Introduction to fracture

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DEFINITION:

A fracture is a complete or incomplete break in a bone resulting from the application of excessive force.

Up to the age of 50, *more men suffer from fractures than women* because of occupational hazards. However, after the age of 50, *more women suffer fractures than men* because of osteoporosis.


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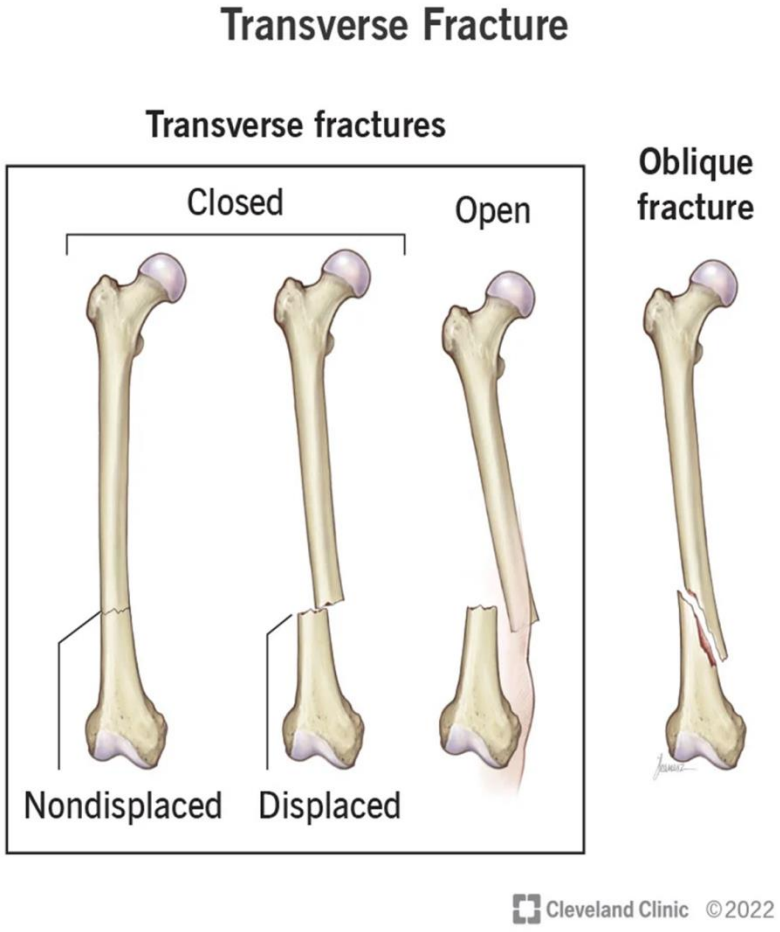
Fracture classifications include ;-.

1). **Simple fractures** (more recently called "closed") are not obvious as the skin has not been ruptured and remains intact.

2) **Compound fractures** (now commonly called "open") break the skin, exposing bone and causing additional soft tissue injury and possible infection.

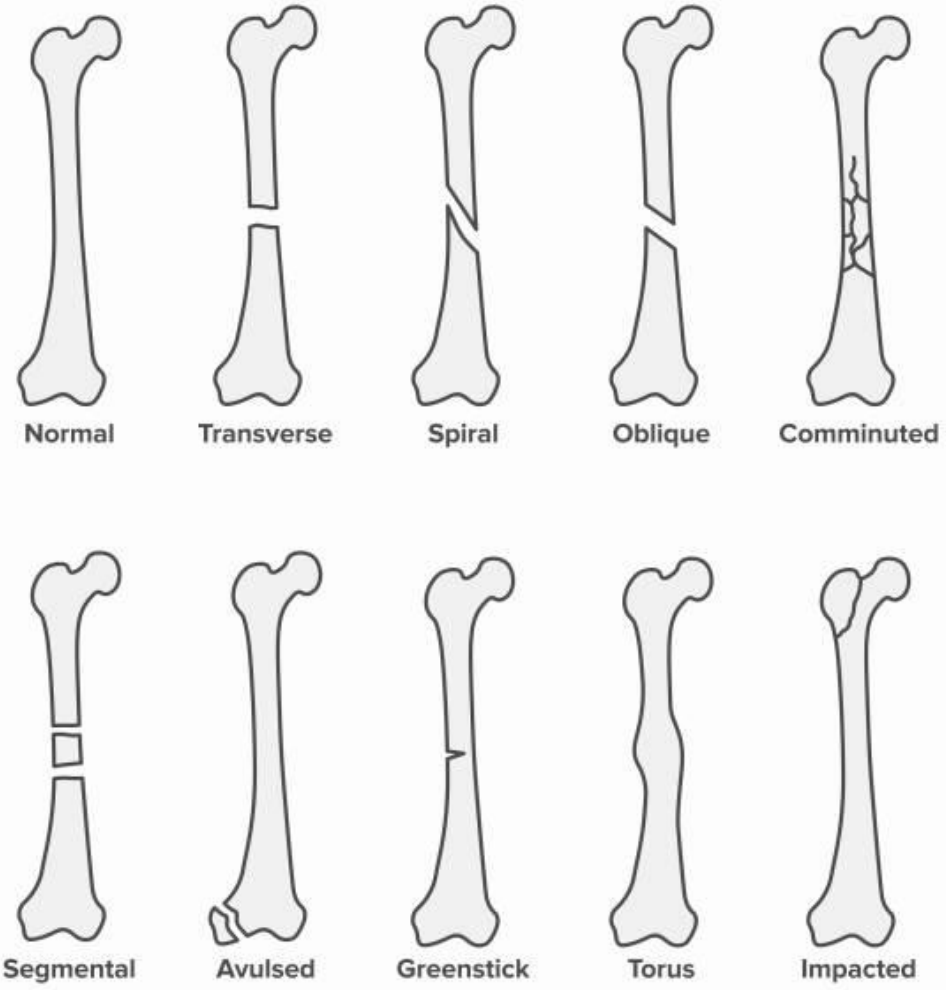


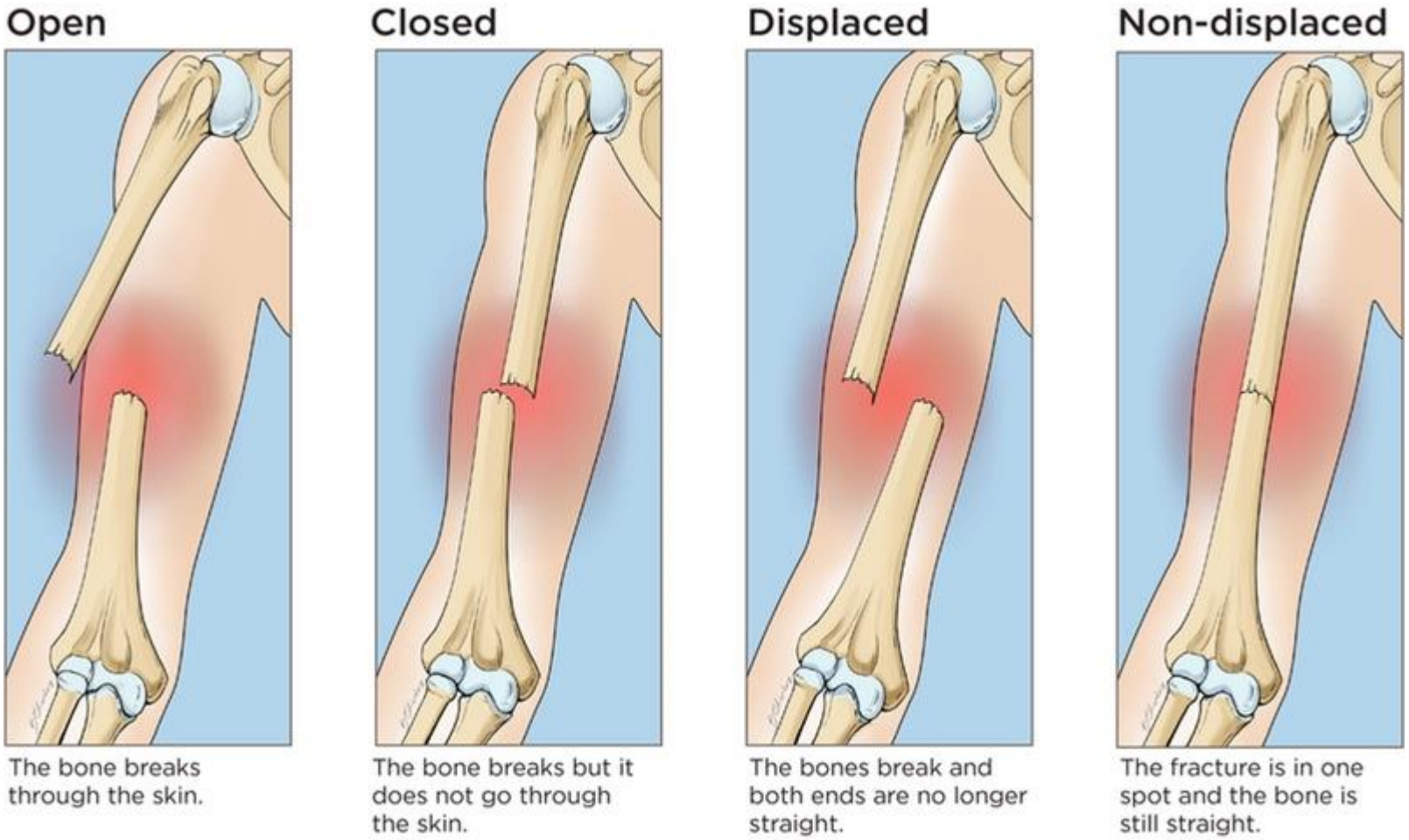
OPEN & CLOSED FRACTURES

COMPLETE FRACTURES

If the break is completely through the both bone cortex which can classify according to :

1) **Identification of a fracture line** .as in linear, oblique, transverse, longitudinal, and spiral fractures
2) **positions of bony fragments** these are described as comminuted, non-displaced, impacted, overriding, angulated, displaced, avulsed, and segmental.





MECHANISM OF INJURY BY THE FORCED APPLIED :

(A) SPIRAL PATTERN (TWISTING);

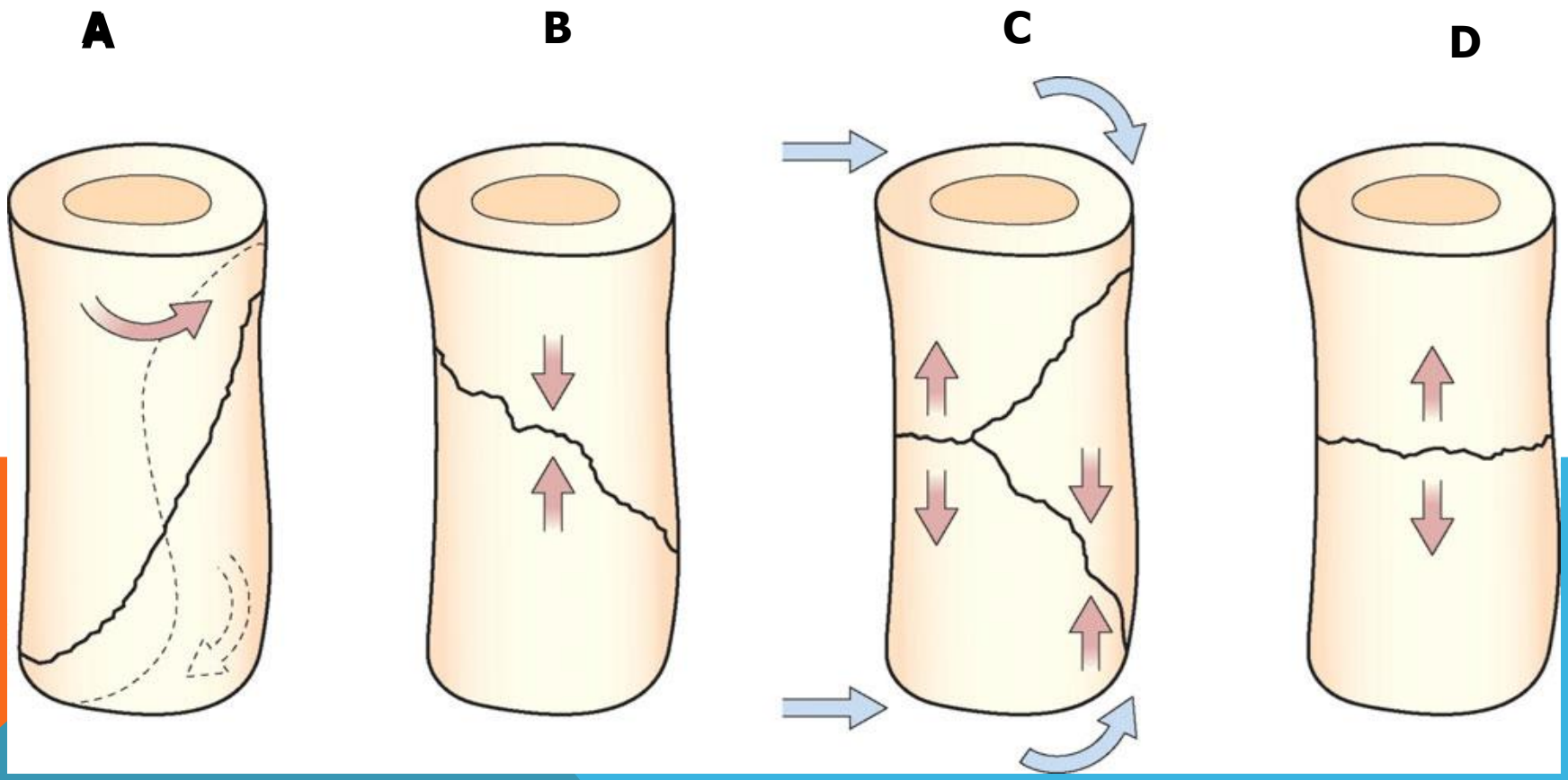
(B) SHORT OBLIQUE PATTERN (**COMPRESSION**);

(C) TRIANGULAR 'BUTTERFLY' FRAGMENT (BENDING)

(D) TRANSVERSE PATTERN (TENSION).

NOTE:

SPIRAL AND SOME (LONG) OBLIQUE PATTERNS ARE USUALLY DUE TO LOW-ENERGY



Incomplete or "greenstick“

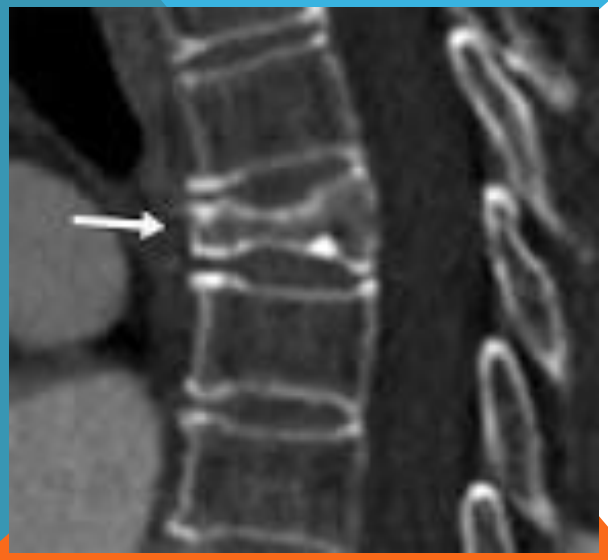
if the fracture occurs partly across a bone shaft & it is often the result of bending or crushing forces applied to a bone.

-Such an angulation force tends to bend the bone at one cortex and to buckle or break it at the other, thus producing an in complete fracture

-The bone is bent just like a tree branch.

-You can reduce the fracture by reversing the force of bending. The fracture is peculiar to children, whose bones, especially before the age of ten, are springy and resilient..

COMPRESSION FRACTURE:



fracture of cancellous bone (as in the vertebrae or the pelvis). It compresses the material of the cancellous bone into a smaller size. In this type of fracture because the spongy bone substance is crushed almost to powder it can't be restored fully to its original trabecular form. Thus in case of compression fracture it is wisely to accept the altered shape of the bone as permanent and to concentrate upon restoring function, rather than to attempt to restore the bone to its original form

Terms in fractures:

-**A single fracture** means that one fracture only has occurred

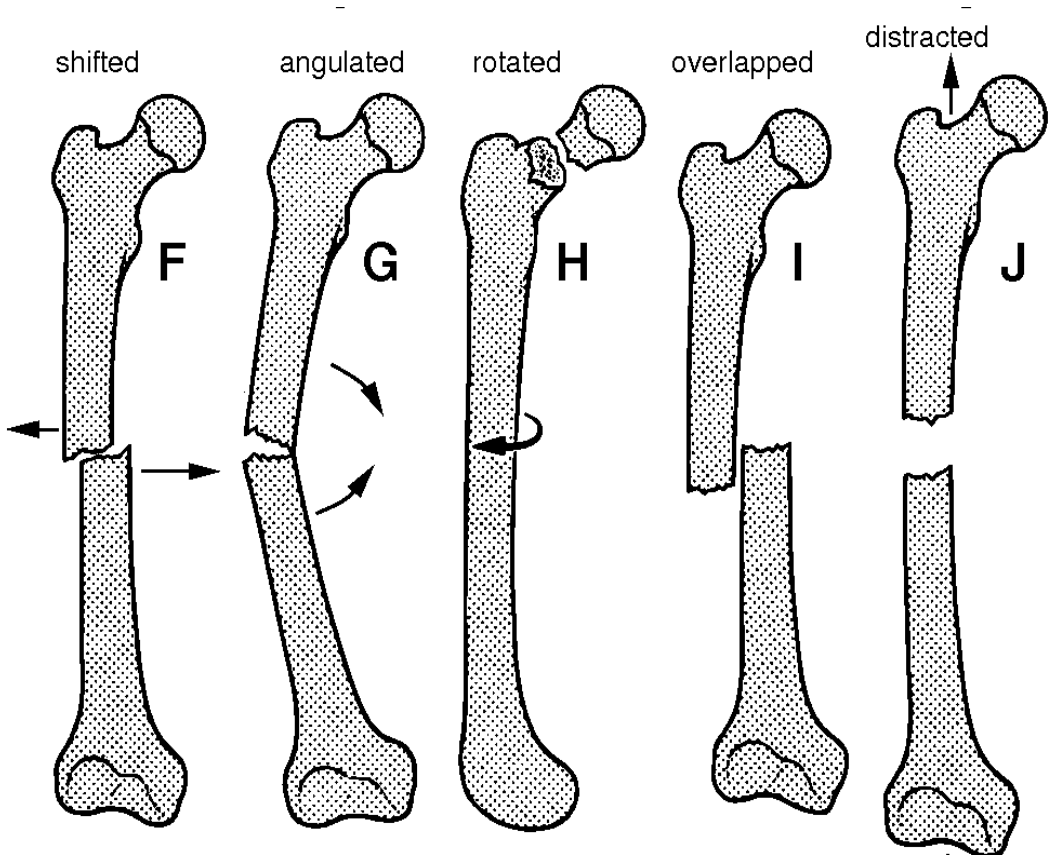
- **multiple fractures** refer to more than one fracture occurring in the same bone.

-**Fractures according to the specific part of the bone involved** and the nature of the break.eg: fracture neck femur

-**fracture-dislocation** when a fracture involves the bony structures of any joint with associated dislocation of the same joint

FRACTURE DISPLACEMENT :- The fracture may be undisplaced or usually displaced according to the type of injury and the direction of fracture line, also depends on localized muscle action and gravity; displacement described according to the direction of distal segment, this can be in form of:

1. **Shift** (the fragments are shifted to one side as anterior, medial or lateral... and the axis of the two pieces is just the same).
2. **Overlap** (some part of the bone overlapping on the segment above)
3. **Impaction** (pieces getting jumped into each other)
4. **Tilt** (when there is an angulation)
5. **Twist/ rotation:** the limb may be aligned well but if you look at the foot or knee the there is either internal or external rotation.


shifted
angulated
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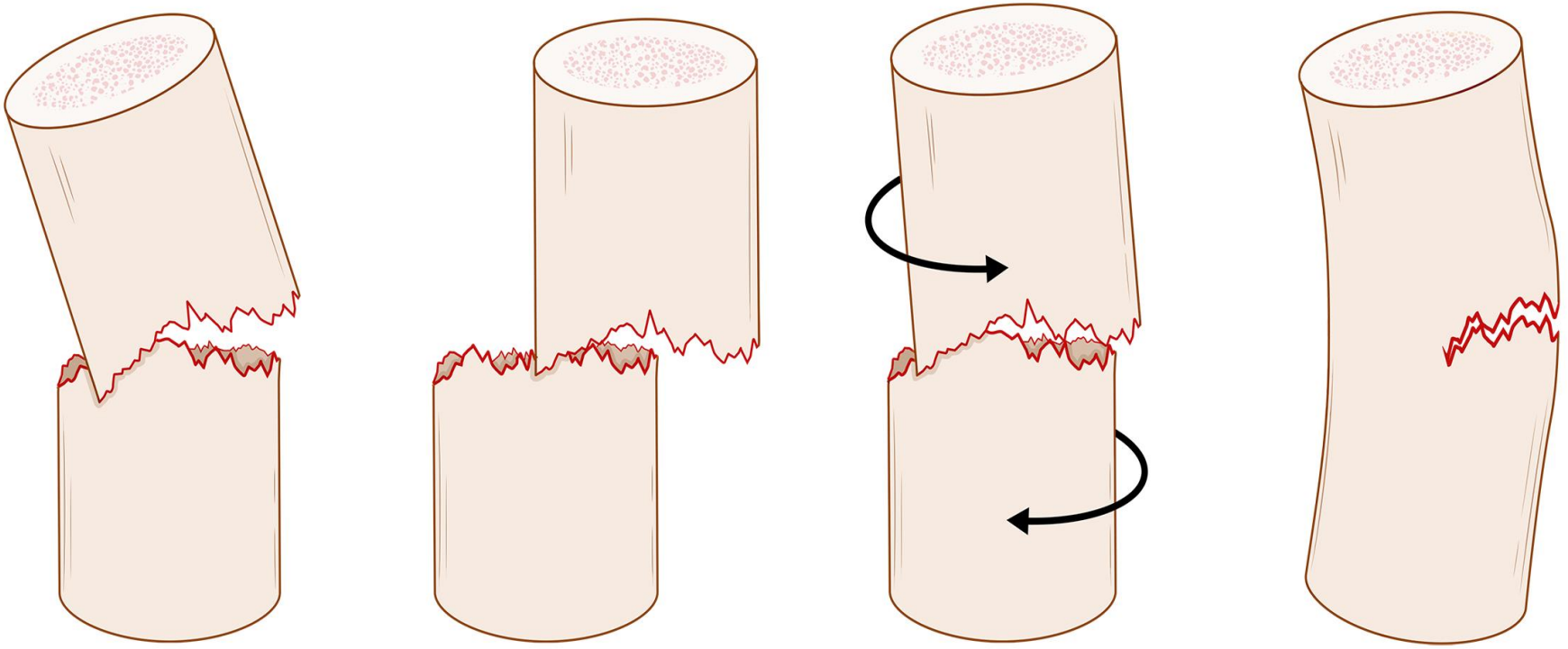


CAUSES :-

1)Traumatic fractures: individuals with a very high activity level have a greater risk of fractures. This group includes children and athletes participating in contact sports, below 50 years more common in men& above 50 increase in women ,

2)Pathological fractures: ***disease*** that weakened the bone eg. Osteomyelitis ,paget's disease ,ontogenesis imperfecta. ***Tumors*** ..eg multiple myeloma ,osteosarcoma**.**
Osteoporosis Either

Primary osteoporosis there is decrease in amount of estrogen bone matrix in the bone.

Secondary osteoporosis which include (Ageing)senile osteoporosis., Disuse osteoporosis as in stroke (CVA) with hemiplegics paralysis,, P.O.P casting ,or osteoporosis due to chronic dis. as diabetes ,chronic renal failure hepatic failure, Drugs induce osteoporosis as methotrexate, steroid. Malabsorption syndrome , alcoholism ,smoking, thyrotoxicosis ,….etc

3) Stress fractures: occurs mainly due to minor repetitive trauma ,mainly in fibula & metatarsal bones mostly occurs in soldiers & nurses

SINGS & SYMPTOMS

1) **intense pain** Pain that prevents the use of a limb may also indicate a break.

2) **Swelling due to fracture haematoma** An open fracture is often accompanied by bleeding or bruising

3) **Deformity** misshapen limb, point to a possible fracture

4) **loss of function** If a leg is fractured, there will usually be difficulty bearing weight on it.

5) **Numbness & parasthesia** In severe fractures, there may be a loss of pulses below the fracture site and a resultant numbness, tingling, or paralysis in the feet, hands, fingers, or toes below the site.

6) **Signs of shock** as dizziness, sweating, disorientation, or thirst

DIAGNOSIS:

BEGINS IMMEDIATELY BOTH CLINICALLY & RADIOLOGICAL

1) **A thorough medical history and physical examination.**
2) **Observation of signs &symptoms of fractures with a history of trauma**
3) **An x ray of the injured area is most commonly used to determine the presence of a bone fracture**. Any x-ray series performed involves **at least two views** of the area to confirm the presence of the fracture because not all fractures are apparent on a single x ray. Some fractures are often difficult to see and may require several views at different angles, the initial x ray may not show any fractures, but if it is repeated seven to 14 days later **.**

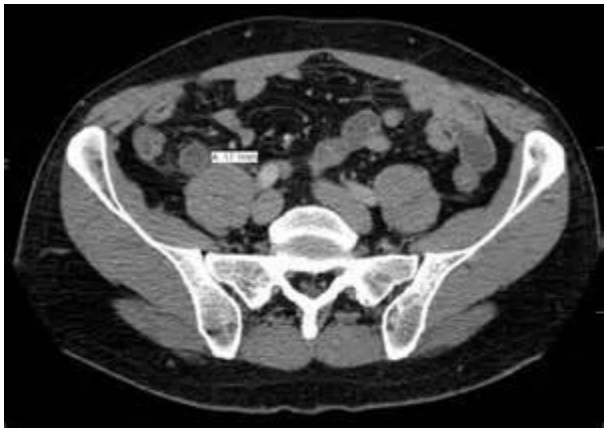
X-ray should always involve joint above & a joint below the injured area .Rule of Two(2 Veiw ,2 Limb,2occasion ,2 person)

4) CT, MRI :

4) CT, MRI :

sometimes are required to demonstrate fracture specially in complicated comminuted fractures of the bone end involving joint surface . **In the event of stress fracture**(micro-fractures due to excessive stress**.**

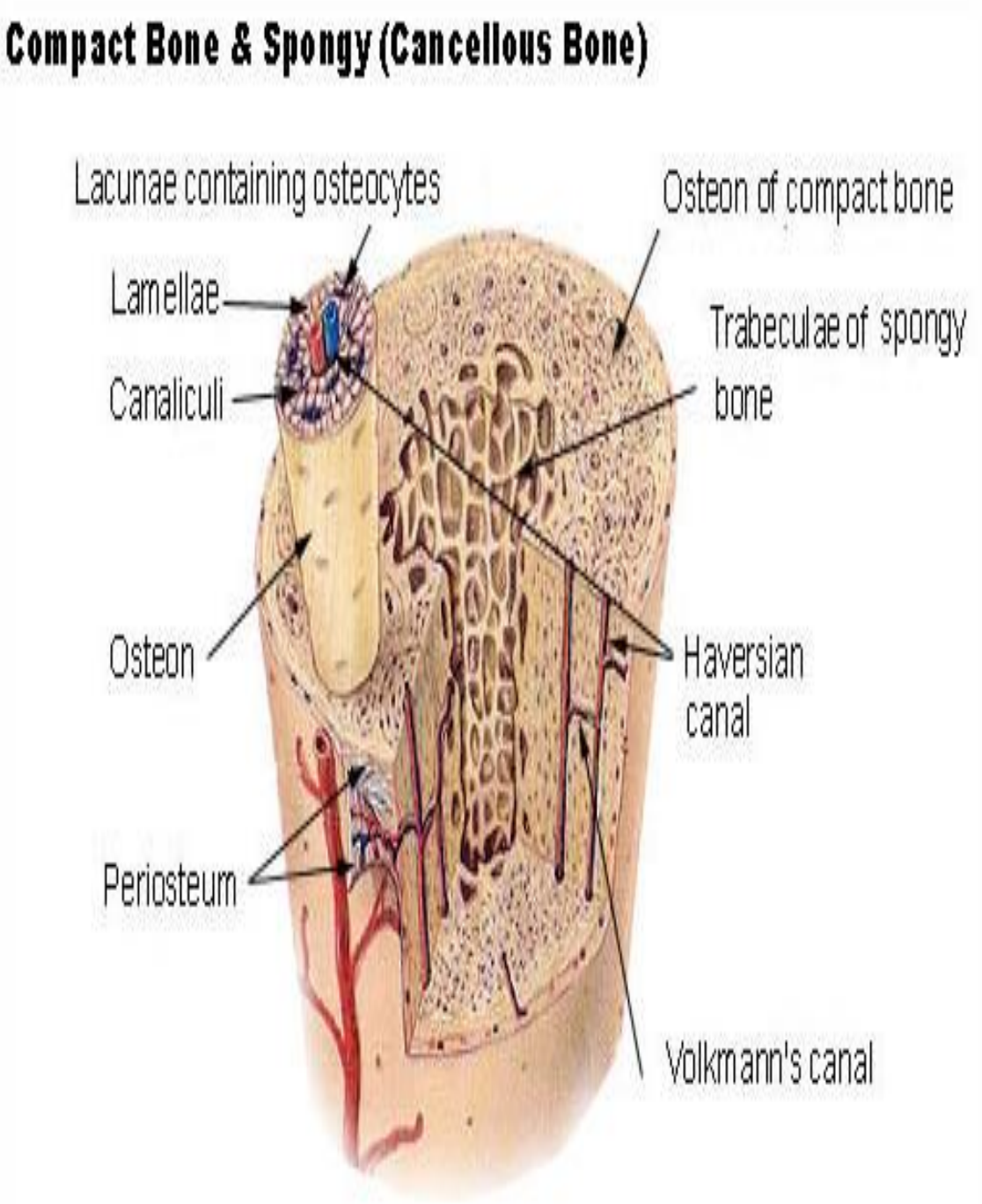
5)Bone scans ((a radioactive tracer is injected into the bloodstream and images are taken of specific areas or the entire skeleton by CT or MRI.)), being use to detect a fractures .but it's rarely used .

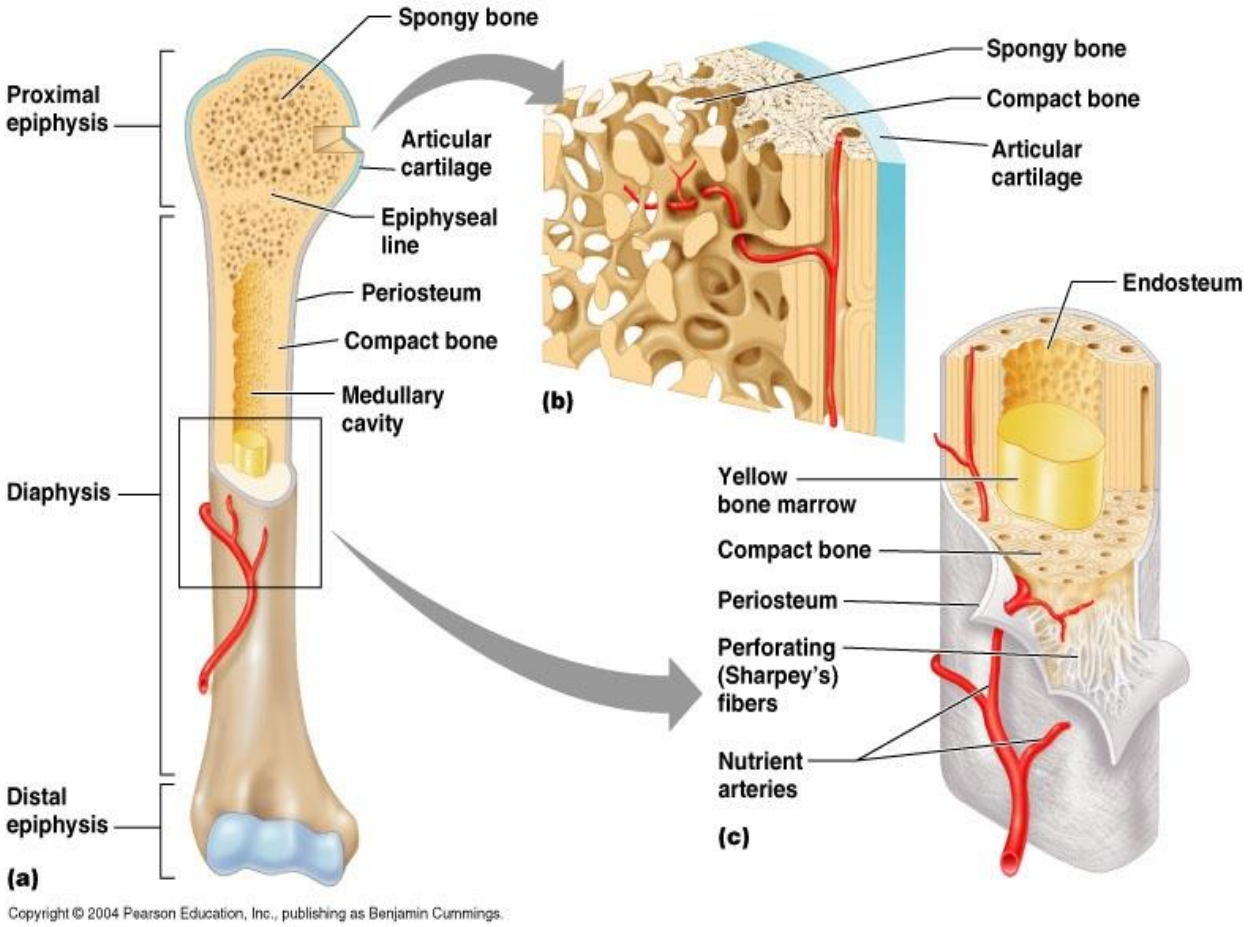


BONE

-There are two types of bone tissue: *compact and spongy*.

-The names imply that these two types are of different density, how tightly the tissue is packed together.





There are three types of cells that contribute to bone homeostasis.

1)**Osteoblasts:** are bone-forming cell,

2)**Osteoclasts:** resorb or break down bone

3)**Osteocytes:** are mature bone cell,,, An equilibrium between osteoblasts &osteoclasts maintains bone tissue.

Bone healing

(BONE HEALING, OR FRACTURE HEALING)

IS PHYSIOLOGICAL PROCESS IN WHICH THE BODY FACILITATE THE REPAIR OF THE BONE FRACTURE

FRACTURE HEALING OR UNION HEALING PROCESS DEPENDS UPON:

1-TYPE OF BONE #

2-SITE OF #.

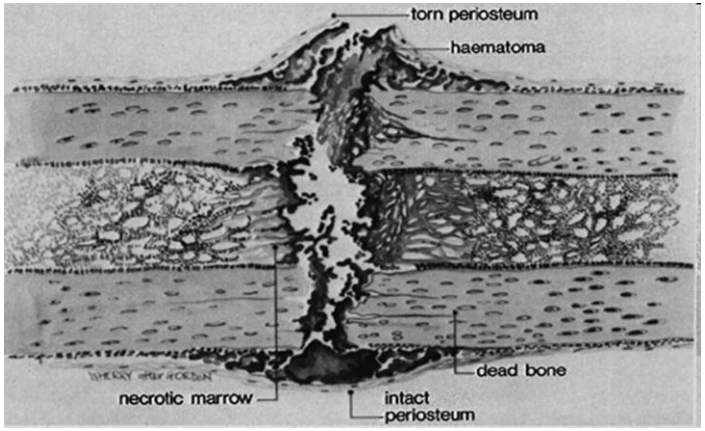
3-AGE OF THE PATIENT

4-VASCULARITY OF THE FR. BONE

5-DEGREE OF MOVEMENT AT FRACTURE SITE

TYPES

1) HEALING BY CALLUS FORMATION (SECONDARY HEALING);-



Steps of fracture healing :

1- tissue destruction and haematoma formation .

2- acute inflammatory reaction and cellular proliferation .

3- callus formation (step of union) .

4- consolidation .

5- remodeling .

In a tubular and in the absence of rigid fixation healing proceeds in five stages :

1-A tissue death and a hematoma forms around and within the fracture bone at the fracture surfaces, deprived of a blood supply ,dies back for a millimeter or 2 .

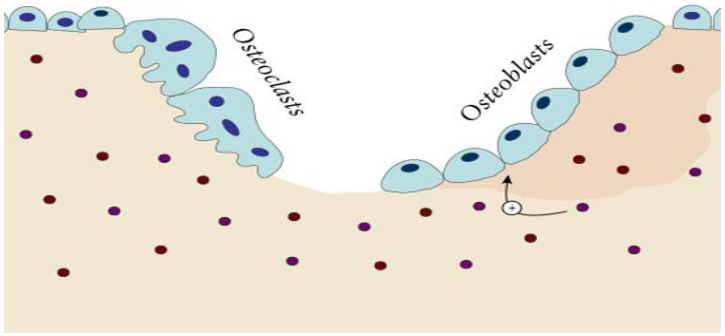
2-Inflammation and cellular proliferation :Within 8.hours of the fracture there is an acute inflammatory reaction with proliferation of cells under the periosteum and within the medullary canal ,the fragment ends are surrounded by cellular tissue which bridges the fracture site , The clotted hematoma is absorbed and fine new capillaries grow into the area.

3-Callus formation: after (3-7) days from fracture, the proliferating cells are potentially chondrogenic and osteogenic they will start forming bone and in some cases also cartilage, the cell modulation now also includes osteoclasts which begin to remove dead bone ,the thick cellular mass forms the callus on the periosteum and endosteal surfaces. As immature bone or woven bone becomes densely mineralized movement at the fracture site decrease progressively and the fracture units

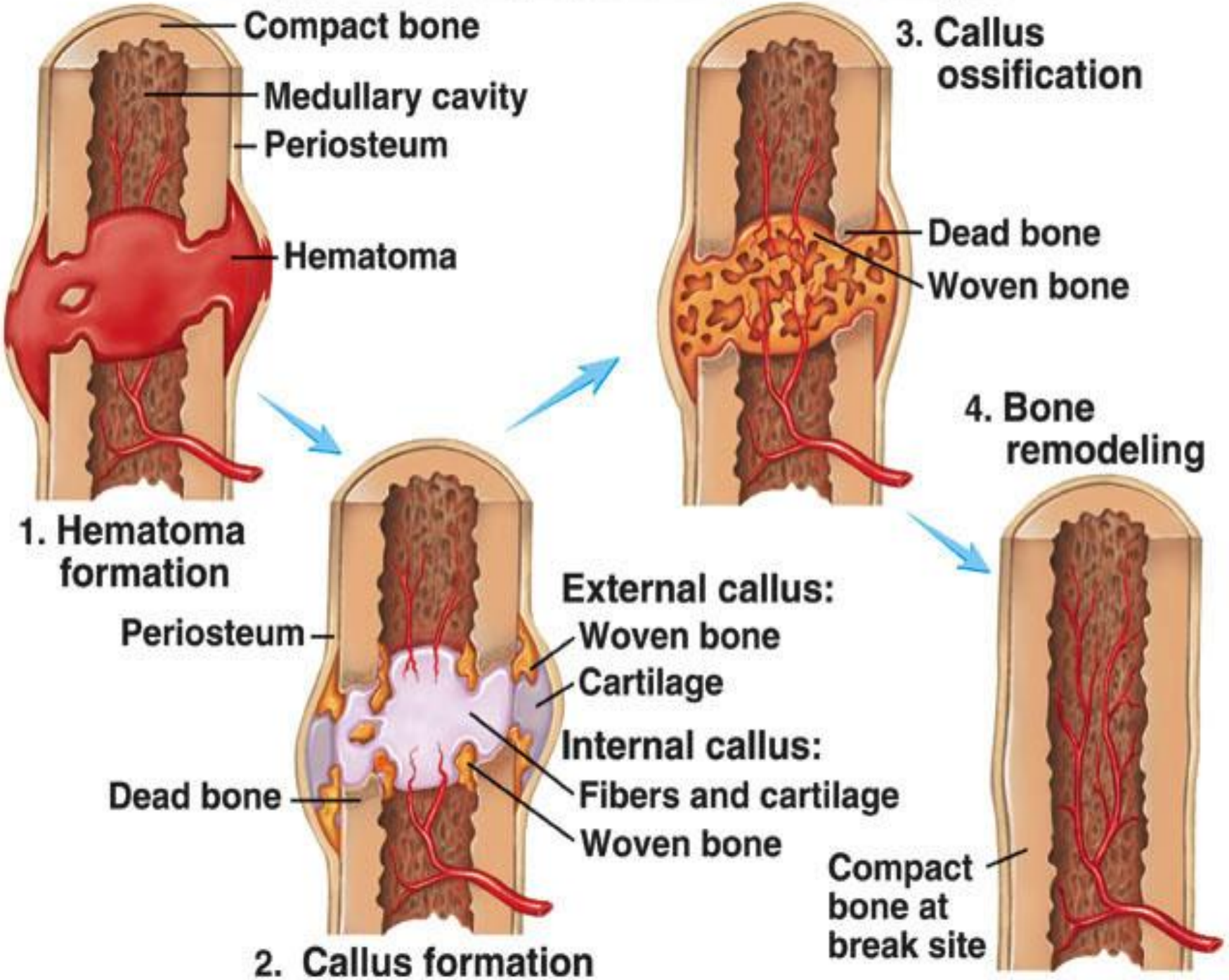
4-Consolidation: With continuing osteoclast and osteoblastic activity the woven bone is transformed into lamellar bone is now strong enough to carry normal loads

5-Remodeling::The fracture has been bridged by a cuff of solid bone over period months or even years this bone is reshaped by a continuous process of alternating bone resorption formation thicker lamellae are laid down where the stress are high unwanted bone are removed away the medullary cavity is performed eventually. In children the bone reassumes thing like its normal shape

REMODELING



1. The remodeling process substitutes the trabecular bone with compact bone.
2. The trabecular bone is first resorbed by osteoclasts, creating a shallow resorption pit known as a "Howship's lacuna".
3. Then osteoblasts deposit compact bone within the resorption pit.
4. Eventually, the fracture callus is remodeled into a new shape which closely duplicates the bone's original shape and strength.



Difference between Union and consolidation

Union_ :

is incomplete stage of healing the unsheathing callus is calcified

Clinically: The fracture still a little tender

*Attempt to angulated the bone painful

Radiological:

-The fracture line is clearly visible

-The callus is fluffy around the fracture site

-Not safe to subject the bone to stress without protection

2-Consolidation:

is complete repair the calcified callus is ossified

Clinically: the fracture site is not tender

-No movement can be obtain

-Attempt to angulated the bone is painless

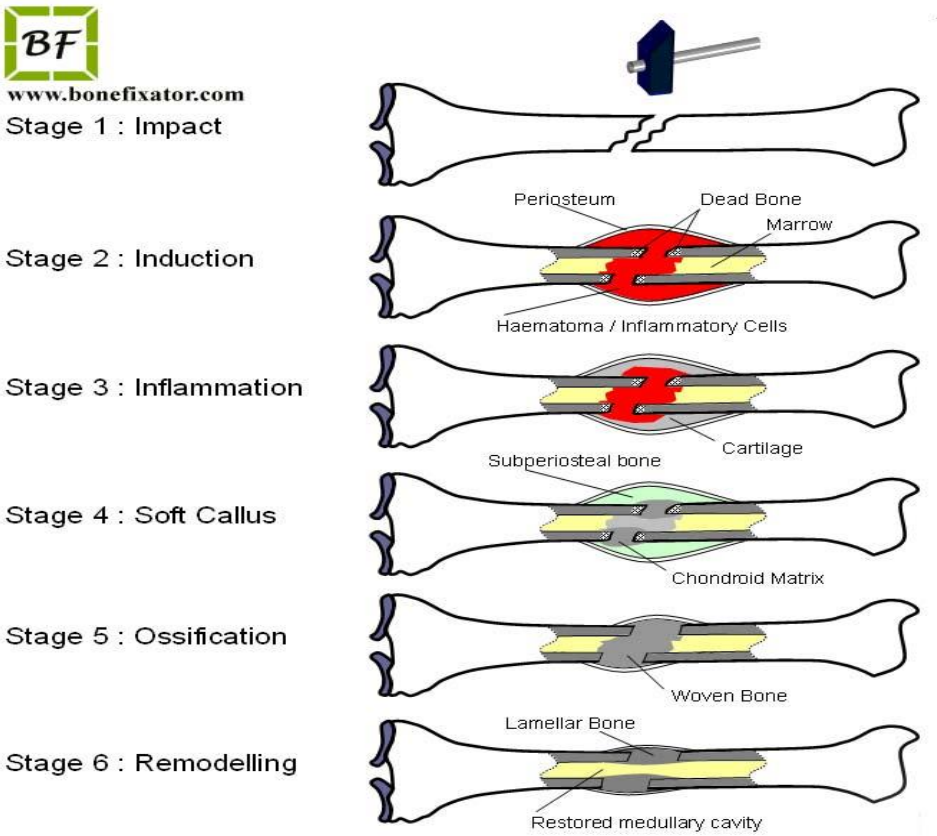
Radiological: t

-he fracture line to be almost obliterated and crossed by bone trabecular

-The callus is well defined around # site

-safe to subject the bone to stress protection

FRACTURE HEALING



TIME FACTOR

REPAIR OF FRACTURES IS A CONTINUOUS PROCESS AND NO SPECIFIC EVEN SIGNIFIES THE MOMENT OF UNION.

Rate of repair depends on:

i. Age: healing in children is as twice faster as in adult.
ii. Type of bone: fracture of scaphoid or neck of the femur is delayed
iii. Type of fracture: transverse fracture takes more time to heal than spiral fracture because in spiral fracture there greater fracture surface area reacting than in transverse fracture so there are more osteoblastic and osteoclastic activity.
iv. State of blood supply & Patient general condition
v. Proper contact and apposition of fractured fragments
vi. Adequate immobility or fixation of the fracture
vii. Absence of infection
viii. Early and good management

Causes of non-union can be:

1-Wide separation of fractured fragments

2-Soft tissue interposition between the fragments

3-Poor local blood supply

4-Excessive movement of the fractured fragments

5-Local infection as in compound fracture or after surgical operation

6-Continuous pull of the fragments by a muscle as in avulsion fracture of patella or olecranon.

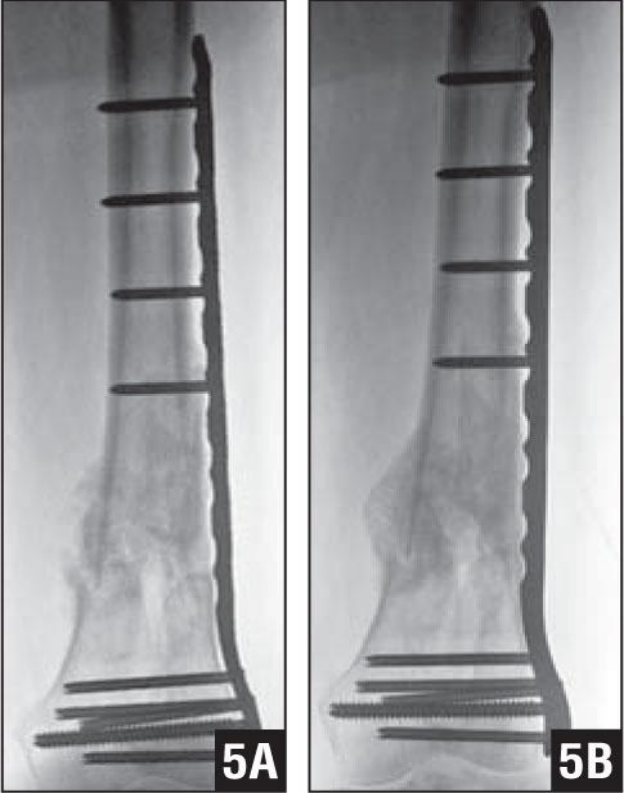
7-Delayed or poor management

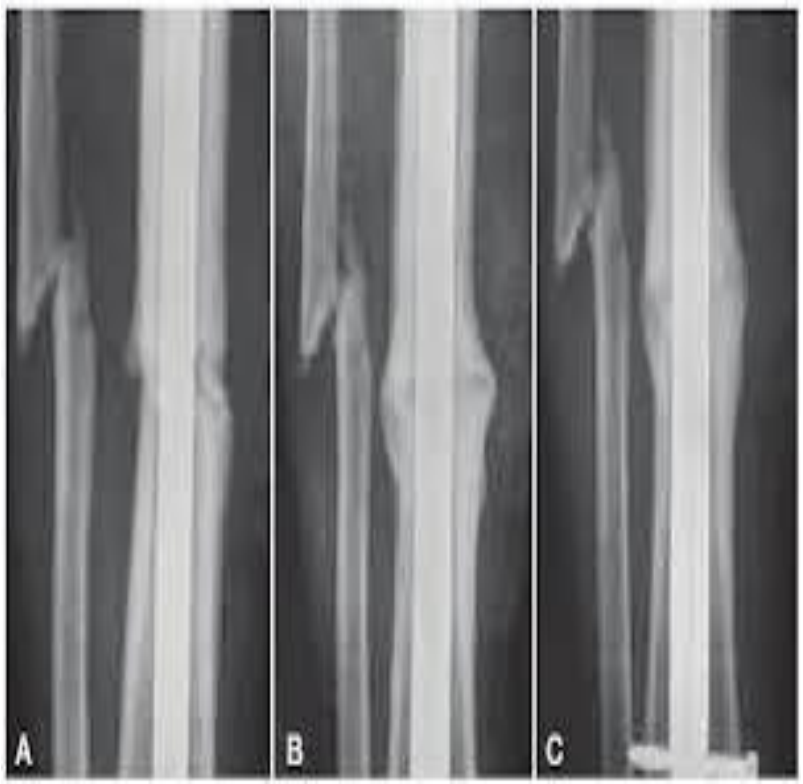
8-In debilitated, elderly or sometimes chronically diseased patients

Expected time of healing in adult

	UPPER limb	LOWER limb
Callus visible	2-3 weeks	2-3 weeks
UNION	4-6 weeks	8-12 weeks
Consolidation	6-8 weeks	12-16 weeks

Children expected healing time is half of the adult





- **2)Healing by direct repair (primary bone healing)**
- it occurs when the fracture fragments are accurately reduced and rigidly immobilized where direct capillary growth and new bone laid across the fracture line (without callus) as in primary healing of the skin. It occurs in fracture of cancellous bone as in compression fracture or fractures that are internally or externally

TREATMENT

1)Prevention is the most effective way to avoid fractures. Wearing protective helmet, or using protective equipment, such as safety gear, while playing sports may greatly reduce the risk of a fracture a Broken bones need to be treated as soon as possible by a specialist.

2)Temporary measures include applying ice packs to injured areas, and the use of aspirin or non steroidal anti-inflammatories (NSAIDS) to reduce pain and swelling. Initial first aid for a fracture may include **splinting, control of blood loss, and monitoring of vital signs**, such as breathing and circulation.

3) Immobilization of the fracture site can be done internally or externally Immobilization by external fixation uses splints, casts, or braces; Open reduction is surgery that is usually performed by an orthopedist. Internal fixation devices, such as metal screws, plates, and pins, hold the bones in place as they heal. Open fracture or comminuted fractures with soft tissue damage which can be treated by external fixation . Fractures with little or no displacement of the bones do not usually require such surgery.

Principle Of Treatment

Gustilo classification of Open Fr.

I - Low energy- wound less than 1 cm, minimal contamination ,comminution, and soft-tissue damage . (infection rat 0-2 %)

II - Wound greater than 1 cm (2-5) with moderate soft tissue damage, minimal periosteal stripping wound bed is moderately contaminated. (infected rate 2-5 %)

III- High energy –wound greater ((5- 10 cm 0r more)) with extensive soft tissue damage:

A - Severe soft-tissue damage and substantial contamination;

coverage adequate , segmental fracture with displacement or fracture with diaphyseal segmental loss ; no neuro – vascular injury . (infection rate10 -15%)

B - same as above + soft tissue is inadequate for cover and requires regional or free flap usually associated with major nerve injury. (infection rat 15- 25%)

C - same as the above + arterial injury (infection rat 25-50 %)

The primary treatment of compound fractures includes:-

A) Early operative debridement procedure

B) Bone stabilization

A) Early Operative Debridement include

1- Exploration of the wound to define the zone of injury

2- Removal of devitalized tissue as non-viable skin and muscle, and mechanical lavage for any foreign article's as clothes ,missels & shells, mud &dirty materials.

3-Fasciotomy should be performed & evacuation of hematoma

4- Removal of Small to medium-sized avascular bone fragments

5- The initial primary traumatic wound should be left open while operative extension of the initial wound may be primarily , sutured

6-Extensive soft tissue damage should be reinspected and additional debridement performed within24-48 hours

B) Bone stabilization

1. Casting ..
2. Traction either (skin or skeletal) .
3. External fixation

Bone stabilization

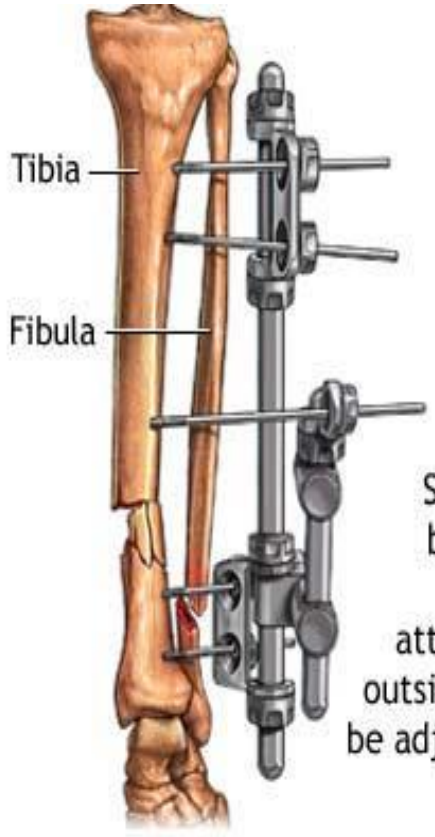
1-Casting ..
2-Traction either (skin or skeletal) .
3-External fixation with or without minimal internal fixation..
4- Internal fixation if the condition allow.

are the main lines for treating a war injured patient with compound fracture

External fixation : **Give a very good results when correctly applied for the correct indications in most of the cases ,but it's not the only way to treat all fractures in war surgery,**

External fixation *is the primary form of initial long-bone fracture stabilization for soldiers treated in battlefield hospitals or civilian victims of explosions& accident's Once the patient is in a stable environment, the receiving surgeon can either continue with external fixation specially if an* extended periods of time are needed to debride wounds adequately,,,, *or select a different treatment method for definitive treatment as intra-medullary nailing (IM-nailing)*

TYPES OF EXTERNAL FIXATOR



Screws are placed into the bone above and below the fracture, and a device is attached to the screws from outside the skin, where it may be adjusted to realign the bone

A.D.A.M.

INDICATION FOR EXTERNAL FIXATO

1)Open compound fracture

2)Multiple fractures

3)Fracture +vascular injuries

4) Fracture pelvis

5) Periarticular fracture

6)Bone sliding & bone lengthening

7) Pathological # as bone Tu. ,,osteomyelitis.

ADVANTAGE OF EXTERNAL FIXATOR

1) easily applied considering the corridors
2) no soft tissue stripping
3) easily removed .
4)Ease the patient transfer & movement
5)Free & Mobil joint above & the joint below
6)Help other specialties to interfere. (plastic & neruo-surgery.) ,

DISADVANTAGE OF EXTERNAL FIXATOR

1)Pin tract infection

2) Mal –union

3) Non-union

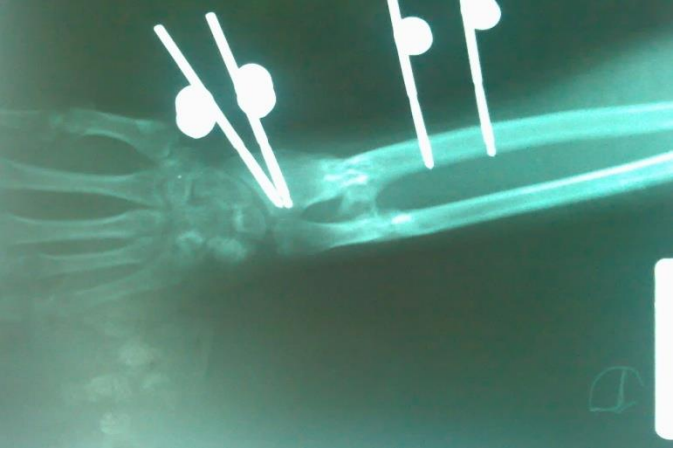
4) injury to neurovascular bundle

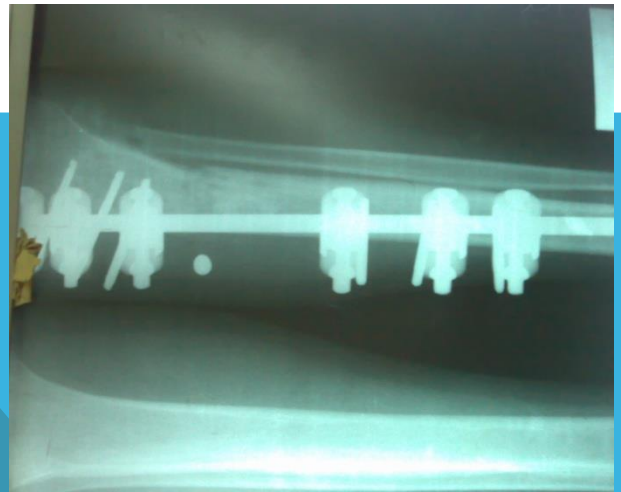
5)fracture through pin tract.

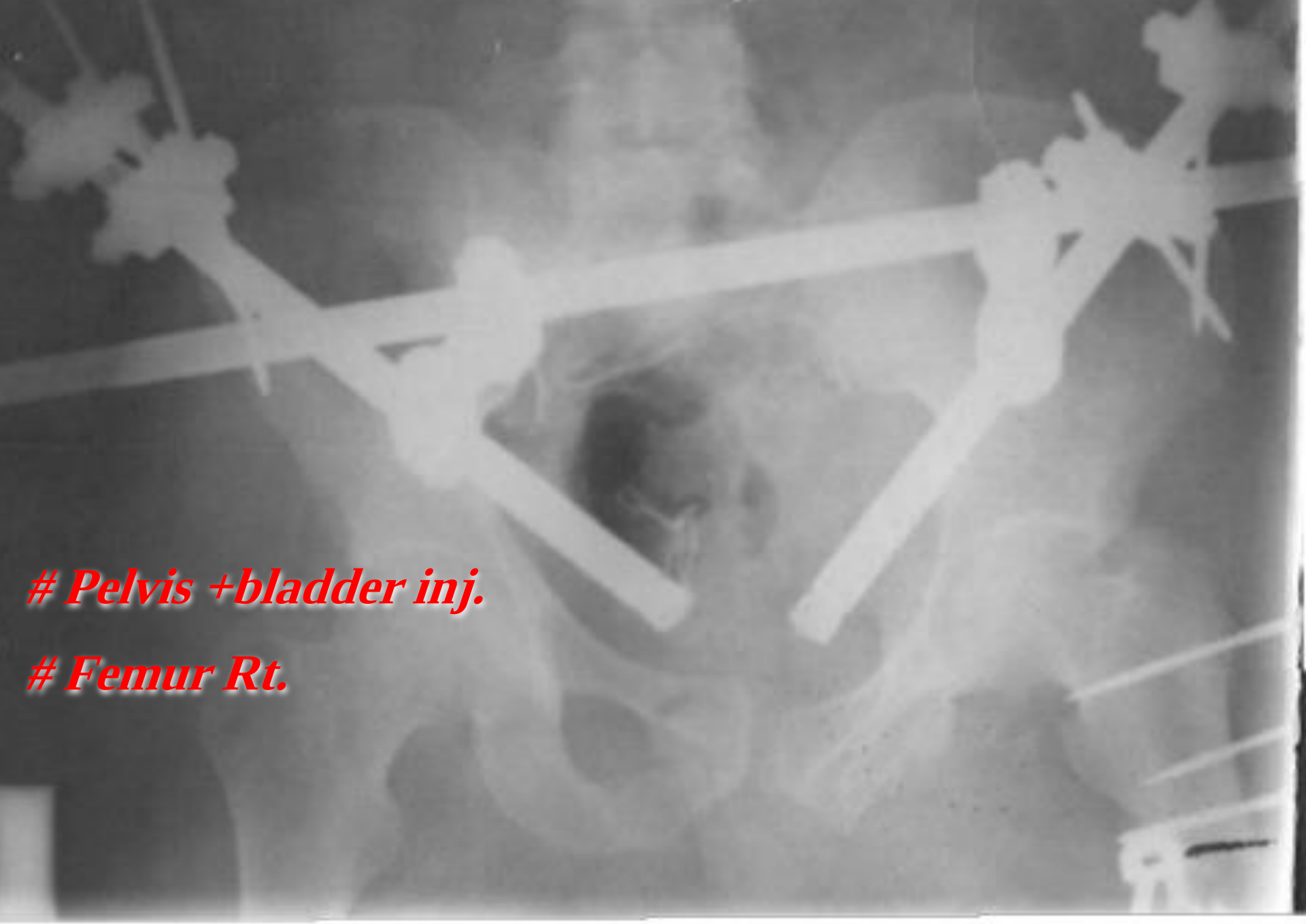
6)broken pin

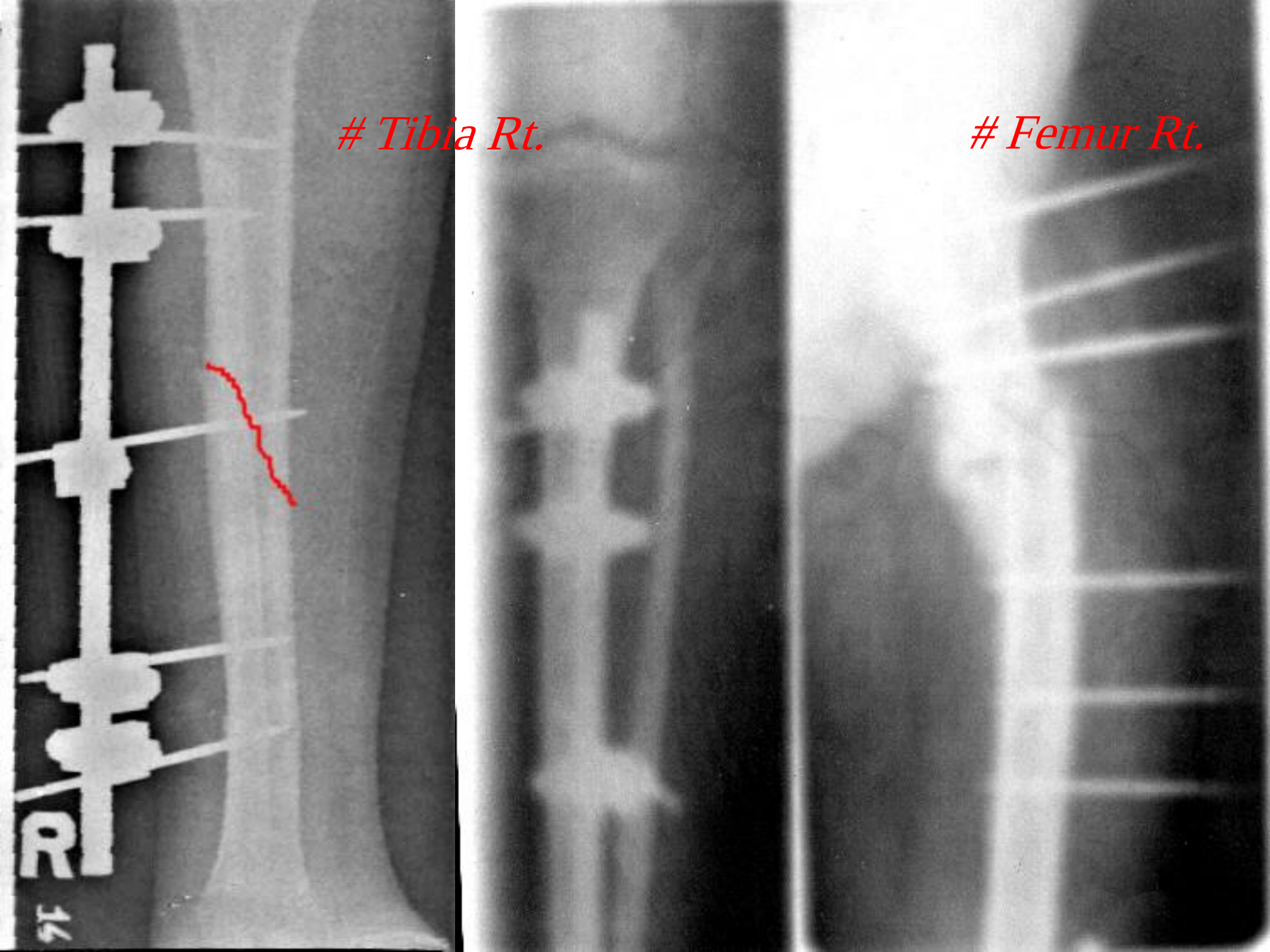
7) losening of the clamps


23.4.10






Pelvis +bladder inj.
Femur Rt.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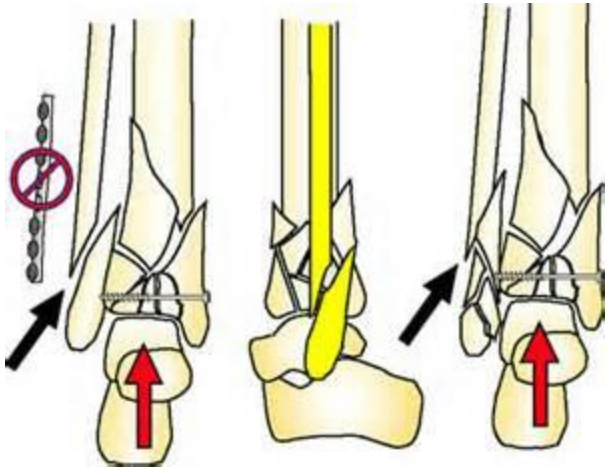
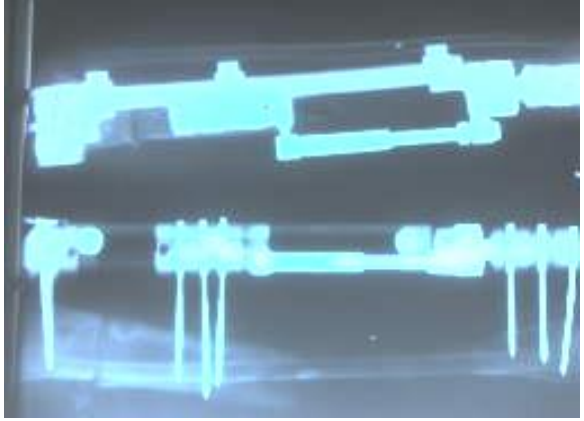
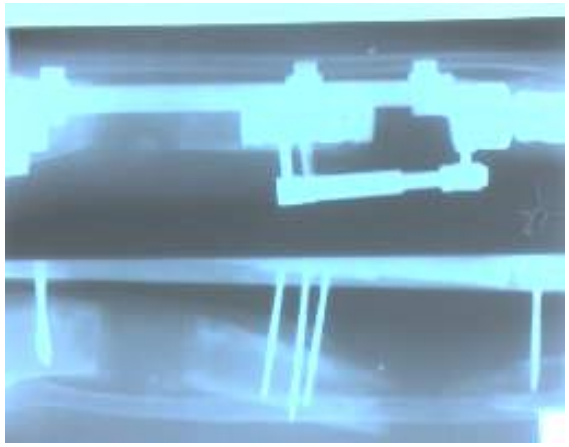
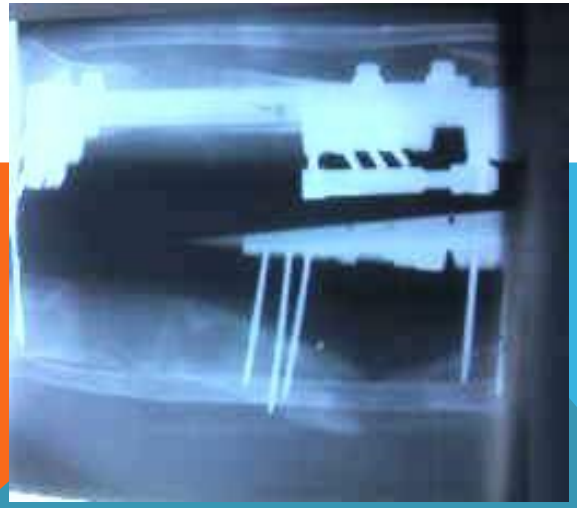


Illizarov external fixation in periarticular fractuer







APPLICATION OF EXTERNAL FIXATION FOR DIFFERENT TYPES OF COMPUND FRACTURES








Bone stablization

1-Casting ..
2-Traction either (skin or skeletal) .
3- External fixation with or without minimal internal fixation..
4- Internal fixation if the condition allow.

are the main lines for treating a war injured patient with compound fracture

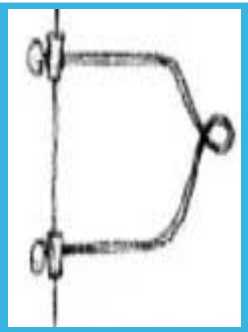
Traction skin or skeletal traction

Advantage

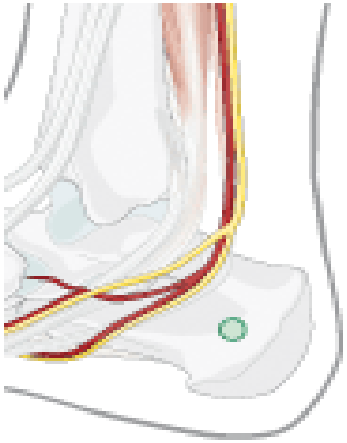
- Is a simple and safe method for fracture holding, especially for the lower limb
- It can be used for initial and definitive stabilization and allows easy wound access and joint mobilization.
- It gives a rapid callus formation.

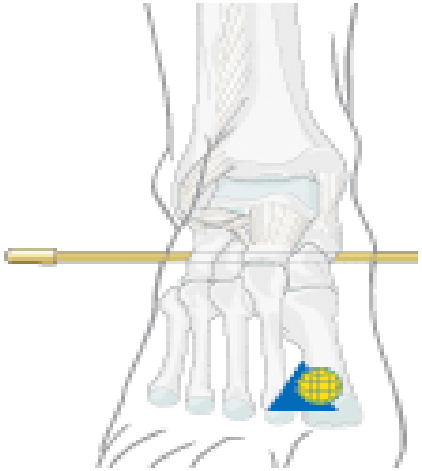
Disadvantages

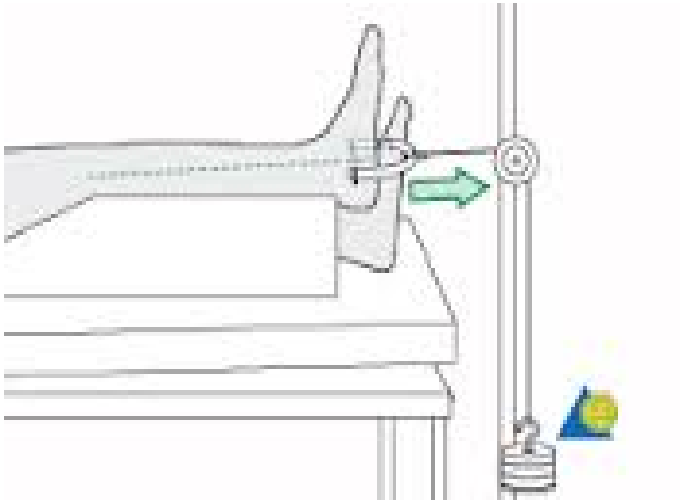
- long bed rest, leading to resp.&urinary infection plus bed sore
- Difficult access to the buttock and posterior aspect of thigh and leg,
- Male-union ((difficulties in getting a perfect alignment of the fracture))
- Traction can be applied in different forms: *gallows traction* for femur fractures in babies up to 3 years or 15 kg of body weight,
- *skin traction* for older children & adult patient
- *SKELETAL or pin-Traction* for pelvis ,femur & tibial fracture



Indications for skeletal fixation ;- many surgeons would hold the unstable fractures by skeletal fixation .

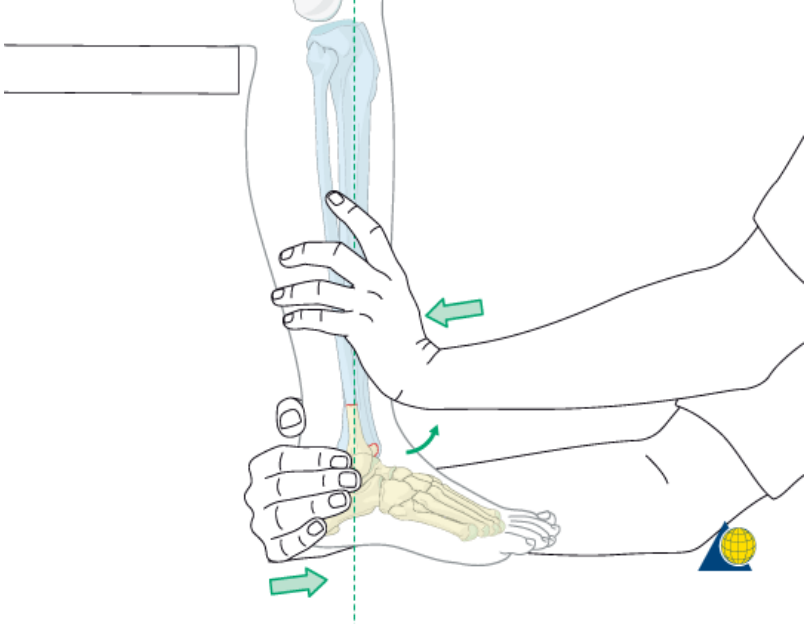


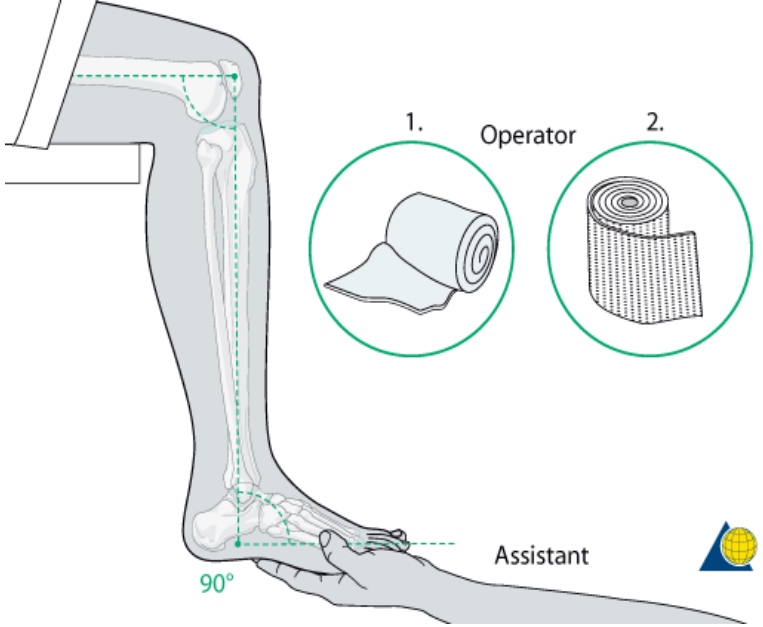




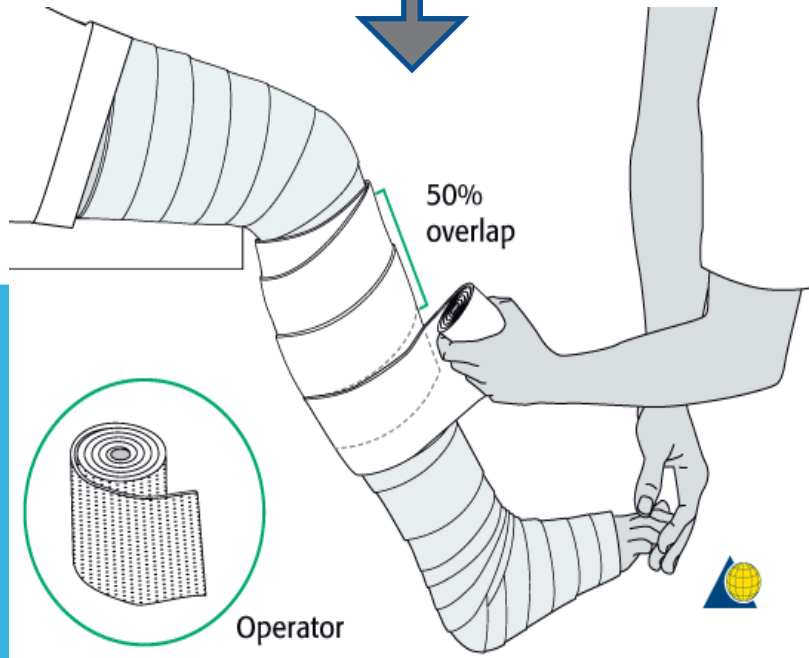
Gypsona

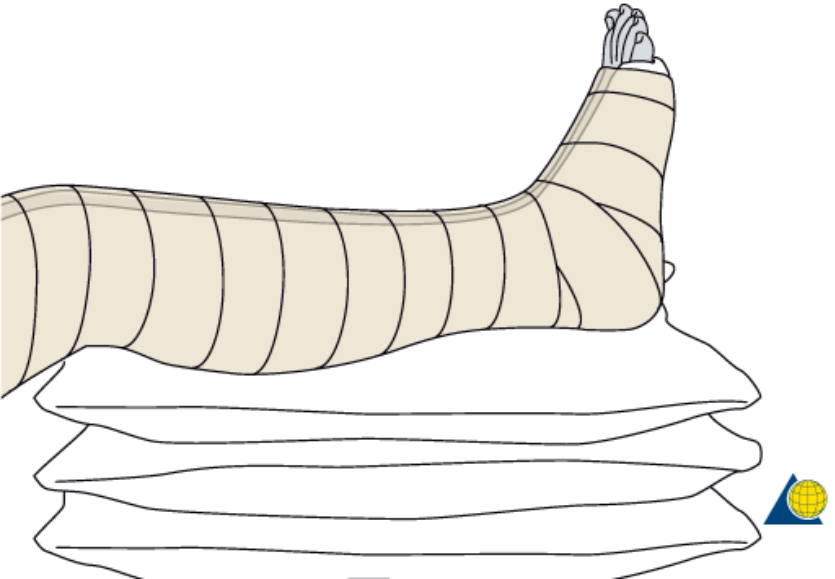
consists of a leno-weave gauze fabric that is coated with a blend of the alpha and beta forms of *calcium sulphate hemihydrate (plaster of Paris),* together with binders and accelerators.





Position : sitting or supine (under anaesthesia) Patient is brought to the edge of the table and both the legs are kept dangling . Holds the leg of the patient and manipulates the fracture and a long leg cast is applied ,,Ankle and knee joint surface should be parallel





Exercise *From the start, the patient is taught to* exercise the muscles of the foot, ankle and knee. When he gets up, an overboot with a rocker sole is fitted and he is taught to walk correctly. When the plaster is removed, a crepe bandage or elasticated support is applied and the patient is told that he may either elevate and exercise the limb or walk correctly on it.

Closed fracture :

A- Reduction: To align the fragments as it is more important than perfect opposition except in intra-articular fractures where perfect reduction is a must.

Methods

1)Closed method: reducing the fracture without opening the site of fracture.

It is done for minimally displaced fracture and most fractures in children.

It must be done under anaesthesia. *This is done by:*

- Pulling on the distal fragment in the longitudinal line of the bone so that the distal fragment is away from the proximal one
- Reverse the direction of the force that caused the fracture
- Align any other plane displacements as nearly as possible to their correct position.

2) Open reduction: if you are not successful in the previous one.

Indications:

- Failure to reduce the fracture by the closed method
- Intra-articular fracture that requires perfect reduction
- Avulsion fracture (the fragments are pulled apart by one of the muscles attached to them) e.g. in patellar fracture the fragments can be pulled by the action of quadriceps muscle.

The choice of the method depends upon the site and pattern of the fracture.

B . Immobilization: To hold the reduction; aiming at:

1. Relief pain
2. Prevent displacement or angulation of the fragments
3. Ensure good position for union
4. Promote soft tissue healing
5. Allow free movements of the unaffected part

Methods of immobilization

1. Continuous traction; in some fractures - notably those of the shaft of the femur and certain fractures of the shaft of the tibia - it may be difficult or impossible to hold the fragments in proper position by a plaster or external splint alone. This is particularly so when the plane of the fracture is oblique or spiral, because the elastic pull of the muscles tends to draw the distal fragment proximally so that it overlaps the proximal fragment. In such a case the pull of the muscles must be balanced by continuous traction upon the distal fragment, either by weight or by some other mechanical device.

2. Cast splintage: apply POP (plaster of Paris). Plaster of Paris is hemihydrated calcium sulphate.

3. Functional bracing: it is made up of plastic material that consists of two segments joint by a hinge to avoid joint stiffness.

4. Internal fixation: it is usually desirable in adults. It achieves good reduction and immobility and the complications will be less.

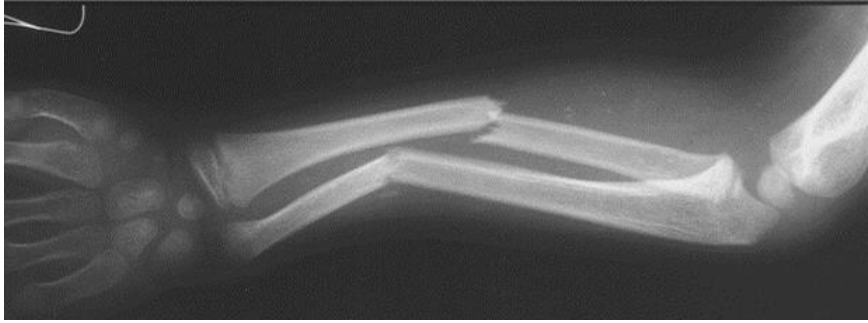
Indications

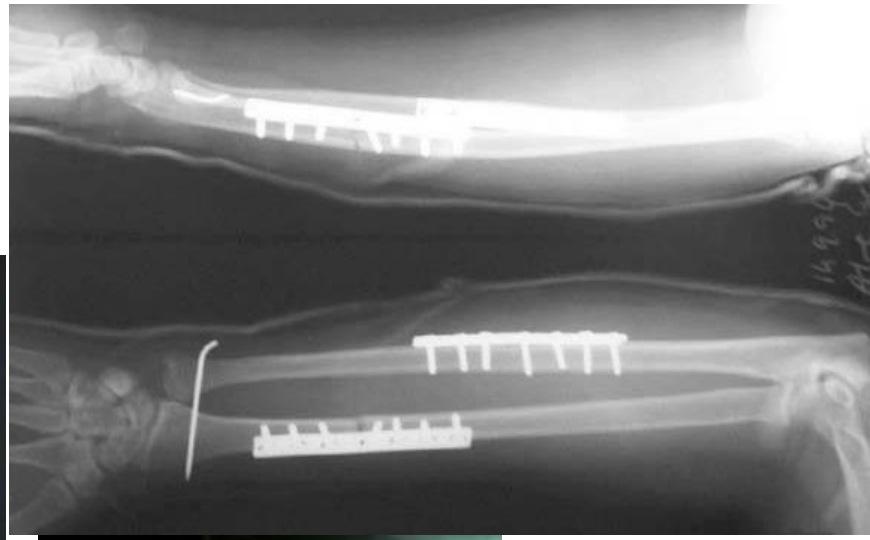
- Fracture that can't be treated by other mains.
- Unstable fracture that is known to unite poorly
- Pathological fracture
- Poly-traumatised patient to decrease the risk of RDS
- Fracture in a patient with nursery difficulties

Methods of internal fixation:

- Plate held by screws
- Bone graft held by screws
- Intramedullary nail
- Nail-plate (combined nail and plate)
- Transfixation screws
- Circumferential wires or bands
- Suture through attached soft tissues








DIAGNOSIS OF HEALING: (how you Dx. Fracture healed)

Clinical: The limb is less swollen, the bruising disappears, no abnormal movement and the patient can move the limb.

Radiological : X ray shows the callus and obliteration of fracture line

PATHOLOGIC FRACTURE

Definition:

A pathologic fracture occurs when a bone breaks in an area that is weakened by another disease process.

Causes :

1) Tumours : Either

A) primary malignant bone tumours: chondrosarcoma, osteosarcoma, Ewing's tumour

B) Secondary carcinomatous deposit :- breast, lung, thyroid, kidney, prostate

2) Generalised bone disease: osteogenesis imperfecta, postmenopausal osteoporosis, metabolic bone disease, myelomatosis, polyostotic fibrous dysplasia, Paget's disease

3) local benign conditions: chronic infection, solitary bone cyst, fibrous cortical defect, chondromyxoid fibroma, aneurysmal bone cyst, chondroma, monostotic fibrous dysplasia

PATHOLOGIC FRACTURE

Clinical features:

Spontaneous or after trivial injury, with local and general features of fracture.

X ray :shows fracture with diseased bone.

Management:

-Biopsy is needed to determine the source of primary tomour.

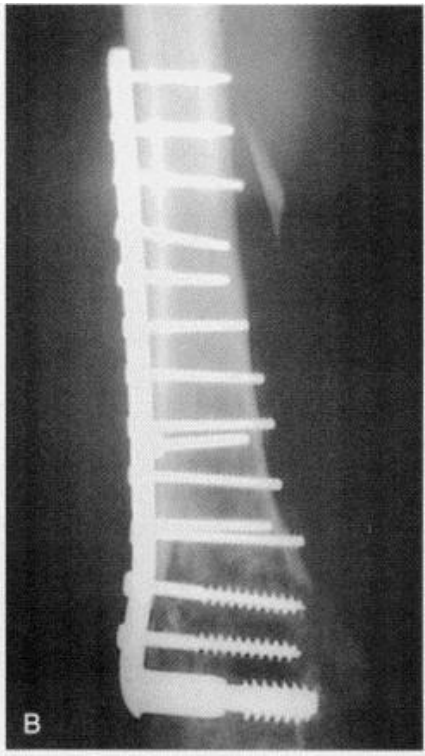
-internal fixation supplemented by cement .Chemotherapy & radiotherapy may be added.

-Prophylactic internal fixation:

If a focus of metastasis with destructive features is shown in a long bone by an x ray, an internal fixation should be done even if there is no fracture because you expect that this may fracture

soon or later


FIG. 11-1 Pathologic fracture. Fibrosarcoma of the distal femoral metaphysis in a dog.



Stress fractures

This is an incomplete fracture in bones. A stress fracture occurs when a low forces happen repetitively for a long period of time on a single bone (usually seen in person who increase his level of activity over a short period of time) these injuries are also known as "fatigue fractures."

Stress fractures are commonly seen in athletes who run and jump on hard surfaces, such as distance runners, basketball players, and dancers. A stress fracture can occur in any bone, but is commonly seen in the foot and shin of the tibia.

Factors that can contribute to the development of a stress fracture are:

1) Dietary abnormalities
2) Menstrual irregularities.

Because both factors contribute to bone health, any problems with diet (e.g. poor nutrition, anorexia) or menstruation (amenorrhea) may place an individual at higher risk for these injuries.

This is one reason that adolescent female athletes are at particularly high risk for development of a stress fracture.