Anesthesiology

Theoretical Principles

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Course Handout

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ANAESTHESIA

1.1 Terminology

Anaesthesia	Term is given to the whole art or science which deals with production of insensibility.
General Anaesthesia	A state of progressive depression of the CNS in which the animal become unconscious and not respond to external painful stimuli. Form: Injection – inhalation – Combination of both
Local Analgesia	It is the loss of sensation in a limited body area through a selective transient paralytic action on the sensory terminal nerves and nerve endings.
Narcosis *(Basal Narcosis)*	It is a state of progressive depression of the CNS in which the animal become unconscious but still respond to extremal painful stimuli. Chloral hydrate narcosis in quine, or Morphine narcosis in dogs.
Analgesic Agent	Substance which temporally abolishes awareness of pain.
Aesthetic Agent	It is a substance, drug or agent which produce in a controllable manner both loss of consciousness together with absence of motor repose to noxious stimuli.
Narcotic Agent	Substance, drug or agent which produces in a controllable manner a progressive depression of CNS to an extant where the animal become unconscious but still responds to external painful stimuli.
Hypnotic Agent	Narcotic substance only used to induce sleep.
Ataractic Agent	Substances which produce sedation without causing generally these are known as tranquilizers.
Local Analgesic Agent	Substance which when applied about sensory nerve fibers, temporarily prevents transmission of nerve impulses
Preanesthetic medication	Drugs which must be administered before application general anesthesia to ensure safety. e.g.; Anticholinergic, Muscle relaxants, and Tranquilizers.

1.2 Aim of Anaesthesia

1. Humanitarian reason; relieve the animal form the pain of surgery.
2. Facilitate animal control, examination, & transport.
3. Technical efficiency of surgical operation.
4. Avoiding sudden movements of animal that could produce complication during surgery or hurt the surgical team.

1.3 Types (Methods) of Anaesthesia

A. Local Analgesia

It is the loss of sensation in a limited body area through a selective transient paralytic action on the sensory terminal nerves and nerve endings.

Types of Local Anaesthesia:

1. Surface Analgesia

Can be performed by one of the following methods:-

a) Freezing of the superficial layers of the skin.

b) Topical application of the local anaesthetic on abraded or eczematous area (Lignocaine® Ointment).

c) Instillation on the mucous membranes as on the cornea and conjunctiva.

d) Intrasynovial injections as Intraarticular, Intrabursal or within the Tendon sheath.

2. Infiltration Analgesia

Can be performed by: -

a) Linear infiltration anaesthesia.

b) Field anaesthesia (field block).

3. Intravenous Regional Analgesia (IVRA).

B. Regional Analgesia

1- Perineural Analgesia

a) Perineural analgesia of the head. **b)** of the limbs. **c)** of the trunk.

2- Perineural analgesia Spinal Analgesia

a) Epidural analgesia.

a. Posterior epidural. **b.** Anterior epidural. **c.** Lumbar segmental epidural.

b) Subarachnoid analgesia.

C. Sedation and Narcosis

- In combination with local or regional analgesia.
- As an adjust to general anaesthesia.

D. General Anaesthesia

a) Inhalation of volatile anaesthetic.

b) Injectable general Anaesthesia by IN, IM, or intra peritoneum.

c) By a combination of the both Injectable and inhalation anaesthesia

1.4 General Considerations in the Selection of the Anaesthetic Method

Selection of anaesthetic methods depends mainly on several factors. The most important of which are:

1. The nature of operation to be performed and its magnitude.
2. Susceptibility to the toxic actions of anaesthetic agent.
3. Site of operation in the animal body.
4. Species of the animal.
5. Duration of operation.

A. The Nature of Operation to be performed and its Magnitude:

In general, using of local analgesia will be sufficient for simple operation such as;

1. **Incision of superficial abscess**: **Spray of local analgesia** such as ethyl chloride without injection of analgesia considered sufficient.
2. Small **Neoplasm** and **Castration** of immature animals: The use of **local infiltration analgesia** is recommended.
3. **Simple interference** such **as equine capped elbow:** Which may have special anaesthetic requirement as the operation difficult to be performed under **local infiltration analgesia** only but preferred to use **tranquilizers** with it.
4. Rumenotomy in bovine must be performed in standing position, so, the paravertebral block or field block anaesthesia with tranquilization of the animal are the most suitable anaesthetic methods.

B. The Site of Operation in The Body

The complexity of structures in vicinity of the site of operation may render the operation under local anaesthesia dangerous because of possible movement by conscious animal as in cases of incision of retropharyngeal abscess which necessitate the use of deep narcosis in equine species.

C. Duration of Operation

It also affects the selection of anaesthetic drug especially when general anaesthesia is used. For example:-

1. Surgical interferences **for few minutes duration** as dental operation: It is preferred to use ultrashort-acting barbiturate as; Thiopental - Sodium.
2. **For longer operation:** It is preferable to:
   a. **Select**
      1) Long-acting barbiturate supplemented by local analgesia to give full anaesthesia for increasing duration of operation.
      2) Induce anaesthesia with ultra-short-acting agent and maintain it with inhalation anaesthetic with or without tracheal intubation.

3) In horses or cattle in which chloral hydrate has been used as induction Agent, the relatively high toxicity of this drug must be borne in mind and for the continuation of anaesthesia. so switch to inhalation agent or to one of the less toxic barbiturates.

b. For major operation under general anaesthesia give pre anaesthetic medication (premedication) which have many advantages which are;

1) Increasing the duration of operation.

2) Animal remain quiet for several hours after the operation.

3) Sedative premedication reduce the amount of general anaesthetic.

4) Controlling the excessive salivation which results from some anaesthetic agents.

D. Species of the Animal

1. The operation during the selection of the anaesthie methods not influenced only by the size and temperament of the animal but also with the physiological and anatomical features of each species or breed.
2. In general, it may be taken in consideration that as the animal becomes larger in size, it becomes the greater difficulties and dangers associated with the induction and continuation of general anaesthesia.
3. For example:- Methods which are safe and satisfactory for the dog and cat may be quite unsuitable for the horse or the ox. In a heavy and vigorous creature the mere upset of locomotors coordination may entail risks, also may prolonged recumbence.

E. Susceptibility to the Toxic Action of the Anaesthetic Agent

Factors causing increasing susceptibility to the toxic actions of anaesthetic agents must also become in mind:

1. **Prolonged fasting:**

   This leads to depletion of glycogen store in the liver so, detoxicating power of liver reduces. Therefore, when using parenteral administered anaesthetic drug in computed doses, a range of allowance must be made for an increased susceptibility to them.

2. **Diseased Conditions:**

   a. Toxemias:

   - Toxemia causes degenerative changes to the parenchymatous organs especially liver and heart. As we know, the liver has very important role in detoxification effect.
   - So, the toxemic animal often requires very much less than the norma dose.
   - toxemia may also be associated with a slowing of the circulation and unless this is recognized, it may lead to gross over dosing of 1/V anaesthesia.

   b. Diseases associated with wasting:

   - Such as animal suffering from tachycardia and a soft friable myocardium may be labile to stress of anaesthesia.

1.5 Examination and Preparation of the Patient:

The case history, physical and clinical examination is essential to be carried out before the chosen the anaesthetic regimen.

a. Case History:

As presence of cough may lead to respiratory lung collapse and obstructions by secretions when cough reflex suppressed by anaesthesia.

b. General Condition:

By examination of body temperature, pulse rate and respiration. The general condition of the animal (anaemia, internal heamorrhage .. etc.).

1. Food should be withheld on the day of the operation is performed so that the action of the diaphragm is not impeded by distension of the stomach and vomiting is also minimized, this is done in general anaesthesia.
2. Through examination should be adopted.
3. In toxemic animals the detoxicating power of the liver should be reinforced by the administration of glucose 3-4 days before the operation.
4. In emergency cases glucose-saline should be injected sub cut or intravenously before operation.
5. Narcosis or premedication if necessary, before anesthesia should be applied.

LOCAL ANALGESIA

- Local analgesia means loss of sensation in definite body area without loss of consciousness.
- It is produced by application of substances having selective paralytic action on the sensory nerves and nerve endings.
- Local analgesia is particularly useful in veterinary practice because it enable the performing of operation in standing position so, avoid dangerous in large animal from costing and recumbence.
- It is also easy and can be performed without a specialist and does not need special equipment.

There are several features of local analgesia which render it particularly useful in veterinary practice:

a. Its use **enables prolonged/protracted operation to be performed on standing animals**, and in large animals this avoids the dangers associated with forcible casting and prolonged recumbence.

b. The surgeon can induce local analgesia and operate without the assistance of an anesthetist.

c. The techniques of local analgesia are not difficult to learn and do not involve the use of expensive or complicated equipment.

A. Indication of Local Analgesia:

Minor surgical operations as:

1. Incision of superficial abscess.
2. Drainage of wounds, hematoma.
3. Excision of neoplasm & cyst in the skin.
4. Castration of horses in standing position (with sedatives).
5. Patellar Desmotomy.

B. Local Analgesic Agents

Desirable characteristics of local analgesic agents:

A number of characteristics are desirable in a local analgesic agent. They include:

1. Good penetrating qualities in body tissues.
2. High potency so that low concentrations can be used.
3. Rapid onset.
4. Long duration of action.
5. Low systemic toxicity.
6. Non-irritant to nerve and other body tissues.
7. Reversible in its action.
8. Availably in sterile solution or ease of sterilization.

N.B. Some local analgesics have a systemic sedative action when they are absorbed from sites of injections (as. Lignocaine). So, the dose of any sedative drug given must be reduced to allow for this effect.

Potentiation of Local Analgesic Agent

1. **Potentiation by <u>Vasoconstriction</u>**
   - **a. As a general rule**, the addition of vasoconstrictor to a local analgesic agent, such as epinephrine at a concentration of **1:200,000** allows for **Increased intensity** and **Prolonged analgesic activity**.
   - **b.** The effect of epinephrine is to produce a marked vasoconstriction; hence the analgesic is removed from the site of injection much more slowly.
   - **c.** The **maximum safe concentration of epinephrine** with a local analgesic agent is **1:50.000; greater conc.** may **cause** local tissue **necrosis**.
   - **d. An exception** to this rule is **in epidural analgesia** where concentration **up to 1:10.000 may be safely used.**

   Vasoconstrictions are **contraindicated** in extremities because the **ischemia produced may cause gangrene.**
2. **Potentiation by <u>Hyaluronidase</u>**
   - **a. Hyaluronidase** is a mucolytic enzyme which **hydrolyses hyaluronic acid**, the ground substance preventing diffusion of foreign materials in the tissues.
   - **b. When hyaluronidase is added** to solutions of local analgesics, it **promotes diffusion and absorption**. In therapeutic doses it is nontoxic.

c. The ratio of toxic to therapeutic dose being 200:1.

d. It would seem to be of particular value in nerve blocks, in that the analgesic would not have to be deposited so accurately.

e. On the other hand, the duration of analgesia is decreased and the toxicity increased due to more rapid absorption. This can be counteracted by addition of epinephrine to the solution.

C. Local Analgesic Drugs

1. Local analgesics have a chemical pattern of aromatic group and amino group. Aromatic group is lipophilic, while Amino group is hydrophilic.
2. The intermediate chain is either ester or amide;
   Ester linkage is **hydrolyzed by Esterase** as cocaine, procaine while
   Amide linkage is **hydrolyzed by Liver enzymes** as Lidocaine or Bupivacaine HCl-Marcaine®.
3. Some drugs as benzocaine lack the hydrophilic tail so it is not soluble in H_2O and not injected but used for mucous membranes.
4. **Modifications of the chemical structures of the drug change its physical properties as:**
   a. Lengthen of intermediate chain or **addition of Carbon atom** to aromatic or amide> **increase in the potency** to a maximum.
   b. Addition of butyl group >> **increase lipid solubility** >> **increase** the **duration** of local analgesic and systemic toxicity,
   c. The more lipid soluble >> **the more potent**.
   d. The protein binding determines the duration of block.

1. Cocaine

1. No longer available as local analgesic.
2. From the leaves of Erythroxylon coca.
3. It is used as an aqueous solution.
4. 2% solution for skin & mucous membrane.
5. 3-4% solution for perineural injections.
6. 4.5-5 % solution for anesthetization of cornea (instilled for five minutes).

Disadvantages:

1. The toxic properties & it's addictive in man on C.N.S after its absorption.
2. Exaggeration during operations.
3. In toxic dosage it causes colonic convulsion, loss of consciousness and paralysis of medullary centers.
4. Should not inject in dog & cat as it causes cocaine positing.

2. Procaine (Novocaine)

- Its trade names are Chlorocaine, Kerocaine, Planocaine, Novutux and Novocaine.

1. Less toxic than cocaine especially when combined with adrenaline.
2. The analgesic action is 1/3 than that of cocaine but its toxic effect is 1/10 (when combined with adrenaline solutions).
3. It can be sterilized by boiling and it is not irritant.
4. Care should be taken to do not inject it in vein.
5. It is rapidly deteriorated by the liver, so may secondary infiltrated without danger of toxicity by accumulation.
6. Combining with adrenaline 1:100000 absorption is slow.
7. For general infiltration of skin & gums in dog cat >> 2%.
8. For skin infiltration & perineural in horses & cattle -> 4 - 5%
9. For epidural injection -» I-2 5%.
10. Analgesia starts within 10 minutes and persist for about an hour.

Disadvantages:

1. Procaine has a very poor penetration.
2. Anesthesia to mucous membrane is inferior to cocaine.
3. It's action on the cornea is 1/60 of cocaine.

4. Increase bleeding if not used with adrenaline.

3. Amethocaine HCl

1. It is used in desensitization of the mucous membrane.
2. 1% solution is used in instillation in the eye.
3. 2% solution is used in pharynx, larynx & nasal mucous membrane.

4. Tutocaine HCl

More potent than procaine.

5. Cinchocaine: (Nupercaine, Dibucaine®)

1. It is soluble in H_2O & can be boiled for sterilization.
2. It is decomposed by alkali so, must added traces of HCl when the solution stored.
3. It should store in alkaline free glass container & all needles boiled in H_2O free from bicarbonate.
4. The drug is more toxic than procaine, but it is balanced by its smaller dosage (1/14 than that of procaine) and time of analgesia is much longer than Procaine HCl.

6. Lignocaine Hydrochloride: (Lindocaine® or Xylocaine®)

- It is stable and not decomposed by alkaline or acids.

Advantages:

1. Shorter period of onset (Latency period).
2. More intense action & more prolonged action.
3. Spreader through the tissue is more than procaine.
4. Applied to the mucous membrane or cornea (on cornea 4% lignocaine is equal to 2% Cocaine).

The toxic effects of lignocaine are:

1. Drowsiness (absorbed lignocaine >> sedation).
2. Twitching and respiratory depression.
3. Convulsions & hypotension.
4. The appearance of toxic effects from lignocaine depends upon the concentration of the drug in the blood. It depends upon the dose of injected lignocaine & rate of absorption.

The maximum infiltration dose is:

- Horse - cattle >> 8.0 gm equivalent to 300 ml 2% solution.
- Dogs >> 0.6 gm equivalent to 30 ml 2% solution.
- Higher doses will not cause tissue damage or irritation but sedation and general anesthesia.

7. Mepivacaine HCl (Carbocaine®)

1. As lignocaine but less toxic.
2. 2-2.5 stronger than procaine.
3. It has a fast onset.
4.

8. Bupivacaine HCl® (Marcaine®)

1. It is 4 times potent than lignocaine. So, 0.5% solution of Bupivacaine is equal to 2% solution of lignocaine.
2. Period of analgesia is twice than that of lignocaine,
3. The addition of adrenaline in low concentration increases both the speed of onset and duration of analgesia.
4. The rate of onset and depth is similar to that of lignocaine, but of much longer duration.
5. Resistant to boiling with strong acid or alkali and show no change on repeated autoclaving.
6. Indicated for use in situation where prolonged analgesia is required as for relief of pain in equine acute laminitis.

	Potency	Dose	Lethal	Onset	Duration	Toxicity
Procaine (Novocaine)	**1.** 1/3 than that of cocaine. **2.** For general infiltration of skin & gums in dog cat >> 2%. **3.** For skin infiltration & perineural in horses & cattle -> 4 - 5% **4.** For epidural injection -» I-2 5%.			Slow After 10 minutes.	30 – 90 minutes	**1.** Its toxic effect is 1/10 than that of cocaine (when combined with adrenaline solutions). **2.** Procaine has a very poor penetration. **3.** Anaesthesia to mucous membrane is inferior to cocaine. **4.** It's action on the cornea is 1/60 of cocaine. Increase bleeding if not used with adrenaline.
Lignocaine HCl	**1.** **1.5 -2x** stronger than procaine. **2.** On cornea 4% lignocaine is equal to 2% Cocaine **3.** Spreader through the tissue is more than procaine.	0.5–2.0 dog 0.5–1.5 cat	6.0 3.0	Rapid 5-10m	Prolonged action. 45-180 minutes.	**1.** Drowsiness. **2.** Twitching and respiratory depression. **3.** Convulsions & hypotension.
Mepivacaine HCl	**2-2.5x** stronger than procaine.	3.0 dog 1.5 cat	6.0 3.0	Fast onset 5-10m	120-180 minutes	Less toxic than Lignocaine.
Bupivacaine HCl	**8 x** stronger than procaine. So, 0.5% solution of Bupivacaine is equal to 2% solution of lignocaine.	1.0–1.5 dog 1.0 cat	3.0 2.0	Intermediate 20-30m	3-8 h	
Cocaine	**1.** 2% solution for skin & mucous membrane. **2.** 3-4% solution for perineural injections. **3.** 4.5-5 % solution for anesthetization of cornea (instilled for five minutes).			Rapid	Medium	**1.** The toxic properties & it's addictive in man on C.N.S after its absorption. **2.** Exaggeration during operations. **3.** In toxic dosage it causes colonic convulsion, loss of consciousness and paralysis of medullary centers. **4.** Should not inject in dog & cat as it causes cocaine positing.
Tutocaine HCl	More potent than procaine					
Amethocaine HCl	**1.** 1% solution is used in instillation in the eye. **2.** 2% solution is used in pharynx, larynx & nasal mm.			Rapid	Short	Nil
Tutocaine HCl	More potent than procaine.					

Cinchocaine					Much longer than procaine	More Toxic than procaine

D. Interaction of local Analgesics with other drugs:

1. Adrenaline

1. The duration of nerve block is increased and the risk of systernic toxicity is decreased by its combination because it delays absorption from the injection site.
2. It used in I: 100000 or 1: 200.000.
3. Dilute solutions of adrenaline is unstable.
4. It is better to add the adrenaline immediately before use.

2. Nor-Adrenaline & Phenylephrine

May used as vasoconstrictor but not effective as adrenalin

3. Muscle relaxants as (Phenothiazine derivatives & Pethidine)

Local analgesics enhance the duration of action of this drugs.

E. Methods of Producing Local Analgesia

A. Surface Analgesia

1. Agents which cause **freezing** of the superficial layers of the skin are sometimes used for analgesia. **Ice** is the simplest, but generally volatile substance which cause freezing by their rapid volatilization from the skin are used.
2. **Ethyl Chloride Spray**, **Ether spray** and **Carbonic acid snow** are examples.

   Their action is very superficial and transient, and their use is limited to the simplest forms of surgical interferences, such as incision of small superficial abscess or in case of old hematoma.
3. **Analgesic solution**
   a. May be used by **Instillation** to produce surface analgesia of the **conjunctiva**, **cornea** and to suppress **blepharospasm**.
   b. Solutions may be infused into the **urethra** of animals suffering from obstruction due to calculi with good results. The **spasm is relieved** and passage of stones facilitated.
4. **Topical analgesics** are commonly used for **laryngeal** and **teat surgery**.
   a. **Jelly** and **Ointment forms of analgesics** are useful in lubricating endotracheal intubation as they help **prevent laryngospasm and post- intubation cough.**
   b. Jelly form also possesses very **good lubricating** properties and is an excellent lubricant for urethral catheters.
5. **Intrasynovial Analgesia**
   a. Surface analgesia is also used for the relief of pain arising from pathological conditions involving joints, bursa and tendon sheaths and for diagnostic purposes (lameness).
   b. A local analgesic solution is injected into the synovial cavity and then dispersed throughout the cavity by manipulation or passive movement of the joint.
   c. If the synovial cavity is distended with fluid, it is first drained to ensure that the injected solution is not excessively diluted.
   d. The **injection** renders the **synovial membrane** insensitive.

B. Infiltration Analgesia

- By this method the nerve endings are affected at the actual site of infiltration (operative site).
- Infiltration should never be carried out through or into infected or inflamed tissue.
- Sharp and sterile needles, sterile syringes in good working condition and.
- Sterile analgesic solution should always be used. The injection sites should be surgically prepared to minimize chances of infection.

Methods of producing Local Infiltration analgesia:

1. Linear infiltration.
2. Field block.
   a. Inverted L block. b. Circular block. c. Ring block.

- Basically, in the field block all the nerves entering the surgical field are desensitized.
- Compared to linear infiltration, the **Advantage of Field Block** is deposition of the analgesic solution away from the incision site, thus **Minimizing** Edema, Hematoma, and possible Interference with Healing.

Disadvantages of local infiltration analgesia include

a. Incomplete analgesia.

b. Muscle relaxation of the deeper layers of the abdominal wall

c. Possible toxicity after injecting significant amounts of analgesic solution.

Technique of local infiltration:

- The limits of the area to be infiltrated are defined and marked.
- The needle is thrust into the skin until it enters the subcutaneous tissue
- For infiltration of a straight line (linear infiltration) a needle about 10 cm long is introduced along the proposed line.
- Before injecting any local analgesic solution, aspiration is attempted to ascertain that the needle point has not entered a blood vessel.
    - If blood is aspirated back into the syringe. the needle is slightly withdrawn and reinserted in a slightly different direction.
    - If no blood is aspirated, injection of the local analgesic is carried out as the needle is slowly withdrawn so that a stream of solution is deposited subcutaneously (about **one ml** of the solution is required for **each centimeter** long of the incision).
- If the proposed incision is longer than the needle, it may be infiltrated from its middle through one puncture site, the needle being introduced first in one direction and then in the opposite direction so that the animal only suffers the sensation of one needle puncture.
- For producing **Inverted L Filed Block** infiltration analgesia, **two linear infiltration** must be carried out
    - **The first line** into the tissues bordering the dorsocaudal aspect of the last rib
    - **The second line** into the tissues of the ventrolateral aspect of the lumber transverse processes.
- **Circular field block** is used for desensitizing the skin and subcutaneous tissue around a swelling such as Hernias, Tumors, Bursitis, etc.
- **Ring block** is commonly performed for inducing analgesia of the distal parts of extremities by injecting the analgesic solution in circular manner. Also, it can be used at the **base of the teat** for some surgical procedures.
- To infiltrate several layers of tissues, the procedure is to inject, from one puncture site, first subcutaneous tissue and then by further advancing the needle, the deeper tissues.

C. Intravenous Regional Analgesia

Intravenous Regional Analgesia (IVRA) is a simple and safe method for producing analgesia of the limbs in most farm animals.

- The technique involves placing either an elastic bandage or a tourniquet either
    - Above elbow and above or below the carpus in the **Thoracic Limb**
    - Above or below the tarsus in the **Pelvic Limb**.
- The efficiency of the tourniquet is improved in the pelvic limb by including a roll of a bandage
- in the depression between the tibia and the Achilles tendon.
- Analgesia is produced by intravenous injection to any superficial vein distal to the tourniquet.
- The skin over the vein to be injected is prepared aseptically.
- A very fine needle directed either proximally or distally and local analgesic solution without any vasoconstrictors (impair its diffusion) is injected.
- **To prevent hematoma** formation, digital pressure and gentle massage are applied at the site of injection.
- Within 5-10 minutes, analgesia of the limb distal to the tourniquet occurs.
- Once the operation has been completed, the tourniquet is released.
- About 5-10 minutes after tourniquet removal, sensation and motor function return to the leg.
- Toxicity in early tourniquet removal is avoided if the tourniquet is loosened for 10-15 seconds and retightened for 2-3 minutes and this procedure is repeated several times.
- If tourniquet is applied longer than 2 hours, ischemic necrosis, sever lameness and edema occurs. In dogs, irreversible toxic effect occurs after leaving the tourniquet in place for 4 hours due to sepsis and endotoxemia occurs if the tourniquet is removed after 8-10 hours.

The dose of the local analgesic injected is:

- For large animals: 10-30 ml 2% lignocaine HCl.
- For small ruminants: 3-10 2% lignocaine HCl.
- For dogs: 0.5 m/kg. b. wt. of 2% lignocaine HCl.

There are advantages of IVRA when compared to ring block or regional nerve block; they include the fact that it is less time consuming an requires only a single injection site. In addition, the possibility of tissue trauma and contamination is lessened because it 'requires only a single injection site. The amount of bleeding at the surgical site is decreased

Also the needed amount of local analgesic solution is greatly reduced.

F. Systemic and Toxic Effects of Local Analgesic Drugs

- Toxic reactions to local analgesic drugs arise when the drugs are absorbed into the general circulation at a rate greater than that at which they can be broken down by the body.
- Rapid absorption occurs from any hyperemic or inflamed tissue and the reabsorption is increased by the use of solution which contains spreading agents such as **hyaluronidase**.
- Accidental intravascular injection may occur even though no blood can be aspirated into the syringe.
- Local damage consists of transient or permanent injury to the tissues.
- The accepted drugs currently in use do not produce local toxicity when used cautiously.

In general, the toxic reactions are avoided by:

1. Limiting the total quantity of drug used.
2. Use of dilute solutions.
3. Retarding absorption by addition of vasoconstrictor.
4. The administration of a CNS depressant prior to local analgesia.

When the concentration of local analgesic in the general circulation reaches the toxic level, two types of symptoms may be seen either singly or together. These are cardiovascular and central nervous types.

A) The Cardiovascular Type of reaction

1. Caused by decreased cardiac output due to depression of the myocardium.
2. Characterized by sudden collapse, pale mucous membrane, tachycardia and disappearance of pulse.
3. Vasopressors administered intravenously will overcome the hypotension.
4. Primary cardiac failure must be treated by cardiac massage.

B) The Central Nervous Type of reaction

1. Caused by stimulation first of cortical, then subcortical, mid-brain, and finally medullary centers.
2. Cortical stimulation produces generalized colonic convulsions.
3. While stimulatory on the medulla cause an increase in the rate and depth of respiration, tachycardia and vomiting.
4. Barbiturates are used to counteract the convulsive action of local analgesics.
5. Respiratory stimulants (analeptics) are contraindicated for treatment of the apnea.
6. Local analgesics depress the CNS and it does not respond to these stimulants. Artificial respiration and oxygen must be commenced at once.

REGIONAL ANALGESIA ABOUT THE LIMB

It is one of the most important parts of lameness evaluation in horses.

Joints of Fore & Hind Limbs

Forelimb joints		Hindlimb joints	
Shoulder J.	Scapula ***with*** Humrus.	**Hip J.**	Pelvis ***with*** Femur.
Elbow J.	Humrus ***with*** Radius.	**Stifle J.**	Femur ***with*** Tibia.
Knee/Carpal J.	Radius ***with*** Cannon (Metacarpal).	**Hock J.**	Tibia ***with*** Cannon.
Fetlock J.	Cannon ***with*** Long pastern (1st Phalanx).	**Fetlock J.**	Cannon ***with*** 1st Phalanx.
Pastern J.	Long pastern (1st Phalanx) ***with*** short pastern.	**Pastern J.**	1st Phalanx ***with*** 2nd Phalanx.
Coffin J.	Short pastern (2nd P) ***with*** Pedal/coffin (3rd P).	**Coffin J.**	2nd Phalanx ***with*** Pedal/coffin bone.

Type of Regional Analgesia

a. Perineural infiltration (nerve block).

b. Ring block.

c. Intrasynovial injection (joint capsule, bursa or tendon sheath).

Principle

Once a painful lesion is desensitized, **lameness** and pain response to palpation or manipulation **resolves** partially or completely, **thereby proving** that the **site of pain** lies **in the desensitized area**.

Technique

1. **Sequential nerve blocks** going **from distal to proximal** *(hoof to shoulder)* on the limb are used in combination with intra-articular injections to separate anatomic sites which might be the site of pain and resulting lameness.
2. All blocks Should be performed using sterile disposable needles and syringes.
3. The Skin should be properly prepared;
   a. Clipping the hair where Its length precludes cleaning the skin.
   b. As many scrub/alcohols preps as Necessary to clean the area, are used prior to
   c. Spraying with antibacterial Solution.

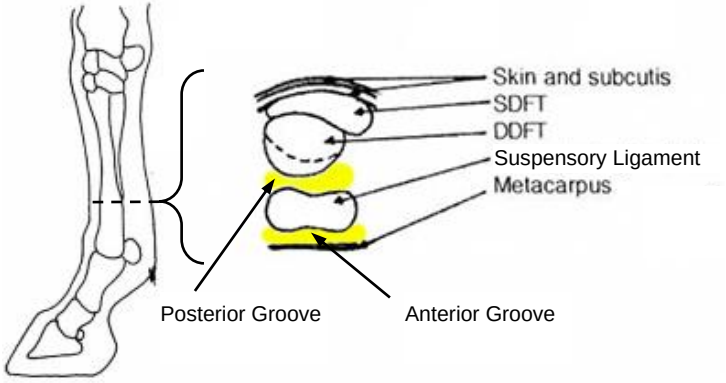
- Diagnostic nerve block and synovial injections may be used to locate an obscure lesion causing lameness. It should be used only in obscure Lameness that cannot be diagnosed by other means. To do nerve block You should know;
  1- The anatomical site where each block is performed
  2- How much anesthetic solution is required?
  3- What structures are blocked with each successive block.

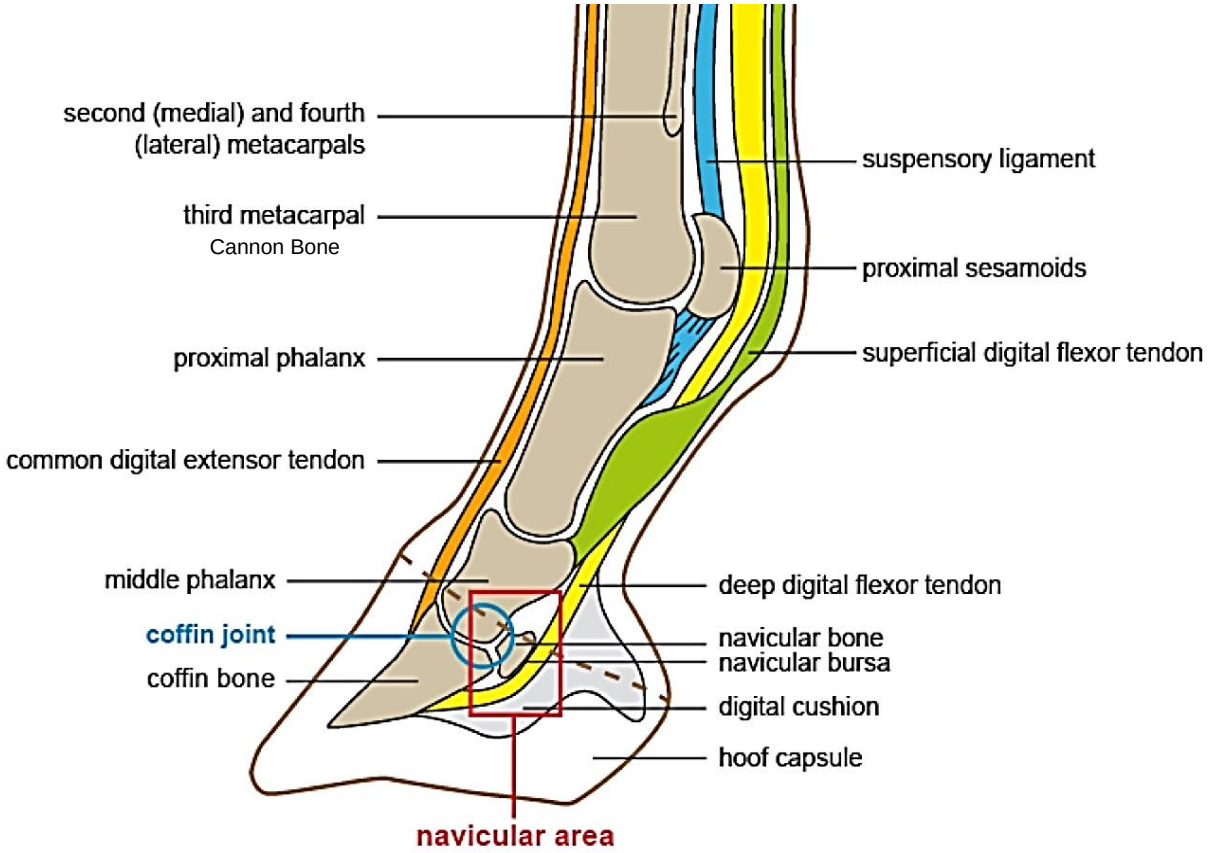
Anatomy of Foot

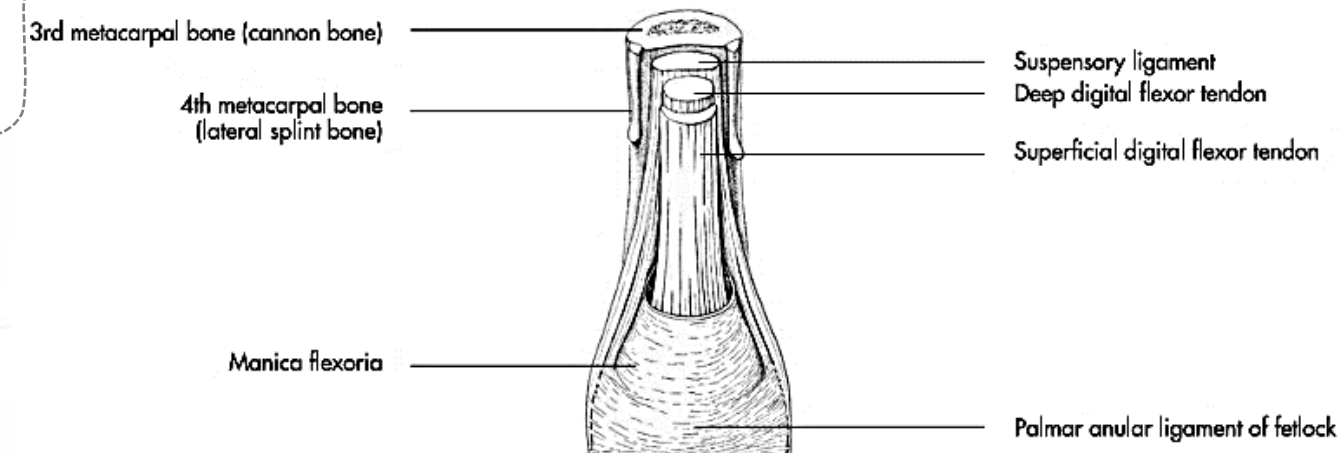
1. Common Digital Extensor Tendon *(on Dorsal aspect).*
2. Suspensory Lig. *(on palmar aspect)* inserted in the Proximal Sesamoid Bone & 1st/Proximal Phalanx
3. Superficial Digital Flexor Tendon, **SDFT**, is inserted in the distal extremity of the 1st Phalanx& Proximal extremity of 2nd Phalanx (Pastern Bone).
4. Deep Digital Flexor Tendon, **DDFT**, is inserted in the Semilunar Crest of 3rd Phalanx (Coffin Bone) in **Hoof Roll**.
5. **DDFT** lies beneath **SDFT**, both palpated as one structure, both covered by Common Sheath.
6. **Hoof Roll (capsule)** →
   DDF.
   Navicular bone (Distal sesamoid bone).
   Navicular Bursa.
   Navicular Syndrome: affection/injury/trauma of all 3 parts (DDF + Navicular bone + Navicular Bursa).
7. **Digital cushion** (Foot cartilage).

Grooves

Boundaries	**Anterior grove**	**Posterior groove**
Anteriorly	Post. Border of metacarpus	Ant. aspect of suspensory Lig.
Posteriorly.	Post. aspect of suspensory Lig.	Ant. aspect of DDFT.







*Palmar aspect of Forelimb foot (Metacarpal area) illustrating structure & arrangement of Suspensory, SDFT, **DDFT** Common Sheath*

A. Local Nerve Blocks of Limbs:

1. Palmar Digital Nerve Block

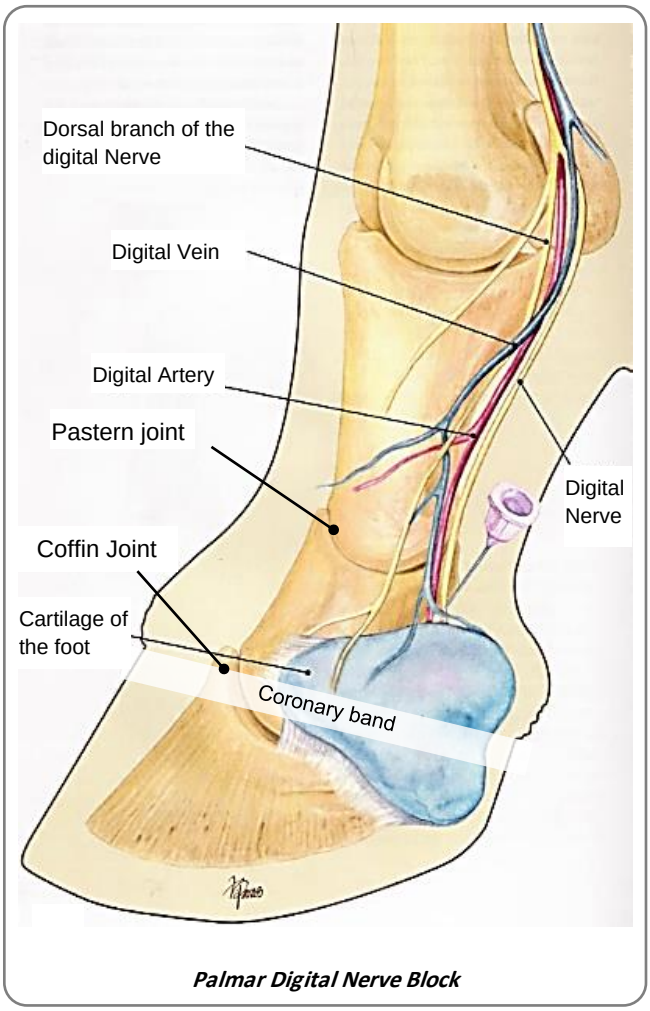
Site of Injection:

a. Between **Fetlock** and the **Coronary Band** At point about equal distance from both**.**

b. **In the Groove** formed by the **First Phalanx** and the Deep Digital Flexor Tendon, **DDFT**.

Technique:

1. The Palmar Digital Vein is palpated and the needle inserted tangentially 3 mm posterior to it.
2. The injection can be made with the leg either elevated or supporting weight.
    a. When elevated the landmarks are somewhat harder to identify.
    b. When standing the risk of personal injury somewhat greater.
3. The local analgesic solution (5-10 ml) should be injected subcutaneously over each nerve. A bleb should be seen.



Palmar Digital Nerve Block

Significant Desensitized Structures:

a. **All structures supplied by Palmer N.:**

1. Navicular bone.
2. Navicular bursa.
3. Digital cushion.
4. Distal Sesamoidean Lig.
5. Distal SDFT and DDFT.
6. Palmar aspect of the phalangeal joints.
7. Corium of the frog.

b. **Except → Coffin Joint** won't be desensitized, so of the lameness persists, so lesion must be with the coffin Joint.

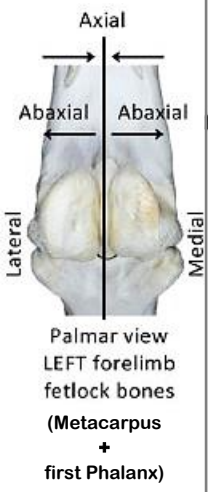
2. Abaxial Sesamoid Block (Basilar Sesamoid)

Site:

- On palmar aspect of proximal sesamoid bone, adjacent to fetlock J..
- Palpation from the front to the back of fetlock → the nerve can be felt to roll beneath the finger immediately caudal to Digital artery.

Technique:

- A 25-gauge ¾ inch needle is inserted over the palpable nerve on the Abaxial *(lateral & medial)* surface of each sesamoid bone.
- 2 - 3 ml of the analgesic solution is deposited.



Palmar view
LEFT forelimb
fetlock bones
(Metacarpus + first Phalanx)

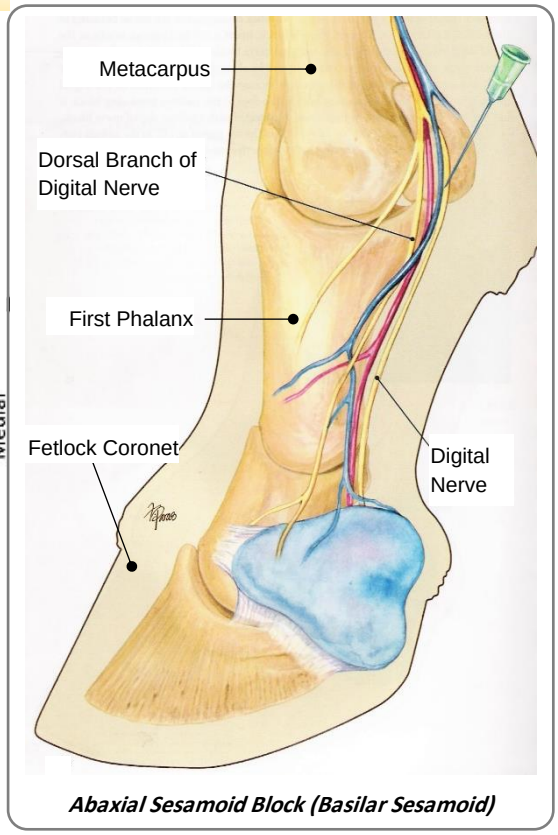
Significant Desensitized Structures:

a. A successful block will desensitize **All the Structures Distal to the site of Injection.**

Except

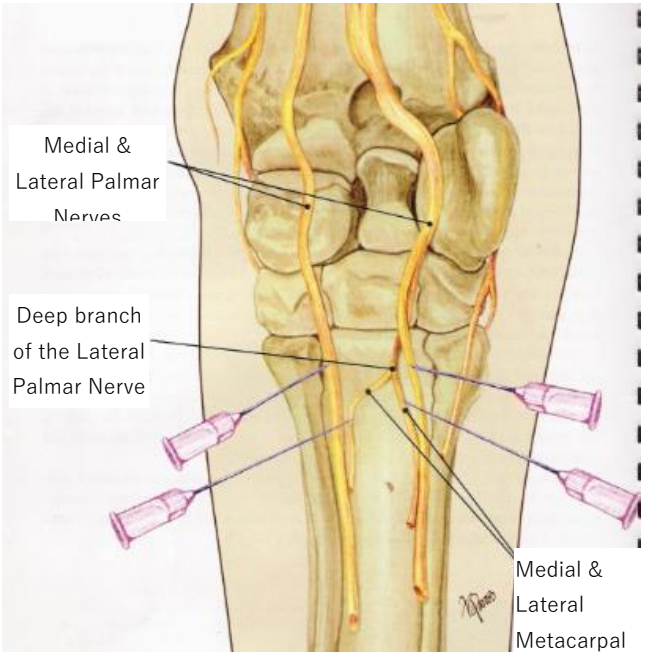
b. The Sesamoids and Fetlock joint will not be affected.

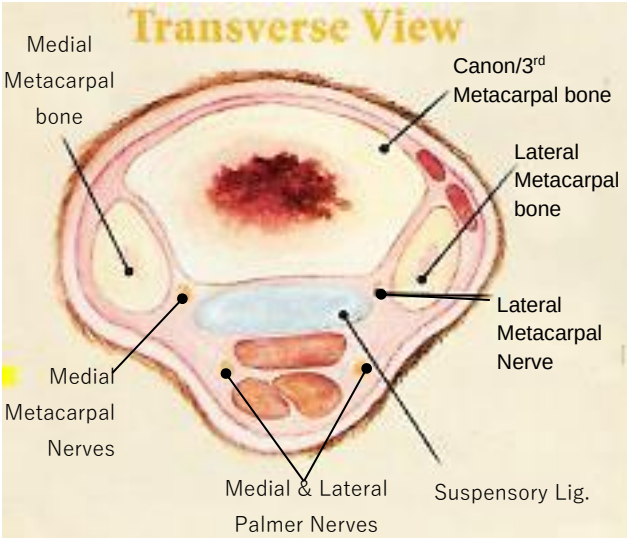
c. A dorsally located V shaped region extending distally from Fetlock coronet *(dorsal part of coronary band)* will not also be affected.



Abaxial Sesamoid Block (Basilar Sesamoid)

3. Low Palmar & Palmar Metacarpal Nerve Blocks (Low 4-Point Block)	4. High Palmar and Palmar Metacarpal Nerve Blocks (High 4-Point Block)
Site	
a. **Above distal enlargement of Cannon bone** by (10cm) **b.** **The lateral and Medial Palmar Nerves** lie just under the skin and dorsal to the edge of the DDFT (in a groove between the DDFT and the suspensory Lig.). • It is located closer to the deep digital flexor tendon. **c.** **The Lateral and Medial Palmar Metacarpal Nerve** runes deep and parallel to the 2nd and 4th and metacarpal bones. *(Beneath palmer nerve).* (in a groove between the suspensory Lig. & Metacarpal)	**a.** **Below Proximal enlargement of Cannon bone** by (10cm) **b.** Below the level of the Carpal, block the palmar nerve (medial and Lateral branches). **c.** Then block the palmar metacarpal nerve (medial and lateral branches) which runs parallel to the Second and Fourth metacarpal (Splint) bones.
Technique	
A. **Palmar Nerve** **1.** **Above the fetlock joint (distal enlargement of cannon bone)** 2 to 3 inches (10 cm), i.e., at the same level as the distal ends of the splint bones, and below the level of the medial anastomosing branch. **2.** Detect the palmar vein that is usually palpable, use a 25-gauge ¾ inch **needle** to inject 3-4 ml of the analgesic solution about **3mm posterior to Palmar vein**. **B.** **Palmar metacarpal nerves** • By infiltration of 2 to 3 ml of the local analgesic solution **at the end of** the **2nd** and **4th** metacarpal bones.	**A.** **Palmar Nerve** **1.** **Below the level of the carpus**, above the communicating branches of Palmar N. (medial and Lateral branches). **2.** Flex the carpus and **insert a needle** (1.5 inch 22 or 20 gauge) **into the Space** beneath the accessory carpal bone **between the Suspensory Lig. and the DDFT** on each side. **3.** Infiltrate 5 ml local analgesic sol. in each side. **B.** **Palmar Metacarpal Nerve** (medial and lateral) By infiltration of 3-5 ml of local analgesic solution **between** the **3rd** Metacarpal bone, **Suspensory Lig.** and the **2nd** and **4th** metacarpal bone **Respectively**.
Significant Desensitized Structures	
1. Structures below the fetlock and the deep Structures of the fetlock **2.** **N.B.** Some skin sensation may be present over the dorsal surface of the Fetlock as a result of the sensory supply from the *Medial Cutaneous Antebrachial Distribution*.	The high 4-point block will effectively desensitize the deep structures of the metacarpus with the **Exception of** the proximal part of the suspensory Ligament.





5. Median Nerve Block

1st Site (Triangular Approach)

Base line of the Triangle: Distance between Elbow & Skin Fold of the shoulder.

Head of the Triangle: **Chest nut.**

Draw a Perpendicular Line that connects between the **Head** & **Baseline** of the Triangle.

└► the **midway** of the Perpendicular Line **is the site of injection.**

2nd site:

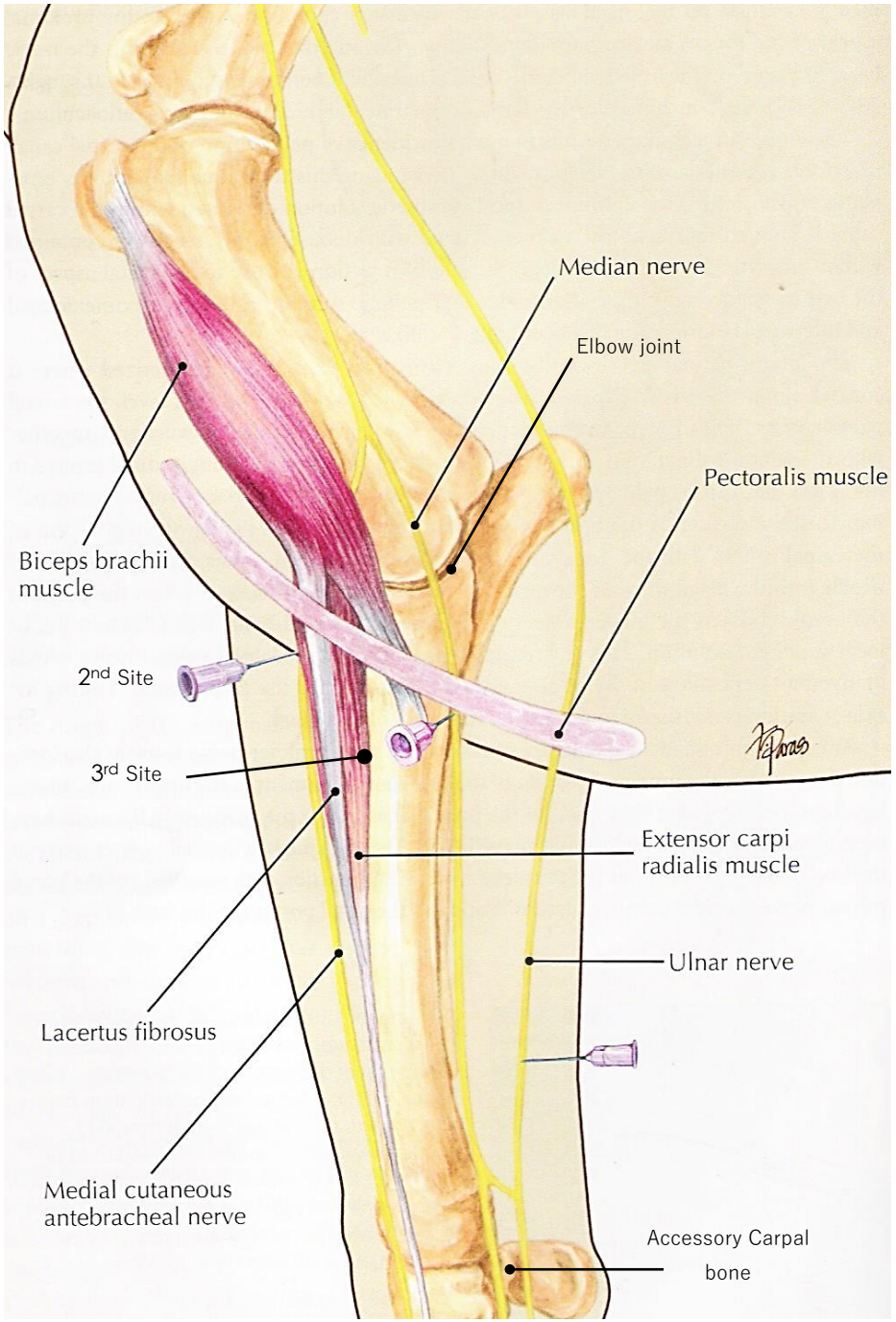
At **Mid Radius,** the nerve is caudal to the radius at **Caudal border of the Flexor carpi radialis.**

Technique:

- The needle (I inch, 20 or 22 gauge) is directed to the radius, 10 ml of analgesic solution is deposited at a depth of 1-1.5 inches.

3rd site

- On the medial side of the radius, Caudally, approximately 5-7.5 cm below the elbow joint, at the site where the nerve passes from the medial to the posterior side of the radius and where it is covered only by Skin and deep fascia.
- The needle is inserted where the Caudal Superficial Pectoral Muscle meets the radius.
- Median A. may be palpated & a pulse felt. The nerve is just Caudal to the site of the pulse.
- The needle is then directed slightly caudal. A 20-gauge 1 inch needle is used and 7-10 ml of analgesic solution is deposited.



6. Ulnar Nerve Block

Site:

- The ulnar nerve is anesthetized approximately 10 cm **Above** the **Accessory carpal bone** on the **caudal(palmar) aspect of the forearm in the groove** lies **between** the **Flexor carpi ulnaris &** the **Ulnaris lateralis.**

Technique:

- A 1 inch 22-gauge needle is inserted to penetrate the deep fascia or to a depth of 1 to 1.5 cm. 3-5 ml of the analgesic solution is deposited.

Significant desensitized structures:

- The blocking of ulnar nerve desensitizes the lateral skin of the forearm from the injection site down to the fetlock joint.
- Accessory carpal bone and Suspensory Lig. are also partially blocked by Ulnar N. block.
- **All of the Manus** (carpus, metacarpus and the digit) **can be anesthetized by Blocking** the **Median N., Ulnar N.** and **Medial Cutaneous Antebrachial Nerve.**

7. Tibial Nerve Block

Site of injection:

- **Above Hook Joint** about by 10 cm, on **medial** aspect.
- In **Groove between** the tendon **Achilles** and the **Deep Flexor Tendon**.
- The nerve can be felt as a structure approximately 6mm in diameter lust Caudal to the deep flexor tendon.

Technique:

- A needle (1.5-inch, 18 gauge) should be used.
- When it is obvious that the needle has penetrated the fascia enclosing the nerve, 15-25 ml of local analgesic agent is injected.
- Move the needle superficially and deeply, and caudally and cranially Until the region is adequately infused.

Significant desensitized structures:

This nerve is blocked in conjunction with the superficial and deep Peroneal nerves for the diagnosis of hock lameness.

8. Superficial and Deep Peroneal (Fibular) Nerves

Site:

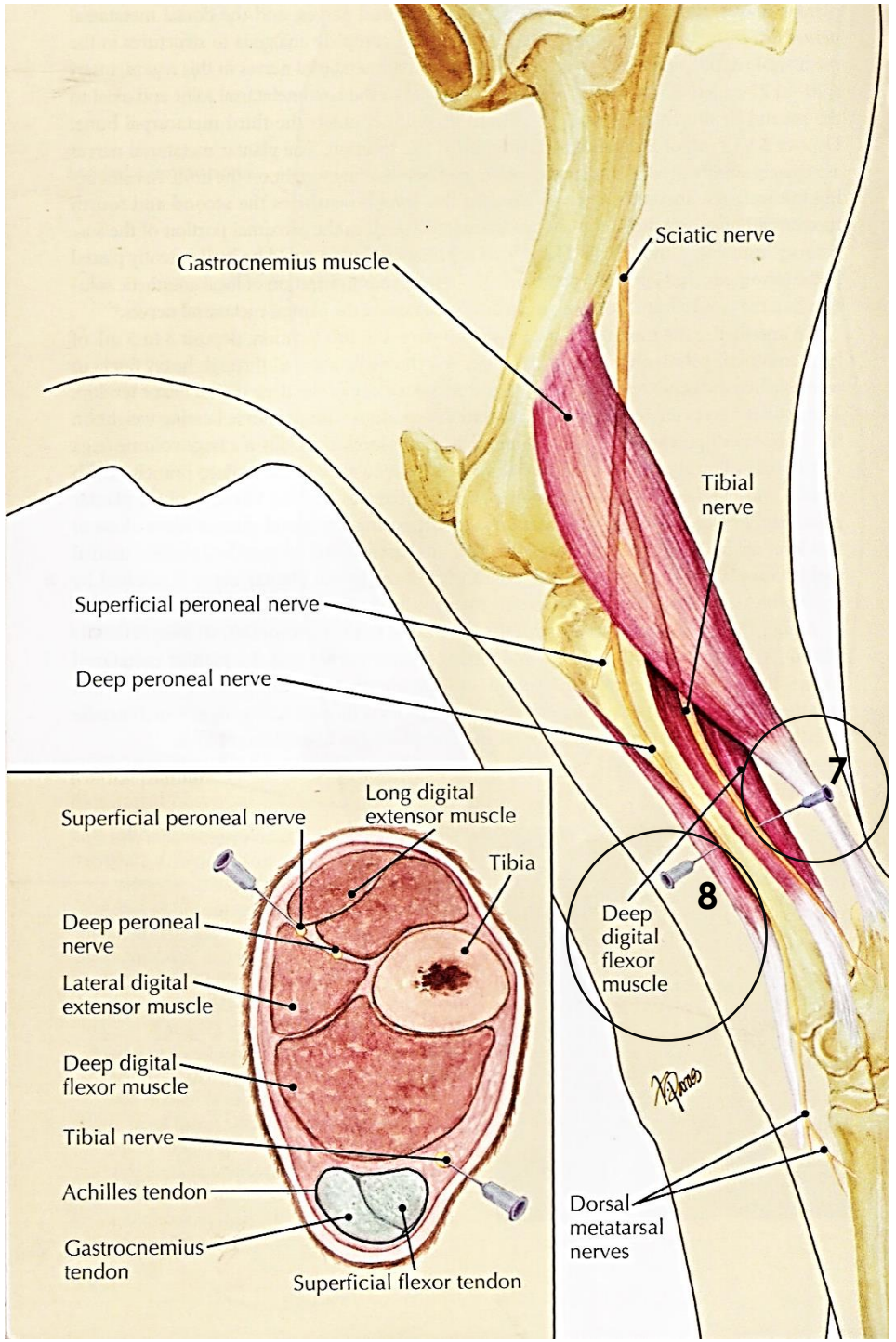
- **Above Hook Joint** about by 10 cm, on **lateral** aspect.
- At the most prominent portion of the Muscle bellies of the lateral digital Extensor and long digital extensor muscles in the groove formed by these Two muscles.

Technique:

- To block the deep peroneal, 10 cm of local analgesic solution is injected On the deep edges of the two extensors and the lateral border of the Cranial tibial muscle close to the tibia.
- To block the superficial peroneal nerve the needle is retracted and Another 10 cm is injected superficially with the needle moving cranially and caudally.

Significant desensitized structures:

- This nerve should be blocked with the tibial nerve for diagnosis of hock Lameness especially for spavin.



B. Intraarticular Analgesia

1. Coffin J. Pedal J. Distal Interphalangeal Joint (DIJ)

- Present within hoof.

a. The needle is inserted 1 cm **above the coronary band**, 1-1.5 cm medial or lateral to the midline (CDET).

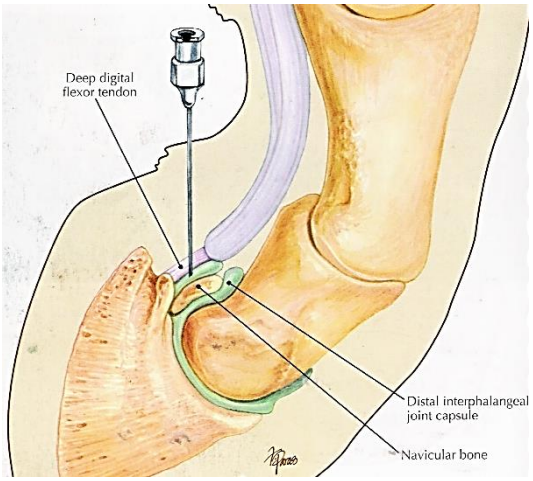
b. Direct the needle **downward** and **toward** the midline and slightly caudal.

c. Inject 7-10 -ml of the analgesic solution.

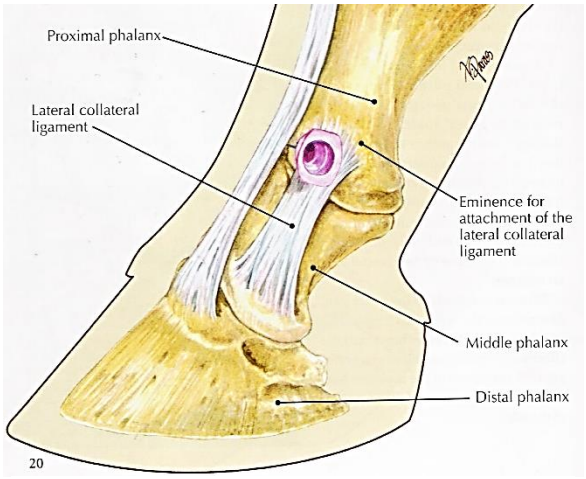
N.B. Always withdraw equal volume of synovial fluid the same as analgesic sol. To be injected.

2. Pastern J. Proximal Interphalangeal Joint (PIJ)

- Pastern Joint present in midway between Coronary band & Fetlock J.
- The needle is inserted on a line just dorsal to the condyles of the long Pastern bone and directed **vertically** toward the midline beneath the Digital extensor tendon.
- needle insertion: on lateral or medial aspect.
- Inject 5 ml of the analgesic solution. With withdrawing the same amount of the synovial fluid.



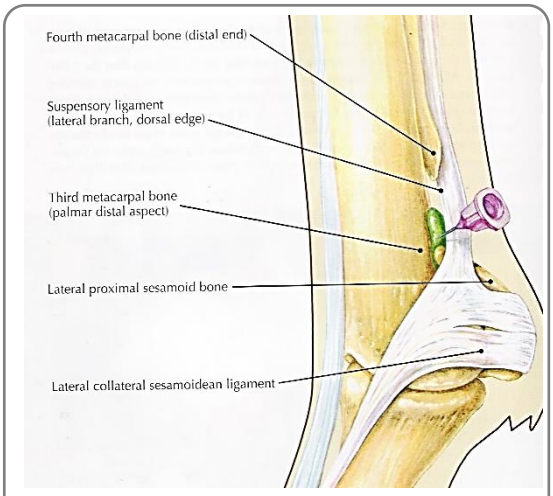
Desensitizing Pastern J. & Navicular Burse.



Desensitizing Pastern J. by injecting beneath common Digital Extensor Tendon.

3. Fetlock Joint

- **Anatomical features;** Fetlock J. comprised of
  - Distal end of Cannon/3rd Metacarpal bone
  - Proximal end of Pastern/1st Phalanx
  - Proximal Sesamoid Bone
- The needle is **inserted**
  - Just above the lateral proximal sesamoid
  - Between the Third Metacarpal bone and the suspensory ligament (palmar pouch).
- Inject 10-15 ml of the analgesic solution.



Desensitizing Fetlock J. through Palma/Plantar Pouch.

4. Carpal Joint

Anatomical features; Carpal J. comprised of 3 Joints

1) Radiocarpal Joint. **2)** Intercapal Joint. **3)** Carpometacarpal Joint.

Site of injection

a. Flexion of the leg Facilitates palpation and makes the identification of the (Antebrachiocarpal/ **Radiocarpal Joint**) and (Middle carpal joints/ **Intercapal Joint**) easy.

b. **Injections** are made over the **Dorsomedial aspect of the joint.**

c. The **needle inserted perpendicular** in the **depressions lateral** or **medial** to the **Extensor Carpi Radials Tendon**.

d. Injection can also perform from the lateral aspect, through the **Palmarolateral** pouch, just **proximal to the Accessory Carpal bone** and **Caudal to** the palpable **lateral digital extensor tendon**.

Technique:

a. **Locate Radiocarpal J.** by palpating the medial aspect of

1) Distal edge of **Radius**.

2) Proximal edge of **Radial Carpal** bone.

b. The **needle inserted** between Radius & Radial Metacarpal bone **perpendicular** in the **depressions lateral** or **medial** to the **Extensor Carpi Radials Tendon**.

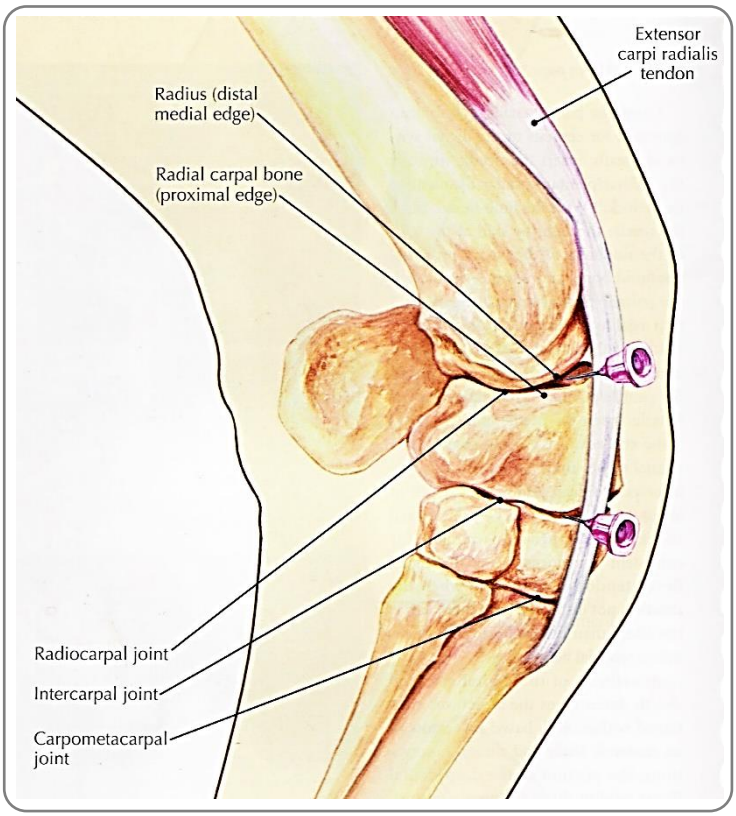
c. **Locate Intercapal J.** by palpating the medial aspect of

1) Distal edge of **Radial Carpal** bone.

2) Proximal edge of **3rd Carpal** bone.

d. Inject 10-15 ml of the analgesic solution.

Note that the **Carpometacarpal** and the **Intercapal J.** communicate with each other. Therefore, one entry/injection is enough to desensitize both of the joints.



5. Elbow Joint

- The needle is inserted along a horizontal plane from the **Lateral aspect** & the Joint where the **Lateral Collateral Ligament** is felt as a tense band.
- The **needle can be inserted** either **dorsal or palmar** to this ligament. Inject 15- 20 ml of the analgesic solution.

6. Shoulder Joint

- Identify the lateral **tuberosity of the humerus** and the Infraspinatus tendon.
- The **needle** (3-4 inch/ in length) can be **inserted** either cranial or caudal to the tendon just **above the tuberosity** and should be Approximately horizontal.
- Direct the needle caudo-medially for a depth of 2-3 inches. Inject 20-30 ml of the analgesic solution.

7. Tarsal Joint

Anatomical features:

- There are four joints in the tarsus
  1) Tibiotarsal J. **2)** Proximal Intertarsal. **3)** Distal intertarsal J. **4)** Tarsometatarsal J.

Site of Insertion & Technique

1) **Tibiotarsal:** At the **dorsomedial** aspect just **below** and in front of the **Medial malleolus of tibia** and caudal to the saphenous vein. Inject 20 ml of the analgesic solution.

- **Note:** the **Tibiotarsal** and **Proximal Intertarsal** communicate with each other, **so injection of tibiotarsal ensure** that the **proximal intertarsal is also anesthetized.**

2) **Distal intertarsal:** Each joint can be individually injected from the Dorsomedial aspect.

- The tarsometatarsal joint is most easily found at the level of the chest nut And careful palpation will allow identification.
- The distal intertarsal joint is found approximately **1 cm above the Tarsometatarsal joint**, just cranioventral to the Cunean tendon.
- Inject 5-7 ml of the analgesic solution.

3) **Tarsometatarsal joint:** A second method for the distal joint is to inject from the **Lateral Aspect** of the tarsus in the space **above** the **head of the Fourth metatarsal bone** directing the needle craniomedial and slightly ventral will access the tarsometatarsal joint.

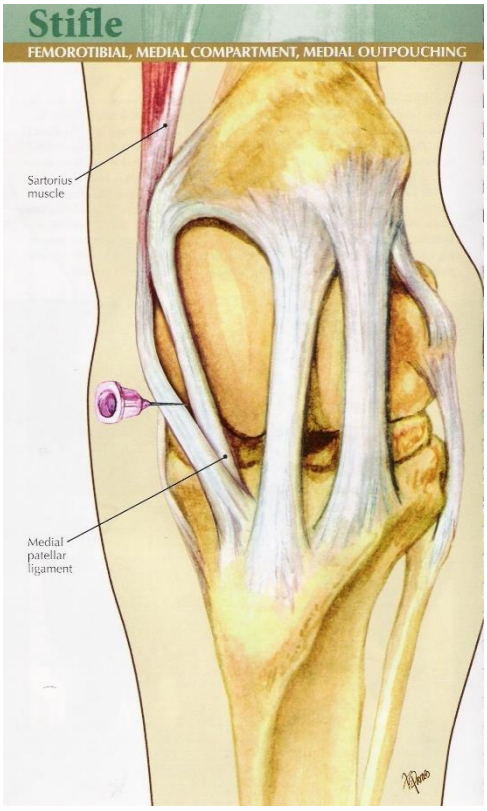
8. Stifle Joint

Anatomical Features

There are Three Joints' Compartments

1) Femoropatellar J.
2) Medial Femorotibial J.
3) Lateral Femorotibial J.

- **Note:** The **Femoropatellar** and **Medial Femorotibial** joints communicate with each Other. Therefore, one entry/injection is enough to desensitize both of the joints.
- The **Lateral Femorotibial** joint occasionally communicate with the **Medial** but uncommonly communicate with the **Femoropatellar** joint.

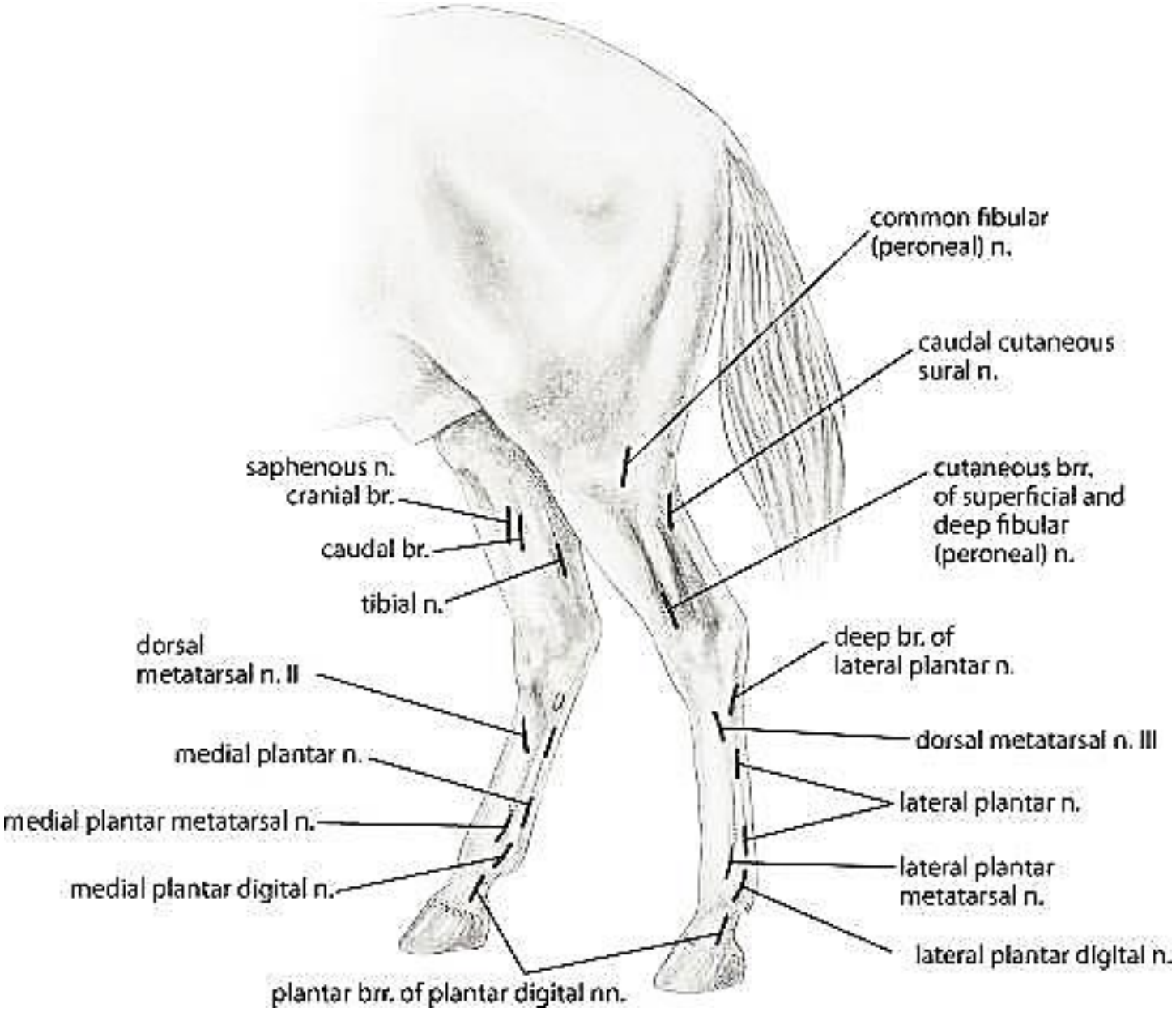


Site of Insertion & Technique

1. **Femoropatellar joint:**
   Penetrate the joint **between** the **Middle** and **Medial patellar ligaments** just **below the patella margin**.
   Inject 30- 50 ml of the analgesic solution.
2. **<u>Medial</u> Femorotibial:**
   Penetrate the joint between the **Medial patellar** and the **Medial collateral ligament** just above the tibial plateau.
   Inject 30-50 ml of the analgesic solution.
3. **<u>Lateral</u> Femorotibial:**
   Penetrate the joint between the **Lateral patellar** and **Lateral collateral ligament** just above the tibia! Plateau. Inject 30-50 ml of the analgesic solution.

9. Hip Joint

- Insert an 10-12 cm needle in an craniomedial direction between the Most proximal part of the greater trochanter and the most lateral portion.
- Inject 30 ml of the analgesic solution.



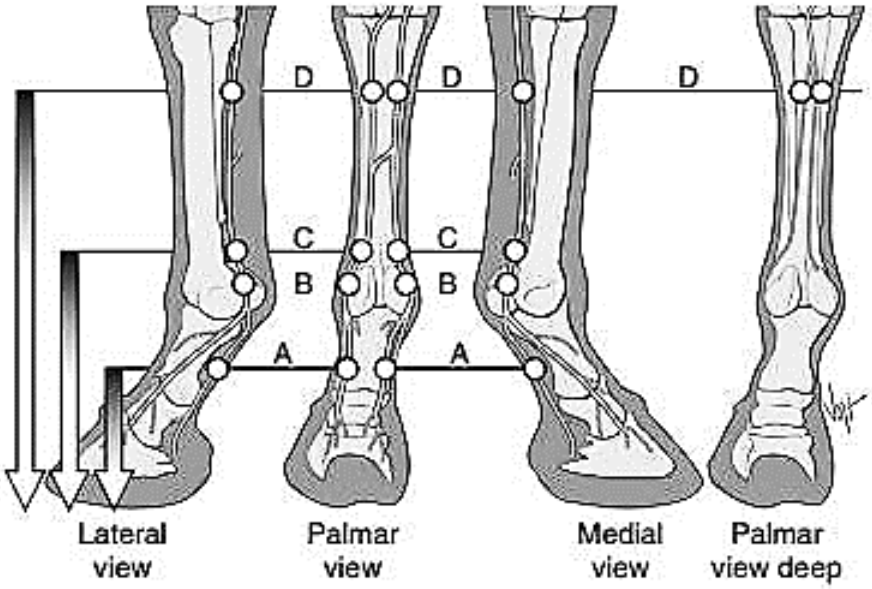


FIG. 6-3. Injection sites for nerve blocks on the left forelimb in the horse. *A*, Palmar (digital). *B*, Abaxial sesamoidean. *C*, Low palmar. *D*, High palmar metacarpal nerves.

REGIONAL ANALGESIA ABOUT THE TRUNK

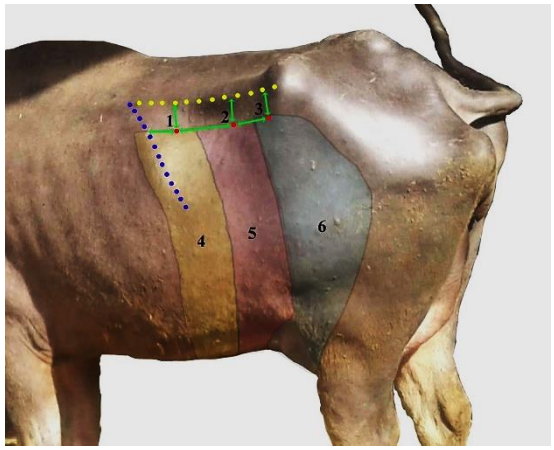
Trunk can be desensitized by

a. Local Infiltration.
b. Nerve Block (inverted L Block).
c. Proximal paravertebral.
d. Distal paravertebral.
e. Epidural anaesthesia.
f. General anaesthesia.

1.6 Local Infiltration Analgesia

Lec. 1 Adel, PhD

1. Linear infiltration (1 ml analgesic sol. for each 1cm incision).
2. Field block.
3. Inverted L block.
4. Circular block.
5. Ring block, *commonly in teats.*



Sites of Nerve Block of each nerve in the flank of buffalo.

1. Desensitized area of *N. Costoabdominalis.*
2. Desensitized area of *N. iliohypogastricus.*
3. Desensitized area of *N. ilioinguinalis.*
4. Site for block of *N. Costoabdominalis* → 4.
5. Site for block of *N. iliohypogastricus* → 5.
6. Site for block of *N. ilioinguinalis* → 6.

1.7 Paravertebral Nerve Block

Definition

Perineural injection of local analgesic solution about the spinal nerves as they emerge from the vertebral canal through the intervertebral foramen. (Proximal/Distal)

Indications:

1. Laparotomy and Rumenotomy.
2. Caesarean section.
3. Abomasal displacement.

Advantages of Paravertebral:

1. The abdominal wall including peritoneum over the infiltrated field is completely and uniformly desensitized.
2. Muscular relaxation is produced.
3. Intra-abdominal pressure is decreased.
4. The method is simple, safe and has a quick effect.
5. Post-surgical convalescent period is short and of no consequence.
6. There is saving of local analgesic solution.

Anatomical consideration

1. **Boundaries:** The flank *(Paralumbar Fossa)* is bounded
   - **a. Anteriorly** by the last rib.
   - **b. Posteriorly** by the angle of ileum.
   - **c. Superiorly** by the Lumbar Transverse Processes.
2. **Nerve Supply:** The flank in cattle and buffaloes is **innervated by**
   - **a.** Thirteenth thoracic nerve **(T13)**
   - **b.** First lumbar nerves **(L1)**
   - **c.** Second lumbar nerves **(L2).**

   N.B.: The Third Lumbar Nerve **(L3)** may also be involved in the block. Although it doesn't supply the flank but it gives a motor cutaneous branch that pass obliquely in front of the ilium
3. Operations involving the ventral anterior aspect of the abdominal wall require additional desensitization to thoracic nerves anterior to 13 thoracic nerves.
4. **The spinal nerve after emerging from the foramina divided into:**

a) **Small Dorsal Branch** supply skin and muscles of lion.

b) **Large Ventral Branch** main nerve supply to the skin, muscles & peritoneum of flank. And also connected with sympathetic supply by ramus communicants (Decrease abdominal pressure of the viscera).

5. The injection must be beneath the Inter Transverse Lig. because injection over it produce improbable analgesia.

Proximal Paravertebral/Farquharson/Cambridge Technique

- In Proximal Paravertebral Tech, you inject 3 injection for each nerve *(3rd lumbar nerve is optional),* each nerve requires separate entry.
- Desensitize nerves just after emerging from the foramen and **before splitting** into dorsal & ventral branches.
- **Needle:** 18 gauge – 10 cm.

Birmingham Gauge; system used to specify thickness or diameter of hypodermic needles; **Smaller gauge** numbers indicate → **larger outer diameters.**

Locates the sites for injection as follows:

A- Site of the 13th thoracic nerve:

Following the last rib with the index finger, the head of the rib can be felt **5 cm lateral to the midline.**

To ensure safe injection:

1) Insert & fix (16 gauge – 1 cm) needle into skin on point of analgesic sol. insertion. The 16 gauge needle acts as fixed/rigid canal through which the analgesic needle passes.
2) The analgesic needle 18 gauge-10cm is inserted *(through the 16 gauge needle)* 5 cm deep to reach the nerve.

Away from the first site of inj. By 5 cm, the lumbar injection is inserted.

B- Site of 1st, 2nd, & 3rd lumbar N:

1) A transverse line is drawn behind the spinous process of the particular vertebra and the needle is inserted at a point on this line 5 cm from the midline.
2) **The nerve lies at a depth about 5 cm** and inject **Procaine HCl 3.4%** about 20 ml around each nerve.
3) Each nerve is behind the other by 5cm, the process of injection is repeated.

Distal Paravertebral/Magda Technique

- This technique is through a lateral approach to the nerves.
- Desensitize nerves after emerging from the foramen and **After splitting** into dorsal & ventral branches.

1. The skin is clipped and disinfected at the ends of the first, second, third and fourth lumbar transverse processes.
2. 10 ml of analgesic solution is injected beneath each transverse process toward the midline.
3. **T13 N** -------on transverse process of **1st Lumbar V.**
4. **1st LN**------- on transverse process of **2nd Lumbar V.**
5. **2nd LN**------ on transverse process of **4th Lumbar V.** as it more deviated.

- **Needle:** 18 gauge – 3 cm.

Injection (T13 Nerve)

1. Palpation of transverse process of lumbar v.
2. Insert the needle at the transverse of 1stlumbar v. and insert needle over the transverse process and inject 15ml, **withdraw needle without removal of needle from skin** and **redirect in ventral aspect** and give 15 ml of analgesic solution.
3. **The same in 1st LN and 2nd LN.**

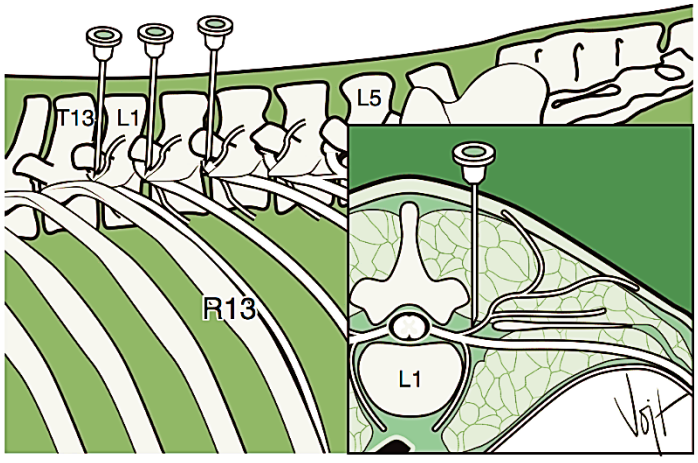


Figure 6-1 Proximal paravertebral nerve block. Note that the needles are placed just cranially to the transverse processes and less than 5 cm from midline.

Figure 6-2 Distal paravertebral nerve block. Note that the needles are placed just above and below each transverse process, and lidocaine is infiltrated in a fan pattern.

1.8 Epidural Anesthesia

- Spinal anaesthesia is the injection of local anaesthetic **around the spinal cord.**
- When local anaesthetics such as Lidocaine or Bupivacaine are used, all the segmental nerves (sensory and motor) which pass through the anaesthetic are paralyzed, although when opioids are used only sensory block occurs.

Spinal Anaesthesia is Divided into Two types;

1- Epidural/ 'True Spinal'.

- **Epidural (or extradural)** anaesthesia refers to depositing of local anaesthetics into the extradural space.
- The needle enters the spinal canal but **does not penetrate the meninges.**
- The anaesthetic is therefore **limited to** the canal **outside the dura mater.**

2- True Spinal Anaesthesia (Subarachnoid Analgesia)

- In which the needle penetrates the dura mater, and the analgesic is injected into the Cerebrospinal Fluid (CSF).

Anatomical Consideration

1. The spinal cord covered by three membranes, the dense dura mater, arachnoid and delicate pia mater.
2. The spinal cord and its meninges lie within the spinal canal.
3. The wall of the spinal canal is formed by the vertebral arches the vertebral bodies, intervertebral discs and the intervertebral ligaments.
4. The spinal canal flattens dorso-ventrally and has two enlargement one post cervical and one in the posterior lumbar region.
5. The spinal cord and dura matter end at the lumbar enlargement and the canal tapers off behind to end at 4-5 coccygeal vertebras.
6. Lateral openings between vertebral arches (intervertebral foramen) where pass blood and nerves.

A. Dura Matter

1. In the cranial cavity, the dura mater is arranged in 2 layers (periosteal and investing) which is firmly adhere except at the venous sinuses.
2. The outer layer forms the periosteum lining the vertebral canal.
3. The investing layer is continued from the cranium into spinal canal but at the foramen magnum it adhere to the periosteal layer.
4. Between the two layers in the spinal canal there is (Epidural space, Extradural, Interdunal).

B. Arachnoid Mater

1. The arachnoid is continuation of the cerebral arachnoid.
2. An incomplete septum divided the spinal subarachnoid space along the midline.

C. Pia Mater

It is closely adhered to the spinal cord.

D. Epidural Space

1. It is formed by splitting of the two layers of the dura mater.
2. Venous plexus lies in the space and may accidentally injured during injection.
3. The space between the nerves, arteries and veins in the space are filled with fatty tissues.

Duration of Epidural Block

1. The addition of vasoconstrictor drug to the analgesic drug constrict the epidural blood vessels that reduce the flow of blood and reduce the absorption.
2. Using of procaine HCl alone in ox--- 1.9 hr
3. While, + adrenaline---- 2.4 hr

Types of Epidural Analgesia

It is divided into:

1- Anterior. **2- Posterior**

According to the distance forward the analgesic agent spreads and the extend of the area in which sensory and motor nerves paralysis developed.

The Types Depend Upon

1. The volume of solution injected.
2. The diffusablity of the drug.
3. The conc of drug.
4. The rate of absorption from the space.

Disadvantages

1. **Infection** of the neural canal.
2. Severe **hypotension** especially in ruminants due to blocking sympathetic vasoconstrictor of the abdominal viscera.
3. Fracture of the animal pelvis, and injury to workers, or veterinarian (anterior block).
4. Asphyxia due to **paralysis** of phrenic nerve.
5. Twisting of the tail few days or even permanent paralysis after injection due to injury of coccygeal nerves.
6. Inadequate blockage due faulty injection or diluted analgesic agent or improper dose.

Caudal (Posterior) Epidural Block	Anterior Epidural
1. The motor control of the hind limbs is uninfluenced. 2. Skin over the tail and croup till mid sacrum. 3. Anus, vulva, perineum and the posterior aspect of the thigh. 4. Anal sphincter relaxed and the posterior part of the rectum is ballooned. 5. Vulva and vagina dilated.	• Some degree of interference with motor function of the hind limbs. • Loss of sensation spreads forwards, according to the dose; (The croup; between hind limbs till the inguinal region, scrotum, and prepuce; over the hind limbs; mammary gland; and finally **flanks** and abdominal wall till the umbilicus).

Animal	Site	Animal	Site
Ox/Cattle	**1st** intercoccygeal space.	**Buffalo**	Sacrococcygeal space
Horse	**1st** intercoccygeal space.	**Sheep**	Lumbosacral space.
Donkey	**2nd** intercoccygeal space.	**Dog**	Lumbosacral space.

Epidural Analgesia in Cattle

The spinal cord ends in the region of the last lumbar vertebra but the meningeal sac is continued as far as the junction of 3-4 sacral segments.

Seat of injection

The first intercoccygeal space between the **1st and 2nd coccygeal vertebra.** Its dimensions are 2 cm transversely, 2.5 cm anterior-posteriorly, and 0.5 cm deep. The canal is 2-4 cm deep from the skin surface.

Location of the site:

1. The tail is gripped at about 6 inches from its base and raised by a "pump- handle fashion". The first articulation behind the sacrum is >> 1st inter coccygeal space.
2. A posterior tuberosity of the ischium is palpated and at about 4 inch in front of it draws a line directly over the back from this point pass on a depression >> 1st intercoccygeal space.
3. Standing on one side of the animal and observing the line of the croup, the prominence of the sacrum is seen, casting the eye toward the tail, the next prominence to be observed is the spine of 1" coccygeal. The depression behind it is the site of injection.

Technique of Injection

1. The needle is inserted with 15° degrees with the vertical. When the needle reaches the accurate site, there will be no resistance for injection, and suction of the drug from the hub of the needle can be seen.
2. The tail is gripped 15 cm from its base and rose in "Pump-handle fashion". Seat of injection is the 1st obvious articulation behind the sacrum.
3. Stand beside the animal and detect the 1st prominence after the croup (prominence of the sacrum), seat of injection is the depression directly behind this prominence.
4. A line has drawn directly over the back connecting two points (one on each side) 10 cm anterior to posterior prominence of the ischial tuberosity. Seat of injection is the point of intersection between this line and midline.

Technique of injection

1. Make S/C weal using fine needle (2 ml local analgesic agent) to facilitate passage of the large spinal needle.
2. Locate the space and the spinal needle is introduced at the center of space at the midline.
3. The directed to the epidural space with an angle of 15 degree from the vertical line.
4. The needle advanced until reach the epidural space which indicated by
   a. Loss of resistance to insertion.
   b. Easy injection of the solution.
5. Aspiration performed before the injection to avoid blood and C.S.F.

Dose

- Posterior block 2% procaine Hcl10-15 ml.
- Anterior block 2% procaine Hcl40-120 ml.

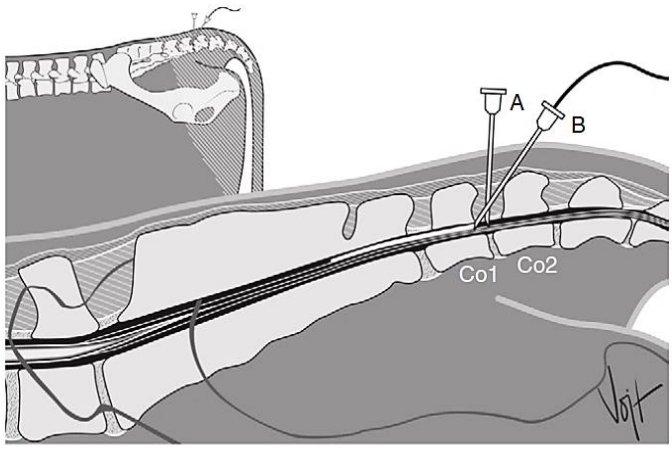


FIG. 5-5. Needle placement for (**A**) caudal epidural anesthesia and (**B**) continuous caudal epidural anesthesia in cattle. Co1 is the first coccygeal vertebra, and Co2 is the second coccygeal vertebra. Desensitized area of skin is patterned in figure above.

Onset and Duration:

a. **Caudal block:**

Paralysis of the tail can be observed after 1-2 minutes, the maximal effect appears after 10-20 minutes, and lasts for 60 minutes, and the animal becomes normal again by the end of 120 minutes.

b. **Anterior block:**

Paralysis of the tail can be observed after 1-2 minutes, the maximal effect appears after 10-20 minutes, and the animal will be unable to rise for 120 minutes, and in coordination may persist for 3-4 hours

Caudal (Posterior) Epidural Block	Anterior Epidural
Indication	
a- Obstetrics: **1-** To overcome straining for correction of malpresentation, or for simpler embryotomy. **2-** Operative treatment of parturient injuries. **3-** Reduction of prolapsed uterus or vagina. **b- General:** **1-** Surgical operations of the tail. **2-** Surgical correction/suture of tears of vulva or perineum. **3-** Examination of the vagina or ext. cervical os. **4-** Protrusion of the uterus.	**a- Obstetrics** **1-** Overcome straining during extensive embryotomy. **2-** Amputation of gangrenous prolapsed uterus. **3-** Caesarean section. **b- General** **1-** Surgery of penis. **2-** Cutting operations about the prepuce or inguinal region. **3-** Castration. **4-** Amputation of the udder. **5-** Surgery of hind limb like amputation of digit.
Dosage	
• **2% Procaine: Heifers** → 10 ml. **Medium cow** → 10 ml. **Large cow** → 15 ml. • **1% sol.:** 12-20 ml. • **3% sol.:** 5-10 ml	**2% Procaine:** **Small size adult;** 40-100 ml. **Medium size adult;** 75-120 ml. **Large size adult;** 100-150 ml.
Onset & Duration	
• Onset of muscular paralysis of tail >> takes 5-10 min. • Maximum extent from 15-20 minutes. • Persist for about 1-2 hour. "Operation time" • Animal will be normal at the end of 2nd hour.	• Onset of bilateral analgesia >> 15 20 minutes. • Animal unable to rise for 2 hours and be uncoordinated for 3-4 hours.

Epidural Analgesia in Buffaloes

The needle is inserted downwards and forwards in the **Sacrococcygeal** with an **angle 45°** with the vertical, through ligamentum flavum.

Dose

Posterior: 8-12 ml.

Anterior: 40-100 ml.

Epidural Analgesia in Equine

The technique is not common in equine as in bovine because the indications for such technique in equine are not frequent and the detection of site of injection is more difficult.

Seat of Injection

1st intercoccygeal space in ***horse*** and **2nd intercoccygeal space in *donkey*.** The depth of the canal is 4-8 cm.

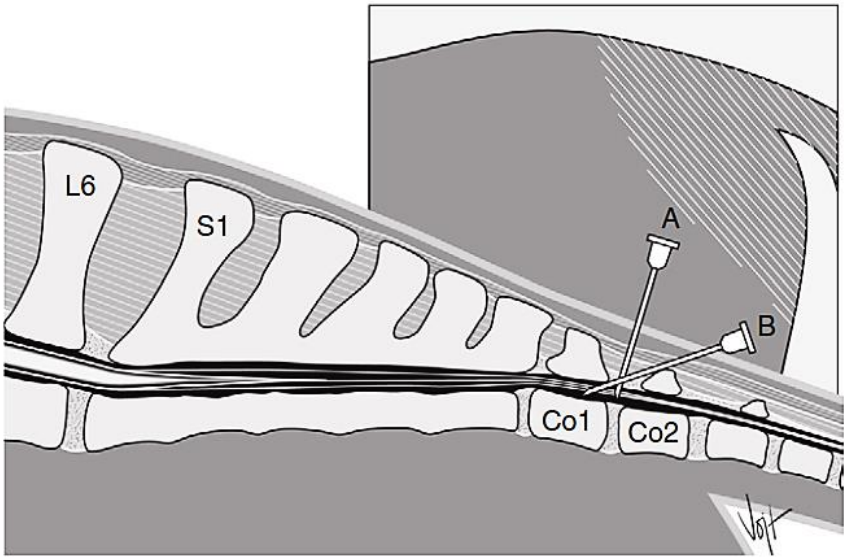


FIG. 6-2. Needle placement into *A* or *B*, caudal epidural space at the first intercoccygeal space (Co1 to Co2). Stippled markings indicate desensitized area after caudal blockade.

Technique

The needle is inserted forwards and downwards with an angle of 30° degrees with the horizontal (60° with the vertical).

1. A line drawn connecting the hip joints and intersects the midline at the level of the sacrococcygeal joint caudal to which the dorsal spine of the 1st coccygeal bone can be felt. The needle inserted into the depression directly caudal to this point.
2. The space is opposite the caudal fold formed on each side of the tail when raised and Pump fashion.

Dose:

- 10-12 ml of 2% lignocaine or 2% Procaine HCl.
- Onset at 20 minutes.
- It persists for 35-50 minutes.

Lumbo-Sacral Analgesia in Sheep

- Injection of analgesic solution into the epidural space in the caudal region (caudal epidural) affords very save method of inducing epidural analgesia, but sometimes it is not easy to produce satisfactory anterior block via this site.
- The lumbar epidural analgesia through the anterior lumbar region or Lumbosacral Spaces, affords a belt of analgesia around the trunk of the animal without affecting the motor function of the hind limbs.

Seat of Injection

Lumbosacral space to avoid puncturing of meninges. It is located just behind the spinous process of **last lumbar vertebra** that lies at a point of intersection between line drawn to connect the anterior borders of the two illiums and midline.

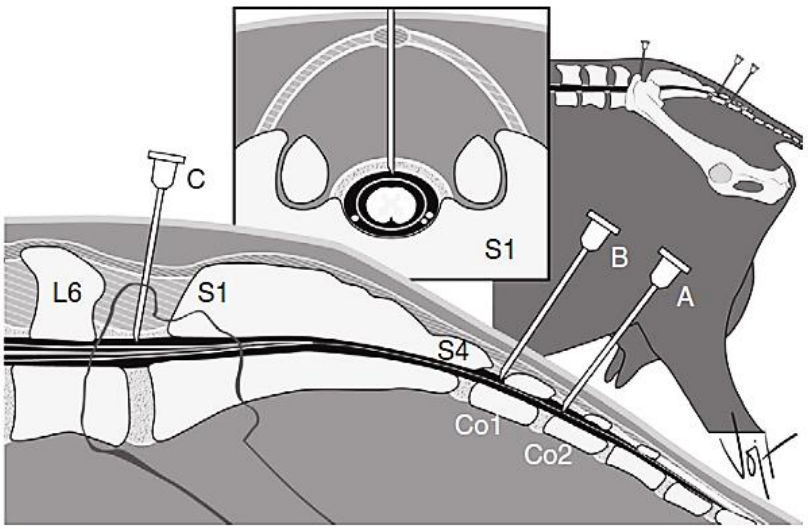


FIG. 5-7. Needle placement for caudal epidural anesthesia (**A** and **B**) and anterior epidural anesthesia (**C**) in the goat. Lateral aspect and cranial view of a transection to the first sacral vertebra. A needle is placed into ***A***, the first intercoccygeal vertebral space; ***B***, the sacrococcygeal space; and ***C***, the lumbosacral space.

Technique

1. The area of injection is surgically prepared.
2. Restrain the sheep in lateral recumbency and full flexion of the lumbosacral spine.
3. Skin weal using 1-2 ml procaine HCl by fine needle.
4. The needle is inserted in the mentioned space with an **angle 15°** from the vertical line after enter the ligamnetum flavum.
5. 20 ml syringe contain 5 ml air, sudden loss of resistance to injection of air indicate that the needle is in the epidural space.
6. Aspiration to avoid C.S.F.
7. Inject the analgesic solution and if unilateral analgesia requires the animal put in lateral recumbency (Undermost), but if require bilateral – turn the animal on its back.

Dose:

8-15 ml Lignocaine 3%.

Indication:

Intra-abdominal, pelvic, or hind limb surgery.

1.9 Lumbar Segmental Epidural Analgesia

In Cattle

- It is produced a belt of analgesia around animal's trunk without interfere with the control of the hind limbs.
- The analgesia encircles the abdomen involving the whole depth of wall include the peritoneum.

Indication

- Rumenotomy & cesarean section.

Technique

1. Restrain the cow in a standing position.
2. Prepare the site of injection.
3. The injection site is the intervertebral foramen between the 1st and 2nd lumbar vertebrae.
4. Skin weal and make skin incision 2-3cm.
5. In standing position, the needle inserted just to right of the lumbar spinous processes and 1.5cm behind the anterior edge of 2nd lumbar transverse process.
6. Insert the needle (16–18-gauge, 10-12 cm) about 7.5cm to pass ligamentum flavum with angle of 10-13°.
7. Infuse the analgesic agent.

Dose:

8-10 ml Lidocaine HCl 2 %.

10-15 ml Tutocaine HCl 2 %.

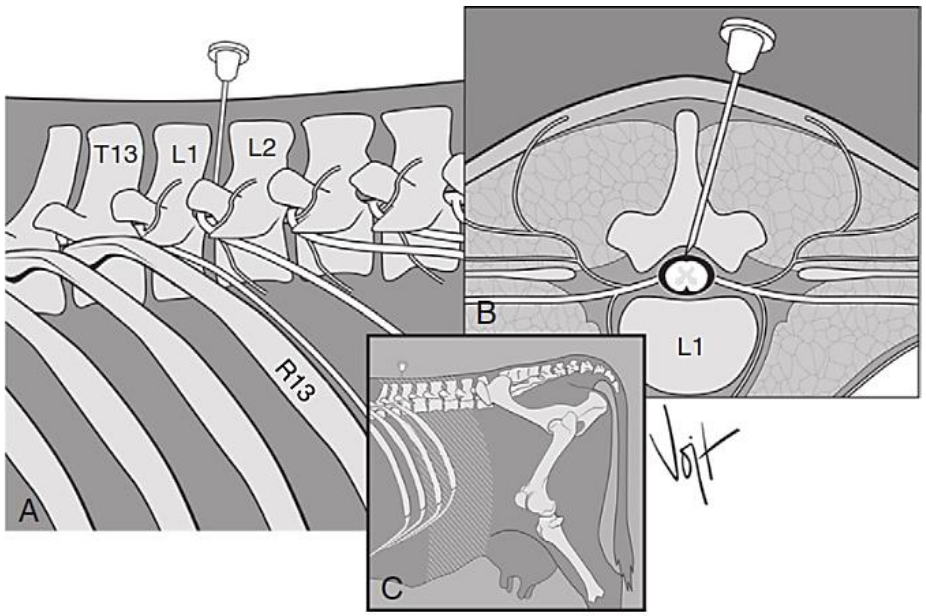


FIG. 5-4. Needle placement for segmental dorsolumbar epidural block. **A,** Left lateral aspect. **B,** Cranial view of a transection of the first lumbar vertebra at the location of the intervertebral foramen. **C,** (inset) Desensitized area of skin after segmental epidural anesthesia (lightly shaded area). R13 is the last rib; T13, L1, and L2 are the spinous processes of the last thoracic and first and second lumbar vertebrae.

إضافة ..الدكتور مقالهوش ..مش عليك

	Advantages	Disadvantages
Proximal Paravertebral Block	**1.** Small dose of analgesic. **2.** Wide and uniform area of analgesia and muscle relaxation. **3.** Minimal intra-abdominal pressure. **4.** Increased intestinal tone and motility. **5.** Absence of local analgesic from the operative wound margins.	**1.** Technical difficulty. **2.** Arching up of the spine due to paralysis of the back muscles (**scoliosis**). **3.** Risk of penetrating vital structures such as the aorta and thoracic longitudinal vein on the left side and the caudal vena cava on the right side.
Distal Paravertebral Block	**1.** The use of more routine size needles, no risk of penetrating a major blood vessel. **2.** Lack of scoliosis (abnormal lateral curvature of the spine) minimal weakness in the pelvic limb and ataxia.	**1.** Larger doses of anesthetic are needed. **2.** Variation in efficiency exist, particularly if the nerves vary in their anatomical pathway.
Infiltration Analgesia	Easiest and most commonly used.	**1.** Edema and hematoma of the multiple injections along the incision site may interfere with healing. **2.** Incomplete analgesia and muscle relaxation of the deeper layers of the abdominal wall. **3.** Toxicity after injecting significant amounts of analgesic solution increased cost due to large doses and longer time required for injection.
Inverted "L" Block	Deposition of the analgesic away from the incision site, thus minimizing edema, hematoma, and possible interference with healing.	**1.** Incomplete analgesia and muscle relaxation of the deeper layers of the abdominal wall. **2.** Toxicity after injecting significant amounts of analgesic solution increased cost due to large doses and longer time required for injection.

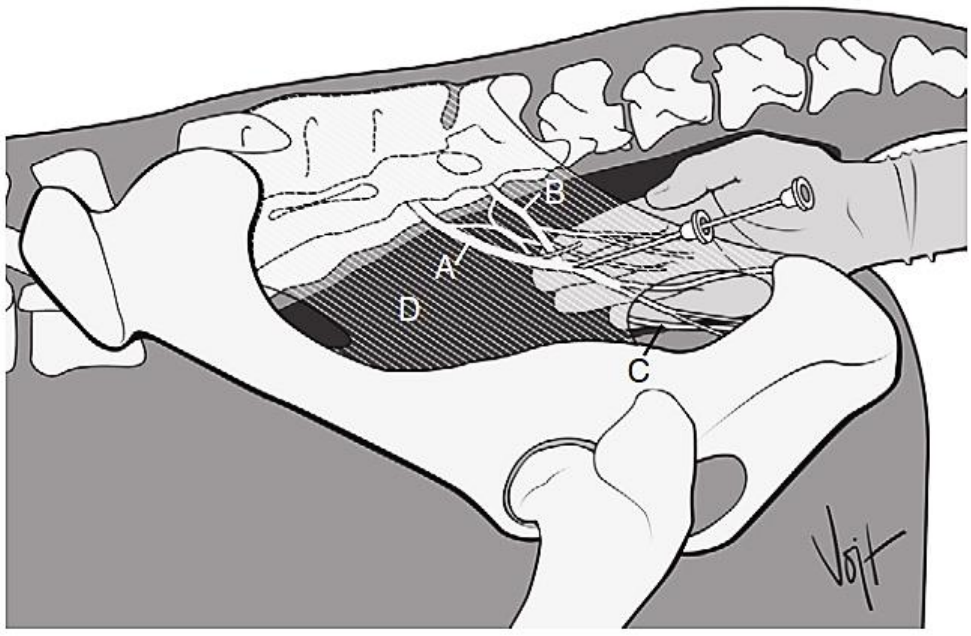


FIG. 5-6. Right hand inserted in the rectum of a cow and needle placement at the internal pudendal nerve on the medial side of the left pelvis. **A,** Internal pudendal nerve. **B,** Pelvic splanchnic nerves. **C,** Pudendal artery. **D,** Sacrosciatic ligament.

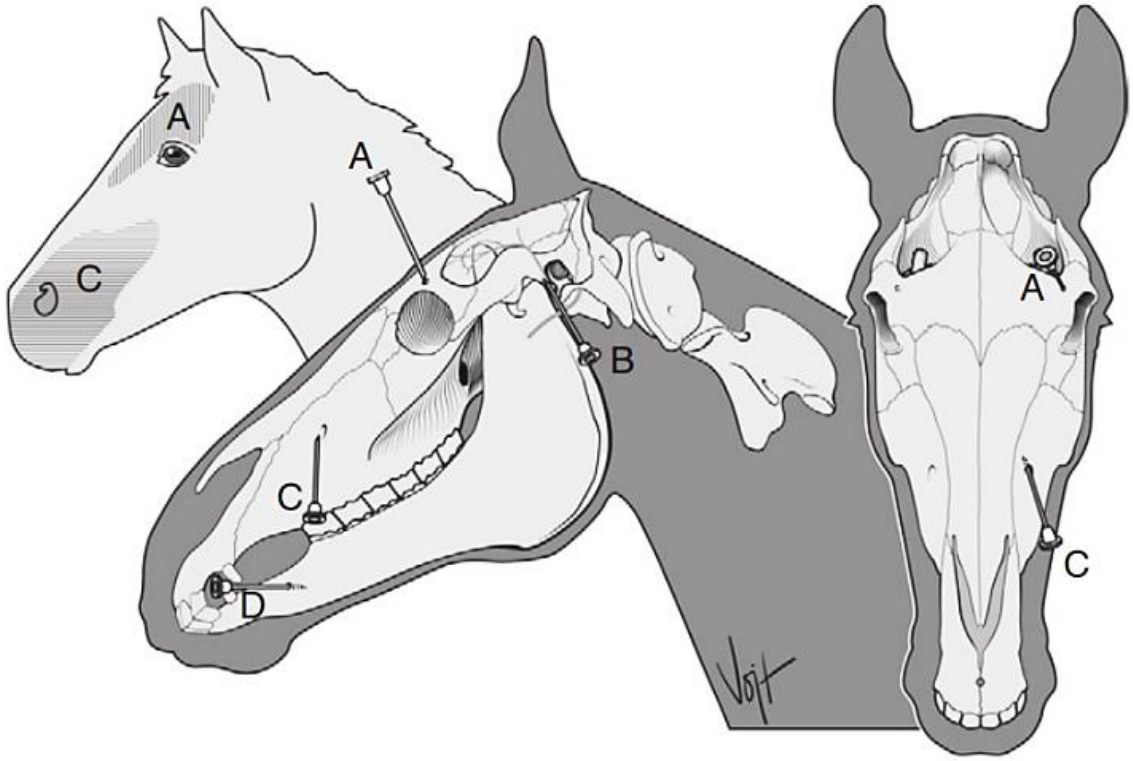
REGIONAL ANALGESIA ABOUT THE HEAD

Basic points in any Nerve Block;

1. Innervation of the Nerve.
2. Landmark.
3. Amount of injected/deposited analgesic solution.
4. **Time of Induction.**
5. **Time of Analgesia**.

- The used **Local Analgesic Agent (LAA)** in Head Analgesia: is Dibucaine (Lidocaine HCL) 2%.
- **Time of Induction** is 5 - 10 min.
- **Time of Analgesia** is 1 – 1.5 hour.

Nerve	Anatomy
Infraorbital Nerve Block	Continuation of Maxillary division of trigeminal 5th Cr. N. enter the infraorbital canal from the pterygopalatine fossa and exit from infraorbital foramen and run under the Naso-Libialis muscle for 2-3 cm.
Mandibular • **Mandibuloalveolar** • **Mental N.B.**	Continuation of Mandibular division of trigeminal 5th Cr. N. enter the mandibular canal from the mandibular foramen at medial aspect of the vertical rams of the mandible.
Supraorbital N.B.	Branch of Ophthalmic division of trigeminal 5th Cr. N. exit from supra-orbital foramen in supra-orbital process with supraorbital artery.
Retrobulbar N.B.	Optic, Oculomotor, Trochlear, Abducens & 3 branches of Trigeminal nerves.
Auriculopalpebral N.B.	Branch of the facial division of trigeminal 5th Cr. N runs from the base of the ear along the zygomatic arch & supply eye lid.
Cornual N. B.	Branch of Ophthalmic division of trigeminal 5th Cr. N. runs at base of the horn.



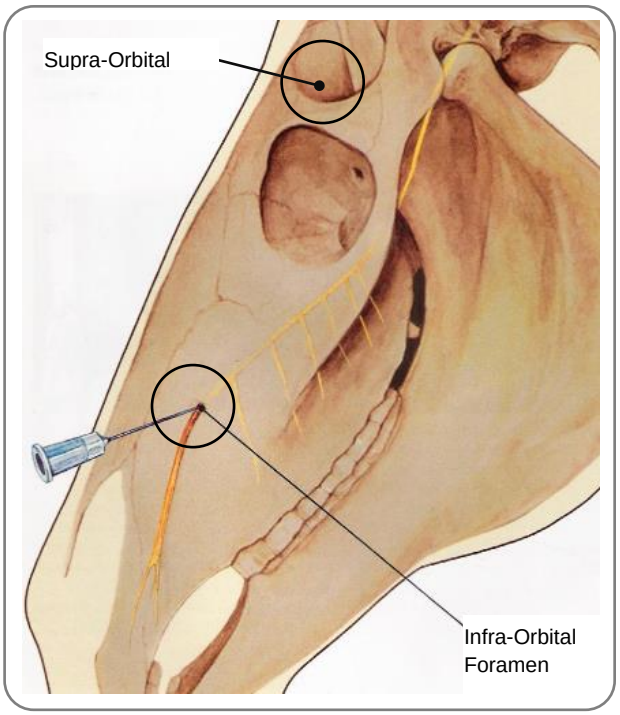
Needle Placement for Nerve Blocks On The Head.

A, Supraorbital (or frontal). **B,** Auriculopalpebral. **C,** Infraorbital. **D,** Mandibular alveolar nerves.

Supraorbital (Frontal) Nerve Block

Anatomy:

- The Supra-orbital nerve (Frontal n.) is a branch of the ophthalmic division of the 5th cranial nerve (trigeminal nerve).
- It passes from the supra-orbital foramen in the supra-orbital process, accompanied by artery.
- **It supplies:** Upper eye lid and skin of the forehead.



Technique:

- Supraorbital foramen is as a **Pit- Like Depression** on the midway.
- Skin is prepared and insensitive weal produced.
- A needle 19-gauge, 2.5 cm is passed in the foramen for 1.5 - 2 cm and injects 5 ml of the analgesic solution.
- **Local Analgesic Agent (LAA)** is Dibucaine (Lidocaine HCL) 2%.
- **Time of Induction** is 5 min.
- **Time of Analgesia** is 1 hour.

Indications:

a. Examination of the eye.

b. Operation about the upper eye lids: laceration, abscess.

c. Suturing of the wounds.

Infraorbital Nerve Block

Anatomy:

- The **Infra-Orbital Canal** runs 2 cm medial to the facial crest, beneath an imaginary line, from medial canthus of the eye to nostrils.
- The **Infra-Orbital Foramen** present 2 cm medial to the facial crest, 1 cm cranial.
- Infraorbital nerve is a continuation of the maxillary division of the 5 cranial nerve after it crosses the pterygopalatine fossa and enters the infraorbital canal.
- It is covered by the Naso-Libialis Muscle.
- **It may be injected (achieved) at the following sites:**

Site	Desensitized Tissue
a. At its point of **Emergence from Infraorbital Foramen**	Lower face as high as infraorbital foramen including upper lip, cheek & nostrils.
b. Within the **Infra-Orbital Canal** (via the foramen)	Upper premolar, molar, canine & incisor teeth with their alveoli & gum. Upper part of face as high as inner canthus of eye.
c. At the **Pterygopalatine Fossa** (point of nerve entry to maxillary foramen)	Desensitized in the previous two sites.

Indications:

a. For interferences about the upper lips & nostrils. Such as suturing of wounds at lips, cheek, & nostrils (as removal of polyps/ atheromas).

b. For **Trephining** of the facial/maxillary sinus (N.B local anesthesia is efficient).

c. Extraction of canine & incisor teeth is seldom in horse, while extraction of molars is preferred by general anesthesia.

Technique:

- Infraorbital nerve lies from 9-12 cm along an imaginary line running down the face from the inner canthus of the eye parallel with the interior aspect of the nasal bone.
- **Blocking the nerve at its point of emergence form canal -** needle introduced until its point can be felt beneath the bony lip of the foramen.
- **Blocking the nerve within the canal ->** pass the needle about 2.5 cm in the canal (To do this the needle must inserted through the skin about 2 cm in front the foramen after reflecting the edge of the muscle upwards).
- Inject **4- 5ml** of the local analgesic by using **19-gauge 5cm** long needle.

Auriculopalpebral Nerve Block

Anatomy:

- The nerve supplies the **Motor Fibers** to the orbicularis oculi muscle which responsible for eyelid & eye movement & encircle the upper & lower eyelids.
- **Landmark:** It runs from the **Base of the Ear** along the facial crest, above Zygomatic notch, and below the eye and give of it branches.

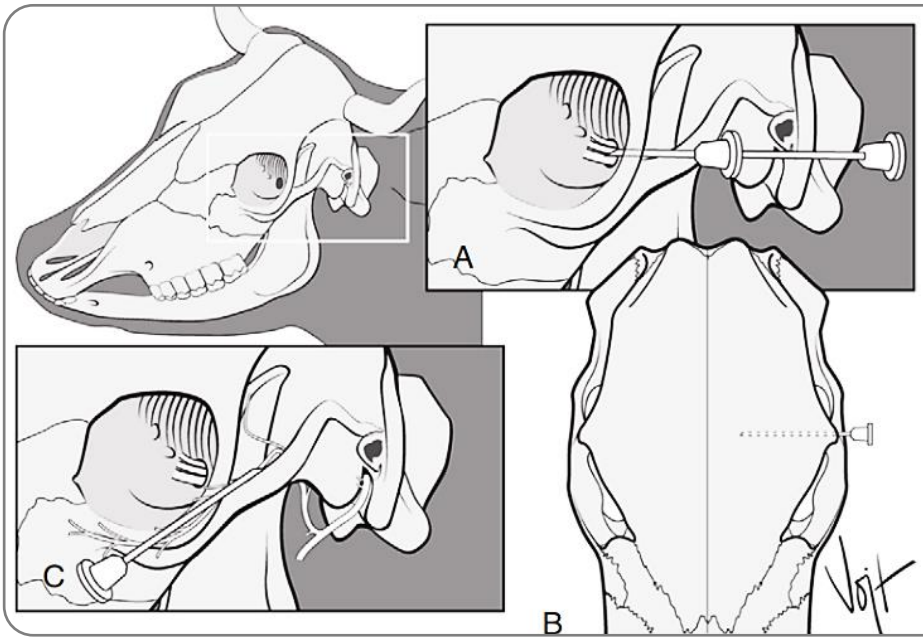
Indication: induce Akinesia of the eye.

- Blepharospasm; relief of severe spasm.
- Subconjunctival, sub bulbar, subpalpebral injections.
- Prevention of eyelid closure during examination.
- Used with topical analgesia for removal of ocular foreign bodies.
- No analgesia to eye ball or eyelid.

Technique:

- The needle (22-gauge 2.5 cm) is inserted dorsal to the zygomatic arch and about 2 cm cranial to the base of the ear and is introduced until its point lies at the dorsal border of the zygomatic arch.
- Inject 10-15 ml of 2% lignocaine with epinephrine under the fascia.

Retrobulbar Nerve Block in *Equine*	Retrobulbar Nerve Block in *Cattle*
Indication:	
Desensitize the nerve behind the eye in retrobulbar space (Trochlear N., Optic N., Oculomotor N., Trigeminal N., & branches of Abducent N.) *(TooTa).* **To Perform** **1.** Enucleation of the eye ball. **2.** Evisceration of the eye. **3.** Exenteration of the eye; Basal carcinoma, sarcoid, panophthalmitis.	
Technique:	
• A needle is introduced 1.5 cm behind the middle of supra orbital process, at supraorbital fossa level. • Push the needle toward the last upper premolar teeth of the opposite side. • Penetrate the tough periorbita. • Inject 10 - 30 ml of the local analgesic solution.	Insert the needle in the canthus(lateral/medial). Push the needle straight behind the eye globe. Deposit the analgesic solution. **Peterson Eye Block** Insert the needle in the Foramen Orbitorotundum that bounded • Dorsally by; Supra-orbital process. • Ventrally by zygomatic arch. • Caudally by coronoid process of mandible.



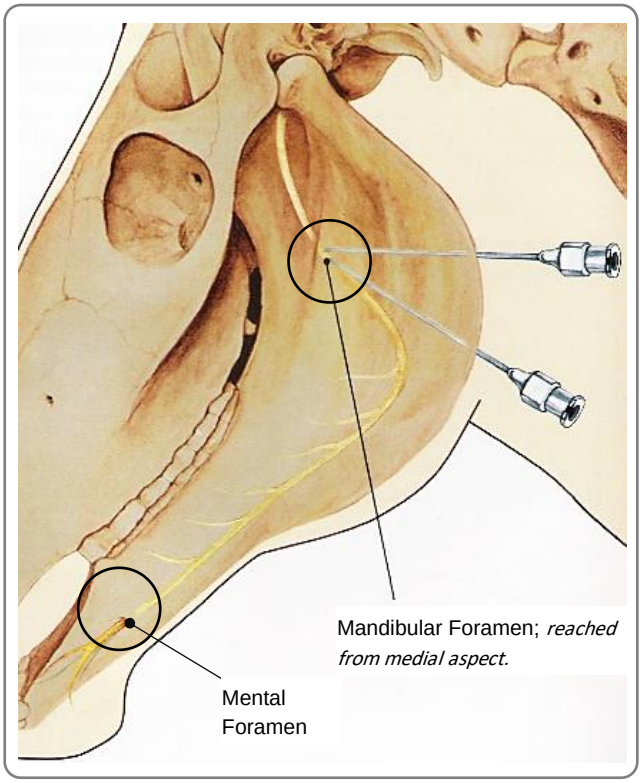
Needle placement for **Peterson Eye Block,** with needle tip at the foramen orbitorotundum.

A, Craniolateral aspect. (coronoid process caudally)

B, Dorsal aspect.

C, Needle placement for akinesia of the eyelids in the cow.

Mandibular Nerve Block



Anatomy:

- The alveolar branch of the mandibular division of the 5th cranial enters the **mandibular foramen on the medial aspect** of the vertical rams of the mandible under cover of medial pterygoid muscle.
- In the mandibular canal it gives dental and alveolar branches on that side.
- The nerve emerges through mental foramen as a mental nerve.
- **be injected (achieved) at the following sites:**

1. Mental Nerve block

- Mental nerve may be injected as it emerges from mental foramen.
- Analgesia to the lower lip of that side.
- Attempts to pass the needle in the canal for a 3 - 4 cm to desensitize the canine & incisor teeth could be tried but it is difficult.

Technique:

Mental foramen is located

- Below mouth commissure by 1.5 cm, mental foramen is pit-like depression, or
- On the lateral aspect of the ramus in the middle of the interdental space.

- Through the skin locate and detect the pencil like tendon of the depressor labii inferior muscle.

Site	Desensitized Tissue
a. At its point of **Emergence from Mental Foramen** (on lateral aspect of ramus at middle of interdental space)	Suturing of wounds of lower lip.
b. Within the **Mental Foramen Canal** (via the foramen)	Suturing of wounds of lower lip. Dental interference (repulsion of molar teeth).

- Inject 4-5ml of the local analgesic by using 19-gauge 5 cm long needle.

Indications:

a. Suturing of wounds of the lower lip.

b. Wiring operation about the infraorbital nerve.

2. Mandibular Nerve Block

- For the nerve enters the canal high up **on the medial aspect** of vertical ramus.
- Desensitize the whole of the lower jaw and all teeth & alveoli on that side.
- It is difficult to be carried out and needs experience.

Indication:

- Molar dental interference in the lower jaw (also, preferred to carried under general anesthesia).
- Guttural pouch wound suturing.

Technique:

- The mandibular foramen lies opposite the point of intersection of a line passing vertically downwards from the lateral canthus of the eye and one extending backwards from the tables of the mandibular molar teeth.
- A point selected on the post border of the mandible, about 3 cm below the temporomandibular articulation penetrate the skin with the needle and allow it to pass in depression between the wing of the atlas and the base of the ear and direct the point of the needle to the site of intersection.
- Injection of 4-6 ml of analgesic solution.

	Mental	Mandibulo-Alveolar
Ind.	Suturing of wounds of lower lip.	Dental interference in lower jaw (preferred to carried under general anaesthesia).
Tec.	• The nerve injected at its emergence from mental foramen (on lateral aspect of ramus at middle of interdental space) • Detect the SC. pencil like tendon of depressor labii Ms. and reflect it.	Point of inj. lied at medial aspect of ramus opposite to point of intersection bet. 2 lines (one passing vertically downwards from lateral canthus of eye & one passing backwards from tables of mandibular molar teeth)
Dose	By using 19 gauge	
	5 cm long needle 5 ml L. A. A.	10 cm long needle Inject of 10 ml.

Mandibular Nerve block

As Mandibular Nerve block, but the needle is inserted in the mandibular canal where the analgesic agent is deposited.

Desensitizes teeth and cheek.

Palpebral Nerve Block

- It blocks the motor innervation of the upper eye lid.

Indication:

a. Examination of the eye.

b. It has no effect on sensory perception of the eye.

Technique:

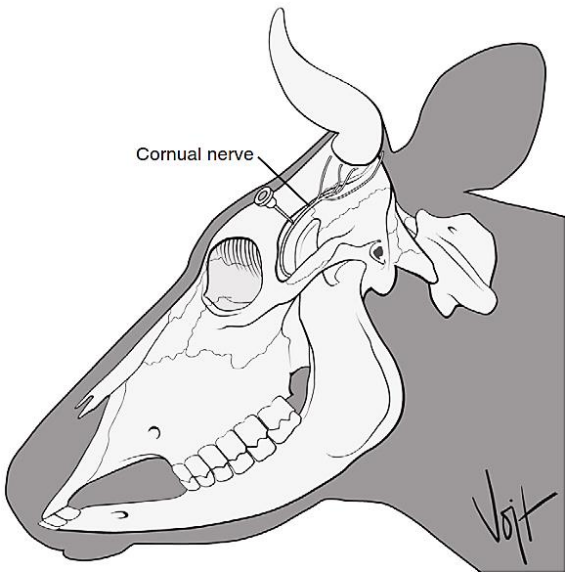
- Detect the site by palpation supra orbital fossa.
- 5 ml lidocaine, 20 gauge.

DEHORNING

Cornual Nerve Block in Cattle	Cornual N. B. in Sheep and Goat
Anatomy	

• Cornual nerve of the zygomaticotemporal (lacrimal) portion of the ophthalmic division of superior maxillary division of the 5th cranial nerve.
• The horn corium and the skin around its base derive its sensory nerve supply from Cornual nerve a branch of the superior maxillary division of the 5 cranial n. (Trigeminal nerve).
• It emerges from the cordite and ascends behind the lateral ridge of the frontal bone.
• In upper 1/3 of the ridge the nerve is relatively superficial covered by skin & thin layer of frontalis muscle.
	▪ The nerve supply to the horn by the corneal branches of
	  • Lacrimal nerve.
	  • Infra-trochlear nerve.
	▪ The corneal branch of the Lacrimal emerges at the roof of supra orbital process. Covered by frontalis muscle at caudo-lateral aspect of the base of the horn to supply caudal and lateral aspect of the horn.
	▪ The Infra-Trochlear Nerve is divided into two branches after emerging from the orbit dorsomedial; dorsal (cornual branch) and medial (frontal branch).
	▪ The cornual branch supply medial and caudal parts of the horn.
	▪ It is covered by orbicular & frontalis muscle.

Technique	
a. **Site of injection** at the upper third of temporal ridge, about 2.5 cm below the base of the horn. **b.** A needle (19-gauge, 2.5 cm) is inserted to a depth of 0.7-1 cm. **c.** Inject 3-5 ml of local analgesic solution. **d.** In large animals with will developed horns make a second injection 1 cm behind the first one to block posterior division of the nerve. • Time of induction is 5.15 minutes. • Time of analgesia is one hour.	• The site for blocking cornual branch of lacrimal nerve, behind the root of supra orbital process. • Needle inserted to the caudal ridge of root of supraorbital process at a depth of 1-1.5 cm. • Site for blocking cornual branch of infra-trochlear nerve is at the dorso- medial margin of the orbit. • Insert the needle as close as possible to the margin of the orbit. • Depth of needle is 0.5 cm. • At each site inject 2-3 ml analgesic solution.
Indication	
a. Dehorning of adult cattle. **b.** Wound suturing/treatment at the base of the horn.	



Dehorning in Cattle:

Needle placement for desensitizing the Cornual branch of the zygomaticotemporal nerve in the cow.

Dehorning in Sheep & Goat:

Needle placement for desensitizing

(A) the cornual branch of the zygomaticotemporal (**lacrimal**) nerve and

(B) the cornual branch of the **infratrochlear** nerve in the

Ring Block for Dehorning

- Circular analgesic infiltration at the base of the horn.
- Consume markable amount of analgesic solution.

Cornual N. B. in Buffalo

Anatomy

Conduction analgesia for dehorning in buffaloes

- **Cornual Branch** of temprozygomatic nerve, and
- **The Infra Trochlear Nerve** which could be located at the middle of the supra orbital process 2 cm above the orbital rime and the needle directed medially toward the medial canthus

Indication

a. Dehorning of adult cattle.

b. Wound suturing/treatment at the base of the horn.

Technique

As cattle

- Inject 10 ml of procaine mol 4.5%.

LOCAL ANESTHESIA FOR THE FOOT - CATTLE

- Intravenous Regional analgesia.

Injecting local anesthetic solution into an accessible superficial vein in an extremity isolated from circulation by placing a tourniquet on an animal's leg (intravenous regional anesthesia)

Area blocked: Extremity distal to tourniquet.

Veins used:

A. Common dorsal metacarpal V;

B. Radial vein;

C. Plantar metacarpal vein in the thoracic limb;

D. Cranial branch of the lateral saphenous vein, lateral plantar digital vein in the pelvic limb.

Needle: 20- to 22-gauge, 2.54- to 3.81-cm.

Anesthetic:

- 10 to 30 mL of 2% lidocaine (without epinephrine) in adult cattle
- 3 to 10 mL lidocaine in small ruminants and pigs.

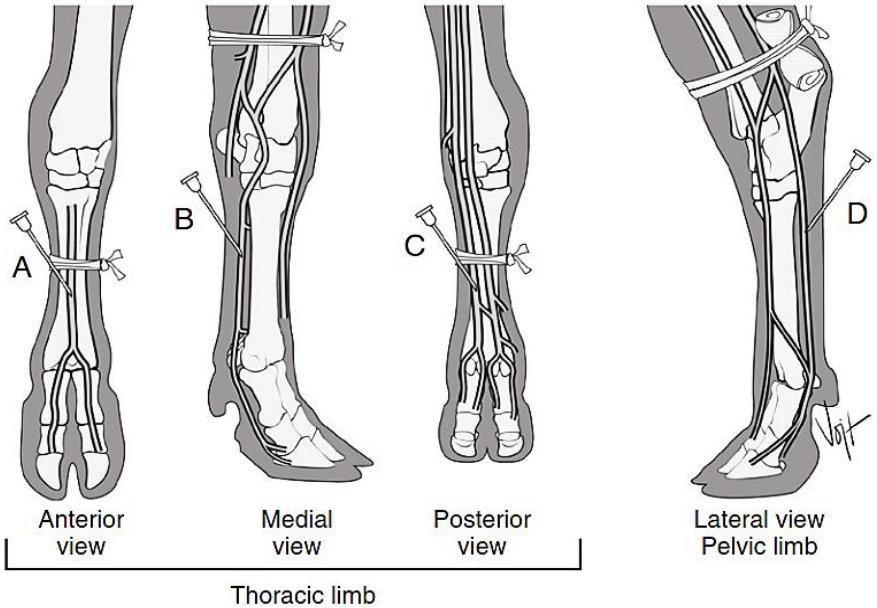
Technique:

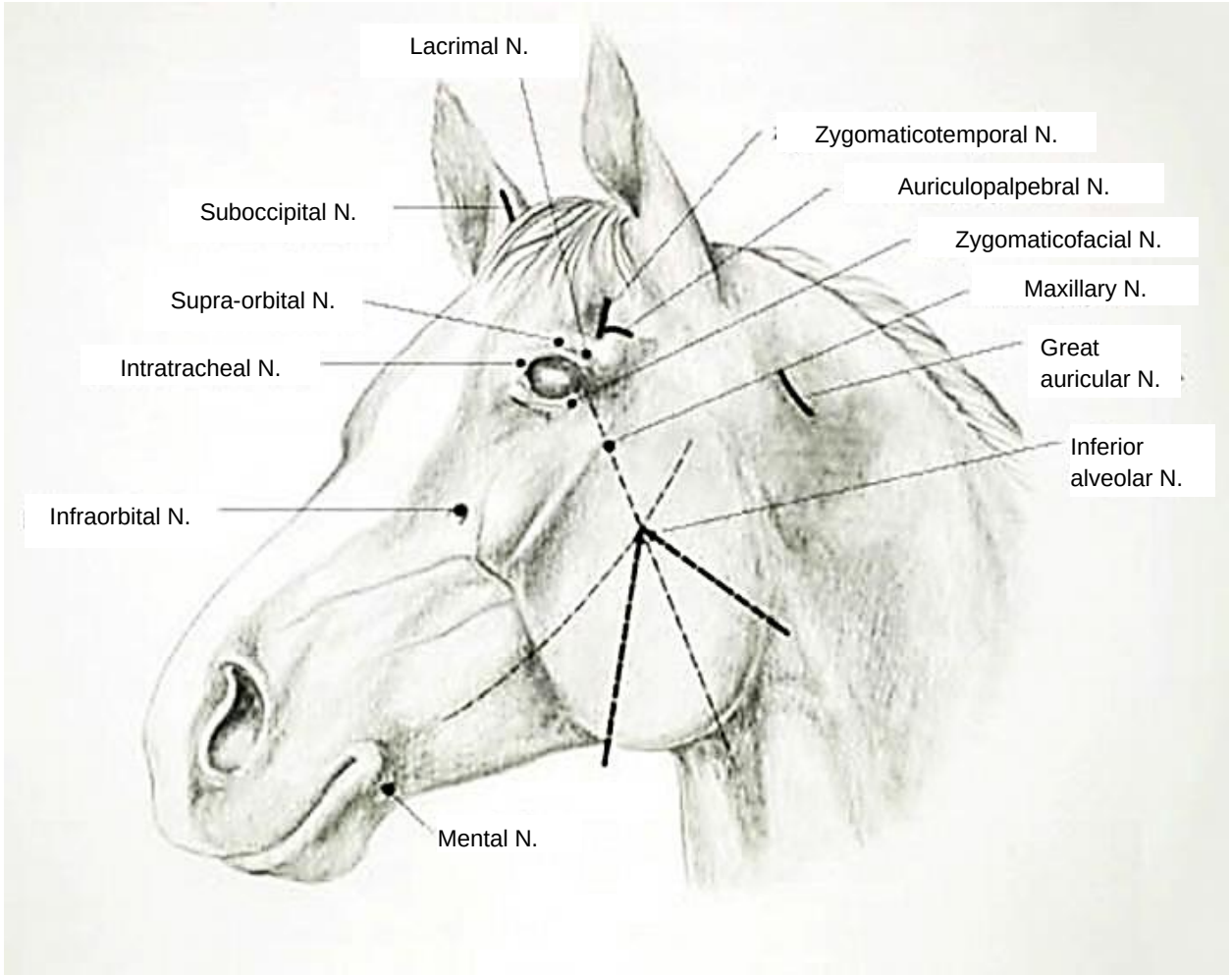
1. Place rubber tourniquet (inflation pressure >200 mm Hg)
   - **a.** Proximal to the metatarsal or metacarpal region for foot surgery or
   - **b.** At a more proximal position for surgery of the carpal or tarsal region;
2. Rapidly inject local anesthetic into the prominent vein, directing the needle either proximally or distally.

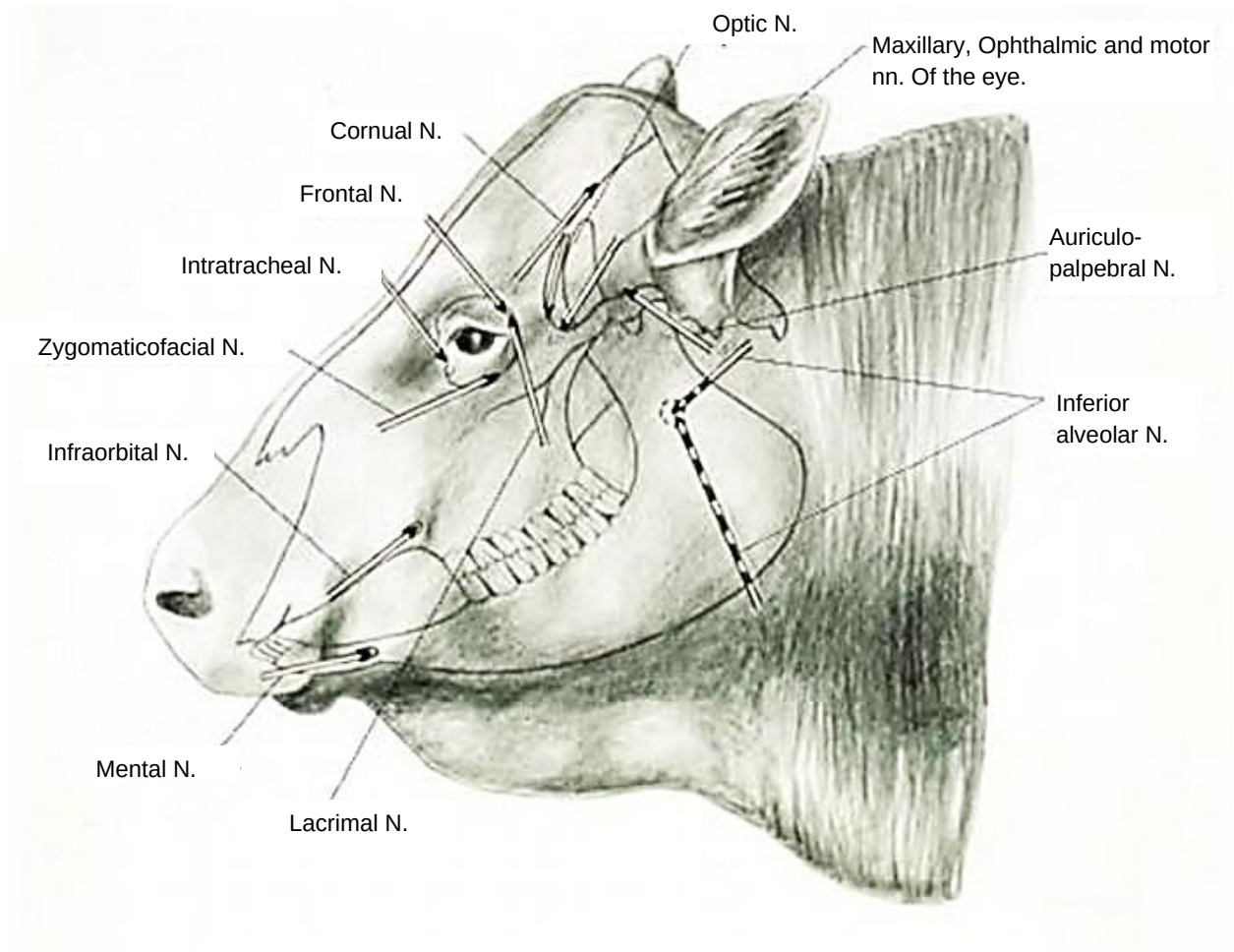
Intravenous regional anesthesia:

Tourniquet and needle placement for intravenous regional anesthesia of the cow. The needle tip is placed at **(A)** the common dorsal metacarpal vein, **(B)** the radial vein, or **(C)** the plantar metacarpal vein in the thoracic limb.

The needle tip is placed at **(D)** the cranial branch of the lateral saphenous vein in the pelvic limb.







Cranial nerves for nerve block, Horse & Cow

BASAL NARCOSIS

Narcosis

Progressive **depression of the CNS** where the animal become **unconscious** but **still responds to external stimuli.**

- Useful only in equine & dog.

Indications:

Valuable to perform **operations of short duration and** which does **not produce much pain** with supplementation of local or regional analgesia, Without supplementation by inhalation anaesthesia.

Narcotic Agent:

- **Horse** is induced by using **Chloral Hydrate.**
- **Dog** is induced by using **Morphine**.

Advantages

1. It overcomes animal fear during restrained.
2. Onset of anesthesia is more regular.
3. Duration of involuntary excitement is reduced.
4. Uniform depth is easily maintained.
5. Cheaper than general anesthesia.
6. Availability.
7. Suitable for minor surgeries, in combination with local analgesia.
8. Reduce the amount of analgesia solution and so increase the safety margin.

NARCOSIS IN HORSES

Chloral Hydrate

The main Characters of Chloral Hydrate:

1. Chloral hydrate is prepared from the action of chlorine on ethyl alcohol.
2. It is colorless transparent crystals.
3. It is freely soluble in water.
4. Sterilized by steaming *(using autoclave)*.
5. Chloral hydrate gives its action through its reduction in the blood into Trichloro-ethanol.

Biological characters of Chloral Hydrate:

Action

1. **In Large Doses:** It is essentially **Hypnotic** & sedative in horse & cattle only.
2. In the past it had been used with other drugs to produce general anaesthesia cut recently it is not recommended to use it as a general anaesthetic agent.

N.B.: all anaesthetic agents measured by milligram-mg. While Narcotic agents measured by gram-gm.

To transfer animal from hypnotic stage to anaesthetic stage, the Narcotic dose is increased.

M.o.A.

- **Depression of the cerebral cortex** and when given as a basal narcosis >> **little or no preliminary excitement** before depression.

ROA "Route of Administration"

1. IV, Drenching, direct introduction to Stomach (by stomach tube from left nostril), Rectal enema, or Intraperitoneal injection (rare).
2. After slow IV injection, narcosis continues to deepen for several minutes after the injection is terminated.

Excretion:

The drug is detoxicated in liver >>excreted in urine as >> Trichloro-ethyl-glycuronate (Could be detected by reduction of Fehling's solution).

Concentration: It is not used in concentrations more than 5% -10%.

Disadvantages/Dangers

1. Contraindicated to be injected IM or SC.
2. Avoid perivascular injection necrosis of vessel wall & surrounding tissue.
3. Overdose >> circulatory collapse & respiratory failure.
4. The main danger associated with Ventricular fibrillation & sudden death during recovery. To overcome these disadvantages, use other agents such as **Magnesium Sulphates** and **Thiopentone Sodium** with the chloral hydrate.
5. Chloral hydrate is contraindicated in patients with hepatic or renal diseases
6. Patients less than one month of age.

Advantages

1. Has a wide safety margin >> lethal dose is about 17 gm/50 kg body (required dose 3-6 gm/ 50 Kg weight).
2. Easily dissolved in water.
3. Detoxicated by liver & execrated by kidney.
4. Easily absorbed from mucous membra e of GIT.
5. Animal able to stand under effect of light & medium narcosis.

Intravenous Administration of Chloral Hydrate:

Route: By gravitation into the jugular vein.

Maximum concentration: 10%.

If a higher concentration is used >> grave danger that any of the solution introduced into the connective tissue that will produce severe local irritation, and its possible serious results.

Dose of Chloral Hydrate Narcosis in Equine:

	Dose (Protocol)	Duration of Narcosis
Light Narcosis	3 - 4 gm/ 50 kg body weight	
Medium Narcosis	4 - 5 gm/ 50 kg body weight	30-45 minutes.
Deep Narcosis	5 - 6 gm/ 50 kg body weight	one hour.

NB · Animal -> go down when the dose ranging between the medium and deep narcosis.

The Signs of the Different Narcotic Levels:

Light Narcosis	Medium Narcosis	Deep Narcosis
• Animal is in the **standing position** and **gait unsteady**.	• Animal **flounder** and **fall** and attempts to rise and fall **again**, so it must be restrained.	• It is a state of **ordering an anaesthesia.**
• **Reduction Reaction** to simple external stimulus. • **Skin sensation unreduced.**		• Skin sensation is **reduced** but **not lost.**
• In **standing** >> No operations. • In **recumbency** >> (**Casting**) you can do **simple operation with local analgesia**.	• **Some operations** can be done **with casting** and with combination of **local or regional analgesia.**	• **Some operations** could be done under the influence of deep narcosis.

- If you want to produce general anaesthesia with chloral Hydrate it is necessary to continue administration after the animal has fallen.

Disadvantages of IV

- The irritation characters of chloral hydrate. So, it must not inject in the Perivascular connective tissue or infiltrate the wall of the vein. If it is injected perivascular >> acute local abscess, phlegmon phlebitis.
- To mitigate the effects of perivascular inj. irritation;
    - Inject a local analgesic agent at site of infiltration to reduce pain.

- Infiltrate normal saline to reduce the narcotic agent concentration in the area.

Calculation narcotic dose for a horse weighting 350 kg

5 gm >>> 50 kg

350 kg = 50 kg x 7

فنضرب الجرعة ف 7

35 gm >>> 350 kg

وللحصول على محلول تركيزه 10%

بمعني

10 gm >>> 100 ml (distilled water)

35 gm >>> ? ml (distilled water)

? = 350 ml

So, 35 gm of chloral hydrate dissolved in 350 ml of distilled water to be given intravenously by infusion set

Estimation of the Dose:

- The estimation of the dose depends on the estimation of the body weight.
- The body weight could be known through:
  1. Horse is weighted routinely if it is available,
  2. A formula for estimation of the body weight was established and you can use it:

$$\text{Weigh (kg)} = \frac{\text{Girth (inches)2 x Length inch}}{660}$$

N.B. If metric scale is used the value is transferred to >> inch by divided by 2.5.

3. One can administer the dose in the standing position by preparation of a sufficient solution and when the horse is failed down a constant depth of narcosis is reached. If deep narcosis is required an additional quantity of about 1/5 of that already injected should be given.

For producing a State of General Anesthesia

1. Must continue administration after the animal has fallen.
2. Additional Quantity of about 1/5 of that already injected should be given after falling down.
3. Using in halation anaesthesia for Maintenance.

Administration into the Stomach:

Rout of Administration:

- Through a stomach tube is preferred.
- Oral administration may be used but because the horse must be very thirstily before it drinks water containing chord hydrate, the horse must be **withholding water for 24-36 hours.**

Maximum Concentration not exceeds 5%.

Dose: When used stomach tube the dose dissolved in 6 to 8 liters of warm water.

Onset of narcosis: 5-10 minutes.

The Maximum Depth: 10-20 minutes.

Advantages of Oral administration are:

1. Agent can be given in greater dilution, low toxic potentiality.
2. No wastage of the drug.
3. No danger.

Disadvantage

1. Mostly the Drenching Pneumonia if not correctly applied.
2. To ensure that the animal's stomach is empty, withhold food for 24 hours and apply muzzle.

3. Low depth, short operation duration.

Administration per Rectum

- This method is not satisfactory and the result is irregular.

Route

- The rectum is emptied by hand (back racking).
- A well lubricant rubber tube is administered >> through rectum into the terminal part of colon. >> Sol. is injected by gravity.

Dose: Should be dissolved in >> 4 Liter of saline or distal water. The solution is injected by gravity.

Onset: Takes about >> 30 minutes.

Duration: Narcosis usually lasts about >> 15 - 20 minutes.

Intraperitoneal Administration

Dose: 10% chloral hydrate in saline and add citrate (citrate 1gm >> to 2 gm of chloral hydrate).

Onset: Takes 20-30 minutes.

Duration (Maximum Depth): Lasts for -» 1-3 hours.

Chloral Hydrate Mixtures

Chloral Hydrate may be mixed with some other drugs as Magnesium Sulphate ($MgSO_4$) or Pentobarbitone Na

A. Chloral hydrate-Magnesium Sulphate (Chloral- Thesia)

2 Part (chloral hydrate 5 g/ 50 kg b. w.) + 1 part magnesium sulphate.

1. Hasten the onset of anaesthesia.
2. Increase its depth.
3. Reduce the toxicity of choral hydrate.
4. Less irritant than chloral hydrate.

B. Chloral Hydrate + Magnesia Sulphate + Pentobarbitone (Equithesin) (Equi-ThesiaR)

Chloral hydrate 28 g + Magnesium sulphate 14 g. + Pentobarbitone sod 6.4 g. + Distal waters 1000 ml. (in Well-developed equine).

1. This solution is with low toxicity.
2. No excitement.
3. Give general anaesthesia.
4. No flounder during recovery.

- It should be freshly prepared 1 hour.
- One may add ethyl alcohol to be more stable.

The Systemic Effects of Chloral Hydrate:

Nervous System:

1. It has a marked **hypnotic** action and free from excitatory properties (**no excitement**).
2. Large quantity is essential to transited hypnotic effect to narcotic one.
   Because it is primary a hypnotic; it is given in large quantity before deep narcosis is produced.
3. Locomotors in coordination (**Ataxia**).
4. Sleep develops early during V injection, but **depress of painful stimuli** is not appear except after very deep narcosis.
5. If IV is continued until surgical anesthesia is produced, recovery is very slowly.
6. Following slow IV infusion of dilute solution narcosis continues to deepen for several minutes after the injection is terminated.

Cardio-vascular system:

1. Decrease of myocardial contractility. Bradycardia.
2. Decrease of arterial blood pressure >> (20 mm/hg). Hypotension.

Respiratory system:

1. Hypnotic doses of choral hydrae >> very little respiratory depression.
2. In the past large dose to induce fail anesthesia severe depression.
3. Large/Fetal dose >> death from depression of respiratory center & circulatory depression.

Metabolic effects:

1. Hypnotic dose >> no effect liver & kidney.
2. Large dose or repeated dose >> fatty change.
3. Trichloro ethanol gluconate is excreted in urine (chloral hydrae + glucuronic acid).

Obstetrics:

- It is a placental barrier but hypnotic doses not effect on offspring.

BASAL NARCOSIS IN DOG

Morphine

Route: Sc or IV.

Dose: up to 5mg/kg.

Onset of Narcosis: 5:10 maximum 30-45 min.

Duration: 1-2 hours.

PREMEDICATION

Def: Administration of drugs usually **before** and sometimes soon **after** administration of the proper anaesthetic or analgesic which **cause sedation** or **decrease salivary** and or/bronchial secretions.

a. Tranquilizers. **b.** Muscle relaxant. **c.** Anticholinergics.

Indication of Premedication

1. Overcome the fear of animal from the operation.
   - **a.** Minimize the incidence of accidents which happens before and after anesthesia.
   - **b.** Onset of anesthesia is without struggling or excitation.
   - **c.** Outset of anesthesia the animal rises up gradually without struggling or excitation.
2. **Minimize shock** production due to their anticholinergic and **antihistaminic** effect.
3. **Minimize the toxicity** of the drug used through reduction of its dose.
4. **Minimize bronchial & salivary** secretion; **avoid suffocation** (respiratory collapse & failure).
5. **Minimize vomiting** to avoid death by drenching pneumonia.
6. Minimize the gastric & intestinal motility.
7. Prevent cardiac arrest.
8. Regulation to respiration & blood pressure.

Tranquilizers

Agents cause **sedation without causing ~~drowsiness~~** they effect mainly on the C.N.S. so called "central nervous system depression syndrome".

A- Strong acting tranquilizers (Major tranquilizers):

- **1-** Chlorpromazine (Largactil®),
- **2-** Promazine (Combelen®).
- **3-** Promethazine (Phenergan®),

B- Minor tranquilizers (Weak acting tranquilizers): That has light sedative effective like Meprobamate derivatives as Quitan, Tranquil® or Equanil®.

Indications/Clinical Use of Tranquilizers

1. Viscous animals Transportation	Calm, get it docile, well tractable & easily handled.
2. Miner operations & surgical interferences	Abscesses Hematoma Prior to patellar luxation X-rays films Endoscopy.
3. Local & regional anesthesia	To avoid general anesthesia.
4. Convulsive diseases (tetanus, distemper & epilepsy)	Act as muscular relaxation.
5. Dislocated joints & fractures	Assist in reduction by **muscle relaxant**.
6. Antipyretic and hypothermic	Depress the thermal centers of the brain.
7. Hyperirritability of the G.I.T	Anti-emetic.
8. Skin irritation	Antihistaminic.
9. Trichomoniasis	Protrude penis for treatment.
10. Food additive for poultry	Restricted movement and reserve it's energy fattening.

Clinical Effects of Tranquilizers in different Animals:

Animal become	Relaxed & Unaware of its surrounding. - Relaxes and hangs its head. - Dropped ear.

1. Cattle	Muzzle dries. The animal appears to be sluggish and tends to lay down. Straggling gait and knuckling at carpus.
2. Calves	Muzzle dries and dropping of ears.
3. Bulls	Protrusion of penis.
4. Camel	Anal reflex released, lip reflex (loose).
5. Horses	Protrusion of penis. Relaxation of muscles. Knuckling at carpus. Loose lip reflex.

Phenothiazine Derivatives

- Drugs of this group are classified as **Antipsychotics** or **Neuroleptics**.
- These are drugs that have a wide range of central and peripheral effects; the degree of activity varies from a drug to another.

A. CNS Effects

1. In general phenothiazine derivatives have a **sedative** effect but **not analgesic effects.**
2. Produce **general calming** & **reduce motor activity.**
3. **Hyper dose** produces **rigidity** & **tremors**.

B. Cardiovascular Effects

1. Blocking of the Alpha 1 Adrenoceptor Agonists *(so having anti adrenaline side effects)* → **Peripheral Vasodilatation.**
2. Their major side effect is the **marked hypotension** that primarily due to peripheral vasodilatation → **Collapse.**
3. Antiarrhythmic effect on the heart that is due to blocking action on cardiac alpha arrhythmic receptors.
4. All phenothiazine derivatives cause **marked drop in body temperature** through increase **Peripheral Heat Loss** from the dilated cutaneous vessels and partially through resetting of the thermoregulatory mechanism.

C. Respiratory Effect: Slight respiratory depression.

D. Digestive effects:

1. **Antiemetic** effect by reduction of gut motility except in horse.
2. They have a powerful action, particularly against opioid induced vomiting.
3. They have a spasmolytic effect on the gut (in horse, gut motility is not affected).

E. Urogenital Effect: Penile prolapse in horse.

Members:

Acetylpromazine (Atravet®, Acepromazine®)

Chlorpromazine (Largactil®, Thorazine®)

Promazine (Sparine®)

Promethazine (Phenergan®)

Propionyl-promazine (Combelen®)

	Acetylpromazine (Atravet®, Acepromazine®)	Chlorpromazine (Largactil®, Thorazine®)	Propionyl-promazine (Combelen®)	Promazine (Sparine®)	Promethazine (Phenergan®)
Action & Use	Most commonly used • No excitement. • Potent sedative action. • Wide safety margin (low toxicity). • Predictable sedation with good muscle relaxation. مايفعله 30 سم Xylazine يفعله 1 سم Acepromazine • It can be mixed with atropine. • It may be used orally, intramuscularly or intravenous.	Similar to **Acepromazine**, but • Less Potent sedative action. • Longer duration. **1.** It blocks the conditioned responses but doesn't interfere with responses to unconditioned stimuli such as needle pricks and painful manipulation. **2.** It is a potent anti-emetic, anti-adrenaline and has vagolytic properties. **3.** The action is enhanced in animals suffering from liver diseases and dereliction is not rapid even in healthy animals.	**1.** More potent in sedation than Largactil® 3: 2 in horse and 5:1 in dogs, cats. **2.** It has been widely used with methadone.	Similar to **Chlorpromazine**, but • Better sedation. • Fewer side effects.	It was the first phenothiazine derivative to be used in the veterinary practice.
Side Effect	• **Priapism** (protrusion of penis in stallions and failure to return into sheath after ceases of drug action and lead also swelling of the organ which necessitates amputation) • Potent **hypotensive** and **Hypothermic**.	• Wide margin of safety but must be used with caution where there is - Severe depression of C.N.S. or heart. - Extensive liver or pulmonary lesion. • The drug possesses a vasodilated effect >> hypotension, and should be Used with great care in animals with shock so, must counteract any tendency to tissue anoxia and to prevent shock.	Wide range of safety margin. • Low toxicity • No effect on liver or kidney.	No excitement or recumbency in horses, so it is preferable than chlorpromazine.	The drug is irritant so, should be injected deeply.
Dose & Route of Administration	**Concentrations:** 2% & 10% and tablets. **Dose:** ▪ Horses, Cattle, Sheep →0.1mg/kg. ▪ Dogs → 0.1-0.2 mg/kg. **Onset** of action is after ▪ 15 - 20 minutes - I/V ▪ 30- 45 minutes - I/M or S/C. **Duration:** Sedation lasts for 2 hours.	**ROA** I/M or S/C. (IV route not used. **Dose:** • **Horses:** 1.1- 2.2 mg/kg. • **Cattle:** 1 mg/kg. • **Dogs and Cats:** 1 mg/kg.	**ROA** I/M. **Conc.** Each ml contains 12.8 mg. **Dose:** • **Horses:** 4 - 5 ml /100 kg.bw. • **Cattle:** ▪ 2-3 ml /100 kg IM, ▪ 4 - 8 ml /100 kg S/C. ▪ 1 ml/100 kg I/V. • **Dogs:** 0.05 - 0.2 ml/kg. • **Cats:** 0.1 mg / kg.	Dose up to 1 mg/kg body weight.	Injected intramuscularly 40-60 minutes before anesthesia and in emergencies can injected I/V very slowly as rapid I/V >> fall in B.P.

Thiazine Derivatives (Alpha 2 Adrenoceptor Agonists)

- Alpha 2 adrenoceptor agonists have been extensively used for their sedative properties.
- The depth of sedation produced with alpha 2 agonists alone may vary and some adverse effects such as occasional violent episodes and kicking out with limbs may occur.
- Usually increasing the dose of alpha 2 agonists increase ataxia without preventing the response of the animal to painful stimulation.
- Peripheral adrenergic stimulation including swaying, sweating, piloerection and increased frequency of micturition were reported.

A. CNS Effects: Calmness, depression, & sedation.

B. Cardiovascular Effects: Initial hypertension (Tachycardia) followed by hypotension (Bradycardia).

C. Digestive effects:

- **a.** Decrease gut motility: - In Ruminants Ruminal tympani. - In Equine Treatment of colic.
- **b.** Decrease salivation.

D. Urinary Effect: Decrease insulin & Antidiuretic hormone (ADH) Frequent urination.

E. Urogenital Effect: Increase the uterine pressure and contractility (contraindicated in last trimester of pregnancy

Alpha 2 Adrenoceptor Antagonists

It inhibits negative feedback effect of Alpha 2 Adrenoreceptors (modulation in the CNS). augmenting release of norepinephrine.

Antagonist	Trade Name	Agonist	Species
Yohimbine	Yobine®	Xylazine	Dogs
Tolazoline	Tolazine®	Xylazine	Horses, ruminants
Atipamezole	Antisedan®	Medetomidine	Dogs
		Detomidine HCl (Dormosedan®)	
		Romifidine (Sedivet®)	

Xylazine "Rompun"

- Sedative, analgesic and muscle relaxant.
- Non phenothiazine, non-narcotic, sedative related to thiazine derivatives.
- Although it is not a true tranquilizer because of its analgesic property, it is considered one of them.
- To avoid some of the unpredictable effects, alpha 2 agonists are often used in conjunction with an opiate (as butorphanol) to produce a state of neuroleptanalgesia **(profound analgesia.)**.
-

Conc.: It is 2% solution (20 mg/ml) or 10% solution (100 mg/ml).

Route

- Mostly I/M or I.V.
- Epidural; has sedative & analgesic effect.
- General: has sedative (preferable to combine a local analgesic agent) & analgesic effect.

Advantages:

1. When used alone → Good analgesia & muscle relaxation.
2. When combined with another tranquilizer or local analgesia → Provide sufficient analgesia & sedation.
3. Significant decrease of total dose of Barbiturate by a 25-75%.

Disadvantages:

1. It has unpredictable analgesia.
2. Decrease insulin → Hyperglycemia. Decrease ADH → increase urination.
3. It can cause severe bradycardia and hypotension.
4. Decrease gut motility→ tympani in ruminant. Used in ttt of colic in equine.
5. It can cause deep sleeping in dogs & cats.
6. It is capable of doing vomiting in cats as it causes emesis in 90% of cats.

Xylazine in Cattle	Xylazine in Sheep & Goat	Xylazine in Horses	Xylazine in Dogs
Dose: 0.05-0.2 mg/kg I/M. 0.05 mg/kg I/M. in cattle. 0.05-0.2 mg/kg I/M. in buffalo. **Conc.** 2% solution I/M.	**Doses:** **Goat:** 0.05 mg / kg b. w. I/M 0.01 mg/ Kg b. w. I/V very slowly). **Sheep:** 0.2 mg/ Kg b. w. I/M - 0.1 -0.15 mg/ kg b. w. I/V (very slowly).	**Dose:** - 1.1 mg/kg slowly I/V. - 3 mg/kg I/M. In controlling pain as in case of equine colic, it could be used as 0.3-0.5 mg/kg b. w. I/V.	**Dose**; 1-3 mg/kg I/M.
Field Dose: 0.25/ 100 kg. cattle. 0.25-1 cm/ 100 kg. in buffalo.		**Field Dose:** 7-10 cm/100 kg. *(high dose due to active liver detoxification)* *(Acepromazine® 1cm/100kg)*	
Onset: Deep sedation and lie down within 10-20 minutes after injection **Duration:** Deep sedation lasts 30-35 minutes **Recovery** within 2-3 hours. The same dose I/V >> profound sedation. • Xylazine produces some degree of analgesia in cattle and so one can operate under the effect of sedation and local analgesia.		• It has a potent sedative / hypnotic effect. • The best drugs for sedation in horses. • It produces sedation with a degree of muscle relaxant.	Good sedation or even hypnosis.
Contraindications: • Not given at last trimester of pregnancy -» premature birth. • Not given at the period of implantation of ova as it causes uterine contraction.		**Disadvantages:** **a.** Expensive. **b.** Causes sinus bradycardia or first or second heart block.	**Side effects:** **a.** Vomiting or seven retching as sedation develops. **b.** Rise in blood pressure (Hypertension) followed by hypotension and bradycardia. **c.** Although xylazine is classified as sedative / hypnotic and increasing the dose led to hypnosis it doesn't consider as a hypnotic because it is associated with severe bradycardia & CVS effect and prolonged recovery.

Detomidine HCl (Dormosedan®)	Romifidine (Sedivet®)
Clinical effects: similar to other Alpha 2 Sedatives (Sedative effect is dose - dependent. antagonized by atipamezole).	
Equine (20-40 µg/kg). Cattle (80 µg/kg).	1 mg/kg.
Used for sedation of horses, ruminants, small animals and wild animals.	
Horses remain standing & relaxation of the neck & **(chin-ground distance become zero**) Ruminants lie down.	
Cardiovascular effects of initial hypertension, bradycardia and decreased cardiac output **similar to xylazine but more profound.**	

Xylazine in Horses:

Signs:

- **a.** Sweating increased after sedation.
- **b.** Penis hangs limply from prepuce.
- **c.** Relief colic.
- **d.** Sedation is lasting for 20-30 min. and recovery within 45 min.
- **e.** Horses don't "go down" after these doses of Xylazine, so can made
- **f.** Laparotomy in standing position with local analgesia.

Xylazine in Dogs:

- Even if sedation is not marked, the induction agent needed after xylazine premedication are greatly reduced.

Xylazine in Cat:

- Dose is: 1-3 mg/kg b.w. I/M which is associated with fairly profound sensation.
- Higher dose than 3 mg/kg of xylazine is anesthetized to cats but it associated with respiratory and myocardial depression.
- Vomiting and severe retching may be developed.
- Following premeditation with xylazine 1/2 dose of barbiturate may be used.
- Xylazine is very useful as a premeditation before ketamine as it will reduce muscle tone during anaesthesia and reduce the incidence of emergence phenomena (hypersensitivity, pupils are widely dilated & appear unable to see).

Medetomidine

Medetomidine (Domitor®) alpha 2 - agonist sedative licensed for use in dogs and cats. Frequently used in wild animals.

Clinical effects:

1. Sedative effect is dose - dependent but large doses will caus profound sedation which is greater than induced by xylazine. Good analgesia.
2. Cardiovascular effects similar to xylazine, except that Medetomidine does not sensitize the myocardium to catecholamines.
3. Other pharmacological effects similar to xylazine.

Butyrophenone Tranquilizers

Drugs in use:

1. Droperidol (Droperidol®, Inapsine®, or mixed with fentanyl).
2. Azaperone (Azaperone®, Suicalm®, Stresnil®)

Clinical Effects:

- **a.** Although structurally different from the phenothiazines, the pharmacological properties of the butyrophenones are similar.
- **b.** The hypotension is less severe than with use of phenothiazines.
- **c.** More sedation than acepromazine.
- **d.** Shorter duration and clearance, more potential for extrapyramidal side effects (motor activity, excitement, aggression).

Benzodiazepines

a. They have sedatives, hypnotic properties, muscle relaxation & anti convulsions properties (sed in vet. Field purlely as anticonvulsant).

b. These are drugs which show dose relating tranquilizing.

c. They are insoluble in water and so, solutions for injection prepared in a variety of organic solvent.

d. Of the available benzodiazepine drugs, Diazepam, Midazolam, Climazolam, Zolazepam have been most utilized in the veterinary practice.

Dose: 0.25 mg/kg IV or 0.5-1 mg/kg IM.

- Dogs & Cats used as premeditation and post-operative to control convulsions.
- Horse not used alone due to its ataxic effect.
- It should not be accompanied with atropine.

Drugs in use:

1. Diazepam (Diazepam®, Valium®).

2. Midazolam (Midazolam®, Versed®).

3. Zolazepam (licensed premixed with tiletamine as Telazol® for use in dogs and cats).

Clinical effects:

1. Sedation by enhancement of GABA mediated inhibition in brain and spinal cord.

- **a.** Neither Diazepam or Midazolam have any great effect on cardiovascular function in healthy patients.
- **b.** Degree of cardiovascular depression partly depends on other drugs used concurrently. In cats, diazepam given alone causes a fall in blood pressure and approximately 25% reduction in myocardial contractility.
- **c.** In healthy dogs, diazepam increases heart rate and does not alter mean arterial pressure but 1- mg/kg I/V decreases cardiac contractility 17%.
- **d.** Midazolam at doses higher than usually used slightly increases heart rate, and decreases arterial pressure and cardiac contractility.
- **e.** Used alone these drugs are poor sedatives in healthy veterinary patients and may even cause twitching, arousal or excitement.
- **f.** More effective with depressed patients.

2. Respiratory depression unpredictable, minimal at standard dosages.

3. Behavior response

- **a.** in cat is variable. Some become sedated, some become excited. Aggressive behavior is usually modified.
- **b.** Dogs may become excited after IV injection of diazepam.
- **c.** It will cause anxiety when used alone in horses.

4. Appetite is stimulated.

5. Midazolam is water soluble (diazepam is not) and is less likely to cause irritation at the site of injection or thrombophlebitis.

6. Diazepam may not be effective IM as the absorption from this site is unpredictable.

7. Flumazenil is a specific benzodiazepine antagonist.

Diazepam

1. Oily solution 5mg/ml (not water soluble).

2. Mostly used to control convulsions of any origin in veterinary origin.

3. In horses it is accompanied with ataxia and so the drug should not be used on its own.

4. Although it is not used as a sedative in horses, diazepam has been incorporated into anaesthetic regimes used in horses.

5. Used in dogs & cats as premeditation for premedication and post-operative to control convulsions especially of toxic drugs in cats.

6. Intravenous injection is painful.

7. It should not be accompanied-with atropine.

Dose; Dogs: 0.25 mg/kg IV, 0.5-0.1 mg/kg I/M.

Anticholinergics Anticholinergic Drugs

Atropine or glycopyrrolate

One of these drugs may be administered for premedication to:

1. Minimize bradycardia due to laryngoscopy during intubation and due to anaesthetic drugs.
2. Decrease bronchial secretions which cannot be eliminated during anaesthesia.
3. To slow intestinal motility and thereby decrease the incidence of nausea and vomiting during recovery from anaesthesia.
4. Glycopyrrolate, rather than atropine, should be used in aged animals because it is less likely to cause tachycardia and increased myocardial work. Glycopyrrolate decreases the acidity of gastric secretions and is the better choice for patients with megaesophagus or a history of vomiting.
5. Anticholinergics should not be used routinely in animals with cardiomyopathy, pathalogic tachycardia, traumatic myocarditis with ventricular dysrhythmias, or hyperthermia (but may be used to treat bradycardia).

Drugs in common use

1. Atropine.
2. Glycopyrrolate (Robinul-V®).

Atropine

Clinical effects of Atropine

Atropine acts on the parasympathetic nervous system by competitive antagonism to acetylcholine. It is therefore:

1. Used to reduce secretions from respiratory tract and salivary glands.
2. Used to reduce GIT motility and decrease risk of vomiting.
3. Used to inhibit effects of vagal stimulation on cardiovascular and respiratory systems which would result in bradycardia and hypotension, laryngospasm or bronchospasm. Increased vagal tone from: ocular surgery, pressure or traction on visceral organs, laryngoscopy.
4. Used to minimize bradycardic effects of other drugs, eg, Xylazine, Medetomidine, Fentanyl, Succinylcholine.
5. Causes bronchodilation resulting in decreased airway resistance and increased anatomic dead space. It is therefore useful for patients with chronic obstructive pulmonary disease. Inhibits mucociliary transport weakening defense against respiratory infection.

- Atropine is not routinely given to horses and ruminants because decreased GIT motility in these species has adverse effects.
- Atropine initially stimulates the vagal center and causes a transitory slowing of heart rate, often with the development or worsening of 2nd degree AV block.
- **Onset of action**
    - One minute following IV injection with **peak duration** of effect approximately 30 minutes.
    - 20 minutes following IM injection with **peak duration** of effect I to 1.5 hours.
- Total elimination of a single dose within 14-15 hours; 2/3 of drug is hydrolyzed and 1/3 is eliminated unchanged in the urine.
- High doses result in postural hypotension, delirium and fever.

Hypotension will occur from the ganglion blocking activity in high doses. Atropine can cross the Blood-Brain Barrier and excessive dosage results in stimulation of the spinal cord.

Dose: Dogs >> 0.02 - 0.05 mg/kg & Cats >> 0.1 mg/kg.

Glycopyrrolate

Clinical effects of glycopyrrolate

1. General pharmacological actions, and therefore reasons for use, are similar to those for atropine.
2. Onset of full action following intramuscular injection longer at 45 minutes.
3. **Duration** of effective activity much longer. Vagal blocking effect 2-3 hours, antisialagogue effect 5-6 hours.
4. The polar nature of glycopyrrolate limits its passage across lipid membranes, such as the Blood-Brain Barrier, and placenta.

5. Heart rate is generally not increased to the same degree as with atropine, and tachycardia is not usually a problem. Can more safely be used in patients with cardiac disease.
6. Glycopyrrolate reduces both volume and acidity of gastric secretions.
7. Was initially introduced for premedication for caesarian section to reduce severity in cases of aspiration pneumonia.
8. Note that significant change in gastric pH is not obtained for at least one hour following IM administration.

Precautions

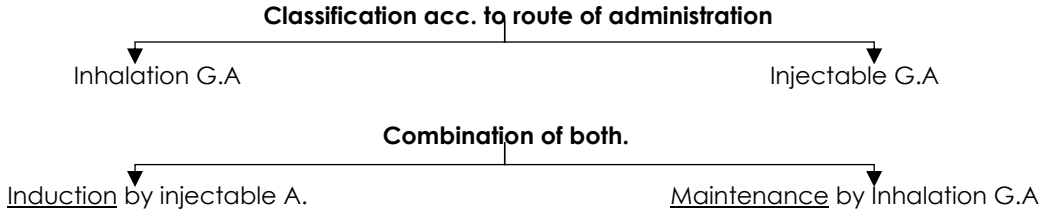
The advantages obtained through use of atropine should be weighed against the possible complications in the following situations:

1. Pre-existing tachycardia (not originating from excitement).
2. Hyperpyrexia or elevated ambient temperature.
3. Moderate to severe cardiac insufficiency where an increase in heart rate might result in a fall in stroke volume and reduction in cardiac output.
4. Glaucoma. However, controlled studies have shown premedicate dosage of atropine causes very little change in intraocular tension in patients with glaucoma.

Do not mix glycopyrrolate in the same syringe with phenothiazine tranquilizers or barbiturates-incompatible.

GENERAL ANESTHESIA

General anesthesia is a state of unconsciousness associated with an entire absence of response to external painful stimuli produced by a process of controlled, reversible intoxication of the central nervous system.



Mode of Action

Inhalation G.A.	Injectable G.A.
1. Blood	**1.** Upper respiratory └► Lung alveoli └► Blood.
2. Diffuse into tissue depending on tissue bl. supply & its lipid contents. **3.** The brain is the highest bl. supply & lipid content so acquire most anaesthetic agent. **4.** It blocks neuronal cellular uptake of sodium molecules >> inhibit nerve impulses >> the brain becomes unconscious & central (not peripheral) desensitization. **5.** Elimination after giving the anesthetic effect in a reverse manner.	
6. Injectable anesthetics pass from brain & tissues >> blood >> liver (decomposition) >> kidney (excretion).	**6.** Inhalation anesthetics pass from brain & tissues >> blood >> alveoli >> expired air.

Anesthetic agent:

It is the substance which produces in a controllable manner both loss of consciousness and complete absence of motor response to noxious stimuli.

- General anesthesia may be volatile or nonvolatile.
- Volatile anesthesia produced by volatile agents as ether or chloroform which introduced into the upper respiratory tract and have b transported to the brain before they will produce loss of consciousness .

There are 3 steps in this process:

(1) First step:

In this step there is transference of gas or vapor from the upper respiratory tract to the lung alveoli. For this step free respiration is necessary and the gases inhaled will contain proportion of the anesthetic agents.

(2) Second step:

In which there is absorption of the gas or vapor from the alveoli the lung to the blood.

It depends upon the flow of diffusion of the gases through the membranes.

(3) Third step:

In which the anesthetic agent circulate by the blood and diffusion into the tissues and results in distribution of the anesthetic agent thought the tissue.

The distribution and rate of absorption depend upon:

a- The blood supply of the organ.

b- Its lipoidal contents.

- So, the brain which has very rich blood supply and high lipid contents acquires a concentration of the anesthetic agent equal to that of the blood.
- Because of the irritant nature of the vapors of the volatile liquid anesthetics as other & chloroform it only given in low concentration, so, the 3 phases take appreciable time.
- But, non-irritant gases as nitrous oxide are not irritant and so >> given m high concentration and it's diffusion into the blood and tissues arc rapid.

- Elimination of the anesthetic agents from the body takes place by uhe reversible manner. It pass from tissues >> blood >> alveoli >> expired air.
- Non-volatile anesthetics given parentally or by alimentary Tract blood >> brain & tissues >> blood >> decomposed in liver >> excreted by kidney.

Mode of Action of Anesthetic Drugs

The exact mode of action of the anesthetic drugs is not known. But may, they inter for with the cell metabolism depend on.

a. The amount of anesthetic agent.

b. The time of exposure of the cells to the agents.

c. The toxicity of the drug.

Anesthetics depress the activity of all cells of the body specially those of the CNS. The most highly developed parts of the brain affected are centers of the medulla and cerebrum.

• Anesthetics have much less effects on the peripheral never than on the cells of the CNS The conductivity of the nerve fibers is unaffected by the general anesthetic agents and the loss of pain is due to the loss of function of the cerebral sensory centers.

It may be that general anesthetic agents release enkephalin (or other endorphins) at opiate receptor. Sites in the pain pathways and it is even possible that the analgesic component of the general anesthesia is d this enkephalin release.

Stages of Anesthesia

- The transition from consciousness to complete surgical anesthesia was divided into 4 stags.
- They are most easily recognized when anesthesia is produced b relatively slow-acting drugs as diethyl other, and are well defined when quicker acting drugs as halothane and thiopentone sodium are used,

Stage 1: Induction stage or stage of voluntary excitement:

1. Animal is conscious and make efforts to avoid being anesthetized.
2. Breath-holding may occur.
3. Fear causes on increase in the respiratory and pulse rates and dilatation of the pupils
4. Urine and faces may be voided.

Stage 2: Stage of Involuntary Excitement:

1. Animal is unconsciousness.
2. Reflex response to stimuli is exaggerated.
3. **Exaggerated body reflexes.** Limb movements may become violent so, must restraint the animal.
4. **Struggling sounds:** Dogs may "whimper" or "howl", cats "swear", horses "neigh"
5. Some individuals pass quietly in this stage.
6. Very **Irregular Respiration** is and breath holding may accompany struggling.
7. The pharyngeal refluxes (swallowing & vomiting) are present.
8. The Cough/laryngeal reflex is present.

Stage 1 & stage 2 > associated with difficulties to the animal, so premeditations as morphine, chloral hydrate and phenothiazine derivatives help to pass.

Stage 3: Stage of surgical anesthesia:

It can be divided into three planes.

First Plane (Light) Anesthesia

a. Is indicated by the onset of regular automatic breathing and cessation of all limb movements.

b. Eye ball moves from side to side and then sluggish movement then

c. Eyeballs become fixed (animal enter 2nd plane),

d. Palpebral conjunctival & corneal reflexes appear as anesthesia

e. Deepness and not present when animal enter 2nd plan.

In dog, cats

- **a.** >> pedal reflex is brisk,
- **b.** Pharyngeal reflex (Swilling & vomiting) > absent.
- **c.** Cough >> present (laryngeal reflex).
- **d.** Relaxation to limb muscles only.
- **e.** Many diagnostic investigations & minor operations as opening of abscesses can be performed.

Second Plane (Medium) Anesthesia

- **a.** Respiration >no change until middle of 2nd stage then rate
- **b.** Increases and amplitude decreases,
- **c.** Laryngeal reflex (cough) >> persists until the middle of the second plane
- **d.** Eye ball >> fixed and central, but in dogs & cats >> eyeball rotates downward,
- **e.** Muscular relaxation >> most muscles accept abdominal.
- **f.** All operation can be done except intra-abdominal operations.

Third Plane (Deep) Anesthesia

Automatic breathing is still present. But the respiratory Fale increases while the depth of respiration decreases and noticeable pause appears between inspiration and expiration.

In Dog & cat

- **a.** The eye balls are >> central & fixed,
- **b.** Pedal reflex disappear.

Stage 4 Over Dosage

1. In this stage -> paralysis of the thoracic muscles are complete, only diaphragmatic activity remains,
2. Movements of diaphragm are jerky and respiration appears gasping in nature.
3. During inspiration: The contraction of the diaphragm causes the- relaxed abdominal wall to bulge outwards while the flaccid thoracic muscles move inward,
4. Expiration cause the thoracic wall to return to it's position,
5. Pulse become rapid >> then gets shown & weaker,
6. Eye pupils >> dilate.
7. Eye balls present a "fish-eye" due to cessation of lacrimal secretion.
8. If these signs are disregarded, the animal condition deteriorates rapidly where respiration cease and cyanosis (heat failure)

Stage of Surgical Anesthesia

Plane	Respiration	Ocular Reflex	Laryngeal and Pharyngeal Reflexes	Relaxation
Light	Regular Thoraco-abdominal breathing	Eyeball moves from side to side. Palpebral, conjunctival and Corneal reflexes depressed.	Vomiting and swallowing are absent. Cough present.	Relaxation of the muscles of the limb only.
Medium	Regular Thoraco-lumbar breathing. Then, less amplitude and increased rate.	Eyeballs fixed and central. It turned downward in dogs and cats. Corneal reflex is absent	Cough persists to the middle of this plane.	Relaxation of most muscles except abdominal muscles.
Deep	Regular abdominal respiration. Minimal amplitude (depth).	Eyeball is fixed and central in all animals.	Cough absent.	Relaxation of the all muscles including the abdominal muscles.

Inhalation Anesthesia

Importance of inhalation Anesthesia:

1. Rapid onset and Rapid recovery.
2. The depth of anesthesia can be modified according to the dose.
3. The progressive cerebral depression gives rise to fear and qu pouring of adrenaline.
4. Inhalation of a pungent vapor gives rise to Tear associated with excessive salivation & bronchial secretion.

Administration of inhalation agents

- At normal atmospheric pressure and temperature some of inhalation agents are liquid (e.g. chloroform & ether) and others are gaseous as nitrous oxide and cyclopropane.
- The method of administration of vapor of the volatile liquids or that gaseous anesthetic agents may be:
    1- Open method.
    2- Closed method with Co2absorption.
    3- Semi-open method.
    4- Semi closed method.

A. Open Method

a. It is used to volatize agents as ether and chloroform,
b. Agents are dropped on the surface of a gauze piece or lint and hold over the animals' nostrils.
c. It may be stretched over a wire frame to make a mask this method is referred to be as "rag & bottle anesthesia".
d. The term open is only said when the mask as schimmelbusch is used which >> not fit the contour of the animal face And >> there is free flow of air between face & mask.

B. Semi-Open Method:

In semi-open or Percolation method all the inspired air is made to pass through the mask on which the vaporization of the agents occurs.

When using the mask of schimmelbusch, two thick layers of Gamgee tissues is employed to ensure that all inspiration air passes through the mask.

- First layer>> small hole on its center so, mouth & nostrils are only exposed from the face. The mask then covered the nose and nostril.
- The second layer-> applied over the mask.

In horses and cattle there are special masks which are cylinders of leather and applied either the upper of both jaws.

Chloroform is applied to a sponge which is inserted in the open end of the cylinder.

Disadvantages of open and semi-open methods:

1- Difficult to maintain a suitable level of anesthesia because the anesthetic agent is diluted to unknown extent by the atmospheric air.
2- There is depression of the breathing which decrease the ear dilution thus concentration of the inspired anesthetic increased.
3- Anesthetist can't control ventilation & respiration.
4- Air doesn't apply adequate oxygen.
5- Very wasteful as large quantities of the anesthetic agents are consumed through volatilization through atmosphere.
6- When agents as ether are used there is risk of explosion.

C. Closed Method with CO_2 Absorption:

a. The anesthetic agents are usually exhaled from the body unchanged except they are mixed with CO_2, the principle of close circuit is to absorb co2 and add sufficient O_2.
b. CO_2 can be absorbed by directing the expired air over a surface as soda-lime used in a granular form and in a container (90% calcium hydroxide, 5% sol. Hydroxide 5% silicates & H_2O) to prevent powdering.
c. Once the anesthesia is reached the anir ! requirement from the apparatus, there is a continuous streail of O2 and efficient absorption of O_2.

Advantages:

1- Simple.

2- No wastage of anesthetic agent in atmosphere.

Disadvantages:

1- There is resistance of respiration due to packed soda lime so, unsuitable for cats, puppies and very small adult dogs.

2- There is conservation of heat and water vapor so >> heat stroke in dogs & sheep.

3- There are two systems in use of closed-circuit CO_2 absorption.

- **a-** "To and from" system,
- **b-** "Circle" system.

The "To and From" System:

Soda lime canister is interposed between the anima! and the re- breathing bag.

Fresh gases being fed into the system as close to the animal as possible to effect changes in mixture rapidly.

Disadvantages:

1- Gas tight condition and inspired gases becomes hot due to reaction between CO_2 & soda-lime.

2- Irritant dust may lead to bronchitis

3- The apparatus dead-space increases during anesthesia i.e. e exhaled gases come into contact with the soda lime at the end of the canister nearest to the patient and the absorbent in this region is exhausted.

Circle system

- It incorporates an inspiratory and expiratory tube with unidirectional valves.
- The re-breathing bag and soda line are placed between these tubes.
- The valves & the tubes offer a resistance to breathing and if the apparatus is not carefully designed >> breathing may cause strain to the animal.

D. Semi-Closed Method

- The general principle of semi-closed method is that gases and vapors flow from the anesthetic apparatus into a reservoir bag from which the animal inhales.
- While part of all of the exhaled mixture passes out through an expiratory valve into the atmosphere.
- Re breathing is prevented by maintaining the total gas flow rate from the cylinders slightly in excess of the animal respiratory minute volume, So, the animal inhales from the bag and wide - bore tubing.
- The exhaled gases never reach the bag because the capacity of the tube is too great and once the bag is distended the pressure inside the system >> open the value.
- For small dogs and for cats this system is unsuitable and so, T-piece system is used, the open tube act as a reservoir and there are no valves.
- The exhaled air is swept out of the open end of the reservoir tube by fresh gases flowing in from the anesthetic apparatus during the expiratory pause
- Unless the capacity of the reservoir tube is at least equal to the tidal volume of the animal the inspired gases will be diluted with air.

Inhalant Anesthetic Agents

- Inhalant anesthetics in use in veterinary anesthesia include Nitrous Oxide, Halothane, Methoxyflurane, Sevoflurane, Isoflurane, Sevoflurane and Desflurane.
- The latter six agents are commonly referred to as "the potent inhalants" as their MAC values (minimal alveolar concentration) are such that they may be used as the sole anesthetic agents during a surgical procedure.
- Nitrous oxide lacks sufficient potency to be used as a sole anesthetic in healthy, young veterinary patients. It must be pointed out that the clinical use of nitrous oxide is, if not controversial, at least contentious among veterinary

anesthesiologists. Many specialists feel that the lack of potency of nitrous oxide renders the drug undesirable as an adjunct to inhalation anesthesia. Nevertheless, nitrous oxide has a place in many situations encountered in the practice of veterinary anesthesia.

- Modern inhalant anesthetics (listed in order of year of Introduction) include Halothane, Methoxyflurane, Enflurane, Isoflurane, Desflurane, and sevoflurane.
- As a general rule, newer inhalants tend to have increasingly lower solubility and higher chemical stability. Thus, the newest of the inhalant anesthetics, desflurane and sevoflurane, are relatively inert and very insoluble. Many inhalant anesthetics such as halothane and methoxyflurane, undergo extensive metabolism within the liver and to a lesser extent in tissues such as the lungs and kidneys.
- Several pathways of drug metabolism exist including oxidation, reduction, hydrolysis and conjugation reactions.
- Metabolism of non-inert inhalant anesthetics can result in the production of metabolites which may cause undesirable side effects such as liver or kidney damage.
- The potential of producing harmful metabolites is markedly decreased with stable or inert anesthetics because they are not metabolized to a large degree by the liver.
- Solubility of inhalant anesthetics in body tissues and blood is important in determining how rapidly a given anesthetic will attain an anesthetizing partial pressure in the brain. Agents having low tissue and blood solubility will, if all other factors remain equal, to provide for rapid equilibration of anesthetic partial pressures between the lungs and brain, This rapid equilibration translates clinically into a patient whose depth of anesthesia is extremely responsive to changes in administered concentrations. This relatively rapid responsiveness necessitates careful monitoring of anesthetic depth if a patient is to be prevented from becoming either- excessively light or deep.
- Low tissue solubility also means that for any given period of anesthesia, less total inhalant anesthetic is taken up. Consequently, less total inhalant is presented to and acted upon by the liver which means there is fewer metabolisms and less production of potentially harmful metabolites.
- Use of rapidly acting inhalant anesthetics may not be advantageous in all settings. An example is methoxyflurane, introduced into anesthesia practice in 1962. Its high blood and tissue solubility translated into slow changes in anesthetic depth, a condition favored by many small animal practitioners of the day.

Halothane (Halothane USP, Fluthane):

- Introduced into veterinary anesthesia practice in 1956, it is still a widely used inhalant anesthetic. Synthesized in an effort to produce a non-flammable inhalant anesthetic, the drug was an attractive alternative to diethyl ether and cyclopropane.
- Clinically useful settings in small animals are 2 3% for induction of anesthesia, and 1-1.5% for maintenance of anesthesia.
- The moderate blood solubility of halothane (blood/gas PC 2.4) translates to a more rapid induction of anesthesia compared with more soluble agents such as methoxyflurane or diethyl ether.

Cardiovascular Effects

1. The cardiovascular effects of halothane may be significant. In a dose dependent manner, halothane decreases blood pressure by decreasing myocardial contractility via direct depression of the myocardium which results in a reduction of cardiac output.
2. Cardiac arrhythmias during clinical use of halothane are frequently encountered. Most are fairly benign and do not require administration of anti-arrhythmogenic drugs.
3. Inhalant anesthetics having high potency (low MAC values) require lower alveolar concentrations to induce general anesthesia. These two physical properties of halothane and isoflurane indicate that isoflurane, having lower solubility, will be taken up more rapidly than halothane will be eliminated. Isoflurane is also less potent (higher MAC) than is halothane, thus it might appear that the more rapid effect seen with isoflurane would be counterbalanced by the higher concentrations needed for anesthesia.
4. Heart rate in the normal rate.
5. Decreased arterial blood pressure.

Respiratory Effects

1. Administration of halothane is associated with a dose-dependent respiratory depression that is initially manifested as a decrease in tidal volume, as anesthetic depth increases a decrease in respiratory rate also is seen.
2. Common to all inhalant anesthetics, the respiratory depressing effects of halothane may be at least partially offset by surgical stimulation.

CNS Effects

1. Inhalation of halothane results in marked depression of the central nervous system,
2. Increasing depth of anesthesia results in reduced EEG activity but unlike with isoflurane a burst suppression pattern is not frequently observed.
3. Halothane decreases cerebral metabolic rate of oxygen utilization and is a potent cerebrovasodilator that results in increased Cerebral Blood Flow (CBF) and Intracranial Pressure (ICP).
4. The dilating effect of halothane on the cerebral vasculature may be. greatly modified by the patient's arterial PCO2 tension. Hypoventilation and associated elevations in $PaCO_2$ will greatly exacerbate the increases in ICP while mild hyperventilation (controlled manually or mechanically) - $PaCO_2$ - 30 mm Hg - will diminish halothane-induced increases in ICP.
5. Since other inhalant anesthetics do not result in the same magnitude of increase in CBF and ICP at similar MAC levels, halothane is usually not recommended for patients presenting with or suspected of having raised ICP.

Other Effects

1. Of all inhalant anesthetics in veterinary use today, halothane is the Jeas inert and most highly metabolized with 20 - 25% of the anesthetic recovered as metabolites.
2. Minimal pathological changes have been found in the liver and kidney
3. It depresses the respiratory center and directly depresses the myocardium and deaths from ventricular fibrillation may occur,
4. Following its use -> hepatitis or renal damage may be encountered,
5. In the dog ethyl chloride does not produce muscle relaxation.

Diethyl Ether

- Color loss. highly volatile liquid with pungent odor and irritating vapor.
- Vapor is 2.6 times heavier than air.
- Inflammable and explosive mixtures are the fare accumulates close to the floor,
- Ether oxidizes in the presence of air or oxygen >> peroxides or aldehydes which are toxic, and also it decomposed by light.
- So > liquid is stored in sealed metal container coated Inside with copper or metal or stored in amber colored dark bottles,
- Ether is irritant to all tissues:
    - Irritate >> mucous membranes of respiratory tract >> breath holding by the patient and marked increase in the flow of saliva & mucous which may interfere respiration Irritates kidney >> anuria during area albumin urea post anesthesia period.
- No effect on liver or heart.
- Very wide margin between anaesth & toxic doses so, ether is one of the safest anesthetic drugs.
- Uses >> used to induction anesthesia in cats, to maintain anesthesia in dogs which induced by barbiturates and in accidents and emergencies.

Injectable Anesthesia

- Many drugs are administered via injection for induction and maintenance of anesthesia. Anesthesia may be maintained, especially for short time periods, exclusively with injectable drugs or, more commonly, for prolonged periods by combining injectable drugs with inhalation agents.
- While a variety of administration routes are broadly applied to veterinary patients the intravenous (IV) injection is preferred. IV agents commonly produce respiratory depression so, the endotracheal intubation of O_2 may be necessary to avoid hypoxemia and hypercapnia. Some IV agents may be given /M or sub/cut but, **Disadvantages** >> variable absorption.
- Injectable anesthetic drugs in current use and reviewed below are classified as hypnotic-sedatives, dissociative, and Opioids. Thiopental is historically the standard to which most injectable anesthetic drugs are compared.

Indications:

1. Induction of anesthesia.
2. As a sole anesthetic agent for short term minor procedures.

Advantages	Disadvantages
1- Simple.	**1-** Superf. vein may be difficult to find.
2- Rapid onset.	**2-** Perivascular inj. is very irritant.
3- No apparatus needed.	**3-** Once injected it cannot be removed.
4- No explosion.	**4-** Cumulative effect of some agents.
5- No pollution hazard.	**5-** Possible apnea.
6- Non-irritant to airways.	**6-** Endotracheal intubation of O_2 may be necessary to avoid hypoxaemia.

Technique of administration:

a. Cannulation.

b. Single dose injection (rapid bolus or slow injection).

c. Continuous infusion.

Hypnotic Sedatives

Thiopental (Nesdonal® /Pentothal®)

- By virtue of a sulfur group substitution at position 2 of the barbituric acid ring, thiopental is classified as a thiobarbiturate.
- Alkalinization (pH 10-11), which is necessary to render the compound water soluble, imparts a bacteriostatic nature to the solution, but also causes the drug to precipitate if re-constituted with an acidic fluid solution (e.g., lactated Ringers).
- Further in part due to the alkaline nature of the solution, peri-vascular ration can result in sloughing of the skin especially at drug concentrations greater than 2%.
- The IV administration of thiopental results in a rapid, smooth onset of action and associated ultra-short duration of action.
- The recommended clinical **dose** (**6-20 mg/kg)** range is intentionally broad so as to allow for these, and other. individual animal considerations and interactions with other drugs.

  For example, the de necessary for intubation is reduced approximately 50% following premedication.
- The **onset of action is 15-30 seconds** following administration and the **anesthetic duration (10-15)** minutes after a single dose is determined primarily by redistribution.
- Excitement is seen with slow administration (especially in non-sedated animals) and hence an initial bolus of approximately one-third of the calculated dose is suggested.
- Clearance from body is dependent almost exclusively on hepatic metabolism and due to the limited ability of Greyhounds dogs to metabolize this drug, its use in these animals is not recommended.
- Thiopental provides dose dependent hypnosis and central nervous system depression without compromise to cerebral perfusion.
- Both intracranial and intraocular pressures are decreased following administration.
- The drug has anticonvulsant properties, but may increase sensitivity to somatic pain.
- An increase in heart rate and an immediate transient decrease in myocardial contractility are observed following administration.
- Changes in blood pressure, stroke volume and cardiac output are mote variable. Ventricular dysrhythmias (e.g., ventricular bigeminy) are more likely to be observed following administration in non-sedated and/or hypoxemic patients.
- Respiratory rate may be decreased following administration, but the response varies with dose and speed of administration of the drug and PaO_2.
- A decrease in the packed cell volume is commonly noted following administration and is, in part, likely due to splenic sequestration of red blood cells.

Propofol

1. Propofol is an alkyl phenol with sedative/hypnotic effects similar to those of thiopental.
2. It is available as a 1% preparation with 10% soybean oil, 2.25 % glycerol and 1.2 % egg-lecithin.
3. The pH is adjusted to approximately 7.5 with sodium hydroxide. Due to the lack of preservative and the nature of the medium used to solubilize propofol, microbial and fungal contamination is an important consideration. As a result, any drug remaining 6-12 hours after initially opening a vial should be discarded.
4. Propofol provides a useful alternative to thiopental for induction of anesthesia and has very similar clinical actions (e.g., decreased intracranial pressure, anti-convulsant, etc)
5. An IV dose of 5-8 mg/kg is recommended in non-sedated animals. Both sedation and the addition of benzodiazepines to the anesthetic induction protocol will reduce the dose requirement and potentially reduce the costs associated with propofol administration.
6. Excitement is uncommon even with slow IV administration of propofol and allows for titration of propofol to the appropriate level of sedation.
7. While some animals may withdraw their limb in response to propofol administration (a burning sensation has been noted by some human patients), perivascular injection does not cause a local inflammatory reaction.
8. The onset of action following IV administration is about 20-30 seconds with rapid redistribution and clearance from both hepatic and extra- hepatic sites.
9. The effective clinical duration of action is frequently less thun je minutes and hence propofol is used primarily to induce anesthesia
10. Additional bolus doses or infusions may be administered to prolona anesthetic duration without significant effect on recovery time in the dog.
11. The cat responds a little less predictably presumably due to hepatic enzyme saturation. Heinz-body anemia, general malaise, anorexia, and diarrhea have been reported with sequential daily administration of propofol in cats.
12. Cardiovascular depression is of a magnitude similar to that of thiopental when propofol is administered as an IV bolus.
13. Arterial hypotension is the most common effect reported and is primarily a result of a decrease in systemic vascular resistance although negative inotropic effects have also been reported. This may be minimized by slow administration of the drug and the prior administration of fluids.
14. Respiratory depression, which is commonly reported after propofol administration, is also minimized by slow administration.

Etomidate

1. Etomidate, is a hypnotic sedative that has been used as an anesthetic agent in humans since the 1960s.
2. It is a weak base (pKa 4.24) and in the United States is available as a 2 mg/ml solution (pH 8.1) in 35 % propylene glycol.
3. Pain and hemolysis of red blood cells following administration are attributed to the hyperosmolar nature of the compound. These effects can be minimized by administration of IV fluids with etomidate.
4. The induction, dose ranges from 0.5-2.0 mg/kg, IV.
5. Premedication is highly recommended prior to etomidate administration to reduce the incidence of side effects (eg., myoclonus, vomiting).
6. Alternatively, or additionally, etomidate may be administered with a benzodiazepine.
7. As etomidate interferes with cortisol synthesis, administration of a physiologic dose of dexamethasone, or other short-acting glucocorticoid prior to etomidate use is suggested.
8. Because of etomidate's expense and the fact that many veterinarians are not familiar wvith its use, the drug is not extensively used in veterinary medicine.
9. However, it does offer significant advantage in the critically ill patient, especially the cat where other drug choices may be limited. This is due to minimal cardiopulmonary effects which include a transient decrease in heart rate and respiratory rate following administration.

Dissociative Agents

Ketamine (Ketelar®)

1. Ketamine hydrochloride, a weak base (pKa of 7.5), is a mixture of two Isomers.
2. It has been administered via IV, intramuscular (IM), oral and rectal transmucosal routes at a wide dose range which varies with species, route of administration, premedication, etc.
3. The dose of ketamine which produces anesthesia in dogs is very near to that which causes convulsions so, ketamine can't recommend as sole agent for canine anesthesia.
4. A very wide range of premedication may be used with ketamine as xylazine, promazine, acepromazine and diazepam.
5. A dose of 5-10 mg/kg IV is commonly utilized in premedicated small animal patients.

Doses:

Ketamine >> 5.5 mg/kg. IV or IM + xylazine >> 2 mg/kg IV or IM or

Promazine >> 2.75 mg/kg IV or IM

Such **Mixture** >> The onset of action following IV administration is 30- 45 sec., anesthesia for 30 minutes and recovery after >> 2 hours.

6. About 93% of the drug is absorbed within 20 min following IM administration whereas only 16 % is available 30 min after oral administration.
7. Recovery from a single dose is determined by redistribution and cumulative effects are seen with repeated dosing or high dose administration.
8. **In dogs,** ketamine undergoes N-demethylation to norketamine (10-20 % activity) and hydroxynorketamine which is then conjugated and excreted.
9. **In cats,** only norketamine is formed due to their limited ability to conjugate with glucuronyl transferase. Hence ketamine may have a prolonged effect in patients with the inability to excrete ketamine and its metabolite.
10. Its dissociative classification is due to its central effects which include thalamocortical depression and hippocampal and limbic activation.
11. Clinically these manifests as rigidity, muscle hypertonicity, seizure like behavior and, in humans, hallucinations in face of apparent lack of awareness, i.e., a dissociative state.
12. Benzodiazepines are frequently administered with ketamine to improve muscle relaxation and facilitate intubation.
13. Increases in intracranial and intraocular pressures are reported and ketamine may have seizurogenic properties.
14. An increase in sympathetic tone which is clinically manifested as an increase in heart rate, myocardial contractility and blood pressure is usually seen following ketamine administration. Due to this and a resulting increase in myocardial work and oxygen consumption, ketamine is best avoided in patients with restrictive or hypertrophic cardiac disease.
15. It should also be avoided in the hemodynamically compromised patient or one in which sympathetic tone is reduced because myocardial contractility may be depressed following drug administration in patients with depleted sympathetic reserve.
16. Respiratory effects include mild transient hypoventilation and hypoxemia unless excitement is observed during induction in which case an increase in respiratory rate is observed.
17. Pharyngeal and laryngeal responses may be maintained following drug administration. This coupled with increases in tracheobronchial and salivary secretions can make intubation more challenging especially in cats when ketamine is used as the sole anesthetic drug.

Tiletamine (Telazol®)

1. Available in powder form as a 1:1 mixture with the benzodiazepine, zolazepam; the reconstituted solution contains 50 mg/ml of each compound or 100 mg/ml of the combination and should be refrigerated.
2. The recommended dose based on the combination of drugs ranges from 3 to 10 mg/kg for IM or subcutaneous administration and 2 to 5 mg/kg. for IV administration.
3. Zolazepam reduces the incidence of muscle rigidity, excitement, and occasional seizure-like activity that can occur with tiletamine immobilization and the combination results in dose-dependent central nervous system depression.
4. Unlike ketamine which stings on IM injection, the response to injection following tiletamine/zolazepam is generally little or none.
5. Recumbence is usually observed within 5 to 10 minutes of intramuscular administration.

6. Prolonged sedation and/or residual ataxia may last 2 to 4 hours follow administration of doses greater than 5 to 7.5 mg/kg.
7. Hypothermia, hepatic or renal insufficiency and hypoxemia may contribute to residual effects.

Cardiovascular and respiratory considerations are similar to those listed for ketamine.

Opioids

1. While opioids are usually considered for their analgesic benefits, they are useful as anesthetic induction agents in specific circumstances.
2. Many opioids, including Fentanyl, Oxymorphones and Hydromorphone have been used IV for induction of anesthesia in the dog and while each individual drug is associated with a different pharmacokinetic profile, all the aforementioned opioids offer the benefit of cardiovascular safety.
3. While they do cause anticholinergic responsive bradycardia, they have minimal other cardiovascular effects.
4. However, they do have the potential to cause excitement and hypersensitivity to sound and are not recommended for routine use for induction in cats or normal, healthy dogs.
5. Rather they are typically used in combination with a benzodiazepine for induction of debilitated and/or cardiac patients.
6. **Dose** for intravenous induction using fentanyl is 10-20 µg/kg and for oxymorphone and hydromorphone is 0.1 -0.2 mg/kg.
7. **Onset** of action of fentanyl tends to be quicker than for the other two drugs and most patients can be intubated within one minute following administration.
8. As laryngeal tone is well maintained, topical application of a local anesthetic may be used to facilitate intubation.
9. Due to the long induction time and as a result of drug induced respiratory depression, hypoxemia is likely and pre-oxygenation is highly recommended prior to opioid inductions and mechanical ventilation following intubation is suggested.
10. When using a balanced anesthetic technique for maintenance of anesthesia, the induction dose also serves as the loading dose prior to the maintenance infusion and provides a major portion of the analgesic component of the balanced technique of general anesthesia.

Injectable Anesthesia in Dogs and Cats

IV injection usually carried out in the cephalic vein but may injected in the Tarsal v., Femoral v., Jugular vein and in anaesthetized subjects the Sublingual veins may be used for intravenous injection.

A. Cephalic vein: In the fore limb, it must be carried out under the usual aseptic precaution so, must clip hair over the vein and disinfection.

B. Recurrent tarsal vein: On the lateral aspect of the hind leg just above tarsus. The recurrent local vein is more prominent than the cephalic vein but it more mobile >> so, more difficult.

C. Femoral vein: In the middle part of the medial aspect of the thigh, it is Obvious by pressure on the inguinal region (avoid femoral a. beneath it).

CLINICAL ANESTHESIA IN DOGS AND CATS

DOGS

Premedication	Dosage (mg/kg)	Induction in dogs	Dosage (mg/kg)
Acepromazine	0.025 (large dog) 0.2 (small dog)	Thiopental	12.0
Acepromazine **Meperidine**	0.03 to 0.1 IM 3 to 4 IM	Thiopental	12
Acepromazine **Butorphanol**	0.03 to 0.1 IM 0.3 to 0.4 IM	Thiopental	12
Acepromazine **Morphine**	0.03 to 0.1 IM 0.5 to 1.0 IM	Thiopental	10
Heavy (eg, ace + oxymorphone or e.g., xylazine + butorphanol or e.g. Telazol 4 mg/kg		Thiopental	2 to 4
None or acepromazine or butorphanol or buprenorphine		Diazepam Ketamine	0.2 0.5
None		Propofol	6 to 8
Mild (acepromazine)		Propofol	4 to 5
Moderate(opioid)		Propofol	3 to 4
Heavy (e.g. ace + oxy, or medetomidine)		Propofol	1 to 2
Diazepam **Oxymorphone**	0.2 IV 0.1 to 0.2 IV	Intubate or facemask with iso or halothane	

CATS

Acepromazine **Butorphanol**	0.1 IM 0.2 to 0.4 IM	Thiopental	8 to 12.0
None or acepromazine and/or butorphanol		Diazepam Ketamine	0.2 5.0 (= 1 ml/10 kg using 50:50 mixture).
Butorphanol **Midazolam**	0.2 IM 0.2 IM	Face mask induction or ketamine IV.	
Mild (e.g. acepromazine)		Propofol	4 to 6

Telazol (100 mg/ml)	4 to 4.4 mg/kg	Telazol, if needed	2
Acepromazine **Ketamine (100 mg/ml)**	0.1 6	Ketamine	2 to 4

*** Atropine 0.04 mg/kg IM recommended**

Injectable Anesthesia in Horses

Site of injection in Equine: **Jugular vein.**

Barbiturate Bolus

- All barbiturates used as anesthetic, are prepared from sodium salts and available as powder to dissolve in water or saline and are strongly alkaline.
- Long-acting barbiturates is for 6-8 hours, medium acting barbiturates is for 4-6 h, short acting barbiturates is for 3 hours while ultrashort acting barbiturates is for about 15 minutes.

Examples of Barbiturates include:

a. Thiopentone sodium (Pentothal® / Nesdonal®).

b. Thiamylal sodium (Surital®).

c. Methohexitone sodium (Brietal Sodium®).

d. Pentobarbitone sodium (Nembutal®, Sagatal).

Actions of barbiturates

1. Depress CNS so, used for hypnosis and sedation but ultrashort acting barbiturates given IV used as anesthetic.

2. They are potent respiratory depression and depress the sensitivity of respiratory center to Co2.

3. No effect in normal doses on cardiovascular or GIT in anesthetic

Dose >> hypertension & decrease rate and motility of G.I.T.

4. Anticonvulsant.

5. Not effect on uterus but placental barrier.

Clinical effects

1. A rapid bolus injection (15 seconds) of thiopental Na (Pentothai; Dipentol, Nesdonal) produces light surgical anesthesia for approximately 10 minutes. [Note that injecting too fast, e.g. 5 seconds, will result in deep anesthesia and apnea].

2. Direct depression of central respiratory centers.

   a. Response to carbon dioxide stimulation is depressed.
   b. Tidal volume is decreased, whereas respiratory rate may be increased.
   c. Arterial pO_2 is consistently lower in horses anesthetized with barbiturate bolus than with any of the other drug combinations already described.

3. Myocardial contractility is reduced with a corresponding fall in cardiac output. Peripheral resistance is increased.

4. The dose of **Thiopentone** in horses is **1 gm/90 kg b. w**. into the jugular vein of unrestrained horse, Horse sinks to the ground 20-30 second of injection. Surgical anaesthesia persists for 3-4 minutes and complete recovery after 35-45 minutes.

5. Perivascular injection of barbiturate (pH 10.8) will result in tissue necrosis Immediately infiltrate with lidocaine (without epinephrine) to precipitate the barbiturate and 200-300 ml saline to dilute it to reduce tissue damage.

6. Recovery usually associated with ataxia and repeated attempts to rise.

Xylazine-Ketamine

Behavioral effects

1. Ketamine causes dissociation of the CNS and the signs and stages of anesthesia cannot be compared with barbiturates or inhalation anesthetics.

2. Ketamine administered alone to the horse causes excitement.
3. Ketamine is not used by IM injection in the conscious horse because the horse may be injured during the period of incoordination occurring while the drug is taking effect.
4. Biologic half-life of ketamine is 45 minutes in the horse, with 99% of a bolus dose eliminated in 4 hours. Recovery to consciousness is due to extensive extravascular distribution of the drug.
5. Ketamine is injected 3-5 min after xylazine. Good sedation must be apparent. Induction of anesthesia occurs about 44 seconds after ketamine injection. Horse falls to the ground characteristically with the forelimbs buckling and the hindlimbs straight. The person holding the horse's head should exert steady backward pressure on the horse during loss of consciousness in an attempt to make the horse sit on its hindquarters and not fall on its nose.
6. Xylazine-ketamine anesthesia is accompanied by strong muscle tone bas for the first 5 minutes, and usually nystagmus, a strong palpebral reflex, and pupillary dilation.
7. The **Duration** of anesthesia varies from 7 min to 20 min. Anesthesia is often short in young horses and in Thoroughbreds.
8. The major **Advantage** of this combination is that recovery is usually smooth, with less incoordination than is seen with thiobarbiturate or guaifenesin combinations. The horse is usually standing 30-40 minutes following a single administration of xylazine and ketamine
9. **The Dose** of ketamine is > 2.2 mg/kg rapid IV. **Recumbency** is within in 85 t 30 seconds. **Recovery** within >> 35 minutes.

Respiratory effects

10. Respiratory rate about 10/min, mild decrease in volume.
11. $PaCO_2$ increase, PaO_2 mild decrease (to 70-75 mmHg).

Cardiovascular effects

12. Cardiac output decreases 30%.
13. Vasoconstriction maintains blood pressure. Pressure immediately after induction of anesthesia is usually similar to that of a conscious non-sedated horse.

Modifications of the xylazine-ketamine combination

a. Detomidine – Ketamine.
b. Xylazine – Ketamine – Acepromazine.
c. Xylazine – Ketamine – Butorphanol.
d. Xylazine – Ketamine - Diazepam.
e. Xylazine – Ketamine - Guaifenesin.
f. Xylazine – Zolazepam – Tiletamine (Telazol).

Prolongation of anesthesia

a. Additional IV injections of one-third initial xylazine and ketamine dose provide about 12 min anesthesia's.
b. Xylazine and ketamine added to a bottle of guaifenesin and administered as a continuous infusion.
c. Infusion of guaifenesin and thiobarbiturate is less desirable but can be used.
d. Inhalation anesthesia.

Xylazine-Guaifenesin-Ketamine

Behavioral effects:

1. Better muscle relaxation than with xylazine-ketamine alone.
2. Duration of anesthesia Is predictable since the duration of action of GG exceeds that of ketamine.

Cardiopulmonary effects

3. Mean arterial pressure is lower than xylazine-ketamine alone, but cardiac output and arterial oxygenation are comparable.

Guaifenesin (Glyceryl Guaiacolate®, GG):

Behavioral effects

1. Produces **muscle relaxation** by **depressing polysynaptic impulses in the spinal cord.** For this reason, GG is used as an induction agent to relax the animal and reduce risk of injury during falling to the ground. In comparison, GG can be used in the dog, but there is no reason to, since induction is not a problem.

2. It is thought that GG produces mild sedation, but it is not an anesthetic. However, because it paralyzes the animal, less anesthetic drug can be used. Therefore, respiratory depression is less in the horse anesthetized with GG-barbiturate than with barbiturate alone, and recovery is slightly more coordinated.
3. GG improves ketamine anesthesia. The duration of ketamine in the horse is unpredictable, varying from 5 to 20 minutes. GG confers a more predictable duration of immobilization. GG also provides more muscle relaxation than is produced by ketamine alone.

Respiratory effects

4. Respiratory rate increases and tidal volume decreases, but the degree of Ventilatory depression is dose related. It is also influenced by concurrent administration of other drugs, eg, the addition of barbiturate.

Cardiovascular effects

5. The effect of GG alone on the cardiovascular system depends on the dose administered. With careful administration, GG produces minimal CV changes. However, GG can produce severe hypotension with large doses.

Other effects

6. In horses, a 10% solution of guaifenesin produces minimal hemolysis. A 10% solution of guaifenesin in water has an osmolality of 242 mOsm/kg, which is closer to the osmolality of equine plasma than a 5% solution, or guaifenesin in 5% dextrose.
7. GG crosses the placenta, but appears to be metabolized by the newborn. GG has proven a useful adjunct to fetal manipulation at parturition and in anesthesia for caesarian section.
8. GG is metabolized and the metabolites excreted by the kidney. No unchanged GG is detected in the urine.
9. Duration of guaifenesin in male horses is 1.5 times that in mares.
10. There is no sex difference in dosage

N.B.

1. A large volume must be administered as quickly as possible. Either a large venous catheter and wide-bore infusion set must be used, or the bottle pressurized.
2. Solutions of GG are irritant to tissues. The higher the concentration used, the worse the tissue damage from perivascular extravasation. A 5% solution will cause some irritation, but 7.5% and 10% cause severe irritation. Immediate infiltration of 200 to 300 ml of saline in the area of perivascular injection may avoid tissue necrosis.
3. Perivascular injection is less likely if a catheter is used.
4. Guaifenesin has a delayed onset of action of about 3 minutes. This must be taken into account during its administration.
5. Use of guaifenesin alone is not advisable in any except the very depressed horse. Without barbiturate or ketamine, the horse appears to retain consciousness and resist casting, with the result that excessive amounts of guaifenesin are administered in an attempt to induce muscle relaxation. With overdose of guaifenesin, the horse becomes stiff. ventilation is impaired, and blood pressure decreases.
6. A 10% solution may precipitate, especially if barbiturate has been added. The solution should not be used if precipitate is present.
7. Warming the solution may dissolve the precipitate. One commercially manufactured product is now available in prepared liquid form that does not have this problem.

Sedation-Guaifenesin-Thiopental

Clinical effects:

1. A single administration will provide about 20 minutes of general anesthesia.
2. The horse should be standing by I hour after administration.
3. Ventilation is depressed.
4. Cardiac output and blood pressure are depressed. Heart rate may be elevated for 10 minutes after induction.

Administration:

1. The horse is premedicated with either acepromazine or xyiazine. The guaifenesin and thiobarbiturate are then administered by one of 2 ways:
   a. Guaifenesin and either thiopental or thiamyial are mixed together in the same bottle and administered by IV infusion. The horse becomes recumbent after half the calculated dose has been given Further solution is infused to achieve the desired effect or up to the full calculated dose.
   b. The guaifenesin and barbiturate are administered separately.

      Approximately half of the calculated dose of guaifenesin is infused and immediately the barbiturate is injected IV as a bolus over 5-15 seconds. The horse will fall down in 30 seconds.

      Additional guaifenesin is infused to achieve the de red degree of relaxation.

2. Anesthesia can be prolonged by the intermittent administration of GG- barbiturate mixture, or GG alone. The main limitation to continued administration of intravenous anesthetics is the arterial oxygenation. It has been recommended that IV anesthesia should not be prolonged beyond 45 minutes in an adult horse without supplying the horse with oxygen to breathe. Any procedure which is anticipated to last longer than 1 hour should not be done with GG- barbiturate anesthesia alone. While it is true that progressive collapse of the down lung occurs with time, thus increasing the ventilation- perfusion mismatch and decreasing arterial oxygenation, this can be an unreliable guideline. One horse can be anesthetized and breathing air for an hour or more and have acceptable levels of oxygen and carbon dioxide, whereas another horse will become hypoxemic within 10 minutes.

Indications and Drug Dosages for Local and Regional Anesthesia Techniques

Technique	Indications	Drugs, Dosages, Equipment (use lower dose range in cats)	Notes
Infiltration anesthesia	Minor lacerations, mass excisions, surgical incision site analgesia	• 2–5 mg/kg 2% lidocaine or 5–8 mg/kg 2% lidocaine plus epinephrine and/or 1–2 mg/kg 0.5% bupivacaine subcutaneously • May increase volume by dilution up to 33% with sterile saline solution • Sterile 22- to 25-ga, 1-in hypodermic needle and syringe	• Avoid IV or intra-arterial injection. • Avoid epinephrine when blocking ears, tails, and distal extremities. • Avoid injecting near tumors or abscesses.
Splash blocks	Direct application to the body wall, peritoneum, or ovarian ligaments	• 4 mg/kg 2% lidocaine or 2 mg/kg 0.5% bupivacaine topically • Sterile 22-ga, 1-in hypodermic needle and syringe	Do not flush the area after application of local anesthetic.
Digital nerve blocks	• Digit surgery • Feline onychectomy	• 0.2–0.4 mg/kg of 0.5% bupivacaine subcutaneously at each site or inject local anesthetic in a ring proximal to the carpus or digit • Sterile 22- to 25-ga, 1-in hypodermic needle and syringe	Avoid using epinephrine.
Intravenous regional block (Bier block)	Surgery of the distal limbs; digit amputation; mass removal or biopsy, wound repair	• 2.5–5 mg/kg (dogs), 2–3 mg/kg (cats) 2% lidocaine; or 1–2 mg/kg (dogs), 1 mg/kg (cats) 1% mepivacaine • +/- morphine 0.1 mg/kg or buprenorphine 0.01 mg/kg • +/- medetomidine 0.5 µg/ml of local anesthetic; alternatively, dexmedetomidine may be used at 0.25 µg/ml of local anesthetic* • Sterile 18- to 22-ga IV catheter and tourniquet or sphygmomanometer cuff	• Bupivacaine should never be used. • Ischemic damage to tissue is possible if the tourniquet is left on > 90 minutes. • Rapid systemic uptake of local anesthetic is possible if the tourniquet fails, resulting in possible toxicosis.
Localized continuous or intermittent local anesthetic delivery (soaker-type catheter)	After limb amputation or large tumor resection, or to palliate painful but nonresectable lesions	• 1–2 mg/kg/hr lidocaine or mepivacaine for continuous administration • 1–2 mg/kg bupivacaine for intermittent administration (every four to six hours) • Soaker-type catheter and elastomeric or electronic reservoir or syringe pump	• Avoid toxic doses. • Intravascular or intraneural anesthetic administration, infection, and hematoma formation are potential complications. • Keep in place one to three days; can be longer with strict aseptic technique.

* The medetomidine and dexmedetomidine dosages are based on the authors' clinical experience. The authors also note that the effective minimum dosages have not been determined, but doses less than 1 µg/kg (total) of medetomidine or dexmedetomidine should be safe in patients with cardiovascular stability.