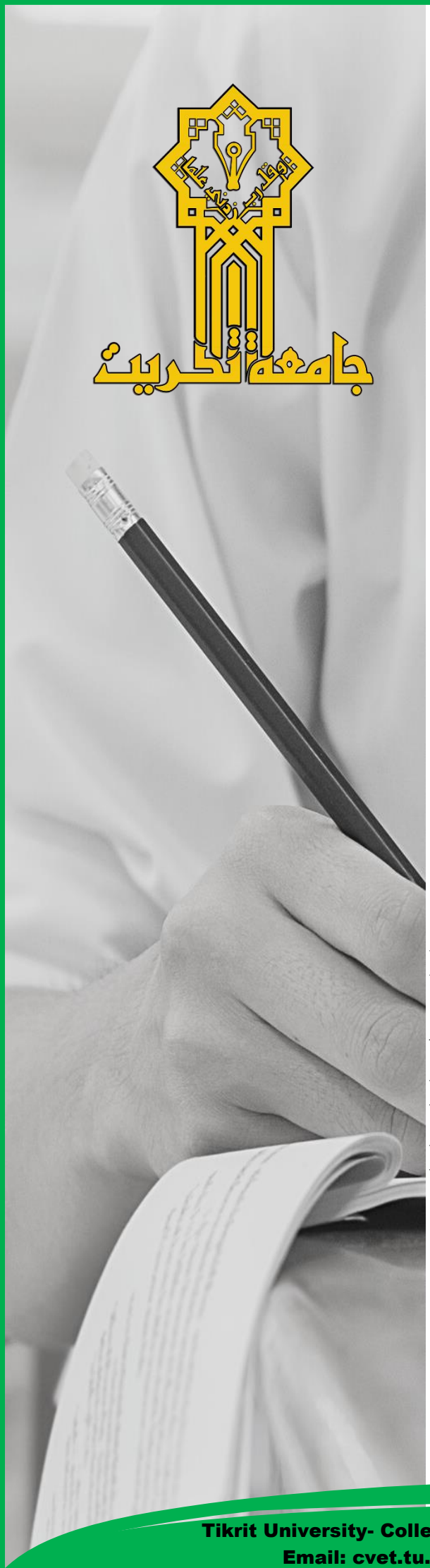

Tikrit University
College of Veterinary Medicine

Lecture Title
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Subject name: **Orthopedic surgery**

Subject year: **surgery \ 4th stage**

Lecturer name: **Hiba Abdulaziz Shekho**

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Orthopedic surgery

Bone:- is a rigid organ that constitutes part of the skeleton. Bones support and protect the various organs of the body, produce red and white blood cells, store minerals, and enable mobility.

Bones come in a variety of shapes and sizes and have a complex internal and external structure.

Bone tissue (osseous tissue) is a hard tissue, a type of dense connective tissue. It has a honeycomb-like matrix internally, which helps to give the bone rigidity.

Structure:-

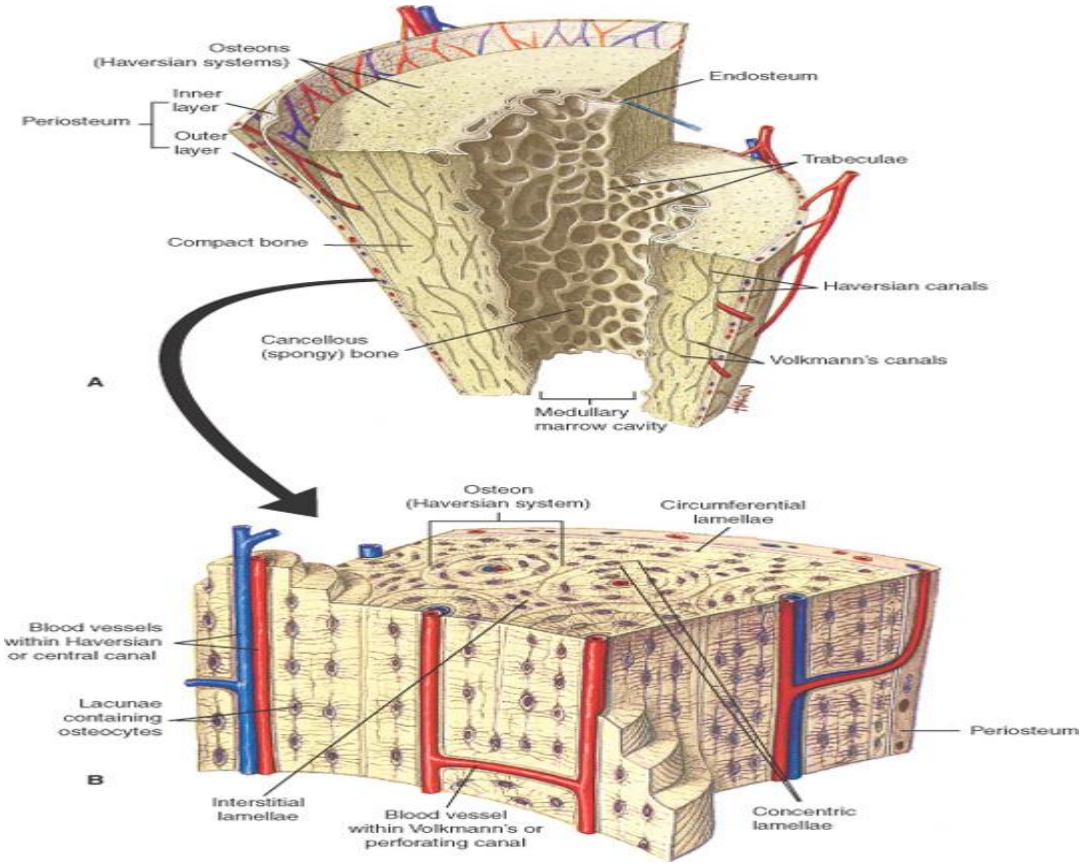
Bone is not uniformly solid, but consists of a flexible matrix (about 30%) and bound minerals (about 70%) which are intricately woven and endlessly remodeled by a group of specialized bone cells. Their unique composition and design allows bones to be relatively hard and strong, while remaining lightweight.

Bone matrix is 90 to 95% composed of elastic collagen fibers, also known as **ossein** and the remainder is ground substance. The elasticity of collagen improves fracture resistance. The matrix is hardened by the binding of inorganic mineral salt calcium phosphate in a chemical arrangement known as calcium hydroxyapatite. It is the bone mineralization that give bones rigidity.

Cortical bone

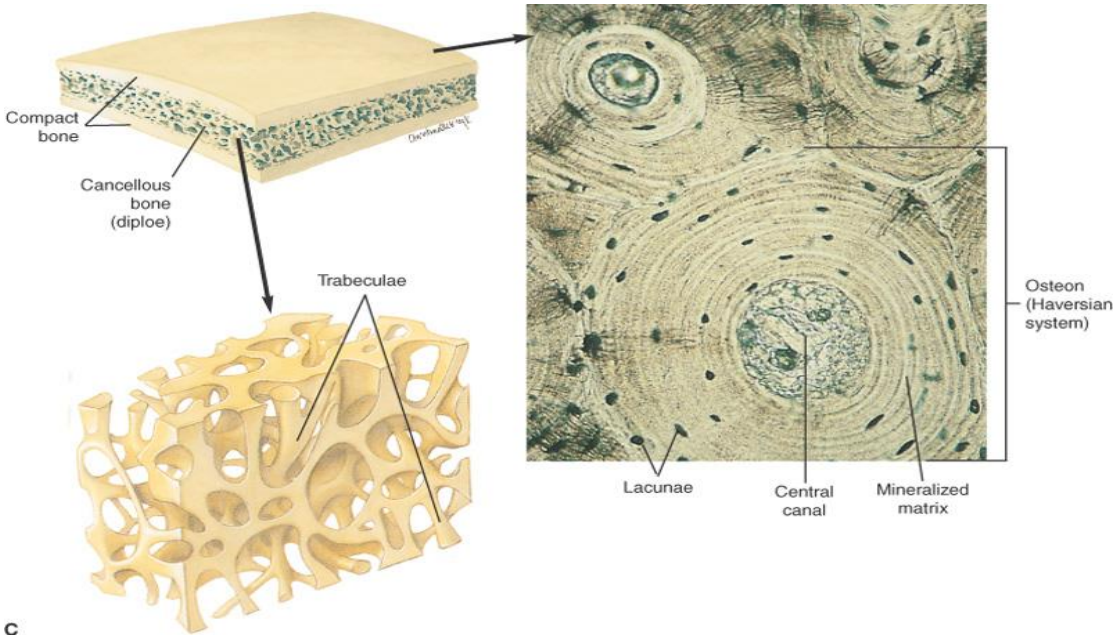
The hard outer layer of bones is composed of cortical bone also called compact bone being much denser than cancellous bone. The cortical bone gives bone its smooth, white, and solid appearance, and accounts for 80% of the total bone mass of an adult skeleton. It consists of multiple microscopic columns, each called an osteon. Each column is multiple layers of osteoblasts and osteocytes around a central canal called the haversian canal. Volkmann's canals at right angles connect

the osteons together.. Cortical bone is covered by a periosteum on its outer surface, and an endosteum on its inner surface.



Cancellous bone

Cancellous bone, also called trabecular or spongy bone, is the internal tissue of the skeletal bone and is an open cell porous network. This makes it weaker and more flexible. Cancellous bone is typically found at the ends of long bones, near joints and in the interior of vertebrae. Cancellous bone is highly vascular and often contains red bone marrow where hematopoiesis. Trabecular bone accounts for the remaining 20% of total bone mass.

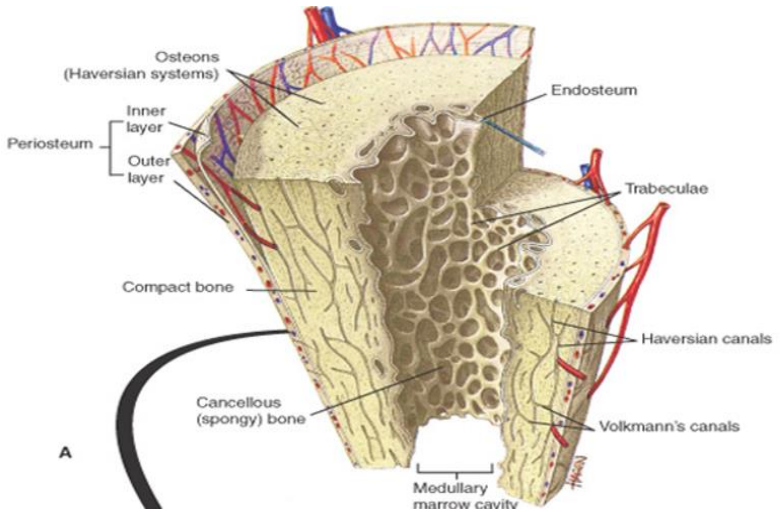


Periosteum

The periosteum is a tough layer of connective tissue that surrounds bones. It is composed of an outer layer of fibrous connective tissue and an inner layer of bone progenitor cells, which is responsible for radial growth of the bone. In addition to bone growth, the periosteum also provides the vascular supply and nutrients for the outer segment of the cortex and is crucial in fracture repair.

Endosteum

The endosteum is a 1-cell-thick lining on the trabecular and inner cortical surfaces of the bone. It is composed of bone lining cells, which are mostly inactive but prevent unwarranted bone resorption by osteoclasts.



Types:-

There are five types of bones in the body: long, short, flat, irregular, and sesamoid.

Long bones:-

Mature long bones have 3 distinct zones: epiphysis, metaphysis, and diaphysis. In development, the epiphysis and metaphysis are separated by a fourth zone, known as the epiphyseal plate, or physis. This segment of the bone is cartilaginous and is the region from which the bone grows longitudinally. Long bones include the femur, tibia, fibula, humerus, radius, ulna, metacarpals, metatarsals, and phalanges.

Epiphysis:-

The epiphysis is the region at the polar ends of long bones. Most commonly associated with joint surfaces, it usually comprises a thin, compact bone shell with a large amount of bony struts (trabecular bone) for support of the cortical shell.

The epiphysis also serves as an attachment region in many bones, allowing joint capsular attachments, many ligamentous attachments, and some tendinous attachments as well. Like most sections of bone, it is strong, but it lacks the rigidity of the diaphysis.

Epiphyseal plate (physis):-

The epiphyseal plate is responsible for longitudinal growth of the skeleton and therefore one's height and stature. Bones can also grow in width from direct bone formation supported by the periosteum.

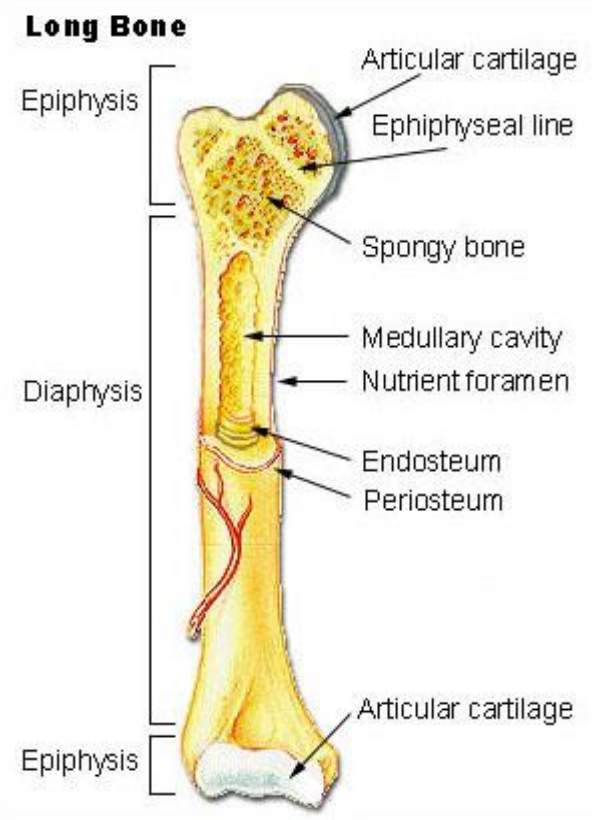
Metaphysis:-

The metaphysis is a transitional zone between the epiphysis and diaphysis. It is also characterized by thinner cortical walls with dense trabecular bone. It is commonly the site of tendinous attachments to bone. It is a metabolically active region and often supports a fair amount of bone marrow. The metaphysis is the region where the bone made by the epiphyseal plate is fine-tuned into its diaphyseal shape.

Diaphysis:-

In the middle of long bones is the diaphysis, a segment of thick cortical bone with a minimal amount of trabecular bone. It is often smaller in diameter than metaphyseal and epiphyseal bone; because its thick cortical layer is extremely strong. The central portion is the least dense area of the bone and is known as the intramedullary canal. The area of the bone inside the cortex is continuous throughout an entire bone and is known as the endosteal area.

Diaphyseal bone’s primary function is structural: it gives the skeleton much of its length and providing much of the surface area for muscular and tendinous attachment.



Short bones

Short bones are also formed by the same model as long bones; however, they tend to have unique shapes and functions. They have a cortical shell on the periphery and a trabecular inner portion. They vary in size and shape. Examples include the carpal bones, vertebrae, patella, and sesamoid bones.

Flat bones

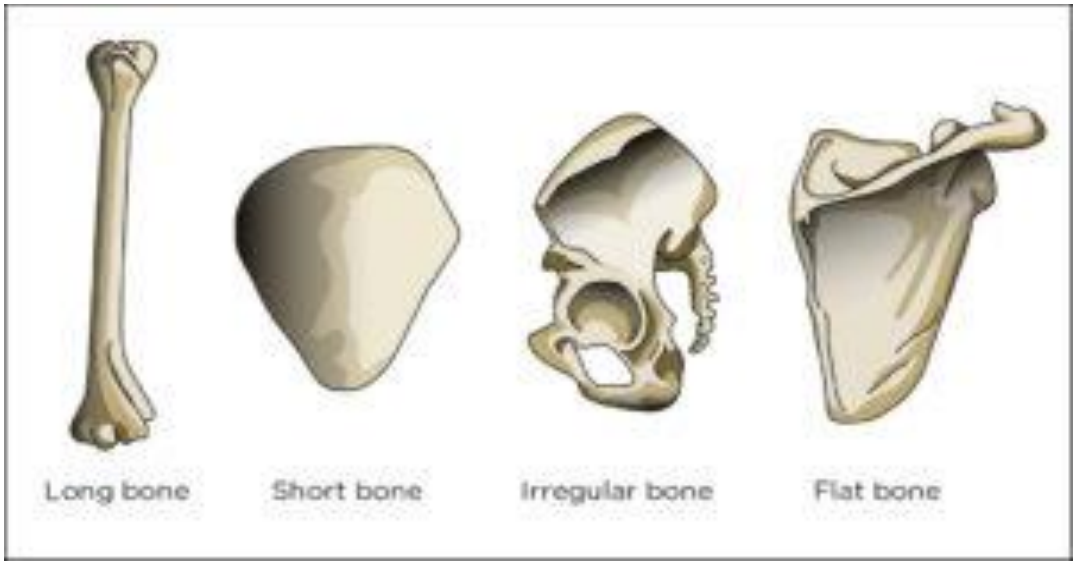
They consist of a cortical shell with a cancellous interior and are often broad and flat. They provide protection (eg, skull) and also offer wide, flat surfaces for muscular attachment (eg, scapula).

Sesamoid bones

are bones embedded in tendons. Since they act to hold the tendon further away from the joint, the angle of the tendon is increased and thus the leverage of the muscle is increased Examples of sesamoid bones are the patella and the pisiform.

Irregular bones

They consist of thin layers of compact bone surrounding a spongy interior. Their shapes are irregular and complicated. Often this irregular shape is due to their many centers of ossification or because they contain bony sinuses. The bones of the spine, pelvis, and some bones of the skull are irregular bones. Examples include the ethmoid and sphenoid bones.



Fracture:-

is a complete or incomplete break in the continuity of bone or cartilage. A fracture is accompanied by various degrees of injury to the surrounding soft tissues, including blood supply, and by compromised function of the locomotor system.

Causes:-

A-Extrinsic factors:-

***Direct cause (force):-**

1-Car accident.

2-Bending force:-in this case the fracture usually transvers or oblique result in opposite to force.

3-Torsion force:-result in spiral fracture.

4-Compression force:-transmitted along the axis of bone may result in crushing fracture.

***Indirect cause (force):-**

The fracture occur some distance from the force, the force of impact transmitted via the bone & muscle to a weak point of the bone.
Ex./lateral condylar fracture of humeral bone .

B-Intrinsic factors:-

a-Muscle force:-

sudden contraction of muscle result in:-
1-Epiphysial separation fracture.
2-Tibial crest fracture. 3-Olecranon process of ulna fracture .

b-Stress & chronic fatigue :-

usually result in carpal & knee fracture due to repeated trauma to this bone.

c-Pathological causes:-

1-Bone weakness :- due to primary & secondary neoplasm.
2-Nutritional disease of bone.
3-Osteomyelitis. 4-Osteoporosis.

C-Predisposing factors:-

Such as:-
1-Sex. 2-Species. 3-Heridetery. 4-Nutrition. 5-uses of animal.

Classification of fractures:-

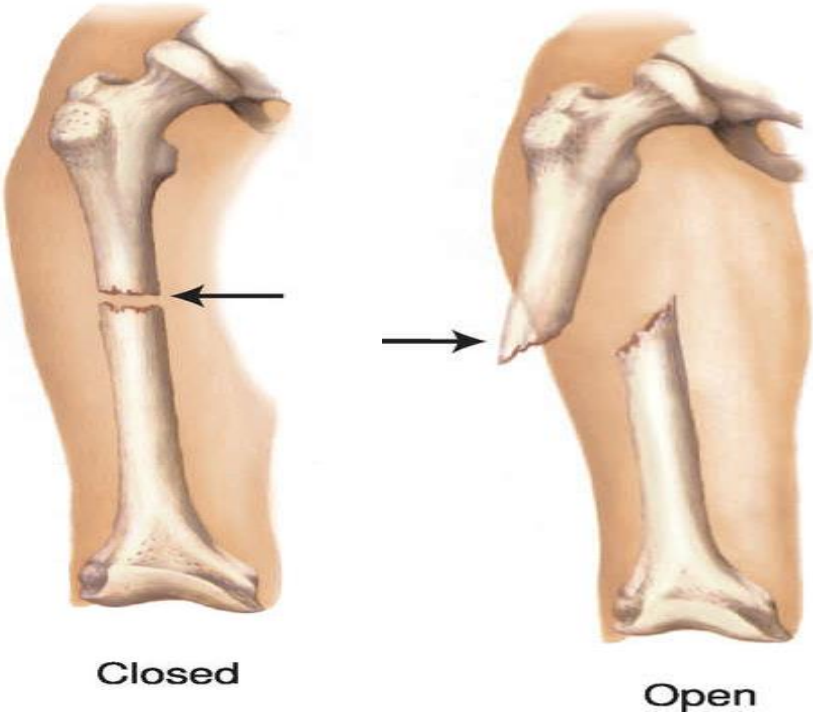
A-According to the external wound :-

1-Simple or Closed fracture:-

There is no communication with outside .

2-Compund or opened fracture:-

There is communication with the outside.



B-According to the extent of bone damage:-

1-Complete fracture:-

Total breaking of the continuity of bone with the marked displacement.

2-Incomplete fracture:-

Little displacement & the periostium is intact at some point.

C-According to the type of fracture:-

1-Transvers fracture:-

The fracture crosses the bone at an angle of not more than 30 degrees to the long axis of the bone .

2-Oblique fracture:-

The fracture describes an angle of greater than 30 degrees to the long axis of the bone.

3-Spiral fracture:-

This is a special case of oblique fracture in which the fracture line curves around the diaphysis.

4-Commonuted fracture:-

More than one fragment with the fracture line & meeting at fracture line.

5-Multiple fracture:-

More than one fragment at fracture line with no meeting at the fracture line.

6-<u>Avulsion (chip) fracture</u>:-

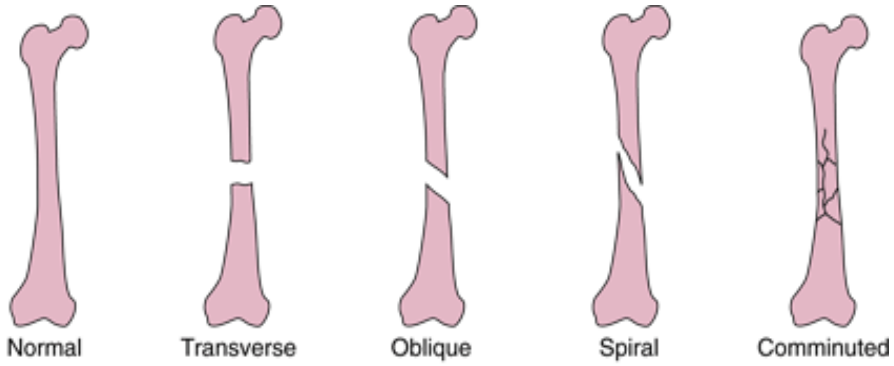
Fracture where a fragment of bone is separated from the main mass.

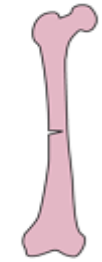
7- Greenstick fracture:-

fracture in young animals because of the bending of the non-fractured cortex.

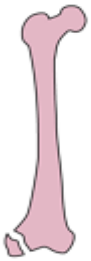
8-Fissure fractures:-

Exhibit fine cracks that penetrate the cortex in a linear or spiral direction. In skeletally immature animals the periosteum is usually left intact





Greenstick



Avulsed

D-According to the location of fracture:-

***Diaphysial fracture:-**

1-Proximal. 2-Distal. 3-Midshift.

***Metaphysial fracture:-**

***Epiphysial fracture:-**

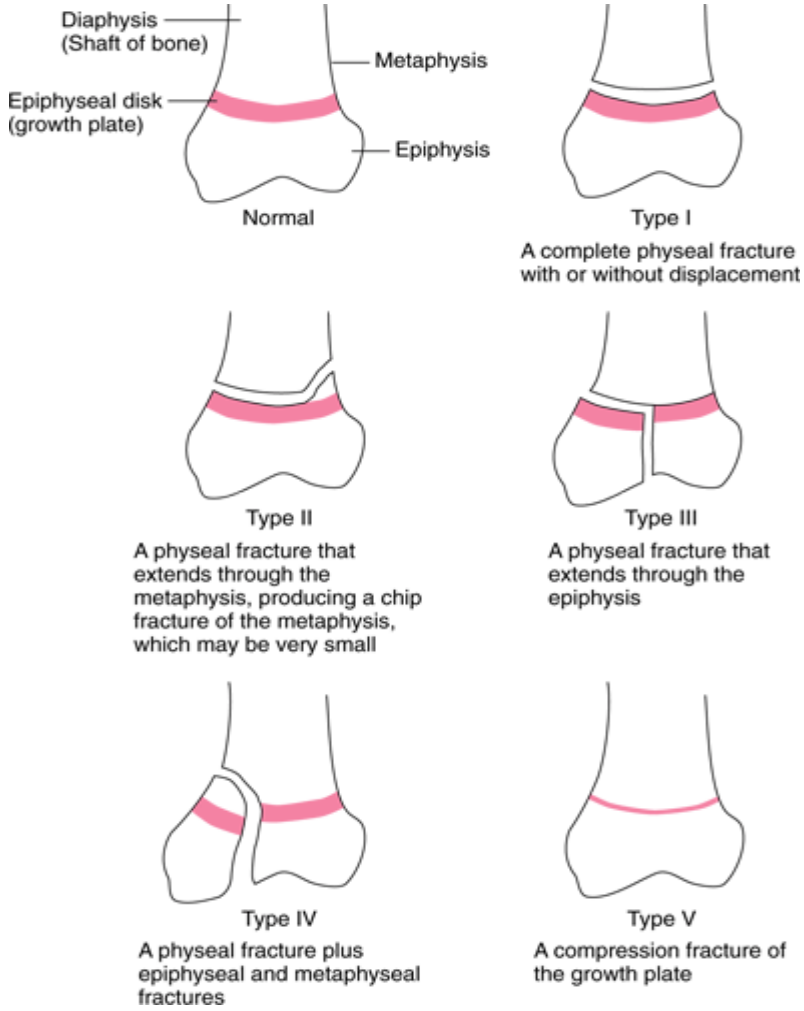
1-Through the growth plate (physeal or epiphyseal plate) only.

2-Through the growth plate & some corner of metaphysis.

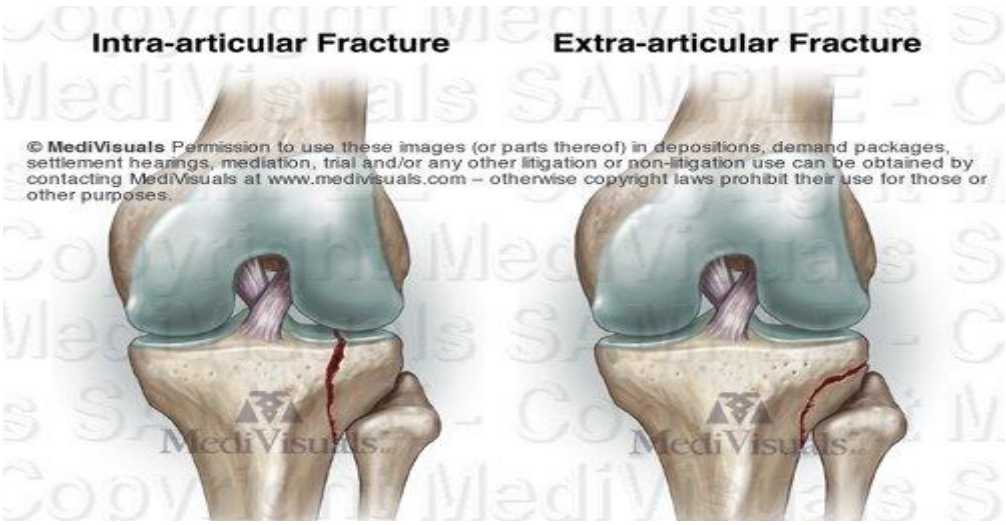
3-Through the metaphysis, growth plate & extent to the joint.

4-Through the growth plate , epiphysis & extent to the joint.

5-Crush the growth plate only without displacement.



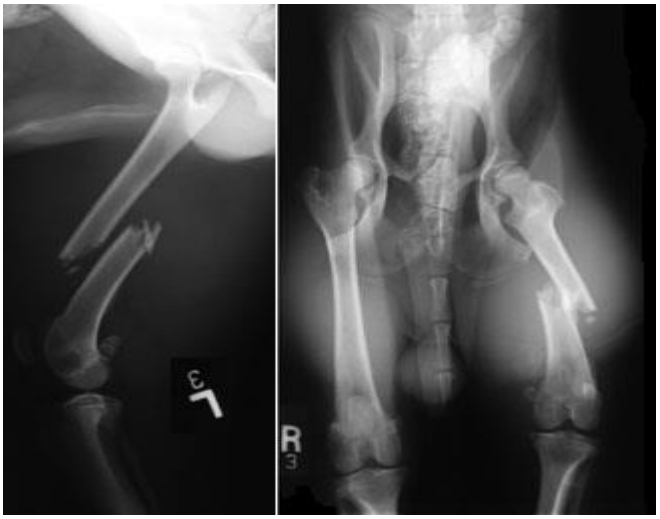
***Intra-articular fracture.**



E-According to the displacement:-

1-Over riding:-

Usually in diaphysial fracture due to muscle force.



2-Distracted fracture:-

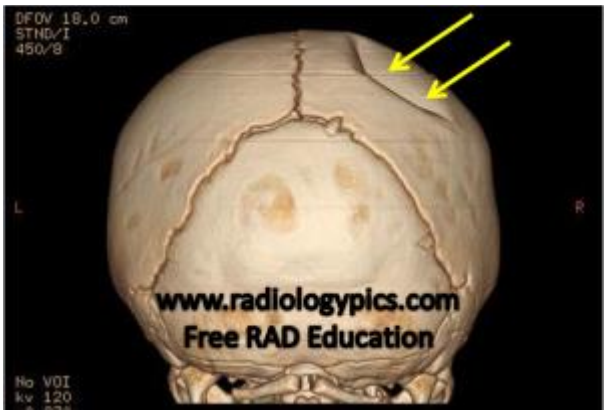
Muscle force pull fragment of bone usually in the tendon & ligament insertion.

3-Compression fracture:-

Usually collapse fracture is the most common type of fracture to occur in the spine. It most commonly occurs in the lumbar spine and thoracic spine.

4-Depressed fracture:-

Usually occur in skull fracture , one fragment push inward.



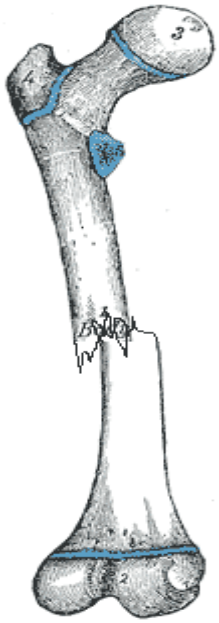
5-Dislocated fracture:-

In this case displacement of part of bone may be associated with fracture.

Ex./dislocation of ulna during fracture of radius bone.

6-Impact fracture:-

A fracture caused when bone fragments are driven into each other.



Clinical Signs of the fracture:-

1-Pain.
2-Loss of function.
3-Local soft tissue injury with edema & swelling.
4-Deformity.
5-Abnormal mobility.
6-Cripitation sound.

Diagnosis of fracture:-

1-Clinical signs.
2-Case history.
3-X-ray image.

The study of the fracture radiography may be required for one or more of the following reason:-

a-To confirm clinical diagnosis.
b-To determine the position of fracture.
c-To determine the age of fracture.
d-To assist the degree of repair.
f-To facilitate suspected fracture not demonstrated clinically.

Fracture healing :-

The pattern of bone healing varies according to the mechanical conditions present within the fracture line after reduction and stabilization of the fracture.

1-Primary bone healing:-

Primary healing (also known as direct healing) requires a correct anatomical reduction which is stable, without any gap formation. Such healing requires only the remodeling of lamellar bone, the Haversian canals and the blood vessels without callus formation. This process may take a few months to a few years.

2-Secondary bone healing:-

Also known as indirect fracture healing . In this type of fracture process known stages which include, stage of inflammation , stage of repair & stage of remodeling.

1- inflammatory phase:-

1-After a fracture, the bone itself is damaged. The soft tissue envelope, including the periosteum & surrounding muscles, is torn, and numerous blood vessels crossing the fracture line are ruptured.

2-There is an accumulation of hematoma within the medullary canal, between the fracture ends, and beneath any elevated periosteum.

3-This blood rapidly coagulates to form a clot. The effect of this vascular is of paramount importance.

4-Osteocytes are deprived of their nutrition & die as far back as the junction of collateral channels. Thus the immediate ends of a fracture are dead; that is, they contain no living cells. Severely damaged periosteum & marrow as well as other surrounding soft tissues may also contribute necrotic material to the region.

5-The presence of so much necrotic material elicits an immediate & intense acute inflammatory response.

6-There is widespread vasodilation & plasma exudation, leading to the acute edema seen in the region of a fresh fracture.

7-Acute inflammatory cells migrate to the region, as do polymorphonuclear leukocytes followed by macrophages. As the acute response subsides, the second phase begins & gradually becomes the predominant pattern .

2- Reparative phase:-

1-The first step in the reparative phase is identical to the repair process seen in other tissues.

2-The hematoma is organized & while there is some controversy as to the necessity of this step, it seems unavoidable in the natural repair process.

3-The cells invade the hematoma & begin rapidly to produce the tissue known as callus, which is made up of fibrous tissue, cartilage, & young immature fiber bone.

4-This quickly envelopes the bone ends & leads to a gradual increase in stability of the fracture fragments

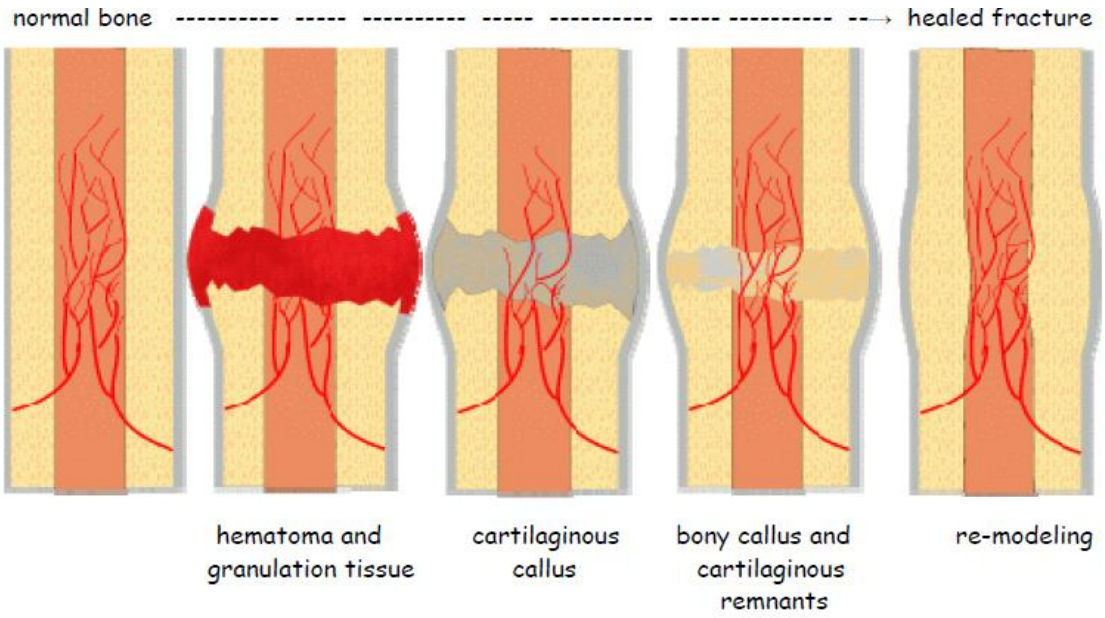
5-Compression or the absence of tension discourages the formation of fibrous tissue. variations in oxygen tension undoubtedly lead to the formation of either bone or cartilage, with cartilage being formed in areas in which oxygen tensions are relatively low, presumably as aresult of the distance of the cell from its blood supply.

3- Remodeling phase:-

1-Remodeling about fracture takes place for a prolonged period of time. Radioisotope studies have shown that increased activity in a fractured bone lasts much longer than had been thought previously.

2-Remodeling phase begins with resorption of unneeded or inefficient portions of the callus & the laying down of trabecular bone along lines of stress.

3-The cellular module that controls remodeling is the resorption unit, consisting of osteoclasts, which first resorb bone, followed by osteoblasts, which lay down new haversian system.
4-The end result of remodeling is a bone that, if it has not returned to its original form, has been altered so that it may best perform the function demanded of it.



1-Union:-
The healing of fractured bone is complete in normal time.
*In small animals (4 weeks).
*In large animals (8 weeks).

2-Delayed union :-
Healing has not advanced at the average rate for the location & type of fracture for 3 month.

3-Non-union:-
Is permanent failure of healing following a fractured bone. This is generally after 6–8 months.

4- **Mal-union**:-

a healing of the bones in an abnormal position,lead to disruption or shortening of the bone.

Mal-unions can be classified as functional or nonfunctional. treated only in case of nonfunctional mal-union, the bone treated as corrective osteotomy.

Radiographical signs of the Union:-

1-Disappear of the fracture line.

2-Bridging of fracture area with the new bone.

3-Remodeling of the callus with restoration of the continuity of the cortex & medullary cavity.

Radiographical signs of the Delayed union:-

1-Fractured line is present.

2-Widden & appear as active with the irregular edge.

3-Not bridging the callus.

4-Marrow cavity still open.

5-Adjacent bone show no significant sclerosis.

Radiographical signs of the Non-union:-

1-Visible fracture line.

2-Poor callus formation .

3-Does not bridging the fracture line completely.

4-Round of fracture end which become sclerosis.

5-Generilized decrease density of the bone of the affected limb distal to the fracture due to atrophy of disused.

Etiology of Non-union & Delayed union:-

1-Ischemia.

2-Neoplasm.

3-Inadequate reduction.

4-Interposition soft tissue between fracture end.

5-Distracted fracture.
6-Bone loss.
7-Inadequate fixation.
8-Striping of periostium.
9-Osteoporosis.
10-Loss of soft tissue attached the fragment.

Prevention of Delayed union:-

1-Good fixation to prevent further tissue damage.
2-Good apposition.
3-Prevent infection.
4-Retain the circulation to normal as possible.

Prevention of Non- union:-

1-Decrease of hematoma as possible.
2-Not interposition of tissue to prevent bridging of the callus.
3-avoid use x-ray at (1^{st} week) of healing.

Factors affecting on fracture healing:-

1-Age of animal:-

In young animal clinical union (4 weeks in horse , 2 weeks in dog) while in old animal clinical union (8 weeks).

2-Speceies of animal:-

Horse tend to heal poorly, dog & cat heal rapidly but in bird the healing is very rapid.

3-Blood supply:-

Related to location of fracture & the extent of injury.

4-Site of injury:-

Callus bone heal rapidly.

5-Fixation:-

To eliminate shorting angulation & rotation.

6-Reduction:-

To reduce the amount of callus required to bridge the gap.

Complication of fracture:-

1-Osteomyelitis.

2-Shock.

3-Nerve injury.

4-Infection of bone with *Pseudomonas mali* .

5-Short of bone.

6-Avasicular necrosis of bone.

7-delayed union, non-union, mal-union.

8-pressure sore:-animal remain in recombined position or due to pressure of plaster .

Treatment of fracture:-

A-Immediate treatment:-

1-Control hemorrhage.

2-Prevent infection.

3-Relif pain.

4-Treatment shock.

5-Temporary fixation.

B-The basic principle of fracture treatment include:-

1-Accurate reduction.

2-Stable fixation.

3-preservation of blood supply & early return to function.

1-Accurate reduction:-

This involve replacement of bone fragment as nearly as possible to their origin position, giving the animal muscle relaxant to facilitate the reduction.

Types of Reduction:-

1-Closed reduction:-

By manipulation (with minimal soft tissue covering the bone). is a procedure to set or (reduce) a broken bone without opening the skin. The broken bone is put back in place, which allows it to grow back together. It works best when it is done as soon as possible after the bone breaks.

Advantage:-

1-Help bone heal quickly and be strong when it heals.
2-Decrease pain.
3-Improve the chances that limb will look normal and will be able to use it normally when it heals.
4-Lower the risk of an infection in the bone.
5-Remove tension on the skin and reduce swelling.

Disadvantage:-

1-The nerves, blood vessels, and other soft tissues near bone may be injured.
2-A blood clot could form, and it could travel to lungs or another part of body.
3-There may be new fractures that occur with the reduction.
4-If the reduction does not work, will need surgery.

2-Reduction by traction & counter traction:-

Traction is applied to the portion of limb that is control while counter traction is applied to the loss controllable portion.

3-Open reduction:-

is where the fracture fragments are exposed surgically by dissecting the tissues.

Indication of open reduction:-

1-Failure to achieve reduction by closed method.
2-intra-articular fracture.
3-Distracted fracture.
4-Application of internal fixation.
5-Mal-union & Non-union.

2-Fixation (Immobilization):-

Consist of fixing the bone fragment so that, they are motion less during the healing process.

Ideal fixation of fracture should be :-

1-Maintain stable reduction (fixation).
2-Not interfere with blood supply.
3-Allow free range of movement.
4-Cheep.
5-Removable.

There are 2 types of fixation :-

1-Internal fixation.
2-External fixation.

1-Internal fixation:-

A surgical procedure that stabilizes & joins the ends of fractured bone by mechanical devices such as bone plate, pins, wires or screws.

Indication of internal fixation:-

1-If it`s impossible to maintain a good position by external fixation.
2-Rigid fixation
3-Adequate reduction.
4-External fixation will not be tolerated.

Types of internal fixation:-

1-Intra-medullary pin:-

(Steinman pin , kirschner pin, Rush pin)

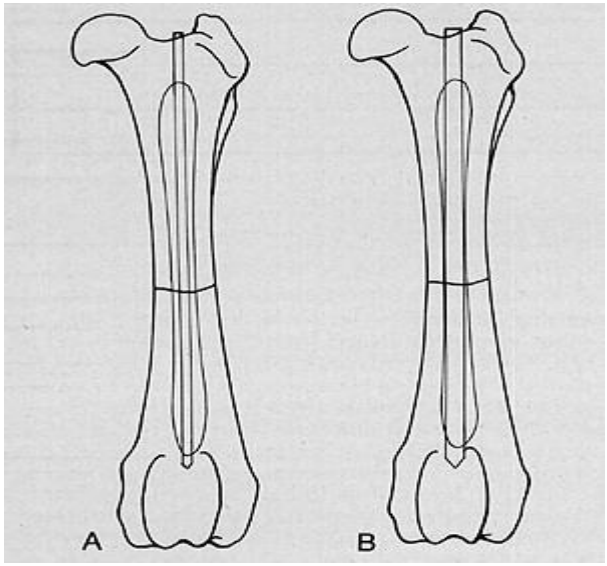
The pin should be have diameter equal to the diameter of marrow cavity. stability & normal length.

A-Normograde insertion:-

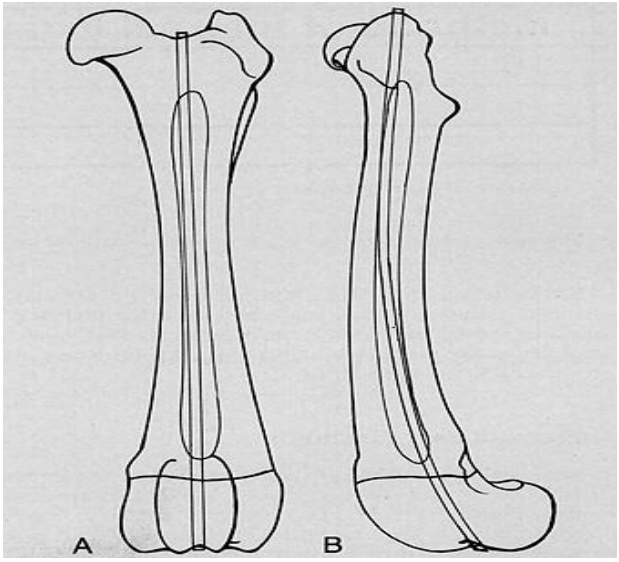
Pin inserted at epiphysis & driven across fracture line, there are 2 types of normograde insertion proximal & distal insertion.

B-Retrograde insertion:-

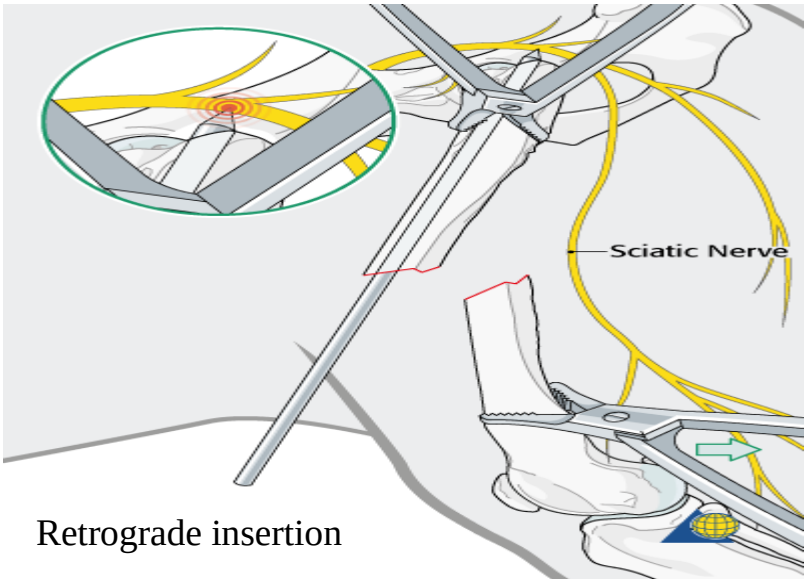
Pin inserted from fracture site & driven through epiphysis. complications of inadequate positioning and soft tissue (usually nerve) damage can be caused by improper retrograde pinning.



Proximal insertion



Distal insertion



Retrograde insertion

2-Bone plate:-

One of the primary objectives in the treatment of fractures is early return to full function of the injured limb. Bone plates are ideal for accomplishing this goal because they have the potential to restore rigid stability to the reconstructed fractured bone when properly applied.87-89 Bone plates are adaptable to many situations, as follows:

1. Most long-bone fractures
2. Multiple and complex fractures
3. Fractures in larger dogs (especially the femur) because postoperative

complications are less frequent and postoperative care is reduced when the

fixation apparatus is covered with soft tissue.

MINI L PLATE FOR 2MM SCREWS

RECONSTRUCTION PLATE FOR 2.7MM SCREWS STRAIGHT

DCP PLATES - 3.5MM

NARROW LC-DCP (LIMITED CONTACT DYNAMIC COMPRESSION PLATES)

BROAD DCP PLATES

T-PLATE FOR 4.5MM SCREWS

DHS BARREL PLATES DCP HOLES

DHS / DCS SCREWS, 12.5MM DIA.

Types of bone plate:-

1-Compression bone plate.
2-Neutrilizing bone plate.
3-Bridging bone plate.
4-Butress bone plate.
5-Dynamic bone plate.

The ideal bone plate should be:-

1-Strong enough to support the load normally placed on the bone while the bone heals.
2-The plate must also have a stiffness similar to that of the bone to which it is attached.
3-The implant must be non-toxic and cannot cause an inflammatory response in the body.

The basic principle of application of bone plate:-

1-The size of bone plate should be choice equal to fractured bone.
2-Place on the surface tension of bone if possible .
3-Application in open reduction with wide exposure.
4-Making a hole through the plate near the fracture line (1cm) from it.
5-Fixation the bone plate by screws.

Advantage:-
1-Resist to all force.
2-Medullary blood supply preservation.
3-Early weight bearing.+

Disadvantage:-
1-Wide open exposure needed.
2-Removable is difficult.
3-Costing.
4-Special instrument may be needed.

The bone plate removed after (4-12 month), if it is not removed lead to:-
1-Corrosion.
2-Breakage.
3-Loosing.
4-Thermal sensitivity.
5-Osteoporosis.

3-Bone screws:-
Used in certain fracture near to the joint. There are two basic types of bone screws: cancellous and cortical.
A secondary function of bone screws is to hold fragments in a fixed

position without inter-fragmentary compression, where it is called a *position screw.* Such use is rare, usually being applied to prevent a small bone fragment or graft from displacing into the medullary canal.

Ex./Condyle fracture, fracture of femoral head, Oblique fracture.

4-Cerclage & hemicerclage wire:-

The term cerclage means "to encircle" or "to wrap into a bundle." This procedure refers to a flexible wire that completely or partially passes around the circumference of a bone and is then tightened to provide static inter-fragmentary compression of bone fragments. The latter method is also known as hemicerclage. Cerclage or hemicerclage wire is never used as the sole method of fixation on any type of diaphyseal fracture.

Indications:-

1-Cerclage wires are used primarily on long oblique, spiral, and certain comminuted or multiple fractures.

2-They are used as ancillary fixation with Intramedullary pins, external skeletal fixators, and bone plates.

External fixation:-

A procedure that stabilize & joins the ends of fractured bones by a splint or cast.

1-Plaster of paris :-

(Gypsona, Cast) which made from Calcium sulfate dehydrate.

Technique of application:-

1-Give the animal general anesthesia or heavy sedative.

2-The limb is covered with a thin layer of cellulose or cotton bandage.

3-Dipping the plaster of paries in water for few second.

4-The wet plaster is rolled around the limb from distal to proximal & should be overlap.

5-Cast should be observed after applying to indicate that is not interfere with blood supply of the limb. (12-36 hours) after applying , when plaster interfere with circulation the signs are:-

a-Pain.

b-Elevation of temperature of limb.

c-Cyanosis & swelling of digit.

6-Two planes of radiograph should be taken after applying of plaster to check the reduction of fracture bone, the amount of cast depend on size of animal.

2-connecting bars:-

1-Used in case of open fracture with sever damage of soft tissue as communicated fracture , mandible fracture

2-in this methods use external rod from one or two side this rod fixed during skin tissue and bone by pins

Complication of external fixation:-

1-soft tissue impingement:-

Impingement of tendon,vessels or nerves during pin placement must be avoided.

2-acute hemorrhage:-

Magjor blood vessels should be encountered only if pins are placed in an inappropriate location.

3-failure to maintain adequate stability:-

The term "adequate stability" can be defined as the effective control of forces which might disrupt fracture healing.

4-catastrophic frame failure :-

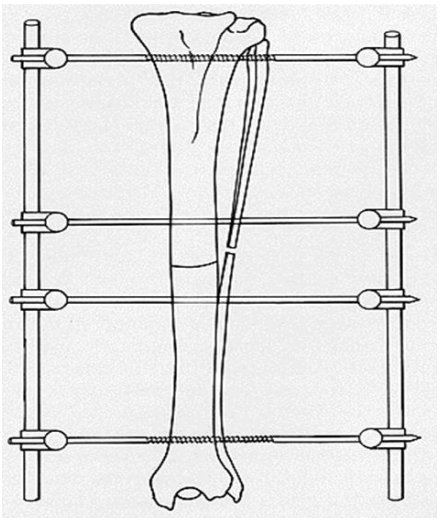
Frame failure is almost always the result of technical error.the construction of a frame that was either too small or not sufficiently stiff & strong to withstand the forces to which it will be exposed during fracture healing will inevitably lead to problems & complication.

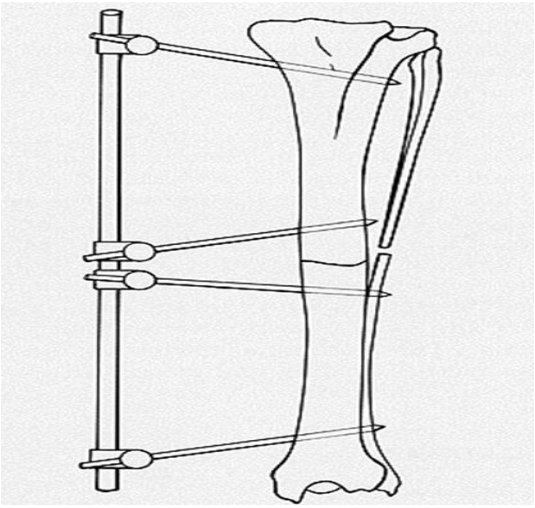
5-pin breakage:-

Providing sufficient appropriately sized pins are used, then breakage of fixation pens is a rare occurrence.

6-pin pullout:-

Pin pullout will occur if smooth fixator pins are placed parallel or near parallel to one another.





3-Splint:-

Ex./Wood strip, Plastic pipe.

Indication:-

1-Temporarly fixation.

2-Correct certain angular length deformity in young animal.

3-With internal fixation due to light as compare with plaster.

4-Sling:-

Used in horse as sublimit to other method of fracture to reduce the stress of injured limb.

5-Modified Thomas splint.