

Orthopaedic Trauma Review **for** **Medical Students**

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Discussion Topics

Contents	Page
1. Bone Healing -----	5
2. Classification of Fractures -----	12
3. Open Fractures -----	14
4. Injuries Around Shoulder Joint -----	16
5. Forearm, Wrist & Hand Injuries-----	27
6. Spine Injuries -----	33
7. Pelvic Fractures -----	43
8. Injuries Around Hip Joint -----	47
9. Knee Joint Dislocations -----	51
10. Compartment Syndrome: Leg-----	52
11. Ankle Fractures -----	56
12. Pediatric Fractures-----	61
13. Child Physical Abuse -----	63
14. Stress Fractures -----	65

PERSONAL NOTE

Throughout my career as an Orthopaedic Trauma Surgeon, I have encountered some of the most complicated cases and as a result I have met some truly inspirational patients. These patients, despite their challenges, maintain focus on their goals, their faith and their blessings. Each day I am reminded to be thankful for my family and my ability to practice medicine, never forgetting that it is my duty to offer help to those in need and my responsibility to keep learning. It is this focus, this commitment to learning, which has helped me to achieve successes in my life. I dedicate time each and every day for maintaining and advancing my knowledge of science and medicine. And over the years, my passion for learning has only further developed my passion for teaching. I embrace the technological advances in education and am passionate about teaching the future doctors and clinicians of this world. I thank you for the opportunity to share in your learning. I hope that you will find these materials useful and that they will excite your love of medicine and enable you to fulfill your gift for helping others.

Sincerely, Dr. Nabil Ebraheim

Dr. Nabil Ebraheim has been a practicing orthopaedic surgeon for approximately 35 years and has trained around the globe with leaders in orthopaedic trauma. He is renowned for his ability to handle the most difficult of trauma cases and has dedicated his life, not only to his patients, but also to teaching the surgeons of the future. The last 30 years have been spent at the University of Toledo, building a department that includes all orthopaedic specialties and is dedicated to providing the surrounding area with superior orthopaedic care. The residency program receives numerous applications, a testament to the training provided, and selects the best and the brightest each year. Dr. Ebraheim is proud to lead the Department of Orthopaedic Surgery for the University of Toledo as Chairman and Professor and will continue to dedicate himself to its clinical and academic success.

Comments & Suggestions:

I welcome your comments and suggestions. Please send your comments, suggestions or questions at following address;

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1. Bone Healing

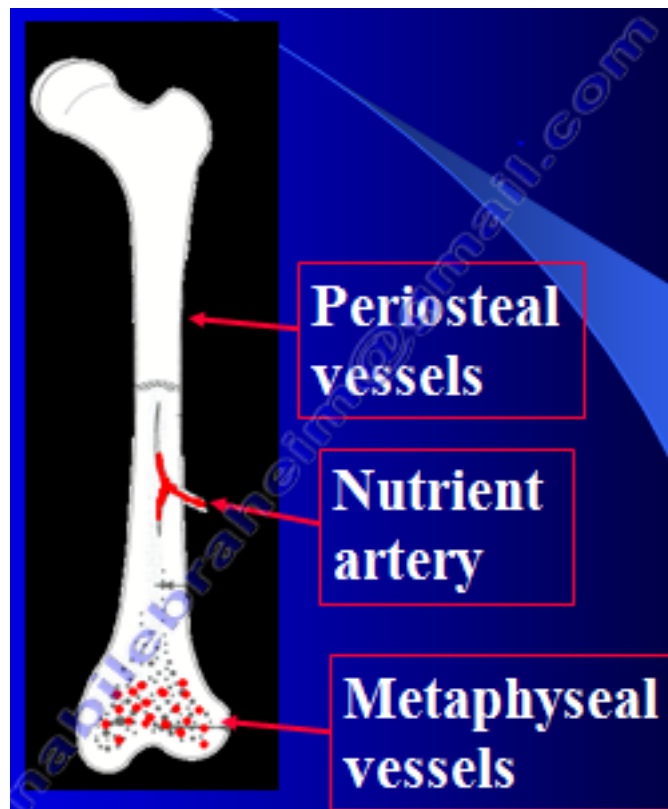
PREREQUISITES FOR BONE HEALING

Vascularity + Mechanical Stability

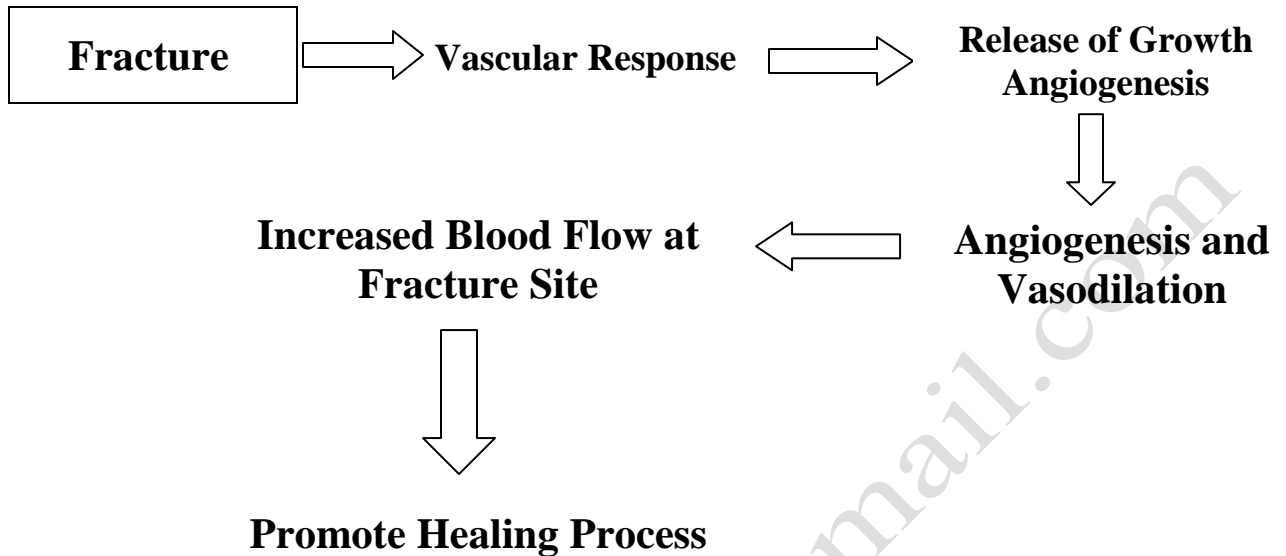
VASCULARITY

- Blood supply of Long Bone
 - Metaphyseal arteries (Metaphysis)
 - Nutrient artery (Diaphysis)
 - Periosteal vessels (Periosteum)

*Preservation of the blood supply is critical for fracture healing



BONE HEALING (continued):



MECHANICAL STABILITY

- Mechanical stability is provided by
 - Cast
 - Rods
 - Plates
 - Screws
 - External fixation devices

Note: Minimal incision preserves a greater blood supply.

COMPLICATION OF BONE HEALING

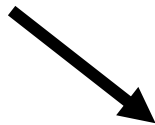
Common complications of fracture healing are:

- Nonunion



Valgus

- Deformities



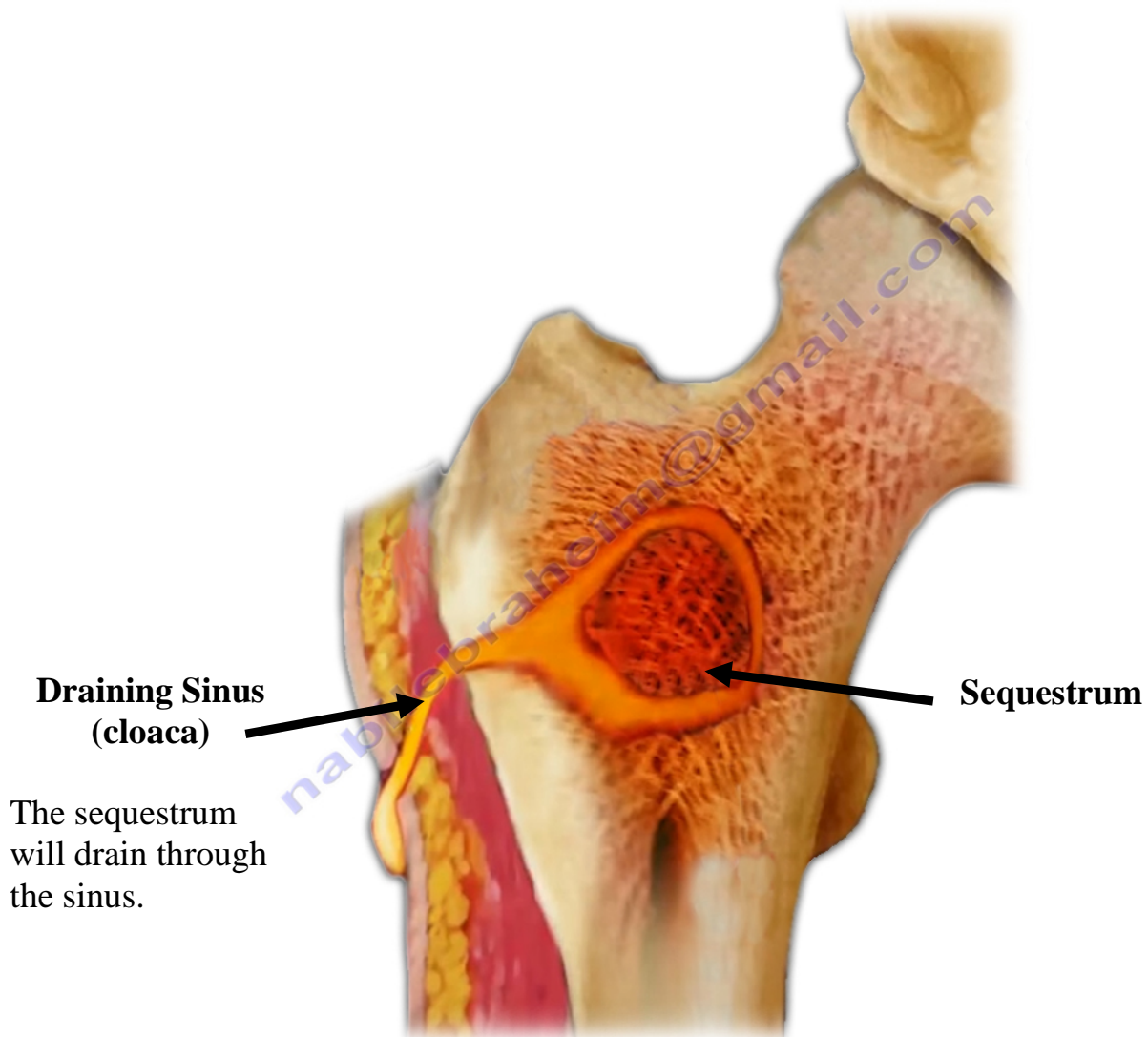
Varus



COMMON COMPLICATIONS (continued):

Osteomyelitis

- Long standing sinus can change into **Squamous Cell Carcinoma (SCC)**
- In **Chronic Osteomyelitis** cases, check for **SCC** in sinus tract



MECHANISMS OF BONE HEALING PROCESSES

1. Primary healing

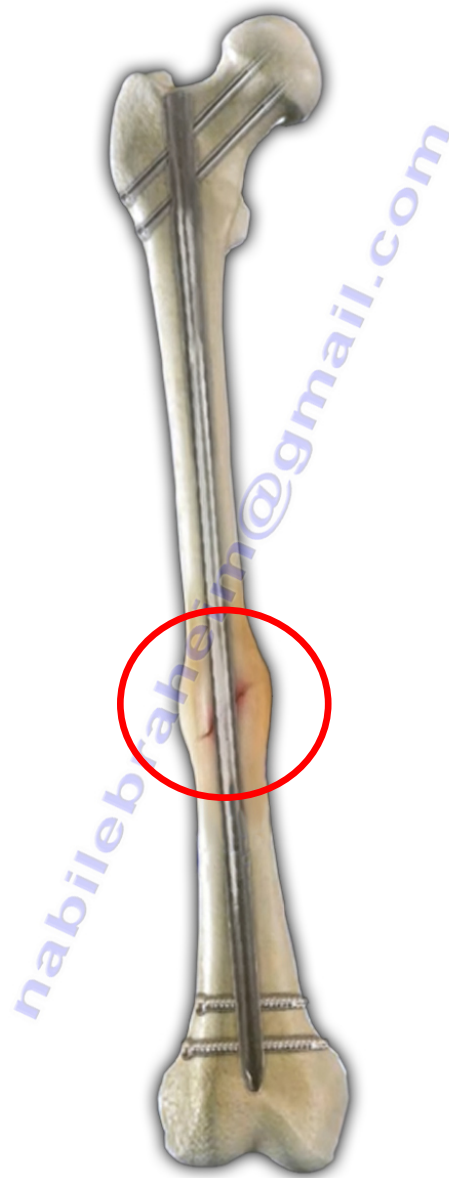
- Cutting cone mechanism
 - **Osteoclasts** eat up or dissolve the bone tissue with their powerful enzyme systems
 - **Osteoblasts** lay down new bone with the help of hormones and growth factors
- Observed in *rigid fixation* of fractures such as in plate fixation
- **Minimal Callus** (observed on X-ray)



MECHANISMS OF BONE HEALING (continued):

2. Secondary bone healing

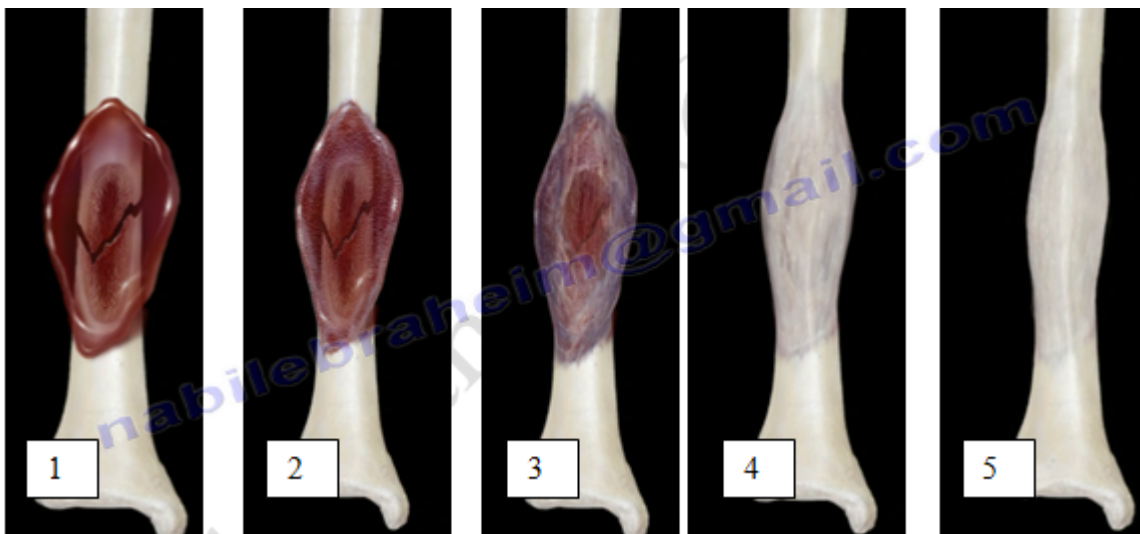
- Endochondral mechanism
- Observed in *Flexible Fixation* of fractures (such as fractures stabilized by rods and cast)
- **Abundant Callus** (as shown in *Red Circle* below)



STAGES OF FRACTURE HEALING

1. Hematoma
2. Stage of Inflammation (time of injury up to 24-72 hrs)
3. Stage of Soft Callus (new blood vessels)
4. Stage of Hard Callus
5. Stage of Remodeling

Remodeling is the process by which immature or woven (cartilage) bone (endochondral mechanism) is converted to mature or lamellar bone; the medullary cavity is reconstituted and bone is restructured in response to **stress and strain** (Wolff's Law).



MORE REMODELING POTENTIAL IN CHILDREN

Notes:

- Bone is made from collagen Type I.
- Hyaline cartilage contains Type II collagen

2. Classification of Fractures

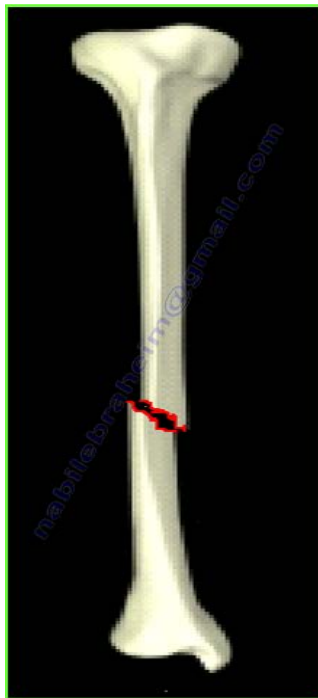


Extra-articular

or



Intra-articular



Diaphyseal

or



Metaphyseal

CLASSIFICATION OF FRACTURES (continued):



Simple

or



Comminuted



Open
(Skin is not intact)

or



Closed
(Skin is intact)

3. Open Fractures

DEFINITION

Fracture of the bone where bone and surrounding Hematoma are in communication with the external environment through break in skin.

CLASSIFICATION

According to **severity of soft tissue damage** open fractures are classified in three following types:

- **Type I:** wound about 1cm, simple fracture, clean wound
- **Type II:** wound 2-5cm, moderate soft tissue damage
- **Type III :** wound more than 5cm, extensive muscle devitalization, high energy injury; wound that is 1 cm with segmental fracture is considered Type III.

Type III is further classified into following three types:

- **Type III A: Adequate** soft tissue coverage
- **Type III B: Require** local or distant skin flap for wound coverage. Early flaps prevent infection.
- **Type IIIC: Vascular Injury** – Requiring Repair
25-90% cases results in Limb Amputation

AMPUTATION is required if:

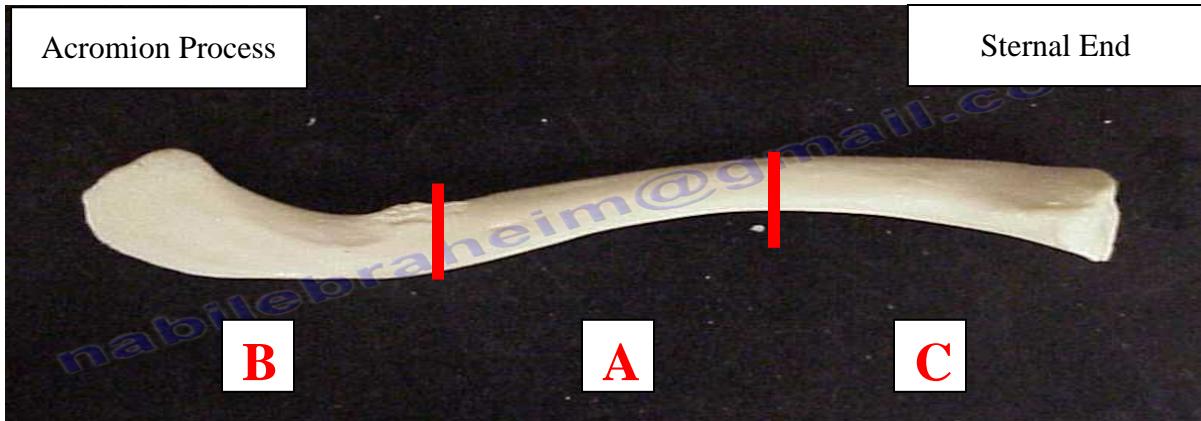
- **Extensive Soft Tissue Injury** (**Very Important**)
- Extensive Vascular Injury
- Muscle & Tissue Ischemia of more than **8 hours**
- Nerve Injury, e.g., no plantar sensation due to Posterior Tibial Nerve injury (not an absolute indication for amputation)

TREATMENT OF OPEN FRACTURES

1. Treat with **antibiotics** within 3 hours.
2. **Irrigation and debridement** of devitalized tissue
3. **Reduction** of fractured bone fragments
4. **Stabilization** with external fixation (if the wound is dirty), rods or internal fixation with plates and screws (e.g., joint injury).
5. **Wound should be covered EARLY** with skin graft or flap.
6. **Bone graft or bone graft substitute** is often used to promote the healing process if the surgeon thinks nonunion might occur.

4. Injuries Around Shoulder Joint

FRACTURES OF CLAVICLE



- A. Group I: Middle third (80%)
- B. Group II: Distal Third (10-15%)
- C. Group III: Medial Third (5%)

TREATMENT

- **Clavicle fractures are usually treated conservatively.** However, there is *high incidence of non-union in distal third fractures.*
- **Surgical fixation of clavicle fractures** is gaining popularity in cases of:
 - **Non-union** (may need bone graft and plate)
 - If there is **more than 2 cm displacement or overlap in acute fractures**
 - **Neurovascular Injury**
 - **Open Injury**

ACROMIOCLAVICULAR SEPARATION

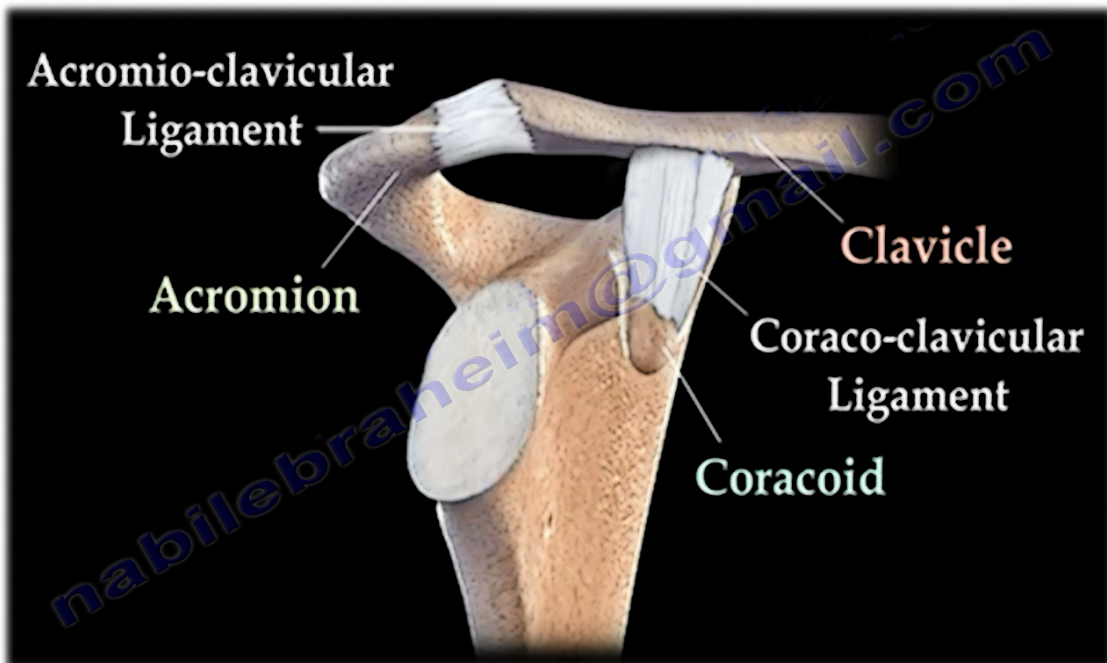
Classified in six types:

- Types I, II and III range from sprains to tears of the **ACROMIOCLAVICULAR** and **CORACOCLAVICULAR** ligaments

TREATMENT (I, II, III) ----- Conservative

- Type IV: *Posterior*
 - Require axillary view images
- Type V: *Very High*
- Type VI: *Inferior*

TREATMENT (IV, V, VI) ----- Surgical Stabilization



STERNOCLAVICULAR JOINT

Dislocation can occur in two directions:

1. Anterior:

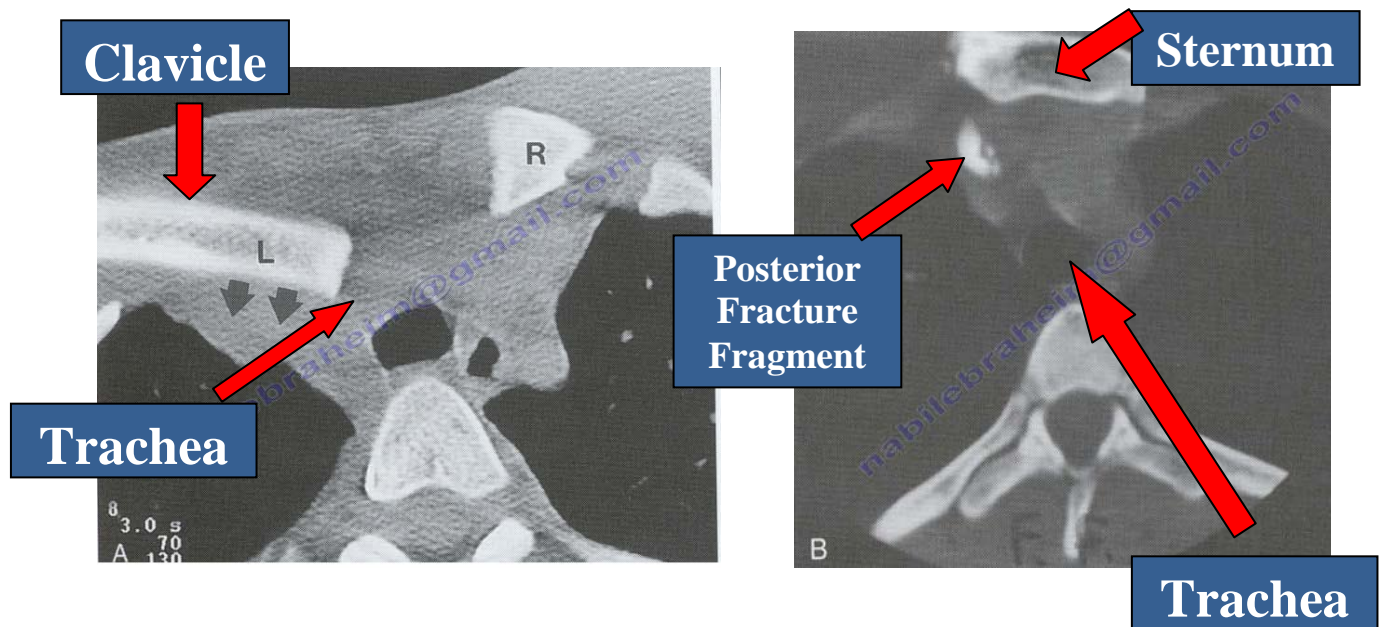
*Closed reduction often fails, recurrence is common however it is benign and leads to residual **cosmetic deformity**.*

2. Posterior:

Posterior sternoclavicular dislocations are SERIOUS and may affect the airway and other mediastinal structures.

Closed reduction is often successful and remains stable.

Open reduction – you may need a cardiothoracic surgery backup.

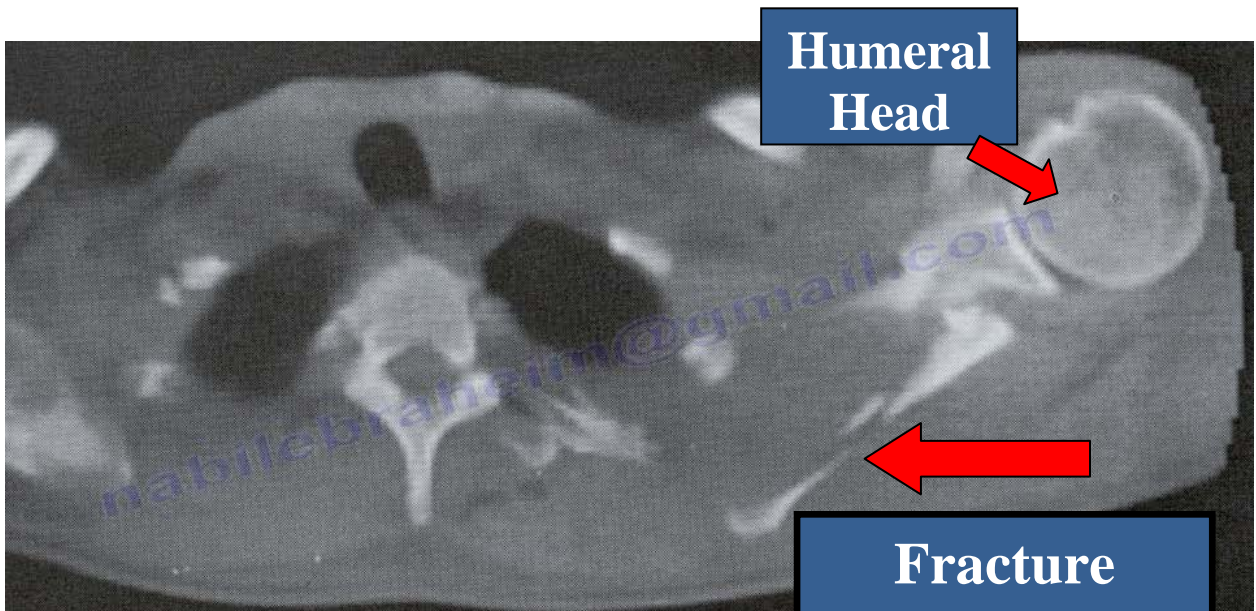


SCAPULAR FRACTURE

- May be complicated by pulmonary complications

ADMIT & OBSERVE

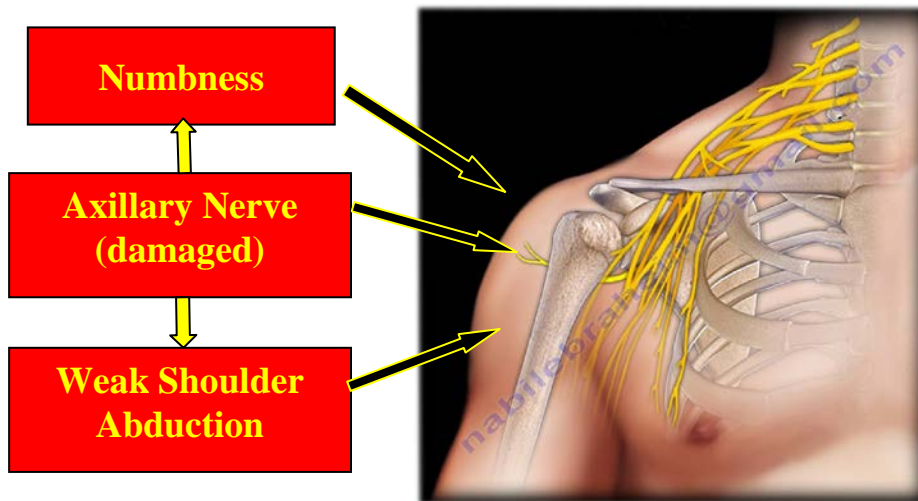
- ALWAYS RULE OUT PNEUMOTHORAX.



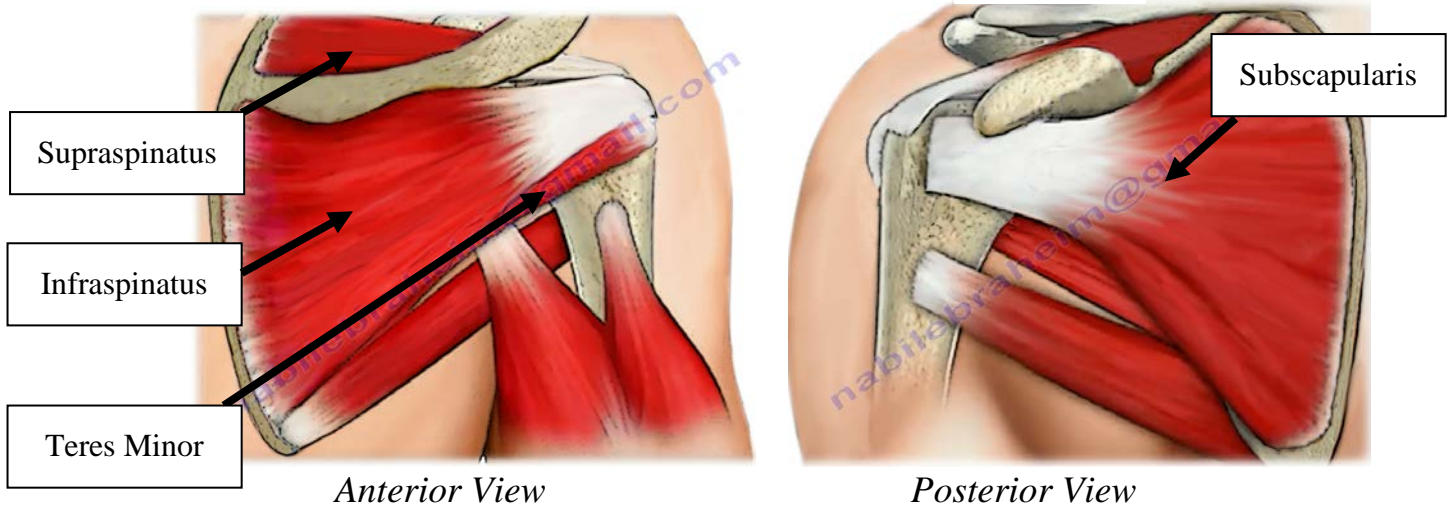
SHOULDER JOINT

SURGICAL ANATOMY

- Though controversial, it is thought that injury to “**Ascending branch of Anterior Circumflex Humeral Artery**” leads to AVN (Avascular Necrosis) of humeral head.
- The **Axillary Nerve**, which innervates the Deltoid and Teres Minor, is **the most commonly involved nerve in injuries around shoulder joint**. It results in:
 - **Numbness around the shoulder**
 - **Weakness of shoulder joint abduction**



Rotator Cuff Muscles



TYPES OF SHOULDER JOINT DISLOCATIONS

- Anterior Dislocation
- Posterior Dislocation

ANTERIOR SHOULDER DISLOCATION:

- Shoulder Joint is the most commonly dislocated joint in body.
- Anterior dislocation is observed in more than 95% of cases.
- Mechanism is indirect force with combination of **ABDUCTION, EXTENSION, and EXTERNAL ROTATION.**
- **If patient can touch opposite shoulder with the hand of involved extremity ----- this EXCLUDES ANTERIOR SHOULDER DISLOCATION**
- **May be associated with nerve injuries (e.g., Axillary nerve, Brachial Plexus).**
- Often found in combination with greater tuberosity fracture and humeral head fracture (Hill-Sachs Lesion).
- There is high recurrence rate in young patients (e.g., labral or bankart injury).
- Anterior Inferior Labrum is usually involved = Bankart Lesion
Anterior Dislocation = Anterior Labrum Involvement
- In elderly it is often associated with **rotator cuff tears.**

ANTERIOR SHOULDER DISLOCATION (continued):

Unable to lift arm after reduction of shoulder dislocation

- **Young patients----- Axillary Nerve Injury**
- **Elderly patients----- Rotator Cuff Tear**



Unable to lift arm due to axillary nerve injury.

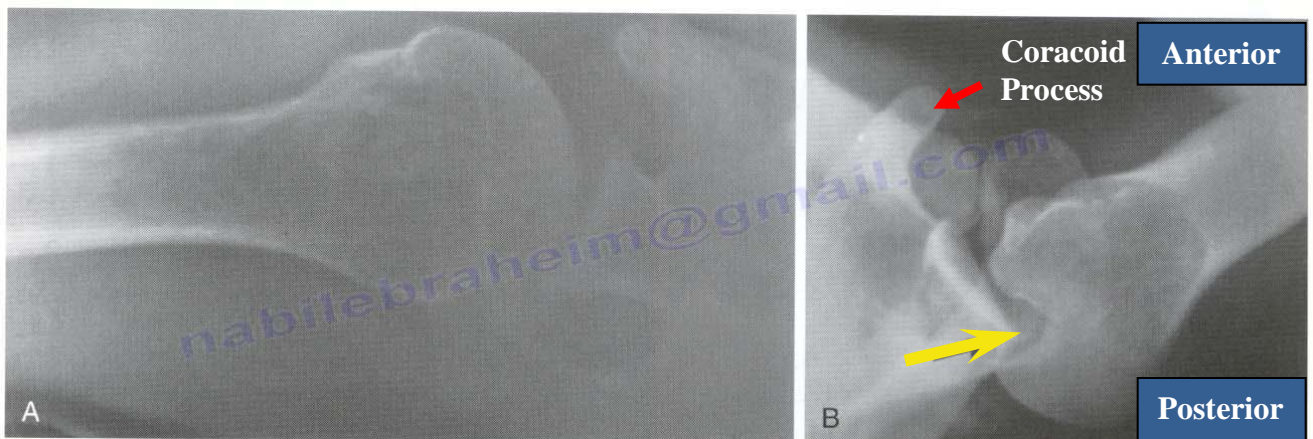
POSTERIOR SHOULDER DISLOCATION

- Associated with **seizures** or **electrical shock**
- **Often missed on radiographs**
- Often goes **unidentified** upon **initial ER visit**
- May be associated with lesser tuberosity fracture or reverse Hill Sachs lesion.
- There is **lack of EXTERNAL ROTATION** movement at shoulder joint on examination.
- **AXILLARY RADIOGRAPHIC VIEW** is used to correctly diagnose posterior shoulder dislocation.

DIRECTION OF THE DISLOCATION IS KEY TO DIAGNOSIS

CORACOID IS ANTERIOR

ACROMION IS POSTERIOR



*Axillary View: **Yellow arrow** in figure B indicates posterior dislocation.
Note: The direction of the dislocation – key to diagnosis.*

INFERIOR SUBLUXATION

➤ Caused by Deltoid Muscle Atony

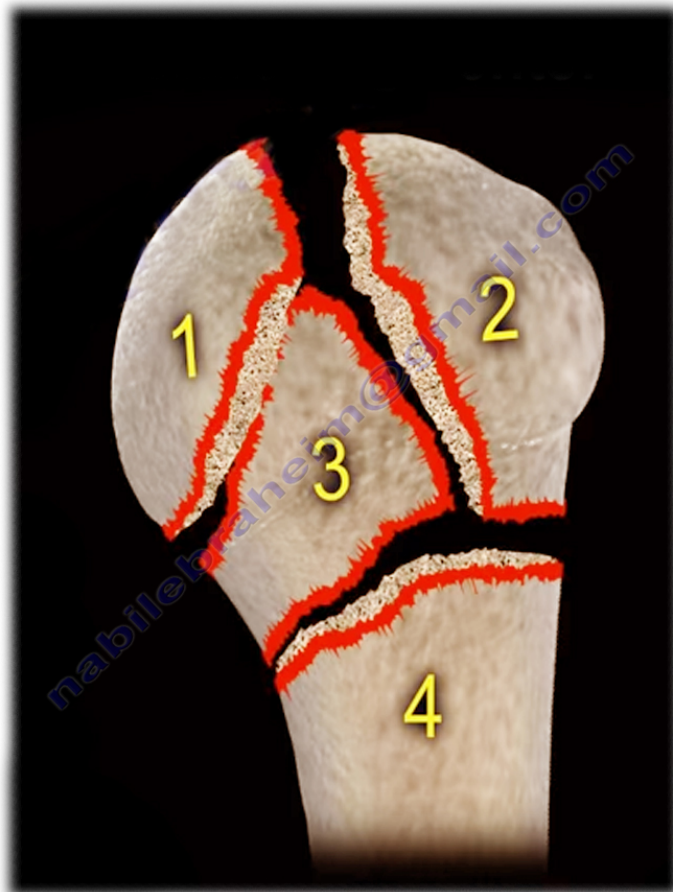
- Often confused with posterior shoulder joint dislocation.
- **AXILLARY VIEW IS NORMAL IN THESE CASES.**
- Use *Electrical Stimulation* of surrounding muscle groups to regain muscle tone / strength.



Shoulder Joint Inferior Subluxation

PROXIMAL HUMERUS FRACTURES

- Incidence **5%**
- **85%** are non-displaced
- More common in females than males (2:1)
- Fracture involves one or combination of following four anatomical structures:
 1. Articular surface of humeral head
 2. Greater tuberosity
 3. Lesser tuberosity
 4. Humeral shaft



PROXIMAL HUMERUS FRACTURES: TREATMENT

- **Sling is used for:**
 - Non-displaced
 - Minimally displaced
 - Impacted fractures
- **Displaced fractures are stabilized surgically** with pins (note: could migrate), plates, sutures or external fixators.
- In severe cases where humeral head cannot be salvaged prosthesis is used.
- **Post-operative rehabilitation is very important.**
- Significant **residual stiffness may remain in elderly.**

5. Forearm, Wrist & Hand Injuries

FOREARM FRACTURES

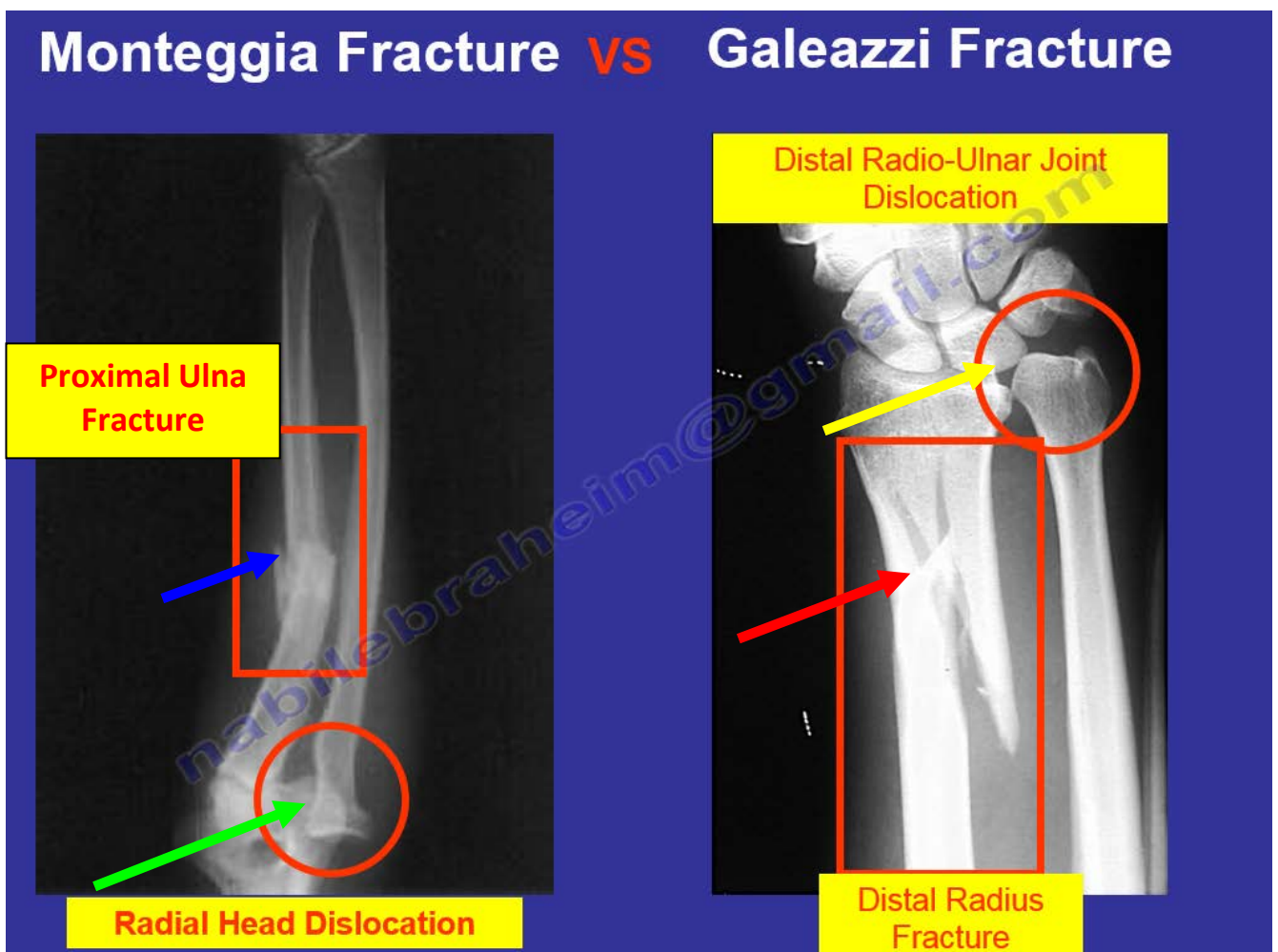
Monteggia Fracture

- Ulna shaft fracture
- Radial head dislocation

VS

Galeazzi Fracture

- Distal radio-ulnar joint dislocation
- Distal Radius Fracture



Note the radial head dislocation indicated by the green arrow and the ulna shaft fracture indicated by the blue arrow.

Note the radio-ulnar subluxation indicated by the yellow arrow and the distal radius fracture indicated by the red arrow.

WRIST JOINT FRACTURES

MECHANISM OF INJURY

Colles Radius Fracture

- Distal fracture fragment displaced *dorsally*
- **AWAY FROM PALM**
- *'Dinner Fork Deformity'*
- Can be treated conservatively

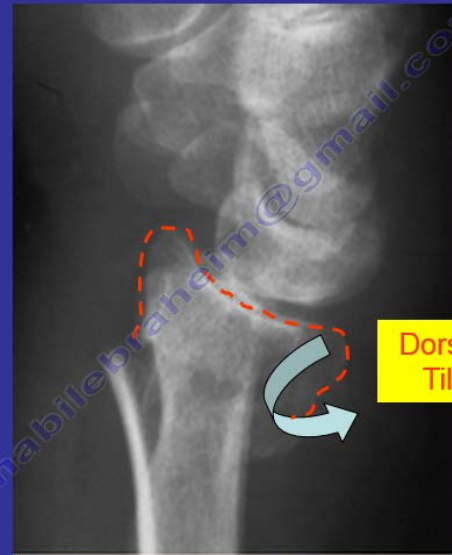


Intra Articular Fracture

- Surgery could be necessary
- 2mm displacement = 90% arthritis



Colles Fracture



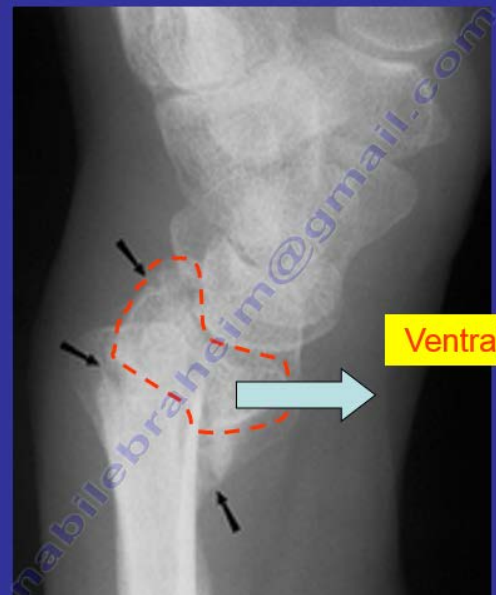
Distal Fracture Fragment displaced Dorsally

Treatment – Closed Reduction

Smith Fracture

- Distal fracture fragment displaced *ventrally*
- **TOWARDS PALM**

Smith Fracture



Distal Fracture Fragment displaced Ventrally

WRIST JOINT FRACTURES: SCAPHOID FRACTURE

- Fracture of the scaphoid usually occurs from a fall onto an outstretched hand.
- *Non-union* and *Navicular Avascular Necrosis* are common
- Fracture can be missed



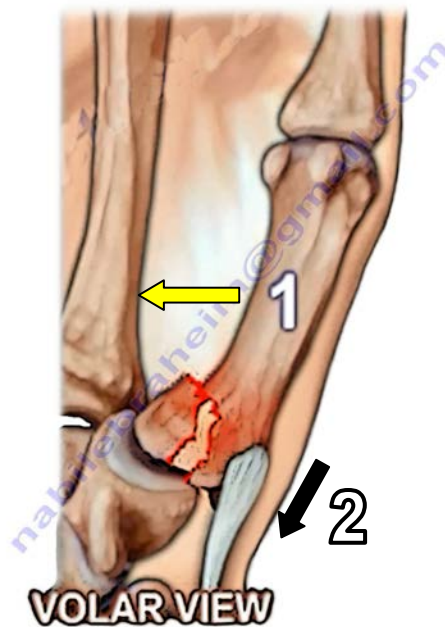
HAND INJURIES & FRACTURES

BENNETT'S FRACTURE

Fracture and dislocation of the first carpometacarpal joint

1. Forceful adduction causes first metacarpal base fracture
2. Pull of *abductor pollicis longus* tendon causes dislocation

(black arrow notes direction of force)



BOXER'S FRACTURE

- Fracture of the fifth metacarpal bone
- Accept some deformity



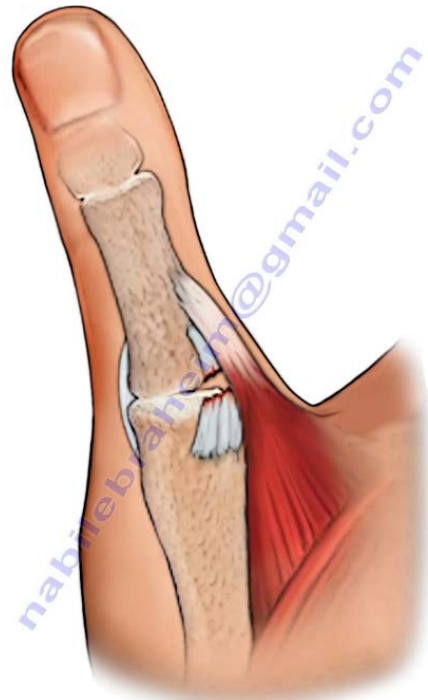
HAND INJURIES & FRACTURES (continued):

THUMB – ULNAR COLLATERAL LIGAMENT INJURY

- Skier's Thumb: Acute Injury
- Game Keeper's Thumb: Chronic Injury



**Skier's Thumb
(Stener Lesion = Surgery)**



Game Keeper's Thumb

BOUTONNIERE'S DEFORMITY

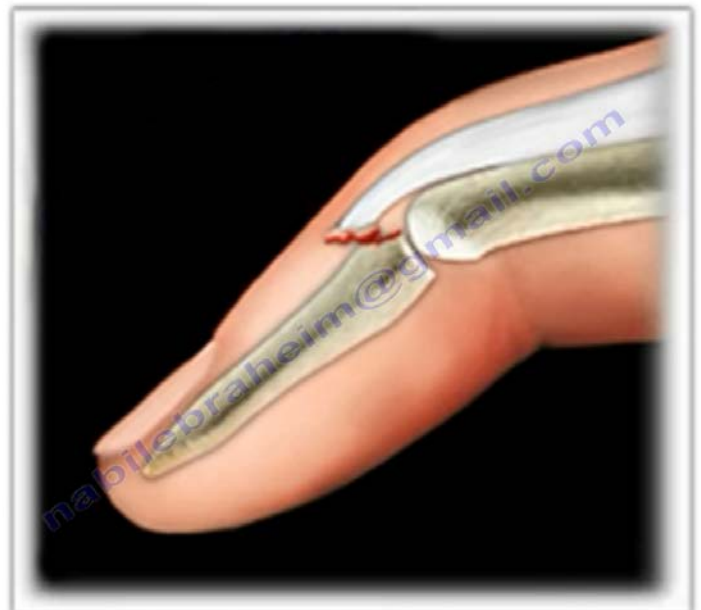
Tear in the central part of the extensor tendon that extends the finger at the PIP joint.



HAND INJURIES & FRACTURES (continued):

MALLET FINGER

Extensor Tendon Injury at the DIP joint



6. Spine Injuries

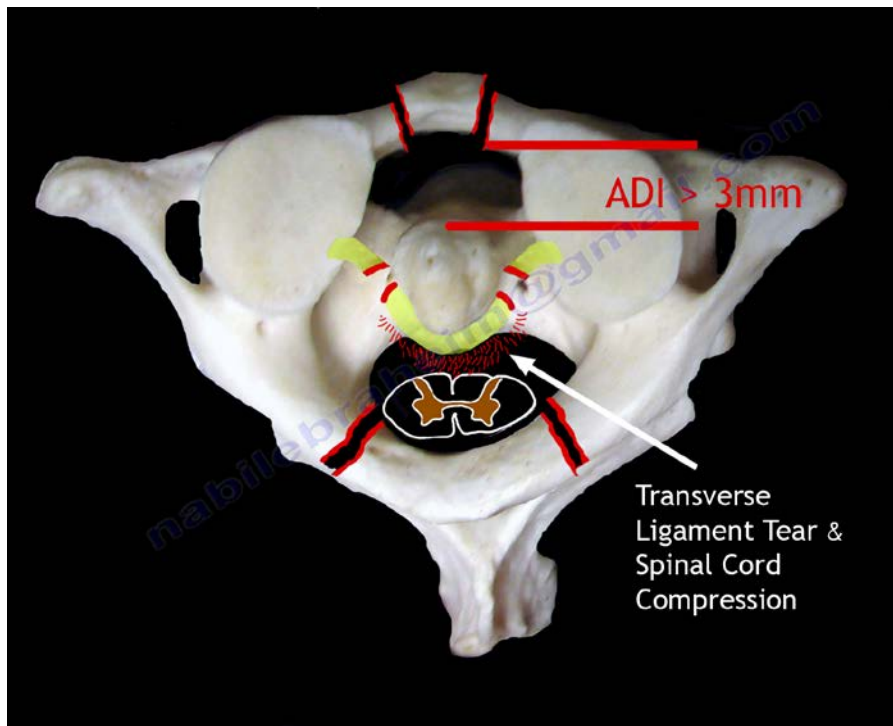
FRACTURE OF (CERVICAL VERTEBRA) C1

- Also called **Jefferson Fracture**
- Mechanism of injury ----- **Axial Loading**
- **CLASSIFICATION: TYPE I**
 - **Type I: Bony Injury - Treated with a Rigid Brace or Halo**



FRACTURE OF (CERVICAL VERTEBRA) C1 (continued):

- **CLASSIFICATION: TYPE II**
 - **Type II: Tear of transverse ligament in addition to the bony injury**
- **If ADI > 3mm ----- this Injury is Unstable ----- can cause spinal cord compression.**
- **TREATMENT is to consider fusion of C1 & C2**

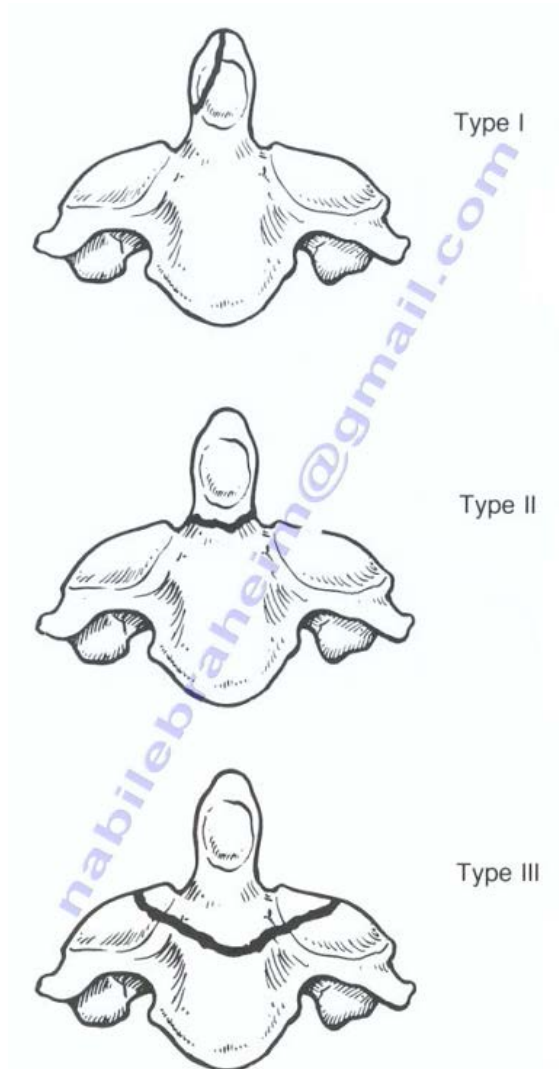


“50 % of Cervical Spine Rotation occurs between C1 & C2”

FRACTURE OF C2

- **ODONTOID FRACTURES**

- Classified in following three types;



Fracture of TIP

Fracture of PROCESS---High Incidence of Non-union

- Hard Cortical Bone
- Nonunion correlates with displacement of the fracture and age.

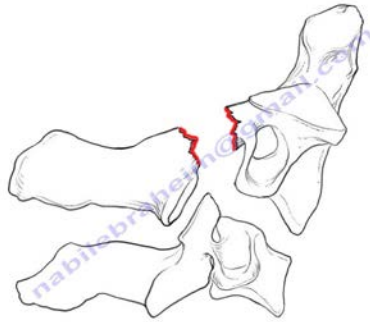
Fracture of BODY

- Cancellous, Vascular Bone
- Better healing

- Type I is managed by **Cervical Collar**
- Type II is managed by **HALO** or **Surgery**
- Type III is managed by **Cervical Orthosis** or a **HALO**
- *Do not use* a **HALO** in the elderly

FRACTURE OF C2 (continued):

- **HANGMAN'S FRACTURE:**



Hangman's Fracture of C2

- Pedicles are fractured in Hangman's Fracture
- Spinal canal is widened
- Neurological Injury ----- RARE
- Hangman's Fracture is stabilized by a RIGID ORTHOSIS or a HALO (depending on fracture displacement)

SPINE LIGAMENOUS INSTABILITY

- Patient presents with unexplained pain in cervical spine after trauma.
- Fracture is NOT observed in radiographs.
- Cervical Spine Flexion & Extension radiographic views are taken to assess spine stability and to demonstrate occult ligamentous injury.
- MRI is a better alternative.
- **MORE THAN 3.5 mm DISPLACEMENT or 11° angle** (as shown in figures 1 and 2, respectively, see below)

➤ **INDICATES SIGNIFICANT SPINE INSTABILITY**

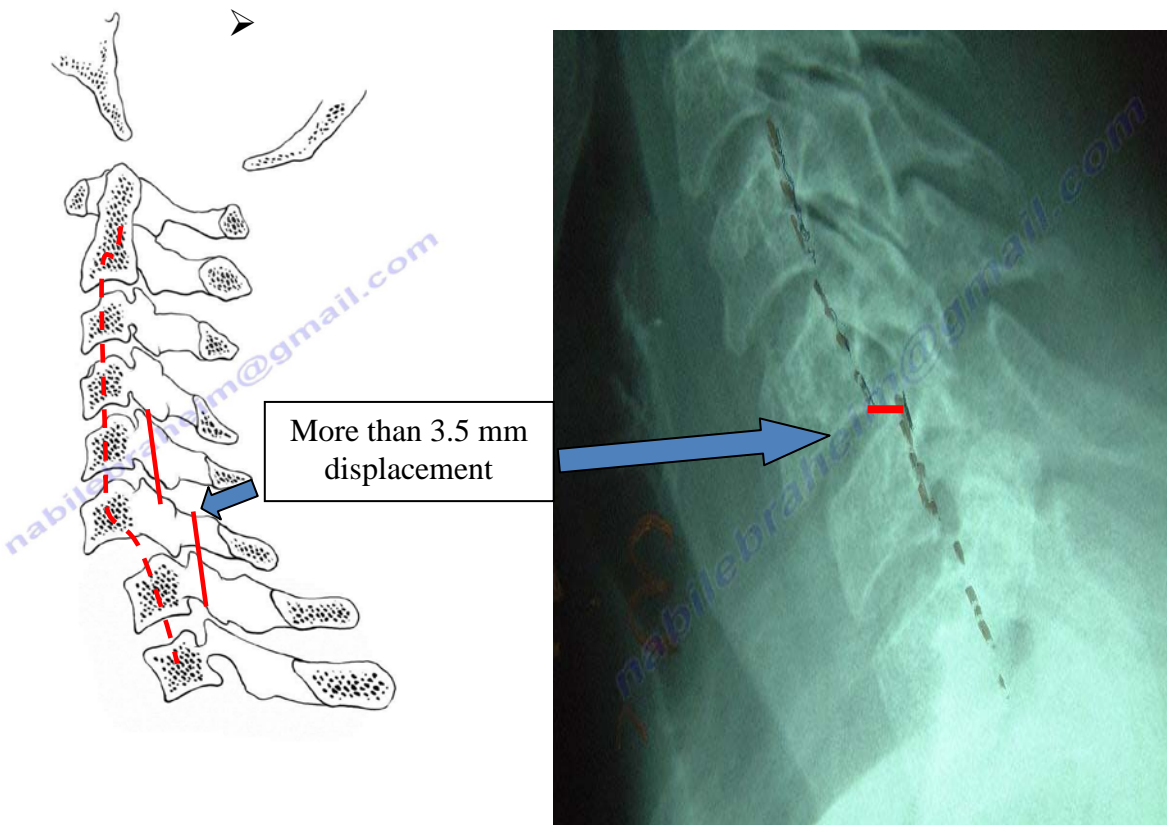


Figure 1: Note displacement in both images of >3.5 mm.

SPINE LIGAMENTOUS INSTABILITY (continued):

- More than 11 degrees angulation between adjacent vertebral bodies is another significant parameter of spine instability

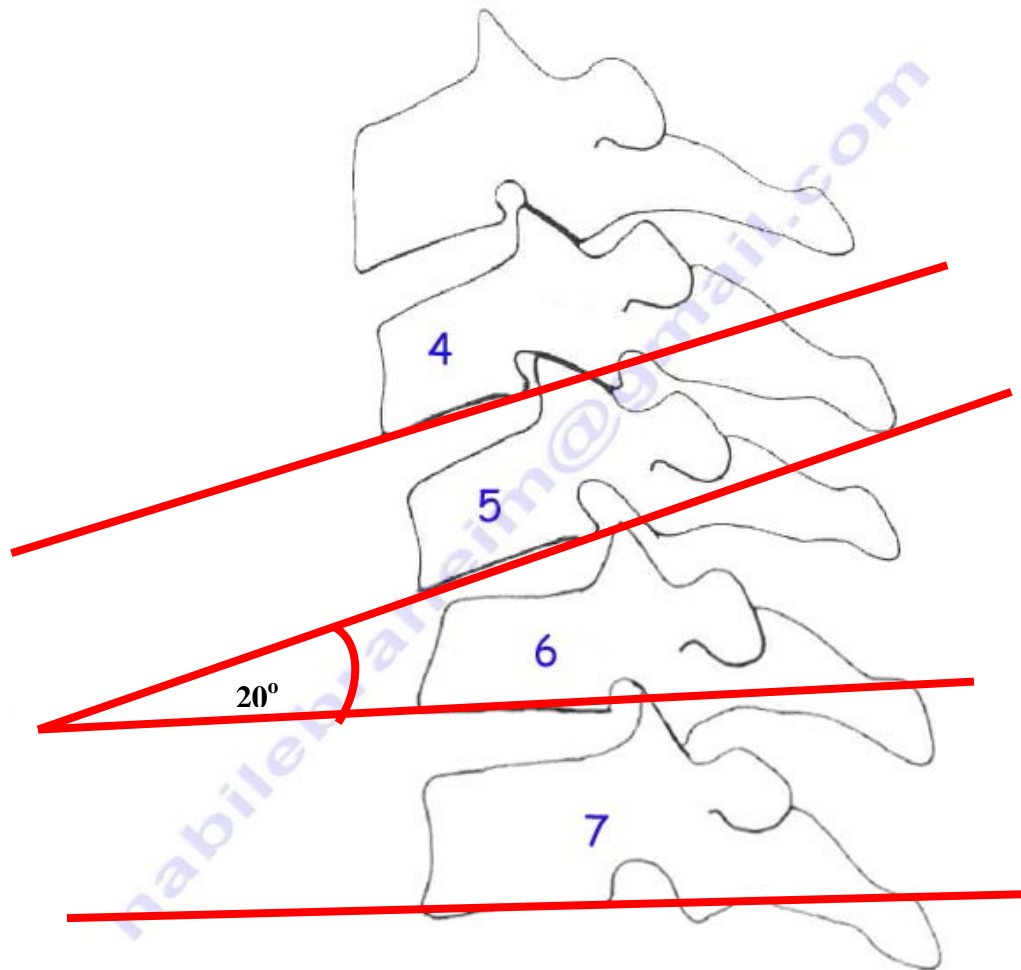


Figure 2: Note angle $> 11^\circ$

- **ANGLE MORE THAN 11 DEGREES**
- **SPINE COULD BE UNSTABLE**

WHIPLASH INJURY

MECHANISM

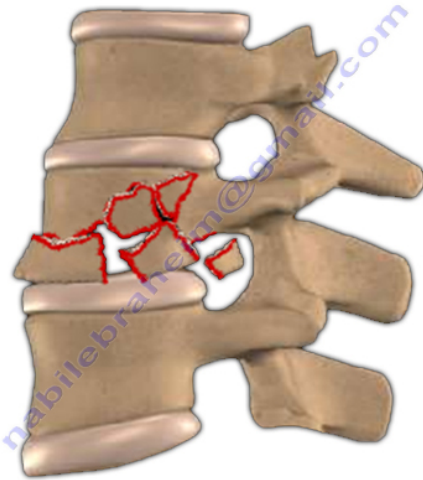
Sudden *flexion* and *extension* movement of the cervical spine



- Radiographs can be **negative** for fractures
- LOSS of LORDOSIS
- Treatment = Physical Therapy, Muscle Relaxants and Soft Collar

VERTEBRAL BURST FRACTURE

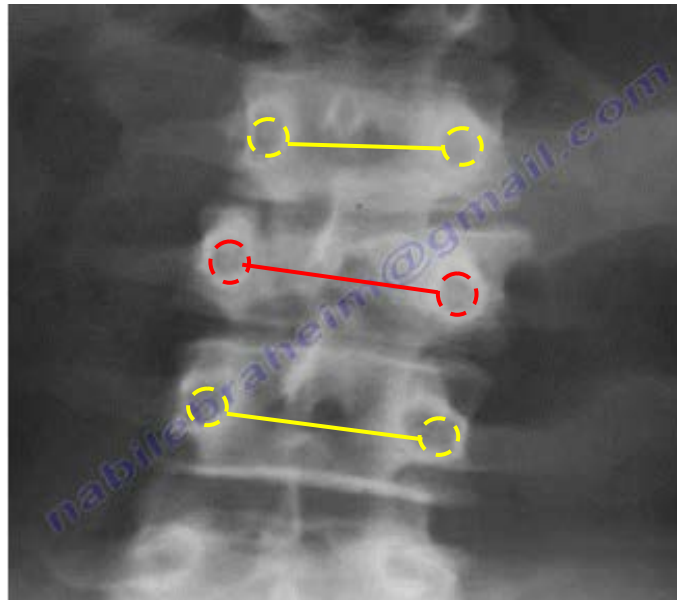
- Increased inter pedicular distance at the level of the broken vertebra compared with the level above and below.
- Fracture extends to middle column with bone in the canal.



Lateral View



Axial View



Note: The red line shows the widening of the interpedicular distance at the fracture level relative to the vertebra above and below.

TRAUMATIC SPINAL CHANCE FRACTURE

Flexion distraction injury results in a Chance Fracture.

- **Mechanism:** Distraction of the posterior spine around a fixed point anterior to the spine (i.e., a seat belt).
 - Bony
 - Ligamentous
- **Treatment**
 - Ligamentous (*figure 1*): Requires surgery
 - Bony (*figure 2*): Can be treated with casting

Note: Rule out colon injury in children.



Figure 1: Ligamentous



Figure 2: Bony

DISC HERNIATION

CLASSIFICATIONS

Disc herniations are classified as Central, Posterolateral and Far Lateral.

1. CENTRAL DISC HERNIATION = CAUDA EQUINA



- Bilateral Leg Pain & Weakness
- Back Pain
- Can cause *Cauda Equina Syndrome* (bowel and bladder symptoms); considered a **SURGICAL EMERGENCY**

2. POSTEROLATERAL DISC HERNIATION



- Unilateral leg pain and weakness
- Positive straight leg raising test
- Nerve root injury

3. FAR LATERAL

A foraminal herniated disc (not common) affects the exiting nerve root (the upper nerve root). For example, an L4/L5 disc herniation affects the L4 nerve root.

7. Pelvic Fractures

- Mortality correlates with shock at presentation.
- Life threatening bleeding is major concern.
- Severe bleeding due to injury to “**Superior Gluteal Artery**”
- **Requires Blood Transfusion.** May require 15 to 20 units of blood.



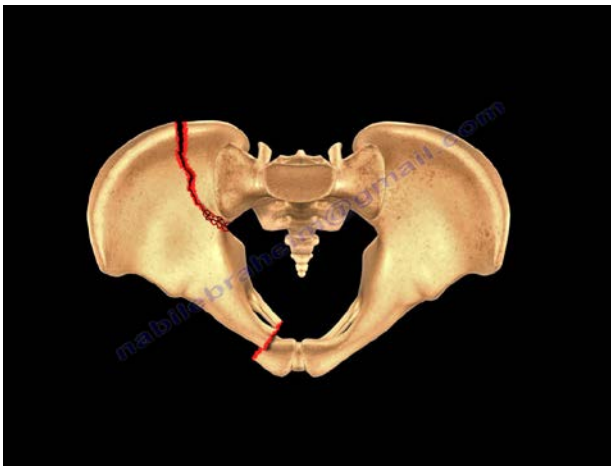
- **Open fracture** ----- HIGH MORTALITY RATE, may need colostomy
- The **PELVIS IS A RING**. An **anterior injury or fracture** (usually noted on radiographs) could be **associated** with **posterior injury or fracture** (could be occult).

- ALWAYS CHECK POSTERIOR PELVIS FOR FRACTURES OR INJURIES
- **OBTAIN SPECIAL VIEWS: INLET and OUTLET radiographic views**
- CT scan is the *study of choice*.

PELVIC FRACTURES ARE CLASSIFIED AS FOLLOWING:

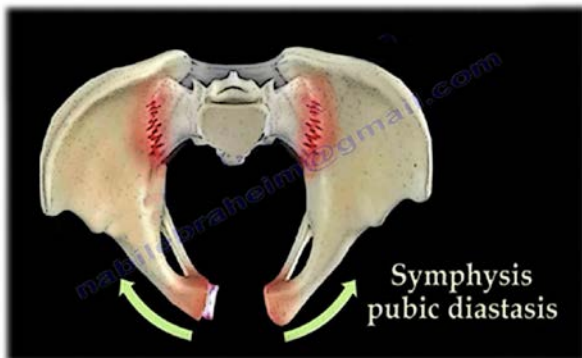
1. Vertical Shear with Posterior Disruption

- BAD FRACTURE
 - **REQUIRES SURGERY** Anteriorly and Posteriorly
- Requires major blood transfusion. *Outcome is guarded*.



More *severe injuries* completely *disrupt* the *sacroiliac joint*.

2. Anteroposterior Compression (Open Book Fracture)



Close the Open Book Fracture by a binder initially to decrease pelvic volume and blood loss.

PELVIC FRACTURES (continued):

“CLOSE THE BOOK” by

- Sling
- Anterior Pelvic Surgery such as external fixator or plates



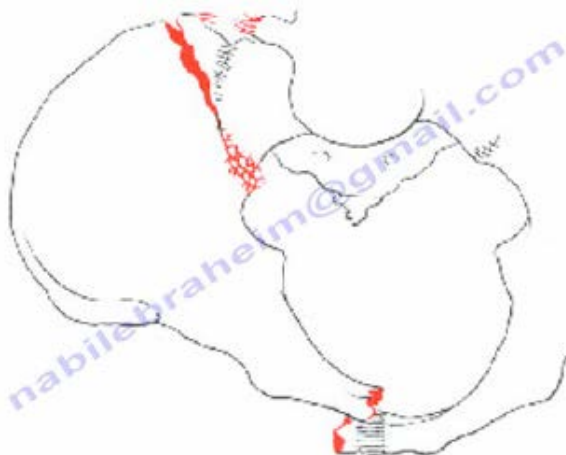
Reduction of open book.



Plate fixture of the open book

3. Lateral Compression

- **Most Common**
- **Good prognosis, usually does not require surgical fixation**



PELVIC FRACTURES - TREATMENT (continued):

- Pelvic Fractures are stabilized surgically by:
 - Blood, Blood, Blood
 - Initial binder and external stabilization
 - After patient becomes hemodynamically stable, internal fixation with plates and/or screws is performed.

ACETABULAR FRACTURES

- *Posterior Wall Fractures* are the most common and observed with *Hip Dislocations*. The **Obturator View**, one of the Judet views, will show the posterior wall fracture.
- Possibility of AVN: reduce dislocation early
- May lead to arthritis
- ALWAYS CHECK SCIATIC NERVE FUNCTION (Dorsi-flexion of Ankle & Toes) ----- *Peroneal Division could be affected.*
- In cases of “**Fracture with Dislocation**”, **IMMEDIATELY** reduce the dislocation. (*This should be done URGENTLY.*)



Posterior Wall Acetabular Fracture

8. Injuries Around Hip Joint

HIP JOINT DISLOCATIONS

ANTERIOR ----- RARE

POSTERIOR ----- COMMON



Posterior Hip Dislocation

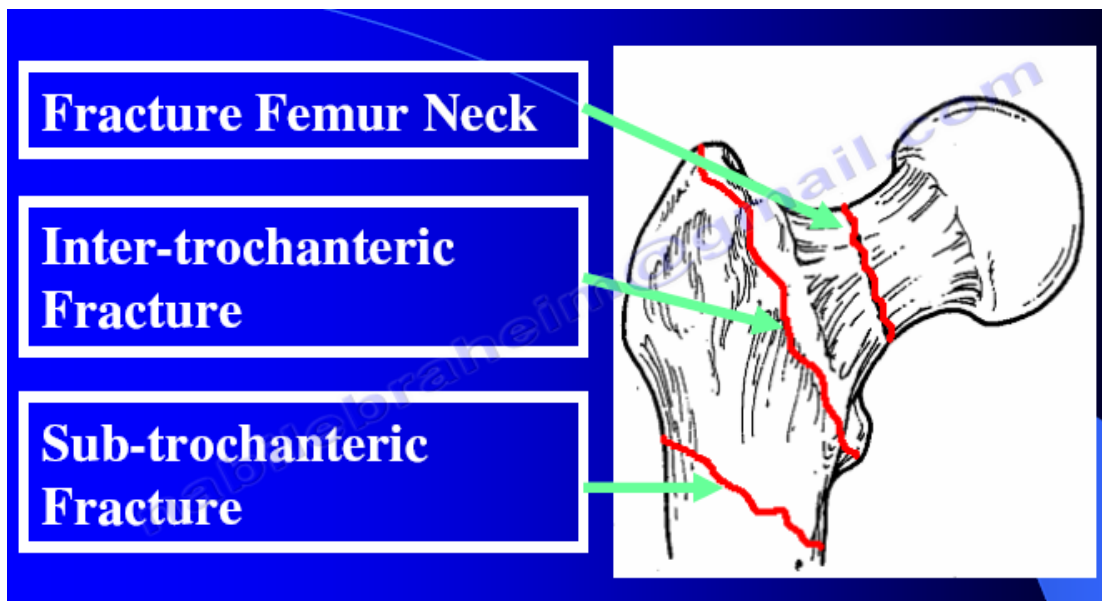
MECHANISM

- **Anterior Dislocation:**
Extension, External Rotation and Abduction
- **Posterior Dislocation:**
Flexion, Internal Rotation and Adduction

➤ **URGENT REDUCTION IS MANDATORY TO AVOID AVASCULAR NECROSIS* OF FEMORAL HEAD**

**Avascular Necrosis is the death of a segment of bone.*

FRACTURES OF PROXIMAL FEMUR



- **Inter-trochanteric Fracture**----- High Mortality Rate
 - 2 Types
 - Regular Pattern (*figure 1*)
 - Reverse Oblique Pattern (*figure 2*) - **Do not use sliding hip screw**

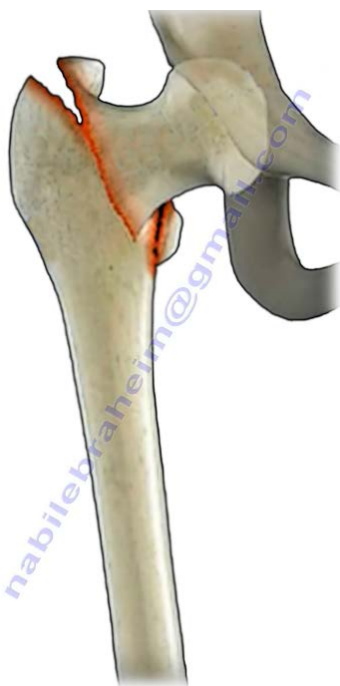


Figure 1

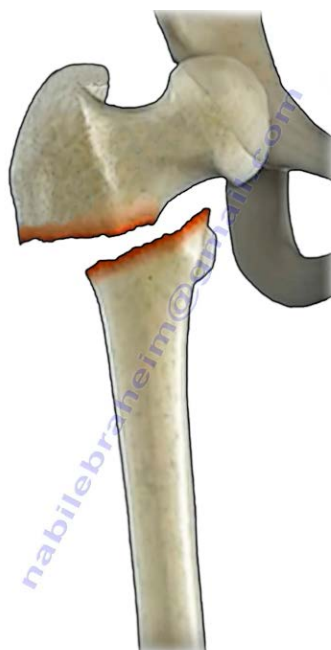
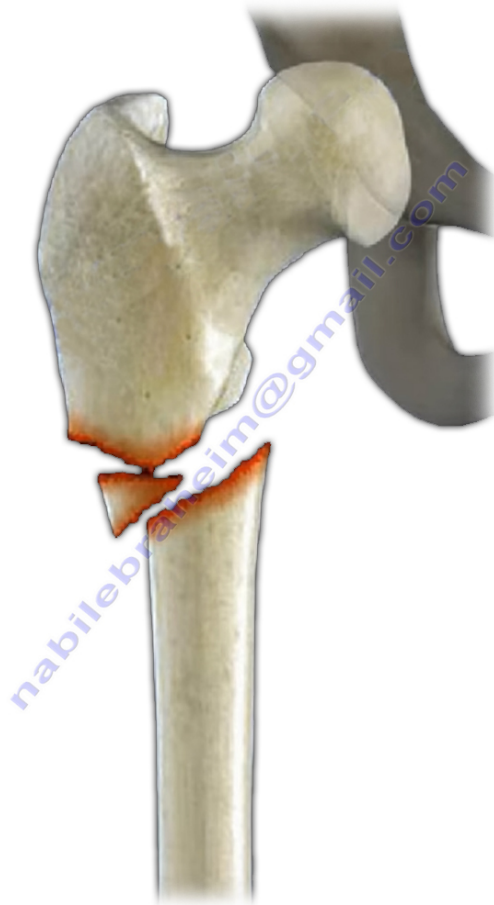


Figure 2

FRACTURES OF THE PROXIMAL FEMUR (continued):

- **Sub-trochanteric Fracture** -----High stress fracture, *Non-union common / Complex Fracture.*



FRACTURES OF THE PROXIMAL FEMUR - TREATMENT

1. Femoral Neck Fracture

- a) Non-displaced: percutaneous screw fixation
- b) Displaced:
 - i) Close reduction or **ORIF** in young patients.
 - ii) Utilize a **prosthesis** in older patients. (Arthroplasty or Hemi-arthroplasty)



2. Inter-trochanteric

- a) Regular Pattern: Use a sliding hip screw or rod
- b) Reverse Oblique Pattern: Do not use the sliding hip screw

3. Subtrochanteric Fracture

- Intramedullary Nail

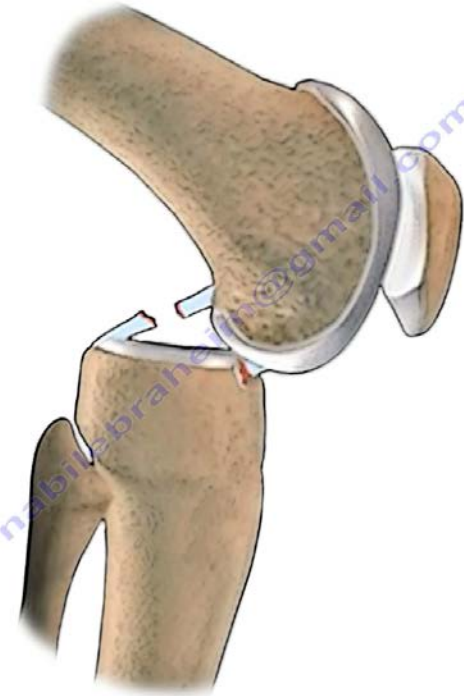


9. Knee Joint Dislocations

TYPES OF KNEE JOINT DISLOCATIONS



Anterior



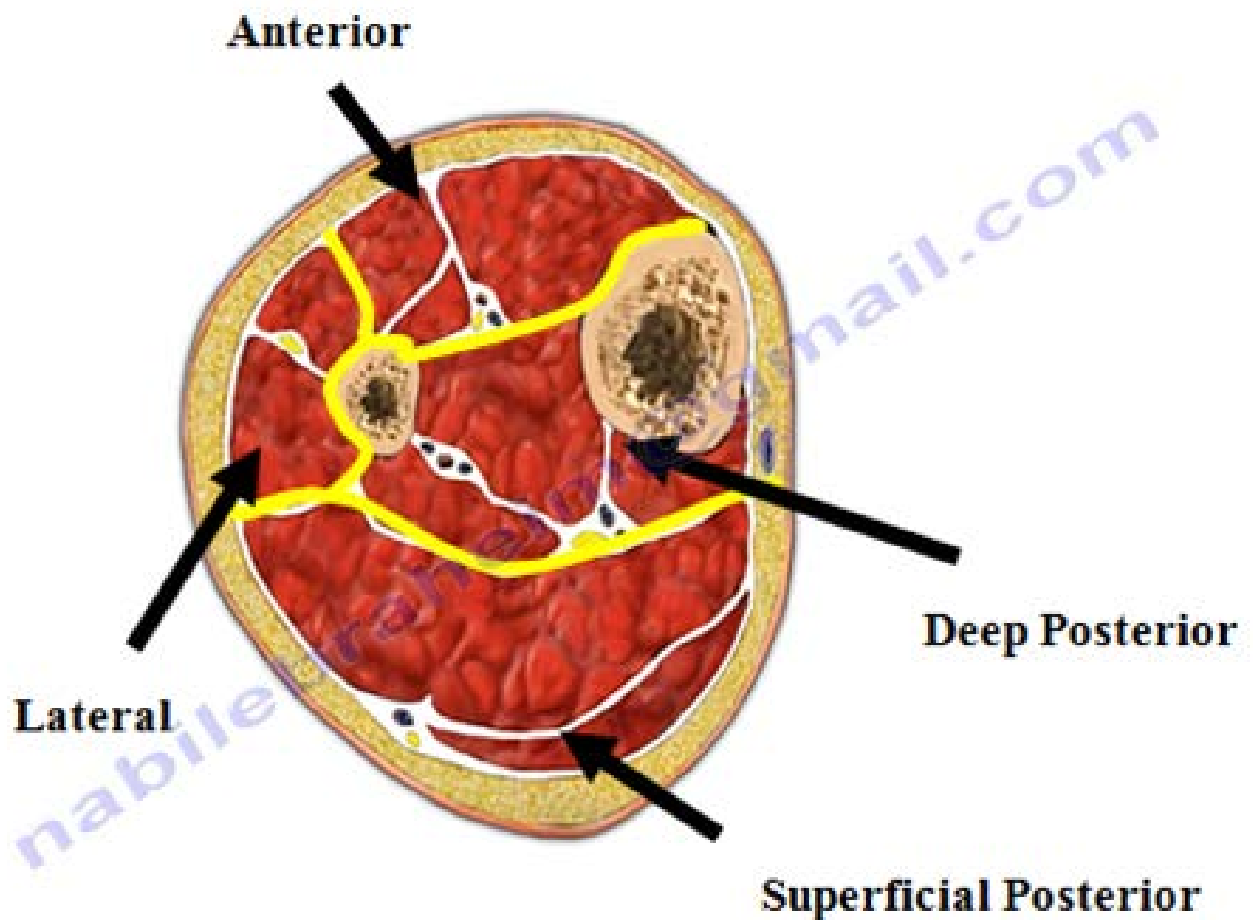
Posterior

- **THERE IS HIGH RISK OF NEUROVASCULAR INJURY**
- ***ALWAYS CHECK DISTAL PULSES, rule out popliteal artery injury***
- May need ***ARTERIOGRAM***
- Perform the **Ankle-Brachial Index test** (i.e., **ABI**). ABI must be above 0.9. Then monitor with serial exam. If ABI is less than 0.9 ($ABI < 0.9$), then study with a CT angiogram or arterial ultrasound.

10. Compartment Syndrome: LEG

The lower leg is divided into following four muscular compartments by strong fascia extending from subcutaneous tissue to bone. Each compartment contains a nerve. Involvement of the specific nerve guides the clinician to the affected compartment.

- **Anterior** Compartment (Deep Peroneal Nerve)
- **Lateral** Compartment (Superficial Peroneal Nerve)
- **Superficial Posterior** Compartment (Sural Nerve)
- **Deep Posterior** Compartment (Posterior Tibial Nerve)



TYPICAL FEATURES OF COMPARTMENT SYNDROME



Late Findings: Five P's

Always split the cast and examine the patient.

For practical purposes, the following are important initial features of compartment syndrome:

- Pain out of proportion to injury or surgery
- Tense swelling of leg
- Pain with passive stretch

**“Paresthesia, Pulselessness and Paralysis
are late findings”**

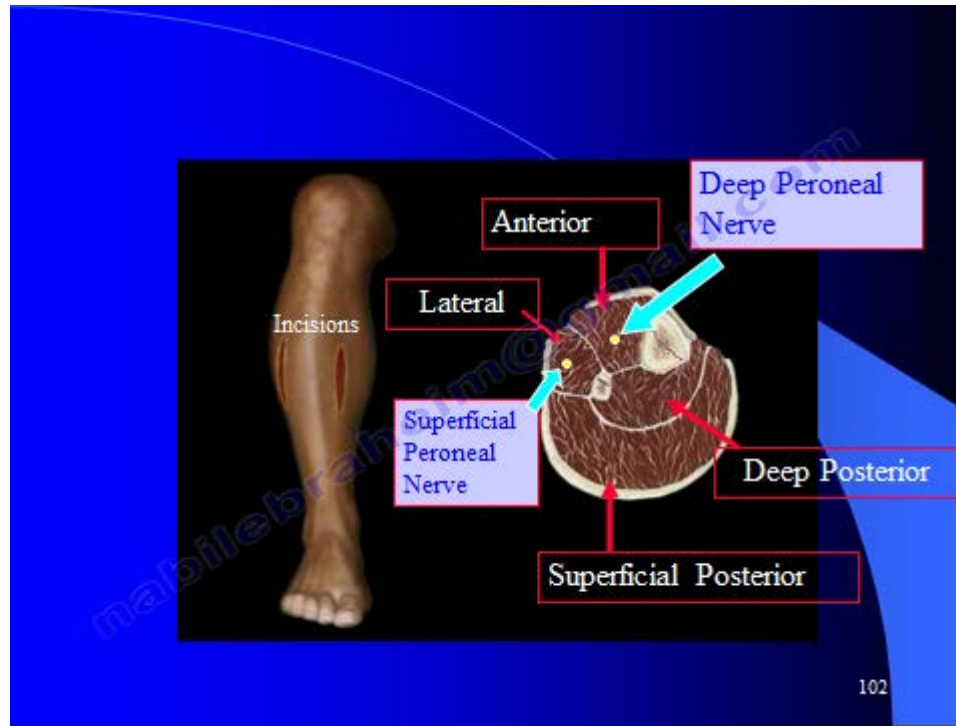
- Increased analgesic requirement in children is important
- *Anterior Compartment Syndrome* is most common
- Check for **LOSS OF SENSATION IN FIRST WEB SPACE OF FOOT**

TYPICAL FEATURES OF COMPARTMENT SYNDROME (continued):

- **DEEP POSTERIOR COMPARTMENT** syndrome
 - IF MISSED → *CLAW TOES*
 - *Claw toes could indicate old tibial fracture or missed deep posterior compartment syndrome*
- Total ischemia of 8 hrs produces irreversible changes in muscle
- **Compartment Pressure Measurement** is **KEY** in salvaging the limb
- **Acute Compartment Syndrome:**
 - Absolute Intra-compartmental Pressure of 30 mmHg or more
 - ΔP within 30 mmHg of diastolic BP
 - $\Delta P = \text{diastolic BP} - \text{intracompartmental pressure}$
 - i.e., Increased intracompartmental pressure within 30 mmHg of diastolic BP
 - **NOTE:** Intraoperative diastolic BP is usually low and therefore does not provide an accurate measurement. Please use preoperative diastolic BP reading **NOT** the intraoperative diastolic BP.

COMPARTMENT SYNDROME (LEG) -TREATMENT

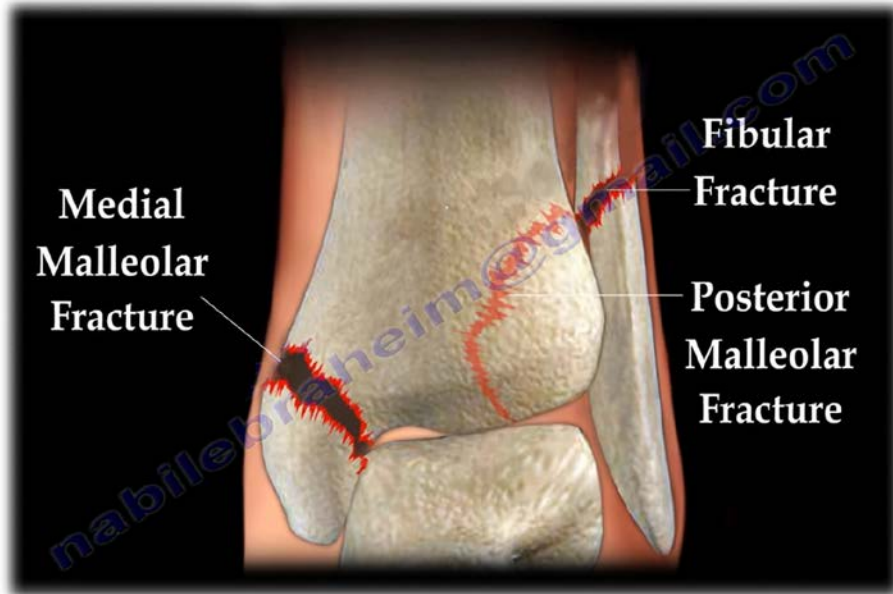
Immediate Fasciotomy



fasciotomy

11. Ankle Fractures

USUALLY BENIGN



**IN CASES OF ANKLE FRACTURE LOOK FOR
SIGNS OF SYNDESMOTIC INJURY”**

**Normal SYNDESMOSIS
(radiographic evaluation)**



ANKLE PILON FRACTURE

- Complicated
- SIGNIFICANT Soft Tissue Injury



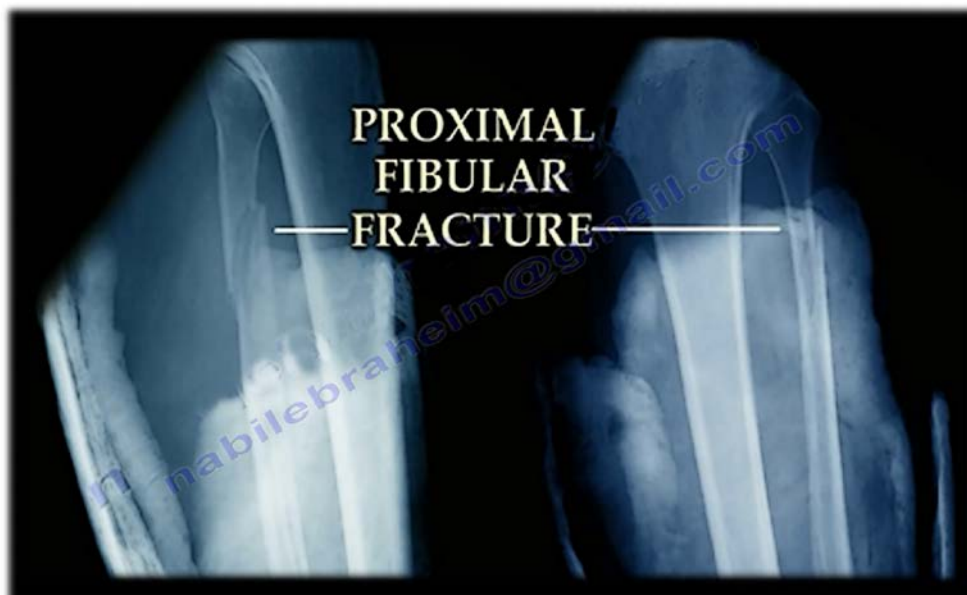
ANKLE FRACTURES: MAISONNEUVE FRACTURE

- Fracture of the *proximal fibula* is associated with an occult injury of the ankle. Often the *ankle mortise is widened*, and the *tibiofibular syndesmosis is disrupted*.
- Patient could mistakenly be treated for having:
 - Proximal fibular fracture alone and *ankle injury is missed*.
 - Sprain of ankle joint and *fibular fracture is missed*.
- High index of suspicion is necessary to diagnose and treat
- **Long Leg Film** that includes the ankle is mandatory in cases of:
 - Proximal fibular fractures to exclude the presence of ankle injury
 - An unexplained *increase in medial clear space of ankle joint* to diagnose the presence of a *high fibular fracture*.

SURGERY IS NECESSARY TO STABILIZE THE SYNDESMOSIS

ANKLE FRACTURES - MAISONNEUVE FRACTURE (continued):

CASE EXAMPLE



- Increased syndesmosis of > 4 mm = Syndesmotic Disruption

ANKLE FRACTURES - MAISONNEUVE FRACTURE (continued):

DIAGRAMMATIC REPRESENTATION

Involves fracture of the proximal fibula (*figure 1*) associated with an occult injury of the ankle (*figure 2*).

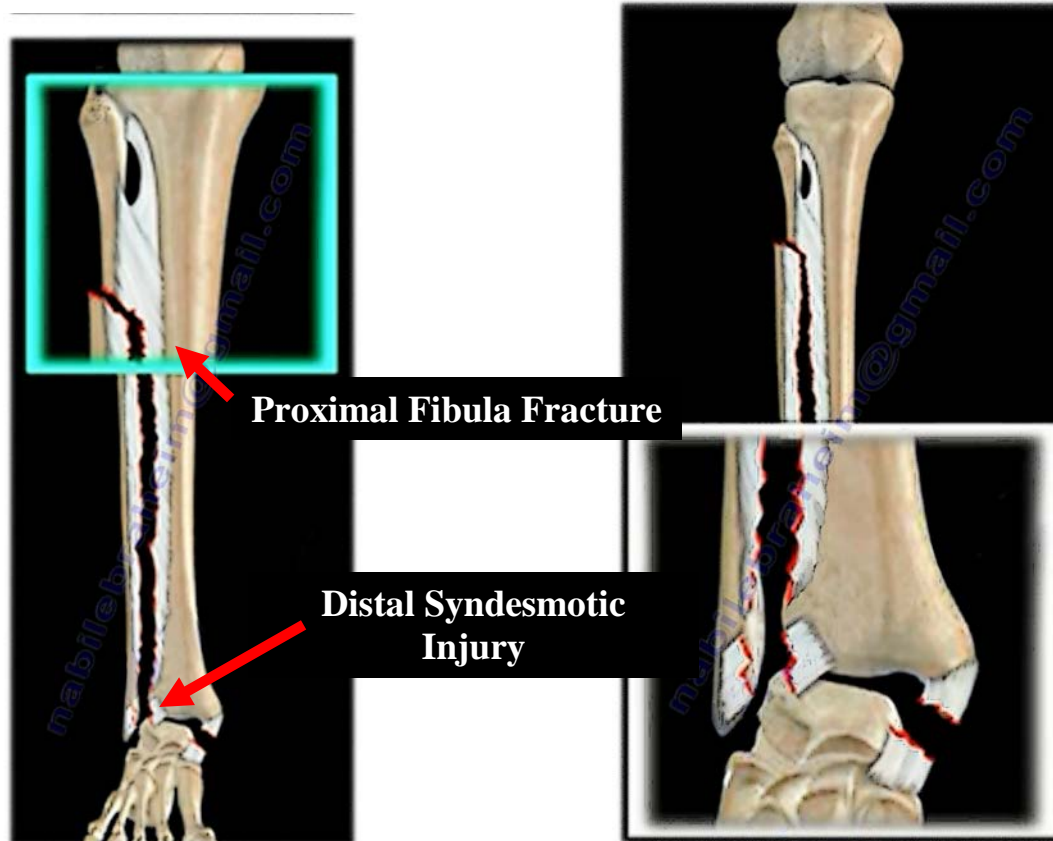


Figure 1

Figure 2

TREATMENT

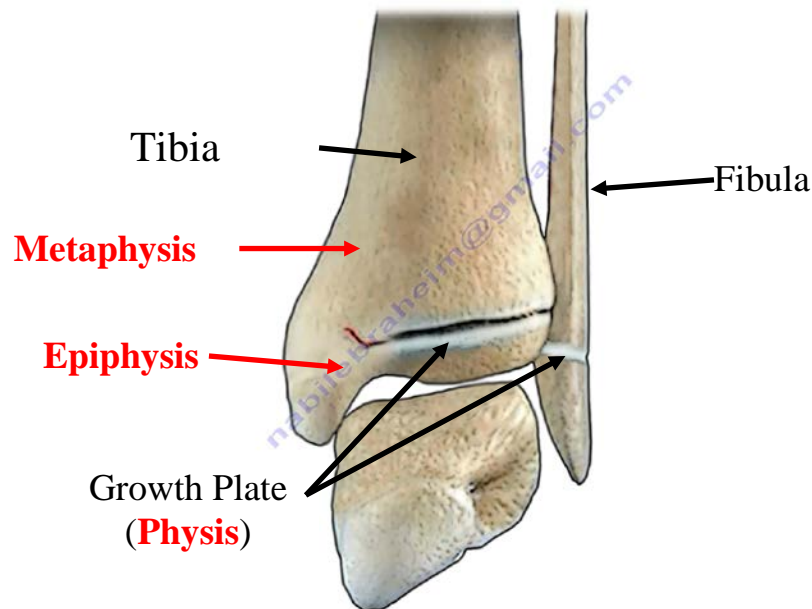
- Fixation: Syndesmodic Screws



12. Pediatric Fractures

SALTER-HARRIS CLASSIFICATION OF EPIPHYSEAL FRACTURES IN CHILDREN

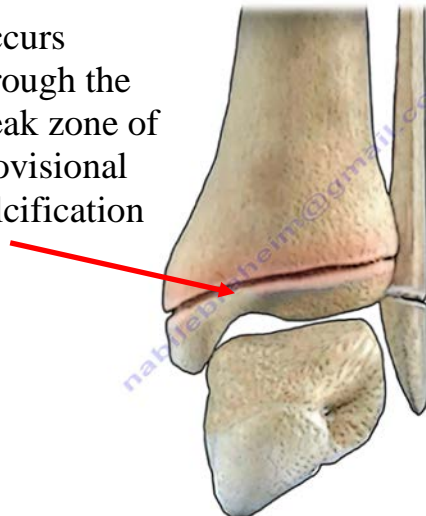
A Salter-Harris fracture is a common injury found in children which involves the growth plates of the long bones.



SALTER – HARRIS CLASSIFICATION: TYPE I, II, III, IV, V

Type I:

- 5% of fractures are Type I
- Occurs through the weak zone of provisional calcification



Type II:

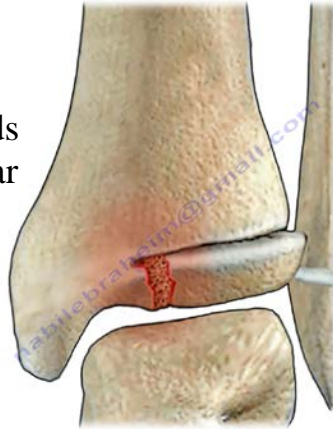
- 75% of fractures
- Fracture of the physis and metaphysis
- Corner of the metaphysis separates (Thurston-Holland Sign)



SALTER – HARRIS CLASSIFICATION: TYPE I, II, III, IV, V (cont.)

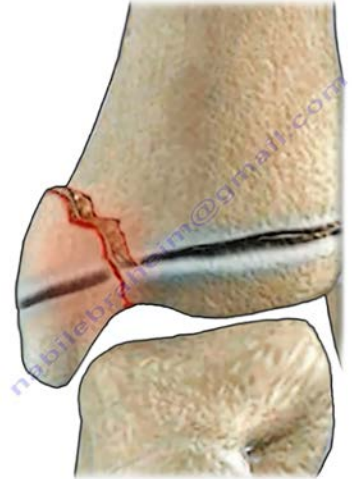
Type III:

- 10% of fractures
- Fracture of the physis and epiphysis
- Fracture extends into the articular surface of the bone



Type IV:

- 10% of fractures
- Fracture passes through the epiphysis, physis and the metaphysis
- Can cause complication such as growth disturbance and angular deformity



Type V:

- Uncommon, $\leq 5\%$
- Compression or crush injury of the growth plate
- No associated fracture of the epiphysis or metaphysis
- Initial diagnosis may be difficult
- **Highest incidence of growth deformity and disturbance**



13. Child Physical Abuse

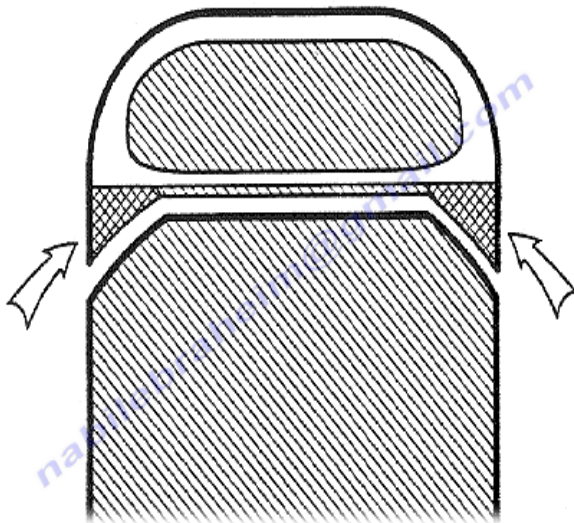
NON – ACCIDENTAL TRAUMA (NAT) in Pediatric Patients

IF SUSPECTED:

“CONSULT SOCIAL SERVICES IMMEDIATELY”

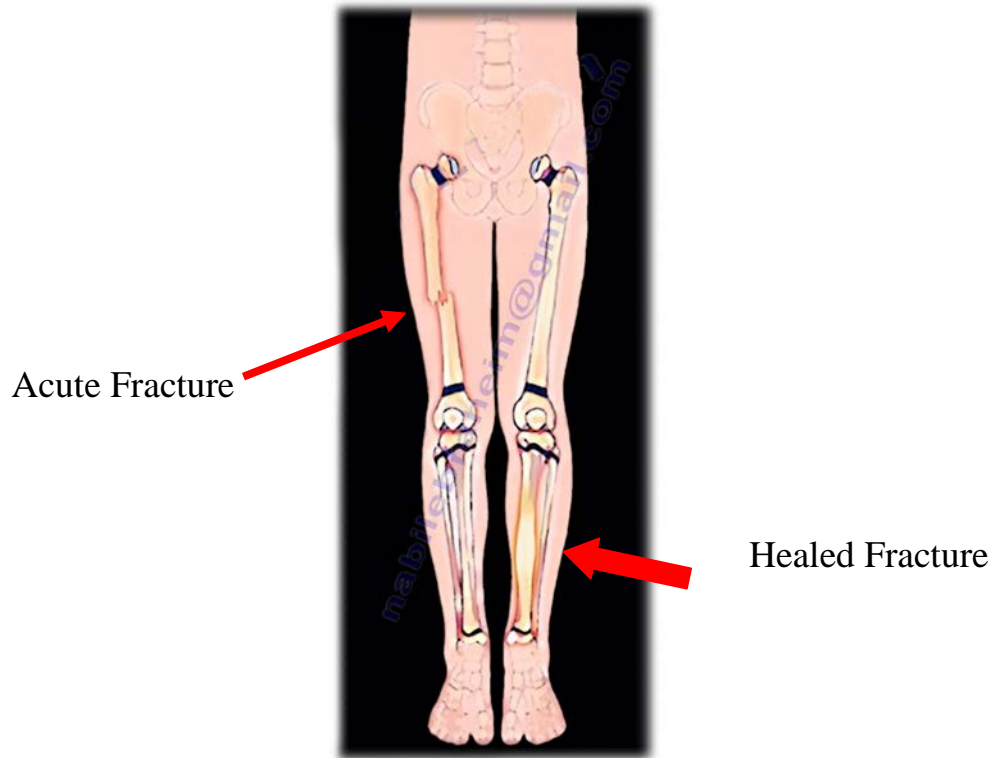
COMMON ORTHOPAEDIC CLINICAL FINDINGS

- Femur Fracture – *before walking age*
- Corner Fracture (*shown in figure below*)
 - Caused by traction / rotation
 - Less Common



COMMON ORTHOPAEDIC CLINICAL FINDINGS (continued):

- Fractures at *different stages of healing*



Multiple fracture sites at different stages of healing. Thick arrow indicates old healing callus. Thin arrows indicate new fracture.

- Transverse or Spiral fractures of long bones
- ***Humerus Fracture ----- most common***
- Metaphyseal BUCKET HANDLE FRACTURE



Metaphyseal or "bucket-handle" fracture (*arrow*) of the tibia.

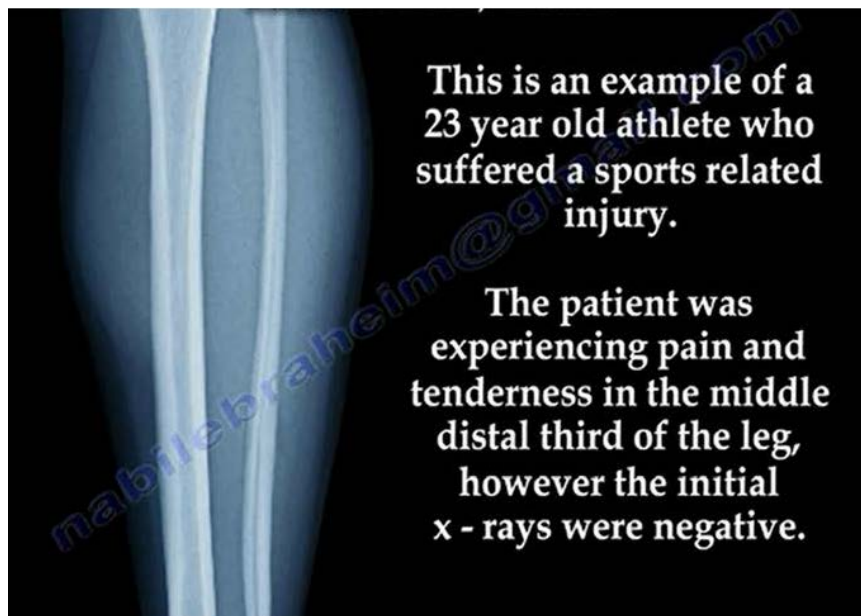
14. Stress Fractures

Patient populations that commonly exhibit stress fractures are:

- *Runners / Athletes*
- Patients with osteoporosis or diseased bone

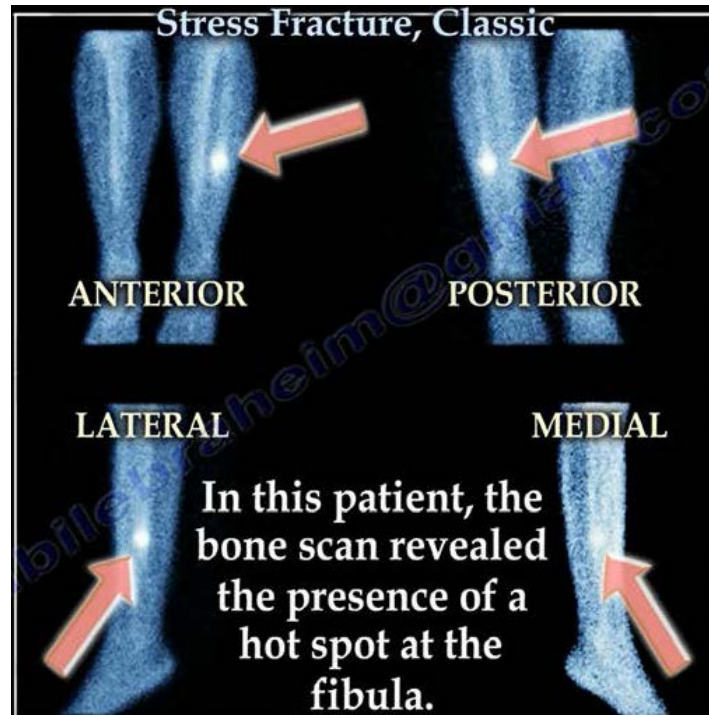
Patients present with:

- Localized severe bony pain
- Initially, normal appearing radiographs



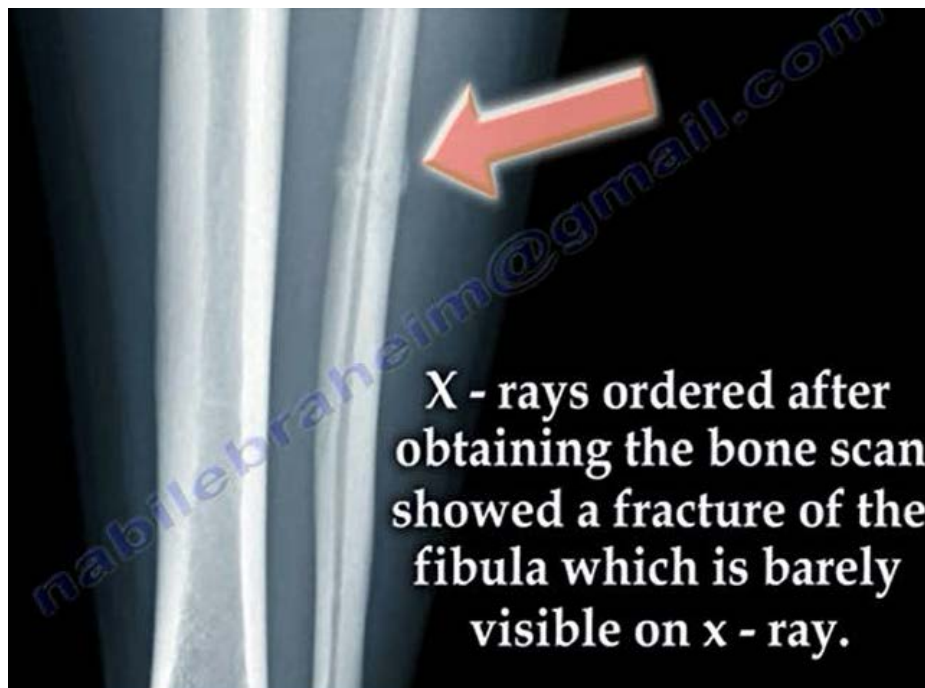
DIAGNOSIS

- MRI
- Bone Scan



TREATMENT

- Rest
- Immobilization
- May require surgery, as in stress fracture of the femoral neck or tibia.



-----Notes-----

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