnosis.

Treatment

Conservative therapy

- Parasympatholytic drugs like atropine sulphate @ 16-32 mg total dose for large animal (horse, cattle, and buffalo) to relax oesophagial spasm.
- Tranquilizers like alpha-2 agonists (Xylazine hydrochloride) or triflupromazine may be tried to relax the oesophagial muscle and for sedation.
- Removal of gas from rumen by inserting a GTV needle or trocar and canula through the left paralumber fossa otherwise, tympany may endanger the life of ruminant.
- If the intra-luminal mass is soft in consistency, the same may be **crushed** by mild pressure in the area and try to **push** the material gently into rumen using the base of a banana leaf/stomach tube/probang without causing any injury to oesophagus. Otherwise, the mouth should be opened by grasping the tongue and locate the material with the help of a torch. An attempt may be made to remove the mass by introducing the hand.
- A loop of steel wire fitted in a probang may be introduced through mouth following sedation and thereupon, to pull the object entangled in it.
- In pet animals, an attempt should be made to grasp the object by tweezers or pliers but not by hand, Quick chest compressions can be made by placing a hand on each side of the chest and gently force air from the lungs to dislodge the object if it is out of reach. Fishing line that may have a hook if suspected should not be pulled.

- Adequate fluid therapy with 5% dextrose solution should be advocated to compensate fluid deficit due to salivation and inability to drink and eat especially in ruminants.

Surgical treatment. If all these conservative measures fail, then surgical interference will be the answer to remove the hurdle. For **oesophagotomy** operation in ruminant, a longitudinal incision is made directly over the foreign body under local anaesthesia. If the wall of oesophagus is damaged to a certain degree but tissues are viable, the line of incision should be placed in healthy area either proximal or distal to the obstructing foreign body. After opening the oesophagus, the obstruction is relieved. The oesophagus is sutured in two rows; first layer being connell and second layer either cushing or simple interpreted including the fascia. If it is needed to remove a portion of oesophagus, end to end anastomosis is to be done like that of intestine. The skin suture should be made routinely with non absorbable suture material. In canine, similar approach is made except that the incision is made through the mid ventral line of neck. For obstruction in thoracic part of oesophagus, thoracic surgery is indicated with positive pressure ventilation under general anaesthesia. Post-operative management includes withholding of food through mouth for 5-15 days depending upon the nature of surgery, administration of broad spectrum antibiotics and adequate fluid therapy followed by providing liquid and semisolid food for a certain days.

TRACHEAL INJURIES

Tracheal injuries are occasionally encountered in animals and are contusions and open wounds. In contusions, there may be rupture of subcutaneous or submucosal capillaries and fracture of the cartilages.

Signs

- Loss of consciousness with cardiac and respiratory syncope.
- Bleeding from nose.

Open wounds of trachea are caused by bite, bullet injury or automobile accidents. There may be emphysema, intratracheal haemorrhage, dyspnoea and even asphyxia and broncho-pneumonia.

Treatment of this condition may be conservative or surgical.

Conservative therapy includes :

- Treatment of contusions and open wounds on general principles.
- Avoidance of entering antiseptic lotion to trachea through open wounds to overcome inflammation and fatal broncho-pneumonia.

Surgical therapy consists of the following :

- Tracheal wound edges are to be debrided and sutured.
- If soft tissue wound is developed, treatment should be directed as open wound healing or debrided and suture with or without drains.
- In severe cases of wound, resection of part is to be done followed by anastomosis. Teflon mesh may be used for the purpose.
- A course of antibiotic therapy is advocated.
- In case of severe bleeding into the trachea and threatening asphyxia, tracheotomy below the affected part is indicated.

TRACHEAL COLLAPSE

Tracheal collapse is a condition characterized by incomplete formation or weakening of the cartilagenous rings of the trachea resulting in flattening of the trachea. It may be congenital or acquired, and extrathoracic or intrathoracic. Collapse of the cervical trachea (in the neck) occurs during inspiration and collapse of the thoracic trachea (in the chest) occurs during expiration. It is most commonly observed in small dog breeds although observed in the cervical trachea of horse, both as a congenital condition and as a result of trauma.



Lateral radiograph of a collapsed trachea. White arrows mark the normal-sized intrathoracic trachea; black arrows mark the collapsed intracervical part.

Etiology

- Congenital tracheal collapse occurs due to deficiency of normal components of tracheal ring cartilage like glycosaminoglycans, glycoproteins, calcium, and chondroitin.
- Acquired tracheal collapse occurs in certain diseases like Cushing's syndrome, heart disease and chronic respiratory disease and infection.
- Obesity is a common contributing factor in dogs with tracheal collapse.

Clinical signs

- Coughing during excitation.
- Exercise intolerance.
- Dyspnoea and gagging while eating or drinking.
- Narrowing of the tracheal lumen.

Treatment

Medical treatment for mild to moderate cases is directed to apply corticosteroids, bronchodilators and antitussives.

Severe cases require **surgical implantation** of a tracheal stent (inside or outside of the trachea) or prosthetic rings.

- Extraluminal (outside the trachea) stenting is generally advocated for tracheal collapse in the neck region.
- Intraluminal stenting has explored more promise for success with intrathoracic cases. Potential problems include stent migration and fracture.

TRACHEAL TUMOURS

Tracheal tumours **are rarely observed in animals although sometimes papillomata are met with.**

Signs

- Interference in respiration that leads to dyspnoea.
- Characteristic noise during expiration.
- There may be distension of the tube.
- Dyspnoea may increase or decrease depending upon compression of the trachea at the level of tumour.

Treatment

- Extirpation of tumour is to be made surgically through a tracheal opening at its level.
- In case of wide base tumour, complete removal is impracticable. Tracheotomy is indicated below the lesion to minimize respiratory distress.
- Removal of malignant tumour is useless, however some tumours respond to chemotherapy. Tracheotomy may be performed to prolong the life of animal for a while.

FOREIGN BODIES IN PHARYNX AND LARYNX

Foreign bodies like pin, needle, fish-hook, bone or piece of cartilage may be lodged commonly in pharynx and larynx in dog and cat. Besides, due to disease condition of pharynx and larynx, food material may pass into the larynx during feeding. Other foreign bodies have been observed in the pharynx and larynx in large animals including potato, onions, piece of turnip, pebbles etc.

Signs

- Early coughing which may or may not be sufficient to dislodge it.
- Dysphagia.
- Salivation.
- Vomiting attempts in dog.
- Fatal broncho-pneumonia may develop.
- Obstruction of the lumen of passage leads to death from asphyxia.

Treatment

- In dog and cat, foreign body should be immediately removed with forceps through the mouth.
- In cattle, generally the foreign body is removed by the hand but in horses, it should be removed after performing laryngotomy.

PHARYNGEAL ABSCESS

Pharyngeal abscess develops after extension of upper respiratory tract infections, including oral infections. Pharyngeal abscesses, which may be either retropharyngeal or parapharyngeal, often derive from metastatic spread via the lymphatics. Pharyngeal abscess has a high potential for airway obstruction and high mortality, early detection and treatment are vital. Abscesses may develop in the posterior or lateral wall of the pharynx.

Etiology

- **Direct injury and infection of the pharyngeal wall.**
- Passage of infection from mucous membrane of pharynx to the lymphatic glands through the lymphatic vessels.

Clinical signs

- There is pain sensation, febrile reaction and anorexia.
- Neck rigidity.
- Pharyngeal oedema.
- In chronic or cold abscesses, there is snoring and interference of swallowing.
- Sometimes, the abscess may burst leading to asphyxia or infective pneumonia and ultimately death may ensue.

Treatment

- Surgical drainage of abscess and exploration to remove suspected or identified foreign bodies is required.
- Broad-spectrum antibiotic agents with anaerobic cover are indicated. Specific antibiotic therapy may be amended as per culture and sensitivity results.

TRAUMATIC INJURIES

Traumatic injuries of larynx and pharynx are occasionally met with in large and small animals. It is caused by accidental ingestion of sharp foreign bodies like nails, pieces of wires, pins, sewing needles, fishhooks, sticks, bones or grass awns etc. Besides, dental instruments and careless passing of probang may also lead to this condition. These foreign materials usually migrate through the pharyngeal mucosa into the retropharyngeal tissues resulting in abscess formation. The pharyngeal trauma may result in haematoma, foreign body granuloma and cellulites or abscess. Bacterial or viral invasion may result into phlegmon.

Signs

- Bleeding from mouth due to wounding of a pharyngeal wall.
- The animals keep their head extended and reluctant to eat.
- There is acute pain.
- If the foreign body penetrates the lateral walls of the pharynx, diffuse swelling occurs in the pharyngeal wall.
- Drooling of saliva from mouth.
- Unable to drink and swallow from mouth.
- Reflux of feed through nostril if pharyngeal paresis occurs.

Treatment

- Removal of foreign bodies causing injury is indicated under light sedation.
- If there is abscess formation due to foreign bodies, draining of pus is needed.
- Irrigation of oral cavity and pharynx with weak saline solution is advocated.
- A course of antibiotic is needed to control infection.

FISTULAE

Occasionally, pharyngeal fistula may be encountered due to traumatic injury in animals. There may be bleeding from the mouth due to rupturing of pharyngeal vessel. Sometimes, abscess in the pharynx may burst externally or internally and leads to development of pharyngeal fistula. The alimentary materials and saliva may escape through this passage. The condition persists for a variable period of time.

UNIT 5

THORAX AND ABDOMEN

CHAPTER

1

Surgical Approaches to the Thorax

There are several surgical approaches to thoracic cavity in small animals:

INTERCOSTAL THORACOTOMY

Intercostal thoracotomy is the standard approach for exposure of a defined region of the thorax and offers well to excellent access to structures in the immediate area of the thoracotomy. Complications are uncommon when airtight closure of the incision is done.

Surgical site

- From 3rd throgh to 10th intercostal space depending on the structure to be exposed.
- A lateral thoracic radiograph may be helpful to determine the intercostals space that best exposes a desired thoracic structure.
- A combined caudal intercostal thoracotomy and diaphragmatic incision are suitable approach for cranial abdominal structures.

Surgical technique

- Incise on the skin and cutaneous trunci muscle parallel to the desired intercostal space and extend from the costovertebral junction to the sternum.
- Incise the latissimus dorsi muscle across its muscle fibres parallel to the skin incision.
- Incise either the scalenus or external abdominal oblique muscle depending on the intercostal space desired.
- Separate the serratus ventralis muscle between its muscle bellies to expose the intercostal space.
- Incise the intercostal muscle in the middle to avoid damage to the underlying vessels and nerves.
- Complete thoracotomy by blunt puncturing and opening the pleura with scissors.
- Intercostal incision may be extended dorsally to the tubercle of the rib and ventrally passing the costochondral arch to the internal thoracic artery.
- Use rib retractor to widen the incision.
- Before closure, an intercostal thoracotomy tube is placed through the dorsocaudal thoracic wall caudal to thoracotomy.

- Closure of the thoracotomy is done by placing heavy gauge interrupted circumcostal sutures around the ribs immediately cranial and caudal to the incision.
- Place the sutures before closure and pass bluntly through the intercostal space to avoid damage to the intercostal vessels.
- The circumcostal sutures may be used by an assistant to approximate the rib while the surgeon ties the adjacent sutures.
- Muscles are closed meticulously in layers to prevent leakage of air.
- Skin is closed in a standard manner.

RIB RESECTION THORACOTOMY :

Less commonly performed.

Advantages

- Provides adequate exposure.
- Adhesion of lungs to thoracotomy site is less.

Disadvantages

- Time consuming surgery.
- Less secure closure of thoracic wound.

Surgical technique

- Exposure of the internal thoracic wall for rib resection is similar to intercostal approach.
- The periosteum of the rib to be resected is incised over the mid-lateral surface of the rib.
- The periosteum is bluntly elevated from the rib over its lateral and medial surfaces.
- The rib is excised with a bone cutter (alternately the rib is rotated or pivoted out of the field rather than excised during thoracotomy and then returned to the periosteum at closure).
- The medial periosteum and parietal pleura are opened bluntly and the incision is extended with scissors to complete thoracotomy.
- Closure is done by interrupted mattress sutures preplaced in the medial and lateral edges of the incised periosteum.
- The remainder of the closure is similar to intercostal approach.

MEDIAN STERNOTOMY

Median sternotomy **provides access to the entire thoracic cavity**.

- Place the animal in dorsal recumbency.
- Incise the skin and subcutaneous tissue on the ventral midline over the sternum.
- Incise the pectoral musculature and elevate slightly to expose the midline of the sternebrae.
- Open the sternum on its midline with an oscillating bone saw.
- Depending on the type and degree of exposure of the thoracic cavity needed, it is desirable to leave either the manubrium or xiphoid or both, intact to increase stability of the sternotomy after closure.
- Median sternotomy may be combined with a ventral midline celiotomy if a combined approach to thoracic and abdominal cavities is desired.

- Similarly, median sternotomy may be extended into the cervical region by combining a sternotomy with a ventral midline cervical approach.
- Before closure of the sternotomy, a thoracotomy tube is introduced into the thoracic cavity from a subcostal position lateral to midline.
- Figure-of-eight orthopaedic wires passed around each sternebrae that incorporate a costosternal junction within the figure-of-eight are used to achieve a stable closure. In small dogs and cats heavy gauge monofilament sutures can be used in place of wire to close the sternotomy.
- The pectoral muscles, subcutaneous tissues and skin are closed in separate layers with separate continuous suture pattern.

TRANSSTERNAL THORACOTOMY

Not a common approach.

Exposure offered by this approach may be considerably increased by extending the thoracotomy through the sternum to connect it with an intercostals thoracotomy on the opposite side of the chest. It is indicated when extensive exposure to a specified region of the thorax is desired. Trans-sternal thoracotomy at 7th intercostal space has been advocated for repair of diaphragmatic hernia.

Surgical technique. Similar to intercostal thoracotomy approach.

- Place the animal in dorsal recumbency.
- The approach is accompanied by extending ipsilateral intercostal thoracotomy to the sternum after ligation of the internal thoracic vessels.
- The intercostal thoracotomy is then joined by a transverse osteotomy across the sternum.
- At closure, the sternal osteotomy may be stabilized with small intramedullary pins and orthopaedic wire.
- The intercostal incisions are closed as with intercostal thoracotomy.

General considerations for thoracic surgery

- One must first consider the location of the lesion when deciding on the approach. Whenever possible, thoracic lesions need to be localized by a combination of ultrasound and thoracic radiograph.
- The surgeon should have a thorough knowledge about the cardiopulmonary physiology and special instruments needed for thoracic surgery.
- The preoperative and postoperative assessment and care are of paramount importance for undertaking thoracic surgery. Anaemic and hypovolemic patient need special attention.
- General anaesthesia should be cautiously used in thoracic surgery. If general anaesthesia is selected, placing the animal in sternal recumbency to optimize ventilation is best. Positive pressure ventilation is a prerequisite in this situation.
- Aseptic site preparation is necessary in all cases.
- Maintenance of adequate ventilation is mandatory in thoracic surgery which can be accomplished by ventilating the lungs intermittently with positive pressure.
- Creation of negative pleural pressure inside the thorax is needed after completion of surgical procedure but before complete closure of the thoracic cavity.

- During the postoperative period, the patient should be closely observed for spontaneous return of normal respiratory movements. The animal should be provided a comfortable room temperature and soft bedding.
- The animal should be placed in sternal recumbency with the support of stuffed gunny bags placed at either side of chest.
- Postoperative analgesic and antibiotics (for a week) are considered to reduce pain and control of infection.
- Transient radial paralysis of the lower limb if develops, may be treated by local massage with liniments, parenteral nerve tonics and infra-red radiation.

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CHAPTER

2

Affections of Thorax

Contusions

Contusions of chest wall may occur as a result of falling, kicking and collisions against a hard object.

Signs. The clinical signs of this condition are those of contusions in general, except in deep seated injury, where thoracic organs are damaged to a certain degree.

- There may be rupture of heart and of the lung caused by severe violence inflicted on the chest wall without fracture of the ribs.
- Laceration of lung may occur caused by penetration of the organ by fragment or sharp pointed fractured ribs and ultimately leading to haemoptysis, haemo-pneumothorax and pulmonary emphysema.

Treatment of this condition consists in keeping the patient at rest.

- Local application for **traumatic inflammation** is indicated.
- Injection of adrenaline is indicated to arrest bleeding and application of cold compress.

Fracture of rib

Fracture of ribs is rarely observed in ruminants and in other animals.

Etiology

- Direct violence such as fall, blow or a collision to the chest.
- Severe muscular violence may lead to fracture of ribs covered by shoulder.

Clinical signs. The clinical signs vary with the location of the affected rib and the degree of displacement of the fragments.

- Inflammatory swelling at the sat site of injury (in simple subcutaneous fracture) and crepitation.
- Deformity of the rib as a depression or flattening of the affected region (in marked displacement).
- Pain is present in the region of the fracture and is aggravated by deep inspiration.
- Voluntary restriction of the respiratory activity on the side of the rib fracture.
- Pneumothorax or haemothorax may ensure if displaced fragments may penetrate the pleura or the peritoneum.

Treatment

- Simple fracture of ribs without any complications can be managed by bandaging and providing absolute rest to the animal.
- Compound fracture of ribs, if occur, is treated on general principles.
- In small animal, use of a K-wire and a figure-8 wire can immobilize the fracture, thereby reducing pain and hastening healing.
- Costal fistula may occur from necrosis of the rib which can be treated by resection of the diseased rib.

Injuries of costal cartilage

Injuries especially fracture of costal cartilage may occur as that of the ribs. The clinical signs and treatment procedure are similar like fracture of rib but there is no crepitation.

Fracture of the sternum

Fracture of the sternum may occasionally occur in animals as a result of falling or collision against a hard object either simple or compound and incomplete or complete.

Signs

- Crepitation may be detected during respiratory movements or the movement of the patients.
- Fractured bone may be felt (when compound). Sternal fistula usually results.

Other signs are similar like that of a contusion or open wound.

Diagnosis is very difficult because of thick muscular covering of the bone.

Treatment of this condition is similar for a contusion, sternal fistula or open wounds.

Perforated wounds

Wounds of the thoracic wall occur as a result of trauma either as non-penetrating or penetrating. Perforated wounds of the thorax allow open communication between the pleural space and the exterior. Splinters or sharp rib ends of fractured ribs may penetrate the lungs and lead to pneumothorax.

Signs

- Hissing noise caused by the passage of air between the pleural sac and the exterior (in narrow penetrating wound).
- Collapse of lung may occur from the loss of negative intrathoracic pressure and space occupying effect of the atmospheric air (in large penetrating wounds).

Diagnosis by probing is contraindicated as there are every chances of introducing infection from the outer part of the wound to the thoracic cavity. However, auscultation and radiography may be helpful to ascertain the extent of damage.

Treatment of this condition is on the same lines as those recommended for wounds in general.

Sternal fistula

Sternal fistula may occur :

- Due to necrosis of sternum following injury and infection of the bone of sternum.

- Due to compound fracture of sternum
- Due to lodgement of a foreign body in the vicinity.

Signs

- Presence of persisting purulent orifice with prominent inflammatory swelling.
- There is suppuration beneath the muscles leading to an enormous abscess under the breast.
- Purulent pleurisy may ensue if pleural cavity is affected.

Treatment of this condition should be made on general principles.

- Initially, fistulous tract may be treated with liquid and solid caustics.
- Hot iron may be inserted into the depth in certain cases.
- Diseased tissue in the tract may be removed by surgical operation.

Pneumocele

Hernia of a portion of the lung is rarely observed in an intercostal space, usually traumatic in origin, often due to a piercing force. Disruption of the intercostal muscles and pleura allows lung lobes to herniate under the skin and reduce compliance of the chest wall. The condition may persist for a varying period of time without any complication except gangrene, which may supervene if there is strangulation of contents. Sometimes, there may be herniation of bowel in intercostal space through a rupture in the diaphragm.

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CHAPTER 3

Traumatic Pericarditis of Cattle and Heart Worm Disease

Traumatic pericarditis

Traumatic pericarditis is an acute, sub-acute or chronic inflammation of the pericardium caused by penetration of sharp foreign body. The condition is commonly encountered in cattle and buffaloes as a sequeae of traumatic reticulitis, where a sharp foreign body may easily pierce the diaphragm and enter into the pericardium and leading to exudative or suppurative pericarditis.

Surgical approach. The surgical approach consists of **pericardiocentesis, pericardiotomy** or **pericardiectomy**.

Pericardiocentesis is carried out in standing animal (between the 4th or 5th right intercostal space) with the forelimb drawn forward to drain the accumulated fluid from the pericardial sac and to inject antibiotics and proteolytic enzymes. However, this procedure provides temporary relief as fluid again accumulates.

Pericardiotomy is carried out by entering the thorax at the left fifth or sixth ribs or intercostal spaces or at the sixth or seventh ribs. Upon entering the chest, the surgeon should look for a fibrous tract that enters the pericardium caudally. The fibrous tract is clamped with a large Oschner clamp to immobilize the foreign body as soon as the tract is identified. The surgeon then incises the fibrous tract with large scissors until the centre is identified. The foreign body is then grasped and removed. The cavity is thoroughly irrigated with warm sterile isotonic saline solution containing antibiotics. Afterwards, the pericardium is sutured with monofilament absorbable sutures in a continuous pattern. The pericardial cavity may be left open to drain or be partially closed and managed with drains if this allows appropriate lavage and adequate drainage.

Pericardiectomy refers to removal of some portion of pericardium. This is indicated in constrictive pericarditis in which pericardium is friable, frustrating to suture and mediastinal adhesions are thick. Complete removal of pericardium is hard because of its attachments at thin wall of atria and great vessel. In that situation, partial pericardiectomy is to be carried out to prevent pulmonary and passive venous congestion. However, limited success is achieved in clinical cases.

Chest bandages to cover the wound or local bandages secured with loops of suture is recommended. If the foreign body returned into reticulum during manipulation, a rumenotomy

is indicated to remove the foreign body at the same restraint or anaesthetic episode. In that situation, it is desirable to postpone the rumenotomy and place a magnet in the reticulum until the initial surgical morbidity of the thoracotomy has resolved.

Heartworm disease (HWD) or Dirofilariasis in dogs

Heartworms are parasites that can be transmitted by mosquitoes. A mosquito will usually bite a dog and transfer the parasites into the blood stream of the dog. Heartworm is a misnomer because the adult worms actually reside in the pulmonary arterial system for the most part, and the pathology is related to the damage in pulmonary arteries and lung.

Etiology : The condition is caused by *Dirofilaria immitis*.

Pathogenesis

Severity of this disease depends on the number of worms (ranges from 1 to over 250), duration of infection and host-parasite interaction. Heartworm resides primarily in the caudal pulmonary vascular tree, occasionally migrating into the main pulmonary arteries, the right heart and even the great veins in heavy infestation. The major effect on the pulmonary arteries is produced by worm induced (toxic substances, immune mechanisms and trauma) villous myointimal proliferation, inflammation, pulmonary hypertension (PHT), disruption of vascular integrity and fibrosis. This may be complicated by arterial obstruction and vasoconstriction caused by dead worm thrombosis and their products.

The **clinical signs** of this condition include weight loss, diminished exercise tolerance, lethargy, poor condition, cough, dyspnoea, syncope and abdominal distension (ascites), in but majority of cases of HWD are asymptomatic.

Diagnosis

- History and clinical signs.
- Microscopic identification of microfilariae on a direct blood smear, above the buffy coat in a microhaematocrit tube, using the modified Knott test or after multipore filtration.
- Immunodiagnostic tests (Heartworm ELISA antigen tests).
- **Radiography** : Thoracic radiography offers an excellent method of detecting HWD, for determining its severity and for evaluating pulmonary parenchymal changes.
- **Electrocardiography** is useful in detecting arrhythmias, but is generally insensitive in detection of cardiac chamber enlargement in HWD when compared to radiography and echocardiography.
- Echocardiography is sensitive in the detection of right heart enlargement.

Clinical pathology : Neutrophilia, eosinophilia.

Treatment

Medicinal therapy includes Melarsomine (Immicide) with 2 doses (2.5 mg/kg deep intramuscular every 24 hours), Ivermectin at monthly for 31 consecutive months (nearly 100% adulticidal efficacy in young HWD). Selamectin continuously for 18 months (kill approximately 40% of transplanted worms). Cage rest is important in the management of HWD after adulticidal therapy, after post-adulticidal thrombo-embolization (PTE) or during therapy of heart failure.

Surgical therapy involves mechanical removal of worm using a flexible alligator forceps under fluoroscopy and with general anaesthesia.

CHAPTER

4

Surgical Approach to the Abdomen

There are several surgical approaches to abdominal cavity in small animals *i.e.* in dog and cat.

Ventral midline approach

The ventral midline celiotomy is the superior and standard-access route for almost all the abdominal contents. The aim is to incise precisely through the linea alba, avoiding the rectus abdominis muscle on each side. After incising the skin, subcutaneous tissue is reflected and the linea alba is exposed. For caudal incision in male dogs, the skin incision is directed paramedian to one side of the penis and prepuce. The linea alba is then incised but not the peritoneum. The peritoneum is punctured with scissors and a finger or instrument is inserted to confirm the absence of adhesions before the incision is extended with scissors. Alternatively, the linea alba is elevated with thumb forceps and the scalpel blade is inserted through it. Once the abdominal cavity has been entered, the incision is extended with scissors. The falciform ligament may be packed to one side or removed along the length of the incision with scissors. Bleeding may be controlled either by use of diathermy or by ligating at the cranial end of incision. Closure of abdomen should be done in three layers : rectus abdominis and its sheath, subcutaneous tissue and skin.

Paramedian approach

Paramedian approach is little practised in small animals like dog and cat. The only indication of this procedure is unilateral cryptorchidectomy to get direct access to the abdominally located cryptorchid testis. Here, incision is made through the skin, the fascia, the external leaf of the rectus abdominis aponeurosis, the rectus abdominis muscle itself, thin internal leaf and the transverse fascia and peritoneum. Closure of the internal leaf, rectus muscle and the external leaf of the rectus sheath is to be done separately.

Flank approach

Indication

- Good access to dorsally located abdominal organs including the kidney, adrenal and ovaries (limited access to both ovaries and uterus).
- Placement of gastrotomy feeding tubes and for gastric decompression.

Restraint : The animal should be placed in lateral recumbency with a sand bag beneath the lumber region on the opposite side.

Procedure : After the skin incision, three muscles i.e. external abdominal oblique, internal abdominal oblique and transversus abdominal are separated in the direction of their fibres and a grid incision is made. The deep and superficial branches of the deep circumflex iliac artery need to be ligated. The transverse fascia and peritoneum are elevated with thumb forceps and carefully incised to give access to the perineal cavity. Closure of the abdominal wall is made by individual suturing of the layers with simple continuous sutures of synthetic absorbable material.

Paracostal approach

This approach provides good access to the cranial and ventral part of the abdominal cavity including organs such as stomach, spleen and caecum. After placing the animal in lateral recumbency with a sand bag beneath the lumber region on the opposite side, a curve incision is made 1 to 2 cm caudal to the last rib. Muscles are incised like that of flank incision, although incision is to be extended more ventrally including transection of part of the rectus abdominis muscle. Finally, the incision is closed by simple continuous suture in each layer.

Apart from the above commonly employed surgical approaches, combined midline paracostal (especially for difficult hepatic surgery) and combined paralumber paracostal approaches ("lazy S" pattern) are also followed to get access to abdominal cavity.

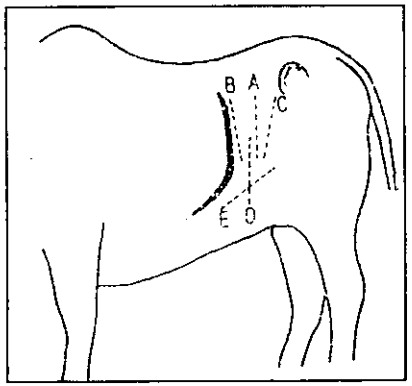
Surgical approaches of abdomen to ruminants

Selection of a desired incision site in abdomen of ruminants depends upon the species, physical condition of the animal, easy access to the organ and the preference of the surgeon. In ruminants, flank incisions (either left or right) remain the most popular approach to get access of major abdominal organs although paramedian and ventrodorsal are also made.

Flank approach

Indications : Indications for upper left flank celiotomy include exploratory laparotomy, rumenotomy, left flank abomasopexy, repair of a ruptured urinary bladder, caesarean section in cattle, buffalo, sheep, goat and camels. Besides, upper right flank approach is indicated for exploratory laparotomy, omentopexy, abomasopexy, surgical correction of intestinal obstruction and caecal dilatation.

For upper flank approach, a 20 to 25 cm dorsoventral skin incision is made 4 cm caudal and parallel to the last rib and 6 to 8 cm ventral to the transverse process of the lumber vertebrae. The incision is to be placed as close to the ribs as possible to allow a more complete examination of cranial abdomen. For ruminotomy, to retrieve a foreign body from the incision, the incision should be made a few cm gained over a mid paralumber



Incision site in the bovine. (A) Mid-upper flank incision. (B) Incision caudal and parallel to the last rib (C) Incision for approach to the urinary bladder, (D) Lower flank incision, (E) Ventro-lateral oblique incision.
Redrawn from Ruminant surgery.

region. A slightly oblique incision below the tuber coxae is generally preferred for approach to the urinary bladder. For caesarean section, the incision is made at lower flank area beginning 10 cm ventral to the transverse process and may extend 30 to 40 cm.

The skin, subcutaneous tissues, external and internal oblique muscles, transversus muscles and peritoneum are incised in the same plane. Closure of the abdominal wounds is made separately in individual layers. The first layer closure comprises peritoneum and transverse abdominal muscle with No 2 or 3 absorbable materials in simple continuous pattern. The second layer includes two oblique muscles along with subcutaneous tissue with the same suture material and technique. Care should be taken during closure to obliterate any dead space. The skin layer is closed with non-absorbable suture material using either simple interrupted or horizontal mattress suture.

Ventrolateral oblique incision

Ventrolateral oblique incision is also made infront of the stifle and extends in a slightly oblique direction. This procedure is made in cattle and buffaloes in lateral recumbency position with hind limbs extended caudally. The skin, subcutaneous fascia, aponeurosis of rectus abdominis muscle, transverse abdominis muscle and peritoneum are incised. The first layer closure comprises peritoneum and transverse abdominal muscle with No 2 or 3 absorbable materials in simple continuous pattern. The second layer includes suturing of external sheath of rectus abdominis muscle in simple continuous or simple interrupted pattern. The subcutaneous tissue and skin are closed in standard manner.

Median incision

Median approach may be used in cattle and small ruminants where incision is given directly in the midline over the linea alba. The subcutaneous tissue is incised to expose the linea alba, which should be evident as a small concave line. The abdominal wall is grasped with tissue forceps and tented, and a small incision is made on the linea alba. The incision is continued through the linea alba and peritoneum, with scissors guided by the operator's index and middle finger. The linea alba and peritoneum are sutured in an interrupted or continuous pattern with synthetic absorbable or non-absorbable sutures (as per choice of surgeon). The subcutaneous tissue and skin are closed routinely.

Paramedian approach

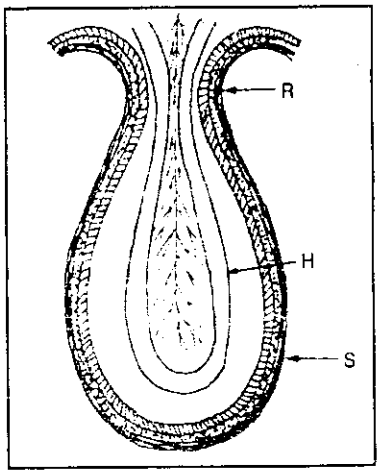
Paramedian approach for abdominal exteriorization is generally made for horses, infrequently in cattle but not in buffaloes and camels.

The incision is generally made between the linea alba and subcutaneous abdominal vein. The approach is continued by using a combination of blunt and sharp dissection through subcutaneous tissues. The external rectus abdominis sheath is sharply incised, the rectus muscle bluntly separated along its fibres and the internal rectus sheath tented, along with the peritoneum and incised. The incisions for abomasopexy extends laterally from just cranial to the umbilicus to the xiphoid process and for caesarean operation, the incision extends laterally from just behind the umbilicus to the udder. For closure, the peritoneum and internal rectus sheath are sutured in a single layer with synthetic absorbable sutures in a continuous pattern. The external rectus sheath is the "holding layer" which should be closed carefully with an absorbable suture. The subcutaneous tissue and skin are closed routinely.

CHAPTER 5

Hernia

Hernia is the protrusion of an organ or tissue through an opening under intact skin. A typical hernia consists of a **hernial ring, sac** and **contents**. The hernial ring is formed due to a rupture in the abdominal wall (ventral hernia), separating structure (diaphragmatic hernia), or due to developmental defects (umbilical hernia). A normal opening or passage may become a hernial ring (inguinal hernia). The hernial sac encloses hernial contents. The wall of the sac usually contains the skin, muscular fibres, fibrous tissue and parietal peritoneum. The hernial contents include the organ (intestine, reticulum) or tissue (omentum) or both.



Diagrammatic representation of hernial constituents. (R) Hernial ring, (H) Hernial contents, (S) Hernial sac.

Classification

- Hernia may be **congenital** (present at birth) or **acquired** (developed later on).
- **According to protrusion of hernial sac :** External or internal. The hernial contents protrude through abdominal wall and come close to the skin in external hernia (ventral hernia, scrotal hernia) whereas, the contents move from one body cavity to another in internal hernia (diaphragmatic hernia, gut-tie).
- **According to hernial content :** Enterocele (intestine), epiplocele (omentum), enteroepiplocele (intestine and omentum), gastrocele (stomach), vesicocele (urinary bladder), hepatocele (liver), hysterocele (uterus), reticulocele (reticulum) etc.
- **According to location of hernia :** Umbilical, inguinal, scrotal, diaphragmatic, perineal, ventral, femoral hernia etc.
- **According to reducibility or not of content :** Reducible or irreducible hernia. A hernia may become irreducible due to adhesions, incarceration or strangulation

Etiology

Predisposing causes

- Imperfect closure of an embryonic defect (imperfect closure of umbilicus leading to umbilical hernia).
- Imperfect formation of the diaphragm causing diaphragmatic hernia.
- Weakness of the abdominal wall due to trauma and inflammation etc.

Exciting causes

- Trauma with blunt objects.
- Increase in intra-abdominal pressure due to straining, parturition, violent coughing, tympany etc.

Diagnosis

- **History**-Hernia present at birth or history of trauma.
- **Clinical signs**-In strangulated hernia, symptoms like abdominal pain, fever and evidence of bowel obstruction may be apparent.
- **Inspection**-Presence of hernial swelling in external hernia is indicative. It should be differentiated from abscess, tumour, cyst and haematoma.
- **Palpation**-It shows a characteristic consistency depending on the hernial contents. Hernial ring can be palpated in reducible hernia.
- **Radiography**-Plain and contrast radiography may be helpful to identify the hernial contents.
- **Ultrasonography**-Readily recognizes the hernial content.
- **Exploratory puncture**-to ascertain the nature of the content.

Treatment

Reduction and retention by bandage : Reduce the hernial content to its original position and apply bandage around the surface for 2-3 months to prevent recurrence. Umbilical hernia may respond with this approach. Use of ligature or clamp or a set of through and through mattress sutures may be applied at the base of the hernial ring after reducing the contents. This facilitates sloughing of the sac and simultaneous closure of the hernial ring.

Surgical approach

- Incise on the hernial swelling and expose the hernial ring.
- Reduce the hernial content to its original position.
- Freshening the border of the hernial ring in order to initiate healing.
- Suture the hernial ring (**Herniorrhaphy**).
- When the hernial ring is too large to close, a biomaterial (fascia lata, stainless steel wire mesh, synthetic material) is used to repair the hernia (**Hernioplasty**).
- Finally, the skin wound is closed after trimming off the excess skin flaps.

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CHAPTER 6

Specific Hernia in Animals

UMBILICAL HERNIA (OMPHALOCELE, EXOMPHALOS)

Umbilical hernias are the most common bovine congenital defect and also occur in foals, pigs and pups. The hernial contents are usually loops of intestine or omentum. Umbilical hernia is usually congenital; however, acquired hernia also occurs few weeks after birth.



Umbilical hernia in a calf

Etiology

- Imperfect closure of the umbilicus.
- Hypoplasia of abdominal muscle.
- Excessive straining due to diarrhoea or constipation.
- Infection of the cord.
- Manual breaking or resecting of the cord too close to the abdominal wall.

Clinical signs

A discrete round swelling at the umbilicus.

Diagnosis

- Hernial contents-omentum or loop of intestine can be palpated.
- A circular hernial ring can be palpated.
- The hernia can be usually reduced after putting the animal on its back.

Treatment

Most foals and calves below one year and pups below six months, spontaneous recovery takes place when the animal grows.

Conservative treatment options for uncomplicated hernias include hernial clamps, abdominal support bandages, elastrator bands, local injection of irritants around the hernial ring and daily digital palpation to irritate the ring. Elastrator bands, hernial clamps (metal or wooden) and

support bandages are only recommended when the hernial ring is less than 5cm long, completely reducible and free from infection. Injection of **local irritants** like hydrochloric or sulphuric acids around the hernial ring may stimulate fibrous tissue formation that will push the contents into the abdomen and close the hernial opening. However the practice is unethical.

Surgical approach depends on accurate preoperative diagnosis and is indicated when the conservative approaches are ineffective.

- Fasting for 12-24 hrs is needed, general anaesthesia in dogs and local analgesia in ruminants should be carried out.
- The animal is controlled in dorsal recumbency and umbilical area is prepared for aseptic surgery.
- The skin over the hernia is incised by an elliptical or linear incision and bluntly dissected to expose the hernial ring.
- The contents are reduced through the hernial ring and the scarred edges of the ring are sharply incised and sutured. When the hernial ring is circular, a triangular piece of tissue from either end is removed to convert it into an elliptical shape in order to suture easily.
- The ring is closed by placing a series of overlapping mattress sutures through its edges using thick non-absorbable suture material. After all the sutures are placed, the ends of the sutures are pulled, tightened and secured starting from the centre towards each of the commissures.
- In larger defects, **tension-relieving sutures** such as near-far-far-near placed at regular intervals may help to appose two sides.
- Large hernias (greater than 15 cm) and hernias un-successfully repaired previously are often candidates for **mesh herniorrhaphy** (polypropylene or plastic mesh).
- **After-care** consists of restricted movement, less bulky diet for a week and antibiotic coverage for 3-5 days.

PERINEAL HERNIA

Perineal hernia is the protrusion of abdominal organ through the pelvic diaphragm that supports the rectal wall. The hernia may be unilateral or bilateral. The hernial contents are generally retroperitoneal fat, diverticulum of rectum, prostate or urinary bladder. The hernial contents are covered by perineal fascia and skin.

Incidence : Very common in old, uncastrated male dogs.

Etiology

- Predisposing cause—Uncastrated male dogs.
- Exciting causes—Straining due to constipation, diarrhoea and enlargement of anal glands.

Symptoms

- A unilateral or bilateral fluctuating swelling lateral to anus in the area between the base of the tail and the tuber ischii.



Perineal hernia in dog

- Retention of urine when bladder is involved.

Diagnosis

- History, clinical signs and palpation.
- Hernial swelling disappears when hindquarter of the animal is raised.
- Radiography and Ultrasonography may detect the hernial content.

Treatment consists of surgical correction under general anaesthesia.

- Restraint the animal in ventral recumbency with raising the hindquarter.
- Temporarily close the anal opening with purse string sutures.
- Prepare the site for aseptic surgery.
- Incise through the skin and perineal fascia over the hernial swelling from below the base of the tail towards the tuber ischii.
- Locate the internal pudic vessels and nerve at about the junction of the lower and middle third of the incision. Ligate the cord to facilitate easier manipulation of the deeper structures.
- When bilateral correction is envisaged, the neurovascular cord of one side is to be spared to avoid paralysis of the rectum.
- Reduce the hernia, find out the gap in the pelvic diaphragm that forms the hernial ring and close the hernial ring, perineal fascia and skin meticulously in layers. Remove the purse string sutures from the anus.

After-care consists of antibiotic coverage for 7 days, daily antiseptic dressing of wound till removal of skin stitches and provision of easily digestible and laxative diet for 10 days.

Measures to prevent recurrence of hernia depend on the herniated organs.

- Castration in order to reduce the size of the prostate glands.
- Fix the urinary bladder to an incision on the linea alba (cystopexy).
- Fix the rectal wall to the flank (rectopexy).

VENTRAL HERNIA

Protrusion of abdominal organs through a tear in the abdominal wall is termed as **Ventral or Lateral abdominal hernia**. More precisely, when the hernia is ventral to the stifle skin fold, it is termed as ventral hernia while hernia appeared on flank region is termed as **lateral hernia**.

Incidence : Most commonly occur in cattle and horses.

Etiology

- External violence-Kick, blows, horn thrusts due to butting by cattle, falling on blunt objects etc.
- Abdominal distension due to pregnancy or excessive straining during parturition, tympany etc.



Ventral hernia in cow

- Sequelae to deep-seated abscess or caesarean section.

Symptoms

- Hernial swelling is visible on abdominal wall.
- Contents of hernia are usually omentum, intestine or rumen.
- Hernia may be reducible or irreducible.

Treatment

Surgical repair of freshly occurred ventral hernia is not recommended till inflammatory swelling subsides by a week. When the hernia is harmless, the surgery becomes elective and if the hernia is complicated due to strangulation or incarceration, an immediate surgery is needed.

Surgical technique

- Performed under local analgesia with or without sedation and pre-operative fasting for 24-36 hours is recommended.
- The animal is restrained in lateral or ventral recumbency and the surgical site is prepared for aseptic surgery.
- Put a linear incision on the skin and subcutaneous tissue and expose the hernial sac.
- Separate the sac from the ring by blunt dissection, the viscera is freed of any adhesion and returned to the abdominal cavity.
- The thick fibrous mass of hernial swelling may be resected at the level of hernial ring and discarded.
- The edges of the hernial ring are trimmed tc provide an irregular surface to initiate healing.
- Close the ring in the abdominal wall by overlapping the edges with a thick suture material. Interrupted sutures may be placed between the overlapping sutures for reinforcement.
- When the hernial ring is excessively large, biomaterials like nylon mesh may be anchored over the defect for satisfactory closure.
- Close the skin and subcutaneous tissue with simple continuous and horizontal mattress sutures respectively after trimming the excess skin margins. A sterile drainage tube may be placed subcutaneous for proper drainage of the wound.

Post-operative care

- Reduce the volume of feed to avoid distension of abdomen.
- Restrict the movement.
- A supportive bandage may be placed around the abdomen to support the suture line.
- Antibiotic coverage for 7 days and removal of skin stitches on 10th post-operative day.

INGUINAL HERNIA / SCROTAL HERNIA

Protrusion of an abdominal organ through the inguinal canal is termed as inguinal hernia (Bubonocele). When the hernial contents extend into the scrotal sac, it is called as scrotal hernia (Oscheocele).

Incidence : Common in bitches. It is also reported in castrated horses, stallions, bulls and pigs. The hernial contents in bitch are usually uterus or urinary bladder.

Etiology

- Usually congenital and a probable genetic predisposion is also reported.
- Exciting causes : Accidental slipping causing stretching of the hind limbs outward, mounting on other animals etc.

Symptoms

- Swelling at inguinal or scrotal area and abduction of hind limbs (**Broad stepping**).
- In racing horses the animal suddenly stops and exhibit signs of severe pain. The testicle of affected side is seen pulled upwards due to contraction of cremester muscle. The animal frequently kicks with the limb of the affected side due to pain (Kick off the pain sign).
- Colic in acute cases.
- In chronic cases of scrotal hernia the affected testicle becomes atrophied.
- Breeding bulls and stallions are reluctant to serve.
- Difficulty in defecation in bitch.

Diagnosis

- From the clinical signs.
- Rectal examination in large animals revealed externally visible movement of the herniated mass.
- Ultrasonographic examination determines the nature of the content.

Treatment

In small animal (bitch)

- Perform laparotomy either through linea alba, or paramedian or pararectal incision close to the hernia under general anaesthesia.
- Reduce the hernial contents by gentle pressure combined with traction exerted by fingers and close the hernial ring.
- Ventropexy (fixing the herniated organ into abdominal wall) may be done to prevent recurrence.
- Close the surgical incision in layers in standard manner.

In large animals

- Local analgesia under sedation.
- Control in lateral recumbency with affected side up. The upper hind limb is abducted for greater exposure of the surgical site.
- Incise the skin over the hernial swelling; expose the sac with blunt dissection.
- The herniated content is returned back into the abdominal cavity through hernial ring.
- The hernial ring may be enlarged when the contents are too large to reduce into the cavity.
- Close the hernial ring by overlapping sutures using heavy absorbable suture material leaving room for the passage of the spermatic cord in males.
- The incision over the sac is closed with simple continuous sutures and the subcutaneous tissues and skin are sutured in a routine manner.

Para lumbar approach

An approach through paralumbar fossa in standing animal may be done when there is no adhesion of the herniated mass. The abdominal cavity is entered through the affected side. The contents are reduced into the abdominal cavity through the inguinal canal and close the incision as usual. Blind suturing through oblique abdominal muscle is cumbersome in this approach.

Surgical approach for scrotal hernia

Castration by covered method when the animal is not needed for breeding purpose

- Incise the skin along the neck of the scrotum ventral to the inguinal canal.
- Reduce the hernial content.
- Severe the spermatic cord with its tunics below the ligature.
- Push the cut stump as far up into the inguinal canal as possible.
- Pack the inguinal canal and scrotum with sterile gauze and put retention sutures on skin wound.
- Remove the gauze pack after 24-48 hours.

Surgical approach for scrotal hernia in breeding bull

- Incise the skin close to the external ring and expose the portion of tunica vaginalis containing the spermatic cord and the hernial content.
- Reduce the hernia and put purse string suture around the tunica vaginalis leaving room for the passage of the spermatic cord as far high as possible to prevent recurrence of hernia.
- The hernial ring may be enlarged when the contents are too large to reduce into the cavity. A portion of omentum that is difficult to reduce may be resected or aspiration of accumulated gas in herniated intestine may facilitate reduction.
- Close the skin as usual.

After-care in all the cases consists of controlled exercise, daily antiseptic dressing of the wound and antibiotic coverage for 7 days.

CRURAL HERNIA (FEMORAL HERNIA)

Femoral hernia is characterized by a swelling on the inner aspect of the thigh between the sartorius and gracilis muscles due to protrusion of an abdominal organ like intestines, broad ligaments, uterus etc. through a defect in the femoral canal.

Incidence : Very rarely occurs in dog and cat.

Etiology

- Trauma and avulsion of the cranial pubic ligament.
- Transection of the origin of the pectineus muscle from the pubis during subtotal pectineal myectomy.

Symptoms

- Swelling at the inside of the thigh.
- Abnormal gait-Affected limb is carried forward in an abducted manner while walking (circumduction).

Diagnosis

- From clinical signs.
- Radiography and Ultrasonography to identify the hernial content.

Treatment

Surgical intervention is not generally warranted. In some cases radical surgery may be required.

- Operation is done under general anaesthesia.
- Incise the skin parallel to the inguinal ligament and expose the hernial sac.
- Reduce the content and ligate the hernial sac as high in the femoral canal as possible.
- If the inguinal canal is intact, close the femoral canal by placing sutures between the inguinal ligament and the pectineal fascia.
- Be careful not to damage the neurovascular structure of the femoral canal.
- Close the subcutaneous tissue and skin in a standard manner.

PELVIC HERNIA (GUT-TIE)

(Synonyms: Intra-abdominal hernia, Peritoneal Hernia)

Pelvic hernia or Gut-tie has been recognized in cattle practice for many years. The condition has been associated with open castration of cattle by traction of the spermatic cord, which may result in either retraction of the spermatic cord into the abdomen with adhesion formation and obstruction or incarceration of intestine or, as in this steer, traction of the spermatic cord may tear the peritoneal fold of the ductus deferens which attaches the ductus to the abdominal wall, permitting loop(s) of intestine to pass through this hiatus and resulting in incarceration. Generally hernia occurs on the right side as rumen left no room for herniation on the left side. Although, the condition is very rare in animals, occasional incidence has been reported in bullocks.

Etiology

- Castration by violent traction on the cord may rupture its membrane.
- Predisposing cause-Abnormal distension of rumen causing increased intra-abdominal pressure on the right side.

Symptoms

- Symptoms are exhibited when there is strangulation of the herniated intestinal part.
- Abdominal pain characterised by restlessness, frequent lying down and getting up, looking towards the flank etc.
- Passing of small particles of faeces mixed with mucous.

Diagnosis

- History and clinical signs.
- **Palpation :** Deep palpation of right flank reveals signs of pain.
- **Per-rectal examination :** Herniated bowel may be palpated at pelvic outlet in the right side. The tensely attached abdominal portion of the severed portion of the spermatic cord can also be palpated on the medial aspect.

Treatment

Conservative approach includes jumping the animal from a height or making the animal descend rapidly a steep incline and to reduce the hernia by per rectal manipulation.

Surgical approach

- Operated under local or regional analgesia with or without sedation in standing position.
- Prepare right paralumber fossa for aseptic surgery.
- Put vertical incision through skin, fascia, muscles and peritoneum sufficiently long to introduce the operator's hand in abdominal cavity.
- Severe the spermatic cord with a protective knife.
- Close the laparotomy wound in a standard manner.

DIAPHRAGMATIC HERNIA (DH)

Diaphragmatic hernia is one in which abdominal organs protrude through the diaphragm into the thoracic cavity. It may be congenital or traumatic in origin. Most commonly, reticulum herniates into the thorax, occasionally omasum, abomasum, intestines, spleen and liver have also been reported to herniate. It is a chronic wasting and inflammatory thoracoabdominal disorder in adult dairy animals that are either in their late gestation or have recently calved.

Incidence: Common in dogs and buffaloes (5-9 years age) and also reported in cows. Higher prevalence of diaphragmatic hernia in buffaloes versus relatively lower prevalence in cows may be attributed to the lesser collagen content, elasticity, and vascularity of buffalo diaphragm. Moreover, habit of wallowing found among buffaloes may also be an exciting factor for the rupture of diaphragm.

Etiology

- This can result from trauma, dystocia or traumatic reticuloperitonitis.
- Increased intra-abdominal pressure caused by tympany, advanced pregnancy, straining at the time of parturition, chronic cough and violent fall.
- Interference of rumen peristalsis owing to reticular adhesions was regarded as major cause of tympany.
- Weakness of the diaphragm.

Clinical signs associated with diaphragmatic hernia include :

- Weight loss, decreased production, dysphagia, colic, bloat and respiratory difficulties (bovine).
- Partial anorexia with suspended rumination, recurrent tympany and scant faeces.
- Muffled thoracic auscultation with borborygmi sounds audible from the thorax.
- Palpation per rectum may reveal a forward position of abdominal viscera and an empty feel to the caudal abdomen in general.
- Vomiting after meal, reluctant to move and prefer to remain in standing or sitting on the haunches position.

Diagnosis

- From the history and clinical signs.

- **Radiography** (lateral or ventrodorsal)—the presence of honey comb pattern of the herniated reticulum inside the thoracic cavity and **ultrasonography** can help to confirm the presence of abdominal viscera in the thoracic cavity.
- **Thoracoreticular puncture** through the 5th and 6th intercostal space reveal ingesta.
- **Exploratory laparotomy/Ruminotomy** is the most reliable methods to diagnose a case of DH.

Treatment

Treatment is surgical or salvage, comprising of reduction of herniated contents and closure of the ring in diaphragm either by thoracic or abdominal approaches. General anaesthesia and positive pressure ventilation of the lungs are the prerequisites in both the approaches. In bovine, prior evacuation of the rumen and assisted ventilation during herniorrhaphy are needed for successful surgical outcome. The animal is kept off fed for 2-3 days following ruminal evacuation and maintained with adequate intravenous fluid therapy using polyionic solutions with dextrose.

Thoracic approach

- Incise over the 6th or 7th intercostal space starting a little lateral to the sternum and extending dorsally for about 5-8 cm.
- Expose the chest cavity with rib retractors.
- Adjust the respiratory pump to inflate the lungs to half of its normal capacity.
- Reduce the hernial contents and close the diaphragmatic ring with chromic catgut.
- Close the intercostal incision by placing sutures around the adjacent ribs.
- Re-establish the negative pressure in the pleural cavity by inflating the lungs to its full capacity immediately before tying the last intercostal sutures.
- Close the skin edges by standard manner.

Abdominal approach

- Establish positive ventilation of the lungs.
- Incise through linea alba from a little behind the xiphoid cartilage towards the umbilicus (in canine) and from 5 cm caudal to the xiphoid cartilage and extending about 25-35 cm long parallel to the costal arch (in bovine).
- Reduce the herniated organ (freeing of reticulum from diaphragm in bovine), suture the diaphragmatic ring with continuous lock stitch pattern using non-absorbable suture material and close the abdominal wound in a standard manner.
- Re-establish negative pressure in the pleural cavity before disconnecting the pressure pump by aspiration following introduction of a proper sized inoculation needle through the intercostals space and a 50 ml syringe.

After-care consists of adequate fluid therapy, broad spectrum antibiotic therapy for 5-7 days, analgesic for 3-5 days and daily wound dressing till removal of skin stitches.

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- **Fluoroscopy.** Antral hypomotility.
- **Endoscopy.** Helpful to confirm a diagnosis.

Treatment

Pyloromyotomy (Fredet-Ramstedt) : Preferred treatment option.

- Make a cranial midline ventral abdominal incision.
- Grasp the greater curvature of the stomach and take the pylorus out of the wound.
- Incise the small gastrohepatic ligament partially from medial to lateral in order to access more mobility to the pylorus.
- Take care not to transect the common bile duct or the proper hepatic or right gastric arteries dorsal to the ligament.
- Pack off the abdomen with moist gauge and put two stay sutures or Babcock forceps proximal and distal to the pylorus.
- Incise on stomach wall through the serosal and muscular layers allowing the submucosal/ mucosal layers to bulge.
- Extend the incision into the antrum and incise all muscle fibres.
- Dissect bluntly to separate the mucosa from the muscularis over at least 180^0 of the pylorus.

Post-operative care consists of offering baby food for 48 hours, analgesics and smooth muscle stimulant (metoclopromide) and water ad libitum.

Prognosis is generally good and results in prompt cessation of signs. When vomition continues beyond 48 hours post-operatively, smaller and more frequent feeding is advocated. In persistent cases, repeated surgery may be needed or a pyloroplasty or partial gastric resection may be needed.

ACQUIRED PYLORIC STENOSIS

This condition is common in middle aged toy breeds (Lhasa Apso and Shih Tzus).

Clinical signs include sporadic vomition, weight loss, anaemia and weakness.

Diagnosis is based on history and clinical signs, radiography and endoscopic examination.

Treatment of this condition includes correct fluid electrolyte acid base derangement, pyloroplasty procedure (Y-U antral flap advancement pyloroplasty) is recommended.

Billroth I pylorectomy (Gastroduodenoscopy) is another option for treatment.

TORSION OF STOMACH

Torsion of the stomach in the dog is characterized by life-endangering distension of the stomach with gas; the stomach is usually found to be severely dilated and congested, and often to have rotated about an axis in the plane of the oesophagus. Torsion of the stomach is seen most commonly in large breeds including the Great Dane and Bloodhound, as well as some of the intermediate size breeds. It has been reported in young adults as well as fully mature dogs. There is no doubt it can occur suddenly after eating, in a previously healthy dog.

Etiology

- The stomach, containing some comparatively heavy food material, is pictured as swinging in a pendulum-like fashion. Then, as a result of a sudden jump from a high bench or from rolling or playing, the pendulum is swung completely around the point of fixation of the stomach, the point where the oesophagus passes through the diaphragm, giving rise to a twist. This occludes both the entrance to and the exit from the stomach so that gas, which is produced in the stomach, cannot escape, giving rise to the distension.
- In addition, it has been shown experimentally if the stomach of the dog is distended with air by means of a stomach tube, the stomach eventually twists in either a clockwise or counter-clockwise direction, depending on the position of the spleen at the onset of distension.

Clinical signs are excessive salivation and drooling, extreme restlessness, attempts to vomit and defecate, evidence of severe abdominal pain (the dog whines and groans if push on the stomach wall) and abdominal distension. There may be rapid breathing; pale gums and the dog may collapse.

Treatment

Conservative medicinal treatment includes administration of large volumes of fluids and electrolytes by intravenous injection, passing of a stomach tube through the dog's mouth and into the stomach to remove the air, provide simethicone to decrease froth and pockets of air.

Surgical approach is indicated for correction of the torsion when the dog is no longer in shock and better able to withstand anaesthesia and surgery. Abdominal celiotomy is performed and the stomach and spleen are placed back in their proper positions followed by gastropexy to prevent the shifting of stomach in future. Strict control of food and water intake for many days after surgery is needed to avoid a recurrence of the condition.

GASTRIC ULCERATIONS

Gastric ulceration may appear as simple epithelial erosions to full thickness bleeding or perforating ulcers.

Causes

- **Physical damage to the gastric mucosa :** Ulcers develop from physical disruption only with sustained or significant trauma to the gastric mucosa.
- **Impaired gastric mucosal defence :** Non-steroidal anti-inflammatory drugs and corticosteroids.
- **Chemical alterations to the gastric mucosa and its repair :** Chemical insult to gastric mucosa may come from endogenous compounds (hydrochloric acid, bile acids, and pancreatic enzymes) or exogenous toxins (house hold disinfectant or lead). Renal and hepatic failure and Helicobacter infection may cause ulcers.

Clinical signs include anorexia, vomiting, haematemesis, melena, weight loss, abdominal pain, weakness and collapse in severe cases.

Diagnosis

- History and clinical signs.
- **Physical and laboratory findings.** Pain on palpating the gastric area. No specific laboratory finding.

- **Radiography.** Plain radiography is not diagnostic. Stagnation of the contrast agent on contrast radiography is indicative of ulcers.
- **Ultrasonography.** Thickened gastric wall lesions with central cavitations suggest ulcers.
- **Gastroscopy** is preferred diagnostic modality. Visualization of the ulcerative mucosa confirms the diagnosis.

Treatment

Medicinal approach

- **Antibiotic** : To prevent bacterial infection.
- Systemic acid reducing drugs are mainstay of non-invasive treatment of gastric ulcer. Histamine blocking agents (cimetidine, ranitidine, famotidine) and proton pump inhibitors (omeprazole, lansoprazole, rabeprozole).
- **Cytoprotective drugs** (Sucralfate) to protect healthy and damaged mucosa.
- **Prostaglandin analogues** (Mioprostol) may improve ulcer healing or prevent ulcer formation.
- Actively bleeding ulcers can be cauterised by endoscopically delivered laser or electrocautery or coagulated with endoscopically delivered haemostatic agents.

Surgical approach

- Surgical exploration allows definitive diagnosis and treatment of perforating ulcers.
- **Omental/serosal patching :** In non-perforating ulcers, a leaf of the omentum is attached to the normal serosa with multiple fine-gauge absorbable interrupted sutures. Serosal patching may be used similarly; a loop of small intestine is brought to the lesion and the serosa is sutured circumferentially around the lesion to the stomach serosa.
- **Gastric wall invagination :** In perforating ulcers gastric wall invagination as an alternative to resection may be done.
- **Gastric resection and reconstruction** : Recommended in deep ulcers.

STOMACH TUMOURS

Tumours in the stomach of dog and cat are not a common occurrence. It generally affects animals of older age groups of above 9 years of age and is of benign (Leiomyomas, adenomatous and polyp) or malignant tumours (Adenocarcinoma).

Symptoms

- Vomiting is the most common signs and its frequency and intensity depends on the location and extent of the tumours.
- Anorexia and weight loss.
- Haematemesis or melena.
- Abdominal discomfort.

Diagnosis

- From the clinical signs.
- **Radiography.** Plain radiography do not provide diagnostic feature due to lack of contrast. Contrast radiographic features include gastric wall thickening, displacement of stomach and oesophagus, derangement of the rugal fold, filling defects and delayed gastric emptying.

- **Fluoroscopy.** Delayed gastric emptying time if antrum is involved.
- **Endoscopy** (Gastroscopy). Mucosal change may be observed and mucosal growth or ulceration is observed.
- **Biopsy.** Examination of the abnormal tissue to confirm a diagnosis.
- **Cytological examination.** Examination of the gastric aspirates obtained by gastric lavage may be helpful in establishing a diagnosis.
- **Exploratory gastrotomy** and **incisional biopsy** for confirmative diagnosis.

Treatment

Treatment includes surgical removal of tumour mass. When the lesion involves corpus or fundus, local resection generally is curative. When antrum is involved, partial gastrectomy followed by some form of gastric reconstructive surgery is recommended. Prognosis in benign tumour cases is good but poor in malignant cases.

FOREIGN BODIES IN THE STOMACH

Most ingested foreign bodies in the dog and cat pass through or are digested and do not cause problem unless they remain in stomach and lodged in the pyloric antrum.

History and clinical signs

- Visualising the act of ingestion of foreign bodies.
- Missing an object from the surroundings.
- Vomition.
- Dehydration, electrolyte and acid base imbalance.
- Anorexia, haematemesis or melena.

Diagnosis

- History and clinical signs
- **Physical examination.** A large fluid-filled stomach may be palpated.
- **Laboratory examination.** Metabolic alkalosis, hypokalaemia and hypochloraemia when pylorus is obstructed.
- **Radiography.** Radio-opaque foreign bodies are visible (Plain radiography) and radio-lucent objects by negative or positive contrast gastrography (Contrast radiography).
- **Endoscopy** is a valuable diagnostic aid.

Treatment

- Restoration of fluid, electrolyte and acid-base imbalances.
- Antiemetic drugs to control severe vomition.
- Anti-ulcer medical therapy when gastric erosion/ulceration is anticipated.
- Endoscopy- Preferred method to retrieve gastric foreign bodies. A basket type snare or grasping forceps is used to take out the foreign body from the stomach.
- Gastrotomy- Surgical incision of the stomach for removal of the foreign body. It has the advantage to inspect the gastric mucosa for any trauma, ulceration and multiple foreign bodies.

Y-U ANTRAL FLAP PYLOROPLASTY

It involves conversion of a Y-shaped full thickness incision into a U shaped closure on proximal duodenum and antrum. The technique offers excellent exposure of lesions in the distal stomach.

- Each limb of the "Y" incision should be 3-5 cm in length depending on the size of the stomach and the base of the "Y" extends a short distance into the proximal duodenum.
- A flap of antrum is moved into the defect created by a longitudinal incision of the sphincter and duodenal wall.
- The tip of the flap is sutured first followed by closure of the lesser curvature, and finally the greater curvature limb.

BILLROTH I GASTRODUODENOSTOMY

- Ligate the vessels that supply the greater and lesser curvature and attached omentum.
- Free the pylorus by partially incising the gastrohepatic ligament.
- Isolate the area to be resected from abdominal cavity with moist gauze to avoid gastric spillage.
- Place intestinal clamps above and below the propose line of incision.
- Resect the tissue and close the lesser curvature side until the gastric luminal opening is approximately equal to the size of the duodenal segment.

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CHAPTER

8

Surgical Treatment for the Affections of Stomach in Ruminants

SURGICAL ANATOMY OF RUMINAL STOMACH

The three non-glandular forestomach compartments in ruminants are the **rumen, reticulum** and **omasum**. The abomasum is the true stomach and has a glandular mucous membrane. The rumen occupies most of the abdomen's left side; its long axis extends from 7th to 8th ribs to the pelvis. The reticulum lies against the diaphragm left to midline opposite the 6th to 8th ribs, and the omasum is right of midline at the ventral aspect of 7th to 11th ribs. The abomasum lies mostly right of midline and extends from the xiphoid area to the 9th or 10th intercostal space in non-pregnant animals. The walls of four compartments of the ruminant stomach from outside to inside consist of serosa, muscularis, submucosa and mucosa. **Blood supply** to the stomach of ruminants is derived from the celiac artery and the veins drain into the portal vein. The vagus nerve, which is made up of 90% sensory fibres, is the primary innervation of the forestomach compartments and abomasum besides sympathetic innervation.

RUMINAL IMPACTION

Rumen impaction develops due to ingestion of plastics, ropes, gunny bags or leather pieces that make large tight balls inside the rumen caused by churning movements. The condition is commonly encountered in cattle and buffaloes, occasionally in camel with deprived appetite. Besides, ingestion of poor quality roughage may also lead to this condition.

Clinical signs include anorexia, listlessness.

Treatment : Rumenotomy is indicated to remove the impacted material.

TRAUMATIC RETICULITIS / RETICULOPERITONITIS (TRP)

Traumatic reticuloperitonitis is associated with the lesions caused by penetration of the reticular wall by accidental ingestion of metallic foreign bodies (wires, needles, nails etc). Wires account for approximately 70% of ingested foreign bodies where as nails and steel objects make up the other 30%. The condition is commonly encountered in cattle and buffaloes due to their indiscriminate feeding habits. In India, the prevalence of the disease is more in buffalo (above 6 years of age) than in cattle.

Pathogenesis

When a foreign body is ingested it gets lodged into the honeycomb pattern of the reticulum. Non-penetrating foreign bodies (nuts, coins, stones etc) lie without any problem or may pass out through faeces. Penetrating foreign bodies pierce through the wall of the reticulum causing reticulitis. Further, the strong reticular contraction and increased intra-abdominal pressure during pregnancy may aggravate the lesions to traumatic sternebrae, traumatic pericarditis, vagal indigestion, pyothorax, pleurisy, liver/spleen abscesses and diaphragmatic hernia. In many cases, the foreign bodies are found located in the abscess when it is opened or come out spontaneously. Extensive adhesions of the reticulum with diaphragm or other organs might interfere with the reticular contractions and eructation process. Generally, the foreign bodies induce localized peritonitis. In severe cases, cardiac involvement, congestive cardiac failure might develop.



Typical posture of TRP in a cattle
Courtsey : Dr. A Patil

Symptoms

- Recurrent tympany, reduced ruminal motility, anorexia, suspended rumination and reduced milk yield (sudden in acute cases).
- Stiffness of forelimbs and abducted elbows.
- Local abscess around brisket region.
- Jugular pulsation and brisket oedema when there is traumatic pericarditis.

Diagnosis

- From the **history** and **clinical signs.**
- A **Neutrophilia with a left shift** is typically seen.
- **Radiography** : A lateral plain radiograph can help identify perforating foreign bodies of the reticular area.
- **Ultrasound examination** of the reticulum helps in diagnosis.
- **Metal detector** can also diagnose metallic foreign bodies in the reticulum.
- **Exploratory laparorumenotomy** may lead to confirmatory diagnosis.

Treatment

Rumenotomy **is indicated to remove the foreign bodies from the reticulum.**

- Operation is done under local/regional analgesia in standing position.
- Prepare left flank for aseptic surgery.
- Put incision at a point equidistant from the tuber coxae and the last rib beginning 5 cm ventral to the lumbar transverse process and extending enough to permit entry of the surgeon's hand inside the abdomen.
- Explore the abdominal cavity to examine outer wall of the reticulum, diaphragm, spleen, and liver for any lesions.

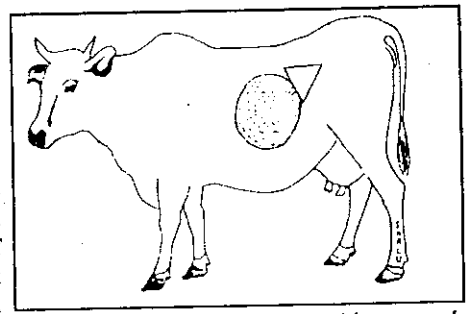
- Apply Weingarth rumenotomy set and perform rumenotomy to avoid seepage of rumen content into the peritoneal cavity.
- Evacuate the rumen partially to facilitate searching of foreign bodies. Introduce the hand into the reticulum and remove the penetrating foreign bodies.
- Drain the abscess if any into the reticulum by using a curved bistoury.
- Close the rumen wound with Lambert pattern with No. 2 absorbable sutures after taking all aseptic precautions. Transplantation of rumen cud from a healthy animal may be replaced in cases where a massive disturbance in rumen flora is anticipated.
- Close the peritoneum, muscles and skin in layers in standard manner.

Post-operative management

- Antibiotic coverage for 5 days to treat the septic reticuloperitonitis.
- Antiseptic dressing of skin wound till removal of stitches on 10th day.
- Oral or intravenous fluids may be needed to correct dehydration.
- Rumen transfaunate can be given to re-establish normal flora and stimulate ruminal motility.

Abomasal displacement

The abomasum is mobile because it is suspended in the dorsal turn of a U supported by the lesser omentum. The abomasum is displaced from its normal position on the abdominal floor (extending from the midline and to the right). The organ may be displaced easily to the left **(left displacement of abomasum-LDA)** or to the right **(right displacement of abomasum-RDA)**. A rotation of the organ on its mesenteric axis may lead to **abomasal torsion or abomasal volvulus (AV).**



Typical area of resonance observed in cases of average sized LDA. Triangle depicts left paralumber fossa (*Redrawn from Rebhun, Cornell Vet 77, 244, 1987*)

Etiology

- **Predisposing factor :** Abomasal atony with increased gas production, concurrent diseases (hypocalcaemia, ketosis, mastitis, fatty liver, metritis and retained placenta) or pregnancy.
- Rapid changes in abdominal topography in the periparturient period.
- **Exciting causes :** Feeding of decreased fibre and high concentrate ration.

Pathogenesis

Abomasum is loosely attached with the greater and lesser omentum and may be displaced easily. Many diseases like metritis, kenonuria, mastitis, traumatic reticulitis, hypocalcaemia, metabolic alkalosis etc. may decrease the motility of the abomasums and predispose to abomasal displacement. In the late stage of pregnancy, the distended uterus can elevate the rumen off the ventral wall and push the abomasum into a more cranial and transverse position. As the uterine volume suddenly decreases with parturition and the rumen is allowed to fill, the abomasum may become trapped on the left. High concentrate feed produces excessive volatile fatty acids in

rumen that pass into the abomasum, lowering its contractibility. As a result, ingesta and gas are accumulated in the abomasum causing its distension and displacement.

Clinical signs

- Intermittent anorexia and gradual decrease in milk production.
- Loss of body weight.
- Abdominal pain exhibited by shifting of body weight from one leg to another.
- Sluggish rumen movement.
- **Simultaneous auscultation and percussion reveal tympanic** ping **on the left side of cow.**
- Loose or pasty, scanty faeces that may be darker in colour than normal.
- Dehydration in later stages.

Diagnosis

- From the history and clinical signs.
- Palpation, auscultation and percussion reveal tympanic resonance **(ping).**
- **Liptek test.** An 18 gauge needle is inserted aseptically just below the area of resonant ping in the left (LDA) or in the right (RDA) abdominal wall and fluid is aspirated for evaluation by using standard pH paper. A pH less than 3.5 indicates a displaced abomasum, whereas a pH greater than 5.5 suggests a ping originating from the rumen.

Treatment

Medical management is carried out to restore abomasum motility sufficiently to allow it to expel gas and spontaneously return to its normal position. The medical approaches include oral or systemic calcium, various oral intestinal stimulants, parasympathomimetic drugs, fluid therapy to correct dehydration and electrolyte imbalances and agents to treat ketosis. Withholding feed for 48 hours, feeding high fibre diets and forced exercise has been suggested in treatments protocol.

Minimally invasive closed procedures involve rolling the animal to stabilize the abomasum in its normal position. The cow is placed in lateral recumbency, tie the feet together and roll the animal from side to side while the animal is in dorsal recumbency. Simultaneous massaging the abdomen while rolling facilitates in normal repositioning of the abomasums. Finally, the animal is to be rolled on the left side and allow it to get up from this position. Because of the limited security of this procedure, it is only recommended for short term relief of symptoms that do not warrant or cannot tolerate another procedure at the time.

Surgical approaches

Right flank omentopexy. This is the most versatile approach for repositioning and stabilization of many types of abomasal displacement and provides the best access to most other intra-abdominal structures. In this procedure, a 15 to 20 cm vertical incision should be made in the right paralumber fossa. Decompression of the gas in the abomasum to facilitate repositioning, minimize tension and Omental tearing is strongly recommended before attempting to move the abomasum. The fold of the omentum distal to the pylorus is grasped, pulled out through the abdominal incision and held with towel forceps or hand. Two mattress sutures of catgut is placed on each side cranial and caudal to the incision through the peritoneum, transverse abdominal muscle and a fold of the omentum. The peritoneum and transverse abdominal muscle are sutured

in a simple continuous pattern incorporating the omentum in the ventral two-third of the incision. Finally, the laparotomy wound is closed in a routine manner.

Left flank abomasopexy. The left flank abomasopexy provides the surgeon with some access to the greater curvature and parietal surface of abomasum in left displaced position. This procedure is found to be safest for left displacements in cows in the last trimester of pregnancy. In this procedure, a 15 to 20 cm vertical incision should be made in the left flank. One needle should be used to take 5 to 8 bites in a continuous pattern through the seromuscular layers of the parietal surface of the abomasum 2 to 3 cm away from but parallel to the attachment of the greater omentum and as far cranially on the abomasum as possible. The procedure should be repeated on the caudal end of the suture. The suture ends are then brought through the ventral abdominal wall as for omentopexy. Finally, closure of the incision is routine.

Right paramedian abomasopexy. The right paramedian approach provides the most direct access to the greatest surface area of abomasum and allows better stabilization than an omentopexy or pyloropexy. A 15 to 20 cm incision should be made parallel and 3 to 4-cm to the right of midline, extending caudally from a point 4 to 5 cm caudal to the xiphoid. A quick but thorough exploration of the abdomen is strongly recommended before proceeding with abomasal repositioning and stabilization. After identifying the abomasum, partial or total decompression of gas from the abomasum is needed. The greater curvature of the abomasum is sutured in a simple continuous pattern through the internal layer of the rectus sheath and peritoneum. The abdominal incision is closed in routine standard procedure. Right paramedian abomasopexy is often considered the most stable fixation method for treating LDA.

OMASAL IMPACTION

This condition is commonly seen in cattle and buffaloes mostly secondary to rumen impaction due to ingestion of poor quality of feed *i.e.* paddy (during winter), excess of husk during summer at scarcity of animal feed resulting to distension of omasum and absorption of fluid.

Clinical signs include chronic recurrent bouts of indigestion, anorexia, cessation of defaecation and an empty rectum, abdominal pain with reluctant to move or lie down and a negative ketone test.

Diagnosis of this condition can be made from history and clinical signs and absence of omasal sounds at the level of right elbow at 9th intercostal space by auscultation.

Treatment

Conservative approach

- Drench sufficient water and 4-5 litres of liquid paraffin or mineral oil through a stomach tube to soften the impacted content.
- To stimulate rumen flora, administer sugar 2-3 kg, yeast tablets 50 or 2-3 litres of rumen fluid from a healthy animal.
- With thick bamboo stick, lift the animal's abdomen to a height of 6"-12" slowly and followed by slow release and repeat the procedure 20-30 time.
- Allow exercise at a moderate speed for 1-2 km immediately after the treatment.

Surgical approach

- Perform rumenotomy and inject sodium bicarbonate in lukewarm water through laparo-ruminotomy opening into the omasum through reticulo-omasal orifice.
- Avoid kneading as it may lead to rupture of omasal wall or shock to animal.
- The flushing should be continued till all the folds of omasum get thoroughly emptied.
- Finally, after evacuation of omasal contents, close the incision in routine manner.

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CHAPTER 9

Surgical Affections of Intestine

COLIC

Colic is a general term, refers to any type of abdominal pain or pain in the 'gut' due to a gastrointestinal disturbance. It is one of the most common diseases in horses and can be brought on by various factors. Although this is a common occurrence, many horses still die from colic, which in cases is a preventable occurrence.

Causes

- Irregular exercise and feeding pattern.
- Lack of water.
- Sudden diet change.
- Too much intense exercise.
- Low grazing.
- Too much feed concentrate or unsoaked sugar beet.
- Stress.
- Sandy soil causing constipation/obstipation.
- Previous abdominal surgery.
- Too much water and /or food after exercise.
- Gas builds up from eating grass cuttings.
- Excessive parasites (Strongyles, Ascarids, Tapeworms).
- Eating mouldy or spoiled hay, grain or forage.
- Dental problems (improperly ground up feed) and ingestion of foreign bodies and materials (including dust and sand).

Depending on the cause of the colic, there may be hyperperistalsis ***or hypoperistalsis/ aperistalsis.***

Signs and Symptoms

Colic is not a disease, but a group of symptoms.

Mild colic symptoms include :

- Lethargy.

- Loss of appetite.
- Fewer droppings.
- Stomach ache.
- Stand and rest in odd positions.
- Rock back against a solid object.
- Repeatedly change weight on the hind legs.
- Pawing the ground with anxiety.
- Lip curling (Flehmen response).
- Kicking its belly or examining its flanks.

In advance stage

- Increased heart and respiratory rates.
- Severely congested (bright red colour) conjunctival mucous membrane.
- Groaning or rolling, especially violent rolling.
- Shallow breathing.
- Sweating and swelling of the abdomen.
- The temperature varies but may be lower. This is due to the horse going into shock. There may be patches of cold area on the body surface of the horse due to shock.
- Cool extremities.

Risk factors

- Insufficient grazing.
- Lack of exercise.
- Digestive disorder such as tooth problems.
- Worm burdens.
- Gut damage (including previous colic surgery).
- Poor feeding regime : soiled food, inappropriate quantities, lack of fibre and/or water, or a sudden change in diet.
- Stress such as hard exercise while unfit or after eating, travelling, sudden change of routine or environment.
- Poor and over-grazed pasture, especially if the soil is sandy.

Classification of Colic

Most colic's fall into one of three groups :

- **Intestinal Dysfunction :** This is the most common category where bowels of the horse are not working properly. Common causes of bowl dysfunction are gas distension, impaction, spasms, and paralysis. *Gas (or flatulent) Colic* is the more common type due to collection of gas in the bowel. It causes pain as it moves through the gut by distending the bowel abnormally. It is considered the least serious type of colic, although the violent reactions of the horse may not give that impression. *Obstructive Colic* is when a mass of food accumulates in the bowel and intestine is blocked. This can happen if a horse bolts his food too quickly or is given inadequate water to drink. *Sand Colic* is caused by the accumulation of sand in the gut. *Spasmodic colic* occurs mainly in horses that

have excitable temperaments. In conditions like lightning storms, preparing to rac entering a show, etc., the horse will experience a "nervous stomach". The contractio become stronger creating distention and the increase of gas production adds to t discomfort felt by the horse. Spasmodic colic is considered medical colic as it does n require surgery. The signs usually desist after a few hours. The signs during the col may include increased gut sounds and a slightly elevated pulse (60 bpm).

- **Intestinal accidents :** These occur less frequently, and include displacements, torsio intussusceptions and hernia. Intestinal accidents usually require emergency surgery.
- **Enteritis or Ulcerations :** These are colic related to inflammation, infections and lesio within the digestive tract. They can be caused by numerous factors, including stre infection, and parasites.

Treatment

Medical management

- Faecal softeners and lubricants (mineral oil about 1 gallon) are administered by stoma tube, as well as water and electrolytes to help fecal matter move through the tract. So cases may require intravenous fluid therapy (preferably Ringers' lactate).
- Walking and even gentle lunging may help to restore normal activity in the intestin
- Colic pain can be treated by NSAIDs (Phenylbutazone, Dipyrone, Ketoprofen et sedatives (Xylazine, Detomidine and medetomidine), Opioid analgesics and ot spasmolytic drugs.

Surgical management. Indications for surgical management include severe abdominal pa presence of enteroliths, severe intestinal gas distensions, uterine torsion, and failure to respo to other therapies. It is necessary to perform an exploratory abdominal surgery to determine cause of problem, evaluate the prognosis for survival and then if possible fix the problem althou only 1%-3% of all horses with colic require surgical intervention.

Prevention of colic

- **Fresh Water**–Plenty of fresh water for drinking must be available through out the ye
- Regular exercise and feeding schedule.
- **Feed horse** sufficient quantity of roughage with proportionate little grain or energy-r supplement and divide the daily feed into two or more rations.
- **Feeding of grain and pelleted feeds only as required.**
- **Don't put hay or other feedstuffs on the ground,** especially where the soil is sandy avoid ingestion of sand soil.
- **Regular deworming** is necessary.
- **Keep stress to a minimum** by eliminating the need for transportation or shows.
- Watch the horses carefully following changes in exercise, stabling, or diet.

Intestinal obstruction

Obstruction is the most common indication for intestinal surgery. This condition is relativ infrequent in ruminant although sporadic occurrence has been reported in other species. It n be termed as :

- **Strangulating obstructions** are invariably associated with a compromised enteric blood supply.
- **Simple obstructions** are not associated with a compromised vascular supply.
- **Complete or partial obstruction** depending upon the degree of occlusion of intestinal lumen.
- **High or proximal obstruction** occurs in duodenum and jejunum.
- **Low or distal obstruction** occurs in ileum and colon.



Radiographic view of intestinal obstruction in canine

Etiology

1. Anatomical obstruction



- Intra luminal obstruction
  - (*i*) Linear and non-linear foreign body
  - (*ii*) Faecolith
  - (*iii*) Nodular warms
  - (*iv*) Impacted ingesta
- Intramural masses
  - (*i*) Neoplasia
  - (*ii*) Stricture
  - (*iii*) Granuloma
  - (*iv*) Haematoma
- Extramural compression
  - (*i*) Adhesions
  - (*ii*) Hernia
  - (*iii*) Neoplasms
  - (*iv*) Strangulation
  - (*v*) Intussusception
  - (*vi*) Volvulus
- Congenital lesions
  - (*i*) Atresia or malformation of the intestine
  - (*ii*) Meckel's diverticulum (embryological defect involving ileum)



2. Functional obstruction

- Paralytic ileus
  - (*i*) trauma due to abdominal surgery
  - (*ii*) peritonitis
  - (*iii*) prolonged distension of bowel due to accumulation of gas

- Pseudo-obstruction
  - (*i*) sclerosing enteropathy
  - (*ii*) systemic lupus erythematosus
  - (*iii*) lymphosarcoma

Clinical signs



- Colic of low or (transiently) moderate intensity which can persist for several days. Colic signs are not observed in buffaloes and sheep however in cattle, it is manifested in initial stages.
- There is gradual abdominal distension and tense abdominal wall.
- Anorexia, vomiting (especially in high obstruction) is also observed.
- There are no faeces in the rectum or only a small amount of faeces mixed with sticky mucous.
- There is dehydration and scanty urine with high coloured.

Diagnosis

- From the history and clinical signs.
- Palpation of the abdomen and rectal examination.
- Laboratory examination : Increased packed cell volume, azotaemia, hypokalaemia and hypochloraemia.
- Ruminal fluid—high chloride concentration.
- Radiograph of abdomen reveals trapping of air in the bowel.
- Ultrasonographic examination may be helpful to detect the site of obstruction.
- Definitive diagnosis of the cause may require an exploratory laparotomy.

Treatment

- Fluid therapy based on clinical and laboratory findings should be instituted prior to surgery to counteract dehydration.
- An **enterotomy** should be made midway along the site of the obstruction (small animals), right flank laparotomy (ruminants) and as much of the foreign body as possible should be removed by gentle traction.
- In chronic cases, perforation followed by fibrosis may have occurred some time previously, and the bowel retains its pleated conformation after removal of the foreign body. In such cases, **resection and enteroanastomosis** may be necessary.
- If neoplasm is the cause, growth should be carefully excised and removed and if hernia is responsible, defect should be corrected accordingly.
- The postoperative care regimen should be tailored by broad spectrum antibiotics and fluids until the animal is able to maintain its own hydration status.

- Electrolyte and acid base balance should be monitored and corrected until the animal is eating and drinking normally.

INTUSSUSCEPTION

Intussusception- the telescoping of a portion of intestine (the **intussusceptum**) into the adjacent segment (the **intussuscipiens**)—develop primarily at the ileocolic valve and in the jejunum. This condition is seen most frequently in young calves and pups, less frequently in adult animals.

Etiology

Most intussusceptions are considered to be idiopathic, but predisposing factors include parasitism, neonatal diarrhoea, an intestinal mass (polyp, granuloma, neoplasm or congenital enterocyst), presence of linear foreign body and previous abdominal surgery.

Symptoms

- Continuous or recurrent colicky behaviour of low intensity.
- Vomiting, straining and dehydration are observed.
- Passing of small quantity blood stained faeces.
- The rectum is empty or contains mucous or sticky blood.

Treatment

- Fluid therapy should be instituted prior to surgery to counteract dehydration.
- Laparotomy is to be performed and attempt should be made to reduce the lesion manually by squeezing the intussusception while applying gentle traction to the intussusceptum.
- If the intussusception cannot be reduced, or if after reduction the segments of intestine are not viable, then **resection and anastomosis** is indicated.
- In all cases, **enteroplication** should be performed to reduce the risk of recurrence.

TORSION AND VOLVULUS

Volvulus is axial rotation of the mesentry and attached small intestine whereas; **torsion** of intestine is a twisting of bowel on its long axis. The condition is rare in buffaloes, dogs but may occur in bullocks and horses. The distal jejunal and proximal ileal segments are more prone to mesentric torsion but the duodenum is not usually involved because of its relatively fixed position in the abdominal cavity.

Etiology

- Vigorous activity
- Dietary
- Trauma or exocrine
- Rolling of cows to correct uterine torsion or left displacement of abomasum.

Pathology

Root of mesentry twist and cranial mesentric artery, vein or their branches are obstructed

↓

Mechanical and strangulating obstruction

↓

Rapid ischemic damage to small intestine

↓

Onset of endotoxaemia

Symptoms

Horse-colic, initial high temperature followed by subnormal temperature.

Cattle-colic, distension of abdomen and varying degree of ketosis.

Dog-abdominal distension, paracentesis reveals sero-haemorrhagic fluid in peritoneal cavity.

Treatment

- Surgical management involves decompression and derotation of the intestine and resection of devitalized bowel.
- Massive intestinal resection may be advisable if the portion of the bowel is too devitalized.
- Broad spectrum antibiotics and intravenous fluids are recommended as supportive therapy.

ENTEROTOMY

Indications

Removal of foreign bodies and inspection of the mucosa for evidence of ulceration, stricture or neoplasia.

Site

Distal to the lesion to avoid incising into devitalized bowel at the lesion or dilated bowel proximal to it.

Technique

- Full thickness incision in the antimesentric border and enlarged as necessary.
- Removal of foreign body through the incision avoiding wound margin tearing.
- Removal of residual intestinal contents by suction.
- Closure of defect with a simple interrupted or simple continuous suture pattern.
- Lavage of enterotomy site with warm sterile saline covered with omentum and replaced back into the abdominal cavity.

ENTERECTOMY AND ANASTOMOSIS

Indication

- Removal of devitalized or perforated bowel.
- Management of mural lesions including strictures and tumours.
- Management of extramural lesions such as adhesions and abdominal abscesses obstructing adjacent intestine.

Technique

- Selection and isolation of the affected segment after assessing the vascularity and viability of intestine.
- Placement of crushing clamps across the intestine (perpendicular to the axis of intestine or at an angle of upto 30° towards the normal segment) adjacent to the diseased segment.
- Milking away of intestinal contents from the site of the resection and placing of non-crushing intestinal clamps 4-6 cm from the crushing clamps.
- Ligation of the jejunal branches of the cranial mesentric artery and terminal arcade.

- Incising the mesentry between the doubly ligated vessels and sharply transecting the intestine at the level of the crushing clamps and removed.
- Removing the intestinal contents adherent to the exposed intestinal mucosa with moist gauze swabs.
- Apposition of the intestinal segments to be anastomosed.
- Completion of the anastomosis with simple interrupted sutures.
- Closure of the mesentric defect with a simple continuous suture.
- Closure of the mesentric defect with simple encircling ligatures.

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CHAPTER 10

Affections of Caecum and Rectum

CAECAL DILATATION TORSION

Caecum may undergo distension, displacement and torsion including spiral colon. Free end of the caecum in cattle is devoid of mesentery and thereby subjected to rotation. Dilatation may precede or follow the torsion. The condition is more common in dairy cows following parturition. It is also reported in pregnant cows, bullocks, sheep and goats.

Etiology

- Not well understood.
- Excessive grain feeding plays a significant role. As excessive grains produces more volatile fatty acid and gas due to fermentation of undigested grains in the stomach. These acids cause hypomotility or atony of the caecum resulting in accumulation of gas and ingesta with subsequent dilatation and possible torsion of the organ.

Clinical signs

- Abdominal pain.
- Hypomotility or atony of the rumen.
- The right paralumbar fossa may be distended.
- Loss of appetite, cessation of defecation and dehydration.
- Temperature, pulse and respiration are usually normal in simple dilatation but subnormal temperature and tachycardia may occur in case of caecal torsion or in advanced cases.

Diagnosis

- History and clinical signs.
- Simultaneous auscultation and percussion on the right paralumbar fossa produce a tympanic resonance.
- The distended caecum may be rectally palpable as a long cylindrical movable gas filled structure in the pelvic inlet or just cranial to the pelvic brim. The resonant area is usually smaller and more caudal in caecal dilatation.
- Most animals with caecal dilatation and torsion develop hypochloraemic hypokalaemic metabolic alkalosis. Haemoconcentration and azotaemia are invariably present.
- Exploratory right flank laparotomy confirms the diagnosis.

Differential Diagnosis : RDA and bowel obstruction.

Treatment

Conservative therapy : May be effective when torsion is absent.

- Saline purgative or liquid paraffin may be given.
- ***Parsympathomimetics***: Neostigmine may be given subcutaneously at 3-4 hrs intervals over 2-3 days at tapering doses of 12.5 to 2.5 mg. The drug may also be given by a continuous drip infusion (200 mg in 10 litres of normal saline, 1 drop /sec).

Surgical therapy : In non-responsive cases with conservative therapy or emergency situation with torsion, surgery is indicated.

- Restraint the animal in standing position and use local infiltration anaesthesia or paravertebral nerve block.
- Perform right flank laparotomy and exteriorise the free end of the caecum.
- Pack-off the laparotomy wound and perform caecotomy to remove the caecal contents.
- Clean the edges of caecal wound with normal saline and apply inversion suture to close the incision using absorbable suture materials.
- Correct the torsion and reposition it into the abdominal cavity.
- Close the abdominal wound in a standard manner.

When the caecum is devitalised or necrotic, resection of the caecum (**typhlectomy**) may be indicated.

Technique for typhlectomy

- Place intestinal clamps on the distal end of the ileum and proximal end of the colon.
- Ligate the blood vessels supplying the caecum and resect.
- Excise out the affected caecum and perform anastomosis of the cut edges of the ileum and colon by Connell pattern suture using chromic catgut.
- Clean the sutured loop with normal saline solution and return into the abdominal cavity.
- Close the laparotomy wound in a standard manner.
- When a part of the blind end of the caecum is necrosed, partial typhlectomy may be done.

Post-operative care

- Adequate fluid therapy to maintain hydration.
- Antibiotic therapy to combat post-operative infection.
- Antiseptic dressing of the skin wound.

Prognosis *:* Good.

Typhlitis : Inflammation of caecum is known as typhlitis. This is not a very common condition. In severe cases, treatment consists of typhlectomy.

PERFORATION OF INTESTINE

Causes

- Bite wounds.
- Gunshot wounds.

- Vehicular accidents.
- Penetrating abdominal injury.

Pathogenesis

- Penetrating abdominal injury may cause direct intestinal perforation.
- Blunt trauma may result in acute intestinal tears or in ischaemic necrosis and eventual perforation secondary to vascular obstruction.
- Both types of trauma may lead to development of septic peritonitis; however, in cases of blunt trauma, the diagnosis is often delayed for several days.

Clinical signs include abdominal pain, vomiting, bloody stool, lethargy, anorexia or shock.

Diagnosis

- History and clinical signs.
- Analysis of fluid obtained by abdominal paracentesis and lavage is important for early recognition of intestinal perforation.
- ***Radiography***: Animals with a penetrating gastrointestinal wound or ruptured hollow viscera may have free gas within the abdominal cavity if the omentum has not sealed off the leak. This free gas can be demonstrated more precisely by taking the radiograph with a horizontal beam.
- Ultrasonography may detect intestinal injury.
- Laparoscopy is helpful in making a diagnosis.
- Exploratory laparotomy for confirmation.

Treatment

Depends on the size, location and number of perforations as well as on the vascular supply to the involved segments.

- Small defects in a healthy intestinal segment may be amenable to debridement and primary closure.
- Large defects or those involving non-viable segments require intestinal resection and anastomosis.
- Serosal patching can be used to cover multiple perforating wounds in the duodenum, where resection and anastomosis are complicated by the presence of pancreas and pancreatic and bile ducts.
- The patch permanently seals the defects, and its serosal surface becomes covered with duodenal epithelium at the site of the perforation.
- If there is extensive ischaemia to the small intestine, fluorescein may be used to evaluate the viability of the affected areas.
- Following correction of the intestinal defects, the peritoneum is lavaged.
- Drainage techniques are considered if peritonitis is generalized and severe.

Prognosis **:** Depends on the duration and extent of damage.

PERFORATING WOUNDS AND FISTULAE OF ABDOMEN

Perforating wounds on abdominal wall may be caused in a variety of ways. The may be classified in the following way:



Perforating wound in abdomen in a bull

- Perforating wounds without injury or prolapse of abdominal organs: Treatment should be initiated to prevent development of peritonitis. Irrigate the wound with antiseptic solution; suturing may be done with provision of drainage. Avoid using a syringe for irrigation owing to the danger of forcing material into the peritoneal cavity. Parenteral antibiotics may be given.
- Perforating wounds with injury of some abdominal organs: Usually the bowel is perforated and escape of intestinal matter into the peritoneal cavity is the potential danger to develop peritonitis. In majority of the cases, peritonitis develops and prognosis is unfavourable. In some cases, when the perforation is very small or small quantity of intestinal content is escaped, local peritonitia may ensue, with adhesions. A stercoral abscess may then form, burst externally leading to recovery. An immediate laparotomy, suturing the wound, removal of the foreign body and peritoneal lavage may save the life of the animal.
- Perforating wounds with prolapse of a portion of bowel: Prolapse of the bowel through an abdominal wound may occur from a laparotomy incision, accidental perforation of the abdominal wall or when an animal is staked in jumping. A portion of the bowel is seen protruding from the wound. Prolapse of the portion of small intestine is more common due to its greater mobility. A loop of protruded bowel may be concealed between the muscles, constituting intraparietal prolapse, whereas, when it is insinuated between the peritoneum and the deep face of the muscular wall it is properitoneal prolapse. Treatment consists of cleaning the prolapsed mass, returning it into the peritoneal cavity and closure of the laparotomy wound in a standard manner. When the case is attended early, before the organ has been altered from exposure, recovery usually takes place.
- Perforating wounds with prolapse of a portion of bowel as well as injury and perforation of the prolapsed organ: It is a serious condition due to injury inflicted on the bowel. Treatment consists of laparotomy and suturing of the wound. If the exposed portion of the bowel is damaged or devitalized, it is necessary to resect it and perform anastomosis. Peritoneal lavage and antibiotic therapy should be initiated.

BOWEL FISTULA-ANUS PRETERNATURALIS

A bowel or stercoral fistula and anus preternaturalis are abnormal orifices discharging intestinal material. The anus preternaturalis gives exit to the greater part of the intestinal contents, while the bowel fistula only gives passage to a small quantity thereof. In the former condition a whole intestinal loop is damaged, where two ends of the bowel opening on the skin, whereas in the later only a portion of the circumference of the organ is involved.

Etiology

- A perforating wound of the abdominal and intestinal walls may be followed by adhesion of the visceral and parietal peritoneum in the affected region, and persistence of the perforation owing to the passage of intestinal material through it.
- An old complicated ventral hernial content communicating to the skin surface.

Symptoms

- Easily recognised by the passage of stercoral material through an abnormal opening in the abdominal wall.
- When the animal drinks water, some of it escapes out through the fistula a few minutes after drinking.

Treatment

- Spontaneous recovery may occur within months.
- Use of local irritant (tincture iodine), blistering, chemical cauterisation (silver nitrate) may be tried to close the tract.
- Surgical closure of the abnormal tract.

Prognosis : Good.

AFFECTIONS OF RECTUM

Rectal prolapse

Rectal prolapse is commonly seen in young, heavily parasite-infested animals, although any breed, sex or age can be affected.



Rectal prolapse in goat

Etiology

- Inadequate tone of the sphincter and/or a high pressure gradient can result in eversion of mucosa. Further irritation of mucosa may occur due to exposure with environment and leads to complete prolapse of rectum.
- Predisposing factors include diarrhoea, tenesmus or increased intra abdominal pressure due to bloat, rectal inflammation, act of parturition, excessive coughing, colitis and cystitis.
- Straining caused by rectal polyps, neoplasia, foreign bodies, constipation, perineal hernia, congenital defects and prostatic disease.

Clinical signs

A mucosal mass is protruding beyond the anus with a variable amount of oedema, inflammation and necrosis. In early stages of prolapse, the mass is bright red and non-nucleated, but in chronic stages, it is either red or blackish in colour with ulcerated or necrotic.

Diagnosis can be made by clinical signs and inability to pass a blunt probe or finger between the rectal wall and prolapsed tissue.

Treatment

Generally, the treatment of rectal prolapse includes elimination of predisposing factors, soothing of the irritated mucosa, elimination of straining and resolving the prolapse. Treatment

protocol depends upon the condition of the prolapsed tissue based on colour of membranes, degree of oedema/haemorrhage and presence and depth of erosions. Epidural anaesthesia will temporarily eliminate straining, facilitate repositioning and allow surgical intervention if needed.

(*i*) **Reducible prolapse** can be treated with a purse-string suture around the anus tied loosely enough to allow passage of soft stools.

(*ii*) **Recurrent prolapse** can be treated with submucosal resection, amputation and colopexy.

(*iii*) **Necrotic, friable, severely oedematous prolapses** should be treated by amputation and rectal anastomosis.

(*iv*) **Extensive prolapse** needs abdominal ventropexy (colopexy).

TUMOURS OF RECTUM

The commonly involved tumours of rectum in ruminants are fibrosarcoma, adenoma, fibroma, leiomyoma and adenocarcinoma. In canine, rectal neoplasia (*e.g.* perianal adenoma, rectal adenocarcinoma) is more common in male dogs than females.



Rectal tomour in a bitch

Symptoms

A tumour inside the rectum may protrude through the anus during defecation. There is dyschezia, haematochezia, diarrhoea, obstipation, tenesmus and pain.

Treatment of this condition is directed to remove the tumour by careful surgical resection via a dorsorectal or rectal pull-through approach.

Tear of the Rectum

Rectal tears may occur primarily due to trauma, secondary to penetrating foreign bodies and pelvic fractures. There may be tearing of all the layers of rectum (mucosa, submucosa, muscularies) and sometimes extend into the peritoneal cavity.



Rectal tear in cattle *Courtesy Dr. A. Patil*

Diagnosis of rectal tear can be based on the presence of fresh blood in rectum in 50% of cases. Besides, abdominal radiograph reveal presence of free gas in the abdomen or gas within perirectal soft tissues. Prognosis is grave when diagnosis and treatment are delayed or when septicaemia is present.

Treatment is immediate exploratory surgery and closure of the tearing rectum via an abdominal, perineal or anal approach. Before surgery, epidural anaesthesia is indicated which relaxes rectum and anal sphincter and facilitates careful examination.

ATRESIA ANI

Atresia ani is a congenital abnormality commonly observed in new born calves, lambs and kids. The condition is accompanied with lack of tail, fistula formation between the rectum and the reproductive tract and abnormalities of urinary tract. Inheritance is reported in swine and lambs and is possible in calves but not published.



Atresia ani in a calf
Courtesy Dr. A. Patil

Clinical signs

- Affected animals show signs of unabling to pass faces (exception in females with a rectovaginal fistula that passes faces through the fistul).
- Other signs include abdominal distension, straining, abdominal pain, depression and weakness.
- If only the anus is involved, the rectum bulges subcutaneously in the normal region of anus during straining and when the abdomen is manually compressed. If no buldge is observed, atresia of the posterior rectum is suspected.

Diagnosis is by physical examination, radiography and ultrasonography.

Treatment

For surgical correction, a circular incision of 1 to 2 cm diameter is made through the skin and subcutaneous tissue at the site where the anus would normally be located. After careful blunt dissection, the rectal pouch is gently pulled caudally with a pair of tissue forceps. The rectum is sutured to the subcutaneous tissue with four to six interrupted sutures, the rectal pouch is incised and the rectal mucosa is sutured to the skin. Faecal incontinence is a frequent complication of surgical correction of atresia ani (et recti) because of absence of anal sphincter muscles. Rectovaginal fistula, if present should be repaired before suturing the rectum to the perineal skin. Usually, no special after-care of the wound is necessary.

ATRESIA ANI-ET-RECTI ET-COLI

Atresia ani-et-recti refer to incomplete development of anus and rectum. When there is complete absence of a portion of colon (mid spiral loop of the ascending part) in conjunction with atresia ani-et-recti, the condition is termed as **atresia ani-et-recti et-coli**. Atresia coli is found to be an inherited disorder and mostly seen in calf.

Clinical signs of this condition include cessation of milk intake after a few meals or incomplete consumption of the milk offered from the birth, no faeces or only blood or mucous in the rectum, colic with increasing and then decreasing intensity, increasing abdominal distension, bulges in the right flank and slow deterioration of the general condition.

Treatment

Immediate supportive medical treatment including rehydration, correction of acid-base imbalances and antibiotic treatment should be initiated before subjecting the animal for surgery.

Surgery for correction of this condition involves removing gas and digesta proximal to the site of atresia through an enterotomy of the blind end of colon. The compromised segment of the dilated blind end is resected and continuity is established to the descending colon by end to side anastomosis. Following the correction of atresia ani et recti (as described previously), the descending colon is anastomosed by single layer of apposing simple interrupted sutures. After-care consists of maintenance of appropriate electrolyte and fluid therapy, antibiotic treatment for 5 to 7 days and gradual oral feeding within 12 hours of surgery.



Inflammation of anal gland in a bitch

AFFECTIONS OF ANAL GLAND

Inflammation of anal gland

The anal sacs (modified sebaceous gland) are located at approximately 4 and 8 o'clock positions around the anus. The secretion of this gland is accumulated due to closure of their orifices and leads to inflammation.

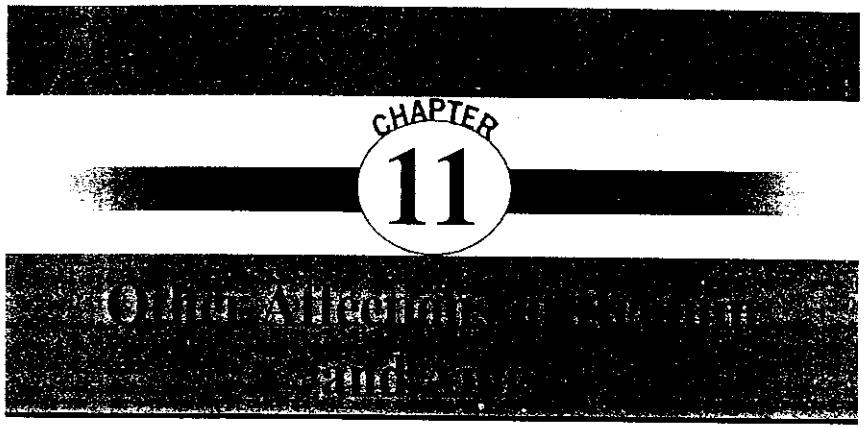
Clinical signs include rubbing of the anus on the floor, tail biting, tenesmus, diarrhoea and feeling of pain. The gland may sometime swollen, bluish, fluctuating and contain pus which may burst if not treated in time and produce an anal fistula.

Treatment of this condition is directed to evacuate the contents of the gland and subsequent injection of an irritant solution or infusion of antibiotic.

Surgical operation (anal sacculectomy) can be done by closed or open technique.

1. Closed technique- Removal of the anal sac can be facilitated by packing with string, plaster, latex, melted wax or acrylic.
2. Open technique- An incision is made through the caudal wall of the anal sac and duct and the overlying tissue by inserting a scissor blade into the duct. The sac and duct are removed with blunt dissection and the wound is either closed or left open to heal by second intension.

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ABSCESS (SUPRA-RECTAL)

Abscesses are commonly observed in horses mostly involving the walls of rectum or surrounding the connective tissue.

The **etiology** for development of this condition is due to injury and infection caused by botriomycosis and involvement of specific disease like strangles. The typical clinical sign of this condition is acute rectitis.

Treatment of this condition includes:

- Opening of fluctuating abscess, evacuate its contents and irrigate its cavity with a mild antiseptic solution. Pointing abscess inside the rectum may be opened by finger or guarded knife.
- Deep-seated abscess can be irrigated with antiseptic solution through rubber tubing attached with a syringe until granulation tissue is well formed.

RECTOVAGINAL FISTULA

Rectovaginal fistula is seen in adult cow secondarily to dystocia and in calves with atresia of the anus. During parturition, the fore foot of a calf typically perforates the dorsal aspect of the vestibule and enters the rectum.

Treatment

- Smaller defect is reduced markedly as a result of wound contraction and heal completely with the passage of time.
- Large and deep fistulae requires surgical repair **(Forssel's operation).**

Technique : A transverse incision is made between the rectum and vagina and the fistula is exposed using a combination of sharp and blunt dissection. Dissection is to be made 3 to 4 cm rostral to the fistula. The rectal defect is closed transversely with absorbable sutures in a simple interrupted pattern placed in the submucosa. The vaginal defect is closed next with a continuous horizontal mattress pattern in a longitudinal direction so that the two suture rows are at right angles to each other and the vaginal mucosa is everted. The cavity between rectum and

vagina is packed with BIPP gauze which is removed on third day followed by daily cleaning of the wound with antiseptic solutions.

PARALYSIS OF RECTUM

Paralysis of rectum is commonly encountered in horse and dog, but rare in ruminants and may be associated with paralysis of the tail or the hind limbs.

Etiology

- Lesions involving the spinal cord or the nerves supplying the rectum.
- Fracture and tumours of the sacral region, thrombosis of the haemorrhoidal artery may lead to this condition.

Clinical signs

- Accumulation of faeces around the rectum and inability to expel it normally.
- The tail is flaccid, powerless and the anus remains open.
- Involuntary excretion of urine with associated paralysis of bladder.
- Feeling of pain.

Treatment

General principles of paralysis treatment should be followed, that include administration of vitamin B complex, potassium iodide and use of electric current. In addition to this, faeces need to be removed manually at intervals during the day.

HAEMORRHOIDS

Haemorrhoids or piles are rarely encountered in veterinary patients, but are occasionally observed in dogs. Haemorrhoids are formed in the rectum area as enlarged bulging blood vessels and in dog just like in humans, they can also occur due to a medical condition, old age and even due to poor diet. If the haemorrhoids are internal, they will be inside the rectum and just below the lining of the anus. Bleeding will occur due to rupture of these internal haemorrhoids caused by bowel movement. Haemorrhoids can also occur externally near the anus while being covered by a thin layer of skin. These can also bleed, if ruptured for any reason.

Clinical signs include blood in stool, constipation, face itching, burning and even pain during defaecation due to irritation.

Treatment of this condition is very similar to human haemorrhoids.

- Application of suppository if they are internal, and cream if they are external.
- A laxative diet should be prescribed.
- Surgical therapy consists of extirpating the mucous membrane round the affected vein and applying a ligature round the swelling.
- In recent days, cryosurgery can be performed for destruction of the condition.

STENOSIS OF RECTUM AND ANUS

Etiology

- Stenosis results from faulty correction of rectal prolapse that has constricted after repair and due to development of tumours or abscess in the area.

- Rectal mucosa inflammation leads to rectal scar formation with subsequent stenosis and eventually possible complete obstruction.
- In dogs and pigs, desquamation of the epithelial surfaces and subsequent uniting of the raw surfaces of the mucous membrane.

Clinical signs of this condition include difficulty in defaecation and feeling of pain sensation.

Treatment of this condition depends upon the degree of stenosis and etiology involved.

- General line of treatment should be followed if there is involvement of tumour, abscess and acute inflammatory lesions.
- Excision of abnormal membrane or bands and cicatrical constriction occluding partly the lumen of anus and rectum.
- Surgical treatment is similar to atresia ani as described previously.

SURGICAL AFFECTION IN LIVER

Hepatic trauma

Liver is one of the most commonly injured abdominal viscera when the animal is subjected to blunt trauma. The most frequently observed injuries are tearing of the hepatic capsule and parenchyma leading to haemorrhage. In some cases the haemorrhage may be profuse and the animal may collapse due to hypovolaemic shock.

Diagnosis

- **Haematological examination :** Continued intra-abdominal haemorrhage is reflected by a progressive decrease in the packed cell volume and plasma protein concentration.
- **Abdominoparacentesis** reveals presence of blood.
- **Laboratory findings :** Injuries of the hepatic parenchyma often lead to significant increases in serum concentrations of alanine aminotransferase and lesser increases of alkaline phosphatase. Serum bilibubin may be increased.
- **Laparoscopy** may reveal traumatized liver.
- **Radiography :** Abdominal radiography may indicate the presence of fluid in abdominal cavity.

Treatment

- Supportive therapy includes blood- coagulant, plasma extenders and blood transfusion.
- Surgical intervention.

INFLAMMATORY HEPATIC DISORDERS

Infectious causes of hepatic disease include viral, bacterial, fungal or parasitic organisms. In many cases, hepatic abscess may develop.

Clinical signs

- Fever, anorexia, abdominal tenderness and vomition.

Diagnosis

- Clinical signs.
- Clinical examination.

- Radiography may suggest enlargement of liver and evidence of localized or diffuse peritonitis.
- Ultrasonography may suggest enlargement of a portion of the liver and the presence of cavitary lesions within the hepatic parenchyma.
- Laboratory findings: Abdominal fluid contains reactive and degenerative white blood cells and bacterial presence. Liver abscesses usually are associated with significant increases in serum alanine aminotransferase and relatively smaller increase in bilirubin and alkaline phosphatase.
- Laparoscopy.
- Exploratory laparotomy.

Treatment

- Supportive therapy includes intravenous fluids, hyperalimentation, vitamins (B complex) and antibiotics.
- Surgical intervention is warranted only when a focal or localized area becomes necrotic or abscessed or a granuloma forms.

HEPATIC TUMOURS

Liver is a common site for the development of tumours. It may be of either primary or metastatic origin. Metastatic tumours are more common than primary ones. Primary tumours include haemangioma, haemangiosarcoma, fibroma, fibrosarcoma, hepatocellular carcinoma, hepatoma, and leimyosarcoma. Metastatic tumours may originate from gastrointestinal tract, mammary gland, pancreas, bone etc.

Clinical signs

- When tumours result in destruction or necrosis of hepatic parenchyma, the signs are similar to hepatic abscesses.

Diagnosis

- Clinical signs and clinical examination.
- Radiography.
- Ultrasonography.
- Laboratory findings.
- Laparoscopy.
- Exploratory laparotomy.

Treatment consists of removing an isolated hepatic benign tumour that often provides prolonged relief from clinical signs even if the tumour is malignant.

LIVER BIOPSY

Liver biopsies are indicated for diagnostic and prognostic purposes and to formulate a suitable therapeutic protocol. There are 3 approaches to collect liver biopsy: percutaneous, laparoscopic and surgical.

Percutaneous approach : Biopsy needle is inserted through a small incision on the skin surface. A tru-cut needle is preferred.

Indication : To diagnose generalized liver disease.

Preparation of the animal

- Blood examination to rule out clotting abnormalities.
- Radiographs are taken to ascertain the size and position of the liver.
- Overnight fasting and a small amount of fat should be given 1-2 hrs before surgery to cause the gall bladder to contract.
- Sedation and local anaesthetic infiltration of the skin and body wall.

Technique

Transthoracic approach

- Needle is inserted across the thorax, usually through the right 7th intercostals space.
- Not a preferred technique as complications is many.

Transabdominal approach

- Preferred technique, keep the animal in dorsal recumbency.
- Prepare the xiphoid area for aseptic surgery.
- A small incision is made in the skin between the costal arch and xiphoid process on the left side.
- Biopsy needle is inserted through the skin incision in a cranial and dorsal direction, angled slightly to the left of the midline.
- Once the needle is beyond abdominal wall, it is further advanced to the surface of the liver.
- The specimen-cutting rod is inserted into the parenchyma of the liver, and the cannula is advanced.
- With the cannula in closed position, the needle is withdrawn and the sample is collected for examination.
- Multiple attempts may be needed to obtain a satisfactory sample.

Complications

- Haemorrhage.
- Perforation of gall bladder and large bile ducts with biopsy needle.

Ultrasound guided biopsy provides greater accuracy and safety for biopsy of localized lesions.

"Keyhole" technique

- An alternative approach where an incision just large enough to allow entry of two fingers is made in the cranial ventral midline of the abdomen, just caudal to xiphoid process.
- The liver is palpated and digitally stabilized against the body wall.
- The biopsy needle is inserted through a separate stab incision made lateral to the first and is directed towards the portion of the liver immobilized against the body wall.
- Following biopsy collection the liver is pressed against the body wall to facilitate clotting.
- The incision is closed in a routine manner.

Laparoscopy : Facilitates direct observation and biopsy collection from the desired site of the liver.

- Preparation of the animal and surgical site as well as anaesthesia is similar to percutaneous approach.
- Laparoscope is inserted across the abdominal wall and air is insufflated to facilitate visualization and avoid trauma to the viscera.
- Biopsy instruments are then inserted either through the laparoscope or via a second abdominal incision.
- The biopsy site is selected and observed while the sample is obtained.
- Biopsy site is examined for effective haemostasis.

Surgical biopsy: By celiotomy which offers biopsy collection as well as thorough examination of the liver and other abdominal organs.

Technique

- Laparotomy is performed under general anaesthesia through mid ventral line extended to the xiphoid process in a standard manner.
- Biopsy can be easily obtained from the edges of the liver lobe by isolating the biopsy samples with sutures.
- A large sample may be obtained from the margin of the liver lobe by placing overlapping or interlocking sutures across the hepatic parenchyma. The tissue specimen is excised a short distance distal to the sutures.
- Samples may be obtained from isolated lesions away from the periphery of the liver lobes using a Keyes or Baker cutaneous biopsy punch. The punch should penetrate no deeper than half the thickness of the liver lobe to minimize haemorrhage. The defect may be closed by deeply placed mattress sutures or may be filled with omentum or absorbable gelatine sponge.

PARTIAL HEPATECTOMY

Indication

- To remove isolated tumours, abscessed liver lobe or to obtain a large biopsy.
- Crush injury or profuse, uncontrollable haemorrhage from the liver as a result of trauma.

Anatomy

- The left lateral and medial lobes maintain their separation from adjacent lobes near the hilus and so it is easy to remove either or both of these two lobes.
- The caudal vena cava is surrounded by the right lateral and caudate (and occasionally the right medial) lobes as it passes through the liver. The location of the caudal vena cava should be considered when operating on these lobes, because inadvertent damage to these structures results in severe bleeding.

Technique ("Fingure-fracture" technique)

- Incise the capsule of the liver along the line of excision.
- Compress the hepatic parenchyma between the fingers along this line, causing separation of the tissues and isolating the still intact vasculature and biliary ducts.

- Apply individual ligatures (2-0 or 3-0 catgut or silk) to these structures and remove the tissue. Alternatively, use a scalpel handle or forceps to crush the parenchyma.
- In very small dog and cat, an entire lobe can be removed after placing an encircling ligature near the hilus. A separate ligature should be used for each lobe (used to remove left lateral and medial lobes).
- In larger dogs, there is a risk of haemorrhage due to dislodgement of ligature following removal of a liver lobe under single ligature. A better technique is to crush the parenchyma near the hilus with fingers or a forcep.

Complications

- Haemorrhage
- Hypoglycaemia

SURGICAL AFFECTION OF SPLEEN

Splenomegaly

Splenic enlargement may be symmetrical or asymmetrical, based on whether all or part of the spleen is enlarged.

Causes : Splenomegaly may be caused by benign or malignant disorders. Administration of barbiturates or tranquilizers may induce symmetrical splenomegaly.

Diagnosis

- Abdominal palpation
- Radiography
- Ultrasonography
- Laparoscopy
- Exploratory celiotomy for confirmation.

Treatment depends on the cause. In some cases splenectomy is indicated.

Volvulus of the spleen

Volvulus of the splenic pedicle can occur alone or in combination with gastric dilatation/volvulus (SDV). Isolated splenic volvulus occurs most often in large-breed dogs.

Causes

- Trauma may also causes isolated splenic volvulus.
- Gastric dilatation (without volvulus) causes displacement of the spleen, somehow predisposing it to rotate on its pedicle.

Pathogenesis : Because the splenic veins are thinner-walled and more collapsible, the initial result of volvulus is obstruction of venous outflow while splenic arterial blood flow continues. The spleen therefore enlarges until intracapsular pressure equals arterial pressure.

Clinical signs

- Acute abdominal pain, distended abdomen and restlessness.
- Shock characterised by rapid heart rate, weak pulse, decreased capillary refilling time and increased respiratory rate.

Diagnosis

- **Abdominal palpation**: Asymmetrically enlarged spleen may be palpated, unless abdominal splinting occurs due to pain.
- **Radiography or ultrasonogrphy** allow detection of a symmetrically enlarged and often C-shaped spleen, with or without GDV.

Treatment

- Splenic volvulus is an emergency, requiring an emergency surgical treatment (*i.e.* splenectomy, if there is neither splenic necrosis nor vascular thrombosis).
- Hypovolaemia due to sequestration of blood within the spleen should be treated before surgery by intravenous infusion of crystalloid fluids, plasma or whole blood.

Prognosis : Untreated splenic volvulus is associated with high mortality, while early surgical treatment results in very low mortality.

SPLENIC TUMOUR

Haemangiosarcoma is the most common primary malignant tumour of the spleen. Fibrosarcoma and leiomyosarcoma, originating from the capsular or muscular elements of the spleen, also occur. These tumours tend to develop, as large asymmetrical masses within the substance of the spleen. Haemangiomas are benign tumours of the spleen that also cause asymmetrical splenomegaly. Nodular splenic hyperplasia, another benign condition causing asymmetrical splenomegaly, may be confused with malignant conditions of the spleen. Mast cell tumours are easily diagnosed by cytological examination of samples obtained from the spleen at surgery. Splenic tumours may enlarge to the extent that it may distend the abdomen. Haemangiosarcomas and haemangiomas often are associated with formation of large haematomas that may rupture, resulting in significant blood loss.

Splenectomy is the **treatment** of choice for splenic tumours in dogs.

SPLENIC TRAUMA

Splenic trauma most commonly occurred from blunt object and occasionally from penetrating wounds or during surgery. Splenic injuries vary from minor lacerations associated with few or no signs, to crushes involving most of the organ and causing profound abdominal haemorrhage. Asymmetrical splenomegaly due to the presence of subcapsular haematomas may also be seen following blunt trauma. Splenic injuries commonly do not pose a life-threatening haemorrhage, but lacerations of large vessels may cause profound blood loss, shock and death, so these injuries warrant surgical intervention.

Treatment

Hypovolaemia should be treated by administering intravenous fluids or occasionally, transfusion before surgery, unless immediate abdominal exploration is indicated by rapid, voluminous haemorrhage. In the later case, blood should be administered rapidly as the animal is being prepared for surgery. Auto-transfusion of abdominal blood may also be done.

Prognosis : Depends on the amount of blood loss and whether haemorrhage is continuing.

SPLENIC BIOPSY

Percutaneous Fine-needle Aspiration

Indication : To obtain a sample for cytological analysis. Ensure that the animal has no coagulopathy and there is no history of bruising or prolonged haemorrhage from minor laceration of the spleen.

Technique : The spleen should be palpated and immobilized digitally against the abdominal wall (usually on the left side). Aspiration is done with a 22-gauge needle 2.5 to 7 cm long, depending on the thickness of the abdominal wall.

"**Keyhole**" biopsy of the spleen, using biopsy needles or punches through a limited surgical approach, is inadvisable due to the high probability of significant haemorrhage.

PARTIAL SPLENECTOMY

It is preferable to go for total splenectomy because of the adverse sequelae of the later.

Indication

- To remove an isolated, benign splenic lesion (*e.g.* a haematoma or a crushed area secondary to trauma).
- To obtain a large biopsy.

Surgical procedures

- Ligate the segmental blood supply to the portion of the spleen to be removed near the splenic hilus and transect. The line of resection is determined by the apparent area of ischaemia that develops following ligation.
- Compress the parenchyma between the fingers to remove splenic pulp from the proximal edge of the ischaemic area.
- Apply two forceps to the spleen about 10-15 mm apart. The line identifying the ischaemic area of the spleen should be halfway between the two forceps. Apply atraumatic forceps to the portion of the spleen not being removed and crushing forceps to the portion of the spleen to be removed.
- Divide the splenic tissue between the forceps 5-7 mm from the non-crushing forceps.
- Place a double row of continuous horizontal mattress sutures (3-0/4-0 absorbable suture) distal to the atraumatic forceps, 3-5 mm from the cut edge of the splenic capsule.
- Close the edges of the splenic capsule with the same suture material in a simple continuous or continuous cruciate pattern.
- Control haemorrhage with direct pressure or placing ligature in the splenic parenchyma. A stapling device may be used both to crush and suture the spleen as an alternative.

SPLENECTOMY

Indication

- Splenic volvulus, thrombosis, neoplasia, large cavernous haematomas involving a majority of the spleen.
- Crushing injuries of the spleen.
- Treatment of immune-mediated thrombocytopenia or haemolytic anaemia unresponsive to medical therapy.

- For use of dogs as blood donors.
- Animal model for haemoprotozoan studies.

Surgical procedures

- Perform celiotomy through a mid ventral abdominal wall.
- Evaluate the spleen with minimum manipulation and extreme care to avoid any damage.
- The splenic pedicle should never be permanently ligated all together, because this may lead to dislodgement of the vessels from within the ligature and massive postoperative haemorrhage. However, while performing splenectomy as a treatment of splenic volvulus, the splenic pedicle may be temporarily occluded with an encircling ligature before removal of the spleen. Subsequently individual vessels are identified and ligated. Sutures or staples may be used to ligate splenic vessels.
- When the spleen is removed to treat autoimmune disorders or to reveal hitherto undetected paracitaemia, 1-2 ml epinephrine (1:100, 00 dilutions) may be applied to its surface to cause contraction, preventing loss of the blood volume contained within the spleen.
- Ligature should be placed near the hilus of the spleen to avoid compromising vessels supplying the stomach and the left limb of the pancreas. Individual vessels may be identified, ligated, and divided, or the vessels may be divided between forceps and ligatures applied proximal to the forceps after the spleen has been removed.

Complications

- Haemorrhage.
- Ischaemic necrosis of the stomach or pancreas due to inadvertent ligation of their blood supply.
- Pancreatitis subsequent to intraoperative trauma.

SURGICAL AFFECTION OF PANCREAS

TUMOUR OF ENDOCRINE PANCREAS

Carcinoma of the beta islet cells (insulinoma) is common in older dogs.

Clinical signs

- Decreased blood glucose, due to excessive production of insulin.
- Generalized convulsions, weakness or collapse, disorientation, muscle fasciculation and ataxia.

Diagnosis

- History and clinical signs.
- Low blood glucose (<60 mg/dl) in an older dog.
- Presence of hyperinsuliemia, preferably determined during a hypoglycaemic episode.
- Calculation of the amended insulin-glucose ratio.

Differential Diagnosis : Hepatic failure, stress due to exertion, hypoadrenocorticism, hypopituitarism, hypothyroidism, sepsis or insulin overdose.

Treatment

- Hypoglycaemia may be controlled with dietary management and medical therapy.

- Metastasis is very common and attempts to achieve permanent control by surgical excision of the primary pancreatic tumours are almost never successful.
- Chemotherapy of the tumour is also not successful.

PANCREATIC ADENOCARCINOMAS

Pancreatic adenocarcinoma is the most common tumours affecting the exocrine tissues of the pancreas. They have a high rate of metastasis, primarily to the liver and draining lymph nodes.

Signs are related to the development of metastatic foci.

Diagnosis : Difficult to diagnose.

Prognosis : Poor.

SURGICAL PROCEDURES

BIOPSY

Indication

- To detect whether the disease is disseminated or focal.
- To decide on the prognosis for treatment.

Technique

- Care should be taken to avoid damaging the larger pancreatic ducts during biopsy.
- Biopsies may be taken easily from the periphery of the pancreas by teasing apart the parenchyma with a fine-tipped forceps. This facilitates identification of the ducts and blood vessels supplying the area to be removed.
- Ligatures are applied to these structures before removing the sample.
- Although the capsule of the pancreas is extremely thin, it is often can be sutured closed after removal of the sample by using fine-gauge (4-0 or 5-0) absorbable suture material in an interrupted horizontal mattress pattern.
- Biopsy of isolated solitary mass can be obtained by using a Keyes or Baker cutaneous biopsy punch or by removing a wedge of tissues. The defect created after removal of the sample can be closed with absorbable sutures in a horizontal mattress pattern.

PARTIAL PANCREATECTOMY

Indication

- Removal of a portion of the pancreas that is affected by a traumatic, necrotic or neoplastic process.
- To treat pancreatitis that is not responding to medical therapy.

Technique

The operation needs skill and expertise. Anterior mid ventral laparotomy is performed under general anaesthesia. The following precautions are to be taken during surgery:

- Extreme care should be taken to avoid damaging to major pancreatic ducts and blood vessels.
- The remaining pancreatic tissue should be left with adequate drainage system to flow pancreatic secretions to the small intestine.

- The mesentery is divided in the area of the portion of the pancreas to be removed, and the segmental blood supply is identified and ligated.
- The pancreatico-duodenal vessels should be protected during dissection of the right lobe of the pancreas to avoid devascularisation of the duodenum.
- Manipulation of remaining portion of the pancreas should be minimum and gentle to decrease the potential for post-operative pancreatitis.
- The pancreatic duct draining the portion of the pancreas to be removed is identified, isolated and ligated.
- Catgut should not be used for ligature because exposure to pancreatic enzymes may accelerate its enzymatic breakdown.
- Drains are not necessary unless large amounts of purulent or necrotic material are present after surgery.

PANCREATECTOMY

Indication

To treat uncontrolled pancreatitis or widespread neoplasia.

Technique

Difficult to perform unless the surgeon is experienced, so referral should be considered.

- The pancreas may be isolated and removed alone or in combination with the associated portion of the antral and pyloric regions of the stomach and/or the proximal duodenum.
- To remove the pancreas alone, the left limb of the pancreas is freed from its attachments to the greater omentum.
- Care must be taken to avoid the splenic artery and vein.
- Multiple small branches supplying the left limb of the pancreas should be identified and ligated near the pancreas.
- The right limb of the pancreas is the approached.
- The caudal pancreatico-duodenal vessels should be identified and preserved, as they supply and drain the duodenum.
- The pancreas can be dissected from its attachment to the duodenum with the tips of a forceps thus facilitating the identification and ligation of segmental branches of the caudal pancreatico-duodenal vessels without tearing them.
- It is difficult to isolate the remainder portion of the pancreas and needs careful dissection to avoid damaging the common bile duct and the blood supply to the duodenum and stomach.
- The mesoduodenum is incised, and the limits of the pancreas are identified and isolated by blunt dissection with forceps.
- Individual vessels are ligated or electrocoagulated as they come into the field.
- The ventral pancreatic duct that joins the common bile duct may not be identified as it is very small or absent.
- The dorsal pancreatic duct may be ligated if it is identified.
- The defect in the mesoduodenum should be closed to prevent entrapment of viscera.

- When the pancreas and associated portions of stomach and small intestine are to be removed, a gastrojejunostomy and cholecystoduodenostomy (Billroth II procedure) is performed.

Post-operative care

- Intravenous fluid therapy for at least 24 hrs post-surgery.
- Small amount of water may be given 24 hrs after surgery and, if no vomition is there, feeding of small amounts of an easily digestible diet may begin 48 hrs after surgery.
- Perioperative antibiotics should be administered until at least 24-36 hrs after surgery.
- Treatment of diabetes or exogenous pancreatic insufficiency should be initiated.
- The animal should be monitored closely for continuing signs of pancreatitis

SURGICAL AFFECTIONS OF KIDNEY

Hydronephrosis

It develops due to outflow obstruction of the ureter, bladder, or urethra. Obstruction eventually destroys renal function due to elevated ureteral pressure and decrease renal blood flow leading to cellular atrophy and necrosis. Complete ureteral obstruction causes progressive dilation of the renal pelvis during the first few weeks, with concomitant atrophy of the cortex. Incomplete ureteral obstruction destroys renal function more slowly.

Etiology

Causes of unilateral hydronephrosis

- Abdominal masses compressing the ureter.
- Ureteral neoplasia, calculi, stenosis or stricture.
- Accidental ligation of the ureter during ovariohysterectomy.
- Torsion of the renal pedicle.
- Ectopic ureter or pyelonephritis.

Causes of bilateral hydronephrosis : Besides the above-mentioned causes, bilateral hydronephrosis may develop due to

- Obstruction of the urinary bladder trigone or urethra by neoplasia.
- Prostatism, calculi or pelvic trauma.

Clinical signs

- Unilateral hydronephrosis is asymptomatic unless the enlarged kidney distends the abdomen. When the kidney is infected, signs of pyelonephritis (fever, leukocytosis, flank pain) may develop.
- Bilateral hydronephrosis is also asymptomatic until signs of uraemia (polyuria, anorexia, vomiting, oral ulcer) associated with renal failure develop.

Diagnosis

- History and clinical signs.
- Radiographic examination: A space occupying mass in the region of the kidneys may be evident. An excretory urogram shows a dilated renal pelvis with loss of diverticula in early stages of hydronephrosis. Later, a thin rim of functioning cortex surrounds a fluid-filled mass and delayed renal clearance time.
- Ultrasonography reveals hypoechoic and distended renal pelvis.

Treatment

Conservative therapy

- The kidney can recover normal function after 2 weeks of ureteral obstruction and may still recover some function after 3-4 weeks of obstruction.
- Kidney function can be assessed by estimating the ability of renal clearance of contrast materials and urine output.
- Treatment is directed to remove the primary cause.
- Fluid therapy.

Surgical therapy

- When the hydronephrotic kidney has minimum function or the obstruction cannot be removed, a nephro-ureterectomy is performed.
- A midline abdominal incision extending from the xiphoid to the pubis may be necessary to remove a very large kidney.
- The fluid is aspirated from the kidney to facilitate excision, and the renal vessels and ureter are ligated and severed.

PYELONEPHRITIS

It is a usually caused by bacterial infection characterised by inflammatory swelling of renal pelvis and compromised renal function.

Etiology

Ascending infection from the lower urinary tract or from haematogenous seeding of bacteria.

Clinical signs

- Animals with pyelonephritis are usually asymptomatic unless systemic signs develop (fever, lumbar pain, anorexia, vomiting).
- Concomitant signs of cystitis (dysuria, haematuria).
- In advanced cases, the animal shows signs of uraemia.

Diagnosis

- History and clinical signs.
- Leukocytosis often is present.
- **Urinalysis :** Bacterial culture of a urine sample obtained by cystocentesis is a reliable diagnostic test for urinary tract infection, without differentiating between upper and lower tract infection. The presence of casts is indicative of renal disease, but their absence cannot be used to rule out pyelonephritis.
- **Radiography :** Excretory urography may reveal dilation of the renal pelvis and a decrease in renal size with chronic bacterial pyelonephritis.
- **Ultrasonography** reveals hypoechoic renal pelvis.

Treatment

Antibiotic therapy : Based on urine culture and antibiotic sensitivity test, suitable antibiotic should be given for at least 4 weeks. The urine culture is repeated 5 days after antibiotic cessation.

- When antibiotic therapy is unsuccessful in unilateral pyelonephritis, **nephrectomy** may be done and the opposite kidney should be evaluated. In an azotemic dog, the pyelonephritic kidney should not be removed unless it is making no contribution to total renal function. Individual kidney function can be assessed by renal scintigraphy.

SURGICAL AFFECTIONS OF URETERS

Ureteral ectopia

Ureters are considered ectopic when they do not open into the trigone of the urinary bladder in the usual location. The ectopic ureter terminates most commonly in the urethra or vagina in dogs. It is a hereditary condition. Urinary incontinence is the presenting symptoms. Definite diagnosis is usually done by excretory urography. Fluoroscopic examination sometimes helps delineate the path of contrast medium and urine into the urethra or vagina. Surgical correction is the usual treatment.

SURGICAL AFFECTIONS OF URINARY BLADDER

Urinary bladder neoplasia

Transitional cell carcinoma is the most common malignant tumour in dogs. Squamous cell carcinoma, adenosarcoma, fibrosarcoma and myxosarcoma have also been reported. In cats, transitional cell carcinoma and squamous cell carcinoma are the most common bladder tumours. Transitional cell carcinomas metastasise most commonly to the regional lymph nodes and lungs, but also may metastasise to the liver, long bones and eyes.

Etiology is unknown.

Clinical signs

- Frequent micturation, blood in urine and dysuria.
- Loss of body weight

Diagnosis

- From clinical signs.
- Cytological examination of urine may reveal tumour cells.
- Radiography: Double contrast cystography outlines bladder masses and thoracic radiographs are examined for evidence of metastasis.
- Ultrasonography reveals tumour mass.
- Microscopic examination of the biopsy confirms a diagnosis.

Treatment

Partial cystectomy

- It is the most common treatment for localized canine and feline urinary bladder tumours.
- The bladder is opened at a point distance from the tumour. The tumour is excised with a 2-cm margin of healthy tissue.
- The remaining bladder is closed using a simple interrupted appositional pattern with synthetic absorbable suture material.
- A tube cystotomy or a urethral Foley catheter is placed to keep the bladder decompressed for 2-3 days after surgery.

Cystectomy

- For complete excision of extensive bladder neoplasia with urinary obstruction or severe haematuria, a cystectomy with trigone-colonic anastomosis (if the trigone is healthy) or uterocolonic anastomosis is required.
- Dogs remain continent after these procedures, voiding watery faeces several times a day.

Complications include gastrointestinal and neurologic disturbances associated with metabolic acidosis, hyperammonemia, and/or uraemia. It can be controlled with sodium bicarbonate therapy and careful management of diet and fluid intake.

BLADDER INJURY

Rupture of urinary bladder is the most common traumatic urinary tract injury in the dog and cat.

Etiology

- External abdominal trauma.
- Pelvic fractures.
- Puncture wounds, traumatic palpation and catheterisation of the bladder.

Clinical signs

- Variable.
- Abdominal pain, vomition and central nervous system depression.
- Urination may or may not present.
- Abdominal distension.
- Dehydration.

Diagnosis

- History of trauma and clinical signs.
- Abdominal paracentesis reveals presence of urine.
- Laboratory examination : Elevated Packed Cell Volume (PCV) and total plasma protein and elevations in serum creatinine, urea nitrogen and inorganic phosphorus 24-48 hrs after the rupture.
- Radiography : Retrograde positive contrast cystography using a water-soluble organic iodine preparation demonstrates the location of the rupture.
- Ultrasonography reveals the ruptured bladder and presence of urine in the abdominal cavity.

Treatment

- Correct uraemia, dehydration and electrolyte abnormalities before anaesthesia and surgery.
- Perform mid ventral laparotomy extending from the umbilicus to the pubis.
- Locate the bladder tear and freshen the wound margins.
- Close the tear in the bladder with simple interrupted or a continuous Cushing suture pattern using absorbable or monofilament non-absorbable suture.
- When the tear is near the ureteral orifice, the ureter should be ligated near its entrance into the bladder and reimplanted more cranially.

कृपया रेषा मारुन
पुस्तक खराब करु नये.

- When the tear is near the urethral junction, a urethral catheter should be passed from the bladder out the urethra to identify the urethral lumen and the urethra is anastomosed to the bladder.
- Lavage the abdominal cavity with warm saline and removed before closing the abdominal cavity.
- Keep the bladder decompressed after repair by allowing the dog to urinate frequently, by urethral catheterisation, or by a tube cystotomy.

Post-operative care

- Fluid therapy should be continued following surgery until the animal drinks on its own.
- Antibiotic therapy.
- Antiseptic dressing of the skin wound.

PATENT URACHUS

The foetal urachus lies within the umbilicus and joins the urinary bladder to the allantoic cavity. After birth, the urachus closes and turns into the fibrotic midline (ventral) ligament of the bladder. When the urachus remains open, urine continues to dribble from the umbilicus. Urine scalds may occur on the ventral abdomen and the animal may have a foul odour and recurrent urinary tract infection. Contrast cystography offers a definitive diagnosis of the condition.

Surgical excision is the treatment of choice. Following a ventral midline incision caudal to the umbilicus, an elliptical incision is made through the abdominal wall around the urachus.

ATONY OF BLADDER



A potential consequence of urethral obstruction is damage to the bladder detrusor muscle by prolonged overdistention. Normal contractibility of bladder is lost due to loss of tonicity of the tight junctions between muscle fibers that spread motor nerve impulses. The bladder cannot voluntarily empty its content even though there is no obstruction and the bladder can be felt manually with a good urine volume.

Treatment of this condition is directed toward keeping bladder empty, so that the tight junctions can reform either by frequent manual expression or with an indwelling catheter. Bethanechol, a parasympathomimetic drug can be tried after a few days of keeping the bladder empty. Bethanechol can increase urethral resistance and it is administered with a urethral relaxant such as phenoxybenzamine. The urethra must be patent during administration of parasympathomimetic drug. Time needed for return of normal bladder function varies with degree of injury.

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CHAPTER 12

Urolithiasis

DEFINITION OF COMMON TERMS

Polyuria–Greater than normal urine output

Oliguria–Urine output less than normal

Anuria–Total absence of urine output

Dysuria–Difficult urination characterized by frequently straining to pass small quantities of urine.

Stranguria–Synonymous with Dysuria

Pollakiuria–Frequent urination

Nocturia–Urination during the night

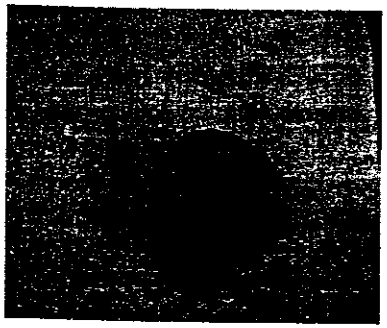
UROLITHIASIS AND URETHRAL STENOSIS, THEIR SEQUELAE AND SURGICAL TREATMENT

Urolithiasis is a general term referring to the causes and effects of stones anywhere in the urinary tract. The term urolith is derived from the Greek *Uro* meaning urine, and *lith* meaning stone. Urinary calculi are organized aggregations of crystals embedded in an organic matrix.

Etiology of urolithiasis

The exact etiology of urolithiasis is affected by many risk factors, some of which are known and some of which are unknown. The following are some of the risk factors for urolithiasis :

- **Urine pH** influences crystal precipitation and calculi formation. Struvite calculi tend to form in alkaline urine while urate and cystine calculi are associated with acidic urine.
- **Urinary tract infection (UTI)** with bacteria that produce urease leads to urine alkalinization as well as increased concentration of ammonium and phosphate, ultimately formation of uroliths.



Retrieved uroliths from the bladder of a bitch

- **Mineral imbalance** especially with calcium and phosphorus may lead to calculi formation.
- **Consumption** of hard water or low intake of water and dietary factors play a pivotal role in urolith formation.
- **Chronic inflammatory condition** of the urinary tract may lead to sloughing of epithelium that act as a nidus over which mineral deposition takes place to form uroliths.
- **Deficiency of vitamin A** also plays a vital role as it is needed for healthy condition of the epithelium.
- **Too early castration** in small and large ruminants may also predispose to urolith formation.

Common site of lodgement of uroliths in different animals

Animal species	Site of lodgement
Cattle	Distal sigmoid flexure of the penis or in the ischial arch
Buffalo	Glans penis or at the sigmoid flexure and in the neck of bladder
Sheep and goat	Urethral process or vermiform appendage
Pig	Sigmoid flexure and/ or the distal penile urethra
Horse	Urethra (at the level of ischial arch)
Camel	Terminal part of urethra and/or sigmoid flexure
Dog	Gutter of os-penis
Cat	Penile urethra

Clinical signs

- Difficulty in urination (stranguria) and urine may be blood-tinged (haematuria).
- Abdominal pain exhibited by frequent lying down and getting up.
- Anxiety, pacing, uneasiness and restlessness.
- A dry muzzle, sunken and anaemic eyes, salivation, anorexia and suspended rumination are common clinical signs.
- Licking at penis.
- Rectal palpation reveals a distended bladder (if not ruptured).
- Swelling of the ventral aspect of abdomen in the region of sheath if urethra is ruptured.
- Bilateral distension of abdomen ('**Water belly**' appearance) if bladder is ruptured in abdomen.

Diagnosis

Diagnostic plan is directed at identifying the type of calculi, predisposing cause and presence of calculi elsewhere in the urinary tract.

- **History and clinical signs**: Preliminary identifications may be based on crystals in urine, sediment and quantitative mineral analysis of calculi (if samples are available).
- **Radiographic examination**:
  (*a*) **Plain abdominal radiographs** will locate **radiopaque** calculi (struvite and calcium-containing stone).
  (*b*) Abdominal **ultrasonography**, excretory urography or double contrast cystography will locate **radiolucent** stone.

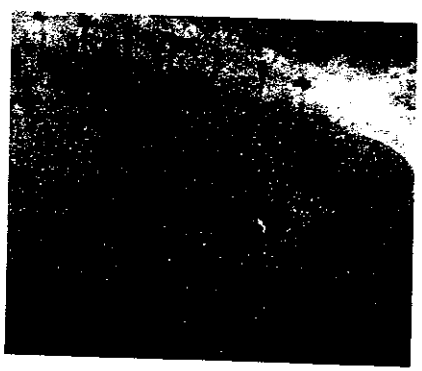
TREATMENT OF UROLITHIASIS IN SMALL ANIMALS

Conservative treatment : Medical therapy is always indicated in preventing recurrence of uroliths after either surgical removal or medical dissolution and to control associated urinary tract infection. Struvite, urate and cystine calculi not causing urine outflow obstruction can be treated with medical dissolution by dietary management.

Surgical treatment : Surgical treatment is indicated for other types of calculi or if medical treatment is unsuccessful after two months.

Cystic calculi

Site of incision : Caudal midline incision in cats or female dogs and a paraprepucial incision in male dogs.



Cystic calculi in a bitch

Method : Following the standard anaesthetic protocol, a ventral midline abdominal incision is made through the linea alba. A ventral cystotomy provides the best exposure of the bladder neck and proximal urethra. The bladder is isolated from the abdomen with moistened laparotomy sponges or towels. A retention suture is placed at the cranial end of the bladder and a second suture is placed at the caudal end of the proposed incision. The bladder is emptied by aspiration of urine using a 22-gauge needle and syringe. A stab incision is then made into the bladder and incision is extended cranially and caudally with scissors. Calculi are removed with forceps or a bladder spoon. Urethral calculi can often be dislodged by passing a urethral catheter and flushing the urethra alternately from the bladder and the urethral opening.

The bladder is closed with absorbable in a two-layer simple continuous or inverting pattern. The suture material does not enter the lumen of the bladder. Both caudal and cranial retention suture is removed. The abdomen is lavaged with warm saline and the abdominal wall is closed routinely.

Post-operative management

- The animals should be allowed to urinate frequently. If this is not possible, the bladder should be kept empty for 2-3 days by intermittent catheterization or with an indwelling urethral catheter *in situ* connected to a closed urine collecting system.
- Quantitative mineral analysis of retrieved calculi should be done and appropriate medical management is initiated to prevent recurrence of urolith formation.
- The animal should receive adequate fluid therapy immediately after surgery and a few days to correct hypovolemia.
- Broad spectrum antibiotic at least for 5-7 days are given to check secondary bacterial infection.

Urethral calculi



Urethral calculi in a dog

Preoperative management

- Complete urethral obstruction requires immediate intravenous fluid therapy and relief of the urethral obstruction.
- The main indications of fluid therapy are to replace water, sodium and chloride, to establish diuresis and to correct azotaemia and hyperkalemia.
- Urethral obstruction is relieved or bypassed with the minimal anaesthesia especially in azotaemic and hyperkalemic patient.
- If the above procedure fails, a cystotomy catheter can be placed to by pass the obstruction temporarily until corrective surgery can be performed.
- An attempt should be made to pass a small urethral catheter past the obstruction but should not be forced as catheter may further traumatize the urethra.
- **Retrograde hydropropulsion** with saline under pressure through a urethral catheter can be made. The proximal urethra is occluded with digital pressure per rectum to allow the saline to dilate the urethra. The occlusion of the urethra is removed and calculi are flushed into bladder and recovered through the cystotomy incision.

Surgical techniques

(*a*) **Prescrotal urethrotomy** provides access to calculi lodged near the os-penis and is performed via a ventral midline preputial approach. A longitudinal incision is made in the corpus spongiosum penis to expose the urethral lumen. The uroliths are removed. A catheter is passed into proximal urethra to identify additional calculi and also passed distally to dislodge calculi within the penile urethra. The urethrotomy incision may be sutured or left to heal by granulation.

(*b*) **Scrotal urethrostomy** is indicated for dogs that are recurrent stone-formers unresponsive to medical therapy, secondary urethral strictures, metabolic abnormalities and irreparable injury. Scrotal urethrostomy necessitates castration in male animal. **Prepubic urethrostomy** is an alternate technique if castration is not desired.

(*c*) **Perineal urethrostomy** is rarely done in dog but is the recommended procedure in cats. It is not indicated for recurrent stone-formers as may cause more bleeding and urine scalding than a scrotal urethrostomy.

SURGICAL TREATMENT IN LARGE RUMINANTS

In bovines, since sigmoid flexure is the most common site of lodgement of uroliths, a post-scrotal urethrotomy is recommended for removal of the same. If the calculus is not lodged at the sigmoid flexure, the incision in the urethra is to be extended upwards or below the ischeal arch downwards.

Post-scrotal urethrotomy

Following local anaesthesia, a midline incision of 3 inches long is made about 3 inches behind the scrotum. After incising the skin and subcutaneous tissue, the muscles are dissected

bluntly. The body of the penis is retracted by passing a curved scissors underneath it. A 1 to 2 cm vertical incision is made on the urethra at the site of uroliths which is then removed. Retrograde urohydropulsion is also performed with large volumes of sterile water to expel the calculus. After removing the uroliths, a suitable sized sterile polyethylene tube is lubricated and inserted into the bladder from the urethral incision. The opposite end is then passed normograde (down the urethra) to exit the urethral orifice and is anchored with the preputial sheath to prevent its dislodgement. Generally, urethra and muscles are not sutured. The skin and subcutaneous tissue is closed with interrupted horizontal mattress or simple interrupted sutures. The catheter may be allowed to remain in place for as long as 10 days.

Ischial urethrotomy is indicated when the calculi are lodged in the area of ischial arch. The penis is exposed through a mid line incision at the ischial arch as in case of post-scrotal urethrotomy. An appropriate sized catheter is passed through the urethral nick into the bladder and its other end is anchored in the subischial region. The site poses more complications.

SURGICAL TREATMENT IN SMALL RUMINANTS (SHEEP AND GOAT)

Treatment options include surgical operation to remove uroliths or relieve the blockage and review to determine whether diet or other factors could increase the risk of urolithiasis within the herd.

Urethral process amputation : The urethral process, or vermiform appendage is a very short (1 to 2 cm), narrow tube-like structure on the tip of the penis, and because of its location and size is the most common site for uroliths to obstruct. Sedation and/or lumbosacral epidural anaesthesia facilitate penile extrusion. Xylazine is not indicated for use in ruminants with urolithiasis, as its diuretic effect may worsen bladder distension if urethral obstruction is complete. If necessary, sedation can be performed with intravenous diazepam (0.1 to 0.2 mg I/V, slowly). After extrusion of penis, amputation or removal of this urethral process with a scalpel blade allow uroliths within this process to pass, but recurrence of obstruction may occur particularly if uroliths are also present higher up in the urethra. Removal of the urethral process has no adverse effect on breeding ability or fertility.

Perineal Urethrostomy : Perineal urethrostomy is a popular surgical method for correction of obstructive urolithiasis in small ruminants. This procedure can be performed with sedation and local anaesthesia, epidural anaesthesia or general anaesthesia. The urethra and its surrounding tissues can be easily felt in the back end 2-3 inches below the anus and just behind the rear legs. When the penis is blocked by uroliths or when rupture of urethra occurs downstream from this area, a new opening can be made to allow the animal to urinate. An incision is made through the skin and into the urethra; and the new urethral opening is sewn directly to the skin. The animal will urinate down and backwards instead of forwards. Complications of this procedure include stricture formation (closure of the hole) in some cases and inability to use the animal for breeding since semen does not pass through the penis.

Tube cystotomy : Tube cystotomy is indicated in animals with urethral obstruction or rupture. This procedure involves diverting urine away from the urethra by surgically placing a rubber tube (preferably Foley catheter) in the bladder and exiting the tube through the belly wall adjacent to the prepuce. The catheter is sutured to the skin at the stab incision to protect it from being stepped on or pulled out. This procedure is performed in conjunction with urethral process amputation and surgical removal of uroliths from the bladder. The tube is kept until urine is seen

dribbling from the prepuce for 48 hours. Then, the tube is clamped and urination is monitored. If the animal can urinate, is not painful, and is able to empty its bladder, the tube is removed. If the animal can only partially urinate and continues to retain urine, the tube is unobstructed to drain its bladder via Foley catheter and the process is repeated. On average, a tube cystotomy is removed 10 to 14 days after surgery.

Potentials complications with this procedure include the risk of reobstruction following removal of the tube, leakage of urine into the abdomen and cystitis caused by ascending infection.

Prevention of urolithiasis

- Animals must be fed a relatively high grain diet with addition of salt (sodium chloride) into the ration at a rate of 2 to 5% (alternatively, ammonium chloride @ 0.5 to 1 %) to promote water intake and production of dilute urine or acidify urine.
- Diets high in calcium may reduce the amount of phosphorus absorbed; so attention must be paid before adding any supplements to the feed.
- Horse-feed (not balanced for small ruminants) should never be fed to small ruminants as may increase the risk of uroliths formation.

Urethral stenosis/stricture

Urethral Stenosis may occur due to dehiscence of the anastomosis or a technically poor repair, caused by a fibrous scar that occludes the urethral lumen. Stricture may also develop months after surgery or conservative treatment caused by contraction of periurethral scar tissue. It is the major complications of perineal urethrostomy. The stricture is evaluated by urethral catheterization and retrograde urethrography.

Treatment

Correction of urethral Stenosis can be achieved by resection and anastomosis or a urinary diversion procedure.

- Repair of short penile urethral strictures (less than 5 cm in length) can be made by a skin incision over the strictured area. The retractor penis muscle if present is retracted laterally and the corpus spongiosum is incised over the stricture. Some portion of the strictured area (one half the circumferences) is removed. Urine should be diverted by insertion of a **cystotomy tube (Foley catheter)** until the urethra heals by second intension (usually 2 to 4 weeks depending on the length of incision).
- **Excision and anastomosis of strictured membranous urethra :** The stricture in the membranous urethra (between the prostate and the proximal penile urethra) is located first. The desired length of urethra (approximately 1 cm in a 10 kg dog) excised on each side of stricture and joined with simple interrupted absorbable sutures. A cystotomy catheter is placed to a closed drainage system to divert urine. The urethral catheter is left *in situ* for 2 days to allow the urethral mucosa to seal. The cystotomy catheter is generally removed after 5 to 7 days.

Complications of urolithiasis

1. **Haemorrhage :** Minor haematuria is common after cystotomy operation.
2. **Blockade of urethral catheter** due to blood clots, casts of cystic cells and kinking of the catheter may occur. This can be overcome by pulling the catheter slightly downwards

or by flushing it with saline. Sometimes, the catheter gets dislodged due to self mutilation by the animal.

3. **Urethral wound dehiscence** may occur due to infection or subcutaneous urine leakage, thus leading to cellulitis and local tissue necrosis.
4. **Granuloma formation** may occur due to closure of a cystotomy incision with braided nonabsorbable suture material.
5. **Primary bladder atony** may occur in small animals but rarely in cattle and buffaloes. Prolonged overdistension due to obstructive urolithiasis causes damage to nerve endings and atony occurs.
6. **Urethral stricture** is a common long term complication.
7. Prolonged catheterization (4 days or longer) often results in **urinary tract infection (UTI).**
8. Faecal and urinary **incontinence** and **rectal prolapse** may also occur.
9. Urolithiasis may reoccur postoperatively and the risk of recurrence increases if the dietary and management changes needed for prevention are not consistently practiced.
10. Although rare, postoperative **renal failure** due to hydronephrosis and/or severe volume depletion may also happen.

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CHAPTER

13

Surgical Affections of Male Reproductive System

ANATOMICAL CONSIDERATIONS

1. The paired **testes** are located external to the abdominal cavity within the **scrotum.** Each testicle hangs to the scrotal wall by the parietal wall by the parietal vaginal tunic and caudal ligaments of the epididymis dorsally and the other end by the spermatic cord and vaginal tunics.
2. The **scrotal** skin is thin, and hair or wool is usually sparse on the scrotum. It is richly endowed with glands. The structures of scrotum from outwards to inwards include skin, **dartos** (a layer of fibroelastic tissue and smooth muscle), scrotal fascia and parietal layer of tunica vaginalis. The dartos divides the scrotum into two pouches called **median raphae** containing each testis. Blood supply to the scrotum is via the **external pudendal artery**.
3. The epididymis runs along the caudomedial surface of the testis and ends in the prominent tail (cauda epididymis). The tail of the epididymis continues cranially within the spermatic cord known as **ductus deferens**.
4. The **spermatic cord** extends from the deep internal inguinal ring to the scrotum. It contains testicular arteries and veins (the veins of which form the **pampiniform plexus**), the lymphatics, nerves, ductus deferens, internal cremester muscle and visceral layer of the vaginal tunic.
5. The **prostate gland** (accessory sex organ) encircles the urethra near the bladder neck and the secretions of which provide a vehicle for spermatozoa. In the bull, there is a disseminate part of the prostate gland, within the wall of urethra.
6. The **penis,** the male copulatory organ is divided into three regions namely root, body and glans. In the dogs, the **glans** contains a small bone called **os penis**. The penis is enclosed in the preputial cavity in retracted stage and comes out from the prepuce during extension.
7. **The prepuce** is having two parts, external **(sheath)** and prepuce proper (joins the sheath to the penis).

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SURGICAL AFFECTIONS OF PENIS AND SHEATH

Penile injury : It is the commonest penile lesion encountered in bovines and rarely in other species. The condition occurs as a result of bite wounds, accidents during mating (by sudden movement of the cow or by thrusting of the bull against the thigh of cow before intromission is achieved), blunt and penetrating trauma.

Clinical signs depend upon the extent of injury.

- Haemorrhage is the most common clinical sign due to rupture of blood vessels of the tunica albuginea. The haematoma may be exacerbated by repeated mating attempts.
- Accidental rupture of penile urethra or fracture of ospenis (dog) may lead to dysuria and haematuria.
- The animal may exhibit signs of pain (arched back or altered gait), tissue oedema and necrosis.

Treatment

- **Mild lacerations and bite wounds** are allowed to heal by conservative therapy. Hydrotherapy with cold water in the acute stage after injury, 2 to 3 months sexual rest and a course of systemic antibiotic are recommended. If there is persistent haemorrhage from deep wound, suture repair of the tunica albuginea of penile mucosa is needed.
- **Fracture of ospenis** in dog is best treated by conservative management that includes adequate rest with urinary catheterization.
- **Extensive haematoma** requires surgical correction under general anaesthesia. Blood, blood clots and serum should be gently removed with attention paid to haemostasis.
- **Incomplete urethral disruption** can be managed conservatively by urinary catheterization and rest. **Severe trauma** with infection or necrosis may need partial penile amputation.

PERSISTENT FRENULUM

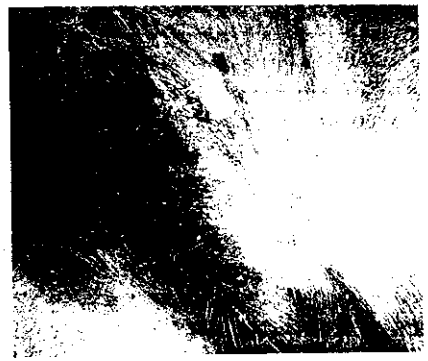
Persistent frenulum is an inherited disorder that can be passed on to progeny. At birth, the integument of the penis is continuous with the lamina interna of the prepuce and separation occurs at the time of puberty, beginning from the tip of the penis and progressing caudally. The **frenulum** is a thin band of fibrous tissue that connects the free end of the shaft of the penis to the lamina interna of the prepuce. Normally, the frenulum ruptures during erection of penis from the prepuce. Failure of such rupture persists along the raphae; the condition is called persistent frenulum.

Treatment of this condition is directed by dorsal penile nerve block with 2% lignocaine hydrochloride and pudendal nerve block. The penis is extended manually as far as possible by traction and the fibrous band is split between two absorbable sutures. The preputial cavity is flushed with an antiseptic solution. Repair of this condition provides instant cure and the animal may be used to service a week after surgery.

PENILE TUMOURS

The commonest tumour of the canine penis is transmissible veneral granuloma and bovine is fibropapilloma. This condition in dog generally occurs due to uncontrolled mating to a infected street dog. Penile tumours interfere with breeding by making intromission impossible in some cases and uncomfortable in others. Intermittent or profuse bleeding from penis may occur which interferes with semen quality.

Treatment of this condition in bull is to remove the tumour under appropriate restraint and local (dorsal penile nerve) or regional (pudendal) nerve block. The pedunculated papillomata may be removed by sharp dissection, electrocautery or cryosurgery. The bull should be sexually rested at least for 3 weeks. In some cases, commercial wart vaccine may diminish the incidence of the condition. In dog, surgical removal of the tumour is indicated alone or in combination with chemotherapy (vincrystine sulphate @ 0.025 mg/ kg body weight I/V) at weekly intervals.



Penile tumour in a dog

DEVIATION OF PENIS



This is the most commonly encountered condition where penis is deviated spirally due to slippage of the apical ligament of the penis during erection but before intromission. Spiral deviation of penis ("Cork screw penis") may prevent intromission in 50% to 100% of attempts although this does not affect the ejaculation once the penis is within the vagina. Diagnosis is based primarily on clinical observation of serving attempts.

Treatment of this condition involves surgical repair by anchoring the apical ligament of the penis so that it can not slip laterally and pull the free part of the penis into the spiral or augmenting the apical ligament with an implant. Synthetic fibres or thin strips of fascia late may be utilized as implant for the procedure.

PHIMOSIS

Phimosis is the inability to protrude the penis after erection through the prepuce. The condition may be congenital or acquired as a result of neoplasia, oedema or fibrosis following trauma, inflammation or infection at the preputial orifice.

Treatment of this condition is urgent, to allow urination and to prevent aggravation of tissue damage and swelling of the penis that may complicate subsequent surgery. The preputial opening is enlarged incising longitudinally, beginning at the ventral aspect of the preputial orifices and extending caudally for a few cm. The incision is deepened to the lamina interna and if necessary, a triangular piece of skin and mucous layer is removed which is then sutured to the skin with simple interrupted sutures of nonabsorbable material.

PARAPHIMOSIS

Paraphimosis is the inability to completely retract penis itself back into the prepuce. The condition is commonly seen in dog and bull after semen collection or coitus.

Etiology

- Direct trauma or trampling of external penis.
- Circular erectile swelling at the base of the penis during copulation (dog).
- Paralysis of the retractor muscles of the penis.
- Swelling due to injury and subsequent infection.
- A constricting band of hair at the preputial orifice and presence of foreign objects around the penis.



Paraphimosis is a dog
Courtsey Dr. A. Patil

Treatment

- Daily hydrotherapy with cold water in the acute stage after injury (about 4 days) to reduce the swelling.
- Gentle cleansing of the exposed penis and preputial cavity with mild antiseptic solution and astringent lotion.
- Attempts to be made to push the penis back into the sheath after lubricating with antibiotic in oily base or liquid paraffin. The prepucial opening may be enlarged to facilitate easy return.
- In chronic neglected cases, a prepucial segment may be resected. If the penile mass becomes necrotic and sloughing starts, penile amputation is recommended.

BALANOPOSTHITIS

Balanoposthitis is inflammation of the glans penis or preputial mucosa. The condition is commonly encountered in dogs, horse and ox but rare in cats.

Etiology

- Trauma and lacerations.
- Presence of foreign bodies into the sheath.
- Accumulation of dirt, urine particles and smegma.
- Infection due to coitus.

Signs

- A mucopurulent preputial discharge is the most common clinical sign.
- Swelling of the prepuce and pain.
- Dribbling of urine and sometimes accumulation of urine in sheath (due to inability to expose the penis).
- Distended bladder due to obstruction of urine flow.
- In chronic stage, sloughing of subcutaneous tissue may occur.

Treatment

- Clipping long hair away from the preputial orifice and thorough flushing of the preputial cavity with a mild antiseptic (potassium permanganate 1 in 1000, dilute povidone-iodine or chlorhexidine) or saline solution.

- If there is accumulation of urine in preputial cavity, draining of urine by incising the preputial sheath.
- If bacterial infection is suspected, an antibiotic ointment may be infused into the preputial cavity for 7-10 days.

AFFECTIONS OF TESTICLE

CRYPTORCHIDISM

Cryptorchidism is the failure of one or both testes to descend into the scrotum. It is the most common congenital anomaly and is believed to be a hereditary condition in male reproductive system. Incidence of left cryptorchidism is more often reported in cattle while a predilection for right cryptorchids has been encountered in goats. The affected testicle may be found near the scrotum, within the inguinal canal or within the abdomen. The higher temperature results in degeneration of germinal epithelium and loss of spermatogenesis. Because of the high heritability of this condition, affected animals with other congenital abnormalities should be removed from the gene pool.

Ectopic testis is a condition wherein the testicle gets located cranial to the base of the scrotum with the long axis parallel to the penis (groin region).

Absence of testicle is called **anorchid** and presence of one testicle is called **monorchid.**

Treatment

Surgical removal of testicle is recommended because cryptorchid testicle has an increased risk of spermatic cord torsion and testicular neoplasia.

(*a*) Testes located in scrotum are removed by standard castration techniques.
(*b*) Abdominal testes are best removed via a flank celiotomy, a ventral median or paraprepucial abdominal incision.

TESTICULAR TUMOURS

Testicular tumours are common in older dogs, less frequent in farm animals, and rare in cats. Undescended testicles are at increased risk. The commonly encountered neoplasms are seminoma, sertoli cell tumours and interstitial cell tumours. Testicular tumours cause palpable scrotal swelling or enlargement of the affected testis. Sertoli cell tumour with oestrogen production can be associated with poor sperm production as a result of atrophy of testicular cords.

Treatment of this condition is surgical removal of the affected testis along with adjacent spermatic cord.

HYDROCELE

Hydrocele is accumulation of fluid between the layers of tunica vaginalis. The condition is infrequently observed in dogs, cattle, buffalo and camels and may be unilateral or bilateral. The etiology of this condition is mostly trauma and faulty castration with burdizzo. Characteristic clinical signs include soft, non-inflammatory, fluctuating swelling mostly in the lower part of the scrotum. Exploratory puncture may reveal amber-coloured fluid in the region.



Hydrocele in a dog

Treatment

- Aspiration of fluid and consequent injection of a counter irritant like Tr. Iodine may be tried in order to produce adhesion and obliteration of the cavity.
- Surgical treatment consists of removal of the affected testicle by open method of castration along with tunica vaginalis.

SCROTAL WOUNDS

Scrotal injury or wound is the consequence of trauma, bite wounds particularly during breeding season. The condition may occur in any species of animal especially in camel. The scrotum is immediately swollen, painful and profuse haemorrhage may occur.



Scrotal wound in dog

Treatment of this condition is allowed to heal spontaneously with local application of antibiotic dressing and fly repellent to prevent maggot infestation. If the scrotum is severely traumatized or necrotic, scrotal sac ablation is indicated.

CASTRATION IN SMALL ANIMALS

Castration is the surgical removal of the testicles. It is also called orchiectomy, testectomy or sterilization operation.

Usable age of castration in dog and cat:

After attaining sexual maturity (ten to twelve months). Prepubartal gonadectomy can also be performed (6-8 weeks of age).

Indications

- To sterilize young males not intended for breeding and to modify certain male behavioural characteristics.
- Testicular neoplasia.
- In enlarged prostate.
- Cryptorchidism.
- Severe testicular or scrotal trauma.
- Perineal hernia.
- Chronic orchitis.

Surgical principles

Cats. The testicles are removed through bilateral scrotal incisions. After incising the skin and by blunt dissection, the testicle and spermatic cord are pulled out. The spermatic cords are ligated in two portions with absorbable sutures and testicle is removed.

Dogs. ***Site of operation***

- Pre-scrotal incision is preferred.
- Longitudinal incision on the ventral aspect of scrotum, lateral and parallel to the median raphae on either side.

Technique. In an open castration, the testicle is squeezed out through an incision in the operated site by mild pressure between thumb and finger. The spermatic cord is severed after ligation and the testis is removed. The other testis is removed through the same opening following the similar technique. The incisional wound is closed in routine manner. Open castration is associated with an increased incidence of scrotal swelling and haematomas.

CASTRATION IN LARGE ANIMALS

Usable age of castration

The desired age of castration varies and depends on an owner's expectation, ease of procedure and the intended use of animal. Some livestock owners feel that castration at a later age is preferable for improved carcass characteristics and weight gain. The usable age of castration is mentioned below.

Calves (beef cattle), goat and lamb	: 1-2 months of age.
Horse	: 1 year old.
Pig	: two weeks of age.

Indications

- To render males more docile and easily manageable as work animal.
- To improve meat quality in calves, lamb, goats and pigs.
- To improve performance, feed conversion and carcass traits especially in pigs.
- Neoplastic diseases or irreparable injury to the gland.
- Scrotal hernia and hydrocele.
- For quick and economic fattening of beef cattle.

Points to be considered in castration operation (closed and open method)

- All small ruminants that are castrated should receive a tetanus prophylaxis (ideally severed weeks before the procedure) because tetanus acquisition is one of the main complications of this procedure.
- It is essential to check that both testes have descended into the scrotum before surgery is contemplated, thus prevents unilateral castration of cryptorchid animals.
- Only spermatic cord should be crushed by burdizzo, avoid crushing the testes, epididymis or penis by mistake.
- The crushing lines on either side of scrotal skin should not coincide as may cause sloughing of skin.

Technique

Open method of castration

Anaesthesia and control

- Local anaesthetic in the scrotal skin and spermatic cord is appropriate.
- Lamb and kid are sensitive to local anaesthetics and so lignocaine HCl should be diluted from 2% to 0.5% or heavy sedation (xylazine HCl @ 0.02 to 0.1 mg/ kg IV or 0.04 to 0.2 mg/kg IM) and local anaesthesia. The lower range is preferred in goats and debilitated, aged, young or depressed animals.

In bovines and small animals- lateral recumbency; Camel-sternal recumbency

Method. The scrotum is grasped and pulled distally, thus displacing the testes proximally. The distal third of the scrotum is excised and the testicle is exposed by separating the dartos and fascia by blunt dissection. Traction is applied to each testis and the spermatic cord is freed by stripping the fascia proximally. The spermatic cord is then doubly ligated by chromic catgut and transected in between ligatures. Transfixation sutures help to prevent ligature slippage. A single skin incision over the median raphae is sufficient to remove the both testes. The scrotal wound is usually left open for drainage and to heal by second intension.

Close method. Close method of castration is performed using burdizzo emasculator to crush the spermatic cord within the scrotum. The spermatic cord of each side is held outward against the scrotal skin and is crushed twice while manipulating the cord within the scrotum. These crushes should be staggered without crossing the midline; so no pressure is applied across the entire scrotum. This reduces the risk of impairing vascular supply.

Complications of castration

- Tetanus in small ruminants if tetanus prophylaxis was not done.
- Seroma formation, swelling and inflammation at the surgery site.
- Infection and haemorrhage.
- Inguinal hernia.
- Scirrhous cord (thickening of cut portion of spermatic cord due to infection).

VASECTOMY

Vasectomy refers to removal of a segment of the ***ductus*** (formerly *vas)* ***deferens*** to render a male animal infertile.

Indications

- To produce teaser males.
- Teasers are used to detect or aid in identification of females in oestrus to allow them to bred by natural or artificial means.

Method

Following routine preparation and restraining in standing or lateral recumbency, a local anaesthetic is infiltrated at the surgical site. The incision is given on the neck of scrotum cranially, caudally or even laterally. Some surgeons prefer a single incision in the median raphae to allow access to both spermatic cord. After incising the skin and parietal layer of the vaginal tunic, the ductus deferens is located by palpation at the caudomedial aspect of the cord. The cord consists of a mass of arteries, veins, nerves enclosed by the visceral layers of the vaginal tunic. The ductus deferens is carefully isolated by blunt dissection and removes a portion of it (3-4 cm) after ligature has been placed on each end. The procedure is repeated similarly on other side. The skin incision is sutured.

CAUDECTOMY OF EPIDIDYMIS (EPIDIDYMECTOMY)

Epididymectomy is an alternative method for producing teaser animals. The technique is very simple and less time consuming as compared to vasectomy. After local anaesthesia, a 2 cm

skin incision is made in the ventral scrotum directly over the tail of epididymis. The tail of the epididymis is carefully separated from the distal aspect of the testis with blunt dissection, ligated with fine absorbable suture material and removed. Trauma to the tunica albuginea should be avoided as otherwise profuse bleeding may occur. The skin incision is sutured or left open to heal spontaneously. The procedure is repeated on the other sides. The technique should preferably be performed 30 days prior to use the animals as teaser.

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CHAPTER 14

Affections of Female Reproductive System Organs, Mammary Gland and Tail

ANATOMICAL CONSIDERATION FEMALE REPRODUCTIVE ORGANS



1. Paired **ovaries** are located just caudal to the kidney and are attached to the body wall by **mesovarium,** containing ovarian artery and vein and by **suspensory ligament.**
2. The **fallopian tube** (oviduct) extends from the ovarian bursa to the uterine horn.
3. The uterus is a hollow muscular organ chiefly consisting of two horns, the body and cervix. It lies in the caudal abdomen between the descending colon and urinary bladder. The uterus is attached by the **broad ligament** to the dorsal body wall and by the **round ligament** (cord like) to the inguinal canal. Blood supply is via the anterior ovarian artery, posterior uterine artery and veins.

SPAYING

Spaying is the surgical removal of ovaries which is performed in bitch, cow and mare.

Indications

- Bad temperament and behaviour.
- To prevent breeding and eliminate oestrus.
- For ovarian pathologies such as cystic ovaries, neoplasia and abscess formation.
- Simplifies interstate movement of animals form areas of endemic brucellosis and enable superior fattening of feedlot heifers in conjunction with growth promoters (cow).

In cow and mare the ovary is approached by abdominal **celiotomy** though the body wall or **colpotomy** (vaginal approach) before performing an ovariectomy. The surgical approach of **spaying in bitch is discussed in ovariohysterectomy part.**

Anaesthesia and control

Epidural anaesthesia; restrained either in standing or recumbent position.

CELIOTOMY (FLANK METHOD)

Generally unilateral ovariectomies are performed via a flank celiotomy. An incision in the caudal paralumber fossa gives the best access to the ovary. A vertical skin incision 4-6 incl long is made at the desired site and then incising the muscle in the direction of its fibres, fasc and parietal peritoneum. The ovary is identified and exteriorized. Once the ovary has bee identified, the vascular pedicle must be ligated and finally severed and removed by ecraseur. The incision site is closed following the routine procedure of laparotomy. In cases where bilateral ovariectomy is desired, colpotomy and laparoscopic ventral midline approaches may be considered that allows access to both ovaries.

Colpotomy approach

Colpotomy (vaginal) approach is only indicated for spaying of heifers with small, normal ovaries to overcome the risk of haemorrhage and evisceration. In this method, withholding of food for 24-30 hrs is necessary to get better access to intraabdominal structures. The perineal area is prepared with appropriate aseptic technique and the vagina is lavaged with a dilute antiseptic solution. The vaginal wall is incised adjacent to the cervix at the 10 or 12-O' clock level with a scalpel blade or short bladed concealed knife. The incision is digitally stretched to first permit entry of several fingers, then the hand and arm. The ovary is located, drawn into the vaginal canal and are severed by ecraseur and removed. The other ovary is removed in a similar manner through the same vaginal incision. The vaginal incision is left to heal as an open wound.

OVARIOHYSTERECTOMY (PANHYSTERECTOMY) IN BITCH

Ovariohysterectomy is the surgical removal of both ovaries and uterus.

Indications



- A common elective procedure to sterilize young females not intended for breeding as animal birth control programme.
- Neoplasms involving the ovary or uterus.
- Prolonged oestrus resulting from ovarian cysts.
- Uterine disease (pyometra, metritis, chronic endometrial hyperplasia, prolapse).
- To minimize the risk of mammary gland tumours.

- Vaginal oedema.
- Prevention of hormonal changes that interfere with therapy for dermatitis, diabetes or epilepsy.

Anaesthesia

- General anaesthesia or combination of xylazine hydrochloride, ketamine hydrochloride and diazepam (relaxation of abdominal muscle).
- Epidural anaesthesia combined with local infiltration if the animal is debilitated or toxaemic.

Surgical technique

- *Approach* : Either a paralumber flank approach or a ventral midline celiotomy (centred between the umbilicus pubis through linea alba). The midline incision allows better visualization, less haemorrhage and easier removal of both ovaries and uterine body.
- *Method* : The abdominal cavity is approached through site mentioned above by incising skin, muscle and peritoneum. The ovaries are exteriorized by stretching or breaking the suspensory ligaments. The anterior utero-ovarian vessels are ligated. The ovary is exposed by incising the ovarian bursa and is disconnected from its anterior attachment. After disconnecting both the ovaries, the uterine pedicles are ligated just proximal to the cervix and cut. If the broad ligament is vascular, one or more ligatures should be placed prior to transection. The stump is to be closed by inversion suture ("Parker-Kerr" sutures). The laparotomy wound is closed following the routine standard procedure.

Complications of surgery include :

- Haemorrhage from the ovarian or uterine vessels leading to haemorrhagic shock.
- Ovarian remnant syndrome or recurrent oestrus from residual ovarian tissue.
- Oestrogen-responsive urinary incontinence.
- Uterine stump pyometra.
- Iatrogenic urethral trauma.
- Granuloma or fistulous tracts formation resulting from ligatures of nonabsorbable multifilament suture material.
- Body weight gain resulting from low systemic estradiol level.
- Eunuchoid syndromes (decrease in aggression, interest in work and stamina).

SURGICAL AFFECTIONS OF UDDER AND TEAT

Destruction of mammary gland

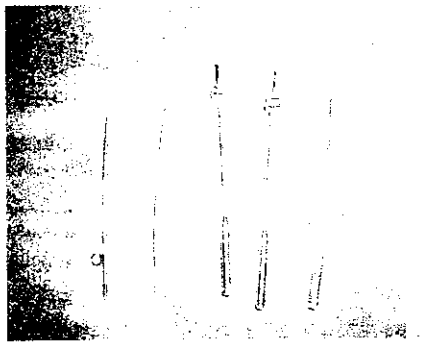
Destruction of mammary gland is indicated in inoperable damage of glandular tissue where normal milk secretion is not possible. Radical mastectomy is occasionally performed in small ruminants and rarely in cattle and buffaloes. Indications include neoplasia, chronic or gangrenous mastitis, a fibrotic or granulomatous udder and precocious udder development. Surgery if necessary should be



performed in a nonlactating animal in good physical status and preferably during fall and winter to avoid fly infestation.

Destruction of mammary gland can be performed by

- **Chemical destruction** : This can be accomplished by injecting one of several irritating preparations into the affected quarter. Chemicals include 100ml of a solution containing 10% formaldehyde diluted in 500 ml of sterile saline, 20 ml of 5% copper sulphate, 50 to 100 cc of 3% silver nitrate solution, or 60 ml of chlorhexidine.
- **Ligation** of external pudendal artery and vein may be advocated to cause rapid atrophy of the mammary gland where it would be unwise to perform major surgery on very sick animals.



Routine teat surgery instrument

TEAT

Supernumerary teats

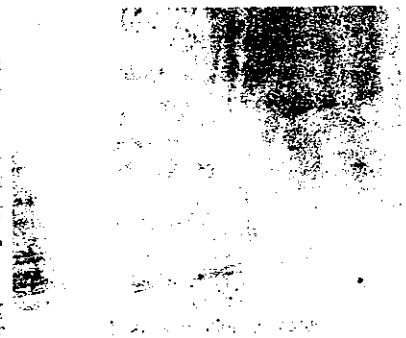
Supernumerary teats are often seen in cattle in between the normal teats. Indications for surgical removal include the following: interference with milking, increased risk of mastitis, and cosmetics. Supernumerary teats can be distinguished from the primary teats at the age of 3 to 6 months. At this age, supernumerary teats are simply removed under local anaesthesia with a pair of scissors in a craniocaudal direction at the base. Wound closure should be done with interrupted sutures using non absorbable suture materials. Supernumerary teats in animals older than 6 months are best removed with an emasculator.



Supernumerary teat in cow

Teat lacerations

Teat lacerations may occur due to trauma caused by barbed wire fences and animal bites. Teats may also be stepped on and lacerated by sharp hoof. Trauma may also be in the form of contusions. Incidence of teat lacerations is more common in goat as compared to cow and buffaloes due to their pendulous udder and long teat. In cows, it has been observed that 95% injuries are self inflicted.



Superficial wounds do not affect the milking and the treatment is mostly on general principles of

surgery. The prophylactic antibiotic therapy is needed to avoid mastitis. Deep non-penetrating wounds of the skin of the teat should be disinfected with non-irritant antiseptics and primary closure by using synthetic suture material is necessary. Penetrating teat wounds are very difficult to treat and there are always possibilities for development of teat fistula and mastitis. Under anaesthesia and strict hygienic measure, closure of the wound should be done. Aftercare consists of prophylactic infusion of antibiotic daily till the healing takes place and removing the milk using sterile teat siphon for few days to avoid the interference of healing process.

Teat fistula

Teat fistula is an accessory opening on the teat that communicates with the primary teat sinus or streak canal through which milk flows out in lactating animals. It can be congenital but usually results from a full thickness teat laceration and occurs as a complication to secondary healing.

It is advisable to treat teat fistula in dry period although immediate care may be taken in fresh wounds. A teat fistula wound should be allowed to granulate until swelling and infection subside and the fistula is well delineated prior to surgical repair. Mild chemical cauterization or electric cautery may be advocated if the fistulous tract is small. However, large fistula requires reconstructive surgery under strict aseptic condition. A longitudinally oriented elliptical full thickness specimen of teat wall centered over the fistulous tract is excised and the teat wall is closed as described earlier for deep lacerations. Standard postoperative care is to be taken. If fistula is repaired effectively, the prognosis for return of normal milking is favourable.

Milk stones (Lactoliths)

Milk stones are floating calculi either completely free or attached to the teat mucosa. These stones are mechanically interfere normal flow when forced towards the streak canal during milking. Lactoliths can be diagnosed by manual palpation or ultrasonography and small stones by forced hand milking. A stone that is attached or too large to be milked out is removed or crushed with a alligator forceps. Besides, sometime it is necessary to slit the sphincter with a teat knife to remove large size of lactolith. This procedure requires strict aseptic manipulation, local analgesia and intramammary infusion of antimicrobial agents.

Teat spider (Membranous obstruction)

Membranous obstruction generally occurs at the base or middle of the teat and it may be acquired or congenital in nature. Congenital obstruction may result in persistent intraluminal membranes or agenesis of the teat sinus. Causes of acquired obstructions include acute trauma, chronic trauma and infection due to unnoticed mastitis during the dry period. The membranous obstruction at the base was perforated by Hudson probe and was twisted and taken out with the Hudson's spiral. Obstruction at the middle of the teat was cut with the teat scissors followed by infusion of antibiotic ointment. The membranous obstruction above a few millimetres from the rosette of furstenberg should be removed with Hug's teat tumour extractor followed by antibiotic ointment.

Stenosis of streak canal (Hard milker, Contracted sphincter)

Hard milker or contracted sphincter is usually acquired as a consequence of self-inflicted injury to the apex of the teat. In this condition, it is difficult to squeeze the milk and milking time is increased. Chronic trauma due to poor function of the milking machine is considered the

second major cause of this condition. Traditional treatment is to use teat dilators to stretch the streak canal and teat sphincter but it often leads to mastitis and trauma to the teat sinus mucosa. A teat dilator may be used to relax the sphincter if small enlargement of the streak canal is required. A constriction higher up in the teat canal is cut under local anaesthesia by using a Litchy teat knife or teat bistoury. Aftercare consists of placing a Larson's teat tube through the teat orifice for 5 consecutive days to keep it patent until healing has occurred.

Free milker (Leaker, Enlarge teat orifice)

In this condition milk is spontaneously coming out from teat orifice due to relaxed sphincter or excessive enlargement for correction of hard milker.

Treatment of this condition includes injection of 0.25 ml of lugol's iodine around the orifice using hypodermic needle. This may reduce the diameter of the orifice.

Imperforate teat (Occlusion of teat orifice)

Occlusion of teat orifice may be congenital (developmental anomaly) or acquired (traumatic) in nature. This condition is mostly observed in cows in first lactation or fresh heifers. A buldge may be seen over the area of the teat orifice when milk is squeezed towards the streak canal.

Surgical correction of this condition includes opening the skin membrane using 15 gauge sterile needle. The apex of the teat should be rolled between thumb and finger for several days before each milking which prevents fibrinous adhesions and helps to open the streak canal. Sometimes the opening was incised with teat knife and subsequently a milk canula may be fixed for 5 days to keep it patent until healing occurs.

Nodular obstructions (Polyp)

This is one of the most common causes of reduced milk flow in dairy cows. In this condition small sized growth is attached to the wall of the teat cistern.

Surgical technique currently used includes removal of growth by introducing a curette, teat tumour extractor or teat polyp extractor. Then the cut portion of the growth can be removed by alligator forceps. Antibiotic infusion to the teat orifice is mandatory to prevent the chances of infection.

Athelia

Athelia (absence of teat) is very rare in cows and buffaloes but partial athelia due to fusion of two teats is occasionally seen. **Treatments** include separation of fusion of the teats by approximate plastic surgery provided the fusion is confined to the bridge of the skin only.

Thelotomy

Thelotomy involves removing of obstructive tissues in the area of rosette of Furstenberg under routine analgesia and aseptic preparation. Here a longitudinal incision is made through the skin and intermediate layers on the lateral aspect of the teat and obstructing tissues is carefully excised in the area of rosette of Furstenberg.

Theloscopy

Theloscopy is a diagnostic and surgical technique that has replaced thelotomy for removing obstructive tissue in the area of rosette of Furstenberg under visual control. Location of actual obstruction can be determined by theloresectoscopy. This procedure involves introducing the

endoscope through the teat sinus with air insufflations which permits adequate visualization of obstructive tissues and subsequent removal of tissues using the cautery sling of the working endoscope.

Teat amputation

This procedure is performed in purulent mastitis to drain the pus and when teat damage caused by severe trauma is irreversible. There are certain conditions to be fulfilled before teat amputation. This includes treatment of mastitis in the corresponding quarter if present and prophylactic intramammary injections of antibiotic and drainage of milk. Surgery is performed by application of 2% local anaesthesia around the base of the teat and an elliptical skin incision in the sagital plane is made around the teat at the junction of the proximal and middle thirds. The teat wall is sharply dissected and the bleeding vessels are ligated. Submucosa and intermediate layers are tightly apposed with continuous suture using 4-0 monofilament suture materials. The skin is closed routinely with interrupted sutures. Routine post-operative care is to be taken till final healing takes place.

Complications of teat surgery

- Occurrence of acute mastitis.
- Increased somatic cell count (somatic cell count depends on severity of the trauma to the teat and the occurrence of ascending infection in the quarter).
- Reduced milk flow.
- Wound dehiscence (wound dehiscence depends on the degree of wound contamination, age of the teat laceration and degree of interference of blood supply to the wound).

Canine mammary neoplasms

Mammary gland tumours are the most frequently diagnosed neoplasms in female dogs and are the second most common tumor (after skin tumors) over all. Mammary neoplasms are uncommon in male dogs, accounting for less than 1 percent of these types of tumours. The incidence of mammary tumours is higher in dogs than in any other domesticated animal. Overall, unspayed bitches have a seven times greater risk of developing mammary neoplasia than do those that are spayed. Approximately half of the tumors (50%) are malignant, and half have metastasized by the time they are initially diagnosed.

Risk factors and causes

Risk factors: Hormones such as estrogen and progesterone may be a risk factor observed by the fact that ovariohysterectomy decreases the incidence of mammary tumors by avoiding the influence of these hormones. Dogs have an overall reported incidence of mammary tumors of 3.4 percent. If a bitch is spayed before the first estrus, risk is less than 1%. If the spay is done before the 2nd or 3rd estrus, the risk is 8% and 26%, respectively and little benefit has been reported with spaying after



the 3rd oestrus. The two posterior mammary glands are involved more often than the three anterior glands.

Cause : The cause of canine mammary tumors is unknown; however, there are several factors that may influence the development of mammary gland tumors.

- Obesity has been correlated with higher prevalence of mammary tumors in dogs.
- Sex hormones certainly play a role in development of mammary tumors in the bitch.
- Dogs with a higher intake of red meat in their diet were at higher risk for developing mammary cancer.
- Feeding of high fat homemade diets may also lead to this situation.
- Several hypotheses on the molecular mechanisms involved in the development of canine mammary tumors but a specific genetic mutation has not been identified.

Diagnosis : Clinical evaluation of the patient is crucial as part of the diagnostic procedures although thorough palpation of both mammary chains is indispensable. Tumors are more often seen in the caudal pair of mammary glands. Multicentric involvement is common.

- Clinical evaluation includes complete blood count and serum chemistry profiles, thoracic (3 views-left and right laterals and ventro-dorsal) and abdominal (2 views—lateral and ventro-dorsal) radiographs to detect metastases. Ultrasound examination is indicated if metastasis to the abdominal organs is suspected.
- The definitive diagnosis is based on histopathology on excisional biopsy specimens.
- In addition to histological classification, tumor-node-metastasis (TNM) staging on canine mammary tumors to provide more practical prognostic information is recommended. This staging is based on the size of the primary tumor, presence/absence of tumor metastasis to regional lymph nodes, and presence/absence of distant metastasis. The greater the stage, the poorer the prognosis.

Stage	Primary Tumor	Regional LN Status	Distant Metastasis	
I	T1	NO	MO	T1 < 3 cm maximum diameter
II	T2	NO	MO	T2 3-5 cm maximum diameter
III	T3	NO	MO	T3 > 5 cm maximum diameter
IV	Any T	N1	MO	NO Histologically no metastasis
V	Any T	Any N	M1	N1 Histologic metastasis MO No distant metastasis M1 Distant metastasis detected

Modified TNM staging of canine mammary gland tumor

Treatment

There are several options to treat canine mammary tumors including surgery, chemotherapy, radiation, immunotherapy, hormonal therapy and diet.

- **Surgery :** Surgical excision is still the most effective modality. Removal of the tumor alone (lumpectomy), simple mastectomy (removal of the affected gland only), modified

radical mastectomy (removal of the affected gland and those that share lymphatic drainage and associated lymph nodes), and radical mastectomy (removal of the entire mammary chain and associated lymph nodes) are the different options. However, removal should be done with wide margins to prevent recurrence as 40 to 50 percent of dog mammary tumors have estrogen receptors. If surgery is successful, with clear & histologic margins, and the patient has no evidence of lymph node involvement or metastasis, chemotherapy is not recommended. Some veterinarians recommended spaying during mammary tumour operation to get better prognosis in dogs. However, no improvement of disease outcome was reported when spaying was performed after the tumor had developed.

- **Chemotherapy :** The most commonly used chemotherapeutic agents are doxorubicin and cisplatin. The potential side effect of doxorubicin is cardio-toxicity, cisplatin with renal toxicity and high incidence of side effects in Paclitaxel. Besides, drugs shown to have *in vitro* activity or potential clinical efficacy include 5-fluorouracil, cyclophosphamide, carboplatin, mitoxantrone and docetaxel. However, chemotherapy has not been proved an effective treatment for mammary tumors in dogs.
- **Hormonal therapy:** Tamoxifen citrate, an antiestrogen drug used in human estrogen receptor-positive breast cancer has been used in a limited number of dogs. The advantage of this medication is that it can be given orally, however, 25% of the animals have side effects such as vulvar swelling and pyometra.
- **Radiation therapy and immunotherapy** have been studied, but efficacy is not confirmed. A theory proposing that a high protein/low fat diet may prolong survival has been advanced.

Prognosis: The prognosis is based on multiple factors. Size of the tumor, lymph node involvement, and nuclear differentiation also affect the prognosis. Dogs with smaller (less than 5 cm in diameter) malignant tumors have a better prognosis for long-term survival. Metastasis is observed in about half of malignant tumor cases. Histologic evaluation is critical not only to determine the origin of the neoplastic cells, but also to find microscopic evidence of possible metastases. Early surgical intervention and the method of surgery play important roles in prolonging survival. Spaying at the time of tumor excision has been recommended to increase survival time.

AFFECTIONS OF TAIL

Traumatic injuries

Injuries of the tail are commonly met in ruminants and horses as a result of trauma. An injury may be caused by the attendant itself by twisting the tail to get the animal to move or stand. An open wound may develop due to rubbing of tail as in pruritis. Sometimes, the tail (coccygeal vertebrae) may get fractured or dislocated as a consequence of trapping between two fixed objects. If the tail is injured near the sacrococcygeal area, complete paralysis may occur.

Treatment of this condition is directed to application of **padded splint** in fractured tail. The wound if present should be treated on general principles. If complete paralysis occurs, **amputation** of the tail may be the only solution.

Necrosis of tail

Necrosis of tail may be encountered in any animal species but buffaloes are more prone to this condition.

Etiology

- Trauma is the initiating cause of this situation.
- Predisposing factors : close confinement, slated concrete floors, large body weight and hot season may lead to trauma and consequent infection.
- Pressure caused by rope or string tied tightly to lift the tail up, the other end being tied to the saddle (especially in camel).
- Application of too tight bandages in treatment of fractured tail may lead to ischemic necrosis.
- Metabolic disorders within the skin and caudal vertebrae producing fissures of the epidermis.

Clinical signs include dry necrosis and alopecia (**in mild cases**), swollen, necrotic with areas of abscessation (**in moderate cases**) and multiple abscessation and severe gangrene (**in severely and neglected cases**).

Treatment

- Cleaning, application of antiseptic and antibiotic is indicated in mild necrotic cases.
- Abscess, if developed, should be opened and treated on general rules. Parenteral antibiotics are necessary based on sensitivity results.
- In severe and protracted cases, amputation is recommended.

Crooked tail

Crooked tail refers to curvature of tail due to congenital abnormality, improperly tail setting operation or due to improper use of the tail set.

Treatment

- Concave portion of the tail is surgically prepared.
- Bend the tail in the opposite direction of the curve to locate the longitudinal furrow between the dorsal and ventral coccygeal muscles. The operative area is infiltrated with local anaesthetic solution.
- An incision is made parallel with the long axis of the tail and a small tenatome with its cutting edge is inserted through the muscle to the vertebrae in an arc-shaped manner and severing the entire dorsal sacrococcygeal muscle.
- The tenatome is removed through the original stab incision.

After-care consists of application of sterile dressing and moderately firm bandage for 24 hours. The stab incision may be left uncovered if it is dry, otherwise, a sterile dressing should be re-applied. The bandage may be kept during the entire healing period to prevent the tail from curving again.

Amputation of tail

Indications

- Irreparable injuries like fracture, ischemic necrosis or gangrene and complete paralysis.
- Fancy purposes in dog and horse (carriage horses).
- In chronic osteomyelitis that is non-responsive to medical treatment.
- Malignant diseases.

- In sheep, to improve ram-breeding efficiency and provide a more balanced carcass to the meat packer.



Amputation of a mature tail is a serious surgical procedure to the veterinary practitioner. In adult animal, amputation is performed under local anaesthesia with 2% lignocaine hydrochloride anaesthesia or epidural anaesthesia. Postsurgical analgesia is always indicated. A tourniquet is applied at the base of the tail for haemostasis and the amputation area is prepared for aseptic surgery. The skin is incised in a "V" pattern, 2 to 3 cm more caudal than the intervertebral space to be incised. The intervertebral space is identified and transected. The coccygeal artery and vein are identified and ligated. The subcutaneous tissue and muscle are apposed with simple interrupted or mattress sutures of synthetic absorbable material. The tourniquet is temporarily released to observe any bleeding points. Closure of skin is made with nonabsorbable suture material in a simple interrupted or horizontal mattress suture pattern. **After-care** consists of application of fly repellent ointment, routine surgical dressing and appropriate antibiotic therapy.

Complication : Occasionally, chronic irritation and self-trauma may be seen following amputation. Repeating amputation slightly more proximally usually resolves this.

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UNIT 6

VETERINARY ORTHOPAEDICS AND LAMENESS

CHAPTER

1

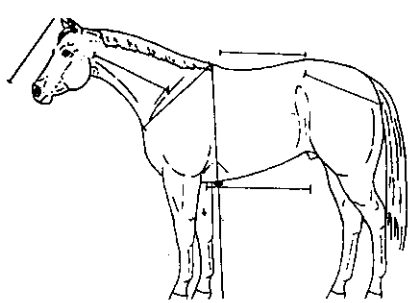
Body Conformation in Relation to Fitness

CONFORMATION

Conformation is the form or outline of an animal or the physical appearance of an animal due to the arrangement of muscles, bones and other tissues. Conformation plays an important role in the phenotypic evaluation of a horse. Evaluation of equine conformation is usually subjective and based upon experience. Simply it can be termed as "the relationship of form to function". The horses with improved conformation generally show increased athleticism. Each breed has ideal characteristics of its body conformation.

Components of Conformation

- Balance
- Head and Neck
- Shoulder
- Topline
- Hindquarters
- Muscle (proportional)



Balanced horse

Characteristics of good conformation

Balance

- Single most important characteristic in equine selection
- Forms the basis for athletic performance

Head

- Lean, clean chisled
- Triangular
- Eyes large and set on corners of face
- Profile—straight or slightly dished

Neck

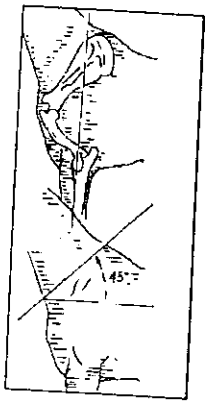
- Assists with balance
- Long, lean, high set—correlated to shoulder slope
- Topline : Bottom line—2 : 1

Chest, heart girth and ribs

- Chest deep and moderately wide
- Rib cage well sprung
- Deep heart girth

Shoulder

- Slope critical to balance
  - ♦ Impacts proportions of neck
  - ♦ Impacts proportions of back
- 45 to 50 degree angle
- Pastern angle: shoulder angle



Topline components

- Withers—Prominent, medium height, clean
- Back—Short and strong, muscled
- Loin—Short and strong, blends smoothly into croup
- Croup—Short and Strong, muscled

Muscle

- Quality
  - ♦ Muscled throughout
  - ♦ Long, clean, defined
- Quantity-varies from species to species

Conformation defect in relation to the forelimb

- Over at the knee.
- **Posterior deviation of the carpal joint (Calf Knees) :** When viewed from the side, with the horse standing straight, this is seen as a backward displacement of the knee. This is a particularly bad fault because it predisposes to lameness both from injuries to the carpal bones and from the great strain which is placed on all ligaments and tendons down the back of the limb.
- **Toed in knee :** When viewed from side flexor tendons appear to be too close to the cannon bone just below carpus. It inhibits free limb movement. A heavy fetlock may rise to appearance of 'toed in knees'
- **Cut out under the knee :** If viewed from side this condition seems a 'cut out' appearance just below carpus on anterior surface of cannon bone
- **Base narrow :** The distance between the centre lines of feet at their placement on the ground is less than the distance between the centre lines of limbs at then origin in the chest when viewed from front. This is most common in horses having large chest and well developed pectoral muscles This conformation may be accompanied toe in (pigeon toed) and toe out (splay footed) conformation. Outside of limb takes the most strain in base narrow conformation—causing lateral aspect of limb to be under constant tension.

- **Base wide :** Distance between the centre lines of the feet at their placement on the ground is greater than distance between the centre lines of limbs at their origin in chest when viewed from front. Here horse is often affected toe-out position of feet. Inside of limb takes most strain in base wide conformation causing medial aspect of fetlock and pastern joints under tension.
- **Bench knee/Sideways displacement of the cannon bone :** When viewing the horse from the front, the cannon bone is not centered squarely under the knee. Lateral displacement is towards the outside that causes excessive stress on the medial portion of the cannon bone and this usually results in the formation of splints.
- **Anterior deviation of the carpal joint (Bucked Knees) :** Forward displacement of the knee when viewed from the side. It may be related to contraction of the flexor muscles of the forelimbs attached to the knee and/or the flexor tendons. However, where both knee (deviated forwards) and the fetlock (deviated down and backwards) is involved together, the horse is generally unsound and can not be used for hard work.
- Bow leg
- **Toe in/Pigeon toed :** Toes point toward one another when viewed from front. This condition is congenital. When affected horse moves there is tendency to paddle with feet. (outward deviation of foot during flight)
- **Splay toed/Toe out :** When viewed from the front, the toes point away from one another. It causes interference with opposite forelimb when advancing.
- **Open knees :** This is best viewed from the side of the horse. The knee looks corrugated instead of smooth and mostly this is an age factor with the gaps in the knee closing with maturity over 3 years. However, some horses may never lose this appearance and, in these cases, this weakness leads to injury of the carpal bones.
- **Splint** is usually associated with injury to the ligament between the second and third, or third and fourth, metacarpal or metatarsal bones, that is, between the cannon bone and either the inside or outside splint bones respectively. When tearing of this ligament occurs due to injury, faulty conformation or faulty nutrition, an inflammation of the outside lining of the splint bone and/or cannon bone occurs. Growth of the splint depends on the amount of original damage and whether the cause has been removed or is continuing to irritate the affected area.

Conformation and Hind limb

- Level of croup
- Length of hip
- Angle of hock

Hindquarters—from Rear

- Angle of hocks from behind
- Hindquarters should appear square
- Widest from stifle to stifle
- Quantity of muscle will vary by breed

Conformation defect in relation to the hind limb

- Sickle—hocked : When viewed from the side, there is excessive angulation of the cannon and hock, the horse appears to be standing with the cannon angled forwards under its body. This predisposes foals and yearlings to 'curb' and bone spavin. This is a serious defect and as there is some evidence it is heritable, efforts should be made to cull those horses from breeding stock.
- Post—legged : The hind limb can be too straight, to such an extent that the femur and tibia appear to have very little angulation. The area over the stifle joint appears dimpled and the patella is easily rocked in and out of position. This condition predisposes to locking patella, bog spavin.
- Cow—hocked : When viewed from behind, the hocks are closer together than normal and usually the lower limb is also displaced laterally (outwards). In adult horses, this condition may predispose to articular problems and lead to 'bone spavin'.

Foot conformation

- Foot Axis = Angle of the dorsal hoof wall
  - ~47-57° forelimb
  - ~55-60° hind limb
- Pastern Axis
  - Line drawn through the center of pastern
- Foot/Pastern Axis
  - Line through the center of the coffin and pastern joint
- Foot Level
  - Median and lateral wall of equal length

Pastern problems

- Horses that have pasterns deviating from normal conformation usually have difficulties if asked to perform heavily either as endurance, racing, jumping or eventing horses.
- The pastern may be **short and upright**, even to the point of being almost perpendicular. This leads to severe concussion of the joint surfaces of the fetlock, pastern and pedal joints and often leads to increased joint fluid effusion, which shows as distension of the joint capsules and also lameness. This is not an uncommon lameness in heavy young horses given too much exercise when immature.
- Where the pastern is **long and sloping** the joint surface can again be damaged, particularly the front of the fetlock joint and the front of the lower end of the cannon bone. There is usually damage to the flexor tendons and sesamoidean ligaments, often with lameness causing increased tendon sheath enlargement.

Abnormal conformation of feet

- Flat feet : Feet lacks normal concerting in sole.
- Dropped sole/pumiced foot: If sole has dropped to or beyond level of bearing surface of hoof wall.
- Contracted foot/contracted heels foot becomes barrower than normal
- Brittle feet associate with dryness of atmosphere; lack of moisture in soil.

- Ring in the wall of foot.
- Club foot : Foot axis of 60 degrees or more with Unilateral mesh. Unfit for saddle use due to intensive rough gait.
- Coon-foot : More sloping angle to be pastern due to broken foot and pastern axis at coronary band.

Relationships of "form to function"

- Long, sloping shoulders correlated with long, sloping pasterns
- Long, trim necks and clean throatlatches—balance, agility and ability to work off hocks
- Depth of heart and spring of rib—lung capacity and endurance
- Long muscles moves a limb further

Structural features that enhance action

- Long forearms—long strides
- Sloping shoulders and sloping pasterns of front leg—graceful, elastic stride
- Toe straight ahead in front—truer action

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CHAPTER

2

Lameness

Lameness : An abnormality of gait that is caused by pain and/or restriction of movement. Lameness is any alteration of the horse's gait. Such abnormalities can be caused by pain in the neck, withers, shoulders, back, loin, hips, legs, or feet. Identifying the source of the problem is essential for proper treatment.

Lameness is one of the most common problems encountered in equine practice and is a major cause of wastage, poor performance and economic loss in athletic horses. Lameness typically results from pain associated with the musculoskeletal system, including abnormalities with joints, bones, tendons, ligaments and muscles. The majority of cases of lameness are localized to areas within the distal limb; however, the sources, causes and locations of lameness are diverse. Lameness can be caused by numerous and diverse conditions, including but not limited to wear-and-tear, overuse, and trauma.

Classification

The following standardized grading scale has been developed and adopted by the American Association of Equine Practitioners (AAEP) for evaluating the degree of lameness in horses:

Grade 0 : Lameness not perceptible under any circumstances.

Grade 1 : Lameness is difficult to observe and is not consistently apparent, regardless of circumstances (*e.g.* weight carrying, circling, inclines, hard surface, etc.).

Grade 2 : Lameness is difficult to observe at a walk or when trotting in a straight line but consistently apparent under certain circumstances (*e.g.* weight carrying, circling, inclines, hard surface etc.).

Grade 3 : Lameness is consistently observable at a trot under all circumstances.

Grade 4 : Lameness is obvious at a walk.

Grade 5 : Lameness produces minimal weight-bearing in motion and/or at rest or a complete inability to move.

Classification based on the character of the presenting symptoms.

- **Supporting limb lameness :** when the foot first contacts the ground or when the limb is supporting weight (stance phase).
- **Swinging limb lameness** shows symptoms as stiffness or reduction of flexion and extension during forward movement. This lameness is evident when limb is in motion.

Pathological changes involving joint capsules, muscles and/or tendons are considered to be causes.

- **Mixed lameness** is evident when the limb is moving (swing phase) and is supporting weight. Mixed lameness can involve any type of combination of the structures affected in swinging or in supporting leg lameness.
- **Complementary/compensatory lameness :** when pain in a limb causes uneven distribution of weight on other sound limb(s) and produce lameness. Complementary lameness in the same limb usually results when excess stress occurs to an otherwise healthy structure as a part to protect the painful region in that limb.

General information on locomotion

Stride-single step of one foot.

Gait-repetitive limb coordination pattern used in locomotion.

- asymmetrical-limb movements of one side do not repeat those of other side (canter, gallop).
- symmetrical-limb movements of one side repeated by opposite side (trot, pace).

Stance Phase—foot on ground.

- Restraint Stage—anterior part of foot fall (deceleration).
- Midstance position—forelimb: metacarpus is vertical, hind limb: hoof under hip joint.
- Propulsion stage—posterior part (acceleration).

Swing Phase—foot lifted and brought forward.

- Stride Length—distance hoof moves during one stride cycle.
- Stride Frequency—number of strides per unit time.
- Timing of Gaits is controlled by central nervous system.
- Vertical Force between hoof and ground.
  - maximum—double body weight of horse.
- Increased Speed—increased frequency or increased stride length.
- Dressage—maintain same tempo with increase or decrease stride length.

Causes of Lameness

The basic processes that cause disease can be remembered by using the acronym **DAMNIT**

D : degenerative, developmental
A : allergic, autoimmune
M : metabolic, mechanical
N : neoplastic (tumors), nutritional
I : infectious, inflammatory, immune-mediated, ischemic (low blood flow), iatrogenic, idiopathic
T : traumatic, toxic

Most causes of lameness fall into the following categories :

- Degenerative *e.g.* degenerative joint disease (DJD, or osteoarthritis).
- Developmental *e.g.* osteochondrosis (OCD), physitis (epiphysitis).

- Metabolic *e.g.* laminitis (founder), exertional rhabdomyolysis (tying up).
- Mechanical *i.e.* overload of a structure—either sudden, massive overload or repeated, marginal overload (wear and tear).
- Infectious *e.g.* foot abscess, infected wound, cellulitis, joint infection.
- Inflammatory—most of the specific causes of lameness have an inflammatory component
- Traumatic *i.e.* injury (external trauma).

Other possible sources of lameness. Also consider these other possible sources of lameness:

- Skin.
- Nervous system (brain, spinal cord, nerves).
- Tack (especially the saddle).

Rider (bridle lameness or rein lameness).

Diagnosis of lameness

Locating the specific area involved requires two basic tools: our eyes and our hands.

(i) Signalment and history

- Breeds and ages of horses
- Past medical history
- Past and present use of the horse

(ii) Physical examination

A complete physical examination and lameness evaluation including visual observation of the body and limbs for symmetry, swellings, stance and other abnormalities is performed. The three skills required are observation, palpation, and manipulation.

Observation

Observation is the key to identifying which is the lame leg :

- Abnormal stance-*e.g.* pointing the toe, resting one leg more than another, dropped fetlock.
- Abnormal movement-head nod (forelimb lameness), hip hike (hind limb lameness).
- Reduced arc of foot flight-often seen as stiffness or reluctance to flex the limb normally.
- Shortened stride length-shortened 'swing' phase of the stride.
- Abnormal foot placement-*e.g.* landing toe-first to spare the heel.
- Look for symmetry between left and right legs, and between the inside and outside of a normally symmetrical structure.
- When asymmetry is found, is it caused by enlargement (*e.g.* swelling) or reduction in tissue mass?

Palpation

- Feel for heat, swelling, pain, and changes in tone or texture of a tissue.
- Characterize any swellings as hard, firm, soft and fluid-filled.

Manipulation

- move the structure or tissue through its normal range of motion.
- Check for pain, altered range of motion (increase or decrease), and crepitus (a grating, grinding, or crackling sensation).

Use these skills to identify the five basic signs of inflammation :

- Pain
- Swelling
- Heat
- Redness
- Loss of function

Investigating specific areas

The Foot-the most common site of lameness.

- ***Observation***—symmetry of the hoof wall; integrity of the hoof wall (cracks, bulges, etc.) and sole (defects, foreign objects, etc.); discharge, discoloration, or odor; shoe and nails.
- ***Palpation***—coronary band (pain, swellings, depressions); heel bulbs; sole (thumb pressure); digital pulses (at fetlock or pastern).
- ***Manipulation***—move the heels independently; tap the hoof wall; use hoof testers (if you have them).

Joints

- ***Observation***—swelling, position (angulation).
- ***Palpation***—nature of the swelling, heat, pain.
- ***Manipulation***—flex (bend) and extend (straighten) the joint, checking for pain and altered range of motion.

Bones

- ***Observation***—swelling.
- ***Palpation***—nature of the swelling, heat, pain.
- ***Manipulation***—pain, instability, crepitus.
- ***Tendons and Ligaments.***
- ***Observation***—swelling.
- ***Palpation***—swelling (subtle swelling may not be obvious to the eye), location of the swelling (within or around the structure), heat, pain, change in tension and texture—if possible, also palpate the sites where the structure attaches to bone.
- ***Manipulation***—pain, instability of the associated joint.

Muscles

- ***Observation***—swellings or atrophy (loss of muscle mass).
- ***Palpation***—pain, change in tone and texture, crepitus, heat or coolness.
- ***Manipulation***—pain, reduced range of motion in the associated joint(s).

Neck and Back. The neck and back consist of a complex series of bones, joints, tendons, ligaments and muscles:

- ***Observation***—symmetry, posture, contour.
- ***Palpation***—nature of any swellings, pain, change in muscle tone and texture.
- ***Manipulation***—pain, reluctance to flex or extend, reduced range of motion.

Additionally, the patient's behavior and attitude along with temperature, respiratory rate, and heart rate and rhythm are evaluated in horses with lameness, especially those with acute onset severe lameness.

Initially the horse is visually evaluated from a short distance from the front, rear and both sides to assess for asymmetry associated with swellings or muscle atrophy (indicative of a chronic

problem). This is further facilitated by careful palpation of the limb(s) both with the horse bearing weight on the leg and with the leg held off the ground. We have to run our hands up and down the limbs palpating for fluctuant swellings (effusion in joints, tendon sheaths and/or bursa, subcutaneous swellings, etc.), firm swellings (such as bony exostoses, mineralized or fibrotic soft tissue etc.), heat and pain on manipulation. Effusion in a joint or tendon sheath typically suggests an inflammatory response such as synovitis or tenosynovitis associated with trauma, infection, or other type of condition. Flexing and extending the joint, and comparing this with findings on the opposite limb, is used to assess range of motion. Subtle pain during manipulation of the joints or palpation of tendons, ligaments or bone may suggest involvement of those structures.

Hoof testers are applied to different areas along the entire circumference of the foot to assess sensitivity to pressure. A positive response to hoof testers could suggest a subsolar abscess, bruising, laminitis (founder), a fracture of the third phalanx (coffin bone) or navicular bone, navicular disease or other abnormalities of soft tissue and bony structures within the hoof. During the examination, conformational faults, angular or flexural limb deformities or abnormalities of the horse's stance are noted.

LAMENESS EVALUATION

Evaluate the horse's gait

- on a level, even surface
- at the walk and the trot
- in a straight line and in a circle (led, lunged, or in a round pen)
  - make sure the horse is on a loose lead or lunge line
  - watch the horse in both directions on the circle
- from the side, in front, and the rear
- on different surfaces (*e.g.* hard and soft)

Bear in mind that there may be a problem in more than one leg.

The horse is evaluated at a walk to assess the presence and magnitude of any gait abnormality or lameness. The more severely lame a horse the more noticeable will be the lameness at a walk. The horse is then evaluated at a trot (jog), which is typically the optimal gait for detection of lameness. The horse is observed from the front and back while they are moving to and from the examiner as well as from both sides. The amount of weight bearing, the length of stride, the flight and landing of the feet, and the carriage of the head and neck are evaluated.

Once the lameness has been graded based upon baseline walking and jogging, then the horse's limbs may be stressed by longing the horse or jogging it in circles to both the left and right, flexing individual joints (usually for 60 seconds), reapplying hoof testers, or other perturbations to try to exacerbate the lameness in order to help localize the source of the pain (lameness).

Interpretation of findings

1. The pain response must be repeatable to be valid.
2. Assuming the opposite leg is normal; use it for comparison if unsure that your findings are significant.

3. Most lameness problems involve a structure in or below the knee or hock. A specific diagnosis often is not possible without thorough and advanced examination and diagnostic imaging.

Joint flexion tests

Hold the horse's limbs in a flexed position and then releases the leg. As the horse trots away, watches for signs of pain, weight shifting or irregular movement. Flexing the joints in this manner may reveal problems not otherwise readily apparent.

Perineural and intra-articular anesthesia

In order to definitively determine the location of the pain, it is usually necessary to perform **regional nerve blocks** or **joint blocks**, which involve temporarily desensitizing an area by injecting a local anaesthetic to determine if the pain is originating from that region and causing the lameness.

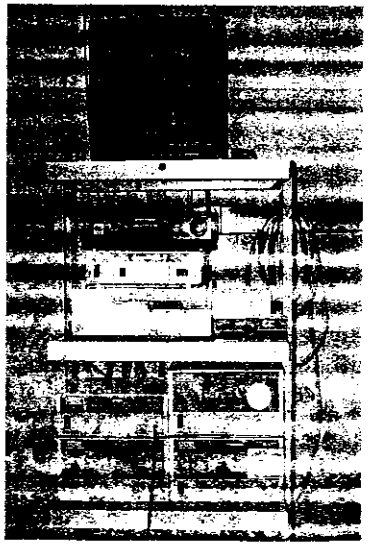
- Nerve blocks are performed sequentially starting from the lower limb and proceeding upward on the limb. These involve injection of a local anaesthetic agent adjacent to a peripheral nerves underlying the skin that block the heel, foot and pastern, fetlock region, and metacarpal/metatarsal region.
- Joint blocks are usually performed after these peripheral nerve blocks are completed and the lameness persists or if there is evidence suggestive of joint, disease based on the physical examination.
- Nerve blocks are performed after carefully cleaning the area with an antiseptic. On the other hand, joint blocks are usually performed after a small area of hair is clipped and effective cleansing with an antiseptic in order to prevent introduction of infection.

Advanced diagnostics

- **Synovial fluid analyses :** the white blood cell count and protein concentration and other characteristics of the fluid, and in cases where joint infection is suspected or present, can be submitted for bacterial culture and antibiotic susceptibility testing.
- **Radiography** is most useful for assessing bony abnormalities including degenerative joint disease (arthritis), osteochondral chip fractures, osteochondrosis (OCD or bone cysts), condylar fractures, navicular bone abnormalities, osteomyelitis (infection), and other abnormalities involving bone.
- **Ultrasonography** is typically most useful for assessing injuries or abnormalities of the soft tissue such as tendonitis, suspensory ligament despites other abnormalities of tendon, ligament or muscle; however, it can also be useful for assessing joints in certain circumstances.
- **Computed tomography (CT),** also referred to as CAT scan, provides a three-dimensional assessment of structures and is most useful for assessing abnormalities of bone. Currently, the modality is not widely available for horses and its use is affected by the fact that horses must be placed under general anesthesia and that only the distal limbs can be evaluated.
- **Magnetic resonance imaging (MRI)** provides a three-dimensional assessment of structures, especially soft tissues such as tendon, ligament, bursa, articular cartilage and joint capsule. Traditionally, MRI has required horses be placed under general anaesthesia,

which has limited its utility; however, newer equipment, technology and computer software has enabled this imaging modality to be used in standing, conscious (tranquilized) horses to assess the distal limb.

- **Nuclear scintigraphy,** also referred to as bone scan, can help identify subtle injuries or abnormalities of bone and even soft tissue. The procedure involves the injection of a labeled radioactive substance into the jugular vein of horses and then with the use of a gamma camera the uptake of the radioactive material into bone and soft tissue is imaged. Uptake of the radiopharmaceutical agent in the bone or soft tissue is usually compared to the same location on the opposite limb. An increased uptake is often referred to as a "hot spot". This imaging modality is most useful for acute onset lameness that can not be effectively localized with nerve/joint blocks. Nuclear scintigraphy is much more sensitive than radiography for assessing active areas of bony turnover, which are most often associated with stress fractures, infection or other types of bony injury. Horses remain radioactive for approximately 24 hours and therefore are required to be quarantined during this time to prevent contact of the radioactive material, which is excreted in the urine and feces, with people.
- **Thermography** is a technique in which a visual image is produced from infrared radiation emitted from the skin surface, which may be an indication of inflammation below the surface. The image is typically displayed in colors that correspond to different temperatures. This modality is sometimes used in lame horses to define the extent of a lesion of which a diagnosis has already been made, localize an abnormal area not previously identified so additional diagnostic tests can be performed or detect early lesions before they become clinically relevant. The main limitation of this modality is the nonspecific information that thermography yields.
- **Arthroscopy** involves the use of a rigid scope and camera system to effectively evaluate the inside of a joint of tendon sheath. Although this modality is used principally for therapeutic purposes, such as removing osteochondral chip fractures, treatment of osteochondrosis lesions (OCD or bone cysts) and other conditions involving joints or tendon sheaths, it can be used for diagnostic purposes. Diagnostic arthroscopy is indicated in horses in which the lameness is localized to a specific joint or tendon sheath by intra-articular anesthesia (joint block), but in which no specific diagnosis can be made with other diagnostic imaging techniques. It is not uncommon for horses with lameness localized to the carpus, stifle, fetlock and hock to have lesions involving cartilage, intra-articular ligaments and even incomplete bony fractures even when standard diagnostic imaging reveals no abnormalities.



Arthroscopy unit

- With subtle gait abnormalities, ancillary diagnostic techniques that might be used. **Videotaping** the horse and then replaying the video in slow motion, **evaluation of the horse jogging across a force plate**, or use of a **kinematic gait analysis system.**

General method of therapy

- Rest
- Thermotherapy
- Radiant heat
- Conductive heat
- Conversive heat
- Shortwave/ ultra short wave diathermy
- Inductotheramy
- Microwave diathermy
- Ultraviolet radiation
- Ultrasonics
- Hydrotherapy
- Hydrokinetic measure : 1. Massage 2. Counter irritation 3. Actual cannery 4. Aspiration injection
- Exercise

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CHAPTER

3

Shoulder Slip, Bicipital Bursitis, Omarthritis, Caped Elbow, Radial Paralysis, Carpitis, Bent Knee, Knuckle Knee

SHOULDER SLIP/SWEENY/SUPRASCAPULAR NERVE INJURY

It refers to suprascapular nerve injury resulting in atrophy of the supraspinatus and infraspinatous muscles, leading to instability of the shoulder joint.

Etiology

- Trauma to the suprascapular nerve (passes from the cranial thin border of the scapula) which is the most susceptible to direct trauma and compression against the underlying bone.
- Chronic nerve compression caused by constriction of the small tendinous band resulting in subclinical neuropathy.
- Overstretching of the suprascapular nerve due to sudden thrust backward.
- Fracture of the supraglenoid tubercle.

Signs

- Clinical sign depends on the extent of the nerve damage and the duration of the condition.
- Pain and reluctant to bear weight in the affected limb in acute condition.
- In chronic phase, lateral instability of the shoulder joint during weight bearing.

Diagnosis

- History of trauma.
- Clinical signs.
- Fracture of the supraglenoid tubercle by radiography.
- Electromyelography confirms selective suprascapular nerve injury.

Treatment

- Reduce the inflammation (NSAIDs, DMSO)in the region of the suprascapular nerve.
- Stall rest.
- Cold hydrotherapy.
- Acupuncture.
- Surgical decompression of the suprascapular nerve.

Prognosis : Favourable.

BICIPITAL BURSITIS

Inflammation of the intertubercular (bicipital) bursa is called bicipital bursitis. This condition may affect in the horses of any age, breed and sex. The bicipital bursa is located between the bilobate tendon of the biceps brachii muscle and the M-shaped tubercles at the cranio-proximal aspect of the humerus. The synovial membrane extends around the axial and abaxial limits of the tendon and onto the margins of its cranial surface.

Etiology

- Trauma (kick, blunt trauma, penetrating or laceration wound, fall or slip) to the cranial surface of the shoulder region may cause primary bursitis.
- Stretching or tearing during training/racing.
- Infection from open/penetrating wound, haematogenous spread (*Brucella abortus*) to the bursa may lead to septic bursitis.

Signs

- Acute onset of lameness (grade 3 or 4).
- Physical examination: swelling and pain over the cranial aspect of the shoulder region with or without wound.
- In chronic case: generalized shoulder and pectoral muscle atrophy.

Diagnosis

- History.
- Clinical signs.
- Radiography to rule out osseous changes in the tubercle and biceps tendon, fracture of the supraglenoid tuberosity or proximal humerus. Mediolateral, craniomedial-caudolateral oblique and flexed cranioproximal-craniodorsal (Skyline) view of the cranial shoulder region may help to assess the condition of bicipital bursitis. If only bursa is involved, no abnormalities will be detected. In chronic phase, common radiographic features are mottled changes in the tubercle, demineralization of the greater tubercle, osseous densities in the periarticular region, osteitis in the bicipital groove and calcification of bursa (advance stage).
- USG of the bilobate tendon of the biceps brachii muscle. Common features are : edema or haemorrhage in the biceps tendon or bursa, disruption of the tendon architecture with peritendinous thickening, an irregular surface of the bicipital groove and hyperechoic material in the bicipital bursa.
- Cytological examination of synovial fluid from the bursa.
- Nuclear medicine may be useful to detect early infection or active remodelling changes.

Treatment

- **Conservative treatment :** Rest followed by controlled rest, parenteral administration of NSAIDs, topical application of dimethayl sulfoxide, intrasynovial injection to the bursa with corticoids and sodium hyaluronate.
- **Surgical treatment :** Incisional and arthroscopic approach may be advocated to remove fractured part, to remove proliferative, malacic bone and necrotic soft tissue and any fibrin should also be removed. In case of infectious bursitis, arthroscopic drainage and lavage is very useful. In chronic case, surgical debridement and synovectomy are needed. Parenteral administration of broad spectrum antibiotics and NSAIDs is also required. Use of therapeutic ultrasound 14 days after surgery is proven beneficial.

OMARTHRITIS

Arthritis of the scapulohumeral joint is called **Omarthritis**. It is relatively uncommon. Performance horses are more susceptible to this condition. Prognosis is favourable if radiographic lesion is not evident.

Etiology

- Developmental origin.
- Articular fracture and/or cartilage lesion due to trauma.
- Injury to the joint capsule.
- Shoulder dysplasia.
- Osteochondrosis of the shoulder joint.

Signs

- Mild swelling of the shoulder joint.
- Disuse atrophy of the extensor carpi radialis.
- Flexion, extension, adduction and abduction may cause a painful response.
- Degree of lameness varies with the severity of the condition.
- Intrasynovial anaesthesia of the shoulder joint usually localize the lesion.

Diagnosis

- History and clinical signs.
- **Radiography** can detect the bony or subchondral lesion.
- **Ultrasonography** helps to diagnose the involvement of the soft tissue support structures surrounding the shoulder joint.
- **Nuclear medicine** is a sensitive tool to identify the area of increased bone metabolism.
- **Arthroscopy** is one of the most valuable technique to visualize the condition and as well as to do the needful as per the needful (debridement, removal of chip fracture, lavage) of the condition.

Treatment

- Rest (up to 3 months) followed by controlled exercise.
- Administration of anti-inflammatory drugs.
- Intrasynovial administration of corticosteroid and sodium hyaluronate.
- Arthroscopic maneuver.

CAPPED ELBOW (Bursitis of the point of the elbow; Olecranon bursitis; Shoe boil)

Etiology

Trauma (acquired bursitis) caused by the shoe on the affected limb hitting the point of the olecranon tuberosity incite accumulation of trasudative fluid under subcutaneous tissue which become encapsulated by fibrous tissue and a synovial like membrane produces the synovial fluid.



Capped elbow in a buffalo

Signs

- Appreciable, freely moveable swelling over the point of the elbow.
- Usually lameness is not evident.
- Infected bursa is generally feel hot and often manipulation is painful.
- If the infected bursa ruptures, discharging sinus followed by exuberant granulation and formation of fibrous tissue is obvious.

Treatment

- Prevention of further trauma may elicit spontaneous recovery.
- Injection of corticosteroids 2-3 times at weekly interval.
- Bursal drainage followed by administration 7% iodine solution is useful in chronic condition.
- Use of copper sulphate and magnesium sulphate powder for chemical debridement is sometime used.
- En bloc resection of the bursa is the ultimate choice. In standing sedation with ring block anaesthesia, curved incision is made in the lateral aspect of the mass. After blunt dissection, the mass is removed. Excess skin may be also removed if needed. Deep and subcutaneous tissue is sutured with synthetic absorbable suture material. Skin is sutured by placing interrupted widely placed vertical suture.

PARALYSIS OF RADIAL NERVE

The largest branch of the brachial plexus, the radial nerve innervates the extensor muscles of the limb and ulnaris lateralis muscle. Radial nerve paralysis results inactivation of these group of muscle.

Etiology

- Trauma to the shoulder region (hyperextension of the forelimb, extreme abduction).
- Fracture of the humerus.
- Neoplasm or soft tissue involvement in and around radial nerve.
- Enlargement of axillary lymph node.
- Prolonged lateral recumbence.

Signs

- Depend on degree and location of nerve insult.
- In acute phase, animal fails to bear weight on the affected limb.
- Dropped elbow appearance.
- Limb appears longer than the normal.

Diagnosis

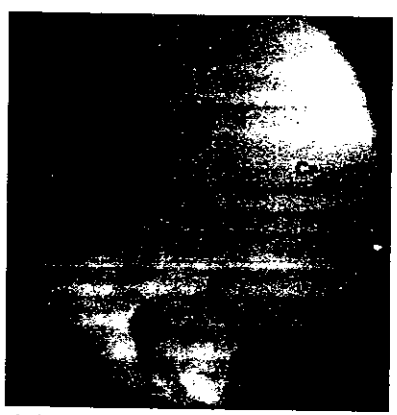
- History and clinical signs.
- Differential diagnosis to rule out rupture of the medial collateral ligament of the elbow, elbow arthritis, Myopathy of the biceps brachii, triceps brachii, anconeous and extensor carpi radialis muscles.

Treatment

- Administration of NSAIDs.
- Stall rest with deep bedding material.
- Application of bandage splint (PVC) in the caudal aspect of the limb from the proximal ante brachium to the fetlock.
- Controlled exercise.
- Nerve stimulation by physical medicine.

CARPITIS (Popped knee)

It is an acute or chronic inflammation of the carpal joint involving synovial membrane (synovitis) and fibrous joint capsule (capsulitis), the associated ligaments of the carpus and the bones of carpus.



Arthroscopic image of chronic synovitis in horse

Etiology

- Concussion and trauma.
- Common in race horses due to unplanned training.
- Poor conformation.
- Paring and hitting a wall with the carpus.

Signs

- Lameness with shortening of the cranial stride.
- Variable size of swelling, predominant on the anterior surface of the bones.
- Pain of palpation.
- Positive carpal flexion test.

Diagnosis

- History and clinical signs.
- Carpal flexion test.
- Radiographic examination-enthesiophytes formation.

Treatment

- Rest.
- Immobilization by pressure bandage (if destabilization injury is evident).
- **Physical therapy :** Hydrotherapy does well. Cold hydrotherapy (application of ice) is beneficial in acute injury. Hot hydrotherapy is useful to relieve pain and tension in inflammed tissue. Swimming is useful during convalescent period.
- Application DMSO alone or mixed with corticosteroid is helpful to reduce soft tissue swelling and inflammation resulting from acute trauma.
- Joint lavage by using conventional needle technique or arthroscopy.

BENT KNEE

The condition is developed due to over-flexion of the knees as a result of contraction of the tendons of the flexor metacarpi muscles, specially the externus and medius. It may be congenital or acquired due to constant hard work. In severe cases, it interferes with joint function.

Clinical signs

- Abnormal conformation at knee.
- Lameness.

Treatment

Severe cases need tenotomy.

Section of the flexor metacarpi externus:

Technique

- Cast the animal with affected limb uppermost. Apply two ropes or webs on the limb, one on the upper part of the forearm directed backwards and the other on the hoof directed the opposite way.
- Incise the skin and aponeurosis.
- Push the curved tenotome flatwise beneath the tendon as far as its posterior border and then turn the edge towards the tendon.
- Whilst the assistant pulls on the ropes, cut the tendon from before backwards without incising the skin.
- Operate on the medius in the same way through a narrow incision at its anterior border.

Prognosis : Good.

KNOCK KNEE (Medial deviation of the carpal joint/carpus valgus)

This condition develops due to abnormalities of the distal metaphysis, physis and epiphysis of the radius, abnormal development and alignment of the carpal bones and small metacarpal bones or from carpal joint laxity. Thus, medial collateral ligament undergoes increased tension, which again puts pressure on the carpal bones and ultimately varying degree of outward rotation of the large metacarpal bone takes place. Carpus valgus of 5 to 7° associated with asynchronous growth of the distal radial metaphysis usually corrects itself with maturity.

Plaster cast or splint is needed at early age to correct other conditions.

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CHAPTER

4

Hygroma, Open Knee Joint, Blemished Knee, Fracture of Carpal Bone, Accessory Carpal, Contraction of Digital Flexors

HYGROMA OF KNEE

Hygroma may be defined as swelling over the dorsal surface of the carpus, which may be lined by cells that secrete a fluid. It is commonly acquired in nature and cause pseudoarthritis resulting from trauma. Extensor carpi radialis and common digital extensor tendon may also be involved.

Etiology

- Trauma.
- Lack of bedding materials.
- Pawing and hitting the carpus on hard ground.

Signs

- Swelling of varying degrees and shapes over the dorsal surface of carpus.
- Palpation and flexion of joint is generally not painful.

Diagnosis

- Needle drainage and cytological examination.
- Acute hygroma: serous type fluid.
- Chronic hygroma: fluid like synovial fluid.
- Arthrography.
- Ultrasonography helps to rule out different other disease.



Hygroma of knee in cow

Treatment

- Injection of corticosteroids.
- Counter pressure with elastic bandage.
- Open and drain the hygroma, Tr. Iodine may be injected (intra-articular).
- Immobilization by using splint.
- Surgical excision of thickened synovial membrane.

OPEN KNEE JOINT (Broken knee, Traumatic arthritis)

Wounds superficial or deep on the front of the knees are termed as broken knee. Once a knee is deeply "broken", the horse is generally prone to fall on it again, owing to the cicatrix impeding the freedom of movement in the joint, and probably to the animal's knee action being naturally defective. The posterior aspect of the carpus is sometimes wounded by the horse getting the limb over the tying-up chain and making efforts to release it.

Clinical signs

- Superficial wounds on the front of the knee do not cause severe lameness, but those on its posterior aspect cause much pain during movement, being more affected by flexion and extension of the joint.
- Synovial discharge from the wound when a tendon sheath or joint is open.

Treatment

- Make a counter-opening over the pocket beneath the skin to provide drainage. Irrigate the wound with antiseptic solution until it is uniformly granulating. Use of dry astringent dressing is recommended.
- Sometimes, suturing may be helpful to keep a displaced flap in position. When suturing is done, a gutter splint, with padding beneath at the back of the knee is applied to prevent tearing of the sutures through skin margins.
- When the synovial fistula is slow to heal, the application of blister or cauterization may be tried.
- When the joint is open, septic arthritis may develop and treatment includes irrigation, drainage and antibiotic therapy.

Prognosis : Depends on the nature of the wounds. Superficial wounds may heal without much problem. Deep wounds heal with blemished knee. In septic arthritis, the prognosis is generally poor.

BLEMISH KNEE

Wound on the knee heals by secondary intension leads a large scar that is termed as **blemish knee**. It affects the cosmetic appearance of the animal and in severe cases, may interfere with joint function.

Treatment

Surgical removal of the scar is the only effective therapy.

- Cast the animal with hobbles and fix the affected limb to a rigid bar leashed to the limb above and below the knee under general anaesthesia.

- Make an elliptical incision with its long axis parallel to the limb, enclosing the scar.
- Dissect out the latter along with the portion of the skin included within the incision, taking care not to damage the synovial sheaths or joint capsule.
- Make two other longitudinal incisions, one on either side of the wound, about equal in length to the latter or about ¾ inch there from to facilitate its edges being brought together.
- Suture the central wound with silk.
- Cover the knee with antiseptic dressing.
- Immobilize the joint by means of a gutter splint applied to the back of the limb from the fetlock to the elbow region with plenty of padding beneath.
- Keep the horse in slings until the wound is cicatricised.
- When there is no severe inflammation, leave the dressing undisturbed for 8-10 days, and then remove the dressing.
- Remove the sutures in 15-20 days.
- Maintain the immobilization devices in position for at least 3 weeks to avoid rupture of the cicatrix.

Prognosis : Good.

FRACTURE OF THE CARPAL BONES

Fracture of the radial carpal bone and third carpal bones are most common. Common fracture type is chip fracture and slab fracture.

Etiology

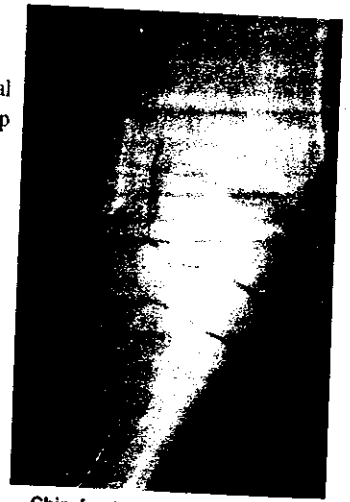
- Trauma.
- Over extension of the limb.

Signs

- Severe lameness.
- Heat, pain and swelling of carpal joint.
- A hard, prominent swelling of carpal joint.

Diagnosis

- Radiography.
- Carpal flexion test.



Chip fracture of carpal bone in horse

Treatment

Surgical manoeuver is warranted to remove loose fragments. Fixation by placement of bone screws is performed to treat slab fracture. Arthroscopic surgery is the minimal invasive technique and the current trend of practice.

FRACTURE OF THE ACCESSORY CARPAL BONE

Fracture of the accessory carpal bone occurs due to external trauma often fractures.

Signs

- Moderate signs of lameness.
- Animal may not put full weight in the limb.
- Crepitation in early stage.
- Distension of the carpal sheath.
- Pain on palpation.

Treatment

- Rest for 3-6 months.
- Immobilization of carpus by plaster of paris.

CONTRACTION OF DIGITAL FLEXORS TENDONS (Contracted tendon)

In this condition, various flexural deformities in the limbs may occur which is considered to be congenital or acquired.



Flexural deformity in a calf

Etiology

- Uterine malpositining of the foetus.
- Genetic effects and teratogenic insults during embryonic stage of pregnancy.

Clinical signs

- One or more limb may be affected.
- Fetlock and carpal flexural deformities are common.
- Generally, both superficial flexor digital and deep digital flexor muscle-tendon units are shortened.
- It is also hypothesized that suspensory ligament is the primary structure involved.
- Involvement of deep digital flexor tendon alone may manifest as a flexural deformities of the carpus.
- Sometime contracture of the carpal fascia and palmar ligament seems to be the primary component.

Treatment

- Some foals with mild congenital flexural deformities (particularly at the level of carpus) improve spontaneously.
- Most of the flexural deformities at the level of fetlock respond well to splinting. PVC pipe may be used. Desired conformation may be achieved by heating the pipe.
- With severe deformities, straight splint is used. As the condition improved, splint may be configured.

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CHAPTER

5

Splints, Sore Thin, Tendinitis, Wind Puffs, Seasamoiditis

SPLINTS

Background anatomy : The second and fourth metacarpal/metatarsal bones are called **splint bones.** Each is attached intimately to the respective third metacarpal or third metatarsal bone by an Interosseous ligament (consist of dense fibrous tissue), thus splinting the large bone. Exostosis of splint bones (small metacarpals/metatarsals) most commonly at the proximal medial aspect **because of localized osteoperiostis is called "Splints".**

Incidence

- Young horse below 5 years (most common in 2 years old) and those are newly put to work.
- More common in fore limb.

Common site : Medial aspect of fore limb (because 2nd MC bears more weight than 4th one) and lateral aspect of hind limb.

Classification

- **Simple splint :** single exostosis on splint bone (2nd, 4th MC, MT).
- **Chain splint :** several small exostosis in a row on splint bone.
- **Knee splint :** upper 3rd splint approach knee joint.
- **Rod splint (peg splint) :** on posterior aspect of cannon bone between bone and suspensory ligament.
- **Jack splint :** large exostosis on metacarpal bone.
- **Spongy splint :** uniform thickening of splint bone due to metabolic disorder.
- **True splint :** develop due to sprain or tear of the Interosseous ligament and seen mostly at 6-7 cm below the carpus.
- **Blind splint :** develop due to inflammatory process of the Interosseous ligament.

Predisposing factor

- Hereditary.
- Conformation abnormalities (Offset carpi, base narrow and toe out) increase the stress on the small MT/MC bones.

- Improper hoof care.
- Mineral imbalance (deficiencies and imbalance of calcium and phosphorus).

Etiopathogenesis

Training and subsequent injury to the interosseous ligament in young aged performance horse incite inflammation or tearing of the ligament. This will lead to proliferation of fibrous tissue and osteoperiostitis. It will eventually result in ossification (proliferative exostosis). The size of the splint usually depends on the degree of inflammation and the surface area involved.

Signs

1. Marked lameness while trotting.
2. Marked lameness on hard ground.
3. Marked lameness down hill than on let ground.
4. Heat, pain and swelling over the affected region.
5. Existence of growth by palpation.

Diagnosis

- History and clinical signs.
- Palpate the splint bones both in standing position and with limb flexed at knee and inflexed.
- **Radiographic examination** : Periostitis of the splint bone.
- **Ultrasound examination** to understand the concomitant injury to the suspensory and ligament impingement.

Prognosis

- Rod/peg splint cause permanent lameness.
- Knee splints is incurable.
- horses below 6 years with splint is considered unsound.
- In old horses, exostosis without lameness not unsoundness.

Treatment

Acute phase

- Anti-inflammatory drugs (NSAIDs, corticosteroids, DMSO) either systemic or local coupled with hypothermia (application of ice) and pressure support wraps.
- Rest.

Chronic stage

- Counter irritation to convert a low—level inflammatory process into an acute phase. This can be done by—
  - *Needle-point firing* is still in use in race horses. Avoid in show horse.
  - Local injections of sclerosing agents.
  - Blistering by application Bin Iodide of Mercury.
- Surgery.
  - Periosteotomy.
  - Subperiosteal removal of the exostosis.

Prevention : Use of shin or splint boots (Guards).

SORE SHIN (Buck shin)

Osteoperiostis involving cranial aspect of large metacarpal and large metatarsal bones are called **sore shin** or **buck shin.**

Incidence

- Young performance horses below 3 years.
- Mostly fore limbs are affected.

Causes

- High strains (high-speed exercise) that induce low-cyclic fatigue of bone (cannon bones are less stiff in early age), resulting in microdamage. Body responds to bone remodelling.

Symptoms

- Acute onset, most obvious after intense exercise.
- Minimal alterations of gait (after short rest).
- Visible convex swelling overlying the surface of the affected portion (cranial aspect) of the cannon bone.
- Pain on palpation.
- In chronic condition, mineralization takes place which leads to exostosis.
- No lameness after exostosis.

Diagnosis

- Clinical findings and age relationship.
- Radiographic examination.

Views

- Dorsopalmar view.
- Lateromedial view.
- Dorsopalmar lateral medial oblique (DPMLO).
- Dorsopalmar medial lateral oblique (DPLMO).

Observation

- In acute dorsal metacarpal affection—no abnormalities.
- In sub acute conditions : Periosteal new bone formation and surface cortical bone absorption.
- In chronic conditions : thickening of the dorsomedial cortex with associated periosteal new bone formation. Occasionally, endosteal reaction may be noted.

Treatment

- Rest
- Cold and astringent application during acute stage
- Anti-inflammatory drugs in acute phase are useful.
- Blistering in chronic case.
- Periosteotomy.

TENDINITIS

Tendinitis, truly, defined as the strain induced inflammation-involving tendon that is surrounded by paratendon and not tendon sheath. If tendon sheath is involved it is called **'tendosynovitis'**. In horses, it refers generally to inflammation of the flexor (superficial digital and deep digital) tendon.

Sites of sprain

- Superficial Digital Flexor (SDF) tendinitis : common in race horses. Forelimb is mostly affected. There may be minor tearing to complete rupture to the tendon.
- Similar findings may be also seen in deep digital flexor tendon (DDFT), suspensory ligament and carpal (distal accessory) check ligament.

Characteristic swelling on the posterior aspect of metacarpal/ metatarsal region resulting from tendinits and peritendinitis is called **Bowed Tendons.**

Etiology

- Defective confirmations (Sloping pattern), oblique hoof, slender fetlock, calf knees.
- Heavy draft breed.
- Slippery grounds.
- Muscular fatigue.
- Bad quality tendons (soft gummy tendon).
- Multiple episode of submaximal strain sustained during athletic performance that induce rodamage in tendon structure that predisposed the tendon to mechanical failure.
- Reperfusion injury.

Symptoms

Acute condition

- Local signs of pain, swelling, distension, thickening and heat.
- Lameness mild to severe and generally resolves in a few days of rest and treatment.
- Dropped fetlock.

Chronic stage

- Fibrosis and hard welling on the palmar or plantar aspect.
- Intermittent lameness.

Diagnosis

- Clinical examination.
- Ultrasonography can help in diagnosis and define the extent of damage. Loss of the normal intense echogenecity can be caused by fibriller disruption and inflammatory process (haemorrhage, edema and cellular infiltration).

Treatment

- Corrective shoeing adopted to pressure slope of pastern.
- Local and systemic anti-inflammatory therapy (NSAIDs, DMSO, corticosteroid), Cold hydrotherapy (Ice application, ice water slurry) and pressure bandaging in acute condition.
- Rest.

- Massaging of affected part.
- Counter irritation—needle points firing, Superficial line firing, Deep needle point firing.

WING PUFFS (Wind galls)

Definition : Distension of joint capsule, tendon sheath or palmar/plantar fossa due to synovial effusion, essentially in the fetlock joint in young horses under heavy training schedule, is called wind puffs or wind galls. This condition does not manifest lameness.

Idiopathic Synovial effusion is also observed in hock joint is called Bog Spavin (discussed later).

Signs

- Firm fluid swelling above, anterior to sesamoid bones between suspensory ligament and cannon bone, indicate articular Wind Gall of fetlock joint.
- Chronic cases—fibrosis of area.
- Do not cause lameness if alone but if accompanied by arthritis, bursitis, tendonitis, results lameness.

Diagnosis

- Clinical examination.
- Rule out OCD by radiographic examination.

Treatment

- Not required.
- Rest.
- Elastic wraps around swelling.

Prognosis : Favourable.

SESAMOIDITIS

Sesamoiditis is characterized by pain associated with the proximal sesamoid bones, at the insertions of the suspensory ligament or at the origin of the distal sesamoidean ligament resulting in lameness.

Incidence

- Race horse, hunter and jumper horses between 2-5 years (more common).
- Fore limbs are more affected.

Etiology

Injuries at the insertions of the suspensory ligament or at the origin of the distal sesamoidean ligament to sesamoid bones alter the blood supply to the sesamoid bone, thus remodelling starts. Numerous sensory nerve supplies elicit pain on manipulation.

Signs

- Pain, heat, swelling.
- Marked lameness after exercise.

Diagnosis

- Ciinical signs.
- Distal MT/MT nerve block.
- Radiography: mottled trabecular pattern.
- Nuclear scintigraphy: increased radioactivity (Hot spot) in the region of the sesamoid bones.

Treatment

- In **acute phase**—anti-inflammatory drugs.
- Alternate cold and hot pack.
- Rest.
- Firing and blistering in chronic stage.
- Radiation therapy, laser heat, shock wave therapy, balanced mineral diet.

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CHAPTER

6

Osselets, Ringbones, Quitter, Sidebones, Navicular Diseases, Pyramidal Disease, Fracture of Extensor Process

OSSELETS

Osselets may be defined as the thickening associated with synovitis and capsulitis of the fetlock joint due to trauma. In chronic condition ossification can develop. This term is less used now a day, practitioner use generally refers to synovitis or capsulitis as per degree and nature of involvement. "**Green osselets**" are referred to the acute stage of inflammatory process of this synovial capsule.

Etiology and pathogenesis

Single or multiple episode of trauma in young race horse may result in damage to the articular cartilage, intraarticular fracture. Redundant synovial membrane and its associated villi are also traumatized which results in synovitis. Capsulitis develop secondary to the synovitis, which is primarily involved in fibrous joint capsule at the attachment of the bone. Direct damage to the fibrous joint capsule develops with concussion of pulling on the fibrous attachment to bone. New bone growth appears at dorsal aspect of the third metacarpal/metatarsal bone and the proximal extremity of the first phalanx.

Clinical signs

- Signs of inflammation (pain and heat) present in acute phase.
- Synovitis characterized by synovial effusion, joint capsule distention (palmar/planter recess).
- Capsulitis located centrally over the dorsal aspect of the fetlock joint.
- Various degree of lameness.
- Periostitis in the area of attachment of lateral digital extensor ligament.
- New bone growth, remodelling in distal extremity of the metacarpal/metatarsal bone (radiographic feature).

Diagnosis

- Clinical signs and symptoms.
- Radiographic evaluation.
- Synovial fluid analysis (to rule out infective origin).
- Diagnostic arthroscopy.

Treatment

- **Rest** (hand walking is allowed) and immobilization by pressure bandage.
- **Physical therapy**
- **Hydrotherapy** (cold)/ice application is very useful in acute traumatic injury. After 24 hrs, hot hydrotherapy may be indicated to relieve pain and reduce tension in inflammed tissues. It also helps resorption of fluid due to vasodialatory effects and increased phagocytic activity.
- **Short wave diathermy** and **ultrasound** may be useful to produce deep heat in the tissues and to enhance vascularity and healing.
- Application of **DMSO** (Dimethyl Sulpfoxide) either alone or in combination of corticosteroid to reduce soft tissue swelling and inflammation. When DMSO is used as carrier, local antiarthritic property of hydrocortisone increases at least 10 fold.
- **Joint lavage** is useful to remove cartilaginous debris and deleterious mediators (form during inflammatory process). Conventional lavage by using two needles (12/14-gauge) may be practiced in field condition. However, arthroscopic lavage is the better option, which helps to visualize the condition of the synovial cavity (articular cartilage, villi, ligament etc.). After completion of the lavage, hyaluronan (chondroprotective drug) may be administered.

RINGBONE

Ringbone is described in general as any bony enlargement of the phalanges in the pastern region below the fetlock joint, which may lead to osteoarthritis (**Phalangeal exostosis**). This condition is more common in the active young race horse.

CLASSIFICATION

- **High Ring bone**—exostosis of the distal aspect of the proximal phalanx (P_1) and proximal aspect of the middle phalanx (P_2) with or without involvement of proximal interphalangeal joint (PIPJ).
- **Low Ring bone**—exostosis associated with distal aspect of the middle phalanx (P_2) and the proximal aspect of the distal phalanx (P_3) with or without distal interphalangeal joint (DIPJ) involvement.
- True (articular) Ring Bone—Exostosis at the interphalangeal joints.
- False Ring bone—Exostosis involving either the structures at the perimeter of the joint (periarticular) or at the shaft of phalangeal bone.

ETIOLOGY

- Hereditary (Defective confirmation)—horses with base-narrow and toe-in or toe-out is predisposed to develop ringbone.

- Direct trauma.
- Concussion.
- Sprain at articular ligament.
- Microfracture (due to stress or repeated micro trauma).

Symptoms

- Osteoperiostis with pain and lameness until exostosis develops.
- Exostosis away from joints-mayn't cause lameness.
- Articular ringbone-severe lameness.
- Lameness not much during walking.

Diagnosis

- Clinical examination (Symptoms).
- Radiography.
- Nuclear scintigraphy.
- Ultrasonography (to evaluate soft tissue structures and ligaments/tendons).

Treatment

- Rest (from weeks to months) followed by controlled exercise.
- Anti-inflammatory drugs.
- Trimming of feet to make it balance, corrective shoeing.
- Blistering.
- Needle point firing.
- Neurectomy—median nerve, external plantar nerve.
- Arthroscopy/Arthrotomy—to remove articular osteophytes.
- Arthrodesis.

QUITTOR

Quittor may be defined as chronic purulent inflammation of a collateral cartilage of the distal phalanx, characterized by cartilage necrosis and multiple fistulous draining tracts to the coronet region. Fore limb and the lateral cartilage are mostly affected.



Quittor in horse

Etiology

- Infection through injuries (penetrating wound/ laceration) to the collateral cartilage or to the soft tissue overlaying collateral cartilage.
- Foot abscess.
- Chronic ascending infections of the white line (Gravel).
- Deep hoof cracks.
- Suppuration extending from sesamoid bones.

Clinical signs

- Formation of abscesses in the collateral cartilages that break open and drain just proximal to the coronary band.
- History of recurrent drainage of the fistulous tract.
- Intermittent severe lameness.

Diagnosis

- Clinical signs and symptoms.
- Differential diagnosis with gravel. In Gravel drainage tract is located at or just proximal to the coronet where inflammatory process is localized. Whereas in quittor there may be multiple fistulous tracts, more diffuse swelling and it is located more proximally over the collateral cartilage.

Treatment

- Best treatment option is to surgical Excision of the fistulous tracts and necrotic collateral cartilage ulcer general anesthesia.
- Other measures include irritation of sinus with antiseptic lotion, applications of red-hot iron through sinus opening, passing of seton through opening, generally do work well.

SIDE BONES

Ossification of the collateral cartilages of third phalanx (P_3) are called **side bones.**

Common features

- Forelimb is more affected than hind limb.
- Lateral cartilage is more affected.
- Female horses are more affected.
- Ossification starts either at the base or centre of the cartilage.

Etiology

- Hereditary.
- Hoof Concussion causing trauma to the cartilage.
- Poor confirmation (base narrow, base wide, toe out).
- Defective shoeing.

Signs

- Lameness solely due to side bones is rare.
- Enlargement of lateral or medial dimensions of the pastern region may be seen visually, if ossification is extensive.

Diagnosis

- Nerve block: palmar digital nerve block just above the collarteral cartilage on the affected side relieves pain.
- Radiographic evaluation reveals extent of ossification of the cartilage(s).

Treatment

- Rest.

- Administration of NSAIDs.
- Corrective shoeing to maintain balance and to enhance breakover.

NAVICULAR DISEASES (SYNDROME)

Navicular syndrome is a degenerative disease involving the navicular bone, navicular bursa and deep digital flexor tendon. It usually becomes apparent in horses between six and twelve years of age, although not confined to this age group.

Anatomy

The navicular bone is located in the palmar/planter aspect of distal interphalangeal when viewing the sole of the foot, the navicular bone is located deep to the middle third of the frog. The deep digital flexor tendon passes over the back of the navicular bone and then attaches to the P_3. Function of the navicular bone is to decrease the amount of concussion to the coffin joint.

Etiology

- Interruption of the blood flow to and from the navicular region.
- Faulty conformation and hoof imbalance that results abnormal biomechanical disorder. Thus, nonphysiologic forces exerted on the navicular bone, supporting ligaments and deep digital flexor tendon. This stimulated intense remodeling of the bone, increases the vascular pressure within the bone thus pain elicited.

Clinical Signs

- Navicular syndrome is generally bilateral forelimb lameness in most cases, although it can occur as a unilateral problem. The condition is uncommon in hind limb.
- Navicular syndrome can affect all breeds of horses. However, the larger breeds (thoroughbreds, warm bloods etc.) are much more commonly affected.
- The lameness in the early stages is intermittent and tends to improve with exercise. however, as the disease progresses; the lameness becomes persistent and is often exacerbated by exercise.
- Navicular syndrome is almost always chronic in nature.
- The horse may be reluctant to work, especially on hard surfaces, and displays a 'stilted' or 'choppy' gait often accompanied by tripping and stumbling.
- The horse may tend to point the affected limb while on rest. In advance case, horse lands on its heel first, tipping its toe up off the ground as weight is applied to the limb.

Diagnosis

- History and clinical signs.
- Hoof examination and application of hoof tester.
- ***Frog wedge test***- Placing a wedge of wood under the palmar 2/3rd of the frog and force the horse to stand on that for 60 seconds, if lameness exhibits the horse is positive for navicular syndrome.
- ***Toe extension test*** by elevating the toe of the hoof with the wedge of wood and forcing the horse to stand on the limb for 60 seconds. If lameness exhibits, the horse is positive for navicular syndrome.
- Phalangeal flexion test.

- Regional nerve blocks.
- Radiographic examination.

  Views :
  - Dorsopalmar 60°.
  - Lateromedial.
  - Palmaroproximal-palmarodistal oblique.

  Look for
  - Alterations in the distal foramina.
  - Cystic changes.
  - Elongation and enthesiophytes formation at the proximal and distal borders of the navicular bone.
  - Flexor cortex defects.
  - Small calcification of the flexor surface of the navicular bone.
- ***Navicular bursography***—3 ml 1 : 1 mixture of contrast material and local anaesthetic may be injected into the navicular bursa and radiography is done. Common observations are- thinning or erosion of the flexor fibrocartilage, complete focal loss of the dye column due to adhesion of flexor to the bone, fibrillation of the flexor tendon.
- **Nuclear scintigraphy** can detect early pathologic changes in the navicular bone. Presence of 'hot spot' between 1 to 4 hours after injection is seen.
- Computed tomography.
- MRI.

Treatment

- Variable period of rest and controlled exercise.
- To allow time for soft tissue inflammation to subside.
- To allow horse to acclimate to corrective trimming and shoeing.
- To allow the navicular bone to begin the remodelling process.
- Generally, a period of complete rest for 3 weeks followed by controlled exercise is recommended.
- Corrective trimming and shoeing is very useful when performed correctly at the earliest onset of clinical signs. It helps to restore normal foot balance, correct foot problem like shearing of quarters and heels, underrun heels and heel bulb contraction, reduce biomechanical forces on the navicular bone and protect injured region.

Recommended therapeutic shoe

- Modified Keg Shoe.
- Natural Balance Shoe.
- Egg Bar Shoe.
- Drugs to improve blood flow.
- Anti-inflammatory agents.
- Drugs specific for the treatment of arthritis.

Medical treatment of navicular syndrome

Nonsteroidal anti-inflammatory

- ***Phenylbutazone***-When used sensibly, they are a very useful and safe adjunct to other forms of treatment. Dosage: 4.4 mg/kg orally for 7-10 days along with rest.
- ***Corticosteroids***-corticosteroids (methyl prednisolone or triamcinolone) @ 40 mg injected into the navicular bursa and/or DIP joint of horses with navicular syndrome. The duration of effect is generally short (3-12 weeks).
- **Haemorheologic agents-*Isoxsuprine hydrochloride***, a b-adrenergic agent with vasodialatory and rheologic properties, causes dilation of the blood vessels to the foot. The vasodilatation might help to improve the venous congestion. Treatment @ 0.66 mg/kg twice daily for 3 weeks followed by 0.66 mg/kg once daily for 2 weeks and followed by every alternate day dosing is useful. There have been a number of reports that will cause a significant improvement in the lameness associated with navicular syndrome.
- Sodium hyaluronate @ 20 mg injection in DIP joint can be useful if administered either in combination with corticosteroid or 3-4 weeks after corticosteroid therapy.
- Polysulphated glycosaminoglycans (PSGAGs) may be used @ 500 mg IM at 4 days interval for seven treatments.

Surgical treatment

- Surgical treatment is indicated if medical treatments including shoeing have proven to be unsatisfactory.
- Palmar digital neurectomy is the surgery most commonly performed for navicular syndrome. This procedure desensitizes the caudal 1/3rd to ½ of the palmar/plantar foot region and sole extending dorsally to the toe. This procedure is done in conjunction with corrective trimming and shoeing. It is purely a palliative treatment and complications can arise.
- Navicular Suspensory desmotomy involves transecting the suspensory ligaments of the navicular bone. These ligaments help to maintain the position of the navicular bone and may act as springs to prevent downward descent of the navicular bone during weight bearing. Efficacy of this technique is comparable with the palmar digital neurectomy.
- Carpal check ligament desmotomy is useful in which dorsal palmar hoof imbalance seems a factor.
- Acupuncture has been used for the treatment of navicular syndrome.

PYRAMIDAL DISEASES (BUTTRESS FOOT)

Pyramidal disease is characterized by pyramidal distortion of the hoof and the distal dorsal pastern region, which is resulting from a large chronic extensor process fracture (most common) or from phalangeal exostosis (advance stage of low ringbone) involving the extensor process of the distal phalanx and the distal middle phalanx.

The exostosis causes an enlargement of the coronary band at the centre of the hoof or in chronic cases cause a triangular (pyramidal) distortion of the dorsal hoof wall.

Etiology

- Excessive strain on the attachment of the long or common digital extensor and the extensor branch of the suspensory ligament.

- Phalangeal exostosis.
- Horses with high heel and short toe are predisposed to this condition.

Signs and diagnosis

- Enlargements of the dorsal pastern region with hair have a tendency to stand upright and foot of the affected limb is smaller than that of the unaffected limb.
- Horses often 'points' the affected toe.
- Digital pressure is painful in early stage of disease.
- Phalangeal flexion test is often painful.
- In chronic stage, the shape of the dorsal hoof wall changes to a pyramidal shape extends from the coronary band distal to the weight-bearing surface.

Treatment

- No treatment is of particular value or relieves pain associated with proliferative exostosis.
- Intralesional injection of corticosteroid is of temporary value.
- NSAID may be advocated.
- Palmar digital neurectomy is a palliative temporary treatment.
- Corrective trimming and shoeing is aimed at easing breakover.
- If large extensor process fracture is the cause, surgical removal of it is advocated.

FRACTURE OF THE EXTENSOR PROCESS

Extensor Process (type 4) fracture of the third phalanx is common in the forelimb. The fragment size varies from small with little articular involvement, to large, with grater articular involvement. This condition is one of the common causes of the pyramidal disease.

Etiology

- Trauma.
- Excessive tension on the common digital extensor tendon (avulsion fracture).
- Overextension of the DIP joint.
- DJD of the DIP joint.
- Osteochondrosis lesion of the extensor process.

Signs

- Distention of the coffin joint dorsal and proximal to the coronet.
- Variable lameness depending upon the nature and extent of the fracture fragment.

Diagnosis

- Radiography (lateromedial, dorsopalmar view).

Treatment

- Prolonged stall rest.
- Surgical removal of the fracture fragment if severe DJD did not evident. Arthroscopic surgery is more encouraging than the conventional arthrotomy.

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CHAPTER

7

Laminitis, Sand Crack, Seedy Toe, Fractures of Third Phalanx, Pedal Osteitis and Sole Penetration

LAMINITIS (Founder)

Laminitis is defined as inflammation of the laminae of the foot. It is in fact a peripheral vascular disease manifested by decreased capillary perfusion within the foot, significant amounts of arteriovenous shunting, ischaemic necrosis of the laminae and pain.

Etiology

The predisposing factors those trigger the development of laminitis are multiple and varied that include:

- Ingestion of a toxic amount of grain (Grain founder).
- Ingestion of a large amount of cold water (Water founder).
- Obesity and ingestion of lush grass pasture (Grass founder).
- Concussion (Road founder).
- Endometritis and severe systemic infections (Post-parturient laminitis).
- Certain corticosteroid therapies.

Pathogenesis

- The digital lesion is thought to result from two interrelated mechanisms involving a vasoactive process and a coagulopathy.
- The pain that develops stimulates the adrenal gland to release catecholamines that acts on alpha-receptors in the dermal vasculature within the foot causing vasoconstriction and increased ischaemia to the digit.
- The systemic manifestations of laminitis include alteration in the cardiovascular, endocrine and renal systems, acid base balance and coagulation.

Symptoms

Acute laminitis

- When all four feet are affected, the horse tends to lie down for extended period. When standing, the horse carries the hind feet well up under him and carries the forefeet caudally so that there is a very narrow base of support.
- Most commonly, only the two front feet are involved. In this case, the hind feet are carried well up under the body and the front feet are placed forward with the weight on the heel of the foot.
- Heat is present over the wall and the coronary band.
- Increased digital pulse.
- Many horses show anxiety, trembling of the musculature from severe pain, injected mucous membrane and increased respiration and temperature.
- The horse feels difficulty to lift one foot from the ground as it throws additional weight on the other affected foot or feet.
- In Grain founder, symptoms usually appear after 12-18 hours of grain ingestion that includes: lameness, diarrhoea, toxaemia, muscular tremors, elevated temperature, pulse and respiration.
- In mare with laminitis resulting from metritis, the symptoms include: elevated temperature, pulse and respiration, injected mucous membrane. Uterine examination will reveal a dark watery fluid and portion of fetal membrane.

Chronic laminitis

- Laminitis becomes chronic after 48 hours of continued pain or when rotation of the distal phalanx occurs.
- Severe lameness may not be present but an acute recurrence may occur.
- Severe rotation of the distal phalanx is often attendant with separation of the coronary band over the extensor process region and serum ooze out through this defect.
- With mild to moderate rotation of the phalanx, diverging rings on the hoof wall will be evident. Typically, the space between the rings at the heel is wider than those at the toe.
- Horses suffering from chronic laminitis with rotation of the distal phalanx have a tendency to land on the heal, followed by an exaggerated toe slap.
- "Seedy toe" resulting from separation of the laminae.
- Trimming the affected feet causes reddening and bleeding of the sole due to increases vascularity with laminitis.

Diagnosis

- Clinical signs make the diagnosis easy.
- Serial radiography to monitor the progress of rotation of the third phalanx.

Treatment

Developmental phase : Neutralize the effect of the ingested grain control the developmental phase of laminitis.

- In grain overload, mineral oil is used to clear the intestinal tract. Treatment is repeated at 4-6 hours interval until all grains are removed from the intestinal tract.
- Short period of exercise (10 min/hour) for the first 24 hours is beneficial.
- Heparin @100 units/kg IV four times a day or 100 units/kg S/C two times a day is recommended. Close monitoring of the patient is a must following heparin therapy.

Acute phase : Aimed at the prevention of distal phalanx rotation.

- Horses should be placed in a stall with soft sand underfoot that provided good physiological support for the sole.
- High dose of phenylbutazone intravenously in combination with phenoxybenzamine or acepromazine may be used to break pain-hypertensive cycle in the patient.
- Perineural anaesthesia of the digital nerves at the base of the sesamoids may be tried in cases that do not respond to analgesic therapy. In some cases, a pastern ring block may be needed.
- Adrenal corticotropic hormone (ACTH) has been reported to be effective in acute laminitis.
- Exercise is recommended by many clinicians, but it is a **'double-edged sword"**.
- Eliminate grain from the diet and offer a good-quality mix legume or grass hay free choice.

Chronic phase : Directed towards preventing further damage to the foot attendant with progressive rotation of the distal phalanx and the systemic lesion. Besides, more normal anatomical alignment of the hoof wall and sole with the distal phalanx should be established.

- Low dose of phenylbutazone along with phenoxybenzamine or acepromazine, angiotensin II, lasix may be used.
- Systemic antibiotics are given when infection is present.
- Trimming and shoeing are advocated as per the merit of the case.
- Carpal check ligament desmotomy and deep digital flexor tenotomy to decrease the tension on the deep digital flexor tendon has been used with varying degrees of success.

Prognosis : Guarded.

SAND CRACK (Toe cracks, Quarter Cracks, Heel Cracks)

Cracks in the wall of the hoof may occur starting at the bearing surface of the wall and extending to a variable distance up to the hoof wall, or cracks originating at the coronary band, as a result of a defect in the band and extending downward.



Sand crack

Etiology

- Excessive growth of the hoof wall, causing a splitting of the wall, from lack of trimming of the feet.
- Injury to the coronary band, producing a weak and deformed hoof wall.
- Weakening of the wall due to excessive drying or excessively thin walls.

Symptoms

- Presence of split in the wall.
- Lameness may not present unless the cracks extend into the sensitive tissues.
- Presence of exudates when the lesions are infected.

Diagnosis

- History and clinical signs.
- Bleeding from the hoof wall crack after exercise.
- Pressure on infected hoof causes exudation of pus.
- Hoof testers to ascertain the pain from the crack in the hoof wall.
- Perineural anaesthesia.

Treatment

It depends on the location of the crack.

Toe crack

- Cleaning, antiseptic dressing and bandaging of the crack.
- Hoof wall on the bearing surface should be lowered about 1 inch on either side of the crack. If the crack does not extend into the coronary band, a pattern should be grooved or burned into the crack to limit its upward progress. The horse is shod with a toe clip on either side of the crack to prevent expansion of the wall.
- Strip out the crack with an electric cast cutter, a hoof groover, a firing iron, or a motorized burr. The enlarged crack is then filled with epoxy glue or plastic.
- Drilling holes in the sides of the crack and shoe lace fashion suturing with umbilical tape of stainless steel wire may be uses.
- When the horse is not shod but allowed to go barefoot, the bearing surface of the wall on either side of the crack should be lowered.

Quarter crack

- The bearing surface of the hoof wall should be lowered in the back of the crack.
- A half-bar shoe should be applied, with the bar on the heel of the affected side.
- The corrective shoe may have a quarter clip on either side of the crack to help prevent expansion of the crack.
- Crack may be stripped as in toe crack.

Heel crack

- Similar to quarter crack, except the half bar may not be needed. The wall behind the crack should be lowered so that it does not touch the sole or ground.
- Application of fiberglass patch and screws.
- Open drainage and topical anti-infective treatment for infected crack.

Prognosis

- Favourable when the crack originates at the bearing surface of the wall and not infected.
- Guarded if infection is present.

SEEDY TOE

Seedy Toe is characterized by the separation of the wall and the sensitive laminae of the foot. The interspace may contain soft abnormal horn. A part or whole of the foot may be affected.

Etiology

- Unknown.

- Wide, spreading feet predisposition.
- Chronic laminitis.

Symptoms

Lesion on the foot is apparent.

- Lameness may not present when the lesion is limited to small area.
- When a large area is involved, lameness becomes apparent.

Diagnosis

- From clinical signs.
- On tapping the affected area yields hollow sound.

Treatment

- The abnormal horn between the sensitive laminae and the wall may be removed after paring away portion of the wall in that region.
- Blistering the coronet region in order to stimulate formation of new horn.

Prognosis : Guarded.

FRACTURE OF THE THIRD (DISTAL) PHALANX (Pedal bone, Os pedis, Coffin bone)

Fractures of the third phalanx are not common. When they do occur, the injury is usually associated with exercise on hard tracks, and the forefeet, particularly the left are affected in horses racing counter clockwise.

Etiology

- Trauma, particularly when associated with a twisting action as the foot lands.
- Penetration of a foreign body through the sole.
- Trauma to a large side bone.
- Stone bruises hard surfaces, improper shoeing, infectious conditions and nutritional deficiencies.

Symptoms

- When articular surface is involved, lameness is evident. In some cases, the horse refuses to place the foot on the ground for as long as 72 hours.
- Lameness appears suddenly during work without any history of trauma.
- Increase digital pulsation and heat in the affected foot.

Diagnosis

- Examination of the foot with hoof testers, along with the history, is often the most accurate way of diagnosis.
- Radiography not only confirms the diagnosis but also reveals location and extent of damage. Care must be taken so that normal vascular channels are not confused with fractures during interpretation of radiograph.

Treatment

- Use of a full bar shoe with quarter clips in order to immobilize the fracture and preventing expansion of the hoof wall.

- Alternatively, the foot can be placed in a rim shoe or be confined in a cast.
- In some cases of persistent lameness, neurectomy of the palmar digital nerves may offer enough relieve that the horse can be returned to full use.
- Use of lag screws may be considered for articular fractures, particularly midsagittal fractures in horses over 3-4 years of age.
- When the fracture is caused by a puncture wound, drainage and antibiotic therapy should be initiated.

Prognosis : Good or favourable.

PEDAL OSTEITIS

Pedal Osteitis is a demineralisation of the distal phalanx resulting from inflammation.

Etiology

- Persistent inflammation of the foot.
- Chronic bruising of the sole (as in navicular disease).
- Persistent corns.
- Laminitis (especially from concussion or road founder).
- Puncture wounds.

Symptoms

Lameness in all gaits.

Diagnosis

- History and clinical signs.
- **Radiographic examination** : Demineralization at one or more points and roughening of the solar border of the third phalanx. One should be careful not to confuse the normal notch (crena) of the toe of the distal phalanx.

Treatment depends on the cause.

- Protective padding, anti-inflammatory therapy and rest are recommended in most cases.
- Shoeing helps keeping the sole away from ground and avoids pressure on it. Pads of leather or Neolite under the shoe may be helpful.
- When the sole is thin and soft, it can be medicated topically with equal parts of phenol, formalin and iodine to toughen it.
- Neurectomy of the palmar digital nerves may be tried when pedal osteitis affects the lateral wings of the solar border of the bone, provided soundness occurs after blocking these nerves with a local anaesthetic.

Prognosis : Unfavourable.

SOLE PENETRATION (SOLE WOUNDS)

Puncture wounds are usually the consequence of poor horse-shoeing technique but can occur when a horse steps on a penetrating foreign object. **"Nail prick"** refers to a nail that penetrated the sensitive lamina. **"Street nail"** implies to the penetration of a sharp object through the sole. **"Nail bound"** describes a hoof that has a horse shoe nail that was driven too deep into

the horn, causing too much pressure. A small wound in the sole does not cause much harm as the elasticity of the sole horn can close the penetration tract. Deep wounds and penetrating vital structures of the foot such as tendons, synovial structures, ligaments, bones, etc. lead to terrible consequences due to damage and infection.

Pathogenesis

When a foreign object pierces the sole of the foot, infection may develop due to entry of microorganisms. Infection may progress to the coronary band, and abscesses may form. Afterward, the pastern and fetlock areas accumulate fluid and swell.

Signs

- Lameness is usually severe following a puncture wound, particularly when the foot bears weight.
- The horse may stand and point the affected foot.
- The foot will show increased pain and may be warm to the touch.
- The hoof has increased pulsation of the digital arteries and might develop fever as well.
- Pressure applied with hoof testers usually elicits pain.

Diagnosis necessitates confirming the site of pain by pulling the shoe, applying hoof testers, and paring down the suspect area to locate the foreign object or its path of entry.

Treatment

- The hoof should be cleaned and thoroughly examined, a hoof knife may be required to remove horn and look for the site of penetration.
- The nail or foreign body should be removed but the site, depth and direction of the tract should be recorded and the point of entry marked on the sole.
- The site should be cleaned very well and the hoof should then be kept in a rubber or plastic boot for 3 to 5 days with a cotton pad soaked in saturated magnesium sulfate solution or other suitable poultice.
- If the pain is severe, regional analgesia provides temporary relief.
- Deep punctures of the foot that involve the deep digital flexor tendon, navicular bursa, navicular bone, or third phalanx require emergency surgery.
- Broad spectrum antibiotics and tetanus protection should be instituted.

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CHAPTER

8

Canker, Thrush and Corn

CANKER

Canker is defined by chronic hypertrophy of the horn producing tissues of the foot.

Incidence :

Heavy draft horses are commonly affected. Most often, the hind feet is affected.

Etiology

- Unhygienic condition in stable, long standing in mud, or bedding soaked with urine and faeces and poor attention of the hooves.
- Specific cause is thought to be an infectious process of unknown agent.

Symptoms

- Foetid order and ragged appearance of the frog.
- Horn tissue of the frog loosens easily.
- Swollen corium covered with caseous white exudates, the corium shows chronic vegetative growth.
- Lesions may extend to the sole or even to the wall of the foot.
- The tissue bleeds easily and has little tendency to heal.
- Lameness usually not present in early stages of the disease.

Diagnosis is based on history and clinical signs. It should be differentiated from ordinary thrush.

Treatment

- Remove all loose horn and affected tissue.
- Apply antiseptic and astringent medicaments.
- A 5% picric acid solution under bandaging is effective.
- Caustic agents like mixture of copper sulphate and zinc sulphate crystals may be used.
- Antibiotic therapy with penicillin has been found effective.
- Protect the affected portion of the sole by a metal, or leather sole.
- Keep the animal in clean, dry and preferably in rocky pasture.

Prognosis: Guarded to unfavourable.

THRUSH

Thrush is a degenerating condition of the frog involving the central and lateral sulci and is characterized by the presence of a black necrotic material in the affected region. The infection may penetrate the horny tissue and extend to the sensitive structures.

Incidence

Heavy draft horses are commonly affected. Most often the hind feet is affected.

Etiology

- Unhygienic stable and filthy surroundings.
- Dirty and unclean feet.
- Lack of frog pressure resulting from poor shoeing or poor foot trimming.
- Bacterial involvement especially of *Spherophorus necrophorus.*

Symptoms

- Presence of increased amount of moisture and a black discharge of offensive odour in the sulci of the frog. Flies may surround the affected foot.
- Swelling of the limbs (stocking-up).
- Lameness is not present.

Diagnosis is based on history and clinical signs. It should be differentiated with canker. There is no vegetative growth or hypertrophy as in canker.

Treatment

- Clean the frog and apply antiseptic foot dressing. Tincture of iodine, 10% formalin or packing the sulci with cotton soaked in 10-15% sodium sulfapyridine solution may be used.
- Local application of 'thrush powder' [ferrous sulphate, copper sulphate and magnesium sulphate].
- Put the animal in a clean and dry stable.

Prognosis : Easily responds to treatment.

CORN

Corn is a traumatic involvement of the sensitive and insensitive tissues of the sole at the angle formed by the wall and the bar (seat of corn). Contusions on the sole and frog are termed as bruised sole and bruised frog respectively.

Incidence

Corns occur most frequently on the inner angle of the forelimb. Corns are more common in horses with thin sole and those previously suffered with laminitis. It is rare among horses that are used barefooted but sole bruising occurs as a result of trauma to the sole from rocks and other objects.

Etiology

1. *Predisposing cause* : Faulty conformation of foot (flat foot, upright walls, turn-in-toes, frog atrophy etc) that is unable to provide anti-concussion mechanism.

2. Exciting causes : Improper shoeing is the predominant cause of corn.

- When shoes are left on the wall and cause pressure on the sole at the angle of the wall and the bar.
- In order to prevent pulling or stepping off the shoe, the inside branch of the shoe is bent toward the frog that puts direct pressure to the sole at the angle and not to the wall and repeated concussion leads to bruising.
- Application of a shoe that is one half to one full size too small for the foot will increase the pressure on the sole area at the angles. Heel cracks further aggravate the effect.
- Improper trimming of the feet, making the heels too low, increases pressure at the angle of the wall and bar causing corn.
- When a horse is shod too closely at the quarter.
- Lack of frog pressure.

Classification

- **Dry corn** : Haemorrhage within the inner surface of the horn resulting from bruising of sensitive tissue usually causes red stains.
- **Moist corn** : Severe injury causing accumulation of serum beneath the injured horn.
- **Suppurating corn** : Corns get infected resulting in necrosis of the sensitive lamina, of the palmar on planter aponeurosis, or of the digital cushion.

Symptoms

- Lameness of varying degrees depending upon the severity of the disease.
- Affected horse will tend to favour the heel, especially on the affected side. If the corn is present at the inside heel, the horse will tend to place more weight on the outside of the foot.
- Sometimes, the horse will tend to bear more weight on the toe and will rest the foot with the knee forward to decrease heel pressure.

Diagnosis

- History and clinical signs.
- Careful examination of the hoof after cleaning may reveal the lesions of corn.
- Hoof tester exam will be positive for pain.

Treatment

- Remove the offending shoe when shoeing is the cause.
- Removal of some of the tissue over the corn helps relieve pressure, but sensitive tissue should not be exposed.
- In suppurating corn, the sole over the region should be removed until drainage of the sensitive tissues is established.
- Footbath and antiseptic dressing.
- Provide rest.

Prognosis : Guarded.

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CHAPTER

9

Monday Morning Diseases, Cording up, Myositis of Psoas Muscle, Iliac Thrombosis

MONDAY MORNING DISEASE (Paralytic myoglobinuria, exertional rhabdomyolysis, myositis, tying-up and azoturia)

Exercise related or exertional myopathies affect the fit working and performance horses and represent varying degrees of the same condition, azoturia being the most severe form while tying-up denotes the mildest form. The term Monday morning disease is coined as it is seen when the horse is rested over the weekend, maintained on full ration, and resumed work on monday.

Incidence

Commonly seen in nervous or excitable and heavily muscled horses.

Etiology

- Exercise after a period of inactivity in which the horse has been on a full ration (high - carbohydrate).
- Carbohydrate loading to achieve an over saturation of muscle glycogen stores during endurance competition.
- Too little oxygen getting to the muscles and vitamin E/selenium deficiencies.
- Fillies are more predisposed than stallions or geldings which are thought to be due to changes in electrolyte excretion in the urine, related to hormonal changes.

Pathogenesis

- Exact mechanism is not known.
- When the horse is exercised and subjects certain muscle groups to anaerobic metabolism, excessive lactic acid are produced which results in swelling of the affected muscle fibers.

Symptoms

Vary according to the severity of the disease.

Mild form (Tying-up)

- Local or diffuse sweating, anxiety, stiffness, myalgia and muscle tremors.
- The horse is reluctant to move and has a short, stilted gait.
- Myoglobinuria may or may not present.

Severe form (Azoturia)

- Muscle stiffness and muscle spasms of the loin and hind limbs, profuse sweating, tachycardia, hyperventilation, slight pyrexia and an anxious facial expression.
- The horse is reluctant to move and may become recumbent.
- Urine colour changes to red brown to black due to myoglobinuria.

Diagnosis

- History and clinical signs.
- Elevation of muscle enzymes (creatine phosphokinase and ASAT).

Treatment

- Minimize movement of the animal.
- Tranquilizers (acepromazine 20-40 mg) are useful to relieve anxiety.
- Intravenous fluid therapy is indicated to combat dehydration and minimize myoglobin precipitation in the renal tubules. Sodium bicarbonate @ 0.5-1 mg/kg body weight along with fluid therapy may help increase the solubility of myoglobin in the urine.
- Analgesic and anti-inflammatory drugs such as phenylbutazone (2-3 gm daily).
- Massage of the affected muscle with hot towels may be helpful.

MYOSITIS OF PSOAS MUSCLE

The psoas muscles are very important in the driving action of the hind limbs and are subject to injury when the horse is improperly trained.

Etiology

- Trauma from muscular strain such as racing.
- Myositis may be one of the after effects of azoturia or tying-up syndrome.

Symptoms

- Stiffness of the back.
- Abnormal propulsion of the hind limbs and gait appears to be stiffened.
- Pain on pressure over the loin exhibited by groaning and dropping the back under hand pressure.
- Hand pressure on the psoas group of muscles per rectal elicits pain.
- Rigidity of abdominal muscles.

Diagnosis

- History and clinical signs.
- Clinical examination to detect pain perceptions.
- Clinical pathology: Elevated serum muscle enzymes, aminoaspartate and creatinine in the active stage.

Treatment

- Adequate rest (at least 30 days) and proper training procedures.
- Injections of vitamin E and selenium @ 1ml /100 lb at weekly intervals for 3-4 occasions are effective.
- Sodium bicarbonate in the grain (2-4 oz) daily may be helpful.
- Non-steroidal anti-inflammatory drugs are also useful.

Prognosis: Guarded. However, most horses return to full use.

ILIAC THROMBOSIS

Thrombus is formed in the caudal aorta, iliac arteries or femoral artery due to the damage causes by *Strongylus vulgaris*. Such thrombi cause lameness of the hind limb as a result of circulatory interference. Thrombus formation may also occur in the brachial artery of the forelimb, causing lameness of that limb.

Etiology

Larval forms of *Strongylus vulgaris* cause damage to the intima of the arteries leading to thrombi formation.

Symptoms

- Characteristic intermittent lameness that appears with exercise and disappears with rest.
- When lameness appears, profuse sweating, pain and anxiety occur if the horse to continue the exercise.
- Affected limb appears cooler and pulsation of the femoral artery appears less than the opposite one.
- Veins on the affected limb appear more or less collapsed while the veins on the normal limb stand out.
- In unilateral involvement, the affected limb does not sweat, while the opposite one does.
- In bilateral thrombosis in the aorta, the horse may have difficulty in supporting hindquarters.

Diagnosis

- History and clinical signs.
- Rectal examination of the aorta and iliac arteries reveals decrease of pulsation in the iliacs of the affected side or fremitus in these arteries or palpation of the thrombosis.
- Comparison of the femoral artery pulsation on the inside of the thigh in both limbs may be diagnostic.
- Affected limb(s) appears cool while in azoturia, the quadriceps muscle becomes hard and urine is coffee-coloured.

Treatment

- Sodium gluconate @ 500-600 mg/kg body weight by slow IV is reported to be effective.
- Besides, thiabendazole @4 gm/100 lb body weight once weekly for 3 weeks causes destruction of the migrating Strongylus larvae.
- Ivermectin may also be tried.

Prognosis: Guarded.

CHAPTER 10

Crual Paralysis, Sub-Luxation of Sacro-Iliac Ligament, Rupture of Round Ligament, Trochanteric Bursitis

CRURAL PARALYSIS (Femoral nerve paralysis)

The condition develops due to paralysis of femoral nerve affecting the quadriceps femoris group of muscles.

Etiology

- Trauma to the nerve.
- Overstretching of the limb during exertion, kicking, slipping or while the animal is tied in a recumbent position.
- After-effect of azoturia.

Symptoms

- Inability to bear weight on the affected limb.
- All the joints of the affected limb remain flexed while the animal in standing position.
- Abnormal gait.
- Atrophy of the quadriceps muscles in long standing cases.

Diagnosis

- History and clinical signs.
- Electromyography of the quadriceps femoris muscles 5 days after the first signs of crural paralysis provides a definite diagnosis.

Differential diagnosis

- Lateral luxation of patella can be diagnosed by palpation of the displaced patella; rupture of the quadriceps femoris muscle can also be palpated.
- A radiographic examination can detect avulsion of the tibial crest where the patellar ligaments insert.

Treatment

- No treatment is available.
- Conservative treatment includes rest.
- Massaging the muscles may be tried.
- When some improvement is noticed, exercise is initiated to minimize muscular atrophy.
- When azoturia is the cause, treatment includes exercise, injection of selenium/vitamin E combination and thiamine.

Prognosis: Guarded to unfavourable.

SUB-LUXATION OF SACROILIAC LIGAMENT

Stress or injury to the sacroiliac ligament disturbs the continuity of the sacroiliac joint characterised by chronic pain resulting from partial displacement and instability.

Etiology

Predisposing causes

- Horses that work primarily at gait other than a gallop (draft, carriage and endurance horses).
- In cattle, the hormone relaxin, produced by corpus leutium, and/or estrogens predisposes the condition. Similar condition producing relaxation of the supporting ligaments of the sacroiliac joint might occur in older horses.

Exciting causes : Trauma, falls, slipping or high stress to the sacroiliac joint.

Symptoms

- Pain on pressure over the sacroiliac area.
- Lameness and muscular spasm.
- Dissimilarity or protrusion of the tuber sacral (hunter's bumps), either unilaterally or bilaterally.
- Hiking or jerking motion of the hip when the horse is exercised in circle.

Diagnosis

- History and clinical signs.
- Rectal examination while the horse is walking slowly, and while pressure is put on the tuber coxae in an attempt to produce rotation of the pelvis and crepitation. Rocking of the horse back and forth, causing the horse to shift its weight from one hind limb to the other often produces diagnostic crepitation.
- Radiographic examination can be informative.

Differential diagnosis

It should be differentiated from iliac thrombosis, azoturia, fracture of ilium, trochanteric bursitis and myositis of lumbar muscles.

Treatment

- Complete rest, preferably in a box stall for at least 30-45 days.
- Injection of irritant locally into the region of the ventral sacrosciatic ligament. Injection of some of the irritant into the sacrosciatic joint in the region of the joint capsule under strict aseptic condition is also beneficial.

Prognosis : Guarded.

RUPTURE OF ROUND LIGAMENT

The condition arises when the round ligament of the coxofemoral joint that lies between the head of the femur and the acetabulum. In this case, coxofemoral luxation is not developed, but the head of the femur has a greater range of motion than normal, causing degenerative changes in the joint.

Etiology

Trauma, violent over-extension and falling on the point of the stifle.

Symptoms

- Toe-out, stifle out and hock-in appearance of the affected limb.
- Crepitation over the joint may be present.

Diagnosis

- History and clinical signs.
- Comparison of the limbs will show that they are equal in length.
- Radiographic examination.

Differential diagnosis

- Signs of round ligament rupture are very similar to those of luxation except the limbs are uneven in length.
- Radiographic examination.

Treatment

- No effective treatment is available.
- Stabilization of the joint with a toggle pin apparatus may be attempted. However, the joint never returns sound to permit galloping.
- The technique is recommended in cattle as the animal may walk.

Prognosis : Unfavourable.

TROCHANTERIC BURSITIS (Trochanteric lameness)

It is caused by inflammation of the bursa beneath the tendon of the middle gluteus muscle as it passes over the greater trochanter of the femur.

Incidence

Common in standard breeds.

Etiology

Predisposing causes

- Short heels, long toes in the hind feet.
- Racing on small tracts, where the turns are close together.
- Horses working on their hind limbs that are frequently exercised in soft, deep arenas.

Exciting causes

- Bruising because of falling on the affected side, by straining the tendon during racing or training, by a direct kick on the trochanter.
- As a sequel to distemper, bone spavin and hock lameness.

Symptoms

- Pain on pressure over the greater trochanter.
- The affected limb remains flexed at rest.
- While walking, the horse puts weight on the inside of the foot so that the inside wall of the foot wears more than the outside wall. This becomes more apparent when the animal is observed from behind, the foot is carried inward and the animal sets the foot down on a line between the forelimbs. The horse tends to travel "**dog fashion**" since the hind quarters move toward the sound side because the stride of the affected limb is shorter than that of the sound side.
- Atrophy of the gluteal muscle in long standing cases.
- Persistent lameness when cartilage or bone of the trochanter may also be fractured due to trauma.

Diagnosis

History and clinical signs.

Differential diagnosis

Difficult to differentiate from inflammation of the coxofemoral joint or fracture through acetabulum (when no crepitation is present) or spavin lameness. Injection of a local anaesthetic into the bursa may help differentiation.

Treatment

- Application of hot packs in acute stages.
- Analgesic (Phenylbutazone) may be given to relieve pain.
- Corticoids injection into the bursa provides good result.
- Lugol's iodine injection in and around the bursa as a counter irritant.

Prognosis : Guarded to unfavourable.

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CHAPTER

11

Upward Fixation of Patella, Stringhalt

UPWARD FIXATION OF PATELLA



Upward fixation of patella in cattle

The condition occurs on the medial trochlea of the femur between the middle and medial patellar ligaments. The fixation of the patella on the medial trochlea of the femur prevents flexion of the affected hind limb. The condition is commonly bilateral, although it may be worse in one limb.

Etiology

Predisposing causes

- Hereditary : "Straight hind limb" (steep angle between femur and tibia) conformation.
- Debility and poor condition.

Exciting causes

- Trauma from over extension of the limb.
- Abrupt training and confinement to a stall.

Symptoms

- In acute cases, hind limb is locked in extension. The stifle and hock cannot flex, but the fetlock can.
- In some cases, the locking may be relieved and recur in next few steps or it may remain locked for hours or days.
- In some cases, "catching" of the patella occurs when the animal walks and the limb never truly locks in extension.

Diagnosis

- When the limb is locked, diagnosis is simple.

- On palpation, when the limb is locked in extension, patellar ligaments are tensed and the patella is locked above the medial portion of the femoral trochlea.
- Make the animal walk up and down a slope. Since animals with intermittent upward fixation of patella are reluctant to fully extend the stifle when they walk uphill, they assume a slightly crouched position and are reluctant to allow the stifle to be thrust caudad. As they descend the slope, a jerky gait may be noted as the result of incomplete extension of the stifle.

Differential diagnosis

- Intermittent upward fixation of patella may be confused with stringhalt. The patella should be forced upward and outward over the femoral trochlea to observe if it can be temporarily locked that would help to rule out stringhalt.
- Radiograph of the stifle should be made on animal less than 3 years of age to eliminate the possibility of concurrent osteochondritis dissecans of the trochlea and subchondral bone cysts of the medial condyl.

Treatment

Conservative approach

- In acute upward fixation of the patella, a sideline may be applied to the affected limb so that as the limb is drawn forward, the patella is pushed medially and downward, which often disengages the fixed patella.
- Startling the animal with a whip so that the sudden jump may release the patella.
- Backing the animal while at the same time pushing inward and downward on the patella may release it.

Surgical approach : ***Medial patellar desmotomy***

- A ¼ to ½ inch incision is made over the middle patellar ligament near the tibial attachment of the ligament under local analgesia.
- A blunt bistoury is inserted underneath the medial patellar ligament close to its tibial attachment. (Alternately a curved mosquito forceps are forced through the heavy fascia beneath the medial patellar ligament. This tears the fascia so that a large bistoury can be inserted beneath the ligament.)
- The blade is turned outward and the medial patellar ligament is severed.
- Skin wound is closed in a standard manner.

Prognosis : Favourable.

STRINGHALT

It is an involuntary flexion of the hock during progression and may affect one or both hind limbs.

Etiology

- Exact etiology is not known.
- Nervous diseases, degeneration of the sciatic and/or peroneal nerves, affection of the spinal cord, toxic factors and articular lesions within the hock and stifle are thought to be responsible for the condition.
- Involvement of lateral digital extensor.

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Symptoms

- Some horses show mild flexion of the hock during walking, while others show a marked jerking of the foot towards the abdomen.
- Some horses show these signs at each step, while in others it is spasmodic.
- The signs become more apparent when the horse walks after rest and the signs may diminish later on.
- Clinical signs increase in cold weather whereas decrease in warm weather.

Diagnosis

History and clinical signs.

Differential Diagnosis

- It must be differentiated from fibrotic myopathy, in which the foot is jerked suddenly downward and backward before being put to the ground.
- It must also be differentiated from intermittent upward fixation of the patella. In stringhalt, there is no locking and releasing of the patella and the patella cannot be locked when forced upward and outward on the trochlea of the femur.

Treatment

Lateral digital extensor tenotomy

- Operated in standing or in lateral recumbency with affected limb upper most under local analgesia.
- A 4-inch incision is made over the muscle of the lateral digital extensor just above the level of the point of the hock.
- Incise through the fascia and the muscle belly is exposed. Pull the muscular portion to reveal movement in the distal portion just before it attaches to the long extensor.
- A ½ inch incision is then made over this distal portion before it joins the long extensor.
- Skin and subcutaneous tissues are cut with a scalpel and then a blunt pointed bistoury is slipped under the tendon and severed.
- Exert tension on the proximal portion to pull out the tendon.
- When the whole tendon is exposed (about 7 inches) through the upper incision, the tendon should be cut off, removing a 3-4 inch portion of the muscle belly with it.
- After removal of the tendon, subcutaneous fascia is sutured.
- Skin wound is sutured in a standard manner.

Prognosis: Favourable to guarded.

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CHAPTER

12

Gonitis, Chondromalacia of Patella, Fracture of Fibula, Rupture of Tendo-achilles, Rupture of Peroneus Tertius, Fibrotic Myopathy and Ossifying Myopathy

GONITIS

It is the inflammation of the stifle joint and clinically characterized by generalized swelling of the stifle region and hind limb lameness.

Surgical anatomy

Stifle joint is the largest and most complex joint in the horse. The joint consists of two separate articulations (femoropatellar and femorotibial) and three synovial compartments (femoropatellar, lateral femorotibial and medial femorotibial). The medial femorotibial and femoropatellar joint spaces frequently communicate and occasionally the lateral femorotibial and femoropatellar joint pouches do as well. Fibrocartilaginous menisci are interposed between the articulations of the lateral and medial femoral condyles and the proximal tibia. Cruciate ligaments positioned cranial and caudal within this joint stabilize it in a cranial and caudal direction, whereas lateral and medial femorotibial collateral ligaments provide support laterally and medially.

Etiology

- Trauma, infection, congenital malformation, developmental defect, vascular disturbances and degenerative process.
- Certain conditions of the stifle joint (upward fixation of the patella, chondromalacia of the patella, osteochondritis Dissecans and subchondral bone cysts).

Symptoms

- Distention of the stifle joint.
- Varied degree of lameness according to the severity of the lesion.

- The cranial phase of the stride is shortened and the foot is carried closer to the ground.
- A toe drag is frequently heard when the horse advances the limb at a trot and a toe wear in apparent in chronic cases.
- Asymmetry in the gluteal rise while trotting, when viewed from back of the horse.
- Although the hip of the affected side generally elevates more that the opposite side, the duration of gluteal rise is shorter, which is referred to as "**hip hike**".
- Gluteal muscle atrophy in long standing cases.

Diagnosis

- History and clinical signs.
- Careful observation of the gait.
- Palpation of the joint. Pain associated with palpation of the trochlear ridges and pain and crepitation associated with manipulation of the patella are indicative of synovitis and capsulitis. Pain of palpation may provoke the horse to kick.
- Flexion test of the hind limb (flexing the hock and stifle, and to some extent the hip) often aggravates signs of lameness.
- Crutiate ligament test to identify sprain, trauma or crutiate rupture.
- Radiography (plain and contrast) is helpful to evaluate stifle joint.
- ntrasynovial anaesthesia of the stifle joint may be helpful because of the different compartments of the joint capsule.
- Arthroscopy can be used for the direct visualization of the intra-articular structures of the stifle joint.

Treatment

Specific treatment depends on the etiology of gonitis. Palliative treatment includes:

- Absolute rest for long period (at least 45 days) is advised when sprains and injury to the joint capsule or ligamentous attachments occurs without rupture.
- Firing, blistering and intraligamentous injection of irritants have been employed with inconsistent results.
- Corticoid therapy should not be combined with a treatment that produces inflammation.
- Intra-articular lavage with antibiotic as well as parenteral antibiotics based on sensitivity test is recommended in septic arthritis of the joint.

Prognosis

- Favourable when mild sprain trauma to the ligaments or upward fixation of patella is the cause.
- Guarded to unfavourable when cartilaginous or bony changes are extensive.

CHONDROMALACIA OF PATELLA

It is the degeneration of the articular cartilage of the patella due to inflammation of the stifle joint or from a combination of inflammation and pressure exerted upon it from a partial or complete upward fixation of the patella. Repeated trauma from a mal-aligned patella is the etiology of the condition. There is little clinical evidence to support the diagnosis as a singular entity at this time.

FRACTURE OF FIBULA

Fracture of the fibula can occur as a result of a direct trauma, it probably does not cause lameness, and in most cases careful examination is needed to diagnose the fracture. A defect in the union of the proximal and distal segments of fibula mimics a fracture on radiography. This defect in union of the bone can be demonstrated in a high percentage of horses. When a radiograph of the opposite fibula is taken, it is usually found that the defect is also present there.

RUPTURE OF ACHILLES TENDON

Rupture of Achilles tendon includes the tendons of the gastrocnemius muscle and the superficial flexor of the hind limb. Though the occurrence of the condition is rare, but when occurs, has a serious consequences.

Etiology

- Trauma.
- Lacerated wounds.

Symptoms

- Inability to support weight on the affected limb.
- Dropping of hock to the ground or close to it.
- The horse has great difficulty in advancing the limb at all, especially when both Achilles tendons are ruptured.
- The angle of hock deflection is greater than that in rupture of gastrocnemius tendon alone.

Treatment

- Placing the horse in a full limb cast and slinging for 6-10 weeks may be attempted.
- A modified Thomas splint made from a ¾ inch electrical conduit or a cast material may be helpful.
- Use of flexible carbon fibre for the repair of severed tendon has been attempted.

Prognosis : Unfavourable

RUPTURE OF THE PERONEUS TERTIUS

Rupture of the peroneus tertius muscle flexes the stifle, but not the hock.

Anatomy

The peroneus tertius is a strong tendon that lies between the long digital extensor and the tibialis cranialis muscle of the hind limb. It is an important part of the reciprocal apparatus, mechanically flexing the hock when the stifle joint is flexed.

Etiology

- Over extension of the hock joint: When the limb is entrapped and the horse struggles violently to free its limb or during a fast start, when tremendous power is transferred to the limb.
- As a complication of a full limb cast of the hind limb.

Symptoms

- Affected stifle joint flexes as the limb advances and the hock joint is carried forward with very little flexion. That portion of the limb below the hock tends to hang limp as if it is fractured.
- When the foot is put down the horse faces no trouble in weight bearing and shows little pain.
- As the horse walks, however, there is dimpling in the Achilles tendon.

Diagnosis

- History and clinical signs.
- ***Clinicel examination*** : If the limb is lifted from the ground, one can easily produce a dimpling in the tendon of Achilles by extending the hock. It can be noted that the hock can be extended without extending the stifle; this cannot be done in normal limb.

Treatment

- Complete rest is essential. The horse is placed in a box stall and kept quiet for at least 4-6 weeks.
- Then limited exercise is recommended for the next 2 months. Most cases heal and gain normal limb function.

Prognosis : Favourable to guarded.

FIBROTIC MYOPATHY AND OSSIFYING MYOPATHY

The conditions most commonly affect the hind limb and develop as a result of old injuries to the semitendinosus, semimembranosus and biceps femoris muscles. The lesions are generally unilateral. The fibrotic lesion in the semitendinosus muscle has clinical importance as this muscle adhere with the others and thus limits the action of the semitendinosus muscle, causing an abnormal gait. The lameness mostly is seen in Quarter horses because of the nature of the work. Fibrotic myopathy lesions may turn into ossifying myopathy due to ossification of the lesions. Ossifying myopathy has also been reported in the forelimb. A congenital form of fibrotic myopathy-type syndrome has been identified.

Etiology

- **Trauma** : Involved muscles may be injured during sliding stops in rodeo work or resisting a sideline or catching a foot in a halter of from intramuscular injection.
- Etiology of congenital form is not known.

Symptoms

- Lameness, more pronounced during walking.
- ***Abnormal gait***: Cranial phase of the stride is shortened, so consequently the caudal phase is lengthened. In the cranial phase of the stride, the foot of the affected hind limb is suddenly pulled caudally 3-5 inches just before contacting the ground.

Diagnosis

- History and clinical signs.
- ***Palpation*** : A hardened area can be palpated over the affected muscles on the caudal surface of the affected limb at the level of the stifle joint and immediately above it.

- ***Histopathology*** : Shows hyalinization of the muscle cell cytoplasm with loss of striations and moderately pycnotic nuclei.

Differential diagnosis

It should be differentiated with stringhalt. In stringhalt, the limb is pulled toward the abdomen, while in fibrotic myopathy the foot is pulled towards the ground in a caudal direction just before the foot contacts the ground.

Treatment

- ***Myectomy technique*** : Surgical removal of a 4-inch portion of the semitendinosus tendon at the level of the stifle joint has been used under general anaesthesia to treat traumatically induced fibrotic myopathy. The involved piece of tendon is removed at its junction with the muscle belly before the tendon divides. The surgical treatment also includes separation of the adhesions between the semitendinosus muscle and the semimembranosus and biceps femoris muscles.
- ***Partial myectomy technique*** : The insertion of the semitendinosus tendon at the caudomedial region of the proximal end of the tibia is transacted. The technique appears to be equally effective as the previous one, yet it is less difficult to perform and fewer complications have been noted.

Prognosis : Favourable.

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CHAPTER

13

Thoroughpin, Bog Spavin, Spavin, Curb and Capped Hock

THOROUGHPIN

Tenosynovitis of the tarsal sheath is called **Thoroughpin**. The tarsal sheath encloses the deep digital flexor tendon of the hind limb. Thoroughpin is a morphologic description of the swelling at the hollow of the hock on either side of tendoachillis and while most cases would be an idiopathic synovitis. In this condition, synovial effusion develops but without inflammation.

Etiology

- Unknown.
- Conformation.
- Chronic low-grade trauma.

Symptoms

- Distension of the tendon sheath due to effusion is the typical sign.
- No signs of inflammation, pain or lameness.

Diagnosis

- Clinical signs.
- Synovial fluid examination.

Differential diagnosis

Distension of the tarsal sheath may be confused with bog spavin or intertendinous calcaneal bursitis.

Treatment

- Aspiration of synovial fluid and injection of a corticosteroid has been effective.
- Use of bandaging following injection may improve the success rate.

Prognosis : Favourable.

BOG SPAVIN

It is a chronic distension of the tarsocrural (tibiotarsal) joint capsule of the hock, causing a swelling of the dorsomedial aspect of the hock joint.

Etiology

Predisposing cause-Faulty conformation. A horse that is too straight in the hock joint is predisposed to bog spavin.

Exciting causes

- Injury to hock joint.
- Osteochondrosis.
- Deficiencies of calcium, phosphorous, vitamin A or D, alone or in any combination.



Bog Spavin in horse

Symptoms

- Lameness may be present in bog spavin with traumatic origin.
- Appearance of three characteristic fluctuating swellings, the largest of which is located at the dorsomedial aspect of the hock joint. Two smaller swellings may arise on either side of the surface of the hock joint at the junction of the tibial tarsal and fibular tarsal bones. These swellings are lower than the swellings of through pin. Pressing of one swelling will increase tension on others.

Diagnosis

- History and clinical signs.
- Most important factor in diagnosis is to determine the etiology, whether the condition is due to conformation, trauma, osteochondrosis or nutritional deficiency.
- When lameness is present, chip fractures in the tarsus should be ruled out by radiographic examination.

Treatment

- Bog spavin, of traumatic origin, can be treated by injecting corticoid into the joint capsule at weekly intervals for 2-3 injections. Counter pressure by bandaging following injection and rest for 3 weeks are recommended.
- Chronic cases of Bog spavin are treated by conventional methods of firing, blistering and s/c injection of irritants, but without much success.
- Treatment of Bog spavin caused by osteochondrosis consists of removal of bony fragments and curettage of the affected cartilage. Arthroscopy has been proved as an excellent tool for such situation.
- Treatment of Bog spavin caused by nutritional deficiencies is approached by corrective measures in the diet.

Prognosis : Guarded to unfavourable.

SPAVIN (Bone Spavin, True Spavin, Jack Spavin, Osteoarthritis or Degenerative Joint Disease of the distal tarsal joint)

It is an osteoarthritis and periostitis that involves the distal intertarsal, tarsometatarsal and occasionally the proximal intertarsal joints. In most cases, exostosis arises on the postero-infero-

internal aspect of the hock in front of the chestnut (seat of spavin). Exostoses may also be seen at higher region (high spavin), anterior aspect of hock (anterior spavin) or of very large size (jack spavin). Typical spavin lameness with no exostosis present outside is termed as occult spavin.

Etiology

Predisposing causes

- Hereditary.
- Poor conformation (Sickle hock, cow hock or narrow, thin hock.
- Asynchronous movement of the tarsal bone, particularly in the horses that draw a load.

Exciting causes

- Violent movement during rearing, jumping, slipping etc.
- Repeated compression and rotation of the tarsal bones and excessive tension on the attachment of its ligaments.
- Mineral imbalances, deficiencies, excess protein or protein deficiencies as well as endocrine imbalances.

Symptoms

- Presence of exostosis.
- Spavin lameness characterized by imperfect flexion of hock, dragging of the toe, circumduction, long stepping, lowering of hip when the limb is advanced, lameness aggravates when the horse is put to work immediately after a period of rest and diminishes when the animal is exercised for some period, during rest the hock is kept in a state of spasmodic flexion, in some cases and atrophy of the gluteal muscle in long standing cases.

Diagnosis

- History and clinical signs.
- Most cases respond positively to spavin test (hock flexion). The test consists of flexing the hock for 1-2 minutes and then putting the horse into a trot. In positive cases, the horse takes several steps that show more lameness than before the test.
- Radiographic examination provides accurate diagnosis and prognosis.

Treatment

- Needle point firing and blistering may be done to induce ankylosis.
- If corrective shoeing is used, an effort should be made to force the foot of the affected limb to break over the medial aspect of the toe. This can be done by using two heel calks and two additional calks, one near the center of the outside toe, and one between the first and second nail holes on the inside.
- Cuneal tenectomy is removal of a portion of the cunean tendon from the tibialis cranialis muscle.
- A 1.5-inch long incision is made over the center of the longitudinal axis of the cunan tendon where it crosses the medial aspect of the hock under local anaesthesia.
- Isolate the tendon and remove 1-1.5 inch section of the tendon.
- Close the skin wound in a standard manner.
- The horse should be rested for at least 2 months.

- In persistent cases, satisfactory ankylosis is produced by surgical destruction of the joint surfaces.
- Anterior and posterior tibial nurectomies may be attempted as a last resort.

Prognosis : Always guarded.

CURB

It is an enlargement of the planter aspect of the fibular tarsal bone due to inflammation and thickening of the planter ligament.

Etiology

Predisposing causes

- Abnormal conformations like sickle hocks and cow hocks.
- Exciting causes.
- Violent exertion, trauma from kicking walls or tailgates in trailers and violent attempts to extend the hock.

Symptoms

- Enlargement on the planter surface of the fibular tarsal bone.
- In acute cases, lameness, sign of inflammation (heat, swelling, pain etc) are evident. If the inflammation is septic, severe swelling and cellulites occur.
- In chronic cases, tissues surrounding the area often become infiltrated with scar tissue and a permanent blemish results.

Diagnosis

- History and clinical signs.
- Radiographic examination.

Treatment

In acute cases

- Rest, application of ice packs, anti phlogistic pastes and anti- inflammatory drugs are indicated.
- Corticoids S/C into the area of the curb under strict aseptic measures is recommended when no infection is present.

In chronic cases: Firing, blistering and application of iodine ointment are tried.

Prognosis

- Favourable in horses with good conformation of the joint.
- Unfavourable with poor conformation.

CAPPED HOCK

Capped hock, also known as "**pseudobursitis**" of the hock, is a quite common disorder affecting all breeds of horses and sometimes in cattle. A capped hock is simply a distention and inflammation of the bursa that lies at the point of the hock.

It occurs as a consequence of direct trauma such as lying on poorly bedded stall floors, kicking a stall wall, gate, or trailer door, or self-inflicted trauma when lying down to the point of the hock (or tuber calcaneous). Due to injury, separation of tissue planes occurs and as a result

there is accumulation of subcutaneous fluid along the point of the hock. In essence, a "false" bursa (or synovial sac) is formed and with time, the bursa develops a permanent lining that constantly produces synovial-like fluid.



Signs

- Lameness may or may not be present. In most cases, a capped hock is merely a cosmetic blemish.
- Swelling is usually fluctuant (soft) initially, but in due course become quite firm.
- In many cases swelling becomes permanent unless it has been successfully treated during the acute stage.

Treatment

- **Stall rest**—most effective in acute cases.
- **Cold-water application** (also application of ice)—more effective in the acute stage.
- **Topical therapy** with dexamethasone Sweat Spray/DMSO may be helpful in acute, subacute and chronic cases along with a systemic inflammatory like phenylbutazone.
- **External pressure** via wrapping of the area with the elasticized support bandage to reducing swelling. Bandaging of the hock area is very difficult and often results in secondary complications to other support structures in the hock region.
- **Drainage** of bursal fluid via needle aspiration. Although this provides temporary relief, fluid quickly re-accumulates within the bursa unless some measure(s) are taken to prevent recurrence.
- **Intrasynovial** injection of corticosteroids along with antibiotics to check severe inflammation in the bursa if any and possible infection. This technique is not fruitful in every situation but it has proven to be an effective approach for treatment of capped hocks with a chance of recurrence in about 40% of cases treated via this technique.
- **Surgical debridement** of the bursal sac. Since most+ horses with capped hocks are not lame, surgical treatment poses a considerable risk with regard to creating chronic postoperative lameness and is therefore infrequently recommended.
- Recurrence of capped hocks or an initial case may be prevented either by keeping the horse on pasture or provision of sufficient bedding for adequate cushioning when the horse lies down and that the stall itself is large enough so that the horse is not excessively banging himself when he lies down and rises again.

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CHAPTER

14

Bovine Lameness

CONTUSIONS OF SOLE (bruised sole, aseptic traumatic pododermatitis)

The lesion is characterized by the presence of stained horn due to extravasations of the blood affecting one or more feet. More common in cattle that are used to pull heavy load carts, especially on metallic roads for a longer period.

Etiology

- Pressing of a blunt foreign body into the horn.
- Excessive wearing of the sole.

Symptoms

- Lameness of various degrees.
- Flat and pliable sole.
- Affected area turns pink, yellow or bluish initially and finally blackish.
- Adducted or abducted position to avoid weight bearing on the medial or lateral digit respectively.
- The animal is reluctant to walk on hard surface and prefer soft grounds.

Diagnosis

- History and clinical signs.
- Clinical examination of the hoof.
- Hoof tester.

Treatment

- Avoid the animal to walk on hard surface, provide rest and keep the animal on soft bedding.
- Cleaning and freshening of the wound. Use antiseptic dressing and bandaging.
- Antibiotics may be used when infection is suspected.

ULCERATION OF SOLE (Pododermatitis circumscripta)

It occurs at sole-heal junction. Sole ulcer generally occurs on the lateral claw of the hind foot and medial claw of the front foot. It however, more commonly occurs in the hind foot and one or both foot may be affected. Sole ulcer is among the most common causes of lameness in dairy cattle.

Etiology

- Inherited predisposition.
- Excessive weight bearing by lateral claw following horn overgrowth.
- Abnormal claw.

Symptoms

- Moderate to severe degree of lameness.
- Under-run heel horn exposes sensitive laminae.
- Granulation tissue may protrude through horn.

Diagnosis is made from clinical signs.



Ulceration of sole in cattle

Treatment

- The aim of treatment is to relieve pressure on the ulcer.
- Therapeutic trimming consist of pairing out of the affected area around the ulcerated sole or lesion that helps to relieve pressure and allows healing to occur.
- Topical application of copper sulphate and /or astringents followed by bandaging is necessary to control infection and prevent regrowth of the granulation tissue.
- Confine to box and straw bedding for 5 days.

Prophylaxis

- Avoid overgrown claws and factors predisposes to laminitis and interdigital dermatitis.
- Do not breed from affected young cows.

LAMINITIS (Pododermatitis aseptica diffusa or diffuse aseptic coriitis)

Laminitis is the inflammation of laminae and papillae inside the hoof. It can be broadly classified into three categories depending upon the severity and duration of the illness i.e. acute/ sub acute, chronic and sub clinical laminitis. Laminitis is one of the leading causes of lameness in cattle. In addition to the economic importance, laminitis is also considered as a welfare issue in animals due to severe pain and stress felt by the affected animals.

Symptoms

Acute/sub acute laminitis

- Lameness accompanied by systemic illness.
- All feet may be affected.
- Animals are often seen standing with all feet tucked up underneath the body or with their front feet close together or crossed.
- Animals refuse to move, particularly on the hard ground.
- In severe cases, animal may not be able to rise.
- Muscular tremors and excessive sweating are also common.
- The pulse and respiratory rates are often increased.
- Mucous membranes are hyperaemic but rectal temperature is usually normal.

- The hooves are tender and warm above the coronary band.
- A prominent distension of the veins is common in hind legs.
- Pulsation can be felt on the volar common digital artery at the distal quarter of the metacarpus.
- Swelling, redness and tenderness of the band may also be present.

Sub clinical laminitis

- Hooves show irregular and marked horizontal ridges and concavity at the dorsal wall. Flattening, broadening and overgrowth of the hooves.
- Horn becomes physically softer and there may be yellowish discolouration of the sole.
- Haemorrhagic stains are manifested in the solar area particularly in the area of white line, apex of the sole and sole-heal junctions. These haemorrhagic lesions become more evident on trimming the sole.
- White line separations, frequent dorsal wall ridges and rotations of the pedal bone are characteristic internal manifestations of subclinical laminitis.

Chronic laminitis

- The local changes in chronic laminitis are more severe and advanced than the subclinical form.
- The growth pattern of the keratinised horn is disrupted and the shape of the digit is altered to become more elongated, flattened and broadened.
- The groves and ridges on the dorsal wall become more prominent giving the hoof a rippled appearance.
- Internally, the pedal bone could be separated from the dorsal wall.
- Ulceration can be demonstrated at the solar regions of the foot.
- Double sole with yellowish discolouration.
- The white line may be loosened and penetration of the white line with dirt and infection may result in white line disease.
- In severe situations, the distal aspect of the pedal bone can protrude through the corium and hard horned tissue of the sole.

Treatment

The multifactorial etiology and obscure pathogenesis of laminitis make the treatment difficult. Therefore, the symptomatic treatment has been the most popular treatment of laminitis.

- Acute inflammation and pain can be controlled by administration of NSAIDs, the antihistaminic or corticosteroids.
- Jugular phlebotomy has also been recommended by various workers. Removing of 3 to 5 litres of blood by jugular phlebotomy was found quite effective. However, the mechanism whereby this technique works is not clear.
- Removing the animal from the suspected cause is by far the most important step. The animal should be kept in a comfortable environment with soft bedding and adequate rest. Feeding of carbohydrate diet should be stopped and adequate dry hay may be helpful.
- The administration of mineral oil may be useful to block absorption/remove the toxic substances from the gut.

- Administration of peristaltic stimulants may be beneficial in accelerating the action of mineral oil.
- Transfer of rumen contents from healthy animals to diseased animals in cases of acetonaemia may also be useful. About 5 litres of ruminal contents can be transferred after removing the abnormal contents as much as possible.
- Administration of electrolytes containing sodium carbonate intravenously as well as orally may be useful is correcting the acidosis.
- In the early course of the disease, if there is no perceptible heat in the hooves, hot w therapy may be helpful to eliminate the toxic elements through vasodilatation and incr circulation.
- In later stages, however, standing the cattle in cold running water could be useful.
- Claw trimming may also be useful to dig out hoof lesions, provide drainage, and to lowe the lesion area to have proper healing.
- In severe cases, application of foot block (nailed/adhesive) to normal claw is done.
- In more severe case, digit amputation is carried out.

Prevention and control

Laminitis related lesions have a high heritability. Diet and feeding arrangements are importa to prevent and control laminitis. All measures to increase the optimal rumination and reduce th risk for acidosis should be applied. Supplementation of trace elements, minerals and biotin ma have beneficial effect on hoof health in intensively managed primiparous dairy calves. A sudde change in the diet should be avoided when the animals are first introduced to concentrate feeds. The animals should be raised in a comfortable environment. Sudden transfer of the animals t hard surface at the time of parturition should be avoided. Free stalls with enough lunge space and soft bedding to improve line comfort will reduce involuntary standing and exposure to hard surface. Claw trimming has been found to reduce the lameness associated with laminitis when correctly performed. Regular claw trimming can also help to detect lesions at an early stage and also prevent lesions by correcting the loading.

DECLAWING/AMPUTATION OF THE ACCESSORY DIGIT (Dewclaw)

Amputation of the accessory digit of the hind limb is described to prevent self-inflicted tea laceration.

Surgical technique

- Simple and easy to perform on calves of 4-8 weeks of age.
- The animal may be sedated and restrained in lateral recumbency.
- Area around accessory digit is prepared for aseptic surgery.
- Apply local block around the dewclaw.
- The dewclaw is pushed proximally to avoid resection of the planter annular ligament and planter common digital artery.
- Start dissection with a sharp scalpel to remove the dewclaw.
- Adopt haemostasis.
- Apply antiseptic ointment and bandage the wound.
- If surgery is done on older cattle, a tourniquet around the digital metatarsus may be used to control haemorrhage.

SAND CRACKS (Vertical and horizontal fissures, wall cracks, quarter cracks)

Vertical fissures or sand cracks are longitudinal fissures of the dorsal horn wall of the hooves of ungulates. In addition to age, the prevalence of fissures increases with increasing weight and body condition score.

Etiology

Predisposing factor

- Hereditary.
- Dry weather.

Exciting causes

- Imperfect horn growth as a consequence of coronet injury.
- Improper diet.
- Chronic laminitis.

Symptoms

Animal feels severe pain when the underlying tissue gets exposed or the coronet is involved.

Treatment

- Continuous rasping, inverted 'V' shapes firing, filling the coal tar and synthetic resins reduce the extension of ventral sand cracks.
- Treatment of horizontal fissure includes removal of a section of horn at toe to reduce the movement of loose wall during locomotion. In severe painful condition a hoof block should be applied to the sound claw. Nerve blocks may be tried and whole digit must be desensitized. After some time the 'thimble' of the claw will gradually grow out and animal will be normal. However, in severe cases with all the four limbs affected, it may be advised to cull the animal.

INTERDIGITAL SKIN HYPERPLASIA (Interdigital granuloma, Interdigital vegetative dermatitis, fibroma, wart)

It is proliferative reaction of interdigital skin and /or subcutaneous tissue to form a firm mass. It can affect one or more limbs, but hind limbs tend to be affected more frequently.

Etiology

Predisposing factors

- Common in heavy, fat animals such as bull and mature cows.
- Cattle with splay toed feet.
- Common in Holstein.

Symptoms

- Moderate lameness.
- Lesion may be large enough for visual inspection at the dorsal interdigital area.

Diagnosis

- From clinical signs.
- Examination of the interdigital area.

Differential diagnosis : Should be differentiated from interdigital necrobacillosis ar interdigital foreign body.

Treatment

In simple cases with small growths, the treatment may not be necessary.

Surgical removal may be required in advanced cases. The mass should be removed leavi as much of interdigital skin as possible. If any fat pretends when the claws are pressed togeth it should be removed. A snugly bandaging with a figure of eight may be applied over a cott support. Parenteral administration of antibiotic and topical application of antiseptic/antibiot ointment (copper sulphate-sulfanilamide 1:4) results in good healing.

HOOF DEFORMITIES

Hoof deformities may be hereditary or acquired. Intensive housing, heavy feeding concentrates and environmental stress on hoof may contribute acquired hoof deformities. ***Vario types*** of hoof deformities include:

Elongated hoof : Hoof may become elongated or overgrown due to lack of proper we Breeding bull is most commonly affected with involvement of one or more feet. Lameness a deformity of the claw are present. The toe and quarters of the hoof are elongated and the affect digit may be turned in. Treatment consists of trimming of the excess horn tissue.

Beak claw : A hereditary condition where the toes are turned up and the dorsal surface the hoof is concave whereas the weight-bearing surface is convex. The animal rocks wh standing due to the convex weight-bearing surface and feel difficulty in walking. The conditi is incurable.

Scissor claw : It is characterized by overlapping of the toes as a sequel to excessi overgrowth of both the hooves. Severe form of chronic laminitis may cause this abnormali Treatment consists of trimming of the hooves.

Corkscrew claw : It is an inherited condition where there is inward spiraling of the abax hoof wall of the lateral hind claw towards the medial claw. Generally the condition is manifest before three years of age. There is abnormal angulation of the middle phalanx. The result strain on the abaxial collateral ligament of the distal interphalangeal joint leads to periarticu exostosis; this in turn puts mechanical pressure inside the hoof causing increased horn producti on abaxial wall and thus the axial rotation of the digit. In severe form, the animal is unable move with adverse effect of production. Treatment consists of trimming of the affected claw

Corrective paring is an essential prophylactic measure particularly in intensive dairy farmi to avoid hoof deformities.

Preventive measures

- Preventive management for foot disorders requires knowing the cause of ailment. It difficult to ascertain any single causative factor for occurrence of foot lesion. In most the cases the etiology is multi-factorial depending upon the combination of environment managemental and stress factor.
- Preventive measures are mainly concerned with the managemental faults *viz.* lack paddock hygiene, irregular trimming, excessive or faulty nutrition. Providing pacca a insufficient floor, lack of exercise/grazing and negligence in early diagnosis etc.

- Over crowding should be avoided.
- Dairy cows should be allowed to lie down 10 to 14 hours per day. Prolonged standing causes sore feet that can become susceptible to a disease.
- Exercise grazing is important for stimulating blood to flow through the feet and keeping the tissue healthy.
- Soft bedding is essential and it must be free of small stones, which can penetrate the sole horn.
- Regular hoof trimming may increase the functional life of a dairy cattle by providing the claw stability and distributing weight equally between the claws.
- Topical sprays and footbaths of antiseptics or antibiotics, some times are very beneficial to protect the feet from many digit disorders.

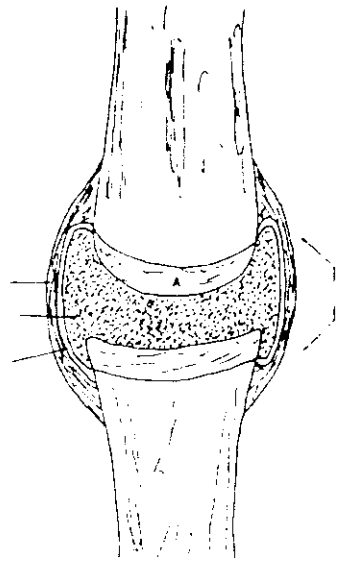
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CHAPTER 15

Specific Joint Diseases in Large Animals and Treatment

ANATOMY OF JOINTS

- Articular surfaces are specialized layers of compact bone on the surfaces which articulate with other bones.
- Articular cartilage (hyaline cartilage) consists of water, cells (collagen type II) and intermediate ground substances. Hyaline cartilage has smooth and cloudy surfaces, ensures softening of mechanical impacts between adjoining bones, closure and smoother contact to joint ends and makes nearly friction less movement. Cartilage is avascular, receives nutrition from the synovial fluid and having no nerve endings. Cartilage injured or destroyed by pathological process cannot be repaired and damage to this tissue is usually permanent in nature.
- Joint capsule consists of two layers *i.e.* internal (synovial) and external (fibrous) layers. The synovial membrane consists of elastic fibers and connective tissue extending from the edges of the articular cartilages of the adjacent bones. This membrane is vascular tissue and secretes the synovial fluid (joint oil). The outer fibrous layer connects adjacent bones and help to stabilize the joint.



Normal synovial joint. (A) Articular cartilage, (J) Joint cavity, (C) Joint capsule, (F) Fibrous layer, (S) Synovial lining.

- Synovial fluid is sticky, viscous, clear or somewhat cloudy. It contains hyaluronic acid, sodium chloride, residual nitrogen, mucin, proteoglycans, protein, WBC and other biochemical mediators. The main function of synovial fluid is to lubricate the joint, provide nutrition for cartilage and ensures smooth and light movement of the joint.

Synovial fluid analysis plays a vital role in diagnosing joint disease as the quality of synovial fluid deteriorates following joint injury and inflammation.

- Ligaments are connective tissue bands that connect bones across the joint whereas tendon connects muscle to bone. Ligaments in relation to joints are of various types *i.e.* intra-articular ligaments and peri-articular ligaments (anterior and posterior ligaments and annular ligaments). Ligaments are flexible and relatively in elastic in nature.

CLASSIFICATION OF JOINTS

Joints can be classified according to anatomical development, nature of uniting structures and their normal range of movement or by combination of both.

- Fibrous joint or Synarthrosis is an immovable joint and is united with connective tissue. *e.g.* cranial sutures.
- Cartilaginous joint or Amphiarthrosis has a hyaline cartilage, fibrocartilage or a combination of both and allows limited motion between bones (vertebrae, pelvic symphyses and epiphyseal plates of growing long bones).
- Synovial joint or Diarthrosis has a joint cavity with a synovial membrane lining the joint capsule. Synovial joints are freely movable and are commonly associated with injury. The major joints of the appendicular skeleton are of this type (*e.g.* elbow, stifle and hip).

JOINT DISEASES IN LARGE ANIMALS

SEPTIC ARTHRITIS

It is the inflammation of the synovial membrane and articular surfaces caused by infection.

Etiology

- Bacterial arthritis (Staphylococci, Streptococci, Coliform, Salmonella) and Mycoplasma (in claves and lambs).
- Haematogenous infectious arthritis- commonly seen in calves and lambs.
- Umbilical infection, retropharyngeal lymph node abscessation, urogenital tract infection, suppurative mastitis, metritis, pneumonia, endocarditis, myocarditis and enteritis.
- Direct penetrating trauma.

Signs

- Acute onset of pain, lameness and a hot and distended joint capsule.
- Systemic signs of pyrexia, depression and anorexia.
- Joint capsule may rupture to form an open joint (in severe cases).

Diagnosis

- From clinical signs.



Infectious arthritis of carpal joint in horse

- Radiographic imaging includes periarticular soft tissue swelling, distention of joint capsule, increased joint space, periosteal proliferation and concurrent osteomyelitis.
- Laboratory testing of synovial fluid.

Treatment

- Immediate treatment.
- Both systemic and intra-articular antibiotic therapy.
- Removal of purulent exudates by drainage and joint lavage (Needle debridement, through-and-through lavage, arthrotomy with or without synovectomy).

OSTEOCHONDRITIS DISSECANS

The term **osteochondrosis** refers an abnormal development of the cartilage on the end of a bone in the joint. **Osteochondritis dissecans** (OCD) is an inflammatory condition that occurs when the diseased cartilage separates from the underlying bone. It most commonly affects the shoulder joint but the elbow, hip, or knee (stifle) may also be involved.

Incidence

This is a developmental disease that occurs in rapidly growing medium to large/giant breed dogs typically between 6 and 9 months of age, more often in male dogs than females (due to the males' larger size and increased stress on the joint) and receiving too much energy and calcium in the diet. It has been reported in small dogs and cats, though it is not very common.

Etiology

The etiology of OCD is considered to be multifactorial. Factors that contribute to the formation of OCD lesions include trauma to the joint, genetics, rapid growth, low copper and high zinc levels, hormone imbalances, and nutrition.

- ***Trauma:*** Injury to the surface cartilage may lead to the separation of the cartilage from the bone or cause a decrease in blood supply that leads to cartilage flap formation.
- ***Genetic predisposition:*** genetic link between parents and offspring and the formation of the disease.
- ***Rapid growth:*** it occurs during periods of rapid growth. Therefore, it has been suggested that nutrition that creates rapid growth may lead to the increase in incidence of the disease.

Clinical signs

- Limping/lameness in the affected leg or legs and possibly some muscular atrophy. The lameness tends to deteriorate after periods of exercise and improves after rest.
- During manipulation of the affected joint, the dog will often cry out in pain.
- The affected joint may be swollen and warm to the touch. In some cases, the lameness may be mild and intermittent while in other cases, the dog may be in constant pain, and avoids bearing weight on the affected leg.
- If affects the shoulder, a shortened forelimb stride may be noticed due to reluctance to flex and extend the shoulder joint.

Diagnosis

- Based on history, age, breed, sex, clinical signs and physical examination.
- ***Radiological examination***-several radiographs/views are necessary in order to get an accurate assessment of various bones and joints. Sometimes, short-acting anesthetic or sedative may be required in order to achieve full relaxation of the joint and the optimal positioning for diagnostic purposes. If the radiographs are not positive but OCD is still suspected, radiographs may be taken again in 2 to 3 weeks.
- For confirmatory diagnosis, arthroscopic examination may be done.
- Computed tomography (CT-scan) and magnetic resonance imaging (MRI) are also valuable diagnostic tools for visualizing the extent of any internal lesions.

Treatment

For treating this OCD, two approaches either conservative medical treatment or surgical removal *of the lesion can be accomplished.*

Conservative treatment: Indicated for dogs that have early mild symptoms of OCD or where a specific lesion cannot be identified on radiographs.

- Strict rest for 4 to 8 weeks and leash walking but no running or playing is allowed.
- Anti-inflammatory and painkillers drugs may be indicated along with the use of glucosamine/chondroitin products.
- "Passive range of motion" exercises in which move the joint through its normal range of motion while dog is lying on its side to maintain the joint's flexibility and mobility.

Surgical management : Surgery is indicated in animals with severe symptoms, in cases where radiographs are highly positive or when conservative treatments fail. Surgery includes opening the affected joint (or by using an arthroscope) and the offending flap, defect, or joint mouse is removed. The animal will be restricted to short leash walks only and passive range of motion exercises for the first 2-3 weeks postoperatively. Anti-inflammatory medications and joint supplements will be provided. After 3 weeks, the amount of controlled exercise will be increased, and specific rehabilitation exercises such as swimming may be prescribed.

The **prognosis** is favourable in shoulder joint and guarded in elbow joint affection. In all cases, the prognosis improves if surgery is performed early in the course of the disease and before secondary degenerative joint disease occurs.

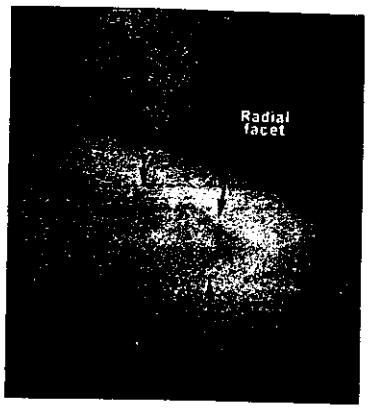
Prevention is aimed at good genetic selection (careful selective breeding), reduced activity (Avoid jumping activities), careful feeding (provision of good balanced diet) and weight control (to avoid unnecessary stress on the joint).

DEGENERATIVE JOINT DISEASE (DJD)

Degenerative joint disease is a slowly progressive disease of diarthrodial joints, affecting load-bearing joints in particular. It is characterized by articular degeneration, eburnation of subchondral bone, synovial effusion, bone remodelling, low grade synovitis and periarticular fibrosis. Degenerative joint disease is also called osteoarthritis, arthritis, osteoarthrosis or degenerative arthritis.

Etiology

- Trauma, ageing, nutritional deficiencies and inheritance.
- Progressive articular deterioration due to stress.
- Abnormal stress in normal cartilage or normal stress in abnormal cartilage.
- Release of inflammatory mediators from synoviocytes and chondrocytes.
- Enzymatic degradation of cartilage.
- Secondary to or associated with rickets, osteomalacia, magnesium deficiencies and flurosis.



Arthroscopic view of DJD

Clinical signs

- Slow progressive lameness which may be intermittent mild to severe.
- Shorter stride.
- Decreased joint motion and decreased weight bearing.
- Shifting of weight.
- Signs worsen after exercise, during wet and cold weather.
- Affected animals spent more time in recumbency if pain, lameness and stiffness are severe.

Diagnosis

- From clinical signs and physical examination.
- Radiographic changes include periarticular swelling, joint effusion, joint space narrowing, subchondral bony sclerosis and osteophyte formation.
- Examination of synovial fluid.
- Bony remodelling (severe cases).

Treatment

Non-surgical and non-medical

- Rest is an integral part.
- Controlled exercise on soft surface.
- Weight control.
- Therapeutic heat and cold therapy.

Medical management

- NSAID-aspirin/phenylbutazone reduces soft tissue inflammation and pain.
- Corticosteroids.
  - PG synthesis inhibitor.
  - Chronic administration-hastens degeneration of cartilage.
  - Depression of hypothalamic pituitary-adrenal axis.

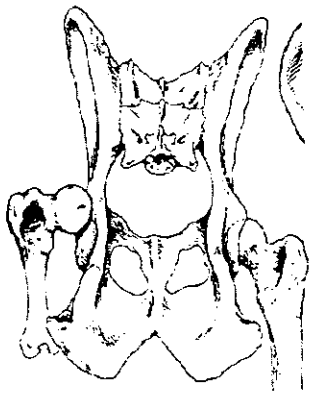
- Joint fluid modifiers may be used but cost of treatment and value of animal must be considered.

Surgical management

- Arthroscopic intervention
- Arthrodesis

DISLOCATION OF HIP (Dislocation of coxofemoral articulation, coxofemoral luxation)

The condition is common in bovine and rare in equine. It may be bilateral or unilateral. The dislocations may occur in craniodorsal, cranioventral, caudodorsal and caudoventral directions. Craniodorsal dislocation is more common followed by caudoventral dislocation.



Schematic diagram of hip dislocation

Etiology

Predisposing factors

- Anatomical peculiarities in bovine hip predispose the species to hip dislocation. In bovine, the acetabulum is comparatively shallow, its superior border is deeply notched, and the articular head of the femur has a smaller radius of curvature. The ligament is entirely intra-articular and sometimes absent while the accessory ligament is always absent.
- In cows, the condition is more common during estrus or parturition. It is thought that oestrogen may increase the elasticity of the ligaments causing coxofemoral luxation.
- The laxity of the pelvic ligamentous structures at the time of parturition and associated weakness and ataxia caused by milk fever, acetonaemia or obstetrical obturator nerve injury may predispose to hip dislocation.

Exciting factors

- Trauma.
- Slipping.
- Jumping or mounting on other animals.

Clinical signs

- Lameness of various degrees.
- Limited abduction, easy adduction and a pronounced shortening of the limb with unusual prominence of the great trochanter.
- There is a great swelling of the soft tissue along the femur and around the hop joint.
- In caudoventral luxation, the animal is usually recumbent and unable to stand.

Diagnosis

- History and clinical signs.
- Clinical examination of the affected joint.

- Rectal examination of the femoral head at the brim of the pelvis or in the obturator foramen is helpful to diagnose caudoventral or cranioventral dislocation.
- Radiography demonstrates dislocation of the femoral head.

Treatment

Close reduction : Close reduction may be effective when it is attempted within 12-18 hours.

Technique

- Restraint the animal in lateral recumbency with the affected limb uppermost under general anaesthesia or deep sedation.
- Pass a rope under the thigh in the inguinal region and tie it to a fixed object to prevent movement of the pelvis.
- Tie another rope to the lower part of the affected limb above the fetlock.
- Apply traction using a block, ropes and a pulley.
- Apply traction initially in a line, which passes through the displaced femoral head and acetabulum. During this process, the femur should be rotated by pushing down on the stifle and lifting the hock.
- When the femoral head is returned to its position a sudden "clunk" is felt.
- If reduction is not achieved, the femur may be rotated in the opposite direction or prolonged traction may be needed to pull away the femoral head from the pelvis.
- Reluxation is a common problem after successful close reduction.

Open reduction

- Prepare the hip area for aseptic surgery.
- Approach the joint through a craniolateral incision, which centers over and just cranial to the greater trochanter. The incision is continued through the fascialata along the cranial border of the biceps femoris muscle and extended proximally through the gluteal fascia.
- Retract the fascialata cranially, the biceps femoris caudally and the middle gluteal muscle dorsally to expose the joint capsule and the femoral head and neck.
- Reduce femoral head in the acetabulum. After this the greater trochanter is replaced somewhat distally using multiple 3 mm Steinmann pins and 18 gauge wires placed in a 'figure of eight' tension band fashion.
- Close the wound in layers.
- Animal is maintained on a non-slippery floor and antibiotic and analgesic coverage is provided for 7 days.

Prognosis : Poor.

EXCISION ARTHROPLASTY (Femoral head and neck osteotomy)

Excision arthroplasty (Femoral head and neck osteotomy) is indicated as a last resort to relieve pain and make use of the animal for breeding and milk purposes.

Technique

- Expose the joint as above.
- Dissect through the joint capsule and remove the femoral head and neck using osteotome or wire saw.
- Close the joint capsule or leave it, as the new pseudo joint will form.
- Close the wound in a standard manner.
- Animal is maintained on a non-slippery floor and antibiotic and analgesic coverage is provided for 7 days.

Prognosis : Though the animal remains lame, the outcome is good.

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CHAPTER

16

Specific Joint Diseases in Dogs and Their Treatment

OPEN JOINT

Open joint is commonly observed in animals and leads to a danger of severe complications. The wounds are penetrating or lacerated caused by nails, broken glass, barbed wire etc. and traumatic due to accidents. It may also occur as a consequence of hoof blows by other animals, falling, slipping and rupture of joint capsule. There may be injury of cartilages and epiphyses and sometimes leads to intraarticular fracture.

Clinical signs

- Escape of synovia and becomes cloudy on the third-fourth day.
- Infection may likely to enter into the joint and cause infectious arthritis.
- Elevation in the general body temperature is observed in horses.
- Lameness of the affected limbs.
- Tissues in the vicinity of wound become oedematous and painful.

Treatment

Treatment of this condition should be directed on general principles as for infectious arthritis and open wound. The following approaches may be followed:

- Basic requirements for this condition are rest to the animal and protection of open joint against secondary infection.
- Early debridement and joint irrigation are mandatory.
- Preservation of articular cartilage and other supporting structures of joints as far as possible.
- Appropriate parenteral antibiotic therapy based on the culture and sensitivity test is necessary.
- Decision on closure of the skin over the wound depends upon the degree of tissue injury and their possible contamination.
- Finally, immobilization of the affected limb is considered an integral part of therapy.

SPRAIN OF JOINT

Sprain of joint may be partial or complete tearing of some of the supporting structures of the joint caused by abnormal movement, falling, slipping and false stepping.

According to the degree of tissue damage sprain may be:

- First degree with stretching or minimal tearing of ligament. The clinical signs are mild inflammation, tenderness, swelling and pain.
- Second degree with partial tearing of ligament. The clinical signs are inflammation, tenderness, swelling and moderate pain.
- Third degree with complete tearing of ligament. The clinical signs are inflammation, tenderness, swelling, severe pain and joint instability.

Treatment

Treatment should be directed based on the severity of tissue damage.

(*a*) **Conservative treatment**:

- Rest and bandaging of the affected joints.
- Cold and astringent application.
- Application of moist heat and blistering in chronic case.
- Application of iodine ointment for resorption of inflammatory exudates.
- NSAIDs may be useful in acute stages to reduce inflammation and discomfort.
- Mild exercise in recovery stages is essential.

(*b*) **Surgical treatment**

- Surgical repair in unstable joints is necessary either by direct suturing of ligament or by prosthetic ligament techniques.
- In chronic and severe cases of multiple ligament injury, arthrodesis of the joint is indicated.

INTERVERTEBRAL DISC DISEASE (IVDD)

Intervertebral disc disease occurs when the disc material between the vertebrae ruptures, forcing its interior fluid out towards the spinal column. This puts the spinal column under a great deal of pressure, causing pain and possibly paralysis.

There are two general places where IVDD occurs: **Cervical** and **thoracolumbar.**

IVDD is rarely seen in the thoracic region because extra ligaments connect the ribs and help to reinforce the outer, fibrous portion of the disc.

Classification

Two types of Intervertebral Disc Disease :

Type I IVDD

- Complete rupture of disc.
- Primarily occurs in dogs breed that have short, thick legs.
- Occurs at a young age (3-6 years).
- Commonly occurs in several sites.
- Relatively quick developing with serious consequences.

Type II IVDD

- Protrusion of disc material without complete rupturing.
- Typically occurs in large breed dogs.
- Seen in older dogs (8-10 years).
- Usually occurs in only one disc.
- Clinical signs develop slowly.

Cervical IVDD

There can be instability between C-1 and C-2. This can cause neurological probl especially in large dogs.

Signs

- Dog may appear quiet and lethargic.
- Sensitive to touching in the neck area or obvious neck pain.
- Shivering.
- Crying when moving head.
- Decreased appetite.
- Dragging of rear legs or paralysis of all four limbs (tetraparesis).

Thoracolumbar IVDD

Thoracolumbar IVDD is very common area to have disc disease.

Signs

- Quiet and lethargic.
- Sensitive upon touching back area where ribs end.
- Shivering.
- Crying.
- Dragging of rear legs.
- Inability to move.
- Decreased appetite.
- Hunched back.
- Uncontrollable bladder and bowel movements.
- No feeling, or paralysis in rear end.

Other Characteristics and signs of IVDD

- One side of the body may be affected more than the other due to the disc materia bulging on one side more than the other.
- Muscle spasms around the affected area of the spinal cord may also occur.

Genetics of IVDD

- Polygenic
- Heritability has been estimated to be approximately 0.7 in dachshunds.
- Presence of disc calcifications at an early age may indicate the likelihood of future development of IVDD.

Diagnostic tests

- **Myelography**-It is the contrast radiographic study which is able to distinguish disc protrusion from other diseases such as spinal neoplasia and degenerative myelopathy and is most important in determining the site (s) of disc herniation as well as in lateralization of the disc material within the spinal canal prior to surgical decompression.
- Spinal Tap.
- Radiographs.
- CT scan.
- **Magnetic Resonance Imaging** provides information about the health of the spinal cord and is used if myelogram is inconclusive.

Treatment options

- Medication and strict cage rest.
- Surgery.
- Acupuncture and therapeutic ultrasound.
- Neuromuscular stimulation.
- Massage and passive range of motion.
- Hydro-treadmill.
- Ambulation exercises.

Treatment : Medication and cage rest

- Anti-inflammatory drugs will help alleviate pain by reducing the swelling around the spinal cord.
- Along with cage rest, medications will allow the disc time to repair with no additional fluid leakage.
- Dog should be let out only when necessary and should be on a short leash at all times.
- Consider surgery if there is not improvement within three weeks.

Surgery

- Recommended if dog is showing signs of neurological damage or with repeated episodes of pain and weakness.
- Surgical procedures are the only way to remove disc material that is compressing the spinal cord.

Prognosis typically ranges from fair to good. Prognosis is poor with paralysis or if there was a loss of pain perception for more than 24 hours.

Physical therapy

- Acupuncture is used to increase the rate of nerve regeneration and to relieve pain.
- Ultrasound can be helpful in decreasing inflammation, pain and muscle spasms.
- Neuromuscular stimulation can help to slow down or prevent muscle atrophy.
- Gentle massage is used to stimulate circulation.
- Range of motion can be used to prevent joint degeneration.
- Hydro-treadmill and ambulation exercises help to strengthen and re-educate the activities of muscles and nerves.

SPONDYLOSIS

Spondylosis (also called spondylosis deformans, ankylosing spondylitis, or diskospondylosis) is a generalised disease of ageing secondary to the degeneration of intervertebral disks which lie between the vertebrae in the spine. Generally osteophytes (bone spurs and are bony projections) grow on the ventral and lateral surfaces of the vertebral bodies. It rarely causes problems as spinal cord does not become compressed; however the spine will be immobilized in that particular location.

Etiology

The exact reason of spondylosis is not understood, but it is a non-inflammatory disease.

- The spinal changes that occur in spondylosis are a response to instability in the intervertebral disk spaces of the spinal column.
- Although, mapping of the canine genome is well under way, the condition is unlikely to be a simple inherited problem (genetic predisposition).
- Too much intake of vitamin A has been concerned in some cases of spondylosis in cats (due to feeding a lot of fresh liver).
- Contributory factors include obesity, injuries, other orthopedic problems, poor diet and over-or under-exercising.

Breed Occurrence

Spondylosis occurs at all ages but increases in incidence in geriatric animals. The breed predilection of spondylosis is more frequently in some breeds such as Boxers and large breeds of dog like German shepherds. Nowadays it is thought that all dogs and cats, regardless of breed or sex, will develop a degree of spondylosis if they live long enough.

Signs

Spondylosis is often present in animals without causing any clinical signs.

- If nerve roots that lead out from the cord to the peripheral nerves become encircled or pressured, spondylosis can lead to pain and suffering for the animal.
- The most common signs are stiffness, difficulty in getting up or down, difficulty in jumping, lameness (limping), back pain and sometimes knuckling or dragging of the feet.

Diagnosis

- **Radiological examination.** It is characterised by the formation of new bone (osteophytes or spurs) around the affected disk, and occasionally complete bridges can form causing stability across the disk space. Myelogram is often used to diagnose spinal cord compression if suspected.
- CT (computed tomography) and MRI (magnetic resonance imaging) will also reveal the lesions.

Treatment

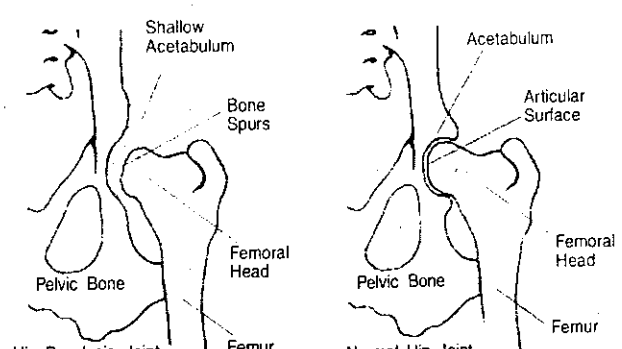
The treatment of this condition depends almost solely on the degree of back pain, lameness, stiffness or loss of muscle mass the patient experiences.

- Symptomatic treatment with pain killers for pain relief (either NSAIDs or corticosteroids).
- There is no generally accepted satisfactory surgical treatment. Some severe cases, however, may necessitate surgery to relieve the pressure on the spinal cord caused by the bone spurs.
- The use of nutraceuticals (like glucosamine) or polysulfated glycosaminoglycans appear to be helpful to the cartilage between the joints, may well improve function and decrease pain.
- Acupuncture is probably the most common alternative treatments now being utilized.
- Obese animals need to reduce the body weight by feeding high fiber and low fat foods, getting adequate water along with its food intake and plenty of exercise especially swimming in the water.
- Moist heat application in treating moderate to mild pain and help in reducing its intensity.

Prognosis. The prognosis is guarded because the disease cannot be totally treated. Long term setback is total ankylosis of the spinal column in the worst affected cases. This can lead to an abnormal gait and difficulty negotiating stairs, jumping and other activities in which movement of the spine is important.

HIP DYSPLASIA

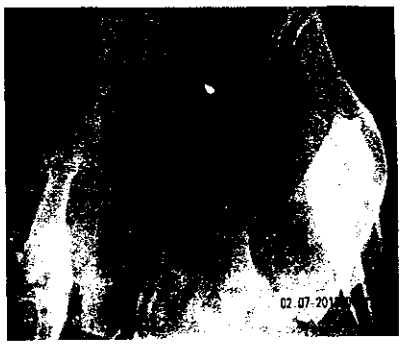
Canine hip dysplasia (CHD) was first described by Schnelle in the mid-1930s and today, is the most common orthopaedic disease in large and giant-breed dogs. The simplest definition of hip dysplasia is a literal translation from its Latin roots: "faulty development of the hip". A more descriptive definition was introduced by Henricson *et al* in 1966; hip dysplasia is "a varying degree of laxity of the hip joint permitting subluxation during early life, giving rise to varying degrees of shallow acetabulum and flattening of the femoral head, and finally inevitably leading to osteoarthritis".



Hip dysplasia joint **Normal hip joint**

Incidence of the condition is most common in large and giant breeds. Prevalence varies by breeds of dogs and the **Orthopaedic Foundation for Animals** has estimated that for many of the popular breeds of dogs, the breed prevalence of CHD is between 10 and 48%.

Causes



- Genetic (polygenic) and environmental factors (body size, growth rate, nutrition, dietary anion gap, in utero endocrine influences).
- Disparity between muscle mass and disproportionately rapid skeletal growth.
- Permeability and mechanical strength of the joint capsule.

Signs

The clinical signs of this condition can be seen either in young dogs between 4 and 12 months of age or in dogs over 15 months of age with chronic disease.

- Difficulty in rising with decreased willingness to walk, run and climb stairs (in young dogs).
- Positive **Ortolani sign** (Sign is detected by placing the animal on its back and forcing the femurs dorsally. The limbs are then slowly abducted. A positive ortolani sign exists when the femoral head palpably seats into the acetabulum as the limb is abducted).
- Lameness after prolonged or heavy exercise, a waddling gait and restricted range of motion of the joint (in older dogs).
- Prefers to sit rather than stand and gets up slowly with great difficulty.

Diagnosis

- History and clinical signs.
- Physical examination by palpation of 6-8 weeks old puppies for hip joint laxity.
- Radiographic examination preferably sedated, in dorsal recumbency, its legs fully extended and its stifle internally rotated.
  - **Mild**—Slight flattening of the femoral head with minor subluxation.
  - **Moderate**—Shallow acetabulum, flattened femoral head, poor joint congruency.
  - **Severe**—Complete dislocation of the hip joint and severe flattening of the acetabulum and the femoral head.

Treatment

Conservative treatment includes minimizing activity to restrict the exercise below the level of hips, weight control and analgesic therapy (Buffered aspirin @10-15 mg /kg b wt 12 hrly or meloxicam, Carprofen@ 2 mg/kg bwt, prednisolone@ variable, avoid in chronic cases) to relieve pain and use of joint fluid modifiers.

Surgical management of hip dysplasia includes palliative (Pectineal myectomy), Preventive (Intratrochanteric osteotomy, Pelvic osteotomy), Salvage (Femoral head and neck excision, Total hip replacement, Pectineal myectomy).

ELBOW DYSPLASIA

Elbow dysplasia may also occur in dogs and is characterized by generalized incongruence of the elbow associated with fragmented medial coronoid process of the ulna, ununited anconeal process or osteochondrosis of the medial humoral condyle.

Fragmented medial coronoid process (FMCP)

Incidence: This condition is most frequently occurred in giant-breed dogs, especially Labrador retrievers and can occur in dogs of any age but usually manifests at 6 months of age or older.

Clinical features:

- Mild to moderate lameness that worsens with exercise.
- Swelling of the medial aspect of the joint and pain on palpation in this region.

Diagnosis : Radiographic examination (may often difficult) in oblique view reveals periarticular osteophyte production in the region of anconeal process, medial epicondyle or radial head.

Treatment: Surgical excision of the fragmented coronoid process through a medial approach.

Ununited anconeal process (UAP)

Diagnosis:

- There is intermittent lameness and exacerbated by exercise. Joint effusion is present.
- Radiographic confirmation at 20 weeks of age or older because the growth plate of the anconeal process does not normally close before this age.



Un-united anconeal process (lateral view)

Treatment : Surgical excision of the anconeal process along with stabilization by a bone screw.

RUPTURE OF CRUCIATE LIGAMENT

Cranial cruciate ligament prevents cranial displacement of tibia, limit excessive internal rotation of the tibia and prevent hyperextension of the stifle joint

Etiology

- Trauma.
- Anatomical peculiarities-tibial plateau angle, narrowed intercondylar notch and standing angle.
- Immune mediated-anticollagen antibodies.
- Hereditary-predisposed breeds vs. protected breeds.

Mechanism of injury

- Rapid inward rotation of the stifle.
- Hyper extension of the stifle.

- Degenerative changes within the ligaments include variations in conformation, repeated minor stresses, ageing and patellar luxation.

Signalment

Almost all breeds can get ruptured CCL. The common predisposed breeds are Rottweiler, Labrador, Retriever and Newfoundland and protected breeds is Greyhound. Animals of 1-8 years age group and overweight are most susceptible.

Clinical signs

- Lameness.
- Thickened Stifle Joint.
- Decreased Range of Motion.
- Pain—hyperextension of stifle when in lateral recumbency.
- Orthopaedic examination.
- Compare the girth of stifle.
- Compare the quadriceps femoris muscle girth.
- Palpate patellar ligament.
- Tibial compression test.

Diagnosis

- **History** includes acute or chronic bilateral lameness and subtle to non-weight bearing lameness.
- Clinical signs.
- Cranial Drawer.
- Cranial Tibial Thrust.

  Radiography. The features include joint effusion, osteoarthritis and presence of osteophyte.
- Arthroscopy.

Treatments

- **Nonsurgical management** includes rest, confinement, least walks and swimming.
- NSAIDS like Aspirin or Carprofen may be given.
- Nutraceuticals like Chondroitin sulphate and Glycosaminoglycans may be used.
- Weight control is imperative.

Surgical management can be made by extracapsular technique (in small breeds and chronic cases) or intracapsular technique (large breeds and acute cases).

- Explore stifle.
- Remove torn ligament.
- Inspect meniscus (medial) and remove damaged part.
- Stabilize the joint.
- Postoperative physical therapy.

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CHAPTER

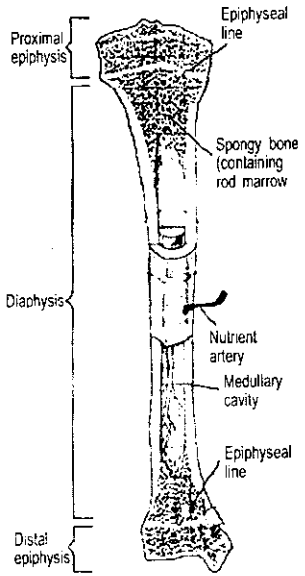
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Fracture and Dislocation

BONE

(A) Gross anatomy

1. **Cortical bone** is the denser outer shell while the inside contains a finer network of bone that resembles a sponge, thus '**spongy**' or '**cancellous**'.
2. The **epiphysis** is the portion of bone from the growth plate to the joint surface. It is composed of compact and cancellous (woven, spongy) bone, covered by hyaline cartilage.
3. The **growth plate** is the **physis** of long bones and is composed of hyaline cartilage.
4. The **metaphysis** is the region on the other side of the growth plate which is rich in cancellous bone and is highly vascularised.
5. The **diaphysis (shaft)** of the bone is the central portion and contains mostly cortical bone.
   (*a*) The **periosteum** is the covering of cortex consisting of connective tissue. Blood supply of long bones includes the principle nutrient artery, the metaphyseal artery and the periosteal arterioles.
   (*b*) The **endosteum** is the internal connective tissue lining of the cortical bone.



Anatomical structure of bone

Microscopic anatomy

1. Both cortical and cancellous bones are normally composed of lamellations of collagenous fibers that appear as stacks of parallel or concentrically arranged layers. In mature compact bone, the lamellae are often arranged concentrically around a vascular canal (Haversian Canal) and collectively the structure is called an 'osteon' or 'Havarsian System'.

2. Bone Cells:
   (*a*) **Osteoblasts** are the cells that synthesize the bone matrix (osteoid) and participate in bone mineralization.
   (*b*) **Osteoclasts** are the cells present on the mineralized surface of the bone and are responsible for the resorption of bone.
   (*c*) **Osteocytes** are found buried within bone in 'lacunae' and are formed from osteoblasts that have been entrapped and buried during bone formation.
   (*d*) **Bone lining cells** are present in 'inactive' or 'resting surfaces' of bone and are responsible for partitioning of the bone fluid from interstitial fluids, a role in the regulation of plasma calcium levels, nutritional and metabolic support of osteocytes and initiation of osteoclast resorption.

FRACTURE

A complete/incomplete break in the continuity of bone or cartilage or both is called fracture.

Causes of fractures

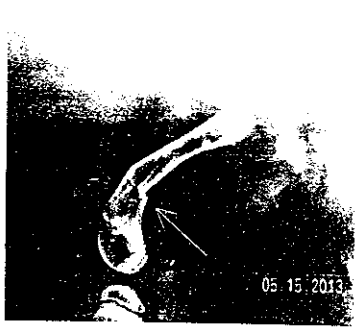
1. **Trauma**
   (*a*) **Direct fractures** are those resulting from force applied to bone; 75 to 80%—car accidents, firearms, falls from height.
   (*b*) **Indirect fractures** can result from force transmitted to point of fracture from other area via a muscle or tendon *e.g.* Fracture of femoral neck, avulsion of tibial tubercle.

2. Pathology. Bone diseases may weaken the bone so as only a little trauma produces fracture *e.g.* bone neoplasms, infection.

Classification of fractures

Metaphyseal	Any fracture within the anatomic metaphysis of a long bone either proximal metaphysis or distal metaphysis as long bone has two (and thus two metaphysis).	
Diaphyseal	A fracture of the diaphysis of a long bone either may be proximal, distal or middle third.	
Epiphyseal	A fracture involving the epiphysis in a mature animal (with closed physis) either may be proximal or distal.	
Physeal	A fracture that happens at or across the physeal line in an immature animal. It may be subdivided into Salter-Harris (S-H) classification.	
	S-H Type I	A complete separation of the epiphysis from the metaphysis along the physis.
	S-H Type II	A fracture that happens partially along the physis and exits through the metaphysis.
	S-H Type III	A fracture that happens partially along the physis and exits through the epiphysis.
	S-H Type IV	A fracture that crosses the physis, with one end of the fracture line exiting at the metaphysis and the other exiting at the epiphysis.
	S-H Type V	Impaction fracture of the physis.

Condylar	A fracture in a mature animal that involves condyles of the distal humerus, distal femur, proximal tibia or talus and comprises metaphyseal, physeal and epiphyseal segments of bones. This type of fracture falls under Salter IV category.	
Articular	A fracture that involves the articular surface of a bone.	
Incomplete	***Depression***	In this fracture areas of bone that are allowed to move away from the direction of force by intersection of multiple fissure lines. This type of fracture occurs in calvarium, maxilla and frontal bones.
	Green stick	Incomplete fracture in which one side of the bone is broken or splintered and the other side only bent. This type of fracture is limited to young animals. Displacement is minimal.
	Fissure	Incomplete fracture in which one or more fine cracks penetrate the cortex in spiral or longitudinal direction in which periosteum is still intact.
Complete	Fracture in which the bone is broken entirely across usually with displacement, overriding and deformation.	
	Simple	The bone is fractured into separate fragments.
	Comminuted	Fracture in which a number of small fragments (at least three) are formed with interconnecting fracture lines due to the bone being splintered or crushed.
	Transverse	Fracture at right angle to bone axis caused by tension distractive forces.
	Oblique	Fracture at an angle to the long axis of bone that is caused by a compression force.
	Spiral	Fracture that curve diagonally (coils) along the long axis of bone and is usually caused by rotational forces.
	Impacted	Fracture in which bone fragments are driven firmly together.
	Avulsion	Fracture in which a fragment of bone, which is the site of insertion of a muscle, tendon or ligament, is detached as a result of a forceful pull.
	Segmental	Fracture in which bone is broken into 3-4 more segments which don't meet at a common point.
	Multiple	Two or more bones fractured in the same animal.
	Unicondylar	One condyle is involved or fractured.
	Bicondylar	Both condyles are involved. Common term for "y" fractures of distal humerus.
	Eponyms	Certain fractures and diseases using a proper name. *e.g.* Monteggia's fracture, a cranial luxation of the radial head combined with a proximal third fracture of the ulna.
Closed	**Fracture that does not communicate with outside environment.**	
Open Compound	**Fracture involves communication to outside with contamination/infection.**	



Pathological fracture



Compound fracture



Supracondylar fracture of femur



Oblique fracture of tibia



Mandible fracture



Vertebral fracture

Incidence

Canine : Common in femur and pelvis, less common: tibia, radius and ulna and occasional in vertebrae.

Bovine : Common in tibia, humerus, metatarsus and pelvis, rare in radius and ulna, femur, scapula, carpal, tarsal.

Horses : Pelvis – external angle of ileum.

Symptoms

- **Deformity** occurs due to the displacement of fragments and may be manifested by deviation from the normal posture or position, e.g. shortening, angulation, rotation, abduction, adduction etc.
- **Loss of function** is manifested by inability to bear weight.
- **Abnormal mobility** is manifested by the ability to move the fractured segment of bone in a direction in which normal movement is not possible.
- **Pain** is evinced especially when the fragments are moved.
- **Crepitus** can be felt by manipulation of fracture ends against each other.

BONE HEALING

The healing of a fracture is an extremely interesting process. In optimal conditions, injured bone can be reconstituted without a scar almost identically to its original shape. Bone healing has been under extensive investigation for many years.

The process of fracture healing can occur in two ways: Direct or primary bone healing occurs without callus formation. Indirect or secondary bone healing occurs with a callus precursor stage.

Primary fracture healing

Primary fracture healing occurs when fracture ends are readily apposed, rigidly apposed, rigidly fixed and no vascular disturbance. Under these conditions, bone-resorbing cells on one side of the fracture show a tunneling resorptive response, whereby they re-establish new havarsian systems by providing pathways for the penetration of blood vessels. Radiographic findings of primary bone union are characterized radiographically by absence of periosteal callus, disappearance of a fracture line and continuity of the medullary cavity along the previous fracture site.

Secondary fracture healing

Inflammatory phase. Trauma, due to damage to the bone, periosteum, surrounding muscles, periosteal and endosteal blood vessels etc, results into haematoma formation in between fracture ends, medullary canal and underneath the periosteum. This vascular damage deprives the osteocytes of the nutrition and hence causes them to die as far back as the junction of collateral channels. They along with severely damage periosteum, marrow and surrounding soft tissue contribute to the necrotic tissue formation which elicits an immediate and intense acute inflammatory response. Inflammatory response is accompanied by vasodilatation, plasma exudation and acute edema of the region, resultant to chemical mediators of inflammation. Macrophages, leucocytes and inflammatory cells invade the area. As the acute inflammatory response subsides the next phase begins.

Reparative phase. Haematoma organizes and provides fibrin scaffold for migration of pleuripotential cells of mesenchymal origin. The pleuripotential cells may originate from vascular endothelium, nucleated red cells, wandering cells, endosteal cells and cells from cambium layer of the periosteum. This happens in the first 3-4 days. These cells migrate to the fracture site with ingress of capillaries and form a callus composed of fibrous tissue, cartilage and blood vessels in 4-9 days. The callus surrounding the bone fragments is termed as anchoring callus and that closing the bone marrow is referred as sealing callus. The callus quickly envelops the bone ends and leads to a gradual increase in stability of the fracture fragments. This envelop is referred to as external (periosteal) bridging callus and can lead to formation of a mature callus. At the same time formation of medullary bridging callus and intercortical uniting callus takes place. The stability of the fracture fragments dictates the mode of osteogenesis at the fracture site. Under conditions of good blood supply and excellent stability, most bone is formed directly from mesenchymal cells. Under less stable conditions fibrous tissue is formed which mineralizes and undergoes necrosis and is reabsorbed by macrophages and in its place bone is laid down. Under greater instability and or distraction mesenchymal elements lay down cartilage where chondrocytes hypertrophy; extrude ground substances which calcifies resulting into isolation of chondrocytes from their nutrition source and death. As this calcified cartilage disintegrates, osteoblasts and capillaries invade (periosteal bud) the remnants of irregular cartilaginous network thus mimicking endochondral ossification.

Remodelling phase. The callus remodelling phase consists primarily of the replacement of callus with packets of new bone. Callus undergoes remodelling along lines of functional stress in accordance with Wolff's Law. Osteoclastic resorption of poorly placed trabeculae occurs and decreases the size of the callus. Simultaneously new bone is laid down that corresponds to lines of force or stress caused by mechanical use and muscle forces across the fracture. Complete replacement of callus with functionally competent lamellar bone by remodelling takes one to four years.

Diagnosis

- Radiography is the most effective tool to document fractures and determine fracture configuration. At least two different views of the affected bone, which include joints above and below the fracture, are needed to accurately assess fracture configuration. Analgesia or general anaesthesia is necessary to provide patient comfort and allow proper positioning of the fractured limb during radiography.
- Computer-assisted tomography (CAT) scans or magnetic resonance imaging (MRI) may be used for diagnosis of fracture of pelvis, tarsus, or carpus but usually not available in veterinary practices.
- Bone Scintigraphy may be helpful to determine the site of bone injury if physical examination fails to detect a site of fracture and in nondisplaced fractures.

Principles of fracture repair

'4R' should be considered during fracture repair : (*a*) Recognition (*b*) Reduction (*c*) Retention (*d*) Rehabilitation.

A. Recognition refers to identifying the site of fracture manually or by radiographic examination.

B. Reduction refers to replacing the fractured bone segments in their original anatomic position. When a fracture occurs, all muscles, flexors and extensors contract maximally thereby causing overriding and shortening of the bone. In addition, trauma and injury of the surrounding soft tissue further increases the spastic contraction of the muscles. Hence to achieve normal anatomical alignment of the bone segments, an early reduction under conditions of optimum muscles relaxation be attempted. The secret of reduction is the application of continual steady pressure over a period of time.

Closed reduction : It is achieved by

- Application of traction; counter traction, bending, levering, and other manipulative means.
- Muscle fatigue and relaxation is achieved with balanced anaesthesia and use of traction with Gordon extender and by hanging the extremity against patients own body weight.

Open reduction

- Most commonly employed technique especially for complicated or unstable fractures.
- Fragments are reduced and aligned after making an appropriate exposure of the bone segments under direct vision.
- It is achieved by the application of traction, counter traction, rotation, levering with bone forceps, osteotomes and other equipment.
- Follow good surgical practice while making an approach to the bone e.g.
  (*a*) Gentle handling of soft tissues.
  (*b*) Follow normal muscles separation.
  (*c*) Avoid cutting into or through major blood vessels or nerves.
  (*d*) Preserve soft tissue attachments to the bone.
  (*e*) No periosteal stripping.

C. Retention refers to keep the already anatomical reduced bone fragments into apposition so that there is no motion at the fracture site.

D. Rehabilitation is the returning of normalcy of bone as it was prior to fracture, as a single unit and early ambulation is possible.

Key points for temporary stabilization and management

Temporary stabilization of fractures considered for delayed repair is performed to increase patient comfort and to reduce local soft tissue swelling and further soft tissue injury.

- Fractures below the elbow and below the knee should be stabilized with external coaptation until definitive treatment.
- External support should extend from just proximal to the joint immediately above the fracture and distally to the toes.
- Fracture above the knee and above the elbow is difficult to stabilize with external coaptation and the animal should be cage confined without splinting until definitive treatment.
- Prophylactic antibiotics in patients with closed fracture should be discouraged as indiscriminate use of systemic broad-spectrum antibiotics may lead to increased risk of nosocomial infection.
- Open fracture sites should be cultured and the animal placed on empirical broad-spectrum antibiotic or combination while awaiting culture results.

DISLOCATION OR LUXATION

Dislocation is defined as complete displacement of articular ends of bones, while subluxation refers to partial dislocation. Dislocation may be:

- **Complete dislocation**—one completely separating the surfaces of a joint.
- **Simple (closed)**—one in which there is no communication with the air through a wound.
- **Compound**—one in which the joint communicates with the air through a wound.

- **Pathological**—one due to paralysis, synovitis, infection or other diseases.
- **Complicated**—one in which there is breach in skin integrity, lacerations of soft tissues, injury to nerves, vessels, tendons and tearing of cartilage.
- **Acute luxation**—one that is of recent occurrence.
- **Chronic luxation**—existence for a long time.

Etiology

- Dislocation may occur congenitally due to improper position of a joint or under-development of articular ends of bones of foetus.
- Traumatic dislocation may occur due to direct violence caused during jumping and accidental slipping.
- Dislocation may occur due to some pathological conditions of joints, paralysis and atrophy of muscles, destruction of articular ends of bones and ligaments.

Incidence

Dislocations are relatively less common both in large and small animals due to presence of heavy muscle mass, sufficient strength of supporting ligamentous and tendinous structures. The frequency of occurrence of common dislocations in animals is:

- Bovine—(*a*) Femoropatellar joint (*b*) Coxofemoral joint (*c*) Rarely other joints.
- Equine—(*a*) Fetlock (*b*) Stifle (*c*) Hip (*d*) Rarely other joints.
- Canine—(*a*) Hip (*b*) Shoulder (*c*) Rarely other joints.

Symptoms

- Unnatural position of the limb, shortening or lengthening of it, and disturbance of function.
- Change in the external shape of the joint is marked, bulging of soft tissues by the head of the displaced bone and formation of pits.
- Passive movements are restricted and painful in majority in cases.
- Inability to use the limb and immobility of joint.
- There is excessive movement of joint in all directions when all the ligaments including the capsular ligament are ruptured.

Differential diagnosis

Signs	Fracture	Dislocation
Pain sensation	No period of numbness	Constant
Noise while movement	Crepitation	Rocking noise
Tenderness	More diffuse	Intense, diffuse
Chances of recurrence	Recurs immediately unless	Very little chances of immobilized recurrence after reduction
Mobility	Abnormal mobility	Restricted mobility or immobility
Location	Anywhere in the bone, joint may be involved	Only joint area

General principles of treatment

Rehabilitation of the whole animal patient is the object of the treatment dislocations. When dealing with dislocation, the clinical signs shown by the animal may mimic those of fracture. Physical examination may at times be confusing when trying to separate dislocation from fractures. It is important to use radiographs in the diagnosis and evaluation of dislocations. The possibility of complete superimposition of the two components of a joint so that the joint appears to be intact makes two-plane radiography a necessity. Radiographs will also delineate the possibility of a fracture associated with the dislocation (fracture- dislocation). Neural involvement can occur with dislocations, especially those that leave the joint completely unstable. Anatomically most nerves pass very close to the joints as they radiate to the distal extremities.

The basic treatment of dislocations involves:

- **Reduction** of the joint.
- **Immobilization** while attempting to gain stability.
- **Remobilization** of the joint to gain function.

Reduction of a joint should be done under general anaesthesia. Most joints are difficult or impossible to reduce under heavy sedation and would require unnecessary suffering by the patient. Reduction should be carried out as soon as the animal is stable enough to undergo general anaesthesia. The majority of joint dislocations that are seen in small animal orthopaedics can be reduced in a closed manner. It is important to have a thorough knowledge of the anatomy of the joints involved as well as the mechanism for luxation. Most luxations are successfully reduced by reversing the cycle of dislocation and a characteristic "**clicking noise**" is heard when the articulating surfaces are brought to the same level by traction. In large animals, traction is generally done by means of two ropes; one placed to the proximal and the other to the distal parts of the limb.

Once the joint is reduced it must be **immobilized** so that stability is regained. There are certain exceptions to this rule, such as a ventral dislocation of the hip in which stability is achieved at the time of reduction. In this case mobilization of the joint is carried out while at the same time preventing abduction of the limb, which would allow recurrence of the dislocation. The type of immobilization required for each dislocation may vary even with involvement of the same joint. It is important to take the affected joint through a range of motion to determine what position will yield the greatest degree of stability. Some joints always require the same position for immobilization to be successful. The time interval for immobilization of the joint depends on the severity of the soft tissue injury. In general relatively short periods of immobilization (10 days to 2 weeks) are advocated in order not to permanently impair joint function and range of motion. Further support, allowing more motion of the joint, may then proceed.

The **mobilization** of joints following immobility is usually left to the ingenuity of the patient and its owner. Attention paid to this portion of the treatment will often make a significant difference in the end result. Rehabilitation of the patient through **physiotherapy** techniques has only recently been introduced in veterinary orthopaedics.

APPLICATION OF EXTERNAL IMMOBILIZATION FOR FRACTURE TREATMENT CASTS

1. Plaster of paris (POP) cast

The most popular form of external immobilization is the plaster of paris cast. It has the advantage that it can be easily and accurately moulded to the contour of the limb but has the disadvantages that it is heavy, slow setting time, impervious to fluids and resented by many patients.



Plaster of Paris cast application in humerus in dog

To obtain satisfactory immobilization, the joints immediately proximal and distal to the fracture must be included in the cast. The most frequent complications following the application of a plaster cast are as follows: removal by the patient; excoriation of the skin at the extremities and if the foot is not included in the cast, uneven pressure may interfere with the circulation and results in a swollen foot. Plaster of paris cast must be examined the day after application and thereafter at least once weekly until removed. A serious danger with plaster fixations is the tendency for excessive pressure to be applied to the limb; if this is sufficiently severe, it will result either in damage to the skin where the pressure has been applied or it may cause a total suppression of the blood supply to the area, which can result at least in an ischaemic contraction of muscle.

Application

- After reduction of fracture, boric acid or sulpha powder is liberally applied to the limb followed by placement of one or two layers of ordinary bandage.
- It is advisable to spread a uniform layer of cotton (preferably non-absorbent) wool over the area to prevent injury due to friction or compression.
- The bandage is immersed in water (30°C-35°C) until bubbling of air stops and squeezed to remove excess water which should immediately be used for bandaging. It solidifies in few minutes and then the whole bandage becomes a stiff cast over the region.
- The plaster cast should be applied with enough but not excessive pressure as it may compromise circulation and cause pressure sore.
- The plaster bandage should be applied spirally from top to bottom or vise-versa, rather than being wrapped at one place.
- Each turn of the plaster bandage should overlap previous turn by half of its width and may be folded on itself to change the direction.
- Each layer should be smoothened with hand provided good bond with the preceding layers.
- Longitudinal POP splints may be incorporated into the caste to provide additional support especially in small ruminants.
- At the knee and hock joints, plaster is applied in the 'figure of eight' fashion to prevent breakage of the cast just below these joints.

- After final application of cast, the surface is rubbed with hands to provide a smooth and hard coating. Sufficient time should be given for hardening of plaster cast.
- A full-limb cast provides the most rigid stability and the cast padding layer should not be more than two layers thick to provide optimum fracture stability.
- The animal may require assistance to rise in the first few days till they adapt to the cast and learn to rise without assistance.

Fiberglass cast

Fiberglass resin-impregnated cast is a new synthetic material that replaced the plaster casting materials. It is light weight, Impact resistant and radiolucent. The material hardens quickly and reaches to its maximum strength in as shorter time. When wet, they do not lose their strength, and they can be easily dried and reused. However, the material is not commonly available and high cost limits its routine use. Moreover, the material does not contour a limb as easily as does the POP.

The method of application is similar to that of POP cast. However, water proof stockinettee should be used to wrap the limb before application of cast otherwise water may seep to the skin due to porous nature of the material.

Orthoplast

Thermally sensitive plastic such as orthoplast combine malleability, strength and cohesiveness in the construction of splints of various application. It can be placed in a conventional microwave oven at a medium-high setting for 60 seconds. After the material is warmed, it can be easily cut and contoured to the desired pattern and then necessary to create a splint suitable for coaptation distal to the elbow and stifle joints. The material can be folded onto itself to increase its rigidity. Wrapping the material 180 degrees around the limb also improve stability.

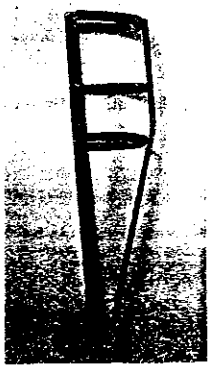


Orthoplast application in Kangaroo

2. Splints

The application of a rigid structure which is held in position by bandages is useful in certain relatively exposed regions such as metacarpus, metatarsus, the distal end of the radius and ulna and the distal end of tibia. Splints can be constructed from relatively inexpensive and readily available materials e.g. bamboo, wood, polyvinyl chloride (PVC) and metal bars.

- **Metal splints** have recently acquired considerable prominence in the form of the "gutter" splint. This is made of aluminum which is bent into the form of a half tube with its ends and edges belled outward and small punch holes stamped outward to afford fixation for the bandage. This is mainly used in the lower parts of limbs of small animals.



Metal splints

- **Mason meta splints** are useful for caudal application distal to the elbow and stifle joints. They are usually made of aluminum or heavy plastics. The plastic splint usually has foam-padded sponge linings and can be easily trimmed to the desired length. The indication for use of these splints are mainly metacarpal injuries, dorsal ligamentous injuries of the carpus and distal to the tarsus.
- **Wooden or bamboo splints** are commonly used for fracture management which is applied after being suitably padded to prevent pressure sores in the limb. Excessive padding should be avoided because it reduces the effectiveness of the splint by getting compressed with time. Each end of the splint should be padded prior to its application. Although it is carefully applied, subsequent displacement is liable to occur, which needs resetting or changing of splints.



Wooden or bamboo splints

- **Polyvinyl chloride (PVC) splints** are commonly used in pets and ruminant now-a-days. A 15 cm diameter pipe is used to make gutter splint for adult ruminants and 7-10 cm diameter pipe for sheep, goat and calves. Padding of each end of PVC splint is must before application.

Thomas splints

Thomas splints are metal loops which fit around the proximal end of the limb with a longitudinal loop projecting beyond the distal end of the limb. These splints were designed to apply longitudinal traction on the bone. They are made out of light metal rods (aluminum) available in sizes of 3/16 inch, ¼ inch, 3/8 inch etc. both for fore and hind limbs. The ring of thomas splint should be properly padded and contoured in such a way so that it will fit comfortably into groin areas and should not rub on the shoulder areas. The leg bars should be straight in fore limbs while bent in hind limbs to contour the angles of the stifle and hock. In ruminant, metal foot plate provides suitable anchorage for the hoof. If the thomas splint is properly applied, rarely fails although some complications may be encountered like abrasions and rubbing sores in the axillary and groin areas. Prolonged use should be avoided as may cause disuse muscle atrophy.



Thomas splint

External Pin splints

Dr. Stader was first to design the first veterinary external pin splint in mid 30's. Later during late 40's, Dr. Ehmet prepared many types of external splinting model and is marketed by Kirschner Mfg. Co. as the K-E splint.

K-E Splint components:

1. Fixation pins :
   - Trocar pointed Steinmann pins, usually non-threaded.
   - Single point small pins : 5/66" (1.95 mm) Diameter.
   - Medium pins : 3/32" (2.38 mm); 1/8" (3.17 mm).
   - Large Pins : 3/16" (4.78 mm); 1/4 (6.35 mm).
2. Ext. Fixation Rod/bar or connecting rod/bar :
   - Small Rod : 1/8" (3.17 mm) diameter.
   - Medium : 3/16" (4.72 mm) diameter.
   - Large Rod : 7/16" (11.02 mm) diameter.
3. Fixation Clamps :
   - Single: Small, Medium, Large.
   - Double: Small, Medium, Large.

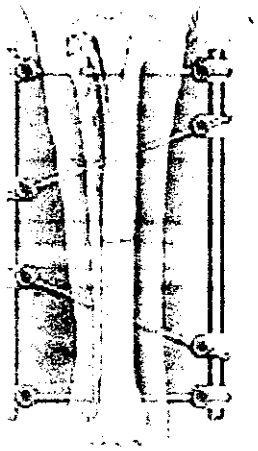
Classification of K-E apparatus (Heirholzer)

Depending upon configuration



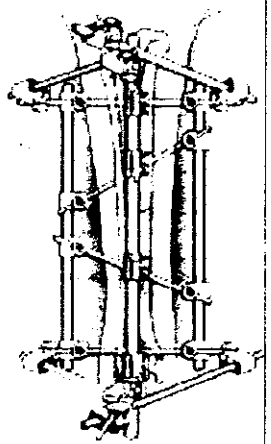
Type I

Fixation pins (Half pin) pass through one skin surface and both cortices. Connecting bar(s) on one side.



Type II

Fixation pins (Full pin) pass through both skin surfaces and both cortices, connecting bars placed on either (opposing) sides.



Type III

Combination of type I, II : *i.e.* Half and full pin each. Each system is interconnected to create three-Dimensional or a triangular frame.

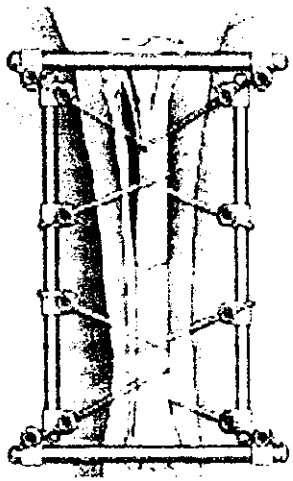
K.E apparatus again may be classified as either uni-planar or bi-plannar.

If all the fixation pins and connecting bar(s) occupy a single plane, then the fixator is uniplaner. Type II configurations are uniplaner whereas when the fixation pins and connecting bars are placed at another plane it is called biplaner fixation technique. Most type I configurations

are uniplaner; however, if 2 half-pin splintage fixators are placed at 60 degree to 90 degree of axial rotation to each other and the frames interconnected, the resultant type I configuration is biplaner. Type III configurations, by definition, are also biplaner.

Indications

- ***Adjunct to other internal fixation*** : To prevent axial rotation or/and collapse of fracture site *e.g.* IM pin, Cerclage wiring, cross pin etc. It can be removed in 3-5 weeks after assessing the callus by radiography, generally up to the formation of bony callus (strong or organized) which can prevent rotation or collapse.
- ***For Primary fixation in:***
  1. Hypertrophic non-unions.
  2. Atrophic non-unions open reduction manner with decortification and bone grafting.
  3. In severe comminuted fracture, where proper reduction, immobilization and fixation is not possible in closed reduction manner.
  4. Open gunshot or infected fractures.
  5. Corrective osteotomies.
  6. Stable/non-stable fractures.
  7. Mandibular fractures.
- Arthrodesis along with cross pinning.
- Limb lengthening procedures.



Type I biplanar : 2 half-pin splintage fixators are placed at different plane of axial rotation to each other and the frames interconnected

Type II and III external fixation technique is applicable only below the stifle and elbow.

Principles of application

- Strict asepsis.
- Ensure normal anatomical reduction which may not be perfect during closed application/reduction.
- Pins must be maximally spaced in each segment.
- Use as minimum as possible pin length and connecting bars.
- Pins must penetrate both bone cortices.
- Clamps should be attached as close to skin as possible.
- Use adequate size pins (not more than 30% the diameter of the bone) and connecting bars.
- Insert pins without causing thermal necrosis.
- Avoid distortion of skin or underlying muscles during insertion.
- Application of three pins in each segment gives 50 to 100% more strength in compression, bending and torsion than two pins.
- Most common technique of application is type I and or type II.

- Type I frames (unilateral) are the least stiff. Type II (bilateral, uniplaner) frames, which are frequently used for tibial, radial, and ulnar fractures, are 100% stiffer than type I.
- Frames 2 Type III (biplaner) fixators are stiffer then uniplaner fixators.

Key notes



ESF application in radius

- External fixators applied to long bones in the proximal limbs are limited to type I frames (unilateral connecting bar).
- Placing a double connecting bar will increase the stiffness of the type I frame and may be particularly helpful in larger dogs. Alternatively, type I biplaner configurations or curved connecting bars may be used to increase frame stiffness.
- An intramedullary pin can be left protruding through the skin and incorporated in the connecting frame. This is known as a "tie-in" configuration and significantly increases the strength of the repair.
- Tibial, radial, and ulnar fractures are particularly amenable to external fixation.
- Type II frames are easily applied to the tibia and radius and provide rigid stabilization.
- For fractures in large dogs or for comminuted fractures in which limited load sharing exists between the fixator frame and the bone fragments type III frames may be used.
- Articular fractures, fractures located near joints, arthrodesis, and adjunctive support of tendon repairs are additional conditions in which ESF can provide additional support as a transarticular fixator.

Advantages

- It does not interfere in the proper fractured area.
- It can be used in closed method.
- It is simple and quick.
- It can be used as hybrid fixation technique, *e.g.* Lag screws + K – E apparatus or IM Pin + K – E apparatus.
- Adequate skeletal fixation without the physical presence of metal at Fracture site.

Disadvantages

- Strength of fixation sometime may not as great as with certain other devices especially on femoral and humeral fracture in large breed.
- Pin tract infection is the common problem thus, requires highest post-operative care till the ex-fix apparatus is removed.

APPLICATION OF TYPE I HALF-PIN-SPLINTS

Procedure :

- Reduce the fracture (open or closed).
- Maintain in reduce position during insertion of fixation pins.

- Inset minimum of 2 pins in each fragment at same plane.
- Pins must cross one skin and 2 cortices and must be inserted at 35-45° to each other.
- Place the proximal (1) and Distal (4) pins relatively near the end of the bone.
- Attach the connecting bar with four clamps.
- Tighten the clamps on the two end pins.
- Insert the center 2 pins through clamps and tighten all clamps.
- The splint is covered with gauze and tape.
- In open reduced fracture splint is applied away from incision line.

Type II (Full pin splintage) Standard Type II

- All fixation pins are driven through both skin surfaces (skin- bone-skin) so that fixation bars can be placed on both (opposing) sides of the bone.
- Provides better support than type I *i.e.* 20-50% more stiffness over type I.
- Fixation pins are driven perpendicular to the bone or at slight angle, which prevents medial to lateral motion of the fixator.
- medial to lateral motion of the fixators can also be avoided by compressing the top 2 pins and bottom 2 pins together (toward each other) while tightening the fixation clamps.
- Application limited to the bones below the stifle and elbow, primarily tibia and radius.

Complication of K-E apparatus

- ***Pin tract sequestra*** : Generally, due to thermal necrosis if present should be removed.
- ***Local Infections of pin tract and drainage*** is the most common problem, which could be caused by excessive skin and soft tissue movement, tension against the skin and loosening of the pins.
- ***Loosening of skeletal fixator*** : pins loosen due to angle of insertion being less than 35° and due to loosening of single fixation clamp.
- ***Bending of the transfixation pins*** may occur due to too much weight bearing, insufficient strength and number of pins and inappropriate size.
- ***Iatrogenic fractures*** may also takes place due to use of oversized pins, pins placed too close together or near the fracture line or in a fissure, unrestricted activity causing fracture through pin holes.

Client education

- Restrict activity.
- Leash walk.
- Avoid fencing etc which may catch or tangle the apparatus.
- Inspect apparatus daily for any foul smell discharge etc.
- Return every 2 wks for checkups and evaluation.
- Restricted activity to continue for additional 6-8 wks even following removal of splintage.

APPLICATION OF INTERNAL IMMOBILIZATION FOR FRACTURE TREATMENT

Intramedullary pinning (IMP)

IMP is the most commonly used internal fixation devices used in veterinary surgery. Steinmann pins, K – wire, Rush pin and Kuntschner nail are used for this.

Steinmann pins : Steinmann pins commonly used are 9" to 12" long and 1/16" to 1/1" in diameter. The pins may be available in chisel Trocar and Threaded trocar point. It may be double pointed or single pointed. The chisel point is less apt to leave the medullary cavity or penetrate out of the opposite cortex. A chuck and key is required for its insertion. Due to its round, smooth shape it offers little resistance to rotation. It may be used for stack pinning using a large pin that fills the medullary cavity.



Intramedullary pinning

- Healing is due to the development of periosteal bridging callus.
- When K-E apparatus is to be used in conjunction with an I.M. pin the size of IM pin should be about 60-70% of the medullary cavity.
- IMP should be used in small and medium breeds.
- Open or closed approach may be followed. Closed technique used when fracture is of recent origin easily reducible, and stable.
- Mostly fractures of long bones *i.e.* femur, Tibia, Humerus, ulna Radius may be treated with the IMP.

Indications

- Diaphyseal Fracture of long bones.
- Irregular transverse and short oblique Fracture.
- In spiral and comminuted fracture with auxillary fixation.

Advantages

- Simple technique.
- Inexpensive.
- Minimal surgical time.

Disadvantages

- Cannot resist the rotational, compression or traction forces.
- Damage to medullary blood vessels and osteogenic tissue.

Technique

Retrograde Technique : (Femur) (Humerus)

- Pin is inserted from the fracture site into the medullary canal of the proximal fragment with a steady pressure by using either the manual chuck or battery operated chuck till it comes out of the trochanteric fossa and out of skin.
- The pin chuck is disengaged and applied to the pin protruding from the skin. The pin is withdrawn slowly, again by making 1/4th turn of the wrist, till its end is level with the distal end (Fracture end) of the proximal segment.
- Fracture is reduced, aligned and held in this position.
- Pin chuck is advanced to place the pin down the medullary cavity of the distal segment at metaphyseal epiphyseal area.

- The pin setting is evaluated by measuring with an other pin of same length or by radiography.
- The excess pin, protruding from the skin at trochanteric fossa is cut with pin cutter as close as possible and pushed under the skin.
- Penetration of distal/adjacent joint surface is absolutely is avoided.

Antegrade/Normograde/Direct pinning

The pin is directed into the medullary canal of one fragment from the appropriate point on the epiphyseal area up to the fracture line. Then the fracture is reduced and held in reduction while the pin is advanced to across the fracture line into the other segment and seated securely.

Point of Start/Entrance	Bone	Seating of pins
Subtrochanteric fossa	Femur	Distal caudal condyle
Ant crest of greater tubercle	Humerus	Medial condyle
Medial slightly behind straight	Tibia	Medial malleolus
Patellar ligament	Ulna	Olecranon process
Distal epiphysis at the cranial border	Radius	(Mostly avoided)

Multiple (Stacking) Pins

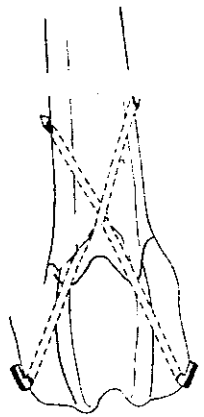
- Provide more secure fixation.
- Pins can be inserted by retrograde/normograde technique. Otherwise first pin by retrograde method and then following reduction additional pins by antegrade method. Multiple points or contact provide more rigid fixation against rotational stress.
- Caution against iatrogenic trauma/fracture particularly when cortex is thin or there are fissures present.

Intramedullary bone pin size required in dog and cat

Body weight (kg)		Size (mm)
Femur		
>18	:	3.96875-4.7625
9-18	:	3.175-3.96875
4.5-9	:	2.38125-3.175
<4.5	:	1.5875-2.38125
Tibia		
>18	:	3.175- 3.96875
9-18	:	2.38125-3.175
4.5-9	:	1.5875-2.38125
<4.5	:	1.143-1.5875
Humerus		
>18	:	3.175- 3.96875
9-18	:	2.38125, 3.175, 3.96875
4.5-9	:	1.5875-2.38125
<4.5	:	1.651-1.5875

Cross Pining

Pins are placed across fracture line at converging angles to provide 2 or more points of fixation. This technique of fracture management is useful for treating metaphyseal or epiphyseal fracture I-IV (Salter Harris fracture).



Cross pinning

Advantage includes stable reduction without invading joint and ensures early joint motion.

Disadvantages include more difficulty than direct pinning, retrieval of pin and may retard physeal growth.

Rush pinning

Indication

- Fracture of metaphyseal region.
- Fracture of Proximal humerus, Tibia and distal femur.

Technique

- Pin when driven into bone provides three point fixation.
- Rush pin has a bevel at one end (to slide off the far cortex and glide along inner cortical surface) and a hook on the other (to engage in the cortex).
- Requires a guide hole to insert the pins.
- Pins come in 3/32", 1/8", 3/16" and 1/4" diameter.
- Steinmann pins can be used as rush pins or in rush pin principle.
- Two pins are inserted into metaphyseal region at an acute angle of 30° to the long axis of bone.
- Pins are hammered slowly in and up the medullary cavity. The beveled end of the pin bounces of the opposite endosteum to engage or rest against the starting cortex. This provides three point fixations.

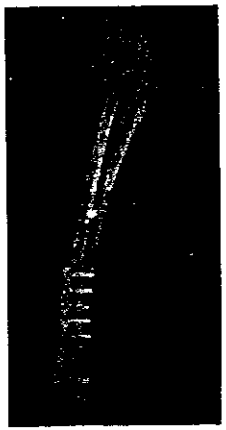
Disadvantage includes premature closure of physis, if used in young animals

BONE PLATES

Application of bone plate is the ideal for accomplishing an early return to full function. Bone plate was widely used before, now in most of the cases; compression plate has replaced the use of bone plate. Bone plate is available in different designs, cross-sectional area and hole types.

Classification of plates

- Compression plate
- Neutralization plate
- Buttress Plate
- Bone plates



Bone plate application in radius-ulna of a dog

Key points

- It is important to choose a plate of correct length and type. Straight plates and semi-tubular plates are the ones commonly used.
- AO, ASIF plates (straight) are made to accommodate 20 mm. 2.7 mm, 3.5 mm and 4.5 mm screws, 4.5mm plates can be had in narrow or broad type (width).
- Semitubular plates are only one mm thick; and are used as tension band plates.
- 1/2 circle—used with 4.5 and 6.5 screws 1/3 circle used with 3.5 screws 4.0 1/4 circle—used with 2.7 screws.
- Round hole plates are used with an external tension device when compression at fracture site is desired.
- Length of the plate should be more or less equal to the length of the bone i.e. continue towards metaphyseal area.
- A minimum of 3 screws should be placed on either side of the fracture.
- The first screws on either side of the fracture should not be less that 5mm from the fracture line. 1 cm would be ideal.
- Correct and accurate contouring of the plate to the bone is necessary. It may be advantageous to prestress or acutely bend the plate where it is next to the fracture line so that there is a gap of 1 to 1.5 mm between the plate and the bone.
- Plates are positioned on the tension side of the bone.
  - Femur — Lateral surface
  - Tibia — Medial surface
  - Radius — Craniolateral aspect
  - Humerus — Craniolateral aspect
- Plates when used in dynamic compression fashion result in primary bone healing.
- Avoid fracture line under the plate hole.
- Indication of screws (the steps involved) is same as with other plating techniques

INTERNAL IMMOBILIZATION BY USING BONE SCREWS

Bone screws are of two types namely cortical screws and cancellous screws.

Cortical screw : It is used primarily in the diaphyseal bone. Screws are fully threaded with more threads per unit length than cancellous screws. Threads are shallower and more flat pitched.

Intra-fragmentary compression with a cortical screw

- It requires drilling a larger hole (the diameter equal to the size of the screw) in the near cortex and another hole equal to the size of the core of the screw in opposite or far cortex.
- The far cortex is tapped with a corresponding tap, diameter of which is equivalent to the size or the screw to be implanted.
- The tap is always moved 2-3 rotation forward and 1/4 rotation backwards.
- Depth gauge is used to measure the distance between the cortices.
- Countersinking is made for proper fitting of the head of the screw in the near cortex.
- An appropriate size (*i.e.* length) screw is tightened.

Cancellous screw : It is used to compress fragments of epiphyseal and metaphyseal area. Cancellous screws may be partially or completely threaded with few threads per unit length. Threads are deep and relatively high-pitched.

Indication and application : Primary fixation in epiphyseal or metaphyseal fractures can be done by placing cancellous screw. It is implanted with no threads crossing the fracture line after drilling the appropriate size hole in both segments, tapping it and the seating the appropriate length screw. Some cancellous screws are self-tapping. Tightening the screw brings compression of the segments as the near fragment slips on the smooth shank.

TENSION BAND WIRE

Principle : Active distracting forces are counteracted and converted into compressive forces. It is achieved by inserting 2 K-Wires and a tension band orthopedic wire.



Schematic diagram of Tension band wiring

Indication

- Avulsion fracture or osteotomies of any epiphyseal area.
- Avulsion fracture of tibial tubercle, medial malleolus, tubercles or acromial process of scapula.
- Arthrodesis of inter tarsal joints.

Technique for repairing fracture of olecranon process

- Reduction of fracture is the first step.
- Insert two pins (parallel) from the top of olecranon process starting from its caudomedial/ lateral corners across the fracture line to engage the cranial cortex of the ulna distally.
- A transverse hole is drilled through the diaphysis below the fracture line and an orthopedic wire is passed through it.
- The wire is twisted in figure of eight fashion and tightened by twisting.
- Individual K-wires are bent backwards, cut and rotated cranially so that ends are buried in soft tissue.

ORTHOPAEDIC WIRING

Orthopaedic wire may be placed around the circumference of a bone that completely or partially goes around it. Wiring is always preferred to combine with other fixation technique rather than a sole method of repair or fixation in any type of fracture.

Indications

- Long oblique (Length of fracture line should be double the diameter of bone), spiral and comminuted fracture.
- For auxillary fixation.

General rules of application of orthopaedic wires

- Use orthopaedic wires of sufficient strength (e.g. 10, 20,22 gauge).
- Apply tightly.
- Indicated on diaphyseal fractures.
- Notching before placement of wire may be needed.

- Wire should preferably be placed 0.5 cm from fracture line.
- Always use at least two 2 wires. Spaces between them need to be about 1 cm.

Application of Cerclage wire

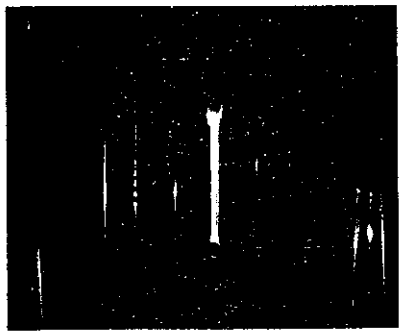
- Reduce fracture segments.
- Pass the wire around both segment with a wire passer or a curved hemostat.
- Be sure not to include any soft tissue between wire and bone.
- Twist wire ends uniformly.
- When it is tight keep tightening and bend it towards bone and cut off the rest.

Hemicerclage application

- Drill a hole on either side of fracture line.
- Pass a wire through the holes and twist the wire ends together to compress the fracture line and cut excess wire off.

INTERLOCKING NAIL (IN)

A relatively new implant system that has been introduced to the veterinary surgeon is the intramedullary interlocking nailing. An IN is a large-diameter "pin" that is introduced into the medullary cavity of a fractured bone and locked in place with screws placed through holes in the IN into the bone. Mechanically, the IN is a hybrid between an IM pin and a bone plate and functions like an IM plate. It has biomechanical advantages over a bone plate because it is placed at the neutral axis of the bone similar to an IM pin. The IN system is most applicable to fractures involving the humerus, femur or tibia.



Instruments for intramedullary interlocking nailing

REHABILITATION

Aim

- To improve the active pain-free range of motion of joint.
- Improve use of limit reduce lameness.
- Improve muscle mass and muscle strength.
- Improve daily function.
- To help prevent further injury.

Standing exercise

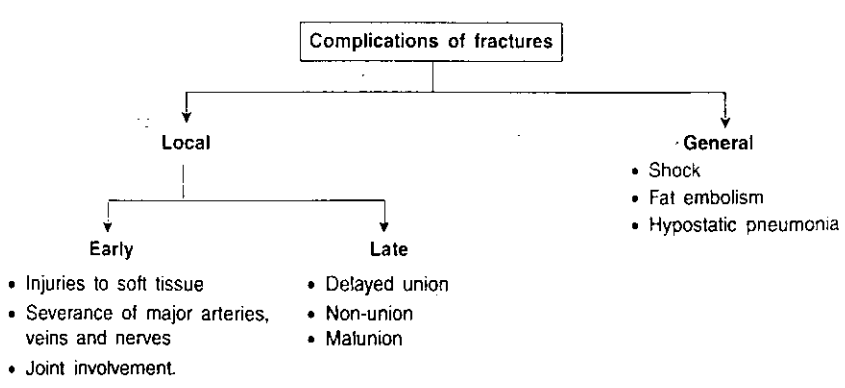
- Place the dog with all four feet squarely underneath, then support the affected body part with a towel or sling to support the body and allow some weight-bearing. When the dog slowly collapses, pull it back up and repeat the exercise. Such exercise should be repeated for 10-15 times two to three times daily and gradually increase to 5 minutes per session.
- Slow walks are perhaps the most important exercise in the early post-operative period. The walks must be at a speed to encourage weight-bearing.

- Climbing stairs is useful to improve power in the rear limb extensors. The dog is consistently using the limb at a walk with progressively decreasing lameness. Slow climbing is encouraged for proper use of the rear limb.
- Treadmill activity is very useful rehabilitation protocol. The ground moving underneath helps to begin using limb of non-weight bearing dog. Treadmills help to reduce the stress and pain of limb movement in conditions like hip and knee.
- Dancing and wheel-barrowing are the techniques to increase weight-bearing and stress on the rear and forelimb respectively. After muzzling, forelimbs are lifted off the ground for dancing and rear limbs are lifted for wheel-barrowing.
- Sit-to-stand exercise helps to strengthen hip and stifle extensors.
- Controlled ball playing in the early rehabilitation period is a good therapeutic exercise.

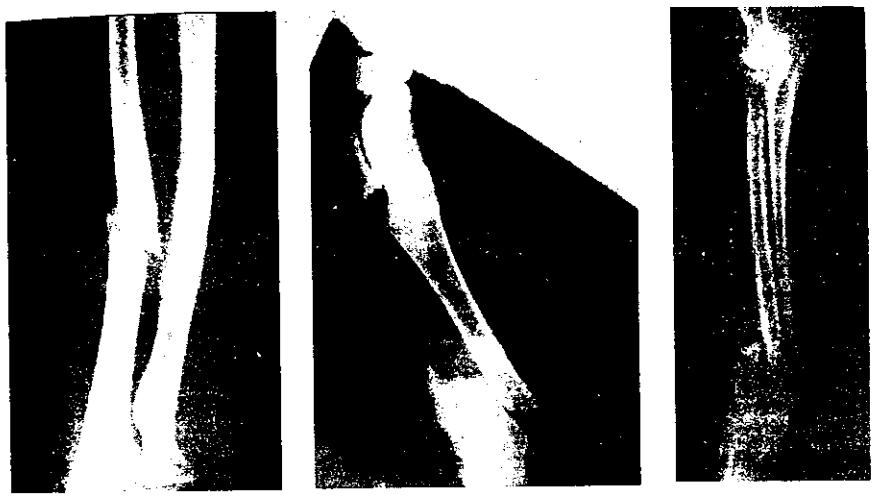
Fracture fixation devices

Fixations	Suggested uses
External coaptation (cast)	Only on fractures below the elbow or knee.
Intramedullary (IM) pin (single)	Limited use on long bones due to rotational instability.
IM pin plus Cerclage	Oblique or spiral fracture line 2 times the bone diameter.
IM pin plus lag screw	Oblique or spiral fractures where space permits screw use.
IM pin plus external fixator	For most diaphyseal and metaphyseal fractures.
Rush pins	Metaphyseal, physeal and epiphyseal fractures.
Interlocking IM Nail	Most diaphyseal fracture configurations.
External fixator	Most diaphyseal and metaphyseal fractures.
Bone plate	Most fracture configurations due to varied plate design.

COMPLICATIONS OF FRACTURES



1. Delayed Union exists when the fracture has not united in the time normally expected of it. In the majority of cases healing is progressing normally but at a slower rate than is usual. The normal time may vary according to age, species, breed, bone involved, level of fracture and type



A. Delayed Union B. Mal Union C. Non Union

of fracture. Radiographically, the fracture line is visible, there is minimal callus formation and fracture site has a feathery or woolly appearance.

Treatment options are to ensure that no abnormal factors are present. Management includes replacing the implant to increase the stability, cancellous bone grafting to accelerate bone healing, infection control and physical therapy.

2. Malunion implies that a deformity is present although the fracture has healed satisfactorily. The joints proximal and distal to the fracture are not in normal anatomic relationship to each other. The factors involve in mal-union include poor reduction and alignment, inadequate immobilization and artificial fusion of epiphysis.

Treatment options include corrective osteotomy and stabilization with external fixator or bone plate to realign joints and the limb axis.

3. Nonunion is the complete cessation of fracture healing and will not occur without surgical intervention. The factors involve in non-union include infection, foreign body reaction, hyperemia, avascular necrosis, interpositioning of soft tissue and distraction. Radiographically fracture line is visible with no callus formation or union in inactive nonunion whereas active nonunion shows incomplete callus formation.

Treatment options include surgical exposure of the fracture site with preservation of soft tissue attachments, procedures to stimulate maximum osteogenic response and accurate reduction and alignment of the fragments and their rigid stabilization with bone plate.

●●●

CHAPTER

18

Affections of Tendon, Tendon Sheath, Bursa and Ligaments

TENDONS AND TENDON SHEATHS (Synovial sheaths)

- A tendon is a band collagenous tissue that attaches a muscle to the bone.
- Consists of fascicles of collagen fibers embedded in a ground substance and generally run parallel to the long axis of the tendon.
- The fibroblasts, present between the collagen fiber bundles, are responsible to produce long fibers of collagen.
- The loose fibroareolar tissue, forming the interstitial tissue (endotendon), binds the bundles together and supply fine blood vessels, lymphatics and nerves.
- A tendon is covered by fine connective tissue sheath called epitendon.
- At the surface of the tendon, the loose tissue is condensed to form a thin, fibroelastic layer, the paratendon, except where tendon sheath is present.
- The paratendon covers and separates a tendon from another tendon and facilitates free and gliding movement of the tendon just like a synovial sheath.
- A tendon sheath/synovial sheath surrounds a tendon in areas where there is a marked change in direction of a tendon or a tendon passes under a ligamentous band or through a fascial sling.
- The tendon invaginates into the sheath to form a closed double-walled cylinder.
- The inner (visceral) layer is closely attached to the tendon by areolar tissue.
- The outer (parietal) layer is attached to adjacent connective tissue or periosteum.
- Because of this method of formation, the inner and outer layers are usually connected by an elongated mesentery, the mesotendon.
- The latter is important in passage of blood vessels and nerves into the tendon tissue within a sheath.
- Tendons get blood supply from two main sources. Small arterioles enter the tendon from adjacent muscle and run longitudinally in the interfascicular areolar tissue, accompanied by veins and lymph vessels. These longitudinally situated vessels anastomose freely with

small vessels from adjacent paratendon tissue or synovial sheaths by means of the mesotendon.

- The nerve supply of tendons appears to be almost entirely afferent, and specialized afferent receptors, neurotendinous endings, exist in tendons, especially near the muscle-tendon junction.

BURSA

True/anatomical bursa:

- Connective tissue sacs lined by secretary endothelium, synovial membrane and containing synovia (a viscous fluid).
- Interposed between moving parts and at points of unusual pressure.
- Situated between tendons, ligaments and muscles and many bony prominences, or occasionally between two tendons.

Acquired/False bursa:

- Develop in animals usually between skin and bony prominences, as a result of chronic trauma.
- Resemble closely to anatomical bursa, however, they are lined not by a synovial membrane but by a flattened layer of granulation tissue.

Ligament

- A ligament connects a bone to another bone.
- Structurally similar to a tendon, predominantly composed of collagenous fibers, but some elastic components are present.

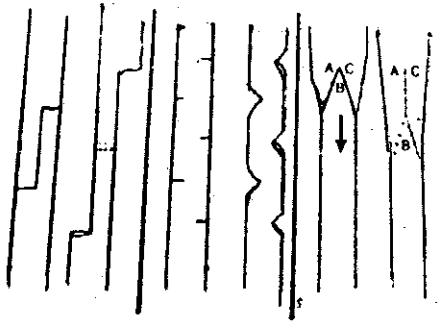
Tendon injuries

- Tendon injuries are common in equine while uncommon in ruminants.
- Lacerations or rupture of flexor and extension tendons in mid metacarpal/metatarsal region are common as they are less protected due to absence of supporting tissues.
- Tendo Achillis in draught bullocks and buffalo bull are also predisposed to injury.
- Rupture of tendon may be partial (tendonitis or strained tendon) or complete subcutaneous division across its fibers.
- In general, rupture of tendon occurs at the musculo-tendinous junction or at the point of its insertion.
- In bovine, rupture of tendons of digital flexor, gastrocnemius and peroneus muscles are common.
- Lameness and inability to bear weight are apparent signs.
- Immobilization of the affected limb and use of biomaterials for encasement to prevent adhesion following tenorraphy is recommended.
- Grafts are recommended in segmental tendon damage.

Contracted Tendons

- Common in new born calves, contraction or shortening of flexor tendons results in knuckling of the fetlock joint.

- Commonly forelimb is affected.
- The degree of knuckling may vary from slight knuckling of the knee to complete flexion of the pastern and fetlock joints which rest on the ground.
- Treatment includes: Application of splints or plaster cast and in severe cases a tenotomy of either one or both flexors is done and the limb is immobilized.



Tendon lengthening procedures (Left to Right sliding Z plasty, according and V-Y plasty

- In chronic tendon injuries with contracture of the associated muscle, a tendon lengthening procedure may be necessary for apposition without a gap. The Z tenotomy, V-Y plasty, and accordion techniques are suggested.

Spastic Paresis

- Characterized by congenital shortening of the gastrocnemious and superficial digital flexor, contraction of the Achilles tendon, straight hock and spastic lameness.
- Occurs commonly in calves of 2-6 months of age.
- Four surgical approaches are used to relieve the condition:
  - (*i*) Gastrocnemious tendon is severed completely and the superficial digital flexor tendon partially between the point of the hock and the distal part of the belly of the superficial flexor muscle.
  - (*ii*) Achilles tenotomy is indicated 10 cm above the point of hock leaving the fascial sheath intact.
  - (*iii*) Partially or completely severe the gastrocnemious and superficial flexor tendons above the point of hock.
  - (*iv*) Severing of the tibial nerve branches supplying the lateral and medial heads of the gastrocnemious.

Tenosynovitis or Tenovaginitis

- Inflammation of synovial sheath that encloses a tendon
- Tendon sheath is distended due to excessive secretions of synovial fluid.
- Generally it is caused by injuries and rarely by infection.
- It may be closed or open type.
- In closed form, lameness develops due to pain caused by distended synovial fluid. Rest, aspiration of fluid and injection of corticosteroids into the tendon sheath provide relief.
- In open form, the infection enters the tendon sheath through open wound caused by sharp penetrating objects. Flushing the digital tendon sheath with saline containing antibiotics is used to control the infection.

Bursitis

- Inflammation of bursa due to traumatic origin, characterized by accumulation of synovial effusion into the bursal cavity.
- Bursitis may be acute or chronic.

Acute Bursitis

- Caused by trauma, infection, open wound or extension of inflammation from tendonitis.
- Initially not much swelling or exudation, however, characterized by pain (Dry bursitis).
- Later, there is pronounced exudation and swelling of bursa (Serous bursitis)
- When bursitis may be complicated by pyogenic infection (Purulent /Suppurative bursitis).
- Treatment includes anti-inflammatory, analgesic and antibiotic therapy. Aspiration and drainage may be needed in suppurative bursitis.

Chronic bursitis

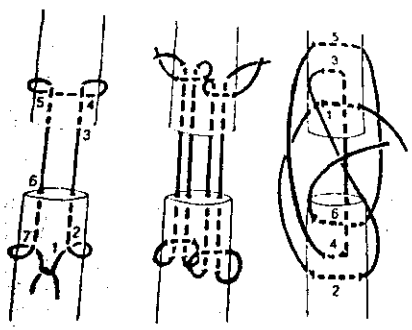
- Caused by mild and repeated trauma or as sequel to acute form.
- Swelling is apparent but pain may not be present.
- Commonly affect point of elbow (Capped elbow), anterior aspect of knee (Capped knee) and point of hock (Capped hock).
- Application of counter irritant, drainage and surgical excision may be required.

Sprain

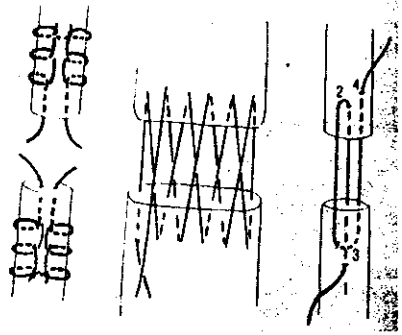
- Joint injuries in which fibers of supporting ligaments of the joint are ruptures but continuity of the ligaments remain intact.
- Differ from strain which is an injury to a muscle or a tendon due to overstretching or overuse of any part of muscle-tendon unit.
- Sprain may be graded as mild, moderate or severe depending on the degree of ligament rupture.
- Clinical signs are inflammatory manifestations, lameness and loss of function of the affected joint.
- Treatment includes: rest, analgesics, support bandage, splints or plaster cast depending on the severity.

Rupture of Crutiate ligament

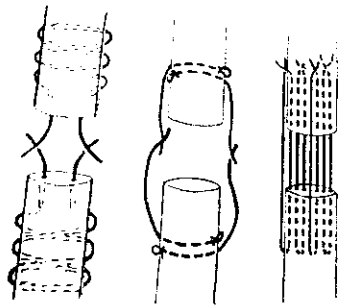
- The intra-articular ligaments, termed as cranial and caudal crutiate (x-shaped), extend from the tibia to the femur.
- These ligaments are the primary restraints against abnormal movements of the stifle joint.
- The cranial crutiate ligament prevents forward displacement of the tibia, whereas the caudal crutiate ligament prevents backward movement of the tibia in relation to the femur.
- Injuries to these ligaments cause abnormal movement between the femur and tibia.
- Rupture of cranial cruciate ligament may occur in dogs but rarely in cattle.
- Reconstruction of ruptured cranial cruciate ligament with carbon fibers, autogenous fascia lata (Paatsama technique) or patellar ligament is done.



(Left to right) locking loop, double locking loop, three-loop pulley suture pattern



(Left to right) Krackow, continuous cruciate and far-near-near-far suture pattern



(Left to right) Bunnel Mayer, Mason-Allen and simple interrupted suture pattern

Upward fixation of patella

- Common non-inflammatory functional disorders of femoropatellar articulation in cattle, buffalo and camels.



Upward luxation of patella in a cow (right hind limb)

- Characterized by jerky movement due to fixation of the limb in extension while the patella glides up over the trochlea to its maximum height on the articular surface.
- Laxity of the patellar ligament predisposes the animal to upward fixation of the patella.
- When one limb is affected, the animal moves forward by swinging the rigid affected limb outward and forward.
- In bilateral involvement of the patella, the animal is unable to move forward or even lie down.
- In bovine, subcutaneous division of medial patellar ligament (medial patellar desmotomy) either by open or closed method is the common surgical treatment of the condition.

As medial patellar ligament is absent in camel, desmotomy is not indicated. Injection of a mixture of turpentine oil and chloroform (15 ml each) along the course of the patellar ligaments as well as around the patella may relieve the symptoms.

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CHAPTER

19

Physiotherapy

Physiotherapy deals with treatment of diseases by physical methods. It aims at correcting deformities, making the joint movements more supple and preventing deforming tendencies, developing paralyzed muscles, healing faster and restoring the functional ability.

Choice of the physiotherapeutic modality shall depend upon a variety of considerations, like species, age, sex, stage and type of illness, therapeutic means available, their indications and contraindications. Usually a combination if physiotherapeutic means / modalities are required to be applied.

Principles of physical therapy

- Decrease pain and facilitate healing of inflamed and injured neurological and musculoskeletal tissues.
- Maintain normal range of motion in affected joints, *i.e.* hind limb, fore limb.
- Prevent soft tissue contracture and fibrosis in weak or paralyzed limbs.
- Prevent further disuse atrophy of affected musculature of hindlimb/forelimb during the healing process of neurological and musculoskeletal tissues.
- Improve strength and function of weak or paralyzed limbs.
- Maximize post-surgical recovery and function of the patient.
- Provide positive psychological effects for the patient and owner.

Classification

The commonly employed physiotherapeutic means are

1. Cold therapy
2. Hydrotherapy
3. Massage
4. Exercise (active and passive)
5. Heat application
6. Use of infrared and ultraviolet rays
7. Diathermy (short wave and microwave)
8. Electricity
9. Cryotherapy

10. Acupuncture
11. Laser therapy
12. Electrostimulation
13. Pulsing electromagnetic field
14. Magnetic therapy.

The scope of physiotherapy is tremendous, practically from womb to tomb. The concept of physiotherapy is age old but its application on scientific lines by veterinarians is still in its infancy and not much in vogue.

Limitations

There are multiple problems in the Institution of physiotherapy in veterinary practice. Veterinarians are faced with the management of animals of all sorts, small to large, light to heavy, docile to vicious, various species and breeds. Heavy body weight, prostration, pressure sores, pre and post-operative recumbency, muscular atrophy, inability to get up etc. are some common problems, especially in large animals.

Electrical stimulation

Electrical stimulation is useful physical therapy modality to-

1. Increase muscle strength.
2. Improve muscle tone.
3. Increase range of motion.
4. Relief of pain.
5. Reduce muscle spasms.

A pair or more electrodes is connected to the patient to deliver muscle stimulation in pulsed format. AC current is commonly used.

Electrical stimulations for diagnosis (Electro Diagnosis)

Electricity may be employed (continuous and reduce currents) to

- Reveal information on the degree of contractibility of muscles.
- The integrity or alterations of motor nerves.
- Ascertain the degree of contractibility of muscles.

Technique

The positive electrode is usually placed at the level of spinal cord in the anterior part of the dorsal vertebrae and in the lumbar region for the examination of the muscles of the forelimb and hind limbs respectively. The other electrode is placed on the muscles or motor nerves to be examined.

Diagnosis is made on the basis of hyper excitability or hypo excitability. A contraction produced with both faradic (AC) and Galvanic (DC) currents or by DC or only by AC indicates the variability of the muscle function. Any difference in the contractions (excitability) is noticed by stimulation with Galvanic current after inter change of the electrode is also noted to understand the functionality.

Electrical stimulations for therapy (electro therapy)

Electrotherapy is mainly useful to treat paralysis and muscular atrophy.

- Continuous currents (DC) Galvanization.
- Induced currents (AC) Faradisation.
- High frequent currents-Dorsogavalisation.

Technique : A feeble current that does not cause pain is used. The electrodes are placed so that the current travels the brain or cord longitudinally from the forehead or from pole towards the lumbar region or transversely from one temple to the other, or perpendicularly from the dorsolumbar region towards the sternum or abdomen.

IONOPHOROSIS

- Electricity used to enhance absorption of medicaments through the tissues.
- By the action of current, the drug molecules in agent are decomposed or some charge positively descends the current and other charge negatively ascends the current.

Agents : Sodium chloride, Slicylate of Soda, iodide of potassium, Quinine, Zinc and lithium.

Technique : the solution must be prepared with distilled water and galvanic current is employed. The electrode positive or negative according to the active ion of the medicament should be covered with a thick layer of cotton wool saturated with solution. This should be placed on the affected region and fixed by an elastic bandage to ensure close contact with the skin. The other electrode is placed at a point so that the current travels in the region involved. The intensity of current gradually increased to a tolerated degree for 10-13 minutes on every alternative day.

Fulguration

Fulguration refers to employment of electrical sparks or splashes in the treatment. It is affected by means of high frequency currents brought to an electrode which is placed at a certain distance from the tumor projects, on to it a series of long flashes. Strong splashes of 8-10 cm long are projected on to the wound for effect. Ten-30 times are required upon the type of tumor.

COLD THERAPY

Mechanism

Cold therapy decreases local circulation, pain, and tissue extensibility. Initially local cold application results in constriction of blood vessels. Vasoconstriction is mediated by local reflexes and central nervous system responses. Reduced blood flow may help to reduce oedema, haemorrhage and extravasations of inflammatory cells. Reduced tissue metabolism may inhibit the effect of inflammatory mediators and enzyme systems.

Because of these effects, cold therapy is often indicated during the first 48 hours of injury. Cyclical rebound vasodilatation, often referred to as "the hunting response", is another response of cold therapy. Following a minimum of 15 minutes of cold therapy that results in tissue temperatures from 10-15°C, cycles of vasoconstriction and vasodilatation occur.

Methods of application

- Cold may be applied by ice water immersion, application of ice packs or cold packs, and Freon or ice water-charged circulation bandages or boots.

- Therapeutic effects of cold occur at tissue temperatures between 15 and 19 °C, (59-66°F).
- Tissue temperatures of 10°C and less may causes cold thermal damage
- Average time of cold application is 15 to 20 minutes.
- Treatments are best repeated every 2-4 hours during the fist 24-48 hours of injury if the goal is to reduce tissue inflammation and oedema.
- Cold therapy should be used with caution in animal with peripheral sensory deficits or impaired circulation. If duration of cold therapy is more, excessive rebound vasodilatation and dependent oedema may result.
- The most effective method of cold therapy is to application of ice water directly with the skin. Buckets or turbulator boots may be used depending on the site.

Indications

Cold therapy is indicated in acute musculoskeletal injuries, particularly effective during the first 24 to 48 hours after injury. Distal limb injuries in horses and small animals can be effectively treated by this method.

HEAT THERAPY

Mechanism

- Heat therapy increase local circulation, decrease pain, reduce of muscle spasm and increase tissue extensibility.
- Local heat applications dilate blood vessels and stimulate local circulation. Increased local blood flow help to mobilize tissue metabolites, increase tissue oxygenation and increase metabolic rate of cells and enzyme systems. As a rule, metabolic rate increases 2-3 times for an increase in tissue temperature of 10°C. These factors are especially beneficial for wound healing or other soft tissue injuries.
- Increased local blood flow may be initiated by three mechanisms.
  - (*a*) The axonal reflex is a direct response of the blood vessels to local increases in tissue temperature.
  - (*b*) Local inflammatory mediators such as histamine, prostaglandins (such as PGE_2 and prostacyclin), and bradykinin may also initiate vasodilatation and increase capillary permeability.
  - (*c*) Local spinal reflexes stimulated by afferent impulses from the thermo receptors at the site of heating and result in decreased postganglionic sympathetic adrenergic nerve activity, which decreases smooth muscle tone of vessels, allowing them to dilate.
- Increased blood flow and vascular permeability may promote resorption of oedema.
- Heat application is recognized to decrease pain. Theories that explain pain relief by thermal agents include : (1) In the gate-control theory of pain stimulus from heat receptors "closes the neural gate" which blocks afferent stimuli from peripheral pain receptors, and (2) Heat may act as a counter-stimulus to pain, making the afferent impulses of pain less noticeable.

Methods of application

- Superficial heat may be applied with hot packs, hydrotherapy, paraffin baths or moist air. These modalities provide heat penetration to approximately 1 cm deep to the skin, which is often sufficient for many veterinary applications on distal limbs because of the lack of an insulating fatty subcutaneous tissue layer in most species.
- Deep heat may be applied using radiant heat ("heat lamp") microwave or shortwave diathermy and therapeutic ultrasound.
- Warm water is probably the most accessible method of heat therapy. Methods of application may be from a hose or with wet towels, or water immersion in a bucket therapy tub, or turbulator boot.

Indications

Heat is best applied after acute inflammation has subsided. It is useful for reducing muscle spasm and pain due to musculoskeletal injuries. Heat therapy can be used to increase joint and tendon mobility, particularly by heating before active stretching. Heat may be beneficial to accelerating the healing response of localized soft tissue injuries.

Contraindications

- Heat therapy should be used with caution in animals with peripheral sensory deficits.
- Local infection and tumors may conceivably be spread by use of heat therapy and local inflammation may be exacerbated.

MASSAGE

Massage may be defined as manipulation of soft tissues with hand and fingers.

Mechanism

Massage improves circulation, nutrition supply, remeves waste products, reduces indurations, looses contracted tendons, ligaments and muscles.

Methods of applications :

Message comprises a series of maneuvers including;

1. **Slight friction** : Fingers of the hand is used in centripetal direction. It gives feeing of warmth and has a numbing effect.
2. **Methodical pressure** : It is applied by firm pressure on to tissue with the pulp of the thumb or with fingers or the hell of the palm or with closed fist so as to act on deep seated structures.
3. **Individual compression of muscles** : Here, a portion of the muscle is hold between the fingers and thumb and uniform pressure is applied from its insertion towards its origin.
4. **Percussion** : Consists of superficial or deep percussion of the tissue by striking the part perpendicularly with the fingers or closed hand.

Indications

Exercise can be combined with the use of liniments in sub-acute, chronic inflammatory conditions.

Contraindications

- Acute inflammatory conditions with a threat of pretend hemorrhage.
- Presence of foreign bodies.
- Existence of neoplasm.

Effects

1. Sensory nerve endings may be stimulated, assists in local and general relaxation.
2. Exercise leads to stimulation of sensory nerve endings, liberation of histamine substances, with local hyperemia results in dilatation of blood vessels.
3. Improves venous and lymphatic return by mechanical assistances due to alternative pressure and relaxation.
4. Mechanical movement causes stretching and softening of fibrous connective tissue.

Lubricants : Olive, mustard or coconut oil or fine talcum powder can be used to reduce friction that softens the skin.

Precautions

- Massage should be done in the direction of the venous and lymphatic flow.
- Smear the part with Vaseline or mild Liniment.
- Massage should be continued for 5-10 min at a time.
- In case of joints massage should be associated with passive movement and exercise.
- Massage be done in the direction of muscle fibres/across the fibres.
- While massaging extremity make use of gravity as assist venous return.
- During massage the motion should be rhythmic and pressure moderate.
- Apply compression bandage to the part after massage if necessary.

EXERCISE

Exercise constitutes active and passive movement of a part or whole body to strengthen or maintain vitality musculoskeletal system. Exercise plays a great role in rehabilitation especially following injuries and disorders of locomotor system and muscular weakness.

Indications

- Joint stiffness
- Abnormal posture
- Spastic Paralysis
- Orthopaedic problems

Effects

- Mechanical movement of joint and muscles improves venous and lymphatic return.
- Sensory stimulation by keeping cortical pathways open.
- Mobility and range of movement of joints can be increased.
- Passive movements can stretch so that softening of the fibrous tissues.
- Balance and coordination can be improved.
- Improve cardiovascular and respiratory capabilities.

Method

I. **Passive Exercise :** in this method, the affected joint is grasped and its flexion and extension is done for 10-15 times.

II. **Active Exercise :** this includes walking, grazing and slow running up and on a slope. Active exercise is coupled with passive exercise and message can help in improving blood circulation, joint mobility, muscle power and coordination. However, the animal should not tire and exercise should be stopped if there is any increase in oedema and pain or decreased mobility of the joint.

HYDROTHERAPY

Hydrotherapy is the treatment of disease by, or in, water. This is a form of rehabilitation therapy particularly appropriate for dogs and horses recovering from a range of conditions - especially those involving problems with limbs. Water absorbs more best per unit of weight than any other substance. The solvent properties of water help checking infection and accelerate wound healing by removing dirt and necrosed tissue. A treatment time of 10-30 min. is sufficient for this effect.

Buoyancy of Water : These can be used to relieve pressure on effected parts. The method is used in the form of an aqua lift system to treat downers cow syndrome if muscles damage has not occurred.

Whirlpool Hydrotherapy : It is essentially a water bath in which an extremity or the entire body is submerged in either warm or cold swirling water. The water is kept in constant agitation and mixed with air by the action of turbine thus producing a gentle massaging effect.

Irrigation : Irrigating the affected part with a stream of water through a house pipe is a simple and cheap method. This is often used for necrotic ponds, like those following sub-cutaneous infiltration of urine in cattle, as an adjacent to the main therapy.

Swimming is another method of hydrotherapy in veterinary practice.

Precautions

- Animal with recent skin grafts.
- Acute edema.
- Fever.
- Marked circulatory disturbances.

Application of cold water : This type of treatment is used during the first 24-48 hrs after trauma has occurred.

Indications

- Acute congestion.
- Recent acute inflammation.
- Septic lesions in which there is no danger of death of the tissues from diminished blood supply.

Effects

Hypothermia of tissues induces vasoconstriction and decreases extravasations of blood so probability of blood and fluid accumulation is restricted. Pain, muscle spasms and tissue metabolism are also reduced.

कृपया रेषा मारुन
पुस्तक खराब करु नये

Methods of Application

Each application of cold water (46.5-59 °F) should last 10-30 min with an interval of at least one hour in between the applications. For deep-seated lesions like sprains, water at a lower temperature may be applied, but if it is very cold, it should only be used intermittently. In Veterinary practices, the water is usually applied directly to the part instead of being allowing to flow through a coil of rubber or metal tubing laid on the part.

HOT WATER APPLICATION

Indications

- Sub acute and chronic inflammations
- Recent inflammation after the acute stage has passed
- Septic lesions in which the vitality of tissues lowered and they are threatened with deaths.

Effects

- Analgesia by softening and relaxing the tissues.
- Hyperemia results leucocytosis, and phagocytosis in septic wound
- Reabsorption of exudates.

Methods

Hot water application is done to increase the temperature gradually to 113°F or even 122° without scalding. Generally, resistance of tissue is diminished at temperature 113°F with moist heats. Intermittent application is warranted. Temperature of the water can be maintained by adding addition hot water. Even then, it is impossible to maintain a local superficial temperature equal to that of the blood. Hydro-thermoregulator may be used, which consists of a reservoir in which the water is pumped by an electric motor into a system of small very flexible tubes placed in variable fashion over the effected region. By this means a temperature of 107-113°F may be maintained for 12-24 hours with excellent effect.

SWIMMING

Mechanism

- Swimming helps to improve general fitness and stamina, improves muscle tone and is helpful in recovering from injury or operation.
- Since cold-water causes constriction of the superficial blood vessels muscles, It is better to swim dogs in heated water.
- Horses are usually swum in cold water to dissipate the enormous amounts of heat they generate under exertion with a less efficient cooling system.
- Swimming is an excellent form of exercise because most of the muscles normally used in movement are involved-without the stresses caused by running on hard ground. Swimming results increased resistance to movement, thus the muscles have to work harder than they would do on land. Swimming strengthens the muscles while avoiding this potentially damaging concussion.
- ***Cardiovascular workout :*** During swimming chest remains under pressure from the water thus every breath requires more effort-the muscles used.

- ***Lungs :*** Under water, the chest is under pressure from the weight of the water squeezing inwards. This means that every breath requires more effort-the muscles used, particularly in breathing in, have to work harder (try breathing while someone sits on your chest). As any muscle strengthens with exercise, this improves the whole respiratory system.
- ***Heart :*** The heart has to work harder in order to meet the increased demand for nutrients by all the muscles which are being worked.

INFRARED THERAPY

Infrared rays are electromagnetic waves (radiant energy) of 770 to 1,00,000 mμ. Sun light is most important natural source. The heat energy obtained from the rays is used to relieve pain. It is useful to treat muscle strain and pain.

Classifications

Infrared rays are of two types

Long wave infrared (1500 to 12,000 mμ) are emitted by all heated bodies and exclusively by low temperature bodies such as hot water bottles, electric heating pads etc. These rays can not penetrate to deeper those 2 mm of the skin.

Short wave infrared (770-1500 mμ) are emitted by all incandescent bodies such as sun, electric incandescent lamps and specially designed high temperature infraradiators. Short wave infrared penetrate 5 to 10mm of skin tissues so they influence blood vessels, lymph vessels, nerve endings and other subcutaneous structures directly. The employment of special red glass filter restricts these sources.

Sources

(*a*) **Natural:** Sunlights is most important natural source of infrared radiation and comprise over 60% in an average sunlight.

(*b*) **Artificial:** The artificial sources are

1. ***Low temperature/Non-luminous/IR radial***-A bare wire or carbon held in a suitable non-conducting material is used. It emits red glow and a quantity of radiation.
2. ***High temperature/Luminous/Heat lamps***-Incandescent filament radiators consists of tungsten filament are principal sources of luminous heat radiation enclosed in a glass bulb mounted at the centre with a concave reflector.

Technique

The patients are placed in a comfortable, relaxed position and the radiation from the generator is directed over the part to be treated from a distance of 2 to 3 feet according to the sensitivity of the parts. Duration of exposure is 10 to 15 minutes.

Effects of infrared radiation

Infrared therapy exerts local as well as central effects.

Local effects : Infrared wave when hits the superficial tissues it causes

(*a*) ***The stimulation of local circulation***-radiant heating the skin causes vasoconstriction of the capillaries and subsequent release of vasodilator substance which again absorbed locally thus more capillaries become active. In this way, blood circulation is increased

(*b*) ***The stimulation of the nerve endings of the skin***-Infrared exposure for a short time cause mild heating results in relief of pain while strong heat stimulates counter irritation.

Clinical uses

- Sub acute and chronic traumatic and inflammatory conditions in locations accessible to external heating contusions and muscle strains
- Traumatic synovitis, tenosynovitis and sprains.
- Various forms of arthritis and rheumatic conditions, neuralgia
- Acute, sub acute and chronic catarrhal conditions of the mucous membranes in accessible location, sinusitis
- Circulatory disturbance of the extremities
- Infections of the skin, folliculate, furunculous and even extended abscess formation in the skin.
- As preliminary heating to other physical measures, like massage, voluntary and passive exercise.

Contraindications

Infrared therapy is contraindicated to use in following conditions

- Defective blood supply to the area
- Any blood loss
- Defective skin sensation (nerve damage)

Complications

Infrared rays may induce following complications:

1. Erythemal response
2. Hypersensitivity followed by erythema, wheel formation, local edema and eventually blistering.
3. Electric Shock
4. Injury to eyes

ULTRAVIOLET THERAPY

Ultraviolet rays are of 390 to 180 mμ wave length. The chief natural source of ultra violet radiation is the Sun. The artificial sources of UV radiation are:

1. ***Mercury Vapour lamp***—Mercury when vaporized in a quartz container by intense heat emits a spectrum rich in UV light. Quartz of silicone dioxide gas is extremely heat resistant and freely transmits UV radiation.
2. ***The Fluorescent sun lamp***—The 20W lamp will produce minimal erythema at a distance of 2 feet in 20 minutes with bare lamp and in 7 minutes with a reflector. Those lamps may be used without a reflector.
3. ***R.S. type suit lamp***—mercury arc tube enclosed in a special glass bulb emits short wave length ultra violet light.

General information

- UV rays can penetrate to a very limited extent through body surface.

- UV rays cause erythemal production, pigmentation and bactericidal effects. Spectral Band at 265.2 mm produces maximum bactericidal effects.
- Ultraviolet rays also produce erythemal of the skin within 2 to 8 hrs.
- Ultraviolet rays produce local/regional analgesia when it hits nerve endings.
- Ultraviolet rays can be absorbed by blood cells and consequently bactericidal activity potentiates. Calcium phosphorus, iron and iodine contents are also increased.
- Repeated irradiation with erythema doses between 280 to 300 mm results pigmentation with deposition of granules of melanin in the basal cells of the epidermis.

Technique

For general irradiation, entire affected body should the exposed; the genitalia should be covered by a cloth; the centre of the part should be in direct line of irradiation. A timer should be used to measure the time of exposure.

Dosage

The erythemal response of the individual patient serves as a guide for dosage for general irradiation. Distance of lamp and duration of exposure are important for dosage calculation.

Duration of exposure

To control local infection 3 to 5 minutes for 5 days is sufficient. Usually 20 exposures are required for complete cure.

Indications

- General tonic effect
- Chronic Ulcers
- Tuberculosis
- Skin conditions (*a*) Psoriasis (*b*) Acne
- For diagnosis—In dermatological cases with the aid of words lamp to detect fungal infection.

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CHAPTER 20

Therapeutic Shoes and Corrective Shoeing

These are an important consideration in the treatment of most lameness. Foot abnormalities may result not only from malconformation and diseases, but also from improper trimming and shoeing. The objective in treatment of both these problems is to achieve a balanced foot with a normal axis. Various types of shoes and their therapeutic uses include :

Square-Toe or Roller-Toe shoes

- Used to promote quick break over and they do create a mechanical advantage for the horse. This is used in the treatment of navicular disease, flexor tendon problem and sesamoid ligament problems.
- When the shoes are placed in the centre of the toe region of the hoof, they promote central foot break over. Used to treat gait abnormalities (paddling, forging, winging).
- Roller-toe shoe on the hind limb is used in the treatment of bone spavin and partial upward fixation of the patella.

Bar Shoes

- Used to protect or support a region, to apply pressure and to stabilize the foot.
- Full-bar plate shoes are used to protect a region from bruising *e.g.* corn, navicular disease.
- Heart-bar shoes are used to apply selected pressure to the frog region to decrease chances of rotation of the distal phalanx with laminitis.
- Egg-bar shoe stabilizes the foot, extends past the flexor surface providing additional support, and increases ground surface area of contact decreasing concussion to the foot.
- Diamond-bar shoe is in similar quality as egg-bar shoe except that it does not extend behind the foot. Bar shoes are important for the treatment of sheared heels.

Placement of the shoe in reverse fashion

- It effectively promotes more rapid break over of the center of the foot and protects the heel like Diamond-bar shoe.
- Used along with padding techniques in the treatment of navicular disease.

Clips

- Shoe clips that are drawn from steel shoes used to prevent hoof wall expansion for horses with fracture of the distal phalanx. They are placed just opposite each other to prevent hoof wall expansion.
- Used for the treatment of hoof wall crack as they stabilize these two surface areas till healing. When clips are drawn and a full-bar shoe is applied best stabilization is achieved.
- Used to secure a shoe to the hoof wall.

Trailers

- They are added to the shoe to reduce the torque of the foot, to support the flexor surface and to decrease the rotation of the foot.
- Trailers that extend straight behind the shoe have a tendency to decrease the torque of the foot as it lands and during takeoff.
- One straight trailer extending from the lateral branch helps prevent twisting of the hock joint in spavin. The trailer along with a roller-toe shoe is very effective in this case. They are also helpful in horses used for jumping and horses that travel close behind.
- If two trailers are used that extend straight out past the bulbs of the heels, they add support to the flexor surface. They are used in the treatment of problems of flexor tendon, suspensory ligament and under-run heels.
- If one of the trailers is bent away from the heel (*i.e.* lateral heel trailer is bent outward0, it will have a tendency to slightly rotate the foot in that direction. They are used in horses that either have a toe-out or toe-in stance.

Wide-Web shoes

- Increase the surface area with the ground and protect the solar surface of the foot. It is highly effective in horses with sore feet or sole bruising.
- Changeable heel calks may be added to the shoe and removed as desired.

Glue-on shoes

- They are made of plastic material that surround the foot and is held in place with a nontoxic epoxy material. They have many advantages like lightweight, durable, and fitted without nails and the expandability of the shoe is similar to the hoof.
- They can be used for the treatment of navicular disease, laminitis and sole bruising.

Elevated heels

- Heel elevation decreases tension on the deep digital flexor tendon and decreases the concussion to the phalanges. For this reason it is helpful in the treatment of navicular disease affection of the deep digital flexor tendon.
- Heel elevation can be achieved by using wedge shoes, wedge pads on flat shoes and heel calks.
- A premade aluminum wedge shoe is available that is suitable for show jumpers.
- Wedge pads are also available that are placed between the shoe and the foot to wedge the heel and protect the bottom of the foot. They are used in sole bruising or pedal osteitis dorsal to the apex of the frog accompanies navicular disease.
- Heel calks, although light in weight, tend to decrease the ground contact area, and this focal pressure serves to increase the discomfort to the horse with navicular disease.

Concaved solar surface

- Concaving the uppermost part (solar surface) of the shoe in contact with the solar surface of the hoof is helpful in removing the pressure off the sole region in flat-footed horses and horses with focal sole bruising.
- Wide-web shoes (at least 0.25 inch thick) are used and the concavity is best created with a grinder. The concavity can be made over the region to be protected from pressure (a focal sole bruising) or around the entire rim to decrease the pressure around the entire sole.

Changing the usable ground surface of the foot

- Here the shoe is placed where the foot is not, but where it should be. In wry foot, the foot is so distorted that it is no longer centered under the limb. The shoe is placed beyond the hoof wall either lateral or medial to help support the region and promote growth.
- Where extending the toe of the shoe is useful for treatment of clubfooted horses, extending the heel of the shoe is very helpful in the treatment of under-run heels and horses with flexor support problems.

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CHAPTER

21

Examination of Animals for Soundness and Preparation of Soundness Certificate

FORM OF SOUNDNESS CERTIFICATE FOR HORSE

No. .....

This is to certify that I have examined the animal, the details of which are given below belonging to Mr./Ms .....

S/o .....

resident of .....

(Name and address of the person on whose request the animal is examined)

.....

to the best of my capabilities and skill for soundness.

Details of the animals

- Species : .....
- Breed : .....
- Age : .....
- Colour : .....
- Sex : Male/Female .....
- Height (inches) : .....
- Pedigree : ..... Sire : ..... Dam : .....
- Identification marks :

  Natural marks : ..... **Artificial (Tattoo) marks :** .....

The said ..... is found as :

(Horse/stallion/gelding/mare)

(*a*) The general health status of the animal is good/poor.*

(*b*) The animal is fit for general work/draught purposes/race/breeding.*

(*c*) The animal has temporary defect, which may or may not lead to soundness. Therefore, a further examination is needed on dated ..... *

(*d*) The animal is suffering from ..... *

(Mention the disease conditions or abnormalities, if any)

*Strike out whichever is not applicable.

The animal described above is in my opinion sound/unsound

Signature .....

Name of the Veterinary Officer .....

Official Designation with Seal .....

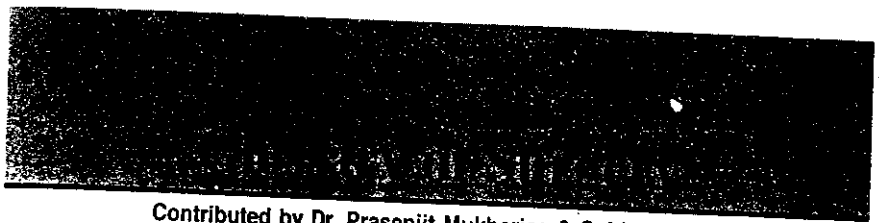
Address : .....

.....

Place .....

Date .....

●●●



Contributed by Dr. Prasenjit Mukherjee & Subhasis Roy

Abaxial : Lying away from the axis of the body.

Abdominal hysterectomy : The uterus is removed through the abdomen via a surgical incision.

Abdominoscopy : A type of surgery using a laparoscope, which is inserted into one or more small incisions, to examine the abdominal cavity. (See also endoscopy, laparoscopy, or minimally invasive surgery.)

Abduction : The withdrawal of a part from the axis of the body.

Abscess : Pus-filled cavity associated with inflammation. Usually caused by bacteria.

Acute appendicitis : Acute inflammation of the appendix due to infection.

Adduction : The act of drawing toward the axis of the body.

Agonist : Drug that mimics the action of a naturally occurring hormone or neurotransmitter.

Allograft : Bone transferred between genetically dissimilar members of the same species.

Alveolar bone : The bone surrounding the tooth roots.

Analgesia : Reduction of pain.

Anaesthesia : Medicine administered for the relief of pain and sensation during surgery.

Angiogenesis : The stimulation and production of new blood vessels.

Ankylosis : Abnormal immobility and consolidation of a joint.

Antagonist : Drug that opposes or blocks the action of a naturally occurring hormone or neurotransmitter.

Anteversion : Turning cranial or inclining cranial, usually referring to a femoral head and neck angulation.

Antibiotics : Medication used to treat infection.

Anticoagulation drugs : Medication used to prevent blood clots from forming.

Antiphlogistic : Preventing or relieving inflammation.

Aplasia : Incomplete or defective development of tissue.

Apnoea : Period of cessation or suspension of breathing.

Apophysis : A bony process or outgrowth that has not had an independent center of ossification.

Appendectomy : The surgical removal of the appendix to treat acute appendicitis.

Appose : To place next to each other; bring into alignment.

Arthrocentesis : Incision into a joint; puncture with a needle.

Arthrodesis : The surgical fixation of a joint by fusion of the joint surfaces.

Arthroplasty : Plastic surgery of a joint or of joints; formation of movable joints.

Arthroscopy : With the use of an endoscope, surgeons can look at the interior of a joint. This technique is most often used to inspect the inside of the knee joint.

Arthrosis : Degenerative disease of a joint.

Arthrotomy : Surgical incision of a joint.

Articulation : A joint; the place of union or junction between two or more bones.

Artificial ventilation : The process of supporting breathing by manual or mechanical means when normal breathing is inefficient or has stopped.

Ataxia : Failure of muscular coordination; irregularity of muscular action.

Atrophy : A wasting away or diminution in the size of a cell, tissue, organ, or part.

Autograft : Bone transferred from one site to another in the same animal.

Autolysis : Destruction and dissolution of cells by lysosomal enzymes.

Avulsion : A tearing away.

Axial : Relating to the central part of the body.

Biopsy : A diagnostic test involving the removal of tissue or cells for examination under a microscope.

Blood pressure : The pressure of the blood in the main arteries.

Brachycephalic : Breeds with short skulls and noses (*e.g.* Bulldogs, persians): all brachycephalic breeds suffer from respiratory compromise (see brachycephalic obstructive airway disease).

Bradycardia : Abnormally low heart rate.

Bronchoscopy : The examination of the bronchi, the main airways of the lungs, to diagnose certain lung disorder.

Buccal : Relating to the mouth.

Calculus : Hard deposit on teeth, caused by mineralized plaque.

Callus : The bony material that bridges fractured bone fragments.

Cannulate : To place a tube into a structure.

Capsulorrhaphy : Suture of a tear or laceration in a joint capsule; usually referring to prevention of joint dislocation.

Capsulotomy : Incision through a capsule; joint capsule.

Catheter : A flexible tube used to drain fluid from or inject fluid into the body. The most common catheter is the foley catheter, used to drain urine from the bladder.

Caudal : Towards the tail.

Cautery : Use of heat to cut or seal tissues and blood vessels.

Cerclage : An encircling device.

Chemotherapy : The use of drugs to treat medical disorders. The term has become restricted to the treatment of (malignant) neoplasia by various agents that slow or stop cell replication

Cholecystectomy : Surgery to remove the gallbladder.

Chondroplasty : Reparative or plastic surgery of cartilage.

Cicatrisation/cicatrix : Scar formed by wound contracture.

Circuit factor : The increase in minute volume required for each anaesthetic circuit to ensure sufficient delivery of oxygen.

Circumduction : The active or passive circular movement of a limb.

Clonus : Spasm in which rigidity and relaxation alternate in rapid succession.

Closed fracture : Loss of continuity of a bone without contact of the bone with the outside environment.

Coagulopathy : Disease or condition affecting the clotting pathways.

Coaptation : A joining or fitting together of two surfaces; fitting of fracture ends.

Colectomy : Partial or complete removal of the large bowel or colon.

Colonoscopy : Test to look into the rectum and colon. The doctor uses a long, flexible, narrow tube with a light and tiny lens on the end. The tube is called a colonoscope.

Colposcopy : Visual examination of the cervix and vagina using a lighted magnifying instrument (colposcope).

Comminution : Breaking into a number of small fragments.

Computed tomography (CT or CAT scan) : Using a computer and x-rays to get a cross-sectional picture of the tissues being examined.

Congenital : Existing at or before birth.

Contaminated : Indicating the presence of microorganisms within a wound. The wound is not termed infected until the microorganisms are reproducing.

Coxa : Referring to the hip or hip joint.

Craniectomy : Excision of a part of the skull.

Craniotomy : Surgical opening of the skull to gain access to the intracranial structures.

Crepitus : Bony crepitus, the crackling sound produced by the rubbing together of fragments of fractured bone; joint crepitus, the grating sensation caused by the rubbing together of the dry synovial surfaces of joints.

Cuneiform : Wedge-shaped.

Cystoscopy : Inserting a viewing tube up the urethra to examine the urethra and bladder cavity.

Cytokine : Protein produced by the lymphoid cells which affects production and chemotaxis of other inflammatory cells (e.g. Interleukin-2, tumour necrosis factor).

Debridement : The surgical removal of foreign material and/or dead, damaged or infected tissue from a wound or burn.

Dehiscence (of wounds) **:** Wound breakdown resulting in the wound splitting open.

Diaphysis : The shaft of a long bone.

Diathermy machine : A piece of equipment used in the operating room to control bleeding.

Diplegia : Paralysis affecting like parts on both sides of the body.

Dislocation : The displacement of any part, more especially of a bone.

Dolicocephalic : Breeds with long skulls and noses (*e.g.* rough collie).

Dominant hand : The writing hand; the hand favoured for most coordinated tasks .

Dorsiflexion : Flexion or bending upward of the paw or toes.

Drawer : Abnormal cranial or caudal movement at the knee.

Dysplasia : Abnormality of development.

-ectomy : To remove all or part of an organ (*e.g.* Splenectomy, colonectomy).

Elective surgery : An operation the patient chooses to have done, which may not be essential to continuation of quality of life. (see also optional surgery.).

Electrocardiogram : A record of the electrical impulses that immediately precede the contraction of the heart muscle.

Electrocoagulation : Electrosurgery which helps harden tissue.

Electrodessication : Electrosurgery which destroys tissue.

Electrolysis : Decomposition of body tissues (bone) by means of electricity.

Electrosurgery : Surgery which uses electrical instruments.

Emergency surgery : An operation performed immediately as a result of an urgent medical condition. (See also urgent surgery.)

Emesis : Vomiting.

Enamel : Extremely hard outer layer of carnivore (and primate) teeth. Consists of 96% mineral (calcium hydroxyapatite), 2% protein (enamelin) and 2% water.

Endarterectomy : The surgical removal of plaque or blood clots in an artery.

Endoscopy : A type of surgery using a laparoscope, which is inserted into one or more small incisions, to examine the abdominal cavity. (See also abdominoscopy, laparoscopy, or minimally invasive surgery.)

Endosteum : Internal periosteum; the membrane lining the medullary cavity.

Epidural anaesthetic : An anesthetic which is injected into the "epidural space" in the middle and lower back, just outside the spinal space, to numb the lower extremities.

Epidural : The space surrounding the spinal cord within the vertebral canal.

Epiphyseolysis : Separation of an epiphysis from its bone.

Epiphysiodesis : Premature union of an epiphysis with the diaphysis.

Epiphysis : A piece of bone separated from a long bone in early life by cartilage, but later becoming a part of the larger bone; the end of a long bone.

Eschar : Dried necrotic tissue (or scab) covering a wound. Usually associated with wound breakdown.

Esophagus : The muscular canal that runs from the voice box to the stomach.

Eversion : A turning outward or inside out.

Extension : A movement that brings the members of the limb toward 180°.

External rotation : Eversion.

Fallopian tubes : The tube that extends from the uterus to the ovary. The fallopian tube transports eggs and sperm.

Fatigue : Material failure caused by cyclic motion.

Fenestration : To make openings or windows into an anatomical structure.

Fibrillation : A fibrillar, striated pattern seen on cartilage undergoing early degenerative change.

Flaccid : Weak, lax, soft.

Flexion : The act of bending from a large angle to a lesser angle.

Fracture : The breaking of a part, especially of a bone; loss of continuity of bone.

Free skin graft : The detaching of healthy skin from one part of the body to repair areas of lost or damaged skin in another part of the body.

Friable : Fragile or brittle.

Gastrectomy : Complete or partial removal of the stomach.

Gastroscopy : Examining the lining of the esophagus, stomach, and the first part of the small intestine with a long viewing tube.

General anesthetic : An anesthetic which causes the patient to become unconscious during surgery.

Genu : The knee: genu varus, bowleg deformity; genu valgus, knock-knee deformity.

Gingiva : Mucosa surrounding the teeth (otherwise known as gums).

Gingivectomy : Excision of excess gingiva.

Haematogenous : Spread (of infectious agents, chemicals or tumour cells) via the blood stream.

Haematoma : Soft tissue swelling filled with blood.

Haemorrhage : The medical term for bleeding.

Haemostasis : Control of bleeding.

Heart rate : The rate at which the heart beats.

'Heath robinson' : Slang term used to denote a repair by unorthodox methods.

Hemiplegia : Paralysis of one side of the body.

Hemorrhoids : Distended veins in the lining of the anus.

Histopathology : Microscopic examination and study of diseased tissue.

Hypercapnia : Abnormally high level of carbon dioxide in the blood.

Hyperemia : Excess of blood (circulation) in any part of the body.

Hyperextension : Extreme or excessive extension; greater than 180°.

Hyperplasia : Overgrowth of tissue.

Hypertrophy : The enlargement or overgrowth of an organ or part due to an increase in size of its constituent cells.

Hypoplasia : Failure of an organ or tissue to grow or develop properly.

Hysterectomy : The surgical removal of the uterus.

Hysteroscopy : A visual inspection of the cervical canal and uterine cavity with an endoscope.

Iatrogenic : Caused unintentionally by the veterinary surgeon (or nurse).

Imbricate : Operative overlapping of layers of tissue; a tightening procedure.

Implant : To insert or graft.

Infection : The invasion of the body by microorganisms that cause disease.

Inguinal hernias : Protrusions of part of the intestine into the muscles of the groin.

Internal rotation : Inversion.

Intraocular pressure : Internal pressure of the eyeball (or globe). Persistent increased intraocular pressure is termed glaucoma and causes retinal and optic nerve damage.

Inversion : A turning inward, inside out, upside down, or other reversal of the normal relation of a part.

Involucrum : A covering or sheath, such as contains the sequestrum of a necrosed bone; localized overgrowth or hypertrophy of bone in response to infection.

Ischemia : Local and temporary deficiency of blood, due chiefly to the contraction of a blood vessel.

Isograft : Bone transferred between animals that are identical in histocompatibility antigens (litter mates).

Keratoconjunctivitis sicca : Immune-based (autoimmune) disease in which the production of aqueous tear film is severely reduced (otherwise called 'dry eye').

Kyphosis : Humpback: abnormal curvature and dorsal prominence of the vertebral column.

Laminectomy : Surgical procedure which includes removal of a portion of the lamina, to provide more room in the vertebral canal; usually for disc herniation or spinal canal stenosis.

Laparoscope : A type of endoscope consisting of an illuminated tube with an optical system.

Laparoscopic cholecystectomy : An operation to remove the gallbladder. The doctor inserts a laparoscope, and other surgical instruments, through small holes in the abdomen. The camera allows the doctor to see the gallbladder on a television screen. The doctor removes the gallbladder through the holes.

Laparoscopic lymphadenectomy : The removal of pelvic lymph nodes with a laparoscope done through four small incisions in the lower abdominal region.

Laparoscopy : A type of surgery using a laparoscope, which is inserted into one or more small incisions, to examine the abdominal cavity. (see also endoscopy, abdominoscopy, or minimally invasive surgery.).

Laparotomy : Surgical incision through the abdominal wall to allow visualization of abdominal organs.

Laryngoscopy : Inspecting the larynx (voice box) with a mirror or viewing tube.

Laser surgery : Using a device which emits a beam of light radiation, surgeons can cauterize a wound, repair damaged tissue, or cut through tissue.

Lavage : Washing or flushing of a wound or body cavity.

Lingual : Relating to the tongue.

Lobectomy : Removal of a lobe of the lung, for cancer, benign tumors, or infections.

Local anaesthesia : Anesthetic medicine injected into the site of the operation to temporarily numb that area.

Lordosis : Curvature of the spinal column with a ventral convexity.

Lumpectomy : Removal of a small, well-demarcated benign cutaneous or immediately subcutaneous mass.

Lymphopenia : Abnormally low lymphocyte count.

Malunion : Union of the fragments of a fractured bone in faulty position.

Manometer : Instrument used to measure pressure.

Meniscectomy : Excision of a meniscus from a joint.

Metaphysis : The flared area of junction of the epiphysis with the diaphysis of a long bone.

Metaplasia : The change in the type of adult cells in a tissue to a form that is abnormal for that tissue.

Metastasis : The shifting or spreading of a disease to other parts of the body.

Metastatic : Ability of a malignant tumour to spread to remote parts of the body.

Minimally invasive surgery : Any technique involved in surgery that does not require a large incision. (See also endoscopy, abdominoscopy, or laparoscopy.).

Minute volume the volume of air moved in 1 min by the patient (minute volume = tidal volume × respiratory rate).

Monoarticular : Pertaining to a single joint.

Monoplegia : Paralysis of a single part.

MRI (magnetic resonance imaging) : With the use of a high-powered magnetic field, cross-sectional images can be made of organs and structures without using x-rays.

Myelosclerosis : Increased density of cancellous bone while cortical bone remains normal.

Needle aspiration : Uses a thin needle and syringe to collect tissue or drain a lump after using a local anesthetic.

Needle biopsy : A procedure to remove a small piece of tissue using a needle with a special cutting edge, after using a local anesthetic.

Neoplasia : Abnormal, uncontrolled growth of tissue. In other words, cancerous growth. May be benign or malignant.

Nephrectomy : Surgical removal of the kidney.

Nonunion : Failure of the ends of a fractured bone to unite; false union; pseudarthrosis.

Normograde : Pin placement that begins at a bone end and exits the fracture site.

Nosocomial : Disease or condition acquired in hospital.

Oblique : Slanting away from horizontal or perpendicular.

Open fracture : Loss of continuity of bone with exposure to the outside environment ("compound" fracture).

Opioid : Any drug having a similar effect to opium.

Ostectomy : The excision of a bone or a portion of bone.

Osteoarthritis : Inflammation of the articular components of a bone.

Osteoclasis : The surgical or manual fracture or refracture of bones.

Osteolysis : A localized area of osteoporosis.

Osteoma : A tumor composed of bone tissue and usually developing on a bone.

Osteomalacia : Faulty mineralization of available osteoid, which may be soft or bend.

Osteopetrosis : Increased bone density resulting from prenatal fetal bone that has not converted to cancellous bone.

Osteoporosis : Bone tissue that is normally mineralized but contains too little mass.

Osteosclerosis : Abnormal hardening or increased density of bone (eburnation).

Osteotome : A knife, used for cutting bone, in which both sides of the cutting edge are beveled.

Osteotomy : The surgical cutting of a bone.

-ostomy : To make a permanent surgical entrance into a hollow organ (*e.g.* Tracheostomy, urethrostomy).

Otitis externa/ media : Inflammation and infection of the external/ internal ear canals.

-otomy : Suffix meaning to effect surgical entry into a hollow organ (*e.g.* Cystotomy, tracheotomy)

Palmar : Referring to the walking surface of the forepaw; volar.

Palmigrade, plantigrade : Stance in which the entirety of the paw (fore and hind respectively) is in contact with the ground. This is the way bears walk.

Palsy : Paralysis.

Paralysis : Loss of voluntary movement in a muscle or muscle group; loss of function (paresis).

Parapatellar : Alongside or near the patella.

Paraplegia : Paralysis of the hind legs and caudal part of the body, both motion and sensation being affected.

Parasympatholytic : Drug which antagonises the parasympathetic system (*e.g.* Atropine).

Partial colectomy : The removal of part of the large intestine.

Perineal : Around the anus.

Perineurium : The sheath surrounding a bundle of nerve fibers in a peripheral nerve.

Periodontal : Area surrounding the teeth and roots.

Periodontitis : Inflammation of the periodontal tissues.

Periosteum : The tough fibrous membrane surrounding a bone.

Peritoneal adhesions : The peritoneum is a two-layered membrane that lines the wall of the abdominal cavity and covers abdominal organs. Sometimes organs begin to adhere to the peritoneum, requiring surgery to free the organs again.

Pes : Referring to the foot or paw.

Phlebitis : Inflammation of veins: usually associated with intravenous catheterization or intravenous injection of irritating drugs.

Piezoelectric : Electric current generated by pressure upon certain bony crystals.

Plantar : Referring to the walking surface of the hind paw; volar.

Plaque : Cellular and organic debris build-up on the surface of teeth.

Plasma : The watery, straw-colored fluid which carries the cellular elements of the blood through circulation.

Plasmatic imbibition : Method by which skin grafts obtain nutrition during the first 2-3 days. The graft absorbs serum, becoming edematous and dark in appearance.

Pneumonectomy : Removal of an entire lung, for cancer, or lung abscesses, bronchiectasis, or extensive tuberculosis.

Pneumothorax/pneumoperitoneum : Presence of air within the thoracic cavity/abdomen.

Polyarticular : Pertaining to two or more joints.

Polydactylism : The occurrence of more than the usual number of toes.

Post-anesthesia care unit : The area a patient is brought to after surgery to recover. Also called recovery room.

Prehension : Taking firm hold of something.

Pronation : The act of turning the forepaw outward from the body.

Prosthesis : An artificial replacement for body parts that may be missing or defective.

Pseudarthrosis : A false joint, as that sometimes seen following a fracture or in failure of an arthrodesis or fusion.

Psychotropic : Any drug that affects the mind or targets mental activity.

Quadriplegia : Paralysis of all four limbs.

Ream : To widen an opening; to open the medullary canal.

Rebreathing system : Anaesthetic system with carbon dioxide absorber, so that air may be recycled through the system.

Recurvatum : A backward bending; a curvature backward.

Reduction : The correction of a fracture or luxation.

Regional anaesthetic : An anesthetic used to numb a portion of the body.

Resection : Excision of a considerable portion of an organ; especially excision of the ends of bones and other structures forming a joint.

Retrograde : Pin placement that begins at the fracture site and exits a bone end.

Rostral : Towards the nose.

Rotation : The process of turning around an axis.

Saline solution : A solution containing sodium chloride.

Salpingectomy : Surgical removal of a fallopian tube.

Saucerization : Excision of tissue (bone) to form a shallow depression.

Scoliosis : Abnormal curvature of the vertebral column, a lateral curvature.

Sequestrum : A piece of dead bone that has become separated from the sound bone during the process of necrosis.

Seroma : Soft swelling, filled with serum.

Shear : The distortion of a body by two oppositely directed parallel forces.

Shock : A dangerous reduction of blood flow throughout the body.

Sigmoidoscopy : Examining the rectum and sigmoid colon.

Simple mastectomy : Surgical removal of the breast and possibly a few of the axillary lymph nodes close to the breast.

Soporific : Causing drowsiness or sleepiness.

Spastic : Of the nature of or characterized by spasms or spasticity.

Sphygmomanometer : Blood pressure cuff with built-in manometer.

Spica : A figure-of-eight bandage.

Spinal anaesthetic : An anesthetic which is injected into the spinal canal fluid for surgery in the lower abdomen, pelvis, rectum, or other lower extremities..

Splenectomy: Surgical removal of the spleen.

Spondylitis : Inflammation of one or more vertebrae.

Spondylolisthesis : Ventral subluxation of one vertebral body referable to the next vertebral body

Spondylolysis : A dissolution of the body of a vertebra.

Status epilepticus : Severe presentation of epilepsy, where the seizure is maintained for a prolonged period of time.

Sterile : Absence of any microorganisms (bacteria, fungi, viruses or spores).

Stomatitis : Inflammation of the soft tissues within the mouth.

Strain : The change in shape that a body undergoes when acted upon by an external force.

Stress : The resisting force occurring in a body as a result of an externally applied force.

Strike : Through the transfer of fluids and microorganisms from one side of a barrier to the other by a process of capillary action.

Subluxation : An incomplete or partial dislocation.

Supination : A turning of the forepaw inward toward the body.

Synchondrosis : The union of bones by means of fibrous or elastic cartilage.

Syndactylism : The condition in which two or more toes are more or less completely grown together or adherent.

Syndesmosis : Artificial ankylosis by fibrous connection.

Synostosis : The union of adjacent bones by means of osseous union of bones that are normally separate.

Synovectomy : Excision of a part or all of the synovial membranes.

Synovial fluid. : A viscid fluid containing synovin, or mucin, and a small proportion of mineral salts. It is transparent and alkaline and resembles the white of an egg. Secreted by the synovial membrane, it is contained in joint cavities, bursa, and tendon sheaths.

Tenodesis : Tendon fixation; suturing of the end of a tendon to bone.

Tenolysis : Separation of a tendon from its tendon sheath.

Tenorrhaphy : The union of a divided tendon by a suture.

Tenotomy : Surgical division of a tendon to correct deformity.

Thoracotomy : Surgery to view the lung and may be used to confirm cancer, or for chest trauma to detect source of bleeding.

Thrombolytic drugs : Medication used to dissolve blood clots.

Tranquillizer : Drug used to reduce anxiety.

Transplant : To transfer tissue from one part to another.

Trephine : A cylindrical saw.

Tumour : Literally, a growth or swelling. Usually, but not necessarily, neoplastic.

Ulcer : Wound involving loss of a basal epidermis.

Uraemia : Presence in the blood stream of abnormally high levels of urea. Causes may be prerenal, renal or postrenal. Determination of urine specific gravity helps to distinguish renal from pre or postrenal causes.

Urinary retention : The inability to empty the bladder.

Uterus : The hollow, muscular organ of the female reproductive system.

Valgus : Bent inward; toward the midline of the body distal to joint described.

Varus : Bent inward; toward the midline of the body distal to joint described.

Volar : Referring to the walking surface of the paw.

Volatile agent : Anaesthetic agent requiring a vaporizer (*e.g.* Isoflurane).

Wedge resection of the lung : A small, localized section of the lung is removed : often for a lung biopsy.

Xenograft : Bone transferred between members of different species.

X-rays : Electromagnetic energy used to produce images of bones, organs, and internal organs onto film.

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GENERAL VETERINARY SURGERY, ANAESTHESIOLOGY AND DIANGNOSTIC IMAGING

A. FILL IN THE BLANKS

1. Best sterilization method for instruments is .....
2. Rubor, calor ....., ... and ..... are the symptoms of inflammatior
3. An inflammatory lesion which does not show the tendency for healing is known a ....
4. The examples of synthetic, absorbable sutures are .....
5. Cargile membrane is obtained from.....
6. Group of boils in different parts of body is termed as .....
7. The important components of hernia are .....
8. Formation of pus in the tissue due to infection of pyogenic organism is called.....
9. Aggressive antibiotic treatment without drainage of pus results in a condition calle .....
10. Blood filled closed cavity is called .....
11. Collagen deposition beyond original shape and size of the wound is called .....
12. Father of antiseptic surgery is .....
13. In surgical infection the choice of antibiotic should be through.....
14. Green stick fractures are seen in ..... animals
15. The 4R in fracture repair is ....., ..., ..., ...
16. Methods of femur shaft simple oblique fracture repair in dogs are ..... internali and application of .... externally.
17. The ability of the tissue to hold sutures depend upon ....., ..., ...
18. Catgut is prepared from .....and generally preserved in .....
19. Silk is a ..... suture material and is mainly used for suturing for .....
20. The most commonly used suturing techniques for closure of uterine stump is ..... and in bladder wound is .....
21. The commonly used sterilization method of surgical instruments is .....
22. Capillary action of a suture material means .....
23. Surgical risk is used to describe .....
24. Shock develops due to massive infection is called .....

25. Polyglycolic acid is a ..... absorbable suture and is absorbed by .....
26. The choice of suturing pattern for suturing of uterus is .....
27. ..... hernia generally develops in old, uncastrated male dogs.
28. Principles of .....are the basis of modern surgery.
29. When fractured bone comes out by tearing muscles & skin, it is called ..... fracture.
30. Haematoma is a .....wound that develops following traumatic injury.
31. Collagen suture material is obtained from .....
32. Hypovolaemic shock resulting from severe ....., ...
33. Chemotherapeutic agents.....healing by inhibiting cell division and collagen synthesis
34. ..... is an injury caused by hot liquids.
35. Surgical infection refers to infections that develops in a surgical ....., within ..... month of the ..... or, one year of .....
36. The infection in wound depends upon the critical level of bacterial contamination, i.e. more than ..... per gram of tissue, and the ..... of the bacteria.
37. The most common seats of arteritis and consequent thrombosis in horse are the termination of the .....
38. .....wounds are caused by long pointed objects and may communicate with body cavities leading to deep seated infection.
39. A fresh wound gets contaminated beyond ..... hrs of injury
40. Aseptic surgery is to perform an operation in an area free from ..... and ..... organisms.
41. .....is a vasoconstrictor used to control bleeding topically
42. Base Colour of 22 gauge scalp vein needle is .....
43. Colour of polygycolic acid suture material is .....
44. Needle holder can be differenced from artery forceps on the basis of .....
45. Formation of pus in the tissue due to infection of pyogenic organism is called.....
46. Aggressive antibiotic treatment without drainage of pus results in a condition called .....
47. Infective inflammation of the connective tissue and tissue spaces is called .....
48. Haematoma is accumulation of ..... in a close cavity
49. Aseptic surgery is to perform an operation in an area free from ..... and ..... organisms.
50. Control of hemorrhage is usually practiced with .....
51. In Cushing suture only difference with Connell suture is that it does not penetrate the ..... layer.
52. Surgical instruments are sterilized by ..... and required temperature is.....
53. .....is a commonly used absorbable suture.

54. Cyst contain .....
55. Polygalactan 910 is a ..... suture.
56. Continuous suture is applied in ..... organ.
57. Common congenital anomaly of meninges is ..... and .....
58. The examples of synthetic, absorbable sutures are .....
59. An inflammatory lesion which does not show the tendency for healing is known as .....
60. In 1762—first veterinary school established by in .....
61. .....,the Indian great king (300 BC) erected the first known veterinary hospitals of the world.
62. At present the oldest veterinary college of India is.....
63. Most of the equipments available in prepackaged form are sterilized by .....
64. Endoscope, cystoscope and bronchoscope etc are sterilized by using.....
65. Shock develops due to massive infection is called .....
66. Group of boils in different parts of body is termed as .....
67. Paralumber anaesthesia was introduced in cattle by ..... and .....
68. The ..... nerve supplies sensory fibers of the horn and surrounding skin.
69. ..... is a state of behavioral change, wherein anxiety is relieved and the patient is relaxed and aware of its surroundings.
70. ..... is a state of artificially induced deep sleep.
71. ..... is loss of sensation in circumscribed body area.
72. Main aim of resuscitation is ..... and .....
73. ..... is the antagonist medicine for xylazine.
74. Trade name of any ultra short-acting barbiturate is .....
75. In case of birds, ketamine ..... (dose) could be safely used.
76. Uptake of inhalation anaesthetic is primarily determined by their .....
77. ..... is known as Father of anaesthesia
78. Xylazine hydrochloride was first synthesized in ..... in the year.....
79. Use of hyperthermia in treatment of septic wound is called .....
80. Most widely used local anaesthetic in veterinary practice is .....
81. For the relief of pain in the mucous membranes of the mouth, pharynx, larynx, vulva and glans penis ..... is used topically.
82. The site for epidural anaesthesia in cattle is .....
83. Dose of xylazine in cattle is .....
84. ..... is used for antagonizing the effects of xylazine hydrochloride.
85. The major disadvantage associated with acupuncture is .....
86. Example of non depolarizing neuromuscular blocking agent are ..... and .....

87. Thiopental sodium is administered intravenously as a ..... freshly prepared solution for the purpose of .....
88. Composition of Helabrun mixture is .....
89. Maintenance of the airway patency via E.T intubations is required during anaesthesia in all but especially in ..... breeds.
90. Aged animals are often poor anaesthetic risk because of ....., ... and ..... function.
91. Preanaesthetic corticosteroids may be indicated in.....
92. The Pedal reflexes in animals are lost in.....plane of .....stage of anesthesia.
93. Paravertebral block produces arrest of impulse of ..... nerves.
94. Cocaine is an alkaloid present in the leaves of .....
95. Rapidly acting non barbiturate intravenous general anaesthesia is.....
96. Tiletamine is a .....type of anaesthetic agent.
97. The basic line of treatment in cardiopulmonary resuscitation is ....., ... and .....
98. The commonly used antidote of xylazine hydrochloride in wild animal is .....
99. Diazepam is need to administer slow intravenously because of the presence of ..... as preservatives.
100. Triflupromazine is ..... times more potent than chlorpromazine.
101. General anesthesia without E.T. is not recommended in .....
102. The intramuscular doses of ketamine in pig is ..... and in rabbit is .....
103. The MAC is .....
104. TIVA is ..... for controlling the animal.
105. The site for epidural anaesthesia in cattle is .....
106. The reducer in developing solution is .....
107. The thickness of the polyester base of x-ray film is ..... and that of a radiographic film is .....
108. The ideal temperature for developer solution is .....
109. tomic number of lead and barium sulphate is ..... and ..... respectively
110. Kv increase ..... of X-ray.
111. mA increase ..... of X-ray.
112. First Noble prize in physics was received by .....
113. The technique for contrast radiographic examination of kidneys and ureters is called as .....
114. ....., ... and .....factors affect the scattered radiation.
115. Skeleton of young and immature animals in skiagram is characterized by .....
116. The ideal temperature for developer solution is .....
117. The measurable unit of radiation exposure is .....

118. X-ray film is coated with ..... crystals
119. Transducer of USG contains ..... crystals
120. ..... Contrast material is used for outlining alimentary tract.
121. Intensifying screens used to ..... the film blackening effect on the.
122. Fluorescent layer of intensifying screens and its main function is .....
123. Example of "rare earth" element is .....
124. X-rays of higher KVP will ..... the object more easily than those of..... KVP.
125. The target in X-ray machine is made from ..... embedded in ..... which is supported on a ..... stem.
126. For getting similar image exposure factors either 80 KV and 4 mAS or ..... KV and 2 mAS or 100 KV and ..... mAS or ..... KV and 16 mAS are applicable.
127. The source of ultrasound in USG machine is .....
128. Echo pattern of liver of an normal animal is considered as.....
129. Cold as a mean of physiotherapy is applied in .....
130. Atomic number of lead and barium sulphate is ..... and ..... respectively.
131. Contrast radiography of gall bladder is termed as .....
132. The fluoroscopic screen has the coating of ..... and crystal size is .....
133. Hardening time >..... > developing time.
134. Absorption of X-ray by urine is more than that of ..... in intestine.
135. "Bremsstralung" is .....
136. Motion unsharpness is minimized by reducing exposure .....
137. In fluoroscopy ..... to ..... mA current is used
138. When electricity is passed in the transducer, ... changes its ....., sound wave is produced.
139. ..... mode of ultrasound is used in Echocardiography, Doppler.
140. There is often a normal bright area immediately deep to fluid: phenomenon is known as.....
141. .....is characteristic artifact observed in cystic calculi
142. ..... die with moderate & lethal radiation dose
143. Biological effect of radiation is amplified by presence of..... in cell.
144. Left kidney is easier to scan the right kidney because ..... is used as window to passage of sound waves
145. The normal liver parenchyma is replaced with fibrous or fat tissue and that results to increased echogenecity in disease condition like .....
146. The gall bladder in dog can be identified in USG in the right side of the midline in between ..... and .....liver lobes.

B. TRUE AND FALSE

1. The major objectives of general anaesthesia are immobilization, unconsciousness and relaxation.
2. Dissociative anaesthesia is associated with cataleptic state.
3. Anaesthesia by hypothermia is indicated in neonates or cardiovascular surgery.
4. Atropine sulphate is used as preanaesthetic medication for its anti-cholinergic properties.
5. The degree of CNS activity determines the dose of anaesthetic required.
6. Nitrous oxide is good inhalant anaesthetic drug for induction of anaesthesia.
7. In propofol anaesthesia recovery is delayed in case of dog.
8. The rate of healing is governed by the length of incision.
9. Moist heat is more effective method of sterilization than dry heat.
10. Haematoma is a closed wound.
11. Healing under scab occurs in superficial wounds like abrasion.
12. Inflammation is an adverse reaction to the site of injury.
13. Scald is more severe than burn.
14. Joint ill is the arthritis of aged and also called joint evil.
15. Shock is a static condition where there is oxygen deficiency in cell.
16. Ulcer is a circumscribed area of suppuration lined by pyogenic membrane.
17. Chloral hydrate can be administered intramuscularly and intravenously in horse.
18. Secondary ruminal tympany is an inherent problem of ruminant general anaesthesia.
19. Old age slows healing.
20. Epidural anaesthesia and spinal anaesthesia are conduction anaesthesia.
21. Echymosis is a type of closed wound.
22. Owner–patient–surgeon relationship is very important in veterinary profession.
23. Dog suffering from extreme systemic diseases like uraemia, toxaemia, may have altered hepatic and kidney functions, therefore, barbiturate (ultra-short acting) are preferred in such cases for general anaesthesia.
24. Inflammation mandatory for wound healing.
25. Dogs, cats and pigs younger than 3 months of age should be fasted for a short period or not at all because of their tendency to develop hypoglycemia.
26. In a febrile state, surgery should be postponed.
27. Lacerated wounds are caused by long pointed objects.
28. Brachycephalic dogs having pendulous soft palate thus patent airway should be maintained in such breeds during general anaesthesia.
29. A surgeon who continuously makes the same errors can never develop sound judgment.
30. Tensile strength of a suture material means in vivo strength.
31. Repeated movement over affected area helps in haemostasis.
32. Local anaesthesia prevents diffusion of sodium and potassium ions, thus causing blockage of the nerve impulse.

33. Metabolic alkalosis in common feature in all types of shock.
34. Catgut is produced from mucosa layer of sheep intestine.
35. Carbocaine has the more potency than of lignocaine, but less toxic with longer duration of action.
36. Best method of sterilization of surgical instruments is by using chemical agents.
37. Application of tourniquet is essential while performing intravenous regional anaesthesia.
38. Very young animal needs low dose of general anaesthesia as it has low metabolism and limited muscular and adipose tissue and immature detoxification mechanism.
39. General anaesthesia is preferred over regional anaesthesia for caesarean section in she buffalo.
40. Twenty four hrs fasting is minimum need as preanaesthetic preparation for GA.
41. Thiobarbiturate is contraindicated in whippet.
42. Pentobarbitone is preferred over thiobarbitone for GA in horse.
43. In respect of recovery pattern, ketamine is better than Propofol.
44. Oral ketamine may be alternate route of anaesthesia for cat.
45. In burn patient, renal failure occurs due to inadequate fluid therapy.
46. String halt occurs in cattle and middle patellar desmotomy is done for correction.
47. Major cause of surgical infections is long duration of operation.
48. 'Kapali' in Rajasthan occurs due to inflammation of saphenous vein in dogs.
49. Cyst is an inflammatory condition containing fluid or blood.
50. A sinus contains purulent discharge and no tendency to heal.
51. For potentiation of anesthesia adrenaline is mixed.
52. Cornual nerve block is indicated for amputation of horn.
53. By paravertebral block, operation can be performed in standing condition.
54. Aural hematoma is mostly seen inside mouth cavity.
55. Analgesia means loss of sensibility to pain.
56. Diazepam antagonist for xylazine.
57. The rate of healing is governed by the length of incision.
58. Inflammation is an adverse reaction to the site of injury.
59. Auriculopalpebral nerve block helps eyelid closure.
60. Fistula is an abnormal passage connecting two cavities.
61. Epidural injection in the sacrococcygeal space is actually extradural.
62. Paravertebral block is used to block L_1 and L_2 nerves.
63. α_2 – adrenoceptor agonists produce bradycardia in animals and can be counteracted by injection of atropine.
64. Epithelialization process of wound healing facilitated by dirty wound.
65. Shock decreases capillary refill time and increases pulse quality.
66. Rise in collagen levels in healing, number of fibroblasts diminishes.

67. Atropine is rapidly metabolized in rabbits and its effect may be unpredictable in this species
68. Doxapram is not specific respiratory stimulants but cause general central nervous stimulation.
69. Intravenous lignocaine (0.5mg/kg) is effective in correcting cardiac dysarhythmia
70. Primary infection originates directly from the site of surgical intervention.
71. Atraumatic division between the muscles can be achieved by transection of muscle across its fibers leads.
72. Violent muscular contraction can be an intrinsic cause of fracture.
73. Regeneration of nerve as a rule takes five to six months.
74. Preanesthetic evaluation of PCV estimation helps to determine the degree of dehydration.
75. Withhold of water in relation to preanesthetic management of nephritic patient even for a short period prove hazardous.
76. In cases of hepatic or renal insufficiency intravenous anaesthesia is preferred.
77. MAC value of Nitrous Oxide is lowest among all inhalant anesthetics.
78. Desflurane was introduced earlier to Sevoflurane.
79. Intravenous regional anesthesia can be produced using saphenous vein.
80. Tensile strength of a suture material means in vivo strength.
81. Catgut is produced from mucosa layer of sheep intestine.
82. Contrast radiography of muscle is called myelography.
83. Confirmatory diagnosis of intestinal intussception is done by USG.
84. Radioisotopes are used in digital X-rays.
85. Local anaesthetic agents prevent the generation and propagation of the nerve impulse.
86. Lidocaine is the most widely used local anaesthetic.
87. Rate of healing is similar but longer time is required to cover a larger area by the healing process.
88. Infection is the most common factor that retards normal wound healing.
89. Feasibility of performing surgery depending on animal's condition.
90. Oral intake of food and liquid is restricted for 2 hours prior to surgery in small animals.
91. Acupuncture therapy is mainly indicated for analgesia.
92. Hypothermia can be developed above 40°C.
93. Atropine is contraindicated in cattle.
94. Barium meal is contraindicated in intussception.
95. Atropine is contraindicated in cattle.
96. Barium meal is contraindicated in intussception.
97. 12 hours water withdrawal is required before USG.
98. Corneal ulceration can be tested by flurosein dye test.
99. The effectiveness of a bactericidal surgical scrub of one's hands and arms depends on the combination of the contact time and scrubbing action.

100. The first phase of the wound healing process is the epithelial phase.
101. The major electrolyte loss in case of burn injury is Potassium.
102. The collagen phase of wound healing extends from 5 -15th day of healing.
103. Povidone iodine (2.5%) solution is used for external dressing.
104. Feasibility of performing surgery depending on animal's condition.
105. Oral intake of food and liquid is restricted for 2 hours prior to surgery.
106. Skin sutures should be removed between 4-5th post operative days according to the condition.
107. Injection atropine sulphate is a general anesthetic drug used during surgery.
108. Dose of xylazine hydrochloride used in canine during anesthesia is @0.1mg/kg body weight.
109. In case of anuria urine can be collected by catheterization.
110. Pregnancy diagnosis is best done by X-Ray at lateral position.
111. Atropine sulphate is used as preanaesthetic medication for its anti-cholinergic properties.
112. The rate of healing is governed by the length of incision.
113. Scald is more severe than burn.
114. Moist heat is more effective method of sterilization than dry heat.
115. Haematcma is a closed wound.
116. Fistula is an abnormal passage connecting two cavities.
117. Inflammation is an adverse reaction to the site of injury.
118. Healing under scab occurs in superficial wounds like abrasion.
119. When plain catgut is treated with chromium salt the durability of the suture increases.
120. Catgut is manufactured from gut of Sheep.
121. Collagen sutures are used extensively in ophthalmic surgery.
122. Polygycolic acid (PGA) is a non-collagenous synthetic, braided monofilament polymer of glycolic acid.
123. Vicryl is synthetic absorbable suture material used to suture skin.
124. Nylon is a nonabsorbable suture material mainly used for suturing skin of cattle
125. The small size animals need large doses of anaesthesia in comparison to an adult animal
126. Moist heat is more effective method of sterilization than dry heat.
127. Old age slows healing.
128. Ulcer is a circumscribed area of suppuration lined by pyogenic membrane.
129. Radiographic image of the visceral organs can be studied well in obese patient.
130. Motion unsharpness can be avoided by increasing the mAs.
131. Intensifying screen is required to replace in every alternate month for quality radiograph.
132. Radioisotope is a stable isotope which emits radiation.
133. Epilation, leukemia. Cancer is the latent complication of radiotherapy.

134. More frequency of ultrasound causes less penetration into the tissue as it has more wave lengths.
135. For echocardiography M mode of ultrasound beam is used.
136. Penetrability of therapeutic ultrasound is more in muscle than fat tissue.
137. Acoustic shadowing is an artifact of Ultrasonography but useful for diagnosis condition.
138. Inversion suture is used for treatment of ear haematoma.
139. X-rays have greater wave length than light waves.
140. Fat is more radiolucent than soft tissue or bone, but is more opaque than gas.
141. Most radiolucent material visible on a film is Gas or air.
142. A small cystic calculus may be difficult to identify in a bladder full of urine, but will be more readily apparent in a pneumocystogram.
143. Irregularity of mucosal border seen on positive contrast study with intestinal lymphosarcoma.
144. Distance is linked with intensity of beam reaching the patient.
145. One duplitised film is of 0.75 mm in thickness.
146. The front part of cassette is made up of radio-opaque substance.
147. W.C. Roentgen was the first Nobel Prize Winner in physics.
148. In therapeutic ultrasound used for physiotherapy the wavelength of sound is 0.75-3 MHz.
149. Microwave diathermy can produce heat in deeper structure than the shortwave diathermy
150. In US plate and X ray plate the Urinary bladder looks black.
151. Infrared light used for physiotherapy produces conductive Heart.
152. Air is a positive contrast.
153. Contrast radiography of muscle is called myelography.
154. Cystography is radiography of urinary bladder.
155. Photoelectric absorption is advantageous for diagnostic X-rays.
156. The filament of X-ray tube is made of cobalt.
157. Like bone, air bubble also emits hyper-echoic image.
158. Rod cells are sensitive to bright light.
159. Bone marrow is most sensitive to radiation.
160. The German word "Bremsstralung" means breaking radiation.
161. A sinus contains purulent discharge and no tendency to heal.
162. Aural hematoma is mostly seen inside mouth cavity.
163. The rate of healing is governed by the length of incision.
164. Intensifying screen is present inside the potter-bucky diaphragm.
165. Wave-length of X-rays is longer than that of safety lamp light.
166. Duplitised X-ray films have two subbing layers.
167. Temperature of processing tanks should differ.
168. Characteristic radiation energy of K shell is highest.

169. The sound wave of 10,00000-100,00000 Hz frequency is used for diagnostic USG .
170. More the frequency of transducer better is the resolution of the image of USG.
171. Anechoic/echolucent image is produced in absence of any echo due to complete passage wave through the solid organs
172. The hydrogen and hydoxil free radical formed by radiation are mutagenic
173. M - mode USG resembles to B -mode but records motion and position of echo.
174. The linear scanner contains some crystals which rotates resulting to rectangular beam.
175. Plain abdominal radiographs will locate radiolucent calculi.

C. MULTIPLE CHOICE QUESTIONS

1. The best method of regional anaesthesia of entire fore limb is
   (*a*) Brachial plexus block (*b*) High epidural block
   (*c*) Radius and ulnar nerve block (*d*) None of the above
2. Cornual nerve block is done for desensitization of horn. Cornual nerve is a branch of
   (*a*) Maxillary nerve (*b*) Trigeminal nerve
   (*c*) Optic nerve (*d*) None of the above
3. Thiamylal sodium a barbiturate is of
   (*a*) Long acting duration (*b*) Intermediate acting duration
   (*c*) Short acting duration (*d*) Ultra short acting duration
4. For pregnancy diagnosis of living fetus on a bitch the following is used—
   (*a*) X-rays, (*b*) A-mode of USG
   (*c*) B-mode of USG (*d*) M- mode of USG
5. The wash tank in a manual processor in dark room
   (*a*) Remove excess chemicals (*b*) Is the final stage of processing.
   (*c*) Prevents contaminations (*d*) Last for 5 minutes
6. As kilovoltage increases the contrast will
   (*a*) Also increase (*b*) Remain same
   (*c*) Not affect the detail and density (*d*) Also decrease
7. Nuclear Scintigraphy uses the emission of which part of electromagnetic spectrum to form an image
   (*a*) Microwaves (*b*) Gamma rays
   (*c*) X-rays (*d*) Infrared rays
8. Confirmatory diagnosis of intestinal intussception is done by USG
   (*a*) Doppler (*b*) Radiography
   (*c*) Ultrasonography (*d*) None of the above
9. The contrast radiographic technique used for evaluation of patency of nasolacrymal system is
   (*a*) Rhinography (*b*) Lacrymalography
   (*c*) Xylography (*d*) Dacrocystorhinography

10. The atomic number of compound to be used as contrast material should be above
    (*a*) 20 (*b*) 30
    (*c*) 40 (*d*) 50
11. Grid ratio can be defined as
    (*a*) Ratio of thickness to distance between lead strips
    (*b*) Ratio of length to thickness of lead strips
    (*c*) Ratio of height to distance between lead strips
    (*d*) Ratio of height to thickness of lead strips
12. The phosphor material used in most intensifying screen is
    (*a*) Titanium dioxide (*b*) Manganese oxide
    (*c*) Cellulose acetate (*d*) Calcium tungstate
13. The degree of sharpness of shadow on a radiograph is
    (*a*) Density (*b*) Detail
    (*c*) Contrast (*d*) None of the above
14. Pregnancy diagnosis is best done by X-ray at
    (*a*) Ventrodorsal position (*b*) Dorsoventral position
    (*c*) Sky line position (*d*) Lateral position
15. The term "Cellulitis" refers to the inflammation of
    (*a*) Cell (*b*) Connective tissue
    (*c*) Cell membrane (*d*) None of the above
16. Polygalactan 910 is a
    (*a*) Synthetic non-absorbable (*b*) Synthetic absorbable
    (*c*) Biological absorbable (*d*) None of the above
17. Restriction of primary beam is the function of
    (*a*) Bucky tray (*b*) Cassette
    (*c*) Collimator (*d*) Developer
18. Which of the following affects the contrast of the film?
    (*a*) Temperature of the developer (*b*) Failure to use grid
    (*c*) All of the above (*d*) None of the above
19. Sodium thiosulphate in fixer solution acts as
    (*a*) Fixing agent (*b*) Acidifier
    (*c*) Hardner (*d*) Preservative
20. Which of the following is not a characteristic of first intention healing?
    (*a*) Minimal tissue contamination (*b*) Minimal tissue damage
    (*c*) Wound edges are not approximated. (*d*) Minimal role of wound contraction.
21. Which suture material is absorbable?
    (*a*) Cotton (*b*) Nylon
    (*c*) Polypropylene (*d*) Chromic catgut

22. Hydrogen peroxide is used in management of wound healing
    (*a*) To remove dead and devitalized tissues. (*b*) To remove healthy tissues.
    (*c*) All of the above (*d*) None of the above
23. The most common agent is used to paint a surgical operation site is
    (*a*) 2% Betadine (*b*) 5% Betadine
    (*c*) 1% Betadine (*d*) All of the above
24. Healing of Soft tissue generally takes place by
    (*a*) 7- 10 days (*b*) 2-3 days
    (*c*) More than 2 wks (*d*) 6 wks
25. Delicate surgical instruments are best sterilized by
    (*a*) Autoclave (*b*) Cold sterilization
    (*c*) Application of disinfectant (*d*) Sterile neutral pH water rinsing
26. Overdosage of alpha-2 agonist drug can be managed by
    (*a*) Flumazenil (*b*) Dexamethsone
    (*c*) Vigorous IV fluid (*d*) Atepamazole
27. W. C. Roentgen discovered X-ray in the year.
    (*a*) 1785 (*b*) 1885
    (*c*) 1895 (*d*) 1985

ANSWER OF MCQ

1. (*a*)	2. (*b*)	3.	4. (*c*)	5. (*b*)	6. (*a*)
7. (*b*)	8. (*c*)	9. (*d*)	10. (*d*)	11. (*c*)	12. (*d*)
13. (*b*)	14. (*d*)	15. (*b*)	16. (*b*)	17. (*c*)	18. (*c*)
19. (*a*)	20. (*c*)	21. (*d*)	22. (*a*)	23. (*b*)	24. (*a*)
25. (*a*)	26. (*d*)	27. (*c*)			

D. DIFFERENTIATE THE FOLLOWING (ANY FIVE)

1. Cardiogenic and Neurogenic shock.
2. Cyst, Abscess, Haematoma, Tumour and Hernia.
3. Tranquilization, Hypnosis, Narcosis and Sedation.
4. Stage II and Stage III of General anaesthesia.
5. Tensile strength and Functional strength of suture material.
6. Differentiate between Local analgesia, Regional analgesia, Hypnosis and Tranquilization.
7. Endotoxic and Neurogenic shock.
8. Sedation and Tranquilization.
9. Inversion and Eversion suture.
10. Dissociative anaesthesia and balanced anaesthesia.
11. CT and CR system of imaging.
12. Physiologic pain vs Pathologic pain.

13. Arterial, venous and capillary bleeding.
14. Cardiogenic and Neurogenic shock.
15. Paralysis and paresis.
16. Neuritis and neuralgia.
17. Contusion and compression.
18. Radical surgery and general surgery.
19. Sterilization and asepsis.
20. Sedation and Balanced anesthesia.

D. ANSWER THE FOLLOWING QUESTIONS

1. Properties of an ideal anaesthetic.
2. Optimal local microcirculation is essential for proper wound healing. Justify.
3. Propofol is superior to thiopentone sodium in dogs. Justify.
4. Tenets of Halstead form the basis of modern surgical craftsmanship. Justify.
5. Scald is more severe than burn. Justify.
6. Fractionation is beneficial for radiotherapy Justify.
7. Mitotic cell die with moderate and lethal radiation dose Justify.
8. Write short note on "Summation effect" on radiography.
9. Management of degenerative joint disease in canine.
10. Justify the indications of A B C in anaesthetic resuscitation.
11. Explain inflammation and its importance in the process of wound healing.
12. Midazolam can be used intramuscularly while diazepam not recommended. Why?
13. Write the common complications of wound healing.
14. Alone Midazolam is not recommended in cat. Explain?
15. Write in brief the mechanism of action of local anaesthetics drug.
16. Write in brief precautionary measure to resist surgical infections.
17. Write in brief posterior paresis following spinal cord injury.
18. Massive infection delays the wound healing process. Justify.
19. Anaesthesia in the very young is attended with high risk. Justify.
20. Asepsis is the basis of modern surgery. Justify.
21. Why equithesin should be freshly prepared ? Write the composition of equithesin ?
22. Why inhalation anaesthetics are preferred over intravenous anaesthetics in systemically impaired patients?
23. Scald is more severe than injury caused by burn. Justify.
24. Write in short on indication and methods of hypothermia in surgery.
25. Write in short on your choice for induction and maintenance of general anaesthesia in 20 kg dog for the purpose of hysterectomy.
26. Factors influencing surgical infections and their prevention.

27. Physical status in relation to anaesthesia and its categorization.
28. Factors to be considered to determine the anaesthetic risk.
29. Advantages and disadvantages of isoflurane.
30. Neonatal anesthesia.
31. Calculate the volume of replacement fluid required for a 4.5 kg cat with 8% dehydration.
32. Write the name of the factors influencing surgical risk.
33. Properties of ideal chemical immobilization drug.
34. Myelography.
35. Write the principle of surgery.
36. Why neonates are vulnerable in dehydration.
37. Write the ideal property of suture material.
38. Factors influencing surgical infections and their prevention.

REGIONAL VETERINARY SURGERY

A. TRUE OR FALSE

1. Heel effect may be corrected by placing the thicker part towards cathode.
2. Burdizzo's castrator is used in dogs.
3. Cleft palate is a congenital problem.
4. In horse the common site of chocking is posterior 3rd of oesophagus.
5. Debudding in calf should be done within 5-25 days of birth.
6. Stenson's duct connects parotid salivary gland.
7. Crib bitting is vices of camel.
8. Dentine is the hardest structure of the tooth.
9. Tonometry is measurement of intra-abdominal pressure in mm of Hg.
10. Fluorescent dye test is performed for detection of corneal ulcer.
11. Phacoemulsification involves manual removal of cataractous lens.
12. After oesophagotomy, patients must be maintained on solid diet.
13. 'Parrot mouth' condition affects the upper jaw.
14. Quidding means foul smell from mouth.
15. Hornless cattle are referred as polled cattle.
16. Paralysis of facial nerve is most common in dog.
17. Nasal polyps originates from turbinates bones of nasal cavity.
18. Guttural pouch seen only in canines.
19. Dogs are more susceptible to middle ear infection.
20. Aqueous humor hydrates the corneal surface.
21. Schirmer test is done to measure tear break up time.
22. Ophthalmoscope can be used to view the retina.

23. The placement of sutures in the repair of aural haematoma is done parallel to the incision.
24. 'Parrot mouth' condition affects the upper jaw.
25. Zepp's operation is performed for otitis media.
26. Shears mouth is not associated with molar teeth.
27. Tympany, salivation are prominent sign of chocking.
28. Atheroma is a degenerative change in the inner and middle coats or arteries.
29. After oesophagotomy, patients must be maintained on solid diet.
30. Sublingual abscess is found beneath the tongue.
31. Intracapsular method of cataract extraction is followed in dogs.
32. Glossoplagia means paralysis of lower law.
33. Lampas is an inflammatory thickening of mucous membrane of hard palate.
34. Normal tear production in dogs by Schirmer tear test is 20 mm/minute.
35. Phacoemulsification involves manual removal of cataractous lens.
36. Horn cancer is commonly found in bulls.
37. In horse the common site of chocking is posterior 3rd of oesophagus.
38. Abomasal displacement is more common in right side than left side.
39. Gastrotomy is done through mid-ventral approach.
40. In diaphragmatic hernia, the hernial content is mainly gut.
41. Low obstruction occurs in duodenum and jejunum.
42. Sutures for repair of aural haematoma should be placed perpendicular to the line of incision.
43. Entropion may be cause of corneal ulceration.
44. Tarsorrhaphy refers to surgical closure of the eye lids.
45. Ophthalmoscope is used to view the parts of the external ear canal.
46. Dental caries is commonly found in goat.
47. Torticolis refers to twisting or distortion of leg.
48. Oesophagotomy refers to removal of some portion of oesophagus.
49. Tracheal collapse occurs due to weakening of cartilaginous rings of trachea.
50. The main constituent of sialoliths is calcium gluconate.
51. Mid ventral approach is commonly practiced for abdominal surgery in Ruminants.
52. Colic is commonly observed in cattle and buffaloes.
53. Enterotomy refers to resection and anastomosis of a portion of intestine.
54. Ultrasound guided biopsy is very accurate technique for collection of biopsy material.
55. Too early castration in small and large ruminants may also predispose to urolith formation
56. Urethral stenosis may occur due to dehiscence of the anastomosis or a technically poor repair.
57. The prostate gland (accessory sex organ) encircles the dorsal surface of bladder.

58. The injection of phenol, is indicted in the hemorrhoid as treatment in dog.
59. Forssel's operation is the technique applicable in mare for correction of rectovaginal fistula.
60. Enlodgement of urolith occurs anywhere of urinary tract but mostly in proximal part of sigmoid flexus in cattle.
61. Occurrence of uric acid urolith is very common in Dalmatian breed of dog.
62. In vagal indigestion in cattle the abdomen from behind is 'papple shaped'.
63. Ruminotomy is the last assort for correction of Ruminal Impaction.
64. For movable foreign body in stomach incision is made at pylorus.
65. Trichophytobezoar is a cause for intestinal obstruction in large animal.
66. Omphalocele is an internal hernia.
67. For perineal herniorrhaphy the best site of incision is mid ventral incision in canine.
68. Diaphragmatic hernia is more in male buffalo.
69. Traumatic pericarditis is more in male buffalo.
70. Complications of Bilroth II is less than Bilroth I.
71. Resolution of hypovolemia is more concern followed by decompression of stomach.
72. Hudson's teat spiral is used for treatment of polyps in teat.
73. Right flank with "grid Incision" is preferable to left flank for routine ovario hysterectomy.
74. Urolithiasis is diagnosed by radiography in all animals.
75. Teat spider is the relaxation of sphincter causing leaking of milk spontaneously.
76. Rectovaginal fistula is more common in adult animals.
77. Umbilical hernia is common in kid.
78. Gastrotomy is done through mid-ventral approach.
79. Cystotomy is performed by inguinal approach.
80. The telescoping of a portion of intestine is called intussusception.
81. Pampiniform plexus supply circulation to stomach.
82. Low obstruction occurs in duodenum and jejunum.
83. Spasmodic colic occurs mainly in horses that have excitable temperaments.
84. Enterotomy operation involves removal of a portion of intestine.
85. If hernial content is intestine then it is termed as vericocele.
86. Failure of penis retraction in prepuce is paraphimosis.
87. Tourniquet should be used before amputation of tail.
88. Removal of ovary is called hysterectomy.
89. In ruminal impaction ruminotomy should be done in standing condition in cattle.
90. Prosthitis is a disease condition of prostate gland.
91. Purse string suture is applicable for management of rectal prolapse.
92. Teat spider is the relaxation of sphincter causing leaking of milk spontaneously.

93. In goat, calculi are generally deposited in sigmoid flexure of penis.
94. Umbilical hernia is mostly seen in bovine calf.
95. Condition in which testis is found in other than scrotal sac is called ectopic testis.
96. Nephroliths are usually formed in urethral process.
97. Recurrent estrous is a common complication of ovariohysterectomy in bitch.
98. Low obstruction occurs in duodenum and colon.
99. Amputation of udder is called thelotomy operation.
100. Obstructive urolithiasis in dog is mostly seen in os-penis.
101. Mid ventral approach is commonly practiced for abdominal surgery in ruminants.
102. Colic is commonly observed in cattle and buffaloes.
103. Amputation of udder is called thelotomy operation.
104. Enterotomy operation involves removal of a portion of intestine.
105. Traumatic pericarditis results from ingestion of foreign body.
106. Placement of non-crushing intestinal clamps are placed 4-6 cm away from crushing clamps during intestinal anastomosis.
107. Spasmodic colic is the result of increased peristaltic contractions in the horse's gastrointestinal tract.
108. Auscultation of the omasum is carried out at the level of right elbow in the 6th intercostals space.
109. Perineal hernia mostly seen in bitch is due to gravid uterus.
110. Diaphragmatic hernia concomitantly occurs with traumatic reticulitis in buffalo.
111. Spaying is the surgical removal of both ovaries and uterus.
112. Epididymectomy is an alternative method for producing teaser animals.
113. In ectopic testis condition, the testicle remain in abdominal cavity.
114. Paraphimosis denotes inability to protrude the penis from the prepucial sac.
115. In sheep, the common site of calculi lodgment is in urethral process.
116. Obstructive urolithiasis in dog is mostly seen in osspenis.
117. Traumatic pericarditis results from ingestion of foreign body.
118. Teat spider is the relaxation of sphincter causing leaking of milk spontaneously.
119. In goat, calculi are generally deposited in sigmoid flexure of penis.
120. Amputation of udder is called thelotomy operation.

B. FILL IN THE BLANKS WITH APPROPRIATE WORDS

1. Recurrent tympany, reduced ruminal motility and anorexia are the characteristics signs of.....
2. Liptek test is generally carried out for diagnosis of .....
3. High obstruction occurs in ..... and low obstruction occurs in .....
4. Intussusceptions is commonly developed in ..... and .....
5. Typhlectomy operation is generally carried out for .....

6. Atresia ani-et-recti et-coli is characterized by.....
7. The method of surgical correction of teat fistula is .....
8. In bitch generally there are ..... pairs of mammary gland
9. ..... suture is not always effective in recurrent rectal prolapse and ..... is the surgical treatment of choice.
10. Perineal hernia sometimes occurs with rectal .....
11. Dental formula in cattle is.....
12. Dental formula in Dog is.....
13. The resection of devitalized and necrotic caecum is called .....
14. Orchiectomy is a routine operation while performing ..... herniorrhaphy in male dog.
15. In Epiplocele the hernial content is .....
16. Heart worm in dog is transmitted by .....
17. Upper obstruction is more harmful because.....
18. ..... is the most common tumour of anal gland.
19. Tear of the rectum is most common in .....
20. Rupture of urinary bladder caused by urolith is called ..... and repair technique is .....
21. Inability to protrude the penis through prepuce is ..... and the opposite condition is .....
22. One most complication of surgical method of castration with inappropriate post-operative care is .....
23. Penetrating metallic object in feed can be the cause of ..... and .....
24. Foreign bodies of plant and animal origin present in stomach are called ..... and ..... respectively.
25. LDA and RDA are ..... and .....
26. Umbilical hernia occurs due to ..... gene.
27. Hernia containing intestine and uterus is called .....
28. Resection of the caecum is called.....
29. Volvulus is ..... rotation of the mesentry and attached small intestine whereas torsion of intestine is a twisting of bowel on its .....
30. ..... influences crystal precipitation and calculi formation.
31. Left flank omentopexy is a technique for correction of .....
32. A rotation of intestine on its mesentric axis is called.....
33. The ideal approach for diaphragmatic herniorrhaphy is at ..... site.
34. The commonest seat of location of urethral calculi in the bovine is at the ..... of penis.
35. Phimosis is.....

36. Accumulation of pus in uterus in canine is called as ..... and surgical correction. of this condition is known as.....
37. Collection of fluid between the layers of tunica vaginalis is called.....
38. The resection of devitalized and necrotic intestine is called.....
39. Paralytic ileus is caused by.....
40. Intussusceptions is commonly developed in ..... and .....
41. ..... is seen as complication of castration in pigs, horses and cattle.
42. Collection of fluid between the layers of tunica vaginalis is called.....
43. The resection of devitalized and necrotic intestine is called.....
44. ..... is the standard approach for exposure of a defined region of the thorax and offers well to excellent access to structures in the immediate area of the thoracotomy.
45. ..... sternotomy provides access to the entire thoracic cavity.
46. ..... ventilation is mandatory in thoracic surgery.
47. Creation of ..... pleural pressure inside the thorax is needed after completion of surgical procedure but before complete closure of the thoracic cavity.
48. Positive pressure ventilator is an essential instrument for performing ..... operation in dog.
49. Orchiectomy is a routine operation while performing ..... herniorrhaphy in male dog.
50. In epiplocele the hernial content is .....
51. If hernial content is urinary bladder than condition is termed as .....
52. ..... is defined as invagination of a segment of the gastrointestinal tract into the lumen of an adjoining segment.
53. ..... and ..... are indicated to remove devitalized intestinal segment.
54. Resection of caecum is called .....
55. Gastric ulcerations are characterized by a break in the ..... resulting epithelial erosion.
56. ..... is indicated to remove the impacted material from rumen.
57. Blood supply to the pinna of the external ear by the.....
58. Salivary stones are called .....
59. Method for surgical extraction of cataract in dog is called.....
60. Separation of the horny covering of horn core is known as .....
61. Common sites for oesophagial obstruction in dog and cattle are ..... and ..... respectively.
62. Epulis is the neoplasm of .....
63. Inflammation of the entire eye along with all the layers is called .....
64. Ranula develops in the area of .....
65. Inflammation of the uveal tract of the eye is termed as .....

66. Accumulation of air in guttural pouch is known as .....
67. In horn carcinoma ..... like growth is found.
68. The congenital fissure of the upper lip is .....
69. ..... duct opens opposite to the 5th cheek tooth in the cheek.
70 Dehorning is done under the control of ..... nerve block.
71. ..... is a prominence of the palate just behind the incisors seen in foal
72. The external ear comprises of .....and .....
73. Inflammation of middle ear is termed as.....
74. Instrument used to examine the ear is called .....
75. A condition where double row of eyelashes is present, causing impinging on the eyeball and irritation is termed as .....
76. Ranula develops in the area of .....
77. Common sites for Oesophagial obstruction in dog and cattle are ..... and..... respectively.
78. Salivary stones are called .....
79. Tumour of gum is termed as .....
80. For amputation of horn in bull, the ideal anaesthetic block is .....
81. Separation of the horny covering of horn core is known as .....
82. Increased intraocular pressure is known as .....
83. Inward turning of border of eyelid is termed as .....
84. Horn cancer, a ..... of the horn is the most common condition affecting mostly .....
85. Chalazion is inflammatory enlargement of a ..... gland in the eyelid.
86. Ankyloblepharon is .....
87. Blood supply to the pinna of the external ear by the.....
88. Method for surgical extraction of cataract in dog is called.....
89. Inflammation and affection of the middle ear is termed as .....
90. Inflammation of the entire eye along with all the layers is called .....
91. .....is the major refractive surface of the eye.
92. Incisor teeth in animals is used for ..... while molar teeth is used for.....
93. Jabot refers to .....
94. Bishoping means.....
95. The main constituents of dental tartar are.....
96. The ideal approach for diaphragmatic herniorrhaphy is at ..... site

D. MULTIPLE CHOICE QUESTIONS

1. The common surgical technique to expose the horizontal ear canal is known as
   (*a*) Bulla osteotomy (*b*) Zepps operation
   (*c*) Myringotomy (*d*) None of the above

2. Corneal ulceration can be tested by
   (a) Fluroscein dye test (b) Liptek test
   (c) Eosin dye test (d) Nigrosin dye test
3. Most common delayed effect of radiation on eyes is development of
   (a) Glaucoma (b) Keratitis
   (c) Cherry eye (d) Cataract
4. The recent and most commonly used technique for cataract operation is by
   (a) Cryo extraction of lens (b) Phaco emulsification technique
   (c) Surgical removal of lens (d) Medicinal destruction of lens
5. Chiloschisis is a congenital condition characterized by cleft in
   (a) Soft palate (b) Hard palate
   (c) Lips (d) Tongue
6. The function of salivary gland can be destroyed by the injection of
   (a) Formaldehyde (b) Tincture iodine
   (c) Potassium iodide (d) All of the above
7. Alveolar periostitis is also known as
   (a) Dental caries (b) Dental tartar
   (c) Periodontal disease (d) None of the above
8. Which is a test for diagnosing displacement of abomasums?
   (a) Wether pinch test (b) Liptek test
   (c) Pole test (d) None of the above
9. In dog which organ resumes its peristaltic movement after laparotomy?
   (a) Stomach (b) Small intestine
   (c) Large intestine (d) None of the above
10. Site of spleenectomy in large animals is
    (a) Right paracostal (b) Left paracostal,
    (c) Left flank (d) Right flank
11. The site for thoracocentesis for drainage of chylothorax is___intercostal space.
    (a) 4th (b) 5th
    (c) 6th (d) 8th
12. Most common site of stone formation in case of sheep is
    (a) Ischeal region (b) Sigmoid flexure
    (c) Urethral recess (d) Urethral process
13. For teaser bull preparation which of the is conducted
    (a) Close method (b) Orchiectomy
    (c) Open-close method (d) Epididymectomy
14. Removal of male generative organ in birds is called
    (a) Orchiectomy (b) Neutralization
    (c) Testectomy (d) Caponisatisation

15. The term ingluviotomy in fowl refers to opening of the
    (a) Crop (b) Gizzard
    (c) Caecum (d) Proventriculus
16. Surgical enlargement of hernia ring is termed as-
    (a) herniorrhaphy (b) hernioplasty
    (c) kelotomy (d) widening of hernia ring
17. The suture technique adopted for typhlectomy is
    (a) Simple interrupted (b) Simple continuous
    (c) Continuous lock-stitch (d) Inversion
18. Paralytic Ileus of intestine is sometimes caused by
    (a) Surgical trauma (b) Foreign body
    (c) Meckel's diverticulum (d) Rectal diverticulum

ANSWER OF MCQ

1. (b)	2. (a)	3. (d)	4. (b)	5. (c)	6. (d)
7. (c)	8. (b)	9. (b)	10. (c)	11. (c)	12. (d)
13. (d)	14. (d)	15. (a)	16. (c)	17. (d)	18. (a)

E. ANSWER THE FOLLOWING QUESTIONS

1. Cold and hot application are indicated in acute and chronic inflammation respectively-justify
2. Write in short the treatment of tympanitis of guttural pouch.
3. Enumerate the different etiological factors for horn cancer in bullocks.
4. Indications for Zepp's operation in otitis media.
5. Write a simple diagnostic technique for detection of blockage in nasolacrymal duct.
6. Lateral resection of external ear canal (Zepp's Technique).
7. Enumerate a simple technique for detection of nasolacrymal patency.
8. Tympanitis of guttural pouch.
9. Site for trephining of frontal sinus of horse.
10. Barium enema in canine.
11. Pitfalls of interpretation.
12. Heel effect.
13. Characteristic X-ray and Bremsstralung.
14. Yolk gall.
15. Jabbot.
16. How heat helps in controlling the inflammation and related symptoms.
17. Write in short the basic mechanism of diagnostic ultrasound.
18. Write in short on Oesophahocele.

19. Write in short on Atheroma in animals.
20. Write short note on "Summation effect" on radiography.
21. Write in short about etiology and treatment of empyema of the guttural pouch.
22. Enumerate the different etiological factors for horn cancer in bullocks.
23. Write in short on tumour neck.
24. Write the indications, mechanism of action and contraindication of cold therapy.
25. Write in brief about the current ocular diagnostic procedures in canine.
26. Classify radiotherapy. Write in detail about Brachytherapy.
27. Write the difference between hog mouth and parrot mouth condition.
28. Yoke gall is the common ailment in working bullocks-justify?
29. Differentiate between Phimosis and paraphimosis.
30. Herniorrhaphy vs. Hernioplasty.
31. Cryptorchid animal should not be used for breeding purpose-explain?
32. What is scirrhous cord and its treatment?
33. Briefly mention complications of ovariohysterectomy in bitch.
34. Teat fistula should be corrected in dry period. Justify.
35. Free milker Vs Hard milker.
36. Teat fistula should be corrected in dry period- explain

VETERINARY ORTHOPAEDICS AND LAMENESS

A. TRUE OR FALSE

1. In shoe boil trauma caused by shoe on the affected limb hitting the point of olecranon tuberosity.
2. Sore shin is osteo-periostitis of cranial aspect of first phalanx.
3. Degenerative condition of horny frog is called Thrush.
4. Synovial effusion of hock joint is called wind galls.
5. Chronic administration of corticosteroids hastens degeneration of cartilage.
6. OCD result in disturbance of the normal process of ossification.
7. The medial coronoid process normally unites with the ulna at approximately 22 weeks of age.
8. Cervical spondylopathy is most common C5-6 or C6-7.
9. Rupture of the peroneus tertious heals well with adequate rest.
10. The inflammation of stifle joint, gonitis involves the femoro-patellar and femorotibial joint.
11. Stringhalt is a common cause of lameness of nervous origin in bovines.
12. Removing a portion of the muscle is a surgical treatment for ossifying myopathy.
13. Horses are more prone to hind limb lameness.

14. Classical sign for detection of hind limb lameness involving both hind limbs is difficulty in "backing" the horse.
15. Local nerve blocks are a modality for detection of lameness.
16. Septic pedal arthritis is characterized by chronic presence of lameness, inflamed and swollen coronary band.
17. Major causative organism for foot rot is *Fusiformis necrophorus.*
18. Majority of hoof disorders develop as a result of environmental factors.
19. Sole ulcer is a true ulceration of the sole of the feet.
20. Tendon does not regenerate, get replaced by fibrous tissue.
21. In laminitis if both fore limbs affected horses try to bear wt. on toe and hinds limbs are found advanced forward to support body wt.
22. Hip dysplasia and hip dislocation is the same condition in two terms.
23. Long oblique fracture is managed by cerclage wiring.
24. Rasper is used for hoof trimming.
25. Joint ill is the arthritis of aged and also called joint evil.
26. Thrush is Common in heavy draft horses in fore feet only.
27. Separation of the wall and the sensitive laminae of foot termed as canker.
28. Poor blood supply to the fractured area may lead to avascular necrosis.
29. After application of casts fracture must be reduced and immobilized.
30. Due to crural paralysis muscles covering the anterio- lateral side of femur is affected.
31. Tendons of gastrocnemious and superficial digital flexor muscles form Achilles tendon.
32. Friction against hard surface is the prime etiology for capped elbow.
33. Removal of part of lateral digital extensor muscle with tendon is treatment for string halt in cattle.
34. Exostosis of metacarpal and carpal bones is known as splint.
35. Inflammatory condition of metacarpal and metatarsal region is termed as sore shin.
36. Stringhalt is a common cause of lameness of nervous origin in bovines.
37. Sole ulcer is not a true ulcer.
38. Injury of tendon is known as strain.
39. Inflammatory condition of metacarpal and metatarsal region is termed as sore shin.
40. Inflammation of bursa of fibricious is known as bursitis.
41. Exostosis of metacarpal and carpal bones is known as splint.
42. Quitter is the inflammation of the sensitive laminae of the foot.
43. Osselets is a disease condition of dog.
44. Supporting limb lameness means when the foot first contacts the ground or when the limb is supporting weight.
45. Bench knee means sideways displacement of the cannon bone.
46. Repetitive limb coordination pattern used in locomotion is called Stride.

47. Arthroscopic intervention in joint is generally carried out for massage purposes.
48. Degenerative joint disease generally affects vertebral joints.
49. Genetic factor may play an important role in canine hip dysplasia.
50. Exostosis of metacarpal and metatarsal bones is known as splint.
51. Friction against hard surface is the prime etiology for capped elbow.
52. Quittor is the inflammation of the sensitive laminae of the foot.
53. Inflammatory condition of metacarpal and metatarsal region is termed as Sore shin.
54. Laminitis may be of nutritional origin.
55. Traverse sand crack is termed as Thimble.
56. Crouch position with flexed knee, toe touching the ground is observed in femoral nerve paralysis.
57. The condition "windpuf "affects Fetlock of horse.
58. Spavin affected horse may feel stiff or jerky to encircle in the affected side or may refuse for that.
59. Tendons of gastrocnemious and superficial digital flexor muscles form Achilles tendon.
60. Fibrosis and ossification of muscles of crus area may result from faulty I/m injection.
61. Medial patellar desmotomy is the operation for correction of upward luxation of patella in cattle.
62. Quitter is the inflammation of the sensitive laminae of the foot.
63. Osselets is a disease condition of dog.
64. Stringhalt is a common cause of lameness of nervous origin in bovines.
65. Sole ulcer is not a true ulcer.
66. Injury of tendon is known as strain.
67. Removal of part of lateral digital extensor muscle with tendon is treatment for string halt in cattle.
68. Exostosis of metacarpal and carpal bones is known as splint.
69. In bog spavin as the disease progresses, the joint space narrows due to formation of small osteophytes and at last joint is ankylosed .
70. Fibrosis & ossification of muscles of crus area may result from faulty I/m injection.
71. Medial patellar desmotomy is the operation for correction of upward luxation of patella in cattle.
72. "Dropped elbow" is noticed in complete paralysis of sciatic nerve.
73. Inflammation of stifle-joint is called gonitis.
74. Medial patellar ligament is a straight ligament.
75. Trochanteric bursa is a true bursa.
76. Fibrotic myopathy occurs in Monday morning disease of horse.
77. Desmotomy is done for treatment of stringhalt.
78. Crural paralysis is the affection of fore limb.

79. The rupture of the round ligament leads to severe coxofemoral luxation.
80. Removal of part of lateral digital extensor muscle with tendon is treatment for string halt
81. Thimble refers to the separation between the wall of the hoof and the sensitive laminae.
82. Fracture of the third phalanx a common cause of lameness in horse.
83. Stringhalt is a common cause of lameness of nervous origin in bovines.
84. Sole ulcer is not a true ulcer.
85. Quitter is the inflammation of the sensitive laminae of the foot.
86. Osselets is a disease condition of dog.

B. FILL IN THE BLANKS

1. Osselets refer to ..... on the dorsal distal epiphyseal surface of the third metacarpal bone.
2. ..... is exostosis on the pastern or coffin joint.
3. Pedal osteitis is demineralization of ..... due to inflammation.
4. Extensor process fracture of P3 common in fore limb is most common cause of .....
5. Polysulphated glycosaminoglycans increase production of ..... and decrease activity of .....
6. Synovial fluid of infectious arthritis is characterized by increased ..... count.
7. Cranial drawer signs are indicative of .....
8. IVDD is rarely seen in the thoracic region because .....
9. Indications for shoeing in horses are ..... and .....
10. The general term to describe synovial swelling that does not cause lameness are ..... and .....
11. Surgical treatment of upward fixation of patella in cattle is called ..... operation.
12. Lameness can be classified into four types ..... and .....
13. The forelimbs in horse bear ..... % of the body weight.
14. Pin hole surgical procedure to detect joint diseases is termed as .....
15. The total hip replacement involves replacing the hip joint with a ..... and ..... prosthesis.
16. Serial X- ray to monitor the rotation of ..... is the most characteristic sign to diagnose chronic laminitis.
17. ..... is degenerative condition of horny frog started from central lacunae and extending up to entire frog.
18. The cranial boundary of abdominal cavity is formed by .....
19. The caudal boundary of abdominal cavity is formed by .....
20. The instrument named ..... is essential for thoracotomy in dog
21. Surgical treatment of stringhalt operation in equine is called .....
22. Dropped hock is a sign seen in equine lameness due to .....

23. The general term to describe synovial swelling that does not cause lameness are ..... and .....
24. Navicular disease can be diagnosed by .....
25. Soundness may be defined as .....
26. Osteomyelitis is a disease condition of ..... and is caused by .....
27. Ideal fixation technique of communited diaphyseal fracture is .....
28. The standard radiographic view for diagnosis of Hip dysplasia is .....
29. A ligament connects ..... and tendon connects .....
30. Stringhalt is a surgical condition of..... and treatment of such condition requires.....
31. For minimal haemorrhage, trauma and loss of function, a muscle should generally be split ..... to their long axis.
32. ..... and ..... are the most common causes of delayed union in large animals.
33. Three primary types of osseous callus at sites of fracture repair at sites of fracture repair of diaphysis of a long bone are ....., ... and .....
34. The normal angle between the shaft of femur to head and acetabular cavity is ..... and is called as.....
35. Inflammation of the sensitive lamina of the foot is called ..... laminitis.
36. Radio graphical distinct feature of laminitis is ..... rotation of third phalanx.
37. Condition leading to ossification of the lateral cartilage is called ..... side bones.
38. Irreducible hernia because of large content and small ring is called .....
39. Azoturia is a cause of lameness in ..... horses.
40. Common site for fracture of the third phalanx is ..... middle phalanx .....
41. In rush pinning technique ..... are inserted into metaphyseal region at an acute angle ..... to the long axis of bone.
42. Sweeny refers to .....
43. The general term to describe synovial swelling that does not cause lameness are ..... and .....
44. Common materials used to make snares in horses are ....., ..., ... and .....
45. Dropped hock is a sign seen in equine lameness due to .....
46. Indications for shoeing in horses are ....., ..., and .....
47. Navicular disease can be diagnosed by .....
48. ..... is seen as complication of castration in pigs, horses and cattle.
49. In upword and forword (anterio-dorsal) dislocation of hip in cattle there is ..... of the affected limb.
50. Dislocation or luxation of patella is of ..... types in dogs.
51. The head of horse is ..... on motion in forelimb lameness.

52. Hoof is .....
53. Ulceration of sole is common in.....
54. Tendo-achilles is the tendon of ..... muscle.
55. Upward luxation of patella is related to..... ridge of femoral condyle.
56. Gonitis is of..... types.
57. Peroneal tenotomy is done at the level of..... joint.
58. Forelimb of horse bears.....% body weight.
59. Disease characterized by aseptic necrosis of femoral head and neck is termed as.....
60. Hansen type I is the disease condition characterized by-.....
61. LMN signs of hind limb and normal UMN signs of forelimb indicate lesion in..... region.
62. Tension band wiring is required for the management of ..... fracture.
63. Fracture disease is characterized by .....
64. IMP can neutralize ..... forces.
65. Circlage wiring is indicated for .....
66. ESF can be classified as linear and .....
67. THR is indicated for .....
68. TWRS is the operative technique for surgical management of.....
69. Paralysis of the femoral nerve affects the ..... Group of muscles.
70. Canker is referred to as .....dermatitis involving the foot.
71. The finger like hypertrophic papillae observed in canker are referred to as .....
72. Exostosis of metacarpal and carpal bones is known as.....
73. Dropped hock is a sign seen in equine lameness due to .....
74. The general term to describe synovial swelling that does not cause lameness are ..... and .....

C. MULTIPLE CHOICE QUESTIONS

1. Long oblique fracture can be best managed by
   (*a*) Lag screw application (*b*) Bone pinning
   (*c*) Circlage wiring (*d*) None of the above
2. The paralysis of intrinsic muscles of larynx in horse may cause a clinical condition known as
   (*a*) Roaring (*b*) Laryngitis
   (*c*) Jabot (*d*) None of the above
3. Swinging limb lameness is evident in
   (*a*) When the limb is supporting weight (*b*) Motion
   (*c*) Backward movement (*d*) when excess stress occurs
4. Completely detached fragment of cartilage that is floating around in the joint is called
   (*a*) Joint mouse (*b*) Joint ill
   (*c*) Joint oil (*d*) Sequestra

5. Ehrmer sling bandage is applied in –
   (a) Forelimb (b) Hind Limb
   (c) Ear heamatoma (d) All of the above.
6. In tenotomy the suture applied is
   (a) Parker-Kerr (b) Bunnel Meyer
   (c) Simple interrupted (d) None of the above
7. Hip dysplasia is very common in
   (a) Young Small breed (b) Old small breed
   (c) Young large breed (d) Old large breed
8. Folding fracture is more common in
   (a) Young Small breed (b) Old small breed
   (c) Young large breed (d) Old large breed
9. The head of the lame animal nodes down from the normal symmetry when steps with
   (a) healthy forelimb (b) healthy hind limb
   (c) affected forelimb (d) affected hind limb
10. The condition chronic, hypertrophic, moist, eczematous dermatitis (CHMED) are sign of.
    (a) Thrush (b) Canker
    (c) Quittor (d) Corn
11. Shoe-boil stands for the synonym for.
    (a) sole ulcer (b) contusion of sole
    (c) caped elbow (c) caped hock

ANSWER OF MCQ

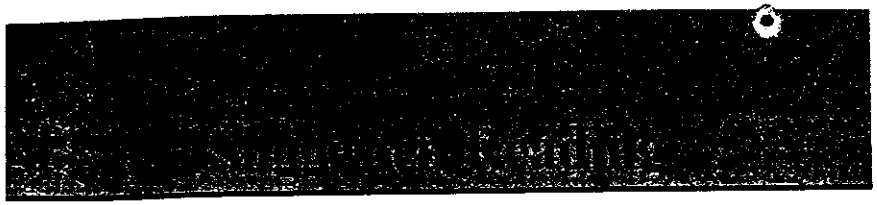
1. (c)	2. (a)	3. (b)	4. (a)	5. (b)	6. (b)
7. (c)	8. (c)	9. (d)	10. (b)	11. (c)	12. (-)

D. ANSWER THE FOLLOWING QUESTIONS

1. Hip dislocation Vs. Hip dysplasia.
2. Fracture and Dislocation.
3. Explain why horses are more prone to forelimb lameness and cattle more prone to affections of hind feet.
4. Blemish Vs Unsoundness.
5. Compound and Comminuted fracture.
6. Delayed union and Non union of fracture.
7. What are the differences between cartilaginous joints and synovial joints?
8. What is the function of synovial fluid in joints?
9. Corticosteroid plays a vital role in treatment of degenerative joint disease. Justify.
10. What is the difference between luxation and subluxation?
11. What is the difference between sprain and strain?

12. Enumerate the etiological factors spastic paresis in bullock.
13. Z-tenotomy is an alternative technique for correction of contracted tendon. Justify.
14. Difference between hip dislocation and hip dysplasia.
15. Type I IVDD vs. Type II IVDD.
16. Hansen type 1 vs. Type 2 intravertebral disk disease.
17. Type 1 vs. Type 2 External skeletal fixation technique.
18. OCD vs DJD.
19. Retrograde Vs Normograde IMP.

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