# Anesthesiology

# التخـدير

**By Staff Members**

**Our website**
**http://veterinarysurgery.itgo.com**

# Table of contents


| | Contents | Page | Page |
|---|---|---|---|
| | **Anesthesiology** | **3** | **108** |
| **I** | **Local analgesia** | **7** | **22** |
| **II** | **Regional analgesia** | **23** | **57** |
| **III** | **Pre-anesthetic medication** | **58** | **72** |
| **IV** | **Basal narcosis** | **73** | **75** |
| **V** | **General anesthesia** | **76** | **108** |
| | **REFERENCES** | | |

# ANESTHESIA

Satisfactory anesthesia is very important for both humanitarian and technical efficacy. Humanity ensures gentle handling of the animal with minimal restraint to minimize possible injury to the animal. Technical efficacy is not restricted to facilitation of the procedure to be carried out on the animal. It must also take into account the protection of personnel from biting, scratching, kicking, and accidental self-injection by sedative or addictive drugs or possible harmful effects of breathing low concentrations of inhalation anesthetics.

The veterinary anesthetist deals with variety of animal species that exhibit variation in size, temperament, and anatomical and physiological development. Response to anesthesia not only varies according to species and breed, but it also varies among individuals of the same breed. Fear and aggressive reaction of animals to casting (prior to anesthesia) and struggling to escape breathing irritant gases, increase the difficulty of anesthetic administration and brain activity that in turn affect the amount of required anesthetic.

Accordingly, sedatives and tranquilizers are used as pre-anesthetic agents to reduce brain activity, fear and struggling to reduce anesthetic dose and to help smooth induction and recovery of anesthesia.

## TERMINOLOGY

***1-Anesthesia: -***

It is the art and the science related to production of insensibility.

***2-General anesthesia: -***

It is a state of unconsciousness as a result of controlled reversible intoxication of the central nervous system, and characterized by loss of sensitivity to external stimuli and motor response to such stimuli.

***3-Anesthetic agent: -***

It is the substance that produces controllable loss of consciousness and absence of motor response to noxious stimuli.

***4-Analgesia: -***

It is the art and the science related to abolish awareness of pain.

***5-Local analgesic: -***

It is a substance, that when applied to the nerve endings or nerve fiber, temporarily prevents the conduction of impulses by the nerve.

***6-Local analgesia: -***

It is the loss of sensation in a limited area of the body by blocking the nerve endings in this area.

***7-Regional analgesia: -***

It is the loss of sensation in a limited area of the body by blocking the major nerve(s) to this area.

***8-Narcotic agent: -***

It is the substance that produces a state of deep sleep (loss of consciousness) that may or may be not accompanied by analgesia. Accordingly all anesthetic agents are narcotic but many narcotics are not anesthetics.

***9-Hypnotic agent: -***

It is a narcotic agent that produces a sleep like state due to moderate depression of the central nervous system, from which the animal can easily be awakened by wide variety of stimuli.

***10-Sedative: -***

It is a narcotic agent that causes mild depression of the central nervous system. The animal is awake, but less alert, and unaware of its surroundings. It can be used to calm a nervous, excited, or vicious animal.

***11-Ataractic or tranquilizer: -***

It is a drug with a predominant action in relieving anxiety without producing drowsiness.

## AIMS OF ANESTHESIA

1-Humanity point of view like prevention of pain during surgical interference

2-Creation of a safe state under which the surgeon and assistants can work

## EXAMINATION OF THE ANIMAL

The general condition of the animal should be evaluated and recorded prior to anesthesia and surgery, including history, temperature, pulse rate, and respiration rate etc….

## PREPARATION OF ANIMAL FOR ANESTHESIA

1-Fastening 24 hours prior to operation

2-Fluid therapy according to animal state

3-Preanesthetic medication according to the nature of anesthesia, surgery, and animal species

# TYPES OF ANESTHESIA

**I-Substances have selective transient paralytic action on sensory nerves**

**1-Local analgesia**

A-Surface application
- i-Topical application
- ii-Intra-synovial analgesia

B- Infiltration analgesia
- i-Intra or sub-dermal infiltration
- ii-Linear infiltration analgesia
- iii-Field block analgesia
  - 1-Cup shape
  - 2-Inverted-L block
  - 3-Ring block

C- Intravenous regional analgesia

D- Local analgesia for fractures

**2-Regional analgesia**

A-Peri-neural nerve block
- i-Peripheral nerve block (head and limbs)
- ii-Paravertebral nerve block (trunk)

B-Spinal analgesia
- i-Epidural analgesia
  - 1- Caudal epidural
  - 2- Lumbar epidural
- ii-Intra-thecal analgesia or sub arachnoid

**II-Sedation, narcosis, and pre-anesthetic medication**

A-In combination with local or regional analgesia

B-In adjunction to general anesthesia

**III-Substances have depressant paralytic action on the CNS producing progressive loss of consciousness and voluntary motor function (general anesthesia)**

A-By inhalation (volatile anesthesia)

B-By intravenous injection

C-By combination of the mentioned types with or without premeditation

# General Considerations in Selecting Anesthetic Method

## 1-Nature and magnitude of the operation

Local infiltration is sufficient for simple interferences like incision of superficial abscess or neoplasm, or castration in immature animals. However some simple surgical operations can't be performed by local infiltration as a result of severe fibrosis, temperament of the animal, or severity and intensity of surgical procedure.

## 2-Site of operation

Presence of some critical structures in vicinity of site of operation may render local infiltration insufficient as the movement of the animal may endanger his life, and the example is the surgery for retropharyngeal abscess.

## 3-Duration of operation

The duration of operation affects the choice of anesthetic method, especially when adopting general anesthesia. Short-duration, simple dental operations, can be performed by using ultra-short acting barbiturates, while longer interferences can be performed by using longer-acting barbiturates with local analgesia, or inhalation anesthesia. Pre-anesthetic medication should be considered when the operation is a major operation with long duration and it is required that the animal remain quite for several hours after surgery. Pre-anesthetic medications not only reduce the amount of anesthetic agent and increase duration of anesthesia, but also control undesirable effect of some anesthetics like salivation.

## 4-Species and breed of animal

Not only size and temperament of the animal affect the choice of anesthetic method, but also the anatomy and physiology of some species affect that choice. Generally the larger size animals have greater difficulties and dangers in induction and maintenance of general anesthesia. The safe satisfactory methods for general anesthesia in pets may be unsuitable for large animals, especially for heavy vigorous one, as the upset of locomotor coordination and prolonged recumbency may entail risks.

## A-The Horse

The animal should be adequately restrained to ensure safety of the veterinarian and the animal himself. Casting methods of conscious animal

and frightening expose him to injury, accordingly, many muscle relaxant drugs can be used to induce casting without endangering the animal.

### B-Ruminants

Generally they are unsuitable candidate for inhalation anesthesia unless endotracheal tube is used, but under field condition, light general anesthesia by intravenous injection has satisfactory results. However the simpler regional analgesic techniques in this species and side effects of general anesthesia make regional anesthesia more popular in these species.

### C-The Dog

General anesthesia has a high degree of perfection in this species that make this method so popular for veterinarians not only for surgery but also for examination procedures in the animal.

### D-The Cat

Cat is a difficult subject to be anesthetized quietly and safely as restraint provokes violent struggling. Accordingly cat should be handled quietly with minimal restraint then general anesthesia can be induced by slow intravenous barbiturate.

## I-LOCAL ANALGESIA

Many surgical procedures can be satisfactorily performed under the effect of local analgesia. The use of sedation with this technique depends up on the species, temperament, and health of the animal, and magnitude of the operation. Sedation should be avoided in surgical procedures when the animal should not lie down, but sedation could be used when reduction of fear and liability of sudden movement is required for achievement of efficient surgery. Moreover, the dose of sedative drug must be reduced on using certain types of local analgesics like lignocaine as it has systemic sedative effect following its absorption.

***Advantages: -***

1-It is suitable for performing surgery on standing animals, accordingly injuries associating casting and prolonged recumbence can be avoided.

2-The technique is simple and requires no expensive or complicated equipment.

3-The technique can be performed by the surgeon himself with no need for anesthetist.

***Disadvantages: -***

1-Injection shouldn't be performed in infected area to avoid spreading of infection.

2-Direct injection of the drug at seat of incision causes delay of healing as a result of histotoxic effect of the drug.

3-The amount of used local analgesic drug is relatively higher than other methods like perineural analgesia, accordingly the cost increases.

## LOCAL ANALGESICS

***Desirable characteristics of local analgesic agents: -***

1-It should has good penetrating qualities through body tissues

2-It should has rapid onset

3-It should be potent so that low concentrations can be used

4-It should has long duration of action

5-It should has low systemic toxicity

6-It shouldn't be irritant to nerve and other body tissues

7-It should has reversible action

8-It should be available in sterile solution or it can be easily sterilized

***Potentiation by vasoconstriction: -***

Addition of vasoconstrictor (epinephrine) to local analgesic, at concentration of 1:200,000 allows prolonged analgesic effect by vasoconstriction and delaying absorption of the drug. The maximum safe concentration of epinephrine is 1:50,000; greater concentrations may cause local tissue ischemia and necrosis, accordingly these agents shouldn't be used in extremities, tail, or teat, etc…to avoid the possibility of ischemia and subsequent necrosis and gangrene. The exception to this rule is the epidural analgesia where concentration up to 1:10,000 may be safely used. Generally the used of analgesic agents that contain vasoconstrictor is contra-indicated in injured tissue as this tissue might be already ischemic and the further injection with epinephrine may deteriorate the condition of the ischemic tissue and causes gangrene.

***Potentiation by hyaluronidase: -***

Hyaluronidase is a mucolytic enzyme that hydrolyses hyaluronic acid that is known as the ground substance preventing diffusion of drug in the tissues. Incorporation of that chemical substance in the analgesic solution

facilitates diffusion and penetration of the analgesic drug into the tissue and accordingly the drug will acquire faster on set.

***Advantages: -***

1-It promotes diffusion and absorption of the local analgesic with which it is mixed

2-It is of particular value in nerve block, especially if the analgesic didn't deposited accurately around the nerve

***Disadvantages: -***

1-Toxicity although the ratio of toxic to therapeutic dose is 200:1

2-Reduction of analgesia duration

3-Increased toxicity by analgesic drug itself as a result of rapid absorption

Generally, the last two disadvantages can be counteracted by addition of epinephrine to the solution

# AVAILABLE LOCAL ANALGESICS

## A-Minor Local Analgesics

### 1-Ethyl Chloride

It is a topical local analgesic, marketed under pressure in containers with a fine capillary nozzle and a control valve that allows the liquid to be sprayed. It has a very superficial and transient analgesic action, and when it is sprayed on the skin, it evaporates leading to freezing of the skin (-20ºC) with induction of surface analgesia for 30-60 seconds. Its use is limited to simple incisions or punctures such as incision of abscess or hematoma.

### 2-Ethyl Alcohol

Injection of absolute alcohol around a nerve produces neuritis, degeneration, and sclerosis, however, 30% alcohol temporarily destroys sensory nerves that regenerate again after a variable period, and nerve function will return by then. Duration of block depends on;

*1-The size of the nerve*

*2-Degree of destruction*

Small-unsheathed nerves may be permanently destroyed, whereas, large heavily sheathed nerves are only temporarily affected.

# B-Major Local Analgesics

Cocaine was the first available local analgesic, but its toxic effect and addictive properties in human restricted its use and availability. Nodaway, many new generations of local analgesics are available, and they vary according to their potency, toxicity and cost. The present three categories are classified according to duration of analgesic action.

| | Analgesia duration | Drug | Duration |
|---|---|---|---|
| 1 | Short | Procaine | 30-60 minutes |
| 2 | Intermediate | Lidocaine and mepivacaine | 90-180 minutes |
| 3 | Long | Tetracaine and bupivacaine | 180-300 minutes |

## 1-Short Duration Analgesic

## Procaine H Cl

Procaine H Cl is a white, crystalline, water-soluble powder

***Advantages: -***

1-Its subcutaneous injection has an efficiency approximating that of cocaine, but it has lower toxicity especially when adrenaline H Cl is added (10 times less toxic)

2-It is non-irritant 3-Relatively stable solution

4-It can be sterilized repeatedly by boiling without loss of potency

5-It is rapidly and completely detoxicated by the liver when absorbed slowly from injection site (ensured by adding adrenaline), so that a second infiltration can be carried out in the course of an hour without a danger of toxicity by cumulative arising.

***Disadvantages: -***

1-Toxic when injected intravenous 2-It has low power of penetration

3-It cannot be used for topical application or intra-synovial analgesia as it has very low power of penetration of mucous membrane

4-Decomposed by alkali

***Concentration, on set, and duration: -***

| Use | Concentration | On set | Duration |
|---|---|---|---|
| General infiltration | 2 % | 5 minutes | 1 hour |
| Epidural injection | 1-2.5 % | 10 minutes | |
| Perineural use in horses and cattle | 4-5 % | 10 minutes | |

## 2-Intermediate Duration Analgesic

## A-Lignocaine- Lidocaine H Cl (Xylocaine® or Debocaine®)

***Advantages: -***

1-It is extremely stable solution and can be boiled with acid or alkali

2-It can be sterilized several times even by autoclaving

3-Its onset is twice faster than procaine

4-It has longer duration of action than procaine (90 min alone and 120 min with epinephrine)

5-It has a sedative effect when injected in a large amount and so the dose of tranquilizer must be reduced

6-It has higher penetration power than procaine and so it is preferred in perineural injection and it is unnecessary to add hyaluronidase to it neither for infiltration nor for nerve blocking purposes

7-It can be used for surface analgesia by intra-synovial injection, or topical for the cornea, or mucous membranes (4%), particularly those of the throat and larynx, prior to endotracheal intubation

***Disadvantages: -***

1-It may cause some local irritation and swelling, which is particularly a problem in the horse.

2-Toxicity happened by over dose that is expressed by drowsiness, twitching and respiratory depression, and finally convulsions and hypotension.

Accordingly the toxic dose is known to be

| Animal | Dose in gm | Dose in ml (2%) |
|---|---|---|
| **Horse and cattle** | 6 | 300 ml 2 % |
| **Dog** | 0.6 | 30 ml 2 % |

***Concentration: -***

1-General infiltration (0.5:1 % without vasoconstrictor)

2-Epidural and nerve block (2% with or without vasoconstrictor)

## B-Mepivacaine H Cl or Carbocaine (Mepacaine®)

This compound closely resembles lignocaine H Cl, and widely used for human dentistry. It is widely used in the horse as it causes very little

swelling and edema in the area of injection, possibly as it lacks vasodilatory action.

***Advantages: -***

1-It is slightly less toxic, even slow intravenous injection over 20 minutes in dog by a dose of 29 mg/kg, produces convulsion that is followed by sedation

2-It has no vasodilatory effect, making the addition of a vasoconstrictor unnecessary. However, a commercial product with levonordefrin is available in market (Mepacaine-L®).

***Concentration: -***

For infiltration and nerve block (1-2%) is satisfactory, but generally it is available as ampoules of 1.8 ml of 2 % Mepivacaine H Cl with or without levonordefrin.

## 3-Long Duration Analgesic

## A-Tetracaine H Cl (Pontocaine®)

***Advantages: -***

1-The onset of analgesia is 5-10 minutes

2-It is 12 times potent than procaine

3-Lesser interference with corneal healing than other agents, so it is the drug of choice for corneal analgesia

***Disadvantages: -***

1- It can't be autoclaved

2- Its toxicity 10 times that of procaine

***Concentration: -***

For the eye (0.2% for 120 min)

For infiltration and nerve block (0.1%)

## B-Bupivacaine H Cl (Marcaine®)

***Advantages: -***

1-Stable solution on boiling with acid and alkali and shows no change on repeated autoclaving.

2-Represented in different concentrations with or without adrenaline

3-More potent 8 times than procaine and 4 times than Lidocaine H Cl so it is used as 0.5 % solution

4-It has greater margin of safety than lignocaine

5-Onset is similar to lignocaine but its effect lasting for 4-6 hours (twice longer period of analgesia). Accordingly it is indicated for use in situation where prolonged analgesia is required like relief of pain in equine during acute laminitis.

6-This drug has a prolonged duration of action therefore it is used whenever long action is required (post-operative analgesia; prolonged surgery etc)

***Concentration: -***

| Aim of use | Concentration |
|---|---|
| **Infiltration** | 0.25% |
| **Nerve block** | 0.5% |
| **Epidural analgesia** | 0.75% |

## Toxicity of local analgesic

Toxic reactions to local analgesic drugs arise when;

1-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 hyperaemic or inflamed tissue and the rate of absorption is increased by the use of solutions which contain spreading agents such as hyaluronidase.

2-Accidental intravenous injection

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: -***

It is caused by decrease cardiac output due to depression of the myocardium. It characterized by sudden collapse, pale mucous membrane, hypotension and tachycardia.

***Treatment: -***

Vasopressors administered intravenously will overcome the hypotension

***B- The central nervous system type of reaction: -***

Usually, sedation is the first obvious sign but a further increase in the brain concentration produces tonic-clonic seizures.

***Treatment: -***

Barbiturates are used to counteract the convulsive action of the local analgesic.

# TYPES OF LOCAL ANALGESIA

## I-SURFACE ANALGESIA

### A-Topical analgesia

Surface analgesia can be produced by freezing of superficial layers of skin by ethyl chloride, ether, or carbonic acid snow, as a result of their rapid volatilization. Their action is superficial and transient, and their use is limited to simple surgical interferences like incision of an abscess. Excessive use may lead to necrosis, and the thawing after their use is painful in man. Surface analgesia can be performed by using lignocaine ointment that is applied by skin friction for relief of pruritis. Surface analgesia may be performed by using lignocaine 2% aqueous solution topically for relief of superficial abraded or eczematous area. Surface analgesia of mucous membrane of the glans penis and vulva can be produced by topical use of lignocaine 2% aqueous solution. Surface analgesia of urethral mucous membrane can be adopted by lignocaine 2% gel that works as lubricant and analgesic. Surface analgesia of the nasal mucous membrane can be performed by lignocaine 4% spray for trans-nasal passage of stomach tube in dog or for surgical procedures of the nasal chamber in the horse. Surface analgesia of the cornea can be performed by topical instillation of 4% lignocaine or 0.2% Tetracaine®.

### B-Intra-synovial

Surface analgesia is also employed for the relief of pain arising from pathological conditions involving joints and tendon sheaths. Surface analgesia of the joints can be performed by intra-synovial injection of 2 % lignocaine. The local analgesic is injected into the synovial cavity and then dispersed throughout the cavity by manipulation of the limb. If the synovial cavity is distended with fluid, it is first drained to ensure that the injected solution is not excessively diluted. Analgesia develops within 5 to 10 minutes after injection and persists for about 1 hour. The injection renders the synovial membrane insensitive but it is not known whether the nerve endings in the underlying structures are affected.

***Uses: -***

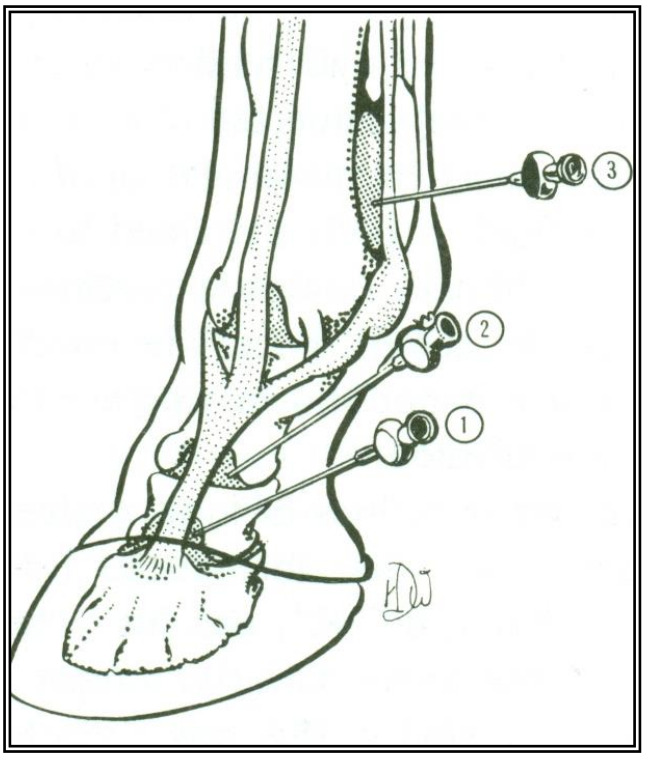
1-Therapeutic, like relief of pain during arthritis

2-Diagnostic, for diagnosis of arthritis or lameness (therapeutic diagnosis)

## 1-Intra-articular injection

### A-Horse

***1-The distal interphalangeal joint (pedal or coffin joint): -***




A 20 gauge needle 7 to 10 cm long is inserted about 2 cm above the coronary band and 2 cm away from the midline, and directed onwards in a medial direction to contact the second phalangeal bone. It is run downwards over the surface of this bone until synovial fluid flows from it. About 5 ml of solution are injected and the horse is then walked to distribute the injected fluid throughout the joint. By diffusion the synovial membrane around the navicular bone is also affected. The horse's foot should be held off the ground while the needle is being inserted in order to facilitate entry into the joint.

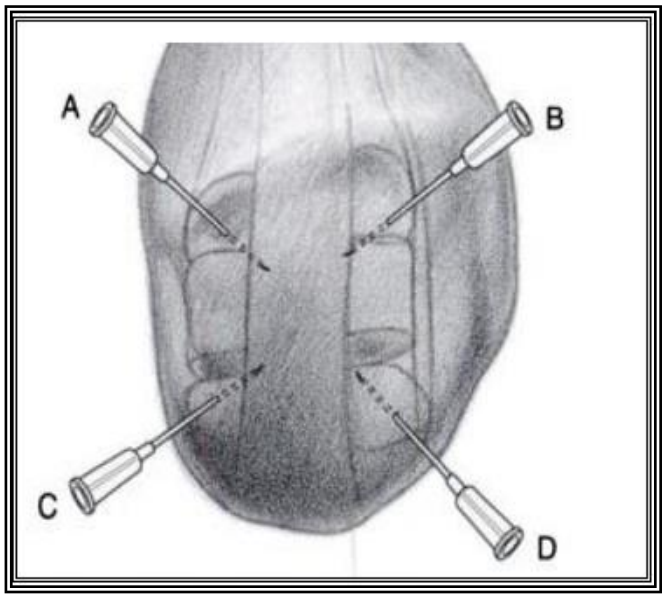
***2-The proximal interphalangeal joint (pastern joint): -***

The limb is held up and flexed, a 20 gauge needle is inserted 1 cm proximal to the joint space in the midline, or slightly paramedian, and directed horizontally or slightly distally into the joint space. 5 ml of the local analgesic is enough to anaesthetize the pastern joint.

***3-The metacarpo-phalangeal/metatarso-phalangeal joint (fetlock joint): -***

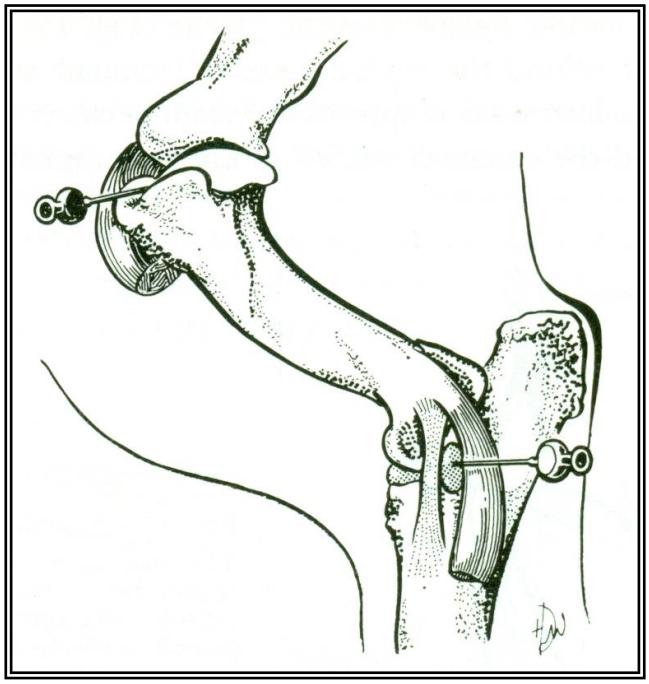
This joint is anaesthetized by 10-15 ml local analgesic. A 20 gauge needle is inserted in the Proximopalmar or proximoplantar pouch of the joint capsule in the triangular space formed by the third metacarpal / metatarsal bone, the proximal sesamoid bone and the suspensory ligament immediately proximal to the condyle of the third metacarpal/metatarsal bone. This injection is made while the horse is standing on the limb.

***4-The carpal joint: -***




Only the proximal (radiocarpal) and middle (intercarpal) joints need to be injected since the dista1 (carpometacarpal) joint communicates with the middle one between the third and fourth carpal bones. Both joint cavities can easily be palpated when the limb is flexed. A 20 gauge needle is inserted in the dorsal aspect of each joint, medial or lateral to the extensor carpi radialis tendon. 10-15 ml of local analgesic is injected in each joint.

***5-The elbow joint: -***

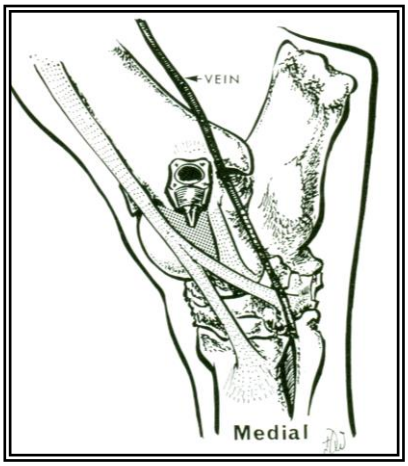


This joint is entered either in front of, or behind its lateral ligament. This ligament can easily be palpated as a tense, cord-like structure about 1 cm in diameter. The needle should be introduced in front of this ligament just under the easily palpated lateral condyle of the humerus and advanced obliquely and inwards along the bone until synovial fluid appears at the hub of the needle. The injection of 10 to 20 ml of local analgesic solution can then be made directly into the joint cavity. If the needle is introduced behind the lateral ligament, the solution is injected into the communicating bursa under the lateral flexor of the carpus.

***6-The shoulder joint: -***

Entry into this joint is made between the anterior and posterior parts of the lateral tuberosity of the humerus. The needle is directed backwards and inwards in a horizontal plane until synovial fluid appears at the hub of the needle, 10 to 20 ml of local analgesic solution can then be made directly

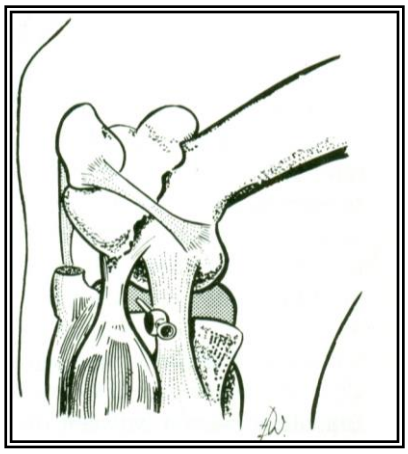
into the joint cavity. The tendon of the infra- spinatus muscle can be palpated running just behind the site where the needle is introduced.

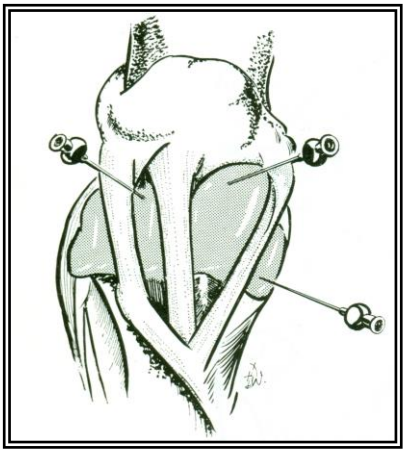



***7-The tibio-tarsal joint: -***

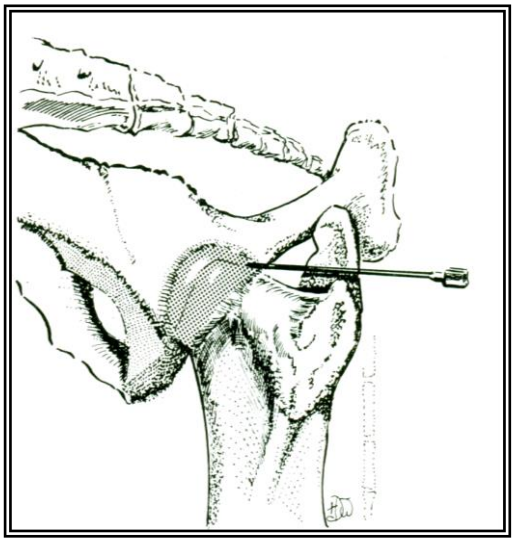
The best site for puncture of this joint capsule is located on the dorsomedial aspect of the joint between the extensor tendons and the medial ligament of the joint, but care must be taken to insert the needle medial or lateral to the saphenous vein.

***8-The stifle joint: -***





This joint has three synovial sacs, one at the femoro-patellar articulation and two (one medial and one lateral) for the femoro-tibial articulation. The femoro-patellar joint capsule can be entered on either side of the middle ligament of the patella. The medial joint sac is entered just behind the medial patellar ligament and just above the tibia. The lateral sac is approached between the lateral femoro-tibial ligament and the tendon of the long digital extensor. The needle should be inserted just above the margin of the lateral condyle of the tibia behind the groove for this tendon. Injection into the femoro-patellar joint capsule also affects the medial half of the femoro-tibial joint in those animals where these two joint capsules communicate.



***9-The hip joint: -***

A needle at least 15 cm long and 2 mm in diameter must be used and it is introduced through the notch between the anterior and posterior parts of the great trochanter of the femur. The skin is incised under infiltration analgesia at the site of introduction of the needle and the

needle is run along the neck of the femur until cartilage is touched or synovial fluid issues from its hub.

### B-Cattle and dogs

The techniques described for the horse are, with only minor modifications, applicable to cattle and dogs.

## 2-Injection into synovial sheaths

A needle can be introduced into synovial sheaths quite easily when they are distended with synovial fluid, but entry into a normal sheath is not easy. When searching for a synovial sheath the exploring needle should be connected to a syringe containing local analgesic solution and a slight pressure maintained on the syringe plunger. As soon as the needle enters the sheath the resistance to injection disappears and some of the solution enters the synovial cavity, lifting its wall away from the underlying tendon.

# II-INFILTRATION ANALGESIA

This technique can be used for minor operations or even for major operation either alone or in adjunction with sedation or basal narcosis. Infiltration analgesia is contraindicated to be used in:

1-Infected area: to avoid spread of infection

2-Inflamed tissue: to avoid rapid absorption and toxicity, as well as the acidic condition in the inflamed area impair dissociation of the analgesic solution.

3- Malignant tumor: as infiltration procedure may transplant tumor cells to other normal tissue.

## A-Intra-dermal or sub-dermal infiltration

It is a process through which analgesic drug is injected intra-dermal to facilitate injection in animals. The main point of this technique is the humanity as it reduces pain during subsequent procedure of infiltration analgesia.

## B-Linear infiltration

This method can be performed by creation of insensitive intra-dermal weal through which the needle is inserted subcutaneously into two opposite directions to create analgesic line, and by this method, a line of analgesia that has double length of the needle can be created with minimal skin

bricking. Usually the drug is injected while the needle is dragged out of the subcutaneous tissue and the amount of required analgesic is 1 ml/cm2. 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 partially withdrawn and reinserted in a slightly different direction. It is always better to overdo local infiltration than to apply it inadequately and to use more of a dilute rather than less of a concentrated solution of local analgesic.

Although sensation is mainly confined to the skin, but in some circumstances it is recommended to infiltrate the muscular layer beneath the skin as sensory nerves pass through it and this will achieve better analgesia, moreover, involvement of motor nerves that pass through the muscles reduces movement of the muscles during incision. A clear example of this is the linear infiltration of the left flank in cattle that involves both subcutaneous tissue and underlying muscles for performing rumenotomy or cesarean section. A simultaneous technique is the creation of insensitive weals beside each other in the form of line.

To infiltrate several layers of tissue, the procedure is to inject, from one puncture site, first the subcutaneous tissue and then, in succession by further advancing the needle, the deeper tissues.

***Advantages: -***

1-Simple and easy technique

2-It consumes smaller amount of anesthetic and shorter time than field block technique

***Disadvantages: -***

Deposition of the local analgesic at the incision site leads to;

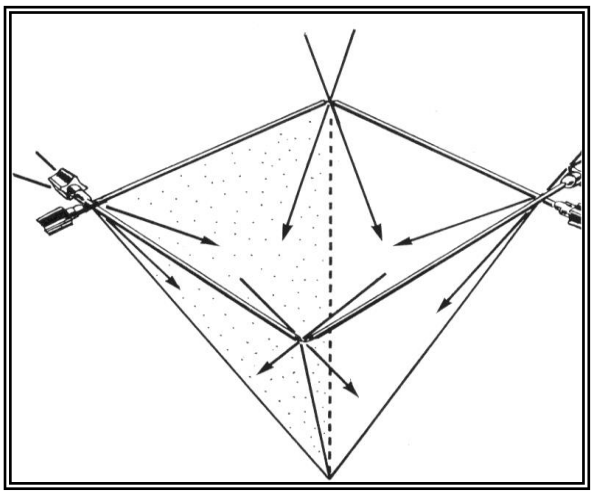
1-Delayed healing

2-Oedema and hematoma formation that may lead to change in the anatomical features

## C-Field block analgesia

In field block all the nerves entering the surgical field are desesitized. The advantage of field block in compared to linear infiltration is depostion of the analgesic solution away from the incision site, thus minimizing oedema, hematoma, and possible interference with healing.

The disadvantages of local infiltration analgesia include incomplete analgesia and muscle relaxation of the deeper layers of the abdominal wall and its possible toxicity after injection of significant amount of analgesic solution.



## 1-Cup shape field block

It is an inverted pyramidal shape analgesic area that is created by two punctures, and can be used when the pass of nerve supply is not exactly known. Usually it is applied to an area of bulky musculature.

***Advantages: -***

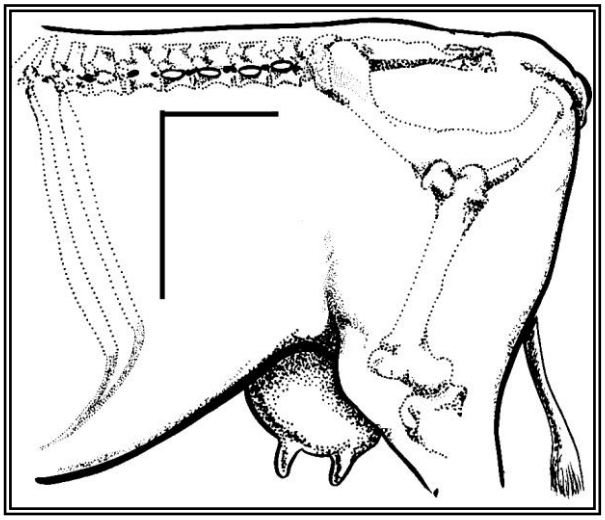
1-Absence of anatomical distortion at seat of incision

2-When the drug contains vasoconstrictor, it will produce efficient ischemia

3-Complete muscular relaxation

4-No retardation of healing

## 2-Inverted-L block



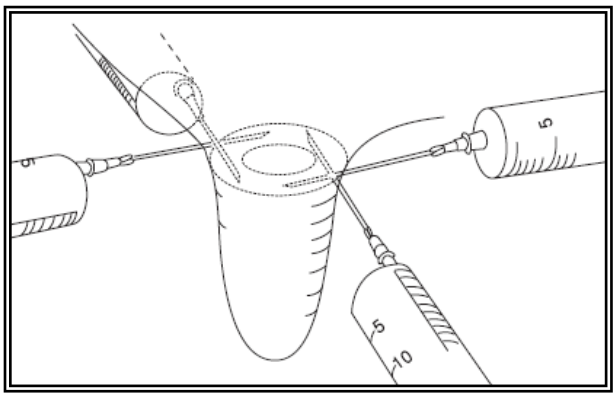
It is a field block technique through which only the dorsal and anterior aspects of the flank region are injected subcutaneously with local analgesic solution to produce complete analgesia of the flank for induction of rumenotomy or cesarean. The main point of neglecting the posterior aspect is that the nerves pass to the flank from the dorsal and anterior aspects caudo-ventrally.

***Disadvantages: -***

1-It consumes larger amount of anesthetic than linear infiltration and paravertebral block

2-It consumes longer time than linear infiltration

## 3-Ring block



It is a technique used for induction of analgesia by injection of analgesic drug in a ring manner at one level like in teat or digit. On induction of analgesia of the teat, adrenaline shouldn't be incorporated in the injected solution as vasoconstriction may cause necrosis of the compromised teat. The technique is useful for surgical repair of pre-sternal bursitis in buffalo calves, umbilical hernia, amputation of digit etc…

## III- INTRAVENOUS REGIONAL ANALGESIA (IVRA or BIER'S BLOCK)

It is a simple technique usually used in cattle, small ruminant and dog to produce analgesia of the digit and it can be used combined with systemic sedation. In dog it can be performed by injection of 2-3 ml of 1% lignocaine intravenous in the cephalic vein after application of tourniquet on the forearm. Analgesia all over the limb can be achieved and the effect can be reversed just the tourniquet is removed. This technique can be performed in cattle through catheterization of the limb vein, then the limb is exsanguinated (usually by Esmarch's bandage) and a tourniquet placed around the limb at a pressure adequate to prevent arterial circulation (> 150 mmHg) at the top of the limb. Local anesthetic (preferably without epinephrine) is then injected into the vein and after a period of 15 minutes the area distal to the tourniquet is anesthetized until the tourniquet is removed.

***Disadvantages: -***

1-Absence of vein after the limb is exsanguinated (so it is best to have a catheter in place first)

2-Cardiac arrhythmias or arrest due to an inadequate tourniquet (in man there are more problems when using bupivacaine than Lidocaine)

3-Failure to take effect due to inadequate tourniquet, inadequate time, and lack of exsanguination (it doesn't work so well without exsanguination)

4-Collapse when tourniquet is removed because of anoxic waste products re-entering circulation.

5-Damage as a result of leaving the tourniquet for more than 1-1.5 hours

## IV- LOCAL ANALGESIA OF FRACTURE

It is a simple technique performed by injection of 2-5 ml of 1% lignocaine (small animals) or 10-15 ml of 1% lignocaine (large animals) into the hematoma as near as possible to the ends of bone. Analgesia will ensue within 5 minutes after injection.

# II-REGIONAL ANALGESIA

Regional analgesia can be achieved by preventing conduction of nerve impulse through sensory nerve that finally retains certain area, analgesic. The technique has been widely used in cattle as general anesthesia is not suitable for that species, and it can be used alone or in conjunction with sedation, on the contrary it is of low value in pets as the general anesthesia in that species is superior to other analgesic methods.

***Advantages: -***

1-The technique requires no expensive equipment

2-Consumes lesser amount of drug

3-It has lower cost than local analgesia

4-It has lower possibility of toxicity than local analgesia

5-Disadvantages of local analgesia like; changes in anatomical features at seat of injection, delayed healing, and possibility of transmission of infection by needle can be avoided.

6-The analgesic area is large enough and there is no need to increase the size of analgesic field during surgery like with local analgesia.

7-It is suitable for operations that should be performed on standing animals, either with or without sedation.

***Disadvantage: -***

1-Technicaly it is more complicated than local analgesia

2-It has risk of toxicity especially when the nerve is associated with blood vessels

3-General complications of epidural including fracture, infection of neural canal, etc….

# I-PERI-NEURAL ANALGESIA

The method comprises the injection of local analgesic into the connective tissue around the nerve trunk. Absorption of the agent by the nerve resulting in block of its function

## A-Regional Analgesia of The Head

### 1-The Horse

## 1-Infra-orbital nerve block

***Anatomy: -***

It is the continuation of the maxillary division of trigeminal nerve (V cranial nerve) and as it passes the infra-orbital canal it innervates;

1-The 3rd premolar

2-The 3 molar teeth

While during it passes through the infra-orbital canal and 2.5 cm before it exits the canal it sends fibers that pass through maxilla and pre-maxilla to innervate;

1-The upper 1st and 2nd premolar teeth
2-The canine
3-The incisors

*and their alveoli and gum*

Then after, it exits through the infra-orbital foramen partially covered with levator nasolabialis muscle, it innervates;

1-Skin of the upper lip 2-Skin of the cheek 3- Skin of the nostril

***Indications: -***

1-Suturing of a wound at the lip or nostril

2-Trephining the facial sinus

3-Tooth extraction (but it is preferred to be removed under general anesthesia)

***Dose: -***

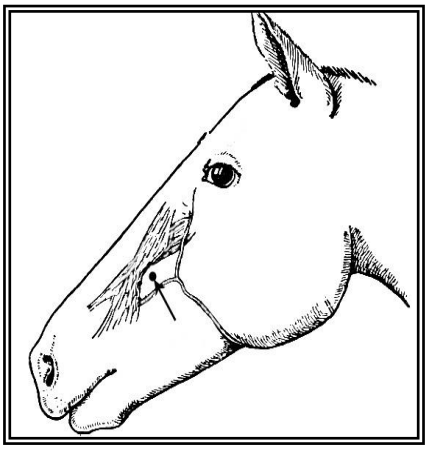
5 ml Lidocaine H Cl 2%

***Seat of injection, technique of injection and desensitized areas: -***

### a-After the nerve emerges from the canal

The lip of the infra orbital foramen can be felt as bony ridge lying beneath the edge of the flat levator nasolabialis muscle, at a point 5 cm forward and downward from the anterior end of facial crest.

The needle is introduced until its point can be felt beneath the bony lip of the foramen then after the analgesic drug can be injected.



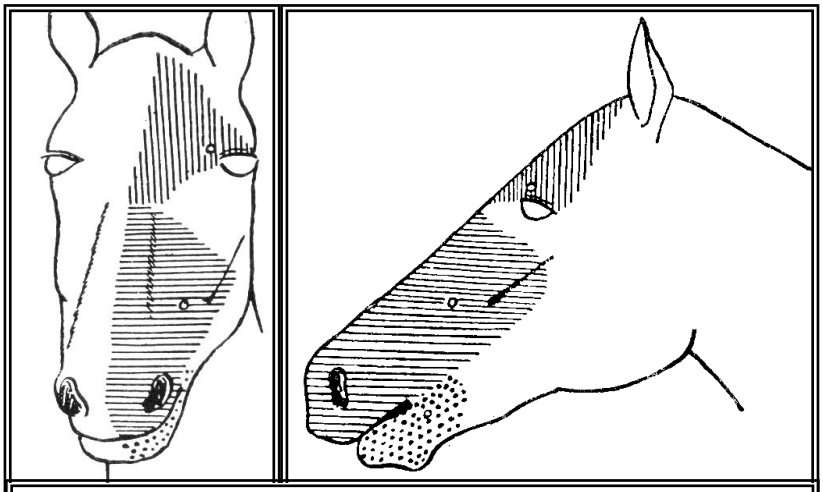
Desensitized areas are:

1-Skin of the upper lip

2-Skin of the cheek

3-Skin of the nostril

4-Skin of face up to the level of infra-orbital foramen



*Areas desensitized after blocking of infra-orbital n. within the canal (transverse lines), supra-orbital n. (vertical lines), and mental n (spotted).*

**b-Within the canal**

The technique of injection is the same as mentioned in site (a) but the needle should be advanced 2.5 cm up the canal.

Desensitized areas are:

1-The incisors
2-The canine
3-The upper 1st and 2nd premolar
4-The skin of the face up to the level of the medial canthus of the eye

*including their alveoli and gum*

**c-Within the pterygopalatine fossa**

With this technique of injection the needle should be inserted at a point on the side of the face opposite to the lateral canthus, inferior to the facial crest, and above transverse facial vessels. The needle is advanced medially, slightly anteriorly to drop into the pterygopalatine fossa, just posterior to maxillary tuberosity. The needle should be pushed until it strikes the perpendicular portion of palatine bone in the region of maxillary foramen at a depth of 7 cm (*generally it is a dangerous procedure and it is not recommended to be used*).

Desensitized areas are:

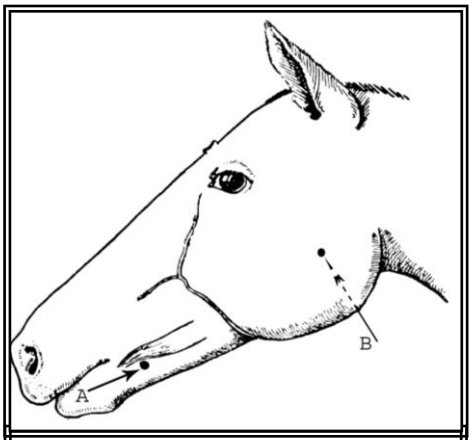
1-All the previously mentioned regions

2-The molar teeth up to the 6th (3rd premolar and all the 3 molar teeth)

## 2-Mental nerve block

***Anatomy: -***

It is the alveolar branch of the mandibular division of the trigeminal nerve (V cranial nerve) that enters the mandibular foramen on the medial aspect of the vertical ramus of the mandible under the medial pterygoid muscle. It traverses the mandibular canal, giving off dental and alveolar branches then it emerges from the mental foramen and called *mental* nerve. The innervation of the incisors and canines arises from the trunk nerve 3-5 cm before it emerges from the mental foramen.




*A: Mental n. block*
*B: Mandibular n. block*

***Indications: -***

Suturing of wounds of the lower lip

***Technique: -***

The mental foramen, through which the mental nerve emerges, lies on the lateral aspect of the ramus in the middle of the inter-dental space and covered with the tendon of depressor labii inferioris muscle

Desensitized areas are:

1-Injection of the nerve at this point desensitizes the lower lip only

2-While advancing the needle 3-5 cm into the canal will desensitize the incisors and canine too, in addition to the previously mentioned structures

***Dose: -***

5 ml of Lidocaine H Cl 2%

## 3-Mandibualr nerve block

***Indications: -***

If the mandibular nerve is injected at its point of entry into the mandibular canal at the mandibular foramen, practically the whole of the lower jaw and all the teeth and alveoli on that side will be desensitized.

***Technique: -***

The mandibular nerve is injected at its point of entry into the mandibular canal at the mandibular foramen. The mandibular foramen lies opposite to the point of intersection of a line passes vertically downwards from the lateral canthus and a line extending backwards from tables of mandibular molar teeth. This nerve can be blocked by *two methods*.

***1-Method I: -***

The needle is inserted into a point 3 cm below the temporomandibular joint between the wing of the atlas and base of ear. Then the needle is advanced towards the point of intersection of the mentioned lines, medial to the medial surface of the mandible.

***2-Method II: -***

The needle is inserted directly in front of the angle of the mandible, medial to the medial surface of the mandible, towards the mentioned point. The needle should be inserted 12 cm forwards at least.

Desensitized areas are:

The whole lower jaw and all the teeth and alveoli on that side

***Dose: -***

5 ml Lidocaine H Cl 2%

## 4-Supra-orbital (frontal) nerve block

***Anatomy: -***

Supra-orbital or frontal nerve is a branch of ophthalmic division of trigeminal nerve (V cranial nerve), emerges from the orbit through the supra-orbital foramen in the supra-orbital process. It innervates the upper eyelid and skin of the fore head.

***Indications: -***

Operations of the upper eyelid or suturing of wounds

***Technique: -***

The upper and lower borders of the supra-orbital process, close to its junction to the frontal bone, are palpated, and the foramen is detected midway between the two borders, then the needle is inserted into the foramen and the nerve is blocked.

Desensitized areas are:

The upper eyelid and skin of the fore head

***Dose: -***

5 ml Lidocaine H Cl 2%

## 5-Retrobulbar nerves block

It is a technique used for blocking of nerves behind the eye ball including;

1-Ophthalmic division of trigeminal — *innervates the conjunctiva, globe, 3rd eyelid, and lower eyelid*

2-Oculomotor

3-Trochlear

4-Abducens

*that innervate ocular muscles*

*Trigeminal* is the sensory n. of the eye and ocular adnexae. *Oculomotor* is the motor n. of the dorsal, ventral and medial rectus, the inferior oblique muscle, and the levator palpebra muscle, and the papillary sphincter muscle. *Trochlear* is the motor of the superior oblique muscle, and *Abducens* is a motor of the lateral rectus and retractor bulbi muscles

***Indications: -***

Induction of analgesia and akinesia of peri-ocular muscles, for enucleation of the eyeball. The large amount of injected drugs creates state of exophthalmos to facilitate enucleation.

***Technique: -***

***1-Method I (Four-point block): -***

The needle is inserted into the orbit at 12, 3, 7 and 9 O'clock positions (*6:00 should be avoided to minimize the chance of damaging the optic nerve*). A slight 'pop' is felt as the orbital septum is penetrated; if the needle doesn't penetrate the septum, anesthetic may migrate sub-conjunctivally.

***Dose: -***

Deposit 5–10 ml of anesthetic at each site.

***2-Method II (Peterson-type block): -***

This is a modification of the Peterson deep orbital block used in cattle. A slightly curved 18-gauge 10 cm needle is inserted 1 cm temporal to the temporal canthus and directed infero-nasally towards the opposite nasal canthus.

***3-Method III ( Infiltration anesthesia of the eye): -***

It refers to injection of local anesthetic agent into tissue regardless of the course of nerves supplying the area of interest. Motor and sensory innervations of the infiltrated area will be blocked, and the sensory component usually affected to a greater extent than the motor component.

This technique generally requires larger volumes of anesthetic agent, and can affect tissue architecture if applied overzealously. The needle is inserted 1.5 cm behind the middle of the supra-orbital process and pushed

towards the upper molar teeth of the opposite side. Generally it can be used for enucleation of the eye ball.

***Dose: -***

20-30 ml Lidocaine HCl 2%

***Potential complications of deep orbital blocks: -***

Retrobulbar hemorrhage, inadvertent penetration of the globe, and laceration of the optic nerve among the most common complications of that technique. Sudden death has been reported following deep orbital blocks in cows, presumably due to injection of anesthetic into the subarachnoid space of the optic nerve which is contiguous with the subarachnoid space of the brain.

***Field block (line block) anesthesia of the eye: -***

Deposition of a line of local anesthetic along the superior and/or inferior orbital rims will effectively block all motor and sensory innervation to the eyelid(s), greatly facilitating surgical procedures and sub-palpebral lavage apparatus placement.

## 6-Auriculopalpebral nerve block

***Anatomy: -***

It is one of terminal branches of facial nerve that carry motor innervation to the orbicularis oculi muscle of the upper eyelid, so its blocking produces paralysis of the upper eyelid without abolishing sensation and it is called akinesia.

***Indications: -***

1-Examination of the eye 2- Relieve of blepharospasm

3-To facilitate sub-conjunctival injection

4-Removal of foreign bodies from the cornea or conjunctive in conjunction with topical analgesia

***Technique: -***

The nerve can be injected at the highest point of zygomatic arch rostoral to the base of ear (*depression on the temporal aspect of zygomatic arch*)

***Dose: -***

5 ml Lidocaine HCl 2%

## 2-The Ox

## 1-Auriculopalpebral nerve block

***Anatomy: -***

It is one of terminal branches of facial nerve, and it acts as a motor nerve supply of the orbicularis oculi muscle of the upper eyelid.

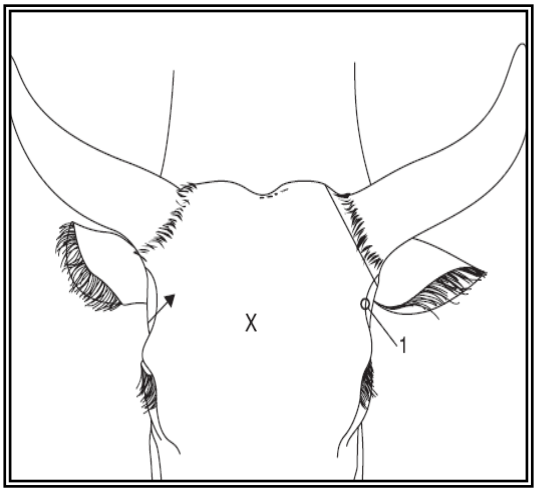
***Technique: -***

The needle is inserted in front of the base of the ear at the end of the zygomatic arch. The nerve can be felt in a depression or notch on the dorsal border of zygomatic arch. The block can be performed by subcutaneous injection of the analgesic drug at that notch.

***Indications and dose: -***

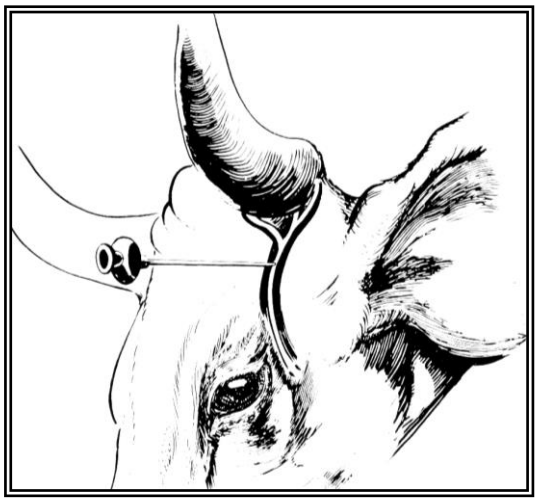
As in horse

## 2-Cornual nerve block




***Anatomy: -***

The horn corium and the skin around the horn base in cattle are innervated by the cornual branch of the zygomatico-temporal (lacrimal) nerve (*a branch of the ophthalmic division of the trigeminal nerve*). It emerges from the orbit and ascends behind the lateral ridge of the frontal bone and it exists superficially in the upper 3rd of the ridge.



***Indications: -***

1-Surgical intervention of fractured or separated horn

2-Dehorning

3-Disbudding in young calves

***Technique: -***

The site for injection is the upper third of the temporal ridge, about 2.5 cm

below the base of the horn. The needle is inserted immediately behind the ridge. The needle must not be inserted too deeply, otherwise injection will be made beneath the aponeurosis of the temporal muscle and the method will fail.

In large animals with well-developed horns, a second injection should be made about 1 cm behind the first to block the posterior division of the nerve. This nerve block has been widely used for the dehorning of adult cattle but the block is not always complete. Variability in the curvature of the lateral ridge of the frontal bone makes exact determination of the site of the nerve difficult. In a struggling animal, it may be difficult to ensure that the point of the needle is at the correct depth. A third injection may be required in adult cattle with well-developed horns; it is made caudal to the horn base to block the cutaneous branches of cervical nerves.

***Dose: -***

5 ml Lidocaine H Cl 2%

## 3-Retrobulbar nerve block

***Anatomy and indications: -***

As equine

***Technique: -***

***1-Method I: -***

The circumference of the eye is considered as watch and classified into 12 hours then the needle is inserted into 4 sites at 3, 6, 9, and 12 O'clock.

***2-Method II: -***

Modified *Peterson's* technique can be performed by inserting needle in the notch formed by supra-orbital process cranially, zygomatic arch ventrally and coronoid process of the mandible posteriorly. The needle is advanced towards orbitorotundum foramen and the analgesic drug is injected to produce block of oculomotor, abducens, trochlear, ophthalmic, maxillary, and mandibular nerves as they exit the thus it produce analgesia of the eyeball and large area of the head.

***Dose: -***

20-30 ml Lidocaine HCl 2%

## 3-The Goat

## 1-Nerve block for dehorning

***Anatomy: -***

*Right lacrimal and left infra-trochlear n. block*

The cornual branches of the lacrimal and infratrochlear nerves provide sensory innervation to the horns. The *cornual* branch of the *lacrimal (zygomatico-temporal)* nerve emerges from the orbit behind the root of the supra-orbital process covered by thin layer of frontalis muscle and innervates the caudo-lateral aspect of the horn. The *infra-trochlear* nerve emerges from the orbit dorso-medially and divided into *dorsal corneal* branch that innervates the dorso-medial aspect of the horn, and *medial frontal* branch that innervates the caudo-medial aspect of the horn. Both nerves are covered with orbicularis muscle at the lower part and with frontalis muscle at the dorsal part.

***Indications: -***

As cattle

***Technique: -***

The cornual branch of *lacrimal* nerve is injected close to caudal ridge of the root of the supra-orbital process to a depth of 1.0–1.5 cm in adult goats. The syringe plunger should be withdrawn before injection to check that the tip of the needle has not penetrated the large blood vessel located at this site. The corneal branch of the *infra-trochlear* nerve is injected at the dorsomedial margin of the orbit, 0.5 cm deep.

***Dose: -***

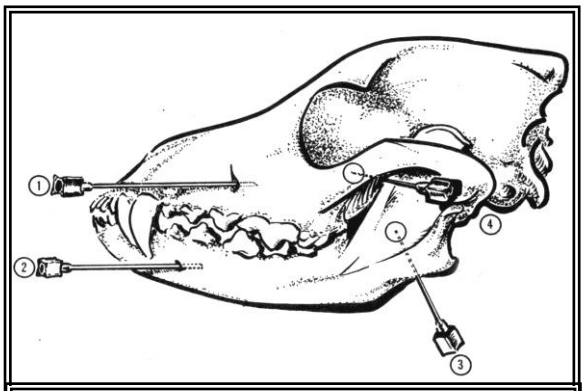
3 ml Lidocaine HCl 2% for each nerve

## 2-Retrobulbar nerve block

As cattle

## 4-The Dog

This is no longer be used in dogs as a result of the development of technique of general anesthesia in this species, and when it is used, it is combined with sedatives.



**1:Infraorbital n. 2:Mental n. 3:Mandibular n, 4: Auriculo-palpebral n.**

## 1-Infra-orbital nerve block

***Anatomy: -***

The maxillary nerve derived from the trigeminal nerve that emerges from the cranium through foramen rotundum, passes forwards in the pterygopalatine fossa, and continued in the infra-orbital canal as infra-orbital nerve. The incisors, canines and molar teeth are innervated in the following manner;

| | |
|---|---|
| The 1st and 2nd molar teeth | innervated by small branches derived from the main trunk before it inters the canal. |
| The 4 premolars and their alveoli and gum | innervated by filaments derived from the nerve as it passes through the canal |
| The canines and incisors | innervated by branches derived from the nerve as it pass the canal and passes forwards in maxillary and premaxillary bones |

***Technique: -***

### a-In the pterygopalatine fossa

At this point the nerve is blocked at its point of entry to the canal so the whole teeth in the upper jaw in that side will be desensitized. A point 4 cm below the lateral canthus in the space between the posterior border of malar bone and anterior border of coronoid process of the mandible is detected. The needle is inserted in this area and advanced in the soft tissue until its point passes the edge of malar bone then after it is redirected forwards towards the maxillary foramen 3 cm far from the point of insertion. The technique is difficult and risky.

### b-In the lower part of the infra-orbital canal

It can be performed through infra-orbital foramen for desensitization of incisors, canines, and first two premolars. It is made through the gum over the 3rd premolar tooth at line of reflection of mucous membrane of cheek under which the lip of the infra-orbital foramen can be detected. The needle should be advanced 1 cm in the canal. The technique is easy but the area of desensitization is small.

***Dose: -***

1-2 ml Lidocaine H Cl 2% 2 ml

## 2-Mandibular nerve block

***Anatomy: -***

It is derived from trigeminal nerve, passes downward deep to the medial pterygoid muscle and inters the mandibular canal at the mandibular foramen on the medial aspect of the ramus.

| | |
|---|---|
| The canines and incisors | innervated by branch derived from the main trunk that passes forwards within the ramus |
| The Molar and premolar teeth | innervated by fibers from main trunk while it stills inside canal. |

***Techniques: -***

***1-Technique I: -***

The needle is inserted into the medial aspect of the ramus at the mandibular foramen, and this will desensitize all teeth of the lower jaw on that side. The needle is inserted at the middle of the depression on the posterior part of the ventral border of the ramus, in a right angle to the ventral border of the jaw, close to the medial aspect of the bone, and advanced for 2 cm to reach the mandibular foramen. Generally the technique is difficult to be performed.

***2-Technique II: -***

The needle is inserted into the anterior part of the mandibular canal through the mental foramen and this will desensitize the lower incisors, canines, and first two premolars on that side. The mental foramen is injected through the gum immediately beneath the anterior root of the 2nd premolar tooth, and the needle should be advanced 0.7 cm in the canal. Despite the technique is easy but the desensitized area is small.

***Dose: -***

1-2 ml Lidocaine H Cl 2% 2 ml

## 3-Auriculpalpebral nerve block

***Anatomy: -***

The nerve runs caudal to mandibular joint at the base of the ear, gives the anterior auricular nerve and then proceeds as temporal branch along the upper border of zygomatic arch towards the orbit, and finally near the orbit it divides into medial and lateral branches to innervate the orbicularis oculi muscle. The nerve is a motor nerve runs behind the mandibular joint at the base of the ear and after giving off the anterior auricular branch, it proceeds as the temporal branch along the upper border of zygomatic arch towards the orbit.

***Technique: -***

The needle should be inserted at the midpoint of posterior 3rd of zygomatic arch, just where the arch can be felt sharply inwards.

***Dose: -***

2 ml Lidocaine HCl 2%

***Indications: -***

1-Facilitating eye examination 2-Surgery of the eye

3-Prevention of blinking and squeezing of the eye after intra-ocular surgery

## B-Regional Analgesia Of The Limbs

## 1-The Horse

Perineural analgesia of the limb in the horse is used for many purposes either *diagnostic* or *therapeutic*.

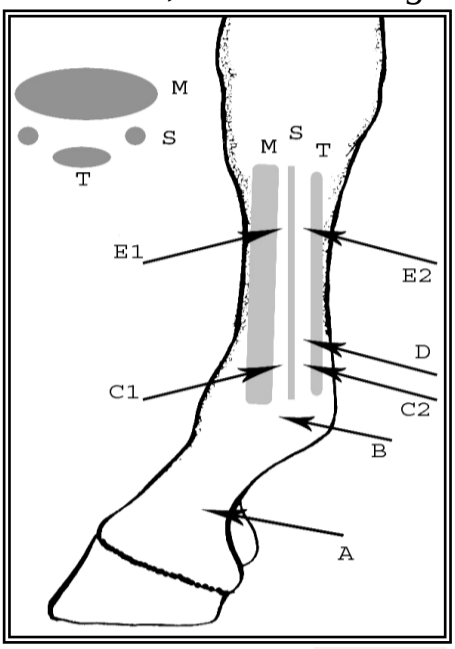
1-Diagnosis of lameness 2-Surgery of the limb

3-Treatment of certain foot affections like laminitis

Generally speaking, during diagnosis of lameness, perinural analgesia should be applied in systemic manner starting at the lowest branch and the level of analgesia should proceed gradually proximally over the limb till reaching definite diagnosis.

***Anatomy: -***

The *medial high volar nerve (palmar/ planter nerve)* passes with the vein and artery (VAN) in the groove between the suspensory ligament and digital flexor tendons. At the middle of the cannon bone, the *medial high volar (palmar/ planter nerve)* sends small branch to the *lateral high volar (palmar/ planter nerve)* that passes behind the flexor tendons and join the lateral branch at the level of the button of splint bone.




*A: Low volar (palmar/planter digital) n. block*
*B: Abaxial (basisesamoid) n. block*
*C1 &C2: Low palmar/planter (low 4-point) n. block*
*D: High volar (palmar/planter) n. block*
*E1&E2: High palmar/planter (high 4-point) nerve block*
*M: Metacarpal bone*
*S: Suspensory ligament*
*T: Superfecial and deep flexor tendons*

At the fetlock region, every volar nerve *(palmar/ planter nerve)* divides into three branches named *low volar nerves (palmar/ planter digital nerve)*) and pass in the same relation to the artery and vein (VAN) but the artery sinks slightly.

1-The *anterior* branch innervates coronary cushion

2-The *middle* branch innervates coronary cushion and sensitive laminae

3-The *posterior digital* branch innervates sensitive laminae and os pedis.

*Palmar* nerves in the forelimb are continuation of the *median* and *ulnar* nerves that fuse at the carpus then separate to form *medial and lateral palmar nerves* at metacarpal region and downward, while in the hind limb, *planter* nerves are the continuation of *posterior tibial nerve*. They have the same anatomical position like the forelimb, but their clinical significance is lower than that of the forelimb, because the digit is innervated by branches from the *anterior tibial nerve (deep peroneal)* and *saphenous nerve*.

## 1-Low volar (post digital, palmar/plantar digital) nerve block

***Technique: -***

The needle is inserted at the midway between fetlock and coronet in the groove between the 1st phalanx and the flexor tendon with an angle of 15° with the vertical line and directed downward and inward.

***Structures Anesthetized: -***

1-Navicular bone 2-Navicular bursa 3-Distal sesamoidean ligaments

4-Deep Digital Flexor tendon and sheath 5-Digital cushion

6-Corium of frog 7-Palmar pastern and coffin joints

8-Palmar distal phalanx / wings of coffin bone 9-Palmar Skin

***Indications: -***

Sensation remains in the anterior and lateral parts of the foot, so it is used mainly for diagnosis of navicular disease.

***Dose: -***

2-5 ml Lidocaine HCl 2%

## 2-Abaxial (basisesamoid) nerve block

***Definition: -***

It is a process through which the *medial and lateral high volar nerves (palmar/plantar nerve*s) are blocked as they pass the abaxial aspects of

sesamoid bone, accordingly all the three branches of low volar are anesthetized and all of the structures below the fetlock joint are anaesthetized except for the anterior aspect of the fetlock.

***Structures Anaesthetized: -***

1-Three phalanges 2-Coffin and Pastern joints

3-Entire corium 4-Entire sole

5-Dorsal branches of suspensory ligament

6-Digital extensor tendon 7-Distal sesamoidean ligaments

***Indications: -***

1-Diagnosis of laminitis 2-Diagnosis of ring bone

3-Diagnosis of injuries to the soft tissue of pastern

4-Neurectomy of low volar nerve

5-Repair of skin lacerations over anesthetized areas

## 3-High volar (palmar/planter) nerve block

***1-Technique I: -***

The site of injection is determined 5 cm above the fetlock at the level of the distal enlargements of the 2nd and 4th metacarpal or metatarsal bones, in the groove between suspensory ligament and flexor tendons. The needle is inserted with an angle of 15° with the vertical line and directed downward and inward then the drug is injected. The technique should be used for blocking of both the medial and lateral branches.

***Anesthetized area: -***

The same as the previous technique

***Indications: -***

Desensitization of the limb from the fetlock and downward, including pastern and coffin joints for;

1-Diagnosis of lameness of affected limb and opposite one

2-Relieve of pain

3-Performing operative procedures like neurectomy or operative procedures of the foot.

***2-Technique II: -***

This technique involves two steps

**a-Low palmar/planter (low 4-point) nerve block**

**1-The *medial and lateral palmar/planter nerves*** are blocked at the space between flexor tendon and suspensory ligament at the level of distal enlargement of small metacarpal (metatarsal).

**2-The *medial and lateral palmar metacarpal/planter metatarsal nerves*** are blocked at the space between suspensory ligament and splint bone at the level of distal enlargement of small metacarpal (metatarsal) where they emerge.

***Structures Anaesthetized: -***

1-Navicular structures 2-Soft tissue structures of pastern and foot

3-Sole Laminae 4-Three phalanges

5-Distal Digital tendon Sheath 6-Coffin and Pastern

7-Fetlock joint (may be not anesthetized and requires *ring block proximal to the fetlock*)

**b-High palmar/planter (high 4-point) nerve block**

**1-The *medial and lateral palmar/planter nerves*** are blocked at the space between flexor tendon and suspensory ligament below the carpus. It doesn't anesthetize deep structures of metacarpus.

**2-The *medial and lateral palmar metacarpal/planter metatarsal nerves*** They are blocked at the space between 3rd metacarpal bone and suspensory ligament, and the 2nd and 4th metacarpal bones at the same level of first injection (below the carpus). As these nerves innervate the interosseous ligaments of 2nd & 4th metacarpal bones, interosseous lateralis and medials muscle, and suspensory ligament, all the deep structures of the metacarpus except for proximal portion of metacarpal bone are desensitized.

## 4-Regional analgesia of distal forelimb

For complete desensitization of the limb below the carpus, three nerves should be blocked. These three nerves are the *median*, *ulnar*, and *musculocutaneous* nerves. This technique of three nerves block can be used for performing of any surgical interference below the carpus.

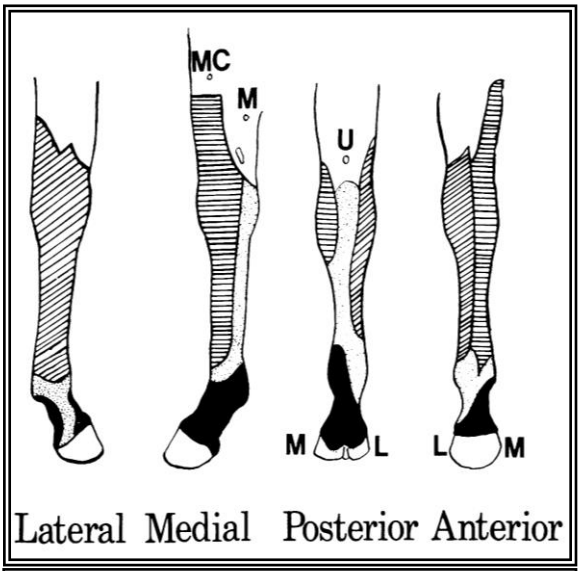
***Dose: -***

10 ml Lidocaine HCl 2% for nerve

**a-Median Nerve Block**

***Anatomy: -***

The nerve lies 5 cm below the elbow joint in the groove between the posterior border of the radius and the flexor carpi radialis, hand fist above the chest nut.




*Areas desensitized after blocking of median n. (black), ulnar n. (oblique lines), musculocutaneous n. (transverse), and additional area*

***Technique: -***

The needle is inserted in the mentioned site, and advanced inward and upward with an angle 20° with the vertical line

***Indications: -***

Indications for median nerve block alone are limited as the desensitized area is little more than that obtained by medial high volar block, however it can be used for median nerve neurectomy.

**b-Ulnar nerve**

***Anatomy: -***

Ulnar nerve can be located at the center of posterior aspect of the limb about 7 cm above the carpus or accessory carpal bone in the groove between the ulnaris lateralis and flexor carpi ulnaris. It innervates dorsolateral aspect of metacarpus.

**c-Musculocutaneous nerve**

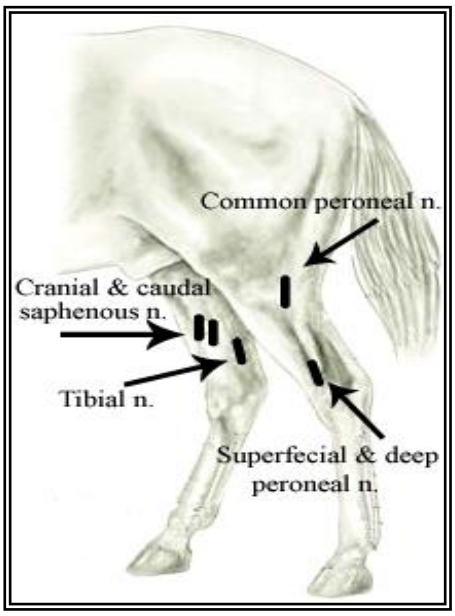
***Anatomy: -***

Musculocutaneous nerve lies at the medial aspect of the limb on the surface of the radius half way between the elbow and the carpus in front of cephalic vein.

## 5-Regional analgesia of distal hind limb (Posterior tibial, peroneal, and Saphenous nerves block)

**a-Tibial nerve**

The *tibial* nerve lies 15 cm above the point of the hock in the space between Achilles tendon and long digital flexor on the medial aspect of the limb. The nerve becomes palpable closer to the Achilles tendon as the limb is flexed and vice versa. It innervates planter structures of metatarsus and most of the foot.




*Tibial* block is used for desensitization of the posterior aspect of metatarsus, the medial and lateral aspects of the fetlock, and the whole digit. For complete analgesia down the hock the *saphenous*, and *superficial and deep peroneal nerves* should be blocked.

**b-Peroneal (fibular) nerve**

The superficial and deep branches of this nerve are best blocked simultaneously in the groove between the tendons of the long and lateral digital extensors about 10 cm proximal to the lateral malleolus of the tibia. First a needle is introduced subcutaneously and 5 ml of the local analgesic solution injected through it to block the superficial nerve. The needle must then be inserted another 2-3 cm to penetrate the deep fascia and about 5 ml of local analgesic solution injected around the deep branch. Desensitizing the superficial and deep peroneal nerve provides analgesia to the antero-lateral tarsal and metatarsal regions and joint capsule of the tarsus.

**c-Saphenous nerve**

*Saphenous nerve* runs along the saphenous vein on the medial aspect of the limb and it only innervates skin of cranio-medial aspect of the thigh to the fetlock joint.

Blocking of *tibial*, *saphenous*, and *peroneal* (superficial and deep branches) nerves will desensitize the dorsal stifle, structures distal the tarsus, and skin of cranio-medial aspect of the thigh to the fetlock joint.

***Technique: -***

The needle is inserted in the mentioned sites

***Dose: -***

20 ml Lidocaine HCl 2% for *tibial*

10 ml Lidocaine HCl 2% for *saphenous*

10 ml Lidocaine HCl 2% for *peroneal*

# 2-The Ox

## 1-Nerve block in the forelimb

Nerve supply of the digits of the ox is much more complex than the horse and for complete analgesia of the digits, 5 points (1, 2, 3, 4 & 5) should be blocked. For analgesia of the medial digit, points (1, 4 & 5) should be injected with analgesic. While for complete analgesia of the lateral digit points (1, 2, 3 & 4) should be blocked.

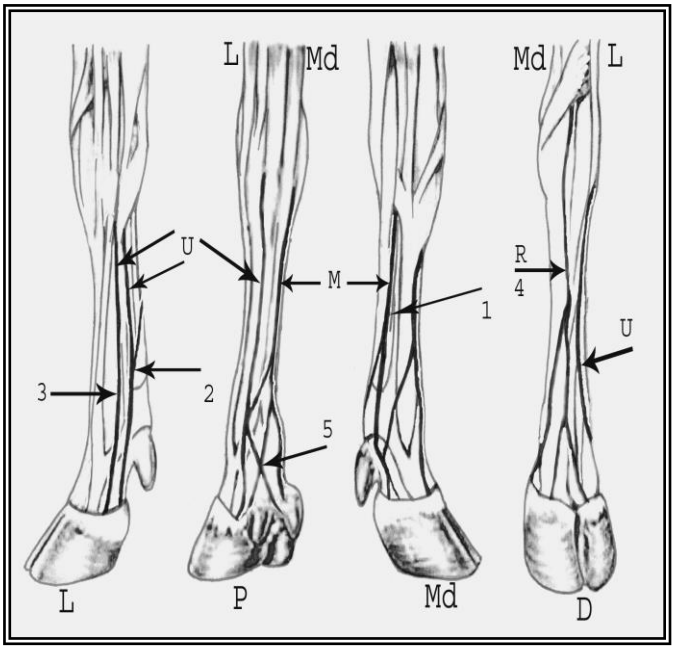
**1-*Medial branch of the median nerve*** can be injected in the grove between suspensory ligament and flexor tendon on the medial aspect.

**2-*Volar branch of ulnar nerve*** about 5 cm above the fetlock, and caudal to the suspensory ligament at the same level of *dorsal ulnar nerve*.

**3-*Dorsal branch of ulnar nerve*** about 5 cm above the fetlock on the lateral aspect in the groove between suspensory ligament and metacarpal bone.

**4-*Dorsal metacarpal* (*Radial*) *nerve*** at the middle of metacarpal bone medial to extensor tendon.

***5-Lateral branch of the median nerve*** and small *branch of the ulnar nerve* can be injected at the midline just above the fetlock on the caudal aspect of the limb.




*1, 2, 3, 4 & 5: Seats that should be blocked*
*U: Ulnar n. M: Median n. R: Radial n.*
*L: Lateral, P: Posterior, Md: Medial, & D: Dorsal aspects*

For blocking of the medial digit, 1, 4 and 5 points should be blocked, while blocking of the lateral digit requires injection of 2, 3, 4 and 5 points, however the technique is not easy and missing of one nerve block requires re-blocking of all the mentioned sites again, so it is preferred to make *ring block* rather than perineural injection for surgical interference at the digits.

## 2-Nerve block in the hind limb

### a-The tibial and external popliteal (common peroneal) nerve block

***Advantages: -***

1-Only two injections are necessary

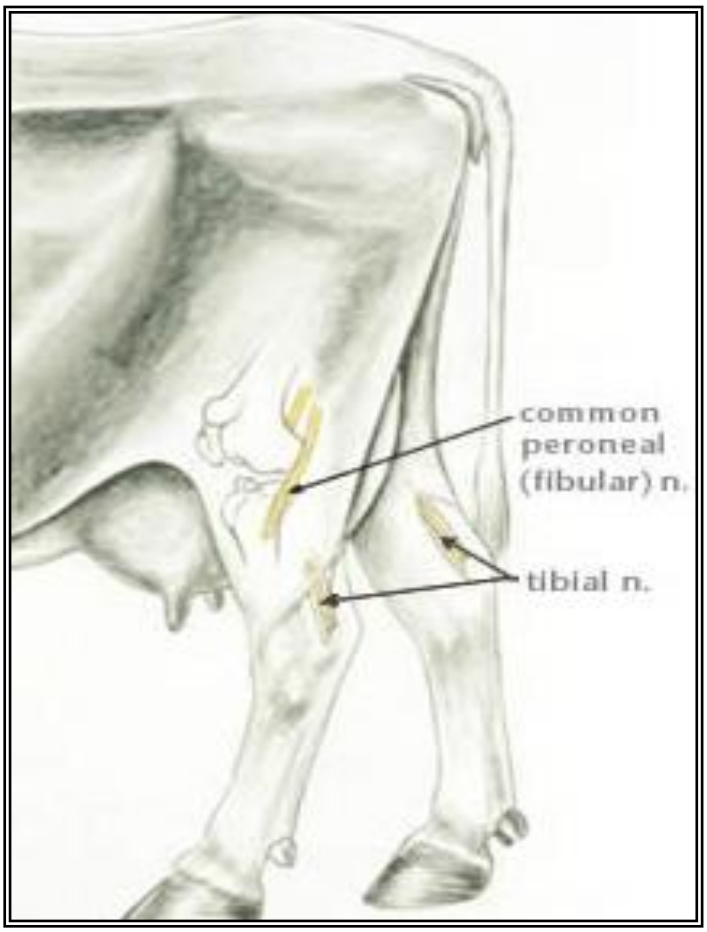
2-Injection to soft tissue and at convenient level permits easy application with thin needle, during standing with minimal restraint

3-The nerves can be located by clear landmarks

4-Moderate interference with the motor function of the limb

5-It avoids complications of injection at the digit diseased tissue

6-Most of the lower limb rendered analgesic




***Technique: -***

1-**The *external popliteal nerve (common peroneal or fibular)*** can be blocked behind the posterior edge of the lateral condoyle of the tibia, over the fibula (before it dips down between the extensor pedis and flexor metatarsi muscles for giving off superficial and deep peroneal nerves). Analgesia and motor paralysis of extensor muscles of the digit develop after 5-20 mins.

2-**The *tibial nerve*** can be blocked 10 cm above the summit of os calcis on the medial aspect of the limb anterior to Achilles tendon.

Blocking of both nerves induces analgesia from fetlock joint and downward.

***Dose: -***

20 ml Lidocaine HCl 2% for each nerve

**b-Peroneal and plantar metatarsal nerve block**

***Technique: -***

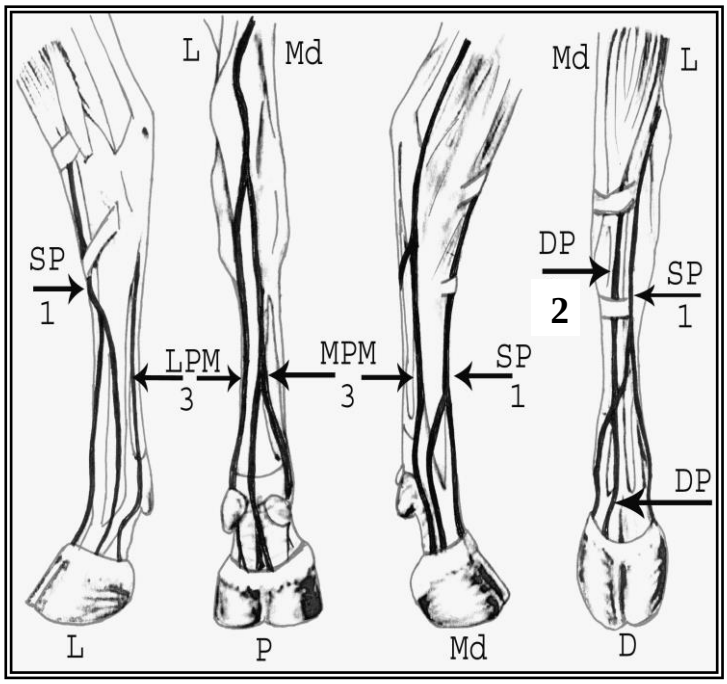
1-The *superficial peroneal* can be blocked, subcutaneously, over the dorsal aspect of the upper 3$^{rd}$ of metatarsus.

2-The *deep peroneal* nerve can be located in a groove covered with extensor tendons, halfway down the dorsal aspect of metatarsus.

3-The two *planter metatarsus nerves* can be blocked on both sides like high volar in horse.

***Dose: -***

5 ml Lidocaine HCl 2% for each nerve of the mentioned 4 nerves




***1, 2,& 3: Seats that should be blocked. SP: Superfecial peroneal. DP: Deep peroneal LPM&MPM: Lateral & medial plantar metatarsus L:Lateral, P:Posterior, Md:Medial, D:Dorsal aspects***

## 3-The Dog

## 1-Brachial plexus block

It is a simple method for induction of analgesia of the forelimb, and it causes analgesia and relaxation from the elbow joint and downwards.

***Technique: -***

With the animal standing, the depression at the center of the triangular area (bounded by the anterior border of supraspinatus muscle, the chest wall, and the dorsal border of brachiocephalicus muscle) is detected. The head is held away, and the 7.5 cm long needle is inserted into of that depression after locating the 1$^{st}$ rib. The needle is guided backwards lateral to the chest wall and medial to subscapularis muscle until its point is judged to be at the level of scapular spine.

***Dose: -***

2 ml Lidocaine HCl 2%

***Complications: -***

1-Hematoma 2-Acedintal intravenous injection of the drug

3-Infection of the axilla 4-Damage and neuritis of the plexus

5-Penetration of the thorax

## 2-Infiltration of digital nerves

These nerves are injected subcutaneously, medial and lateral to the 1st phalanx of each digit, with 2 ml Lidocaine HCl 2%.

## C-Regional Analgesia Of The Trunk

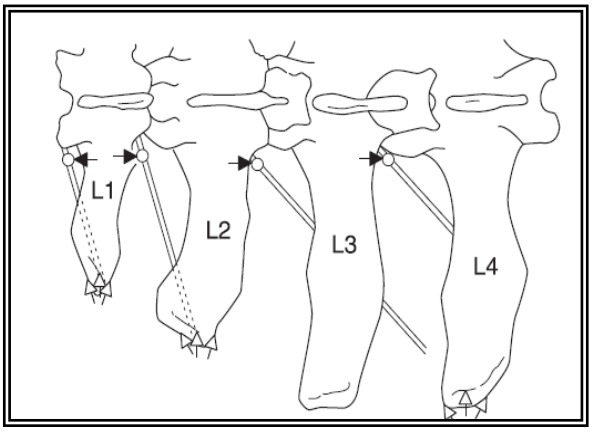
## 1-The Horse

## 1-Analgesia for castration

Local infiltration of the scrotum and direct injection of up to 20 ml Lidocaine HCl 2% into the testicle itself

## 2-The Ox

## 1-Paravertibral nerve block




It is a perineural injection of spinal nerves as they emerge from the vertebral canal through the inter-vertebral foramina. This technique is commonly used to provide analgesia for laparotomy (rumenotomy or caesarian).

***Advantages: -***

1-Short post-surgical convalescence period

2-Lower amount of local analgesia can be used

3-Complete and uniform desensitization of the abdominal wall and peritoneum

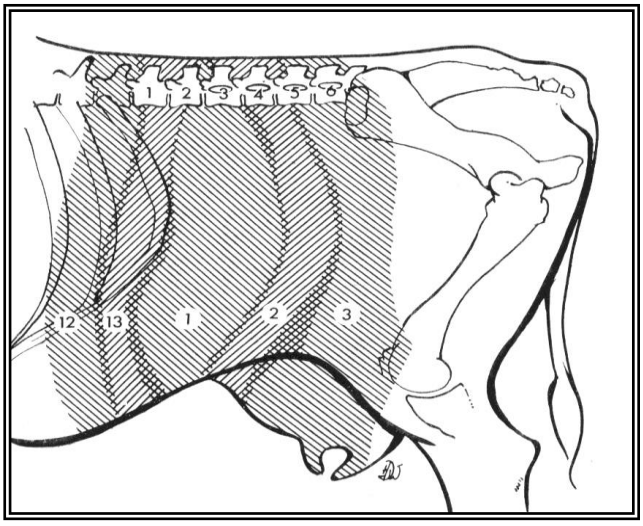
4-Relaxation of the abdominal muscles with reduction of intra-abdominal pressure

5-It over comes the disadvantages of inverted-L block and linear infiltration

***Anatomical and physiological consideration: -***

The area of the flank bounded cranially by the last rib, caudally by the angle of the ilium and dorsally by the lumbar transverse processes, is innervated by the thirteenth thoracic and first and second lumbar nerves. In addition, the third lumbar nerve, although it does not supply the flank,

gives off a cutaneous branch which passes obliquely backwards in front of the ilium. Operations involving the ventral aspect of the abdominal wall will require additional desensitization of the dorsal nerves cranial to the thirteenth thoracic. The last thoracic and first lumbar intervertebral foramina in cattle are occasionally double. The last thoracic foramen lies immediately caudal to the head of the last rib and on a level with the base of the transverse process of the first lumbar vertebra. The lumbar foramina are large and are situated between the base of the transverse processes and approximately on the same level. The spinal nerves, after emerging from the foramina, immediately divide into a smaller dorsal and a larger ventral branch. The dorsal branch supplies chiefly the skin and muscles of the loins, but some of its cutaneous branches pass a considerable distance down the flank. The ventral branch passes obliquely ventrally and caudally between the muscles and comprises the main nerve supply to the skin, muscles, and peritoneum of the flank. The ventral branch is also connected with the sympathetic system by a ramus communicans. Paralysis of the nerves at their points of emergence from the intervertebral foramina will provoke desensitization of the whole depth of the flank wall and complete muscular relaxation. Block of the rami communicantes will result in splanchnic vasodilatation and potential for hypotension.The number of nerves to be blocked will depend on the site and extent of the proposed incision. For rumenotomy, using an incision parallel with and about 7 cm caudal to the last rib, analgesia of the thirteenth thoracic and first and second lumbar nerves is required. While for a more caudal incisions the first three lumbar nerves should be blocked as in caesarian section in the flank region.




***Technique: -***

**I-Proximal Paravertebral analgesia: -**

The more accurate location of the nerves might be obtained by directing the needle towards the cranial border of the transverse process of the vertebra behind the nerve to be blocked. For example, to block the 1st lumbar nerve the needle should be directed to strike the cranial border of the 2nd lumbar vertebra about 5–6 cm from the animal's midline.

To block the thirteenth thoracic and first, second and third lumbar nerves skin weals should be raised in line with the most obvious parts of the transverse processes of the second, third and fourth lumbar vertebrae, 5–6 cm from, the midline of the body. Location of the transverse process of the first lumbar vertebra is usually difficult (particularly in well-muscled or obese animals) so in most cases the site for infiltration around the thirteenth thoracic nerve is found by simple measurement. The distance between the skin weals over the second and third lumbar transverse processes is measured and another skin weal is produced at a distance equal to this, cranial to the anterior weal, to mark the site where the needle is to be introduced to strike the cranial border of the first lumbar transverse process.

A long needle (10cm long, 2 mm bore) is inserted through each skin weal and the underlying longissimus dorsi muscle, and advanced to strike the anterior border of the transverse process. Each needle is then redirected cranially over the edge of the transverse process and advanced until it is felt to penetrate the intertransverse ligament. Injection of 15 ml of local analgesic solution is made immediately below the ligament and a further 5 ml is injected as the needle is withdrawn to just above the ligament. During final withdrawal of the needle the skin is pressed downwards to prevent separation of the connective tissue and aspiration of air through the needle.

Successful infiltration around the nerves is indicated first by the development of a belt of hyperaemia which causes a distinct and appreciable rise in skin temperature. Full analgesia develops in about ten minutes. When a unilateral block is fully developed it produces a curvature of the spine, the convexity of which is towards the analgesic side.

**II-Distal Paravertebral analgesia: -**

The needle is inserted ventral to the tips of the respective transverse process. 20 ml of local analgesic solution is injected in a fan-shaped infiltration pattern. The needle is then completely withdrawn and reinserted dorsal to the transverse process, in a slightly caudal direction, where approximately 5ml of the analgesic solution is injected

***Disadvantage of Paravertebral nerve block: -***

***a- failure or at least partial failure may be due to:***

1-The nerve trunk is situated at a depth of 5-7cm from the surface of the body.

2-The nerves pass obliquely and in some animals the nerve roots are double emerging from double foramina.

3-Penetration of the muscular mass of the back tends to cause spasmodic contraction of the muscles with consequent modification of the needle direction.

***b- Slightly difficult to perform.***

***c- Paralysis of back muscles.***

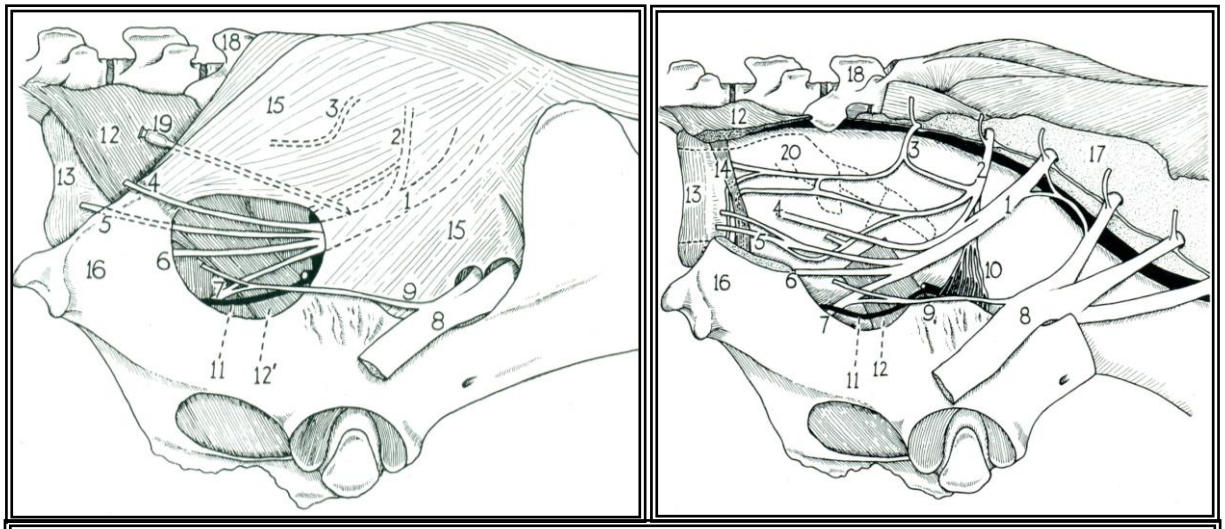
***Complications: -***

1-Potential for penetration of the aorta

2-Potential for penetration of the thoracic longitudinal vein or vena cava

## 2-Pudic or internal pudendal nerve block

This nerve is blocked for induction of protrusion of the penis by a method other than epidural analgesia to avoid the disadvantages of epidural in large or heavy bulls.




***1: Pudic n., 2: Middle hemorrhoidal n., 3: Caudal hemorrhoidal n., 4 & 5: Proximal and distal cutaneous branches of pudic n., 6: deep perineal n., 7: Dorsal n. of penis, 8: Sciatic n., 9: Branch connecting sciatic with branch of pudic, 10: Pelvic n., 11: Internal pudic artery, 12: Coccygenus m., 13: External anal sphincter, 14: Retractor penis muscle, 15: Sacrosciatic ligament, 16: tuber ischii, 17: Sacrum, 18: 1st coccygeal vertebra, 19: Needle, and 20: Hand with finger palpating pudic n.***

***Technique: -***

After location of the nerve per rectum, in the sacrosciatic foramen, the needle is introduced via the ischiorectal fossa medial to the sacroisciatic ligament, and is directed forwards and downwards for 7 cm.

***Dose: -***

30-40 ml Lidocaine HCl 2% (20-25 at the mentioned site and 10-15 slightly behind)

***Disadvantages: -***

1-The success rate of this technique is 66%.

2-The onset can be delayed as late as 30-45 minutes.

3-Some bulls may show protrusion of the penis as long as 24 hours post injection.

## 3-Local analgesia for castration

### a-Surgical castration

The site of the proposed incision in the scrotum may be rendered analgesic by local or subcutaneous infiltration, however this will not block the nerve fibers in the spermatic cord. Accordingly, these fibers can be rendered analgesic by one of the following;

1-Direct injection of 10 ml Lidocaine HCl 2% into each cord at the neck of the scrotum

2-Direct injection of 5-25 ml Lidocaine HCl 2% into the testicle itself. Accordingly the drug will pass through the lymph, diffuses, and blocks the fibers in the spermatic cord.

### b-Bloodless castration

For induction of bloodless castration by Burdizzo, both local infiltration at the skin of scrotal neck and direct injection into the spermatic cord should be performed.

## 3-The Small Ruminants

## 1-Paravertibral nerve block

It can be performed as with cattle, and each nerve is blocked by 7 ml Lidocaine HCl 1% (5 ml below the inter-transverse ligament and 2 ml above it).

## 2-Pudendal nerve block

***Anatomy: -***

The anterior tuberosity of tuber ischii is used as fixed point, and the length of sacro-tuberous ligament is used as a radius. This distance is used to establish a site on a line parallel to the midline in front of the fixed point. A finger is introduced through the rectum for detection of the lesser sciatic

foramen, and the needle is inserted at the previously mentioned point. The penis will protrude 5 minutes post injection.

***Dose: -***

7 ml Lidocaine H Cl 2%

## 3-Local analgesia for castration

1-Direct injection of 2-10 ml Lidocaine H Cl 1% into the testicle itself, followed by local subcutaneous infiltration at the line of incision.

2-Other methods mentioned in cattle.

## 4-The Dog

## 1-Paravertibral Block

The last *three thoracic* and the 1st *four lumbar* nerves should be blocked to produce analgesia and relaxation of abdominal muscles; accordingly it can be used with light general anesthesia. This technique can be used bilaterally to induce complete relaxation of abdominal muscles, however, disadvantage of this technique is time consuming, and its advantage is there is no need for muscle relaxant and artificial ventilation.

***Dose: -***

Lignocaine H Cl 1 % 2 ml

# II-SPINAL ANALGESIA

Spinal analgesia is a special type of regional block comprising the injection into some part of the spinal canal of a local analgesic solution. By coming into contact with the spinal nerves the drug temporarily paralyses them and gives rise to loss of sensation in those parts of the body from which the sensory portion of the nerves carries impulses and, when more concentrated solutions are used, paralysis of those parts supplied by the motor fibers. It is divided into two distinct types:

1. Epi- (extra-) dural injection: in which the needle enters the spinal canal but does not penetrate the meninges, and the injected solution permeates along the spinal canal outside the dura mater.

2. Subarachnoid injection: in which the needle penetrates the dura mater and the arachnoid mater so that the analgesic solution is introduced directly into the cerebrospinal fluid.

**Anatomical consideration**

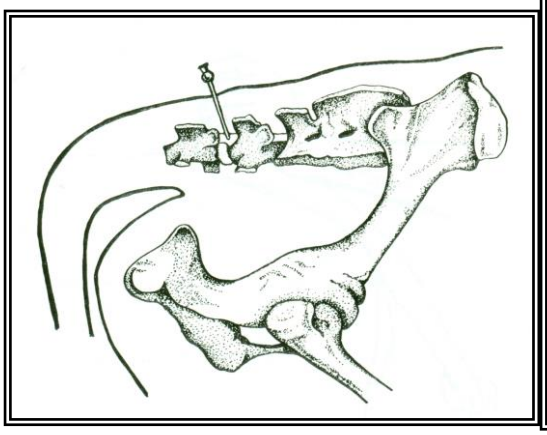
The spinal cord lies within the spinal canal and is covered by three membranes, the dense dura mater, the arachnoid mater and the delicate pia mater. The wall of the spinal canal is formed by the vertebral arches and bodies, the intervertebral discs and the intervertebral ligaments. The tube like canal is somewhat flat in the lumbar region. The spinal cord and dura mater end at the lumbar enlargement and the canal itself tapers off caudal to this enlargement to end in the 4th or 5th coccygeal vertebra. In each vertebral segment the canal has lateral openings between the vertebral arches, the 'intervertebral foraminae', through which pass blood vessels and the spinal nerves. In the cranial cavity the dura mater is arranged in two layers, the 'periosteal' and 'investing' layers. The outer layer forms the periosteum of the inner surface of the cranial bones and in the spine acts as the periosteum lining the vertebral canal. The investing layer is continued from the cranium into the spinal canal but at the foramen magnum is firmly adherent to the margins of the foramen where it blends with the outer or periosteal layer. Between the two layers in the spinal canal is the 'extra-' or 'epidural' (perhaps more strictly the 'interdural') potential space.

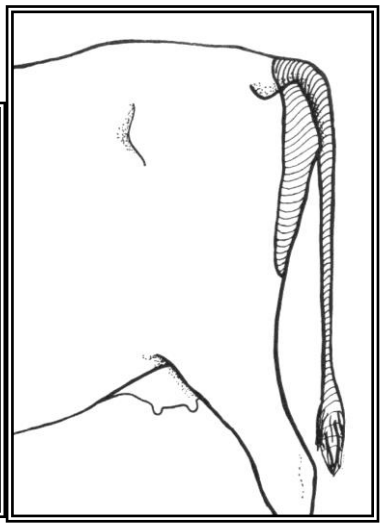
## A-Epidural analgesia

It is now customary to classify epidural spinal blocks as caudal and lumber epidural, according to the site of injection**.**

### 1-Caudal Epidural

### 1-The Ox





It is a process through which the analgesic solution is injected between the two layers of dura matter and affects the terminal nerves or cauda equina thus producing analgesia of the posterior part of the animal. The term anterior and posterior epidural analgesia is related to the dose of injected analgesic solution and not to the site of injection.

## 1-Posterior epidural

It is characterized by no affection of the motor function of the hind limbs, but analgesia or loss of sensation can be observed over the tail, croup as far as the mid-sacral region, the anus, vulva, perineum, and posterior aspect of the thighs. Paralysis of motor fibers predisposes to relaxation of anal sphincter and ballooning of posterior part of the rectum. Defecation will be suspended and stretching of the vulva provokes no response. The vagina will dilate and straining during parturition, ceases without affecting uterine contraction.

## 2-Anterior epidural

It shows some degree of interference with motor function of the hind limbs. This will vary from partial paralysis of stifle flexors, and flexors and extensors of hocks and digital joints, to complete paralysis. In coordination may predispose to injury to the animal or the workers. Loss of sensation spreads forwards, according to the dose; over 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.

As the drug blocks the sympathetic outflow of the thoracic and lumbar segments, hypotension will occur and the normal compensatory mechanism (tachycardia) will be affected as the cardiac accelerator nerves will be blocked so the heart rate will not be increased to compensate the hypotension.

This hypotension has the advantage of lowering the chance of bleeding during surgery but on the other hand, minimal loss of blood threatens the animal life.

### ***Seat of injection: -***

Seat of injection is the first intercoccygeal space between the 1$^{st}$ and 2$^{nd}$ coccygeal vertebra. The dimensions of the opening in the dorsal wall of the neural canal 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.

### ***Technique: -***

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.

1-The tail is gripped 15 cm from its base and raised in pump-handle fashion. Seat of injection is the 1$^{st}$ obvious articulation behind the sacrum.

2-Standing on one side of the animal and observing the line of the croup, the prominence of the sacrum is seen. Moving the eye back towards the tail, the next prominence to be observed is the spine of the first coccygeal bone. The site is the depression immediately behind it.

3-The caudal prominence of the tuberosity of the ischium is palpated and the point selected 10–11 cm in front of it. A line drawn directly over the back from this point passes, in a medium-sized animal, through the depression between the first and second coccygeal spines.

***Dose: -***

**1-Posterior block: -**

| a-Procaine HCl | b- Lidocaine HCl |
|---|---|
| *15-20 ml 1%.*<br>*10-15 ml 2%.*<br>*5-10 ml 3-5%.* | *5-10 ml 2%* |

**2-Anterior block: -**

| a-Procaine HCl | b-Lidocaine HCL |
|---|---|
| *40 ml 3% (mastectomy)*<br>*170 ml 1% or 120 ml 1.5% (digit amputation)*<br>*45 ml 2% (caesarean)* | *60-100 ml 2% (difficult obstetrical interferences)*<br><br>*120 ml 2% (caesarean)* |

***Onset and duration: -***

**a-Posterior 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 up to 3-4 hours

***Indications: -***

**1-posterior block: -**

***a-Obstetrics: -***

1-To overcome straining for correction of mal-presentation, 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 of tears of vulva or perineum

3-Examination of the vagina or external cervical os

4-Protrusion of the penis

**2-Anterior block: -**

***a-Obstetrics: -***

1-To overcome straining during extensive embryotomy

2-Amputation of gangrenous prolapsed uterus

3-Caesarian section

***b-General: -***

1-Surgery of penis

2-Cutting operations about the prepuce or inguinal region

3-Amputation of the udder 4-Castration

5-Surgery of hind limb like amputation of digit

***Disadvantages: -***

1-Fracture of the animal pelvis, and injury to workers, or veterinarian (anterior block)

2-Infection of the nervous system

3-Hypovolumic shock due to involvement of vasomotor nerve fibers and pooling of blood in the venous side with absence of compensatory tachycardia (anterior block)

4-Asphyxia due to paralysis of phrenic nerve

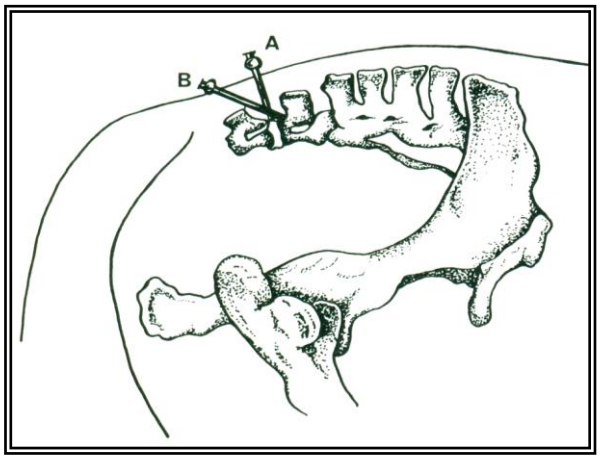
5-Twisting of the tail few days or even permanent paralysis after injection due to injury of nerve fibers innervate the tail

## 2-The Buffaloes

The needle is inserted downwards and forwards in the sacrococcygeal with an angle 45º with the vertical.

## 3-The Horse

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: -***

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

***Technique: -***

The needle is inserted forwards and downwards with a right angle with the contour of the croup (30° degrees with the vertical) and this technique (A) is easier than the other technique (B) where the needle is inserted at the posterior part of intercoccygeal space with an angle of 60° with the vertical to permit gliding of the needle along the floor of the neural canal. The intercoccygeal space can be detected by;

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.

***Indications: -***

**1-Posterior block: -**

***a-Obstetrics: -***

1-To overcome straining during manipulative correction of simpler forms of mal-presentation

2-Partial embryotomy

***b-General: -***

1-Amputation of the tail 2-Operations about the anus, perineum, or vulva

3-Operation for rectal prolapse 4-Caslick operation for wind sucking

**2-Anterior block: -**

Because of the great risk of injury during recovery, there is no place for this technique in the horse. Anterior block to the level of costal arch requires 100-150 ml lignocaine 2%. With this large amount of drug, any signs of hypotension require rapid transfusion of fluid and administration of vasopressors. Accordingly general anesthesia is superior to anterior epidural in this species.

***a-Obstetrics: -***

Obstetrical difficult manipulative repositions and extensive embryotomy

***b-General: -***

Scrotal hernia and cryptorchidism

***Dose: -***

**1-Posterior block: -**

| a-Procaine HCl 2% | b- Lidocaine HCl 2% |
|---|---|
| *5-15 ml (amputation of the tail)*<br>*10-25 ml (perineal and vulvar operation)*<br>*15-30 ml (obstetric manipulation)* | *10 ml* |

**2-Anterior block: -**

| a-Procaine HCl | b- Lidocaine HCl 2% |
|---|---|
| *50-120 ml 1% (severe obstetrical interferences)*<br>*30-80 ml 2% (cutting operation)* | *100 -150 ml (analgesia of hind limbs to the costal arch)* |

## 4-The Sheep

***Seat of injection: -***

Sacrococcygeal space

***Dose: -***

3-4 ml 2% lignocaine HCl (intravaginal obstetrical procedures)

1 ml 2% lignocaine HCl (docking of lambs)

***Indications: -***

1-Intravaginal obstetrical procedures

2-Relief of painful conditions of vagina and rectum that provoke severe straining

## 5-The Dog

***Seat of injection: -***

Sacrococcygeal or 1st intercoccygeal space

***Dose: -***

1 ml 2% lignocaine H Cl

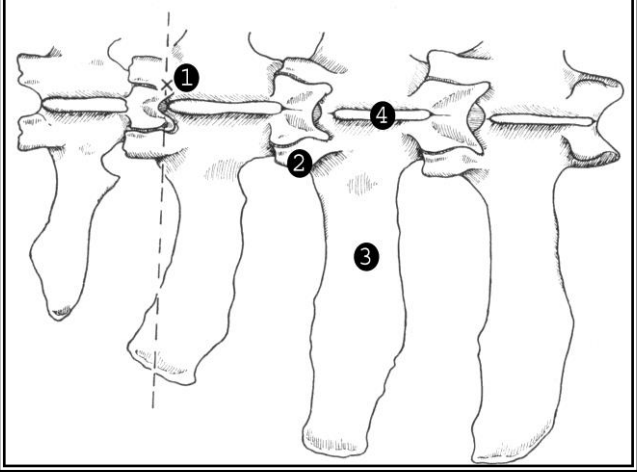
***Indications: -***

Docking of tail

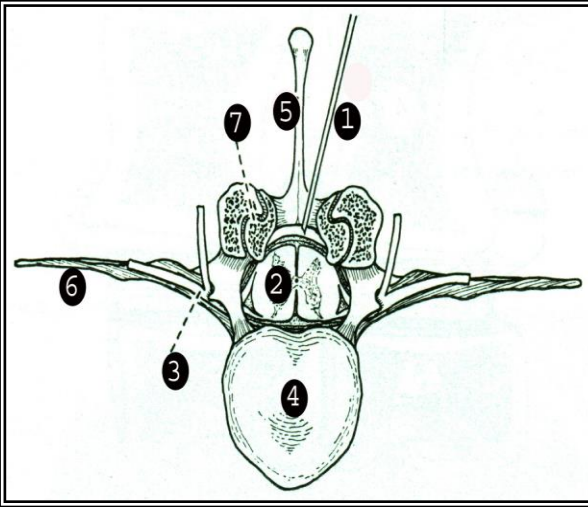
## B-Lumbar Epidural Analgesia

## 1-The Ox

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.




*1:Point of needle insertion, 2:Articular process, 3:Transverse process, and 4:Spinous process*




*1:Needle, 2: Spinal cord, 3:Left 1st lumbar n., 4:Body of 1st lumbar vertebra, 5:Spinous process, 6:Transverse process, and 7:Sectioned interlocking articular process*

***Seat of injection: -***

Seat of injection is just to the right of the lumbar spinous process of the 2nd lumbar vertebra, 1.5 cm caudal to the anterior edge of the second lumbar transverse process.

***Dose: -***

10 ml Procaine HCL 4% (15 ml weakens the hind limbs- 20 ml the animal lie down)

10 ml Lidocaine 2%

***Indications: -***

It is used for induction of flank analgesia for rumenotomy or caesarian.

## 2-The Sheep

***Seat of injection: -***

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

***Technique: -***

The needle is inserted in the mentioned space with an angle 10° anterior and 15° lateral with the vertical line.

***Dose: -***

8-15 ml Lidocaine 1%

***Indication: -***

Intra-abdominal, pelvic, and hind limbs surgery

## 3-The Dog

***Seat and technique: -***

Lumbosacral space as sheep

***Dose: -***

0.5 ml/Kg Lidocaine 1%

***Indications: -***

1-Posterior abdominal (hysterectomy, or cystotomy) or inguinal surgery

2-Treatment of hind limb fracture

# III-PRE-ANESTHETIC MEDICATION

***Definition: -***

It is the drug that usually administered prior to induction of anesthesia for sedation if the animal will be operated under the effect of local or regional analgesia, or for smooth induction and smooth recovery from general anesthesia, and reduction of the anesthetic dose.

***Aims: -***

1-Potentiation of anesthetic agent 2-Reduction and abolishing of pain

3-Smooth induction and smooth recovery of anesthesia

4-Avoiding harms to the animal and surgeon

5-Reducing the amount of anesthetic agent and its toxicity

6-Reduction of salivary and bronchial secretions and the subsequent possibility of asphyxia

7-Reduction of GIT motility

8-Stimulation of cardiac and respiratory functions

## Types

1-Anticholenergic drugs 2-Muscle relaxants

3-Tranquilizers and sedatives

## I-ANTICHOLENERGIC DRUGS (ATROPINE)

It is a water-soluble atropine sulfate that has wide therapeutic uses except individual animals that have proved to be sensitive to the drug.

***Uses: -***

Used as pre-anesthetic medication with wide safety margin prior to wide verity of anesthetic agents (barbiturates, or inhalation anesthetics), sedatives, and narcotics

1-Stimulation of cardiac and respiratory functions

2-Inhibition of salivary and bronchial secretions

3-Dilates bronchi and prevent laryngospasm so it facilitates endotracheal intubation

***Effect on eye: -***

It causes mydriasis and it is contraindicated in cases of glaucoma

***Effect on Respiration: -***

It causes relaxation of bronchial musculature, dilates bronchi, prevents laryngeal spasm during intubation, and reduces bronchial secretion

***Effect on Cardiovascular system: -***

It prevents vagal inhibition induced by narcotics, or tranquilizers, accordingly it prevents bradycardia

***Effect on GIT: -***

It reduces muscle tone of GIT, inhibits motility, and reduces salivation

***Side effects: -***

The use of this drug in equines is prohibited due to

1-Equine don't produce copious salivation

2-Posibility of formation of viscid bronchial secretion with subsequent occlusion of alveoli

3-Interfernce with vision and the animal becomes uncontrollable

4-Reduction of intestinal motility with subsequent intestinal distention and colic

5-It shouldn't be used in cases where tachycardia exists

***Toxicity: -***

Over dose causes convulsion, coma, and death due to respiratory failure

***Concentration, Rout of administration, and Dose: -***

Concentration is 1% (10 mg/ ml), Injection by IV, IM, or SC

| Animal | 1 Kg |
|---|---|
| **Large ruminants** | 0.005 (up to 0.2 - 0.8) mg/ Kg B wt. |
| **Equine** | 0.7 mg/ kg B wt., (up to20 - 60) mg/ Animal |
| **Small ruminants** | 0.6 mg/ kg |
| **Dogs** | 0.04 (0.02 - 0.1) mg/ Kg B wt. |
| **Cat** | 1 mg/ kg B wt |
| **Pigs** | 0.3-1.8 mg/ animal. |

## II-MUSCLE RELAXANT

***Uses: -***

1-Alone to relax the animal to facilitate endotracheal intubation

2-With some anesthetics to produce more complete muscle relaxation

3-To facilitate some diagnostic procedures

## 1-Succinylcholine

***Characteristics: -***

1-It is free from the usual complications of muscle relaxants like hypotension, tachycardia, histamine release, and urticaria

2-It has a rapid rate of destruction due to hydrolysis by plasma cholinesterase (the later is inhibited by phenothiazine like chlorpromazine HCI), so it has no cumulative effect.

3-The myoneural action is intensified when procaine is injected after it.

***Dose and rout of administration: -***

| Animal | | Rout |
|---|---|---|
| **Equine** | 0.6 mg/ Kg | IV |
| **Cattle** | 0.04 mg/ Kg | |
| **Dogs** | 0.01 mg/ Kg | |

## 2-Gallamine triethiodide (Gallamine-Flaxedil)

1-Gallamine produces a non-depolarization block at the neuromuscular junction, vagal block, and tachycardia.

2-It does not produce histamine release in the dog, so it is the non-depolarizing relaxant of choice in dog.

3-It is not detoxicated in the body, but it is excreted unchanged in urine, so it shouldn't be given to animals suffering from renal insufficiency.

***Uses: -***

***1-Surgical application (muscular relaxation): -***

It is very useful in;

a-Abdomino-pelvic, thoracic, and lung surgery

b-Tracheal intubation during anesthesia

c-Immobilizing wild animals

d-Reduction of muscle spasm (help in reduction of dislocated joint)

e-Reduction of amount of general anesthetic agent

***2-Obstitrical application: -***

It can be used especially during parturition in small animals at the stage of full dilatation (as the drug not pass via placental barrier) for relaxation of the perineum to avoid risk of injury or laceration.

***3-Medical application: -***

a-Reduction of traumatic and rheumatic pain

b-Relief of myositis, and tetanus spasm

***Side effects: -***

1-Tachycardia with increased arterial blood pressure with subsequent high incidence of hemorrhage

2-The drug has histamine-releasing effect except in dogs

3-The drug should be used cautiously, as it may cause respiratory failure, accordingly, it can't be used unless artificial respiration tools are available.

***Dose and rout of administration: -***

| Animal | 1 Kg | Rout |
|---|---|---|
| **Cattle and equine** | 0.1 mg/ Kg | IV |
| **Dog** | 1 mg/ Kg | |
| **Cat** | 1-2 mg/ Kg | |

***Antidote: -***

Neostigmine

## III-TRANQUILIZERS (ATARACTICS) AND SEDATIVES

They are drugs used to depress the CNS, and are useful in wide verities of conditions in animals like

1-Facilitation of animal examination

2-Depression of CNS that lowers the required dose of anesthesia

3-Reduction of body secretions like saliva to prevent asphyxia during anesthesia

4-Relaxation of muscle to permit easier surgery etc…

***Classification: -***

### A-Weak acting drugs

Like meprobamate derivatives (Equinal) that is used for human only

### B-Strong acting drugs

#### 1-Phenothiazine derivatives

a-Acepromazine (Acetylpromazine)

b-Chlorpromazine (Largactil or Neurazine)

c-Promazine (Sparine)

d-Propionyl promazine (Comblen)

**2-Thiazine derivative**

a-Detomidine

b-Xylazine HCl (Rompun or Xylaject)

**3-Benzodiazepine derivative (Diazepam, or Valipam)**

a-Short acting (Valium, Neuril, Diazepam or Valipam)

b-Very long acting (Lorazepam)

***Clinical use: -***

1-Preanesthtic drug

2-Relief anxiety of hospitalized animal

3-Restrain of refractory animal during examination

4-Prevention of animals from licking wounds or chewing bandage and splints

5-Used in minor surgical operations like abscess incision

6-Used in conjunction with local or regional analgesia

***Clinical effect: -***

1-The ear drops with sluggish response

2-The eyes close or become semi-closed with protrusion of third eyelid

3-The tongue protruded in some cases

4-In cattle, the muzzle becomes dry with excessive salivation and reduced deglutition that may cause dehydration and disturbance of acid base balance as a result of excessive loss of bicarbonate of the saliva

5-In cattle the head and neck drop and deviate to lateral side

6-Stugering gait of animal that becomes unconscious to the surrounding and try to lie down, and finally the animal lies down

7-Protrosin of penis and dilatation of anal and vulval sphincter

8-Reduction of temperature, pulse, and respiration

***Advantages: -***

1-Easier handling of the animal during induction of anesthesia

2-Reduction of the required amount of anesthetic agent with subsequent reduction of toxicity

3-Smooth induction and recovery from anesthesia (reduction of struggling)

4-Inhibition of vomiting by the anti-emetic action of the drug

5-Phenothiazine derivatives help in prevention of shock

***Warnings: -***

1-Tranqulizer doesn't produce true analgesia

2-Occisionally severe or fatal reactions may occur

3-Not economical as the cost is high in many occasions

4-When administered to shocked animal, alpha-blockage may produce fatal hypotension

## I-Strong Acting Drugs

## 1-Phenothiazine Derivatives

It acts as tranquilizer drug and may cause sedation. Effective sedation of this group in horse is clinically manifested with protrusion of the flaccid penis from the prepuce and care must be taken to avoid physical damage to this organ. Although the penis retracts again in vast majority of animals as the sedation wears off, however, prolonged prolapse may ensue that requires replacement of the penis in the prepuce with suturing of prepucial orifice.

### A-Acepromazine maleate (Acetylpromazine®)

The primary desired effect of acepromazine is its tranquilizing action. However its additional pharmacologic actions include;

1-Antiemetic

2-Antispasmodic

3-Hypothermic actions

4-In the dog it causes lowering of arterial blood pressure, an increase in central venous pressure, and antidysrhythmic effect, as it inhibits the arrhythmias induced by the ultra-short acting barbiturates, and protect against the ventricular fibrillatory actions of halothane and epinephrine

***Uses: -***

Acepromazine is approved for use in dogs, cats, and horses.

***1-Dogs and cats: -***

a-As an aid in controlling intractable animals

b-Alleviate itching as a result of skin irritation

c-As an antiemetic to control vomiting associated with motion sickness

***2-Horses: -***

It has no analgesic effects so the animals should be treated with appropriate analgesics to control pain, however its tranquilization effects can be overridden and it cannot always be counted upon when used as a restraining agent. Anyway, it never sedates more than 60% of the animals and increasing the dose will never produce more sedative effect. Sedated horses may show the signs of deep sedation but with minor stimulation they direct well-placed kicks to the source of annoyance.

a-Pre-anesthetic agent as an aid in controlling fractious animals and to help control behavior

b-In conjunction with local anesthesia for various procedures and treatments

c-Pre-anesthetic agent, at very small doses

***Pharmacokinetics*: -**

**1-The horse**

***Onset: -***

Fairly slow, 15 min after IV, peak after 30-60 min

***Metabolism: -***

It is metabolized in the liver with both conjugated and unconjugated metabolites and eliminated in the urine. Animals may require lower dosages of general anesthetics following administration acepromazine. However, cautious use and smaller doses of acepromazine should be given to animals with hepatic dysfunction, cardiac disease, or general debilitation.

***Contraindications: -***

a-It is contraindicated in patients with hypovolemia or shock because of its hypotensive effects

b-It is contraindicated in patients with tetanus or strychnine intoxication due to effects on the extrapyrimidal system

c-Intravenous injections should be made slowly, and it shouldn't be administer intra-arterially in horses; as it may cause severe CNS excitement/depression, seizures and death.

d-It should be use cautiously in very young or debilitated animals because of its effects on thermoregulation

e-It shouldn't be administered to racing animals within 4 days of a race

**2-The dog**

Acepromazine's effects may be individually variable and breed dependent. In geriatric patients, very low doses have been associated with prolonged effects of the drug. Giant breeds and greyhounds may be extremely sensitive to the drug, while terrier breeds are somewhat resistant to its effects. Boxers are reported to be very sensitive to the hypotensive and bradycardic effects of acepromazine and it should be used cautiously and in small doses in this breed. Atropine is often suggested to be given with acepromazine to help negate its bradycardic effects.

**3-The ruminants**

Although not approved, it is used as a tranquilizer for cattle, sheep and goats. It is not recommended to be used in cattle prior to general anesthesia as it increases regurgitation during induction and predisposes to delayed recovery. It can be used 1 hour prior to local analgesia if it is mandatory that the cow operated on standing position.

***Adverse effects: -***

Hypotension as an effect of Acepromazine on blood pressure is an important consideration in therapy. This effect is thought to be mediated by both central mechanisms and also through the alpha-adrenergic actions of the drug. Cardiovascular collapse (secondary to bradycardia and hypotension) has been described in all major species. Dogs may be more sensitive to these effects than other animals.

In male large animals, protrusion of the penis associates the sedative effects of the drug. In horses, this effect may last 2 hours, so stallions should be given acepromazine with caution as injury to the penis can occur with resultant swelling and permanent paralysis of the penis retractor muscle.

Other symptoms that have been reported in horses include excitement, restlessness, sweating, trembling, tachypnea, tachycardia and, rarely, seizures and recumbency. While acepromazine is a good tranquilizer, its

effects of causing penis extension in horses and prolapse of the membrana nictitans in horses and dogs, may make its use unsuitable for show animals.

There are also ethical considerations regarding the use of tranquilizers prior to showing an animal or having the animal examined before sale. Occasionally an animal may develop the contradictory symptoms of aggressiveness and generalized CNS stimulation after receiving acepromazine. At the same time, its IM injections may cause transient pain at the injection site.

***Dose: -***

Large animals 0.1 mg/ Kg B. wt. IM. However in the horse, 0.02 mg/ kg IV or 0.05 mg/kg IM has been used.

Pets 0.1 mg/ Kg B. wt. Slow IV allows 15 minutes for onset of action

## B-Chlorpromazine (Largactil® or Neurazine®)

Like phenothiazine derivatives, it is not recommended to be used in cattle prior to general anesthesia as it increases regurgitation during induction and predisposes to delayed recovery. It can be used 1 hour prior to local analgesia if it is mandatory that the cow operated on standing position.

***Preparations: -***

Suppositories, tablets, drops, and vials for injection.

***Effect and properties: -***

1-Produces state of calmness with reduction of motor activity, but it doesn't interfere with responses to unconditioned stimuli such as needle pricks and painful manipulations

2-It has potent anti-emetic, anti-adrenaline, and vagolytic properties.

3-It causes vasodilatation and should be used cautiously in shocked animals, but its use prior to operation counteracts tendency of tissue hypoxia, and prevents the onset of shock.

4-It has a wide safety margin and animals will recover from the effects of very large doses, but it should be used cautiously if there is severe depression of the heart or central nervous system, or if there are extensive liver or lung lesions.

5-The liver is the main site for detoxication so the action enhanced in during liver damage.

***Dose and administration: -***

| Animal | 1 Kg | Rout | |
|---|---|---|---|
| **Horse** | Not more than 0.2-0.4 mg | IM | Larger doses cause panic state due to muscle weakness and the animal's response may be alarming and difficult to control |
| **Cattle** | Not more than 1 mg (Not to lie down) | IM 1 hour before local or regional analgesia | Not recommended prior to general anesthesia due to relaxation of the cardia with increased risk of regurgitation, and delayed recovery, but it can be used with local or regional analgesia |
| **Dog** | 0.5-1 mg<br>1 mg<br>2 mg | IV or IM<br>Oral<br>Rectal | The maximum effect appears after 60-90 mins with IM, and 10-15 mins with IV injection |
| **Cat** | Up to 1 mg | IV or IM | |

***Uses: -***

1-Preanesthetic medication, to potentate the anesthetic agent

2-Antiemitic, and used in cases of uremia or gastroenteritis in pets, or with drugs causing nausea and vomiting.

3-Long acting strong tranquilizer

4-In case of tetanus to control titanic spasm and convulsions, and to diminish pain

5-Its use in the horse ensures that the animal will recover quietly from anesthesia

6-Its use in dog ensures absence of narcotic excitement during recovery from barbiturate, and doesn't suppress respiration of puppies or labour of bitch.

## C-Promazine HCl (Sparine® 5%)

### 1-Horses

a-0.4 - 1.0 mg/kg IV

b-0.99 - 1.98 mg/kg orally onset of action generally starts in 45 minutes and lasts for 4-6 hours

***Use and indication: -***

Like chlorpromazine

***Dose and administration: -***

| Animal | 1 Kg | Rout |
|---|---|---|
| Large animals | 1 mg | IM only |
| Pets | 5 mg | IM only |

## D-Propionyl promazine (Combelen® 1%)

It is one of phenothiazine derivatives, yellow crystalline, and soluble in water. The solution used for injection contains 1% of active principle propionylpromazine.

***Uses: -***

1-Sedation

a-Prior to drug administration

b-Examination

c-Minor operations

d-Radiographic examination

e-Dressing of wounds

2-Preanesthtic medication for induction of general anesthesia

3-Potentiation of anesthetic agents by deepening and prolongation of its effect, and reduction of 10-40% of anesthetic dose

***Disadvantages: -***

It should be used cautiously in case of cardiac disorders, and in case of severe lung, liver, or kidney problems.

***Antidote: -***

Caffeine or nor-adrenaline

***Duration: -***

1-8 hours according to rout of administration, dose, and age

***Recovery: -***

Effect disappears completely within 24 hours

***Dose: -***

The dose ranges from 0.2 - 0.3 mg/ kg

| Animal | Weight Kg | Slow IV ml | IM ml |
|---|---|---|---|
| **Horse** | ***100*** | ***0.5*** | ***1*** |
| **Cattle** | ***100*** | ***1***<br>***3 (penile protrusion)*** | ***2*** |
| **Camel** | ***100*** | ***2*** | ***4*** |
| **Sheep and goat** | ***10*** | | ***Up to 1*** |
| **Dog** | ***1*** | ***0.03*** | ***0.05*** |
| **Cat** | ***1*** | | ***Up to 0.2*** |

## 2-Thiazine Derivative (Sedatives)

## A-Detomidine

It is more popular in Europe (cheaper than xylazine) and in contrast to xylazine, the dose is similar to those used in horses 2.5 - 10 mcg/kg IV. Duration of sedation lasts 30-60 mins. 40 mcg/kg IV will produce profound sedation and recumbency. The pharmacologic effects of detomidine in cattle are very similar to those of xylazine in that it causes bradycardia, hyperglycemia, and increased urine production. Similar side effects in all other aspects with xylazine. Precautions are similar to those given for xylazine. It has lesser effect on the uterus than xyalzine in cattle.

## B-Xylazine HCl (Rompun® or Xylaject®): -

It is used in concentration of 2% (20 mg/ ml). It is a potent hypnotic which provides deep sedation and popular as premedicant. Onset of action following IV injection at 2 min, reaching peak effect in 5 minutes. It has dose dependent severe cardiovascular effect as bradycardia and myocardial depression (decreased cardiac output). It may cause hypoxemia and hypercapnia and pulmonary edema (this is most notable or predictable in small ruminants, particularly in the sheep). Xylazine is considered a potent sedative/hypnotic drug in the *horse* that has no poses administration problems, and produces sedation with a degree of muscle relaxation. It causes relaxation of the penis out of the prepuce, and ileus accordingly it has been used for treatment of equine colic.

***Properties: -***

1-It is sedative (depressant effect on CNS), analgesic, anesthetic, and muscle relaxant

2-Ruminants are 5-10 times sensitive than equine

3-It has emetic effect in pets

4-It reduces dose of anesthetic

***1-Sedation: -***

This effect is of clinical importance for;

1-Transportation of animals

2-Changing environment and familiarization with new surrounding

3-Examination and treatment of claw, or shoeing of horse

4-Surgery

5-Artificial examination of less domesticated cattle

***Duration of sedation: -***

| Animal | Period |
|---|---|
| **Horse** | 0.5-1 hour |
| **Cattle** | 0.5-5 hours |
| **Small animals** | 1-2 hours |
| **Wild animals** | 0.5-1 hour |

***2-Analgesia: -***

This effect is of clinical importance for;

1-Management of udder and teat injury

2-Dehorning, fitting of nose ring, flushing of nasolachrymal duct

3-Bloodless castration

4-Treatment of foot affections

5-Sedation of horses with colic due to ileus effect of the drug

***Duration of analgesia: -***

| Animal | Period |
|---|---|
| **Horse** | Variable |
| **Cattle** | Up to 45 mins |
| **Small animals** | 30 mins |

***3-Anesthesia: -***

1-It has local analgesic effect on the cornea of rabbit several times higher than that of procaine H Cl (0.2%)

2-Local anesthetic effect in dogs by 0.1-0.2% with induction of local insensibility for 60 mins

3-Used for epidural analgesia

***4-Muscle relaxation: -***

Used in surgical operations to avoid tetany and to capture the animal

***Duration of muscle relaxation: -***

According to the dose it varies from 20-120 mins

## ***Dose and rout of administration: -***

| Animal | IV mg/ Kg | IM mg/ Kg |
|---|---|---|
| **Horse** | 0.5 mg<br>Onset is almost immediate<br>Lasts 15-20 mins<br>Recovery after 30 mins | 2-3 mg<br>Onset over 10-15<br>Lasts 15-20 mins<br>Recovery after 60-120 mins |
| | (1.1 mg of 2% sol induce deep sedation for 20-30 min with recovery after 45 mins, and the horse doesn't go down after these doses) | (3 mg of 10% sol produce deep sedation over 10-15 mins for 30-40 mins and recovery occurs after 60-120 mins, and the horse doesn't go down after these doses) |
| **Cattle** | 0.05 - 0.2 mg<br>Produces profound sedation similar to deep narcosis | 0.05 - 0.1 mg (standing animal)<br>Onset over 8-12 mins<br>Lasts 30 mins<br>0.2 - 0.3 mg (recumbency) |
| **Sheep** | 0.11 mg | 0.22 mg |
| **Goat** | | 0.05 mg (more sensitive than sheep and sedation may last 12 hours) |
| **Pets** | 0.5 - 1 mg | 1 - 2 mg, Up to 0.2 ml 2% |

## ***Side effect: -***

It causes hyperglycemia, diuresis, sweating, GIT motility depression, platelet aggregation, and uterine contractions in cows (Detomidine in this regard has been regarded better alternative both in cows and mares). Reversal is carried out by using Tolazoline (or by other alpha 2 antagonists such as yohimbine or atipamezole)

### ***1-Cardiovascular system: -***

It causes bradycardia, in a manner resembles that of atropine

### ***2-Respiratory: -***

No great changes with recommended doses

### ***3-GIT: -***

It depresses GIT and ruminal motility and may cause tympany in ruminants but this reduction of motility is helpful in case of equine colic.

### ***4-Uterus: -***

It increases intra-uterine pressure in pregnant cows in a manner resembles that of oxytocin, accordingly it shouldn’t be used in the last trimester. This is not the same in mares that can be given xylazine along the all gestation period with no harm

## 3-Benzodiazepine derivative

## A-Short acting (Valium®, Neuril®, Diazepam® or Valipam®)

Diazepam is minor tranquilizer with a very useful drug in small ruminants and camelids. Intravenous diazepam induces reliable sedation with minimal adverse cardiopulmonary or respiratory effects. Diazepam is probably more suitable than xylazine for young animals or those with cardiovascular compromise. It can be used IM, IV, or epidurally. The anxiolytic properties of diazepam in horse are not clear and it shouldn't be used alone as the dose that produce clear depression of CNS causes ataxia due to muscle relaxation that may cause panic state like that observed with chlorpromazine.

***Uses: -***

1-Preanesthetic medication 2-Sedative and hypnotic

3-Minimal cardiopulmonary depression 4-Control of convulsions

5-Produces Excellent muscular relaxation 6-Epidural analgesia

***Dose and administration: -***

| Animal | 1 Kg | Rout |
|---|---|---|
| **Large animals** | 1 mg | IM |
| **Dogs** | 1 mg<br>5 mg | IM, pre-anesthetic and for control of restlessness<br>Oral, for control of behavioral problems |
| **Sheep and goat** | 15 mg | Oral, for wild sheep and aggressive puck |
| | 1-2 mg | IM or slow IV, for radiographic examination or as pre-anesthetic medication |

## B-Very long acting (Lorazepam)

It is 4 times potent than diazepam, with shorter on set of action and prolonged duration and recovery, and used as pre-anesthetic medication prior to ketamine HCl especially in cat.

# IV-Basal Narcosis

***Definition: -***

It is a stage during which the animals losses consciousness but still responding to painful stimuli, so it is of clinical importance for performing operations in horses and cattle under local or regional analgesia. Accordingly all anesthetics are narcotics but not all narcotic are anesthetics. Its administration should be limited to avoid interference with vital processes. The most common drug is chloral hydrate.

## 1-Chloral hydrate

Chloral hydrate can be considered sedative or hypnotic aside from it is being narcotic. However certain authors refuse its use due to its administration poses problems; and the ataxia, hypotension, and respiratory depression that associate sedation.

1-It is a white crystalline, easily soluble in water, and has penetrating odor

2-It is mainly used for equine and may be used for cattle

3-Detoxicated in liver and excreted by kidney

4-Can be used in different doses to induce three stages of narcosis

5-Can be used strictly IV, orally, or rectally

6-Hypnotic dose doesn't affect respiration, but over dose predisposes to respiratory failure via affecting the respiratory center

***Stages of narcosis, doses, and effect: -***

| Stage | Dose / 50 Kg | Conc. | Rout | Effect |
|---|---|---|---|---|
| **Light** | 3-4 gm | 10% | IV | The animal still in standing position with motor in coordination and reduced response to external stimuli, which facilitate examination of the animal. |
| **Medium** | 4-5 gm | 10% | IV | The animal becomes unable to stand, lies down, with reduced response to external stimuli |
| **Deep** | 5-6 gm | 10% | IV | The animal lies down in lateral recumbency, becomes on the border of general anesthesia, with reduced response to external stimuli |

***Advantages: -***

1-Easily dissolved in water

2-Wide safety margin

3-Detoxicated by liver and excreted by kidney

4-Easily absorbed from mucous membrane of GIT

5-The animal able to stand under effect of light and medium narcosis

***Disadvantages: -***

1-Very irritant, and can't be injected IM or SC

2-Over dose causes hypotension and respiratory failure

***Routs of administration: -***

| Rout | Dose / 50 Kg | Conc. | Onset | Recovery | |
|---|---|---|---|---|---|
| **IV** | 3-4 gm<br>4-5 gm<br>5-6 gm | 10% | Few mins | 1-2 hours | The drug is highly irritant even after dilution to 10%, so it should be injected strictly intravenous into jugular vein, to avoid cellulites and phlebitis. |
| **Oral** | 6-7 gm | About 6-8 L water | 10-20 mins | | It can be applied either by<br>1-In drinking water after fasting for 24 hours (1%)<br>2-By stomach tube after dilution in water (5%), to reduce its irritant effect. |
| **Rectal** | 8 gm | 3-4 L water | 20-30 mins | | By rectal enema |

## 2-Morphine

It is used either as morphine sulfate or HCl, and mainly used in dogs

***Dose, rout, on set, and duration: -***

| Dose | Rout | On set | Duration |
|---|---|---|---|
| Up to 5 mg/ Kg | SC or IV | 5-10 mins<br>(maximum is 30-45 mins) | 12 hours |

***Effect: -***

1-It depresses the higher functions of the brain

2-It stimulates then depresses medullary functions, and stimulates spinal reflexes

3-It produces depression, analgesia, and sleeping in dogs, but in large doses cause coma. Also it Produces pin-point pupil

4-It produces delirium or maniacal excitement in cat

5-It produces unreliable effect in horses, cattle, and pigs (narcosis or excitement), also it may cause sufficient excitement to dilate the pupil

***Side effects: -***

1-It is advised that the dose of morphine as a preanesthetic should not exceed 15 mg even in the large dogs because larger dose causes respiratory depression.

2-It crosses the placenta and reaches the fetus, depressing its respiratory center and making the initiation of breathing difficult after birth, but the analgesic doses of morphine do not affect normal uterine contractions at parturition, accordingly it shouldn't be used for caesarian section.

3-The stimulant effect on the vagal center

a-Increases gastro-intestinal activity

b-Increases the tone of the visceral muscle (especially pyloric, ileo-colic and anal sphincters).

c-Increases segmenting contractions

d-Diminishes the truly propulsive movements.

e-Delays intestinal contents in the large bowel and allows an increased absorption of water

f-Inhibits the normal defecation reflex because the distended rectum no longer produces the usual discomfort.

4-In species with developed vomiting center, it stimulates then suppresses vomiting, and when vomiting occurs, it is not associated with the usual unpleasant emotional reactions, so that animals do not appear distressed.

5-Morphine also produces retention of urine, distension of the bladder

6-It affects respiratory system through the central nervous system and decreases respiratory activity (respiration becomes slow and deep), however the analgesic effect of morphine improves respiration when it is fast, shallow, and inefficient due to pleural pain or trauma, or when lungs are edematous, as in left ventricular failure.

7-Therapeutic doses have negligible effects upon the heart rate and blood pressure, but larger doses slow the heart by depressing conduction in the myocardium and stimulation of the vagal center.

## 3-Xylazine HCl (Rompun® or Xylaject®)

As we mentioned before under title pre-anesthetic medications

## 4-Pentobarbitone sodium

It will be discussed later under general anesthesia

# V-GENERAL ANESTHESIA

***Definition: -***

It is a state of unconsciousness, insensitivity to pain and stimuli from the environment, and absence of motor reflexes to such stimuli due to transit paralytic action of the motor center produced by process of controlled reversible intoxication of the CNS without interfering with vital centers. General anesthesia can be classified according to physical characters of anesthetic agent into injectable and volatile anesthesia.

General anesthetic can be classified into *volatile or gaseous* anesthetic that can be inhaled into the lung, transmitted to circulation and reaches the CNS to produce its action; or *nonvolatile* injectable anesthetic agent that can be administered orally, rectally, or injected intra-peritoneal, intra-venous or intra-muscular after which it is released to circulation and reaches CNS to produce its effect.

Regarding ***equine***, there are numerous problems in anesthetizing this species. These problems are related to the *size* of the animal, and its *temperament* that render surgery under local analgesia in standing position more safe for the animal than general anesthesia although it may be more dangerous for the surgeon. *Size* of the animal determines both the ease of restrain and type of breathing circuit when inhalation anesthesia adopted. Accordingly, foals or small sized horse require minimal restrain and the inhalation anesthesia apparatus of human is suitable for that species, while larger sized horses require restraining by heavy sedation or intravenous anesthesia prior, but the inhalation anesthesia apparatus of human causes too much resistance to breathing. Animals of bad *temper* require the use of agents that can be injected rapidly to avoid dislodging of the needle during injection. Weight of the animal can compromise both arterial blood supply and venous drainage of the lower muscles during general anesthesia, especially when hypotensive anesthetic is to be used (like halothane). Accordingly if preventive measures are not considered, muscular ischemia and necrosis ensue leading to lameness after surgery.

***Ruminants*** are not good subjects for general anesthesia due to;

1-The danger of regurgitation and inhalation of ingesta is much greater in these species compared to other common domestic species.

2-Their docile temperament allows majority of surgical procedures to be carried out by local anesthesia (± sedation) without much difficulty, and many techniques are available (see local & regional anesthesia lectures)

However, some procedures, with economic justifications, are better performed under general anesthesia, and with certain precautions, general anesthesia can be carried out safely without complications

3-Adult cattle carries greater risk of developing myopathies and neuropathies following prolonged recumbency, so good positioning and protective padding must be ensured

4-Following recumbency esophageal opening is submerged in ruminal contents, normal eructation is blocked, and gas accumulates. The degree of bloat depends on the amount of fermentation and on the length of time that gas is allowed to accumulate

5-Gross distension of the rumen becomes a hazard if anesthesia or recumbency is prolonged and regurgitation can follow from this

6-The weight of the abdominal viscera and their contents prevents the diaphragm from moving freely on inspiration and ventilation becomes shallow, rapid and inefficient for gas exchange within the lungs.

7-In unfortunate circumstances, the aspirated regurgitatants obstruct the airway, cause asphyxia, and bring the patient to death within 24 hours of developing the complication.

***The danger of regurgitation can be minimized by;***

1-Starvation prior to anesthesia

2-Water deprivation prior to anesthesia

3-In lateral recumbency, elevating the neck to avoid easy regurgitation and positioning the head sloped down to facilitate drainage of saliva (large amount produced) and other intraoral materials.

4-Passing down a stomach tube to allow drainage of ruminal materials and accumulated gas as well during the recumbency

5-Cleansing solid materials in the mouth at the end of anesthesia, and leaving the ET tube with the cuff inflated until the animal is in sternal recumbency, swallowing and able to withdraw its tongue into the mouth

***Use of general anesthesia: -***

General anesthesia offers the ideal situation for;

1-Aseptic surgery

2-Proper handling of tissue

3-Hemostasis

***Reflexes that disappeared during general anesthesia: -***

1-Pedal reflex 2-Anal reflex 3-Tail reflex 4-Ear reflex

5-Skin pinching reflex 6-Pharyngeal, laryngeal and cough reflexes

7-Ocular reflex (corneal)

***Transportation of anesthetic agent to the brain and from brain: -***

General anesthetics are two types mainly inhalation anesthetics and injectable ones. With respect to inhalation anesthetics, following inhalation of anesthetic agent it passes to alveoli of the lung, then it diffuse to the blood, and finally it distributed throughout the body fluids and tissues. Brain tissue has high lipid contents and rapidly acquires anesthetic concentration equal to that of the blood. However the process of uptake of anesthetic depends up on many factors one of which is the blood pressure and the heart rate.

Heart rate has direct relationship with saturation of the brain with anesthetic, and the faster the heart rate as during excitement or struggling that may associate absence of tranquilization prior to anesthesia, may predispose the brain to rapid uptake of anesthetic agent. Finally the drug eliminated from the body in reverse manner and eliminated by expiration although small amounts may be lost via skin or wound.

Anesthetic drugs administered by injection are mixed with blood directly and transmitted to the brain, while oral administration of anesthetics predispose them to absorption to portal circulation and passes to the liver first then after it passes to circulation to reach the brain. Elimination of these drugs occurs via metabolization in the liver and excretion in urine.

# I-NONVOLATILE ANESTHETIC AGENTS (INJECTABLE)

Intravenous anesthesia is particularly useful either for the induction of anesthesia that is maintained by inhalation technique or when short duration anesthesia is needed, and it should be kept in mind that their effect is not as fast reversal as inhalation type. It is mandatory that the person deal with that type of anesthesia have knowledge about intravenous administration of these drugs and familiar with type of anesthesia produced so that overdose can be avoided.

Clinical level of anesthesia is related to both intensity of surgical stimulation and degree of cerebral depression. Undisturbed animal may

have depressed breathing and relaxed abdominal muscles giving the picture of satisfactory anesthesia (corresponding to 2nd or 3rd plane of 3rd stage anesthesia), but surgical stimulation of that animal may stimulate breathing and induce tonicity of muscles may be with reflex motion of limbs (corresponding to 2nd stage or 1st plane of 3rd stage anesthesia). On the other hand, increasing the dose of anesthesia may produce severe respiratory depression and loss of consciousness during absence of surgical stimulation

## A-Chloral Hydrate

Chloral hydrate is primarily a basal narcotic drug that can be injected strictly IV in concentrations of 10% (to avoid the probability of necrosis associating peri-vascular filtration). The drug may be used with barbiturate or magnesium sulfate, however it is unlikely that these combinations have advantages over the chloral hydrate alone. The dose should be increased up to 6-7 gm/ 50 kg, 10% concentration, and injected strictly intra-venous to induce deep narcosis that bordering the line of anesthesia. Generally this dose is not anesthetic and the anesthetic dose is very close to toxic dose that is why this drug is not used for anesthesia, and it should be noted that the toxic dose is 18.5 gm/ 50 kg.

***Advantages: -***

1-Absence of excitement during induction or recovery

2-Wide safety in healthy animals

3-Absence of post anesthetic nausea or malaise

4-Rapid onset (4-5 mins)

***Disadvantages: -***

1-Necrosis of peri-vascular tissue when it accidentally infiltrated

2-Prolonged recumbency (1.5-2 hrs) is a significant inconvenience

The drug can be used for induction of anesthesia in horse for minor operations like castration, but longer duration surgeries it is not convenient to use additional doses to maintain anesthesia to avoid the side effect on liver, so it is advised in such situations to make shift to inhalation anesthesia or intravenous barbiturate.

## B-Magnesium Sulfate

It is not used alone for induction of anesthesia because of its narrow safety margin, and the marked cardiovascular and respiratory depression. Its use alone is restricted to euthanasia and one liter of saturated solution is sufficient for euthanasia of adult horse.

## C-Chloral Hydrate + Magnesium Sulfate (2-3 parts:1 part)

A mixture of chloral hydrate 5 gm/ 50 kg and magnesium sulfate (2:1 or 3:1) can be used for induction of anesthesia in horse.

[5 gm/ 50 kg chloral hydrate + 1.5 - 2.5 gm/ 50 kg magnesium sulfate (3:1 or 2:1)]

***Advantages: -***

1-Less irritant 2-Faster on set of anesthesia

3-Higher depth of anesthesia 4-Lower toxicity

## D-Magnesium sulfate + Chloral hydrate + Acetylepromazine

It can be used for sedation and induction general anesthesia, generally 3 ml/50 kg of solution (containing 3% magnesium sulfate and 7% chloral hydrate) and 3 mg/ 50 kg acetylpromazine produce sedation in horse

[3 ml (7% chloral hydrate + 3% magnesium sulfate) + 3 mg acetylepromazine] / 50 kg

## E-Magnesium sulfate+Chloral hydrate+Pentobarbitone Na (Equithesin)

It is a satisfactory general anesthesia in equine although it causes prolonged recovery.

***Preparation: -***

[28 gm chloral hydrate + 14 gm magnesium sulfate + 6.5 gm pentobarbiturate + 1000 water]

***Dose: -***

75 ml/ 50 kg

(20 gm chloral hydrate + 10 gm magnesium sulfate + 4.3 gm pentobarbitone sodium)

***Advantages: -***

1-Smooth induction without excitement and smooth rapid recovery

2-Complete muscle relaxation and complete anesthesia

3-Wide safety margin 4-Low toxicity

***Disadvantages: -***

1-Short anesthetic period (15-30 mins) that increases to 40-60 mins by adding 15% of the dose

2-It should be used fresh

## F-Ketamine H Cl (Ketalar®, Vetalar®, or Ketaset®)

It is non-barbiturate general anesthetic of rapid onset and short duration. It produces anesthesia that differ from conventional anesthetic as the patient is described as being dissociated rather than being unconscious with the opened eyes and existence of some degree of swallowing reflex.

***Clinical effect: -***

1-Good analgesic

2-Poor muscle relaxant with induction of toinc-clonic spasm of limbs even in absence of surgical stimulations

3-Salivation that may cause obstruction of respiratory passage despite of presence of laryngeal and pharyngeal reflexes

4-Mild respiratory depression manifested by increased rate without compensation of decreased tidal volume

5-It raises arterial blood pressure controversial to other injectable general anesthetics

6-Its use alone causes good analgesia, poor muscle relaxation, convulsion, and violent recovery period

7-It works well when combined with xylazine or diazepam, with longer duration of action and absence of convulsions

***Doses: -***

### 1-Horse

Ketamine alone causes stimulation of CNS rather than depression with tremors or convulsions and poor muscle relaxation. However incorporation of xylazine produces an excellent induction with rapid very quiet recovery. This combination is much safer than xylazine thiopentone mixture. This method is associated with much gradual onset of recumbency controversial to the effect of thiopentone. Respiratory depression is minimal so that maintenance by inhalation anesthesia can be achieved. Generally it is not recommended to prolong anesthesia induced by this mixture by additional injection of ketamine to avoid its associating excitatory effect.

***Xylazine 1.1 mg/ Kg IV + Ketamine 2.2 mg/ kg IV → lateral recumbency after 1-2 mins***

***or***

| | | | |
|---|---|---|---|
| ***Xylazine H Cl 2.2 mg/ kg*** *IM* | *20 mins* → | ***Glyceryl quaiacolate 55 mg/kg*** *IV 5% in dextrose 5%* | ***Ketamine 1.7 mg/kg*** *IV* |

**Glyceryl quaiacolate** is a sedative and anaesthetic agent in horses. Used alone, or in conjunction with barbiturates, it produces a uniformly smooth recovery from anaesthesia. The need to infuse large volumes to obtain the desired effect is a disadvantage of this agent

## 2-Cattle

Ketamine alone will not cause seizure in cattle but the quality of induction is poor. However it is associated with increased muscle rigidity and excessive salivation and it may cause increased heart rate, cardiac output, and blood pressure. Generally it is better to be used in combination with other sedatives (most commonly with benzodiazepines).

### A-Calves

Calves from one week to one year can be anesthetized in the following manner

1-Ketamine 20 mg/ kg IM or IV

2-Ketamine 10 mg/ kg IM + Xylazine 0.2 mg/ kg IM

***Duration: -***

35 minutes

***Recovery: -***

80-90 minutes

In calves 0.25 mg/kg of diazepam and 5 mg/kg ketamine can be combined and injected IV. Butorphanol 0.1-0.2 mg/kg IV can be included in this combination for better analgesia and muscle relaxation. This regimen provides approximately 15 minute of anesthesia

### B-Mature cattle

**[Xylazine 0.2 mg/ kg (IM) or 0.1 mg/ kg IV + Ketamine 2 mg/ kg IV]**

Injection of xylazine prior to ketamine provides that ketamine produce excellent anesthesia, quite induction, good muscle relaxation, and smooth uncomplicated recovery. Endotracheal intubation can be performed directly after injection of xylazine and induction of sedation, to avoid asphyxia or drenching pneumonia due to either excessive production of saliva or inability to swallow. Prolongation of duration can be assured by

drip infusion of ketamine 2 mg/ml and recovery is completed 45 mins following stopping of infusion.

**[Xylazine 0.1-0.2 mg/ kg (IM) or 0.05-0.1 mg/ kg IV + Butorphanol 0.1-0.2 mg/kg IV +Ketamine 2 mg/ kg IV]**

Another technique includes injection of Xylazine to adult cattle either IM at 0.1 – 0.2 mg/kg or IV at 0.05-0.1 mg/kg to produce deep sedation often recumbency. Butorphanol 0.1-0.2 mg/kg IV can be included in this combination for better analgesia and muscle relaxation. Then after Ketamine is then given IV in doses of 2 mg/kg to induce anesthesia. Often, Endotracheal intubation can be performed soon after the xylazine injection and before ketamine is given and whenever possible this should be done, as ketamine appears to produce copious salivation or an inability to swallow the normal saliva volume. Hypoxia due to hypoventilation during the use of this combination has also been reported. For this reason, supplemental oxygen is recommended.

**[Diazepam 0.1 mg/kg + ketamine 2 mg/kg given IV]**

This combination will produce less cardiovascular depression than xylazine-ketamine. This combination is used for induction in xylazine pre-medicated animals in the dose of diazepam 0.1 mg/kg and ketamine 2 mg/kg given IV inducing anesthesia in 60 seconds

## 3-Small ruminants

Ketamine on its own has analgesic effect in small ruminants yet they aware of surrounding, and maintained ability to eructate, cough, and swallowing. It can be used alone or with other drugs to reduce excitation and increase muscle relaxation. Animals should be pre-medicated with atropine sulfate 0.4 mg/ kg IM, and incorporation of xylazine and/or diazepam increases skeletal muscle relaxation and suppresses excitatory effect of ketamine.

In small ruminants 0.25 mg/kg of diazepam and 5 mg/kg ketamine can be combined and injected IV. Butorphanol 0.1-0.2 mg/kg IV can be included in this combination for better analgesia and muscle relaxation. This regimen provides approximately 15 minute of anesthesia.

a-Ketamine 20 mg/ kg (IM or slow IV)

b-Ketamine 11 mg/ kg + Xylazine 0.22 mg/ Kg IM

c-Ketamine 4 mg/ kg + Xylazine 0.05 mg/ kg IV + Diazepam 1-2 mg/ kg

## 4-Dog

Anesthetic dose is very close to convulsion dose so it is not recommended as sole anesthetic agent in that species. However pre-medication with diazepam and xylazine (even via epidural rout) prolongs duration of analgesia and reduces convulsions.

***Dose: -***

5 mg/ Kg IM (premedicated with Xylazine or promazine)

***Duration: -***

30 mins and recovery is 90 mins

## 5-Cat

As the drug can be used IM, it makes it very useful agent for induction of anesthesia in the cat that is difficult to be handled.

***Dose: -***

a-Ketamine 11-22 mg/ Kg IM

b-Ketamine 5 mg/kg IV + after 1 mg/kg Xylazine IM + 0.3 mg atropine

***Duration: -***

30 mins and recovery is 90 mins

## G-Barbiturate

Barbiturates (thiopental sodium, thiopentone sodium, or pentobarbital sodium) are sodium salt of barbituric acid and when dissolved in water they act as weak acids and the effect (depth of anesthesia) of these derivatives is directly proportional to the acidity of the solution and blood pH. The drug acts via depression of CNS by blocking the passage of impulses to cerebral cortex.

The drug is used mainly for induction of general anesthesia in dogs while in equine its use is limited to obtaining muscular relaxation with chloral hydrate and magnesium sulfate.

On injection, about 30% of the dose should be injected rapidly IV and the rest injected slowly till absence of reflex

***Clinical effect: -***

1-Respiratory depression

2-Circulatory depression centrally and peripherally with dropping of blood pressure

3-Lowering body temperature due to reduction of basal metabolic rate

4-Complete muscle relaxation

## 1-Pentobarbital Sodium

***Characteristics: -***

1-White powder or crystalline granules

2-Soulable in water or alcohol to form colorless solution

***Rout: -***

Freshly prepared solution can be used orally, IV, or intra-peritoneal

| Dose | Duration | Recovery |
|---|---|---|
| 25 mg/kg | 30 mins | 6-18 hrs and cats my not arouse for as long as 24-72 hrs |

***Disadvantage: -***

1-The drug is able to cross the placenta leading to high mortality fetus accordingly it is not recommended for cesarean section.

2-Anesthetised animals exhibit the same signs of anesthesia in reverse order as crying, shivering, involuntary movement, and finally standing with staggering gait.

## 2-Thiopental Sodium

The ultra-short acting thiobarbiturate, thiopental, provides approximately 10-15 minutes of anesthesia when used alone. Recovery is through redistribution of the agent from the brain into the other tissues. Maintenance of anesthesia through continuing use of thiopental is not recommended due to accumulative effect and resultant prolonged recovery. Maintenance of anesthesia for longer periods of time can be accomplished through the use of inhalation anesthesia. 6-10 mg/kg in unpremedicated animals provides 10-15 minute of recumbency. Thiopental (2g) can be combined with guaifenesin (50g) and can be administered at 100 mg/kg guaifenesin-4 mg/kg thiopental titrated to effect. Pentobarbital, a short acting barbiturate was a commonly used injectable anesthetic agent in ruminants but is largely replaced by contemporary induction agents.

***Characteristics: -***

1-Yellow crystalline powder unstable in aqueous solution or air, accordingly solution should be freshly prepared and kept at 5-6 C° to retard deterioration. Old solution becomes turbid with precipitated crystals.

2-It is preferred to be used in diluted solution (2.5%) for;

-The accidental toxicity is less likely to occur

-To avoid spasm of vein and thrombosis

-To avoid skin necrosis and sloughing if the peri-vascular tissue is infiltrated

3-The drug is strictly intravenous general anesthetic

| Dose | Duration | Recovery |
|---|---|---|
| 25 mg/kg | 15 mins | 60-90 mins |

## 3-Thiopentone Sodium (Nesdonal® or Intraval®)

It is ultra-short-acting barbiturate and injection of 1 g/ 90 kg (10 % conc) causes the horse to lie down 30 seconds post injection for 3-4 mins then after signs of recovery becomes apparent and complete recovery (*usually violent in horse and quite in cattle*) occurs after 35-45 mins. Accordingly this drug is useful for induction of anesthesia in standing cows or horses to avoid casting. Accordingly it is suitable for induction of anesthesia that maintained by halothane.

Although it can cause anesthesia for 10 mins in horse, it is unwise to prolong anesthesia for more than 20 mins by repeated injection. Many authors don't consider it suitable agent neither for induction nor for maintenance of anesthesia, however it is useful for use in small does for animals that awake during maintenance anesthesia by other agents. However the induced narcosis by this drug depends up on;

1-The rate of distribution of the drug in the non-fatty tissues

2-The rate of up take by fatty tissue

3-Amount of the injected drug

4-Rate or speed of injection

Both of the last two factors are related, and it means that rapid injection of small amount induces high plasma concentration, high brain level, and rapid induction of deep narcosis. However this is followed by rapid distribution of the high plasma concentration to the non-fatty tissue with rapid reduction of both plasma and brain concentrations leading to rapid decrease in the narcosis depth.

On the other hand, slow injection of large amount of the drug maintains high plasma level as the drug is distributed through body tissue, and this indicated the need for large amount of the drug to obtain deep narcosis, while recovery depends up on drug up take by fatty tissue as the non-fatty tissue concentration will be high at the end of injection.

Rate of detoxication is slow indicating that its repeated injection for maintenance of anesthesia predisposes to prolonged narcosis due to saturation of both fatty and non-fatty tissue by repeated injection.

***Characteristics: -***

1-It crosses blood-brain barrier with very great speed so its rapid injection produces short period of narcosis with rapid recovery.

2-Anesthesia appears about 1 minute after intravenous injection accordingly the CNS depression differs from that of other anesthetics as the excitement stage may be not seen,

3-The drug has little or even no analgesic effect so the reflex to painful stimuli may be not abolished unless very deep stage of anesthesia is achieved. However pre-medication with analgesic drugs enables operative procedures to be performed at lower plasma levels of thiopentone that would be insufficient if thiopentone used alone.

4-The drug should be freshly prepared and after preparation it can be used for up to 5 days when kept under room temperature.

***Effect: -***

***1-On heart: -***

Rapid IV injection causes transient fall in blood pressure, moreover the drug has direct depressant effect on myocardium, and causes cardiac arrhythmia, so it is not preferred to be used or to be rapidly inject it in patients with cardiac diseases.

***2-On respiratory system: -***

It causes period of apnoea after injection due to central depression by high plasma level, also sensitivity of the center to $Co_2$ decrease as narcosis becomes deeper, leading to increased arterial level of $Co_2$. The high level of blood $Co_2$ predisposes to acidosis that increases the un-dissociated fraction of thiopentone (the only fat soluble part). However recorded apnoea never lasts more than 20 seconds and requires no artificial respiration.

***3-Laryngeal and bronchial reflexes: -***

Their sensitivity increases under light narcosis and this is due to inability of light narcosis to block the afferent side of the reflex pathway like other anesthetics do.

***4-Liver: -***

Large doses causes hepatic damage and the dose should be reduced with patients suffer from liver disease.

***5-Kidney: -***

The drug should be used carefully in patients with history of renal diseases as ureamia prolongs duration of narcosis.

***Dose: -***

1 gm/ 90 kg (11 mg/ kg) for *horse* or *cow* IV, or 5.5 mg/ kg when the animal premedicated with xylazine or acepromazine

25 mg/kg 2.5% strictly IV for *dog*

This low concentration ensures that there will be no spasm or thrombosis of vein, and when the drug infiltrates the peri-vascular tissue there will be limited probability of necrosis

***Advantages: -***

1-It can be used for standing *horses* without the need for restraining as an induction anesthesia

2-It can be used in small does for *horses* that awake during maintenance anesthesia by other agents

3-It is useful in *horses* subjected to induction by xylazine/ketamine and maintained by halothane, and still moving, as prevention of moving requires high dose of halothane that may cause hypotension and this can be avoided by IV injection of 0.5 gm thiopentone.

***Disadvantages: -***

1-Sudden falling of the *horses* after injection predisposes heavy breeds for skeletal injuries

2-Recovery associated with violent movement that may cause injury to the *horses* controversial to *cattle*. However this can be avoided by premedicating the horse with 0.4 mg/ kg acepromazine or 0.5 mg/ kg xylazine.

3-Pervascular problems when accidental perivascular injection in high concentrations performed

4-Despite the safety of the drug in cows and horses, it is not preferred, even in small does, for calves under 2 weeks or foals of age less than 1 month as it causes very prolonged recovery

5-The associated respiratory depression interfere with normal inhalation of inhalation anesthetic agent used for maintenance anesthesia. This could be

overcome by halving the dose of thiopentone with premedication by chloral hydrate, acepromazine or xylazine

6-It is not suitable for animals with cardiovascular diseases

## 4-Thialbarbitone Sodium

Its potency is 50% that of thiopentone but it has lesser depressant effect on respiratory system at any level of narcosis

***Characteristics: -***

1-Pale yellow water soluble powder

2-Its solution is stable for one week in refrigerator

3-Used as thiopentone sodium but it has lesser respiratory depression and lesser fall in blood pressure.

4-It increases salivation and should be pre-medicated with atropine

***Dose: -***

25 mg/kg 10% freshly prepared solution

## 5-Pentobarbitone Sodium

It acts as narcotic, sedative, and anesthetic by depressing CNS, however it has weak analgesic effect. It takes fairly longer duration to cross the blood-brain barrier and the maximum depth of narcosis is not reached until 3-5 mins post injection, thus a much slow rate of injection is indicated.

***Dose: -***

It exists as solution of 6.5% concentration and it can be used for induction of basal narcosis in dogs by slow IV injection of 20-25 mg/kg.

It can be used as *sedative* in cattle and horse, generally it can be used for *sedation* and *narcosis* in cattle by using 0.5-1 ml /50 kg (1-2 gm 20% IV) but when it is injected in cattle in a dose rate of 3 gm /500 kg 20% IV, recumbency and loss of consciousness ensues and this can be utilized for induction of basal narcosis prior to induction of general anesthesia.

In small bovine, 1 gm /50 over 4 mins infusion time induce light anesthesia for 30 mins, however the animal will not be able to regain its feet before 3 hours, generally this technique should be avoided in calves younger than 1 month to avoid the prolonged narcosis that may last 2 days and may cause death due to pulmonary edema.

The drug shouldn't be used for *narcosis* in equine as it is causes prolonged recovery rate that is associated with narcotic excitement. However in cattle

and horse, small doses IV 15-20 ml 6.5% (i.e. 1-1.25 gm) prolongs narcosis induced by chloral hydrate. By then it is slowly injected as soon as chloral hydrate depression becomes inadequate, however this injection has the advantages that;

1-The recumbency period is reduced than when another injection of chloral hydrate is given

2-Recovery associated with no excitement in horse

3-More than one injection can be given (up to 4gm) during the course of long operations

***Effect: -***

1-It can cross placental-barrier to foetal circulation tat inhibits foetal respiration

2-It stimulates release of antidiuretic hormones with reduction of renal out put

3-It has no toxic action on myocardium

4-It depresses vasomotor center leading to peripheral vasodilatation and subsequent fall in blood pressure

5-It has no adverse effect on the liver unless high doses are used in already damaged liver

***Disadvantages: -***

In the horse it causes prolonged recovery associated with narcotic excitement

## H-Propofol

Propofol can be used in small ruminants or in calves for the induction and maintenance of general anesthesia. It provides rapid induction and it is very rapidly eliminated from the plasma. 5-6 mg/kg IV produces 4-9 minutes of anesthesia Maintenance of anesthesia can be achieved using a constant rate of infusion. Expense is the primary limiting factor (along with impractically large volume for rapid administration) for use of this agent in large ruminants.

***Advantages of injectable general anesthetics: -***

1-The most direct rout in reaching the CNS with very short induction phase

2-Very economic when compared with inhalation general anesthesia

3-Most injectable general anesthetics are stable and not flammable

4-Most injectable anesthetics can be utilized intra-peritoneally

5-Can be utilized with minimal need for assistance

***Disadvantages of injectable general anesthetics: -***

1-Longer recovery period

2-Management and control of over dose is not as accurate as inhalation

# II-Volatile or Gaseous Substances (Inhalation Anesthesia)

## A-Chloroform

Generally it is the most dangerous anesthetic agents when compared with other agents and deaths had been recorded during induction due to ventricular fibrillation. It can be used by any of the 4 methods of induction of anesthesia and reduction of deaths can be achieved either by the use of phenothiazine premedication to reduce the required amount for induction anesthesia, or by induction of anesthesia by thiopentone sodium. Also deep anesthesia should be avoided as it causes inadequate ventilation and hypotension.

***Characteristics: -***

1-Heavy and clear color liquid with boiling point of 61 ºC

2-Sweet smelling of pleasant odor so it is easy and not unpleasant to inhale

3-It is neither inflammable nor explosive

4-Non-irritant vapour but the liquid is irritant to skin and mucous membranes and causes burn if spilt on them

5-Decomposed by light or air so it should be stored in cool dark place in dark bottle and the residue in the anesthetic machine should be discarded

6-Decomposed by alkali but at the same time it can be used with soda lime as long as it is of good quality

***Effects: -***

***1-Respiratory system: -***

The respiratory center is influenced both directly and indirectly and in the early stages respiration is deep and accelerated by struggling. While during anesthesia the susceptibility of the center to $Co_2$ stimulation is depressed and breathing becomes slow and shallow. In addition the center is directly

affected by the general fall in blood pressure. It produces low cardiac out put and low blood pressure and it produces simultaneous respiratory and circulatory arrest controversial to halothane that causes respiratory failure earlier than circulatory one.

Struggling during induction of anesthesia produces deep accelerated respiration, however as anesthesia ensues, progressive respiratory depression occurs leading to slow shallow respiration and the respiratory center becomes less sensitive to carbon dioxide.

***2-Heart: -***

Regarding circulatory system, it affects the heart itself, medullary center, and the peripheral blood vessels.

During early stages of induction it causes slow heart rate due to vagal stimulation that may cause heart failure, but once anesthesia becomes well established, the slow heart rate becomes regular, but dilatation of the heart and reduction of it contraction force has been noticed.

During early stages of induction, and due to struggling, the increased heart rate associated with reflex stimulation of the center leading to increased blood pressure, but during anesthesia the center is depressed, the peripheral blood vessels dilate and blood pressure falls. In addition to this central effect the walls of the blood vessels themselves are affected and this is a contributory factor in the fall in blood pressure.

It has toxic effect on heart leading to fatty degeneration even with therapeutic doses. Although the entire heart can be affected dilatation of left atrium can be noticed as it is the 1$^{st}$ part of the heart exposed to inhaled vapour followed by ventricles that receive the agent by coronary arteries and there is evidence that adrenaline causes ventricular fibrillation in presence of chloroform. The heart in such condition is much more susceptible to arrest as a result of vagal stimulation, toxic effect of chloroform on the myocardium and adrenaline release and this is the main cause of heart failure during induction.

***3-Body temperature: -***

It falls progressively during anesthesia due to

a-Peripheral vasodilatation with increased heat loss

b-Reduction of heat production by the reduced tone immovable muscles

***4-Liver: -***

Exposure to chloroform anesthesia to any duration produces cloudy swelling, fatty degeneration, glycogen depletion and central necrosis of hepatic lobules that develops 6-10 hrs post inhalation and requires approximately 14 days for repair. Clinical signs include acute acidosis, severe vomiting (in pets), and ictrus.

***5-kidney: -***

The direct effect of the drug on both of heart and kidney produces anuria during anesthesia, which is followed by poly urea and albuminuria after recovery. Severe acidosis is associated by acetonuria

Recorded death 1-10 days post anesthesia occurs due to cardiac, hepatic, and renal lesions accordingly the chloroform is not recommended for patients with cardiac, respiratory, renal, or hepatic insufficiency.

## B-Ether (Diethyl ether)

Its use in cattle is save as well as in other animals, and it can't be used by open or semi-open methods and it is better to be used for maintenance of anesthesia (not for induction) in narcotized cow or horse (by thiopentone or chloral hydrate) by using closed or semi-closed methods due to its high cost and irritation of mucosa with increased bronchial and salivary secretion especially in calves. However it has quiet rapid recovery in cow about 60 mins after termination of anesthesia, but in horse recovery is usually associated with excitement when thiopentone is used for induction so premedication with phenothiazine reduces that excitement during recovery.

***Characteristics: -***

1-Colorless liquid

2-Highly volatile (34 ºC boiling point)

3-It has pungent odor so its use for induction of anesthesia is difficult for anesthetist and unpleasant for the animal

4-In presence of air or oxygen it forms toxic aldehydes by oxidation

5-Lighter than chloroform but heavier than air 2.6 times

*Accordingly inflammable vapour tends to accumulate near the floor*

6-Inflammable and explosive

7-It is decomposed by air, light, or heat therefore the liquid should be stored in sealed dark containers in cool dark place

8-Its vapour irritant to all tissues and its liquid causes burns when spilt on skin or mucous membranes

9-Effect on tissues

***a-Respiratory mucosa: -***

The irritant effect of the vapour causes breath holding during induction of anesthesia, increased flow of respiratory and salivary secretions that interfere with respiration and lowers immune resistance with increased susceptibility of post-operative pneumonia. However it is mild respiratory stimulant.

***b-Renal mucosa: -***

The irritant effect of the agent reduces urine output during anesthesia and induces post anesthetic albuminurea

***c-Hepatic and cardiac tissues: -***

It has minimal effect on liver and cardiac muscle

10-It produces post-operative nausea and the animal refuse to eat several hours post-surgery

11-It has wide safety margin and it is one of safest anesthetic agent

## C-Ethyl chloride

***Characteristics: -***

1-It is a potent general anesthetic but doesn't produce good muscle relaxation in dog

2-It boiling point is 12 ºC, so it exist in gaseous form at room temperature

3-Under pressure and low temperature it is a colorless liquid with ethereal odor and it is supplied as glass tube with spring loaded metal spraying nozzles

4-Its vapour is heavier than air and explosive

5-Non-irritant and causes easy rapid induction

*used for induction not for maintenance of anesthesia and its use is restricted to birds and for very short period in cats*

6-It has narrow safety margin

7-Over doses may ensue during induction and it causes;

***a-Cardiac: -***

It causes depression of myocardium, and ventricular fibrillation that may causes death. It also causes fall in blood pressure due to direct depression of vasoconstrictor center, peripheral vasodilatation, and cardiac slowing.

***b-Hepatic and renal system: -***

It causes hepatitis, renal damage, and renal failure

## D-Nitrous oxide

Nitrous oxide is the oldest anesthetic agent and its use as principle anesthetic in veterinary field is limited. As it is not potent anesthetic, produces no muscle relaxation, has tendency for induction of asphyxia in unskilled anesthetist, and requires very expensive apparatus for using it alone in horse, it can only be used with $O_2$ for vaporization of ether or chloroform for reduction of amount of potent inhalant anesthetic agents (ether or chloroform) that has depressing effect on cardiovascular system.

Controversial to all inhalant anesthetics, nitrous oxide can be administered to patients in high concentrations as it has minimal irritating effect.

Moreover its analgesic effect in human is much more pronounced than animals, and the cost of its use is higher than other inhalant anesthetics.

The drug can be used for maintenance of anesthesia induced by barbiturates with operations that don't affect sensitive structures (because it is weak anesthetic) and when there is no need for muscle relaxation (as it is poor muscle relaxant).

It has smooth rapid recovery especially when minimal intravenous supplementary agents have been used, and when used alone for induction and maintenance, the animal gains its feet 10 minutes after termination of anesthesia.

***Characteristics: -***

1-It is colorless gas

2-Odorless or faint pleasant smell gas

3-It is neither inflammable nor explosive

4-Exist as liquid at room temperature under pressure

5-It is *not irritant* and not toxic (in absence of hypoxia) so it can be used for long duration anesthesia

*occupational exposure to it may cause significant health hazards*

***Advantages: -***

1-It is neither inflammable nor explosive

2-It is non-toxic (in absence of asphyxia)

3-It has rapid recovery with no post-surgical complications

***Disadvantages: -***

1-It is *not potent*, has weak narcotic and weak anesthetic action so it is preferred to be used for maintenance of anesthesia in unconscious animals previously medicated with thiopentone sodium

2-It is not suitable for large animals due to the high *cost* as a result of both the large gas flow rate required in large animals and the cost of the necessary apparatus

3-It is poor muscle relaxant

4-It is associated with high incidence of asphyxia

5-It enters gas containing cavities and causes over expansion (intestine)

## E-Halothane (Fluthane®)

It is potent, safe, mild irritating, of very low toxicity, has fast recovery, has minimal effect on liver and kidney, so it is considered as the most popular in veterinary anesthesia, but due to its high cost, it shouldn't be used by open or semi-open methods and it is preferred not to use it for induction.

Induction of anesthesia in 450 kg *cow* or *horse* requires 30-40 ml that can be maintained for 1 hour by further 25-30 ml and the next hour requires lesser amount that means that the required dose for maintenance is lesser than that required for induction. As a result of its high cost, induction can be achieved by IV thiopentone that can be maintained for 1 hour by the same 25-30 ml halothane, however the use of thiopentone sodium predisposes to delayed recovery.

When anesthesia induced in horses by xylazine/ketamine, and maintained on halothane, the animal gains its feet 30 mins after discontinuation of halothane anesthesia, but this duration duplicated if the same horse was subjected to induction by acepromazine/thiopentone.

***Characteristics: -***

1-It is not inflammable and non-explosive

2-Boiling point is 50 ºC

3-It has characteristic but not unpleasant odor

4-Slowly decomposed by light but not affected by soda lime

***Advantages: -***

1-It is mild irritating and causes minimal mucous membrane irritation so it has smooth rapid easy induction and maintenance

2-It has fast recovery free from excitement as the animal supports himself on brisket 6-7 mins after termination of anesthesia with incoordination after 10-15 mins, and finally it gains its feet after 15-30 mins

3-It is potent 2 times more than chloroform and 4 times more than ether, has wide safety margin (twice more safe than chloroform or ether) and of very low toxicity so it is a very satisfactory anesthetic in cattle

4-It has minimal effect on liver and kidney

5-It has low incidence of inappetence after anesthesia

6-It causes reasonable muscle relaxation

***Disadvantages: -***

1-It is of high cost so it should be used by closed or semi-closed system

2-It is not wise to produce profound muscle relaxation by it due to low blood pressure that decreases by increasing the depth of anesthesia

3-It decreases blood pressure and slows pulse that return to normal after 30 mins

4-It causes direct depression of myocardium and central depression of vasomotor center leading to cutaneous vasodilatation

5-It produces low cardiac output and low blood pressure but it causes respiratory failure long time before circulatory failure

6-It causes relaxation of smooth muscle fibers so it delays involution of uterus after cesarean and predisposes to post-partum uterine hemorrhage

7-It has potent respiratory depression effect that causes difficulty in maintenance of anesthesia induced by intravenous agents especially on using large dose of a drug that has depressant effect on respiration like barbiturates, used for induction, accordingly xylazine/ketamine is preferred for induction if halothane is to be used for maintenance.

## Methods Of Induction Of Inhalation Anesthesia

### 1-Open method or rag and bottle anesthesia

It can be used for to volatilize ether or chloroform via dropping them by dropper bottle on the surface of a piece of gauze or lint that is held over the face of the animal, this gauze or lint may be stretched over wire frame to

form a mask with preservation of free flow of air between the mask and the face. This technique can also be applied by using ethyl chloride spray.

***Disadvantages: -***

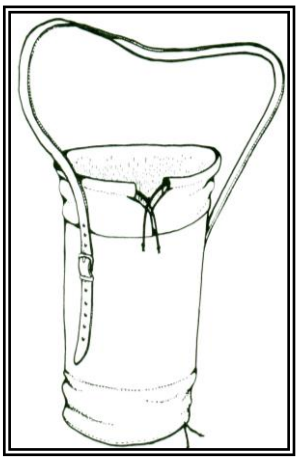
1-Lack of control of ventilation, as oxygen enrichment should be always given during general anesthesia

2-Excessive loss of volatile agents that is not only unpleasant for the surgery team but also explosions and fires may ensue if the used anesthetic agent is inflammable

3-Dilution of anesthetic agent to unknown extent

4-Difficulty of maintaining stable anesthetic state

5-Animal that become more lightly anesthetized tends to awake and animal that becomes more deeply anesthetized tends to have respiratory depression and to become more depressed so that air dilution decreases that increases anesthesia concentration and make the animal nearer to death.



## 2-Semi-open method (perhalation)

All respired air is made to pass through the mask on which the vapourization of anesthetic agent is occurs. The space between the mask and the face is closed with double thick layer of Gamgee. The 1st layer of Gamgee has small hole in its center so that when it is in position the nose and the mouth are the only exposed parts of the face. Then after the nose and mouth are covered with the mask over which the 2nd layer of Gamgee, with large central hole, is applied. The sponge containing the anesthetic agent shouldn't come in direct contact with the nostril to avoid burns when using irritant agents like chloroform.

***Disadvantages: -***

Same as open method

***Hinz's Box: -***

It is a glass or transparent plastic box used for inhalation anesthesia (ether) in cat and dog.

***Advantages: -***

1-Require no restraint and no assistant

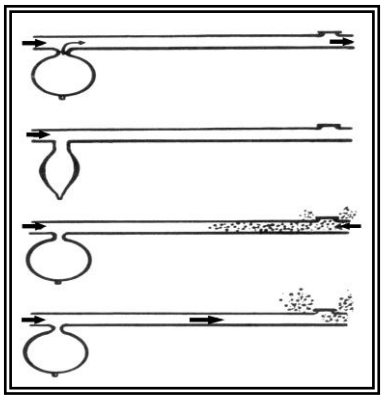
2-Minimized anesthetic emergency

3-Animal passes into a state of anesthesia with minimal amount of struggling

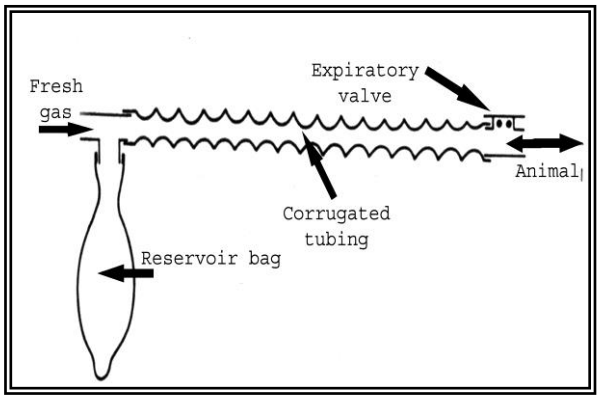
## 3-Semi-closed method

It has two systems, with or without carbon dioxide absorption. Vapours flow from anesthetic apparatus into reservoir bag from which the animal inhales through endo-tracheal tube, while part of the exhaled mixture passes out into the atmosphere through an expiratory valve.

With Magill system the rebreathing is prevented by maintaining the total gas flow rate from cylinders slightly in excess of the patient respiratory minute volume. The animal inhales from the bag and wide-bore tubing, and the exhaled mixture passes back up the tubing displacing its gas contents back to the bag till filling it.

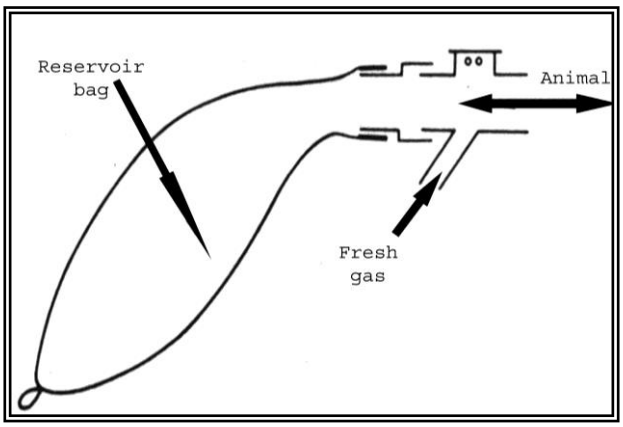


*Magill attachment*




The exhaled gas never reaches the bag due to the greater capacity of the tube and once the bag is distended, the build-up of pressure inside the system causes the expiratory valve to open so that the terminal part of expiration passes out of the valve into the atmosphere. During the pause after expiration and before the next inspiration, fresh gas from the anesthetic apparatus sweep the reminder or the 1st part of exhaled gas from the corrugated tube out through the expiratory valve.

With other systems it is more difficult to prevent rebreathing since the inflowing gases from the anesthetic apparatus will not wash expired gases out through the expiratory valve this difficulty can be over came by interposing soda lime canister between animal and the bag and this system is referred

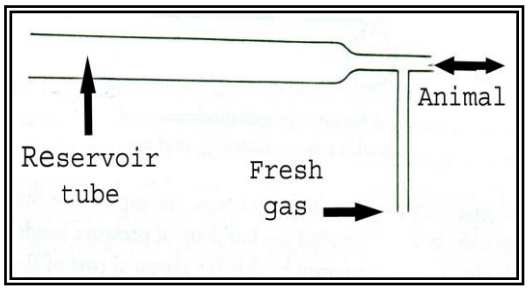



*Semi-closed system without absorption*

as semi-closed system with $Co_2$ absorption.

A similar system can also be arranged with circular type of absorber unite by opening the expiratory valve near the face mask or endo-tracheal tube. Soda lime canister with semi closed system permits lowering in gas consumption but it requires considerable practicing as the expiratory valve setting and the gas flow rates require continuous adjustment throughout the anesthetic period. For pets, none of these systems is suitable and they require T-piece system with an open end tube that acts as reservoir with no valve. The exhaled gas swept out of the open end of the reservoir tube, by fresh gas flow in from the anesthetic apparatus during expiratory pause.

Unless the capacity of the reservoir tube is at least equal to the tidal volume of the animal, the inspired gas will be diluted with air. The T-piece system included three types




*T-piece system*

1-T-piece with expiratory limb of lesser capacity than tidal volume

2-T-piece without expiratory limb

3-T-piece with expiratory limb of greater capacity than tidal volume

The last type is concluded to be the best type and it has open-ended bag attached to the distal end of expiratory limb, accordingly fresh gas flow of 2.5-3 times the minute volume of respiration is required to eliminate rebreathing.

## 4-Closed method with Co2 absorption

In this method, vapours flow from anesthetic apparatus into reservoir bag from which the animal inhales through endo-tracheal tube. The exhaled anesthetic agent that is mixed with $Co_2$, is directed to closed bag at which $Co_2$ is removed by soda lime and $O_2$ is added to satisfy metabolic requirements, then the same vapour is rebreathed.

The soda lime may contain dye that act as an indicator for the degree of saturation or absorbing capacity of soda lime. Soda lime consists of 90% calcium hydroxide, 5% sodium hydroxide, and 5% silicates and water to prevent powdering.

***Advantages: -***

1-It is a simple method that consumes less amount of anesthetic agent (no wastage to atmosphere)

2-Lower probability of fires and explosions

***Disadvantages: -***

1-Resistant to respiration because of the packed soda lime that renders this method unsuitable for cats, puppies, and small sized adult dogs

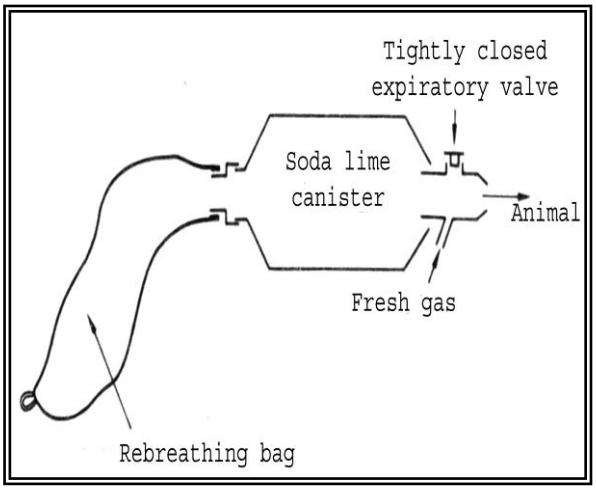
2-Conservation of heat and water vapour afforded by this method may cause heat stroke in dog and sheep.

There are two systems in use for closed-circuit $Co_2$ absorption techniques of anesthesia;

1-To-and-fro system

2-Circle system

## 1-To-and-fro system




A canister of soda lime is interposed between the animal and the rebreathing bag and fresh gas is fed to the system as close to the animal as possible to effect changes in the mixture rapidly.

***Advantages: -***

1-Simple and efficient

2-Inexpensive and may be improvised

2-No wastage of anesthetic agent

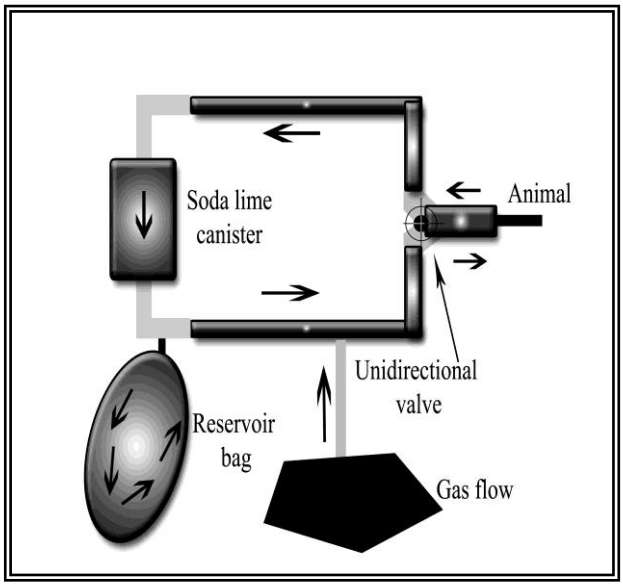
***Disadvantages: -***

1-Difficulty in maintaining the heavy awkward apparatus in a gas-tight condition

2-The inspired gas becomes undesirable hot due to chemical reaction between soda lime and $Co_2$

3-High probability of bronchitis due to inhalation of irritating dust from the soda lime canister

4-It is not really efficient absorber of $Co_2$ due to exhaustion of soda lime at canister end near to the patient




## 2-Circle system

This system for $Co_2$ absorption incorporates inspiratory and expiratory tubes with unidirectional valves to ensure one way flow of gases, and rebreathing bag and soda lime canister are placed between these tubes. The valve and tubing offer considerable resistance to breathing and strain on the animal.

It is not suitable for cats and small dogs because of the resistance to breathing and inevitable degree of rebreathing at the T-piece connection to the patient, however the later could be over came by placing unidirectional valve close to the face piece.

***Advantages: -***

1-Simple and efficient

2-It is more efficient absorbers of $Co_2$ than to-and-fro unites due to their constant dead space so that all the soda lime is available to the respired gas

***Disadvantages: -***

1-Expensive

2-Valve and tubing offer appreciable resistance to breathing that may causes strain on animal

3-Exhusion of soda lime is sudden than to-and-fro so inspired $Co_2$ may become excessive suddenly

4-It is not suitable for field work

## Breathing System And Anesthetic Machine

The primary purpose of that machine and breathing system are;

1-Delivary of $O_2$ and exact amount of anesthetic agent

2-Removal of $Co_2$ from exhaled gas by dilution, non-breathing valves, or $Co_2$ absorber

3-Provision of positive pressure ventilation

**Basically the anesthetic apparatus for inhalation anesthesia is consisted of;**

1-Source of $O_2$ and compressed medical gases as Nitrous oxide

2-Pressure gauge, regulator or reducing valve, and flowmeter for each gas

3-Vapourizing bottle for the volatile anesthetic liquid

## 1-Oxygen and or compressed medical gases cylinder

It is either exists as single cylinders that connected directly to the machine by hose; or as bank of large cylinders or bulk tanks from which gases are piped through copper alloy tubes that ends at the wall of surgery room.

## 2-Pressure gauge, reducing valve (regulator), and flowmeter (rotameter)

*Pressure gauge* should be supplied to each compressed gas to indicate gas pressure in the cylinder and the full scale of the reading gauge should be 1/3 greater than the maximum cylinder pressure.

*Reducing valve* is necessary for;

a-Re-adjustment of the flow as the cylinder pressure decrease over time

b-Easy production of small variations of gas flow by supplying low gas pressure to the control valve spindle. The direct control of high pressure cylinder by simple type needle valve produces large changes in flow rate even by very small movement of control valve spindle.

c-Limitation of the connecting tubing pressure to a low level, that the possibility of bursting of the tube (when the flow is shut off by the flowmeter control) is reduced.

*Flowmeter or rotameter* is consists of a glass tube inside which a rotating bobbin freely move. Diameter of the glass tube increases from below and upward to permit floating of the bobbin and flow of gas around it. The gas enters the flowmeter from its bottom and exits its top. The level of bobbin becomes high, both the gas flow and the space between the bobbin and the glass wall, increases. The glass is graduated to demonstrate the rate of flow.

## 3-Vapourizing bottle for the volatile anesthetic liquid

Vaporizer is used mainly for vaporization of volatile anesthetic like ether or chloroform.

## a-Un-calibrated vaporizer

The Boyle vaporizer is designed as to allow for fairly fine control of the strength of anesthetic vapour. The method of varying the concentration of anesthetic vapour utilizes a permanent partition to prevent the direct passage of gasses from the flowmeter to the patient. When the control lever is in the off position, all the gases are diverted around the partition but away from the bottle. With the tap on the on position, the entire gasses pass thought the bottle containing the liquid anesthetic agent.

The control tap can be placed in any intermediate position and this determines how much of the total gas flow, passes through the bottle. Another mean of control of the rate of vaporization is the fenestrated J-shape tube that passes below or over the surface of the anesthetic agent, and the deeper the position of the tube the more bubbles formation and the greater the vaporization rate.

## b-Calibrated vaporizer

It is designed to deliver known concentration of volatile anesthetics. It consists of vaporizing chamber and bypass. The fresh gas stream flowing into the vaporizer is divided into two portions. The larger one passes through the bypass and the smaller passes through the vaporizer chamber to be saturated with vapour that ensures;

1-No sudden burst of high vapour concentration when the vaporizer is first switched on

2-No affection of vapour output by shaking

Vaporization occurs by removal of heat from the warm liquid with resultant fall in its temperature, so the fall in liquid temperature should be checked to preserve continuous vaporization and to prevent reduction of concentration of output over the time. Preservation of higher temperature of the liquid can be achieved either by;

1-Compensation of the temperature by bimetallic strep valve that arranged to act as a control of the volume of the gas passing through vaporizing chamber. Reduction of liquid temperature stimulates further opening of the valve that allows more gas to pass through the chamber.

2-Using vaporizer made of copper that has high thermal conductivity to allow conduction of room temperature to the liquid that supplies the liquid with the necessary heat for vaporization.

## Stages Of General Anesthesia..

### 1-Stage I (voluntary excitement, analgesia or induction)

This period extends from the beginning of induction of anesthesia to stage of loss of consciousness. At the beginning the animal is conscious and may struggle to avoid being anesthetized leading to release of adrenaline that causes;

a-Increase of the respiratory and pulse rates

b-Dilatation of the pupil

Urine and feaces may be voided and some animal species may show salivation during this stage but towards the end of that stage the animal;

a-Losses ability to stand

b-Acquires lateral recumbency

### 2-Stage II (involuntary excitement or Delerium stage)

Generally it is known as the earliest period of loss of consciousness and characterized by

a-Exaggerated reflex to stimuli and violent movements of the limbs accordingly the animal should be restraint to avoid injury of workers in surgery room

b-Release of adrenaline is continued leading to increased heart rate and dilation of the pupil

c-Respiration is very irregular

d-Salivation may be profuse in cattle and cat

e-Cough and pharyngeal (swallowing and vomiting) reflexes exist but they disappeared near the end of that stage

### 3-Stgae III (Stage of surgical anesthesia)

This stage is characterized by loss of consciousness and can be classified into three planes

#### A-Plane of light anesthesia

Generally this plane is suitable for simple surgical procedures like incision of abscess or diagnostic investigations and it is characterized by;

1-Eyeball moves from side to side (jerky movement) with absence of eye reflex

2-Regular respiration

3-Pedal reflex exists in pets

## B-Plane of medium anesthesia

This plane is suitable for all surgical procedures except for laparotomy and it is characterized by;

1-Eyeball fixed *centrally* in all animals and *ventrally* in dog

2-Sluggish muscle relaxation

## C-Plane of deep anesthesia

This plane is suitable for all surgical procedures including laparotomy and it is characterized by;

1-Eyeball fixed *centrally* in the dog

2-Pedal reflex disappears in pets

3-Decreased respiration depth with longer pause between inspiration and expiration

## 4-Stage IV (Over dose or paralytic stage)

1-Severe depression of CNS

2-Pupil dilation with fish-eye appearance due to cessation of lachrymal secretion

3-Increase pulse rate

4-Gasping respiration due to complete paralysis of inter-costal muscles without paralysis of the diaphragm

5-Relaxation of anal and bladder sphincters with voiding of urine and feces

6-The animal enters stage of death with coma and cyanosis

# Complications Of Over Doses Of Anesthesia

1-Syncopy, and pathologic affection of respiration and circulation

2-Respiratory arrest

3-Liver intoxication

## Treatment of Overdoses Inhalation Anesthesia

1-Stop inhalation of gas

2-Stimulate respiration by remove restraint, supplying the animal with oxygen and $Co_2$, applying artificial respiration, forward pulling of the tongue with removal of saliva, and applying piece of cotton moisten with ammonia near the nose

3-Adminsteration of cardiac stimulant

4-Warming of the animal

## Problems Encountered In General Anesthesia In Bovine

General anesthesia in bovine is so dangerous as a result of presence of rumen that might predispose the animal for asphyxia or drenching pneumonia, so that nerve block and infiltration analgesia are preferred especially if the magnitude of the operation requires standing position of the animal as rumenotomy. However in some of the more sophisticated surgical procedures, general anesthesia becomes mandatory for the sake of asepsis, and complete restraint as in case of repair of penile hematoma, inguinal herniorrhaphy, or cercumcission and correction of preputeal adhesion. Generally, the problems encountered in bovine general anesthesia are;

### 1-Bloat and regurgitation

The excessively formed gases in the rumen can't be regurgitated normally with the animal in lateral recumbency, due to the higher level of ruminal fluid than cardiac opening and this large amount of gases causes;

a-Interference with the already impaired respiration, caused by the recumbence position and pressure on diaphragm

b-Pressure on the cardiac opening that is augmented by the depth of anesthesia, so that the fluid flows from the rumen, collected in the pharyngeal region, and aspirated leading to drenching pneumonia or death

### 2-Anoxia

It results from;

a-Compression of the lower lung by lateral recumbency

b-Increased diaphragmatic breathing by deep anesthesia

c-Pressure on diaphragm by abdominal viscera

***Importance of endotracheal tube: -***

a-It reduces many of potential problems

b-It provides a potent air way

c-It prevents aspiration of saliva as well as regurgitation of food materials

## 3-Radial paralysis

This condition may last few minutes up to few weeks and its occurrence depends up on;

a-Length of time of recumbency

b-Body weight

c-Thickness of subcutaneous fat

Generally this condition can be avoided by placing inflated tire under the point of shoulder at the time of casting

## 4-Salivation

Use of atropine sulfate reduces amount of saliva and increases its viscosity

# REFERENCES

**Hall, C.W., Clarke, K.W and Trim, C.M. (2001):** Veterinary anesthesia, 10th edition

**Hall, L.W. (1978):** Wrights veterinary anesthesia and analgesia, 7th edition

**Tom Doherty and Alex Valverde (2006):** Manual of Equine Anesthesia and Analgesia by Blackwell Publishing Ltd, www.blackwellvet.com