Lecture 6

Editing File

Common Adult Fractures

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Objectives:

- Clavicle fracture
- Humerus (proximal & shaft)
- Both 'bone' forearm 'fracture'
- Distal 'radius' fracture
- Hip fracture
- Femur 'shaft' fracture'
- Tibial 'shaft' fracture'
- Ankle' fracture

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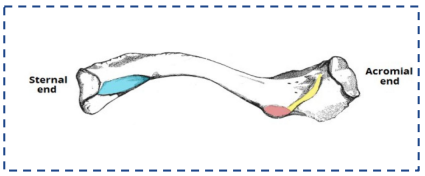
Important | Golden notes | Extra

Upper Extremities

❖ 1- Clavicle fracture

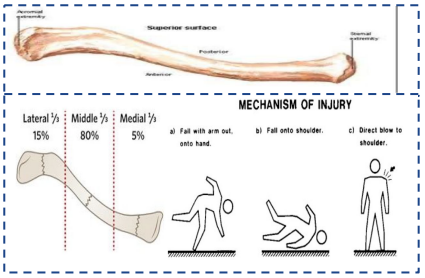
Anatomy

- Clavicle is S shape bone.
- It is anchored to scapula via ACJ (Acromioclavicular joint).
- It is anchored to trunk via SCJ (Sternoclavicular Joint).



General Notes

- Most of fracture occurs as result from fall onto shoulder. FOOSH (Fall on An Outer Stretched Hand)
- Fracture is classified into: proximal, middle and lateral third fractures.
- Most of fractures are of middle third.



Complications

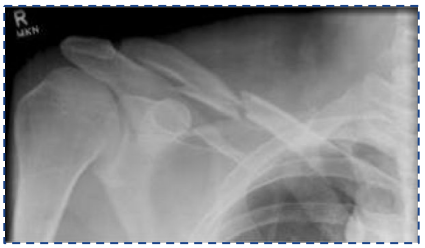
- Injury to brachial plexus and subclavian artery/vein may be present.
- Rarely, Pneumothorax can occur. (when the bone go inferiorly and cause injury to the lung)

Imaging

X-Ray:

- AP chest, to check there is no pneumothorax
- Clavicle special view (focused on clavicle) (30° cephalic tilt),

This X-ray shows middle third clavicle fracture with minimal displacement. [1]



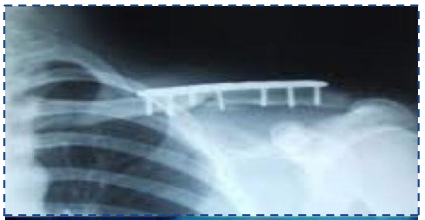
Treatment

Will you reduce clavicle fracture? No, we use the gravity to reduce it. We use a sling as a type of immobilization.

- Most of clavicle fractures are treated with a sling [2]
- Few fractures should be treated surgically with open reduction and internal fixation with screws and plates

When do we perform surgery? (Not necessarily all 3, one is enough)

- Skin is tented [3] why? Might become an open fracture
- Severe displacement: (100% displacement)
- 2 cm overlap. (shortening)



1- We have fragments here. (This X-ray shows a short oblique middle third fracture)
2- Conservative non surgical management for 1-2 weeks
3- Tented skin that might cause skin necrosis and become an open fracture, here we need to perform surgical management

Upper Extremities

What is the difference between open and closed reduction?

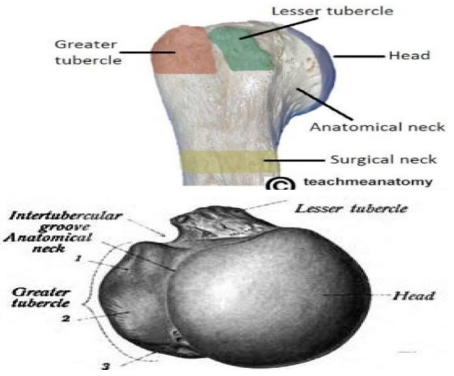
➔ Closed reduction: you can open the skin and everything but **away from the fracture**, and you do the surgery, but you do not expose the fracture site (away from it).

What is the difference between open and closed

➔ Open reduction: if the fractured bone is exposed and you can see the bone fragments by your eyes and manipulated by your hands and you reduce the fragments.

❖ 2- Proximal Humerus fracture

Anatomy



- Head. The anatomical neck separates the head from the tuberosities.
- Greater tuberosity GT → Muscles attached:
  - Supraspinatus (initiate abduction 0-15°)
  - Infraspinatus (external rotation and aid in abduction)
  - Teres minor (external rotation and aid in abduction)
- Lesser tuberosity LT → Muscle attached:
  - Subscapularis (internal rotation)

Bicipital groove runs between GT & LT (Attaches Biceps Brachii and Latissimus Dorsi)

- Shaft.
- Anatomical neck vs. Surgical neck The surgical neck is located between the tuberosities and the shaft. Why is it called **surgical neck? Because this is the location of many fractures that require surgery**

Description

- Younger patients: violent trauma (high energy trauma) such as RTA.
- Older patients: minor trauma. (low energy trauma eg. falling)
- **Most fractures are minimally displaced and can be treated with sling.**

Physical exam:

1. Expose the shoulder very well.
2. Look for fracture signs (swelling, tenderness, erythema, inability to move, ecchymosis)
3. Check the skin. To know if it is an open or closed fracture (although open fractures are unlikely

Examine the axilla, most of times they forget to examine it because pt has a lot of pain or they forget.

4. Peripheral N/V exam, to make sure there is no neurovascular injury
5. Axillary nerve: lateral skin patch (most common nerve affected)

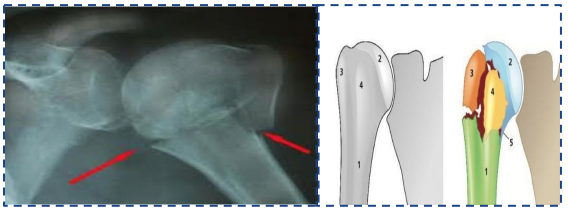
- Patient will lose sensation over the deltoid and will have difficulty in abducting his shoulder

6. Examine cervical spine (the axillary nerve originates from C5 and C6)

- You always have to examine the joint above and the joint below of any injury (cervical and elbow joints)

Upper Extremities

Imaging

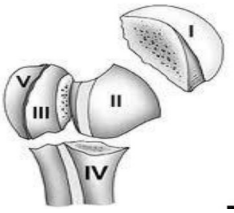


- Defined by the fragments displaced (Neer's classification)
  - 1 part fracture if there is no displacement
  - 2 part fracture if 1 part is displaced and so on
- Displacement: more than 1 cm and/or angulation >45°

Classification:

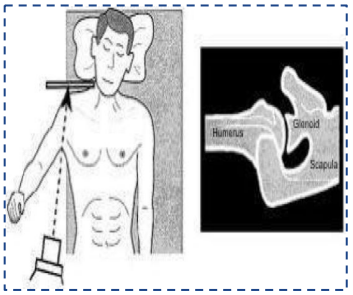
- Imagine that you cracked the anatomical neck, the surgical neck and you have a crack between the GT and LT (you will end by having 4 pieces). If you have 1 fracture line (you will get 2 pieces). 2 fracture lines (3 pieces). 3 fracture lines (4 pieces)
- If we have all the fractures but not displaced, we call this nondisplaced humerus fracture (one-part fracture). If not displaced, we don't count the fragments.

X-Ray: to make sure proximal humerus is not displaced, if displaced and you plan to do surgery you have to do CT

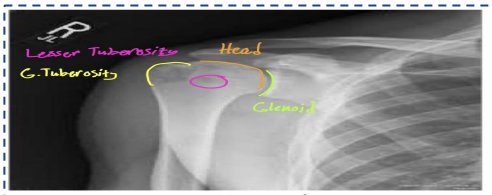


- AP and lateral views: you need 2 perpendicular (Orthogonal) views, Why? To have 3D image of the fracture.
- Axillary view (special X-ray): the patient is laying down, and the beam will go through the axilla to allow you see this view (the whole joint), it can show you if there is a fracture dislocation (it has different management)

  If there is a fracture and obvious displacement we usually do CT to categorize the fracture and see how many fragment.

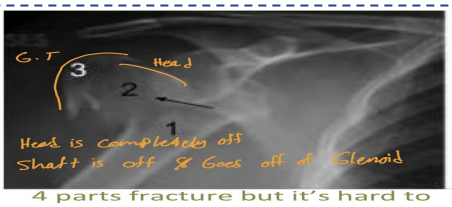


- CT scan for displaced fractures (and fractures extending to the joint)



Normal

Minimally displaced fracture of the greater tuberosity. ~~Anatomic neck~~ Head fracture impeded into valgus bec this is not the normal angle.
Head is tilted back & faces up more than medially
See extra pic



4 parts fracture but it's hard to tell due to overlap.

Treatment

If fracture is not displaced:

- Treatment with sling immobilization and NWB (non-weight bearing) of upper extremity for 6-8 wks. Why? based on the healing process of the fracture.
- Early ROM exercises pedaling exercise after 2-4 wks.
- Normal function can be resumed after 3-4 months.

If the fracture is displaced: or intra-articular

- Surgery is indicated.
- ORIF is indicated (plate and screws).
- Shoulder Hemiarthroplasty is indicated in some cases (severely comminuted fractures)

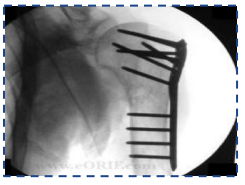
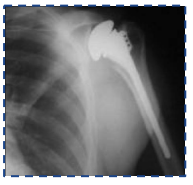


Plate and screws



Hemiarthroplasty

Upper Extremities

❖ 3- Humerus Shaft Fracture

General Description

It can be classified based on location of fracture. (proximal, middle and distal)

Clinical Features

Symptoms: pain, swelling, weakness ± shortening, motion/crepitus at fracture site

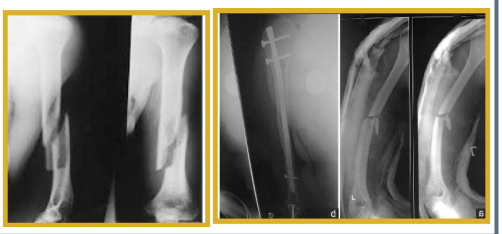
Physical exam:

- Skin. to rule out open fracture
- Compartment.
- N/V (neurovascular): watch for radial nerve palsy. How to examine the radial nerve?

- Motor: Extension of the wrist. Sensory over the dorsum of the first webspace.

Imaging

X-Ray: [1]

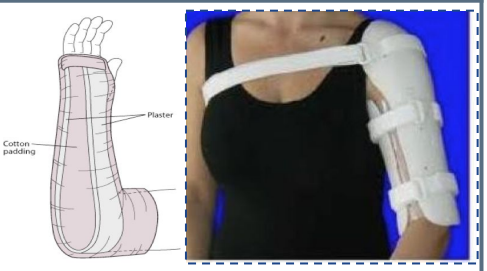


- ❖ Spiral fracture in mid shaft at the junction of middle & distal thirds
- ❖ Displacement
- ❖ Alignment with no angulation

Treatment

Almost all humerus shaft fracture can be treated non-surgically by:

- ❖ Close reduction. at the ER.
- ❖ Functional brace for 4-6 weeks + NWB.
- ❖ Early ROM of elbow and shoulder to avoid stiffness



What is the difference between brace and cast? the brace is removable, plastic with velcro tape, clamshell. There is no significant difference compared to the cast but it's easier to the patient.

Surgery is indicated (ORIF with plate and screws) for specific conditions like:

1. Segmental fracture, big fragment in the middle. (Two fractures or more with a free segment between)
2. Open fracture.
3. Obese patient, **why?** Because of body built which will push the humerus and displace it, and also, they have a lot of fat which push the arm into varus. You can't control the fracture with a brace
4. Bilateral fracture, **why?** Patient can't function with 2 casts (inhumane).
5. Floating elbow (Fracture of forearm and humerus) difficult to control. So basically like segmental, the elbow being the free segment

1- Holstein-Lewis fracture is a spiral fracture of the distal one-third of the humeral shaft commonly associated with neuropraxia of the radial nerve (22% incidence)

Upper Extremities

❖ 4- Both Bones Forearm Fracture

Anatomy

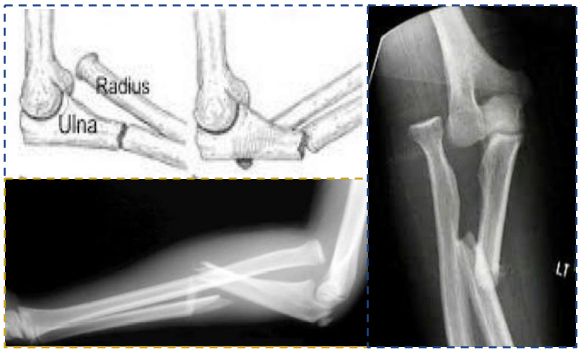
Forearm is complex with two mobile parallel bones; we consider the forearm as a ring or one joint (quadrilateral joint)
Radius and ulna articulate proximally and distally, by the proximal and distal radioulnar joint (RUJ) to allow forearm rotation (supination and pronation)

General Description

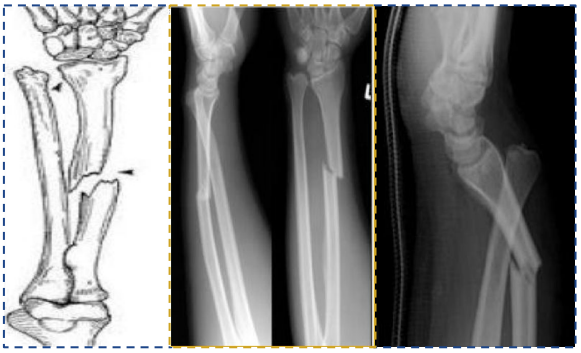
Fractures are often from fall or direct blow. It is very unlikely to fracture only one bone without disrupting the joint.

Types:

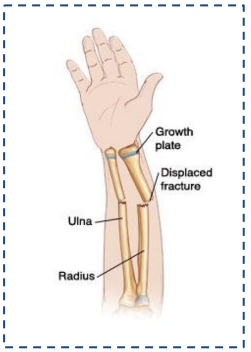
1. **Both bone fracture:** both the radius and ulna are broken
2. **Monteggia fracture :** proximal or middle third ulnar shaft fracture with dislocation of radius (head) proximally (at elbow).
   - Mechanism: direct blow on the posterior aspect of the forearm, hyper-pronation or fall on a hyperextended elbow.
   - Clinical Features: decreased rotation of forearm ± palpable lump at the radial head (dislocation)
3. **Galeazzi fracture :** Means distal or middle third shaft radius fracture with disruption of DRUJ.
   - Mechanism: hand FOOSH (Fall on An Outer Stretched Hand) with axial loading of pronated forearm or wrist trauma.



Monteggia Fracture



Galeazzi Fracture



Both Bone Fracture

Imaging

- ❖ 2 orthogonal views perpendicular on each other usually AP+lateral with joint above and joint below.
- ❖ CT scan if fracture extends into joint (intra-articular fracture to asses the displacement).

Frame A: AP forearm (including both joints)
Frame B: Lateral forearm (including both joints)
Image courtesy of Dr. Naveed Ahmad

Upper Extremities

Clinical Findings

- Symptoms and signs of fracture: deformity, pain, swelling loss of function in hand and forearm
- Check the skin. To make sure it is not an open fracture.
- Check the compartments of forearm.
- Check Ulnar, median and radial nerve (PIN, AIN). "Posterior & anterior interosseous nerves"
- Check vascularity of the hands : color, temperature, capillary refill and pulse.

Treatment

- **Both bone fracture:**

- Reduce and splint at ER/clinic (temporary)
- Are treated almost always with surgery ORIF: (plate and screws) even if it didn't displace because we worry that it will later if we left it.

- **Monteggia fracture:**

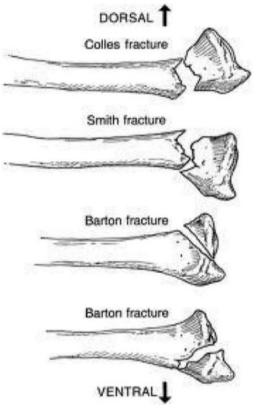
ORIF ulna and close reduction of radial head if closed failed go for open.

- **Galeazzi fracture:**

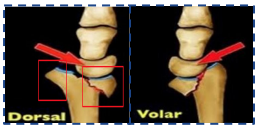
ORIF radius and close reduction of DRUJ.

5-Distal Radius Fracture

General Description

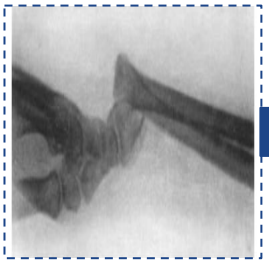


- It is the Most common fracture of upper extremity.
- Most frequently are seen in older women (due to osteoporosis).
  Young adults fractures are most commonly secondary to high energy trauma.
- Types:
  1. Extra-articular fractures:
     - A. Colles fracture: dorsal angulation, shortening and radial deviation
     - B. Smith's fracture: shortening and volar angulation (reverse colles')
  2. Intra-articular fractures :
     - A. Barton's fracture: Volar or Dorsal →
     - B. Others: due to a fall on extended pronated wrist

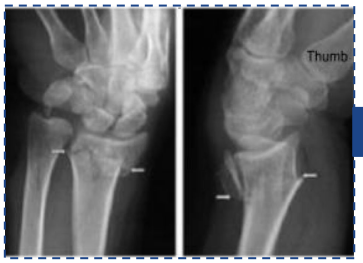


Imaging

- X-ray and do CT if fracture extends into joint. (PA not AP → it's hard to ask the patient to supinate his arm)
- In Barton's fracture you have to see it in lateral x-ray because on AP/Pa there is overlap
- If extended into joint we ask for CT.



Smith's Fracture



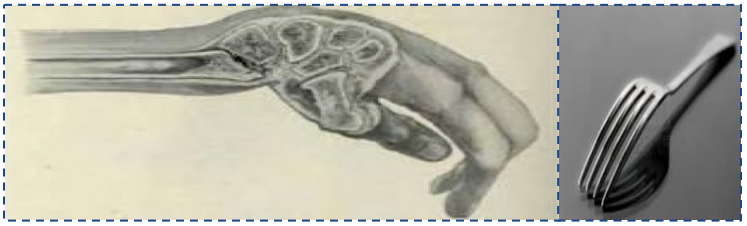
Colles' Fracture

Barton's Fracture

Upper Extremities

Clinical Features

Colles' Fracture	Smith's Fracture
Can present clinically with a "Dinner Fork" deformity	Can present clinically with a "Shovel" deformity



Treatment

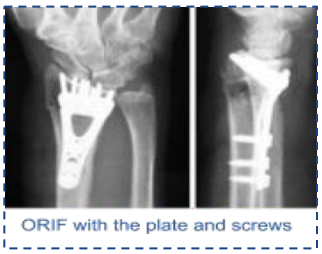
Extra-articular fractures:

- Start with analgesia
- Closed reduction and below elbow cast application "to avoid elbow stiffness"
- Immobilization for 6-8 weeks.
- ROM exercises after cast removal.
- Surgery (ORIF): if reduction is not in an accepted position (post-reduction X ray)
- Compartment syndrome checklist upon patient's discharge

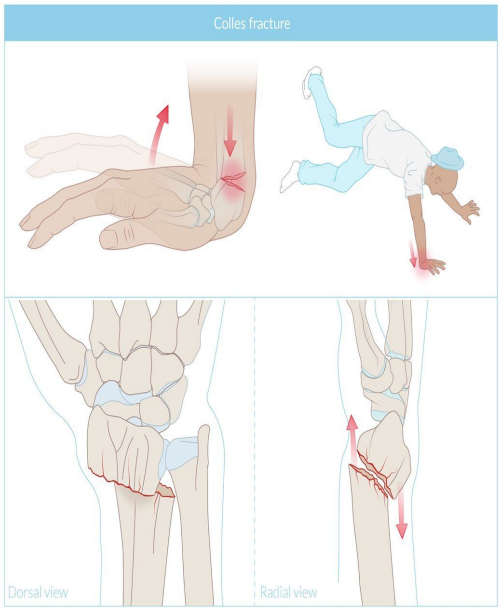
Intra-articular fracture:

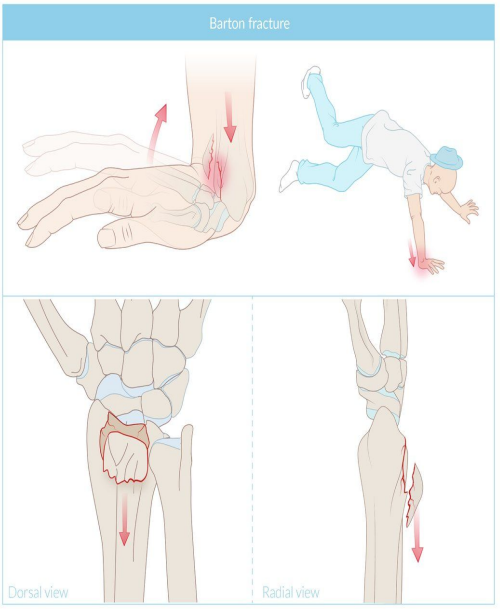
Indications for Surgery → ORIF with plates and screws

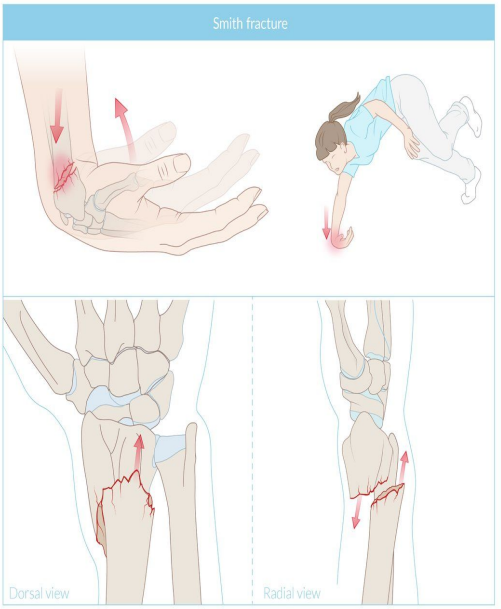
- Displacement of intra-articular fracture more than 2 mm.



ORIF with the plate and screws





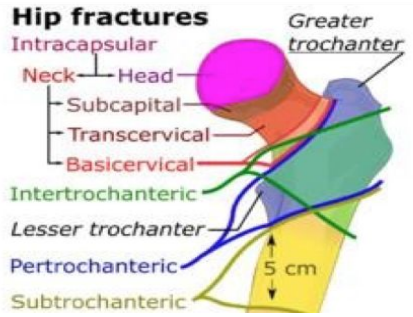


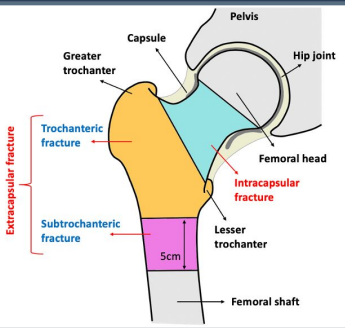
Lower Extremities

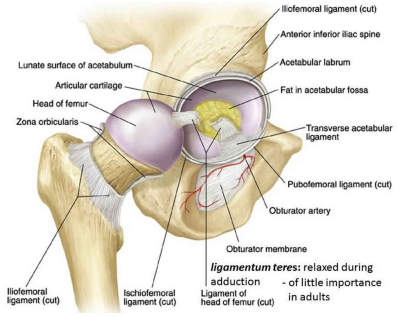
❖ 1- Hip Fractures in Elderly (>60)

- The physiological age is what matters not the exact age, because you can have a 60 y\o male but he is completely fit and healthy with no issues (for the sake of the exam stick to 60 as a cutoff)

Anatomy

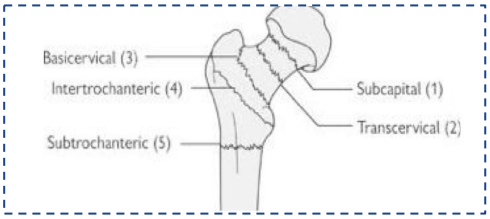






General Description

The usual story of this fracture: a geriatric patient falls down in the bathroom and it is usually managed by surgery.



- ❖ It is the most common fracture of LL.
- ❖ **It is associated with osteoporosis. Like colles in old women**
- ❖ Most common mechanism is **a fall from standing height.**
- ❖ In young people it is usually caused by high energy trauma and is considered a separate entity of fractures that affects elderly
- ❖ **BEWARE → cause of fall (stroke, MI) should be ruled out during clinical evaluation;** a fall might be a manifestation of a much more serious medical condition such as an MI or a stroke
- ❖ It is a life changing event it's not about the fracture itself, but it's about the systemic failure "The patient starts to be senile". Most people will walk but they will not be the same. Mortality: 20% of these people will die 1 year after the fracture. Not because of the fracture, it just tells you how it's linked to systemic failure.

Fractures can be classified into: intra/extra-capsular or displaced and non-displaced

- ◆ **Intracapsular :**
  - Subcapital (directly below the femoral head) (Femoral head and neck junction)
  - Transcervical (mid portion of femoral neck)
- ◆ **Extra-capsular :**
  - Basicervical (base of femoral neck)
  - Intertrochanteric
  - Subtrochanteric (within 5 cm below lesser trochanter)

- ❖ AVN risk is higher with **intracapsular fracture**.

Common Associated Injuries:

1. Distal radius
2. Proximal humerus fracture.
3. Subdural hematoma

Lower Extremities

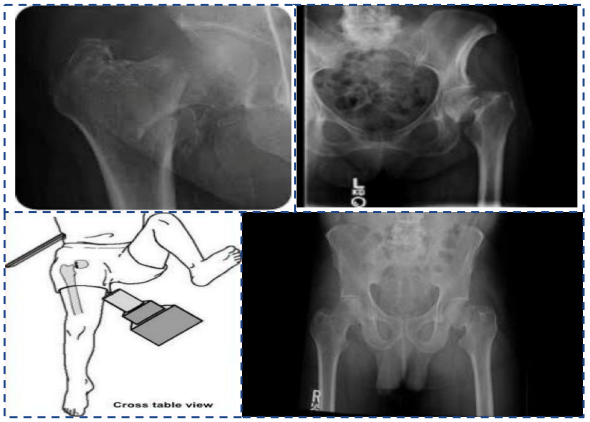
Clinical Features

- Full detailed history of mechanism of injury.
- Rule out MI,stroke, syncope, chest pain, weakness etc.
- A detailed systematic review.
- Deformity for : Abduction, External rotation and shortening..
- Assess distal N/V status the most commonly injured nerve is The sciatic nerve.
- **Avoid ROM if fracture is expected** if patent can not do active, don't try passive ROM.

Imaging

X-Ray:

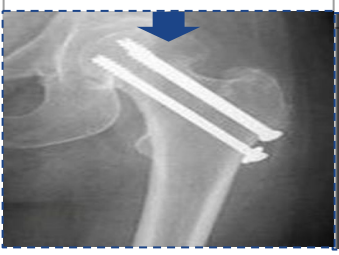
- 3 views are needed:
  1. AP pelvis.
  2. AP hip
  3. Lateral xray of the same hip (Cross-table view) →
- **MRI is sensitive for occult fractures.**
  - They don't appear on an X ray



Treatment

- No close reduction is needed, why? a study showed that there is no difference if you put a traction or not, not cost effective, and no benefit for the patient
- No traction is needed.
- Patient needs surgery ideally within 48 hrs even less
- The goal is to ambulate patient as soon as possible.
- Be sure that **DVT prophylaxis is started.** For all hip fracture
- Be sure that patient will be evaluated for osteoporosis after discharge. (to avoid more fracture)
- **Unstable fractures are:**
  1- Lesser Trochanteric fragment 2- 4 part fractures 3- Fracture extending to subtrochanteric area

Intracapsular			Extracapsular	
Non-displaced	Displaced		Stable	Unstable
Internal fixation in situ with cannulated screws	Elderly	Young	Closed reduction with internal fixation with DHS	Closed reduction with internal fixation using a cephalomedullary nail (CMN)
	Hemiarthroplasty	ORIF With cannulated screws		




Lower Extremities

Complications

1. Nonunion: most common complication in young people
   - ➔ 2% (IT intertrochanteric fractures) very rare.
   - ➔ 5% (non-displaced neck fracture)
   - ➔ 30% (displaced neck fracture and among young people)
2. AVN (femoral neck fracture):
   - ➔ 10% (non-displaced)
   - ➔ 30% (displaced) intracapsular
3. Death:

➔ Early 4%.

➔ At 1 year if you look patient with fracture: 20-40% of them are died. Because of some complication like pneumonia (due to delayed surgery, delayed amputation and bed sores).

4. VTE (Venous thromboembolism)
5. 2.5% associated femoral shaft fracture → in young people because fractures are caused by high energy

Examples: What is the type of the following fractures?

Basicervical

Green line was more clear on slide. Follow the cortex from proximal femur and you will see the fracture right after the lesser trochanter

Subcapital transcervical

Intertrochanteric

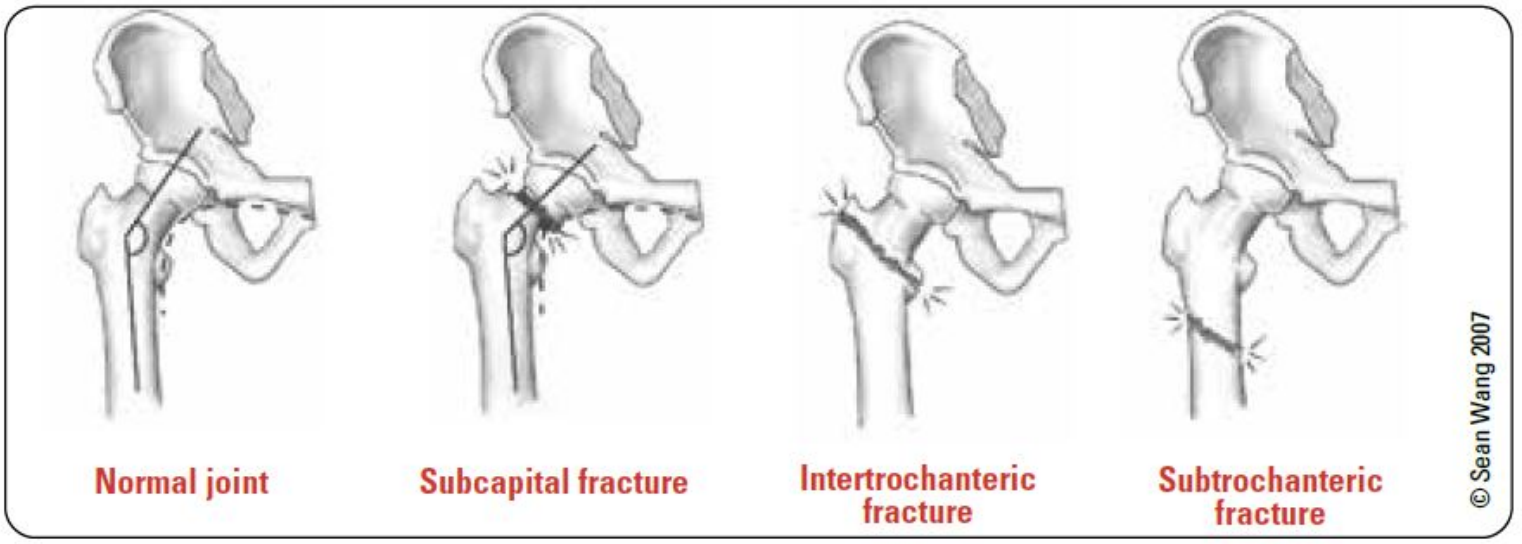


Figure 35. Subcapital, intertrochanteric, and subtrochanteric hip fractures

Lower Extremities

2- Femoral Shaft Fractures

Etiology

More common	Less common
• High energy mechanisms - MVC, fall from a height, gunshot wound • Young patients (male, < 30 years). • ATLS protocol.	• Low energy mechanism (torsional forces) • Old patients. • Spiral type fracture.

Clinical Associations MCQ/SAQ!

MSK injuries	Non-MSK Injuries
1. Ipsilateral femoral neck fracture - 10%. Missed in 30-50% 2. Knee ligaments injuries: 50% 3. Meniscal tear 30% 4. Floating knee injury: less common - Ipsilateral tibial and femoral fractures 5. Vascular/nerve injuries: rare 6. Contralateral femur shaft fracture - worse prognosis among above	1. Fat embolism, usually to the lung 2. ARDS (Acute respiratory distress syndrome) 3. Head injury 4. Abdominal injury

Clinical Examination

- ATLS.
- Fracture symptoms and signs.
- Skin integrity. (to rule out open fracture)
- N/V exam.
- Compartment assessment.
- Knee swelling or ecchymosis.

Imaging

- AP and lateral views femur. Joint above (spine, Bamboo spine) and joint below.
- 15° Internal rotation AP view (to get a good profile of the femoral neck) ipsilateral hip.
- Lateral view ipsilateral view
- If femoral neck fracture is suspected: CT scan hip.
- Knee AP and lateral views

Lower Extremities

2- Femoral Shaft Fractures

Treatment

- ATLS: ABC resuscitation. If we cannot get patient to OR soon we can use skeletal traction (proximal tibial pin) for pain control if surgery will be delayed
- Early surgical fixation: is the key
  - ➔ Proven to reduce Pulmonary complications. (PE or fat embolism).
  - ➔ Must be within 24 hrs (ideally < 6 hrs).
  - ➔ If patient is unstable: External fixation
  - ➔ If patient is **stable** → closed reduction & IM nailing.

Complications

- Malunion:
  a. Most common.
  b. More common with proximal fracture (subtrochanteric fracture) bc of muscles attachments
  c. Rotational, angulation and shortening (or combination of those)
- Nonunion: rare
- Infection.
- VTE. Always give prophylaxis.

3- Tibial Shaft Fractures

General Description

- It is a subcutaneous bone (high suspicion for skin injury). Not a lot of muscles are covering it
- Most common large long bone fracture. (and open bone fractures)
- It can be secondary to low or high energy mechanism.
- It carries the highest risk of compartment syndrome. (cause it is small space and less distal muscles)
- 20% of tibial fracture can be associated with ankle intra-articular fracture.

Classified based on:

A. Location and morphology:
  ➔ Proximal third
  ➔ Middle third
  ➔ Distal third
B. Displaced vs. Non-displaced

Clinical Examination

- Skin integrity. To rule out open fracture.
- Assess compartments of leg: needs serial exam.
- Serial N/V exam.

Lower Extremities

3- Tibial Shaft Fractures

Imaging

X ray:

- **AP and lateral tib/fib.**
- AP/lateral knee
- AP/Lateral ankle

CT scan if fracture extends into joints above or below.

Left pic shows comminuted tibial and fibular fractures + ankle fracture

Treatment

Nonsurgical Management

Indications:

- NO displacement: < 10° angulation on AP/lateral x rays.
- < 1 cm shortening.
- Not comminuted.

Procedure:

- Above knee full cast if non-surgical treatment is chosen: it must be bi-valved to minimize the risk of compartment syndrome.
- Always provide patient with Compartment Syndrome checklist if patient is discharged home with cast. (with all fractures)
- NWB for 8 weeks with cast immobilization.

Surgical Management (most common modality)

Indications:

- Displacement.
- Open fracture.
- Compartment syndrome.
- Floating knee.

Procedure:

- Above knee backslab and U-shape slab until surgery
- Most commonly **IM** nail fixation. Sometimes plates and screws

Complications

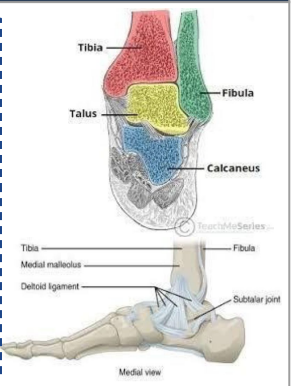
- Non-union: most common complication
- Delayed union
- Infection: open fracture
- DVT/PE

Lower Extremities

❖ 4- Ankle Fractures (Low energy (torsional): malleolus fracture)

Anatomy

- Medial and lateral malleoli, distal tibia and talus.
- Highly congruent joint (stable)
- Fibula is held to distal tibia by syndesmotic ligament.
- Medial malleolus is held to talus by deltoid ligament.
- Lateral malleolus is held to talus by LCL (lateral collateral ligament)
- Lateral ligament complex of the ankle is composed of three ligaments:
  - (ATFL-PTFL) the Anterior/posterior talofibular ligament
  - calcaneofibular ligament (CFL)

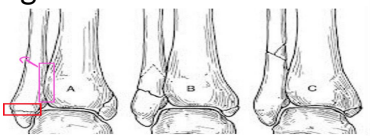


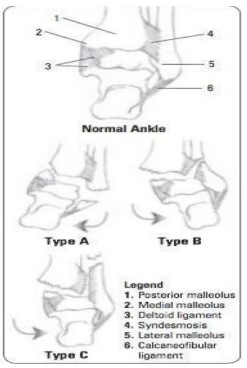
General Description

Classifications:

- Stable v.s. Unstable fracture:
- **Causes of instability → 1- Lateral displacement of talus 2- Bimalleolar fracture**
- Medial, lateral or bimalleolar fracture.
- For Lateral malleolus fractures, we can subdivide them using Weber's classification:
  - A. Below the level of syndesmosis
  - B. At the level of syndesmosis
  - C. Above the level of syndesmosis

Syndesmosis level





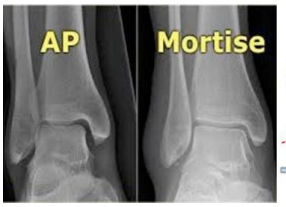
Clinical Findings

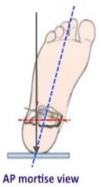
- Look for fracture symptoms and signs.
- Assess medial joint ecchymosis or tenderness to assess medial malleolus and deltoid ligament integrity.
- Assess N/V status (before and after reduction)
- A valgus deformity is present in medial malleolus fractures.

Imaging

X-Ray:

- AP
- Lateral
- Mortise view AP+15° internal rotation (special view)
- Long leg x-rays: if only medial malleolus is broken.

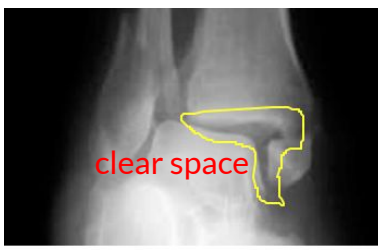




CT SCAN IF FRACTURE EXTENDS TO ARTICULAR DISTAL TIBIA SURFACE.

➔ **We check the clear space on the medial side if it's wider than 4 mm the fracture is considered to be laterally displaced**

Unstable



Stable

Lower Extremities

❖ 4- Ankle Fractures (Low energy (torsional): malleolus fracture)

Treatment

Medial Malleolar Fracture:

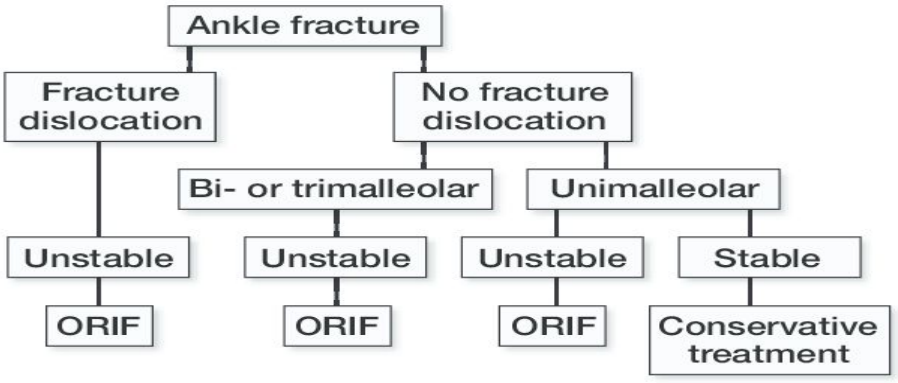
- If non displaced we splint or apply a below knee cast and treat conservatively.

Lateral Malleolar Fracture:

1. Weber A: No surgery
   - Splint + NWB X 6 weeks.
   - Early ROM.
2. Weber B/C: Plate -/+ syndesmotic screw
   - If medial joint line widen (unstable): ORIF, if the tibia and fibula are displaced we will put a syndesmotic screw between them, it is called **syndesmotic screw** because it acts as a syndesmotic ligament (hold the bones together until syndesmosis heal).
   - If stable: Cast + NWB X6 weeks.
   - If not: Call Orthopedic for stress film x-rays to see if it's open or not

Bimalleolar Fractures:

- ORIF (ORIF both bones -/+ syndesmotic screw)



Extra:

Clavicle Fracture

- incidence: proximal (5%), middle (80%), or distal (15%) third of clavicle
- common in children (unites rapidly without complications)

Mechanism
- fall on shoulder (87%), direct trauma to clavicle (7%), FOOSH (6%)

Clinical Features
- pain and tenting of skin
- arm is clasped to chest to splint shoulder and prevent movement

Investigations
- evaluate NVS of entire upper limb
- x-ray: AP, 45° cephalic tilt (superior/inferior displacement), 45° caudal tilt (AP displacement)
- CT: useful for medial physeal fractures and sternoclavicular injury

Treatment
- medial and middle-third clavicle fractures
  - for nondisplaced fractures, simple sling for 1-2 wk prn
  - early ROM and strengthening once pain subsides
  - if fracture is shortened >2 cm, consider ORIF
- distal-third clavicle fractures
  - undisplaced (with ligaments intact): sling for 1-2 wk
  - displaced (CC ligament injury): ORIF

Specific Complications (see *General Fracture Complications*, OR7)
- cosmetic bump (most common complication)
- shoulder stiffness, weakness with repetitive activity
- pneumothorax, brachial plexus injuries, and subclavian vessel (all very rare)

Open Reduction and Internal Fixation vs. Nonsurgical Treatment in Displaced Midshaft Clavicle Fractures: A Meta-Analysis
J Orthop Trauma 2018;32(7):e276-e283
Purpose: Compare outcomes from ORIF and non-operative treatments in displaced mid-shaft clavicular fractures.
Methods: Meta-analysis with 9 RCTs reporting nonunion, functional outcomes, and subsequent surgeries in patients older than 16 yr.
Results: 9 randomized clinical trials with 1027 total patients were included. ORIF was associated with significantly lower nonunion rate of 1.7% compared to 14.5% for the non-operative treatment groups (RR 0.15, 95% CI, 0.08-0.31). Functional outcomes, rated by either DASH or Constant scores, were significantly better in ORIF up to 6 mo. When excluding elective plate removal, the rate of subsequent surgeries was significantly lower in the ORIF cohort (4.7% vs 14%, RR 0.36, 95% CI 0.24-0.56).
Conclusions: ORIF is associated with significant reductions in nonunions and earlier functional outcomes in displaced midshaft clavicular fractures.

Associated Injuries with Clavicle Fractures
- Up to 9% of clavicle fractures are associated with other fractures (most commonly rib fractures)
- Majority of brachial plexus injuries are associated with proximal third fractures

Proximal Humeral Fracture

Mechanism
- young: high energy trauma (MVC)
- elderly: FOOSH from standing height in osteoporotic individuals

Clinical Features
- proximal humeral tenderness, deformity with severe fracture, swelling, painful ROM, bruising extends down arm and chest
- physical exam usually reveals diminished forward elevation, with or without disuse atrophy of deltoid and periscapular musculature

Investigations
- test axillary nerve function (deltoid contraction and skin over deltoid)
- x-rays: AP, trans-scapular, and axillary views of the shoulder are essential
- CT scan: to evaluate for tuberosity or articular involvement and fracture displacement, and if the diagnosis of non-union is unclear

Classification
- Neer classification is based on 4 fracture locations or 'parts'
- displaced: displacement >1 cm and/or angulation >45°
- the Neer system regards the number of displaced fractures, not the fracture line, in determining classification
- ± dislocated/subluxed: humeral head dislocated/subluxed from glenoid

Treatment
- assess for and treat osteoporosis if needed
- non-operative
  - nondisplaced and minimally displaced (85% of patients): broad arm sling immobilization, begin ROM within 14 d to prevent stiffness
  - most displaced fractures in low-demand elderly patients
- operative
  - ORIF (anatomic neck fractures, displaced, associated irreducible glenohumeral joint dislocation) or IM nail (surgical neck)
  - hemiarthroplasty or reverse TSA may be necessary, especially in elderly
  - minimally invasive percutaneous pinning and intramedullary nail fixation are indicated in rare instances

Specific Complications (see *General Fracture Complications*, OR7)
- AVN, nerve palsy (45%; typically axillary nerve), malunion, post-traumatic arthritis, persistent pain and weakness, frozen shoulder

Neer Classification
Based on 4 parts of humerus
- Greater tuberosity
- Lesser tuberosity
- Humeral head
- Shaft

One-part fracture: any of the 4 parts with none displaced
Two-part fracture: any of the 4 parts with 1 displaced
Three-part fracture: displaced fracture of surgical neck + displaced greater tuberosity or lesser tuberosity
Four-part fracture: displaced fracture of surgical neck + both tuberosities

Extra:

Humeral Shaft Fracture

Mechanism
- high energy: direct blows/MVC (especially young)
- low energy: FOOSH, twisting injuries, metastases (in elderly)

Clinical Features
- pain, swelling, weakness ± shortening, motion/crepitus at fracture site
- must test radial nerve function before and after treatment: look for drop wrist, sensory impairment in dorsum of hand

Investigations
- x-ray: AP and lateral views of the humerus, including the shoulder and elbow joints

Treatment
- in general, humeral shaft fractures are treated non-operatively
- non-operative
  - ± reduction; can accept deformity due to compensatory ROM of shoulder
  - hanging cast (weight of arm in cast provides traction across fracture site) with collar and cuff sling immobilization until swelling subsides, then Sarmiento functional brace, followed by ROM
- operative
  - indications: see *NO CAST* sidebar, OR6, pathological fracture, "floating elbow" (simultaneous unstable humeral and forearm fractures)
  - ORIF: plating (most common), IM rod insertion, external fixation (rare)

Specific Complications (see *General Fracture Complications*, OR7)
- failure of functional bracing (seen in up to 30% of patients)
- radial nerve palsy: expect spontaneous recovery in 3-4 mo, otherwise send for EMG
- non-union: most frequently seen in middle 1/3
- decreased ROM
- compartment syndrome

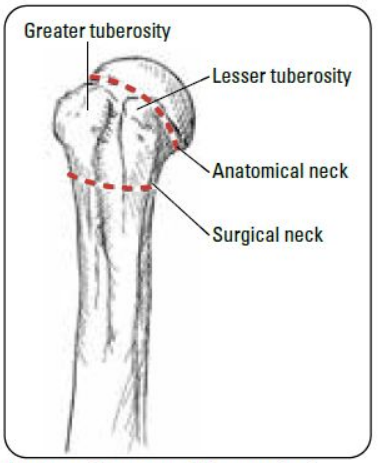


Figure 15. Fractures of the proximal humerus

Acceptable Humeral Shaft Deformities for Non-Operative Treatment
- <20° anterior angulation
- <30° varus angulation
- <3 cm of shortening

Risk of radial nerve and brachial artery injury

Distal Humeral Fracture

Mechanism
- young: high energy trauma (MVC)
- elderly: lower energy falls in patients with osteoporotic bone

Clinical Features
- elbow pain and swelling
- assess brachial artery

Investigations
- x-ray: AP and lateral views of the humerus and elbow
- CT scan: helpful when suspecting shear fracture of capitulum or trochlea, and for preoperative planning
- assess NVS: radial, ulnar, and median nerve

Classification
- supracondylar, distal single column, distal bicolumnar, and coronal shear fractures

Treatment
- goal is to restore a functional ROM of at least 30-130° flexion (unsatisfactory outcomes in 25%)
- non-operative (paediatric patients and elderly patients with medical comorbidities)
  - cast immobilization (in supination for lateral condyle fracture; pronation for medial condyle fractures): short immobilization and early range of motion
- operative
  - indications: displaced, supracondylar, bicolumnar
  - closed reduction and percutaneous pinning (children); ORIF; total elbow arthroplasty (complex bicolumnar in elderly)
  - adult fractures are almost always treated operatively due to risk of elbow stiffness with non-operative management

The anterior humeral line refers to an imaginary line drawn along the anterior surface of the humeral cortex that passes through the middle third of the capitellum when extended inferiorly. In subtle supracondylar fractures, the anterior humeral line is disrupted, typically passing through the anterior third of the capitellum

Extra:

Forearm

Radius and Ulna Shaft Fractures

Mechanism
- high-energy direct or indirect (MVA, fall from height, sports) trauma
- fractures usually accompanied by displacement due to high force

Clinical Features
- deformity, pain, swelling
- loss of function in hand and forearm

Investigations
- x-ray: AP and lateral of forearm ± oblique of elbow and wrist
- CT if fracture is close to joint

Treatment
- goal is anatomic reduction since imperfect alignment significantly limits forearm pronation and supination
- ORIF with plates and screws; closed reduction with immobilization usually yields poor results for displaced forearm fractures (except in children)

Specific Complications (see *General Fracture Complications*, OR7)
- compartment syndrome
- soft tissue contracture resulting in limited forearm rotation – surgical release of tissue may be warranted

Monteggia Fracture

- fracture of the proximal ulna with radial head dislocation and proximal radioulnar joint injury
- more common and better prognosis in the paediatric age group when compared to adults

Mechanism
- direct blow to the posterior aspect of the forearm
- hyperpronation
- fall on the hyperextended elbow

Clinical Features
- pain, swelling, decreased rotation of forearm ± palpable lump at the radial head
- ulna angled apex anterior and radial head dislocated anteriorly (rarely the reverse deformity occurs)

Investigations
- x-ray: AP and lateral views of the elbow, wrist and forearm

Treatment
- adults: ORIF of ulna with indirect reduction of radiocapitellar joint in 90% of patients (open reduction of radiocapitellar joint if unsuccessful)
- splint and early postoperative ROM if elbow completely stable, otherwise immobilization in plaster with elbow flexed for 2-3 wk
- paediatrics: attempt closed reduction and immobilization in plaster with elbow flexed for Bado Type I-III, surgery for Type IV

Specific Complications (see *General Fracture Complications*, OR7)
- PIN injury: most common nerve injury; observe for 3 mo as most resolve spontaneously
- radial head instability/redislocation
- radioulnar synostosis

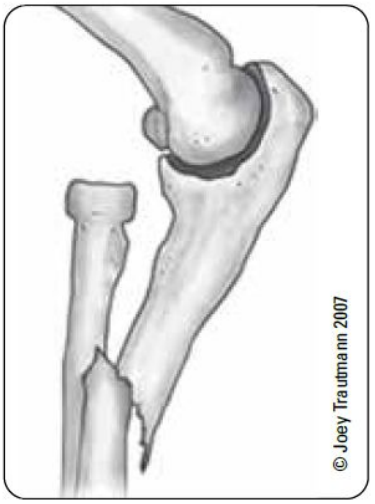


Figure 19. Monteggia fracture

In all isolated ulna fractures, assess proximal radius to rule out a Monteggia fracture

Bado Type Classification of Monteggia Fractures
Based on the direction of displacement of the dislocated radial head, generally the same direction as the apex of the ulnar fracture
Type I: anterior dislocation of radial head and proximal/middle third ulnar fracture (60%)
Type II: posterior dislocation of radial head and proximal/middle third ulnar fracture (15%)
Type III: lateral dislocation of radial head and metaphyseal ulnar fracture (20%)
Type IV – combined: proximal fracture of the ulna and radius, dislocation of the radial head in any direction (<5%)

Extra:

Galeazzi Fracture

- fracture of the distal radial shaft with disruption of the DRUJ
- most commonly in the distal 1/3 of radius near junction of metaphysis/diaphysis

Mechanism
- hand FOOSH with axial loading of pronated forearm or direct wrist trauma

Clinical Features
- pain, swelling, deformity, and point tenderness at fracture site

Investigations
- x-ray: AP, and lateral views of the elbow, wrist, and forearm
  - shortening of distal radius >5 mm relative to the distal ulna
  - widening of the DRUJ space on AP
  - dislocation of radius with respect to ulna on true lateral

Treatment
- all cases are operative ("fracture of necessity")
  - ORIF of radius; afterwards, assess DRUJ stability by balloting distal ulna relative to distal radius
  - if DRUJ is stable and reduced, splint for 10-14 d with early ROM encouraged
  - if DRUJ is unstable, ORIF or percutaneous pinning with long arm cast in supination x 2-3 wk

For all isolated radius fractures assess DRUJ to rule out a Galeazzi fracture

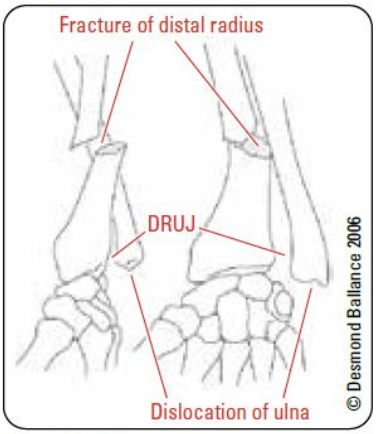


Figure 21. Galeazzi fracture

Wrist

Colles' Fracture

- extra-articular transverse distal radius fracture (~2 cm proximal to the radiocarpal joint) with dorsal displacement ± ulnar styloid fracture
- most common fracture in those >40 yr, especially in women and those with osteoporotic bone

Mechanism
- FOOSH

Clinical Features
- "dinner fork" deformity
- swelling, ecchymosis, tenderness

Investigations
- x-ray: AP and lateral ± oblique views of wrist

Treatment
- goal is to restore radial height (13 mm), radial inclination (22°), volar tilt (11°), as well as DRUJ stability and useful forearm rotation
- non-operative
  - closed reduction (think opposite of the deformity)
  - hematoma block (sterile prep and drape, local anesthetic injection directly into fracture site) or conscious sedation
  - closed reduction: traction with extension (exaggerate injury); traction with ulnar deviation, pronation, flexion (of distal fragment – not at wrist)
  - dorsal slab/below elbow cast for 5-6 wk
  - obtain post-reduction films immediately; repeat reduction if necessary
  - x-ray at 1 wk, 3 wk, and at cessation of immobilization to ensure reduction is maintained
- operative
  - indication: failed closed reduction, or loss of reduction
  - percutaneous pinning, external fixation, or ORIF

Indications for Direct Surgical Management of Colles' Fracture
- Displaced intra-articular fracture
- Comminuted
- Severe osteoporosis
- Dorsal angulation >5° or volar tilt >20°
- >5 mm radial shortening

Features of Inadequate Closed Reduction that Require ORIF
- Radial shortening >3 mm or
- Dorsal tilt >10° or
- Intra-articular displacement/step-off >2 mm

Extra:

Smith's Fracture

- volar displacement of the distal radius (i.e. reverse Colles' fracture)

Mechanism
- fall onto the back of the flexed hand

Investigations
- x-ray: AP and lateral ± oblique views of wrist

Treatment
- usually unstable and needs ORIF
- if patient is poor operative candidate, may attempt non-operative treatment
  - closed reduction with hematoma block (reduction opposite of Colles')
  - long-arm cast in supination x 6 wk

Complications of Wrist Fractures

- most common complications are poor grip strength, stiffness, and radial shortening
- distal radius fractures in individuals <40 yr of age are frequently high energy/comminuted and are more likely to require ORIF
- 80% have normal function in 6-12 mo

Table 13. Early and Late Complications of Wrist Fractures

Early	Late
Difficult reduction ± loss of reduction	Malunion, radial shortening
Compartment syndrome	Painful wrist secondary to ulnar prominence
Extensor pollicis longus tendon rupture	Frozen shoulder ("shoulder-hand syndrome")
Acute carpal tunnel syndrome	Post-traumatic arthritis
Finger swelling with venous block	Carpal tunnel syndrome
Complications of a tight cast/splint	CRPS/RSD

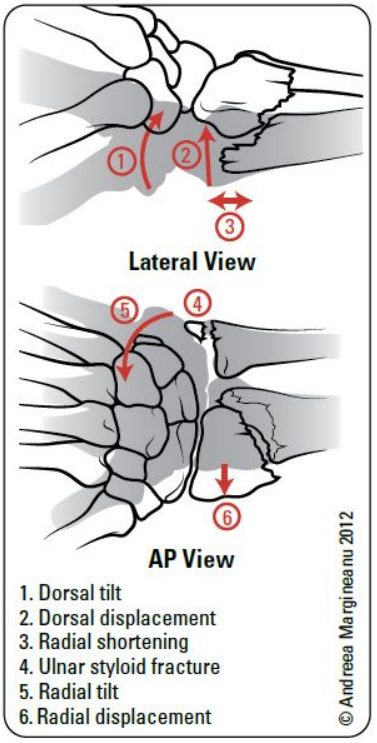


Figure 22. Colles' fracture and associated bony deformity

Extra:

Hip Fracture

General Features

- acute onset of hip pain after a fall
- unable to weight-bear
- shortened and externally-rotated leg
- painful ROM

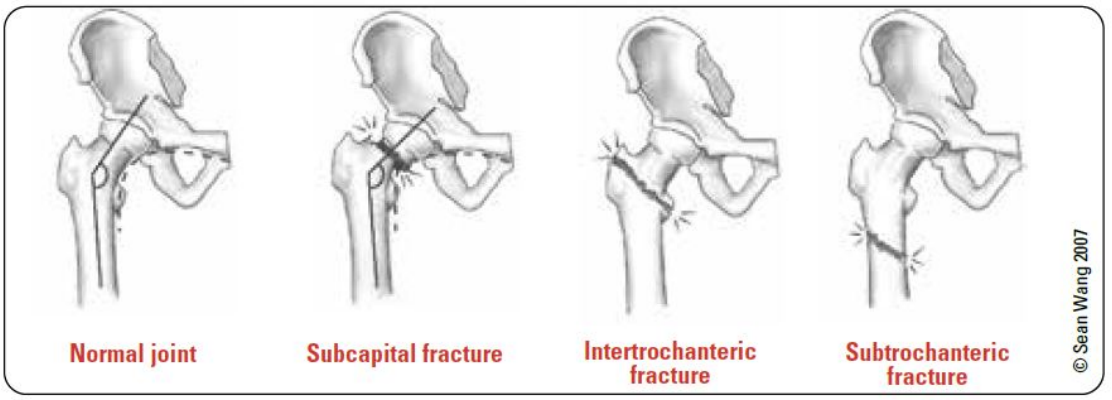


Figure 35. Subcapital, intertrochanteric, and subtrochanteric hip fractures

X-Ray Features of Subcapital Hip Fractures

- Disruption of Shenton's line (a radiographic line drawn along the upper margin of the obturator foramen, extending along the inferomedial side of the femoral neck)
- Altered neck-shaft angle (normal is 120-130°)

DVT Prophylaxis in Hip Fractures

LMWH (i.e. enoxaparin 40 mg SC BID), fondaparinux, low dose heparin on admission, do not give <12 h before surgery

AVN of Femoral Head

- Distal to proximal blood supply along femoral neck to head (medial and lateral femoral circumflex arteries)
- Susceptible to AVN if blood supply disrupted
- Etiology: femoral neck fracture, chronic systemic steroid use, SCFE, Legg-Calvé-Perthes, SLE, RA

Comparative Effectiveness of Pain Management Interventions for Hip Fracture: A Systematic Review

Ann Intern Med 2011;155(4):234-245

Study: Randomized controlled trials (RCTs); nonrandomized controlled trials (non-RCTs); and cohort studies of pain management techniques in older adults after acute hip fracture.

Conclusions: Nerve blockade seems to be effective in reducing acute pain after hip fracture. Low-level evidence suggests that preoperative traction does not reduce acute pain. Evidence was insufficient on the benefits and harms of many other interventions.

Table 20. Overview of Hip Fractures

Fracture Type	Definition	Mechanism	Investigations	Treatment	Complications
Femoral Neck (Subcapital)	Intracapsular	Young: MVC, fall from height Elderly: fall from standing, rotational force	X-Ray: AP hip, AP pelvis, cross table lateral hip	See Table 21	DVT, non-union, AVN, dislocation
Intertrochanteric Stable: intact posteromedial cortex Unstable: non-intact posteromedial cortex	Extracapsular fracture between the greater and lesser trochanters and transitional bone between the neck and shaft	Same as femoral neck fracture Direct or indirect force transmitted to the intertrochanteric area	X-Ray: AP hip, AP pelvis, cross table lateral hip	Closed reduction under fluoroscopy then dynamic hip screw or IM nail	DVT, varus displacement of proximal fragment, malrotation, non-union, failure of fixation device
Subtrochanteric	Fracture begins at or below the lesser trochanter and involves the proximal femoral shaft	Young: high energy trauma Elderly: osteopenic bone + fall, pathological fracture	X-Ray: AP pelvis, AP/lateral hip and femur	Closed/open reduction under fluoroscopy, then IM nail	Malalignment, non-union, wound infection

Table 21. Garden Classification of Femoral Neck Fractures

Type	Displacement	Extent	Alignment	Trabeculae	Treatment
I	None	"Incomplete"	Valgus or neutral	Disrupted	Internal fixation to prevent displacement (valgus impacted fracture)
II	None	Complete	Neutral	Aligned	Internal fixation to prevent displacement
III	Partial	Complete	Varus	Disrupted	Young: ORIF Elderly: hemi-/total hip arthroplasty
IV	Complete	Complete	Varus	Disrupted	Young: ORIF Elderly: hemi-/total hip arthroplasty

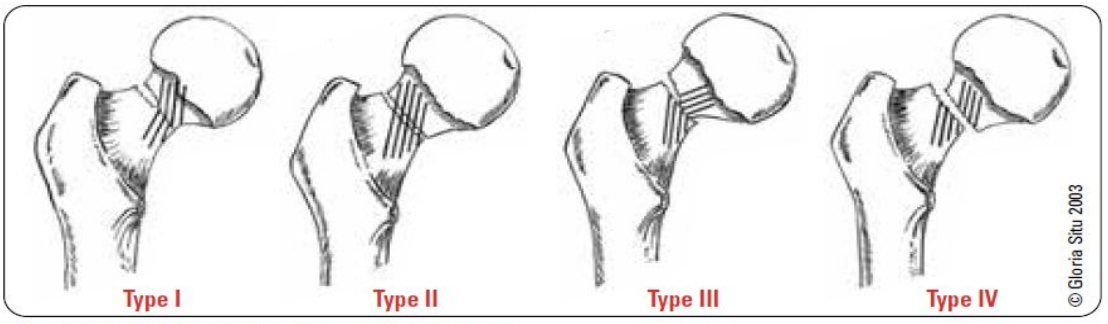


Figure 36. Garden classification of femoral neck fractures

Extra:

Femur

Femoral Diaphysis Fracture

Mechanism
- high energy trauma (MVC, fall from height, gunshot wound)
  - pathologic as a result of malignancy, osteoporosis, bisphosphonate use
- in children, can result from low energy trauma (spiral fracture)
  - always consider the possibility of non-accidental trauma

Clinical Features
- shortened, externally rotated leg (if fracture displaced)
- inability to weight-bear
- often open injury, always a Gustilo III (see Table 6, OR10)
- Winquist and Hansen classification

Investigations
- x-ray: AP pelvis, AP, and lateral views of the hip, femur, knee

Treatment
- non-operative (paediatric, uncommon in adults)
  - possible indication: non-displaced femoral shaft fractures in patients with significant comorbidities who are non-ambulatory
  - most femoral shaft fractures require fixation as this is a life-threatening injury
- operative
  - ORIF with anterograde IM nail (most common) or retrograde IM nail or with plate and screw fixation
  - external fixation may be used initially (e.g. unstable patients or polytrauma patients)
  - early mobilization and strengthening

Complications
- blood loss
- infection
- fat embolism leading to ARDS
- VTE
- malrotation, leg length discrepancy
- malunion/nonunion

Associated Injuries
- extensive soft tissue damage
- ipsilateral hip dislocation/fracture (2-6%)
- nerve injury

It is important to rule out ipsilateral femoral neck fracture, as they occur in 2-6% of femoral diaphysis fractures and are reportedly missed in 19-31% of cases

Ankle Fracture

Mechanism
- pattern of fracture depends on the position of the ankle when trauma occurs
- generally involves
  - ipsilateral ligamentous tears or transverse bony avulsion
  - contralateral shear fractures (oblique or spiral)
- classification systems
  - Danis-Weber
  - Lauge-Hansen: based on foot position and direction of applied stress/force

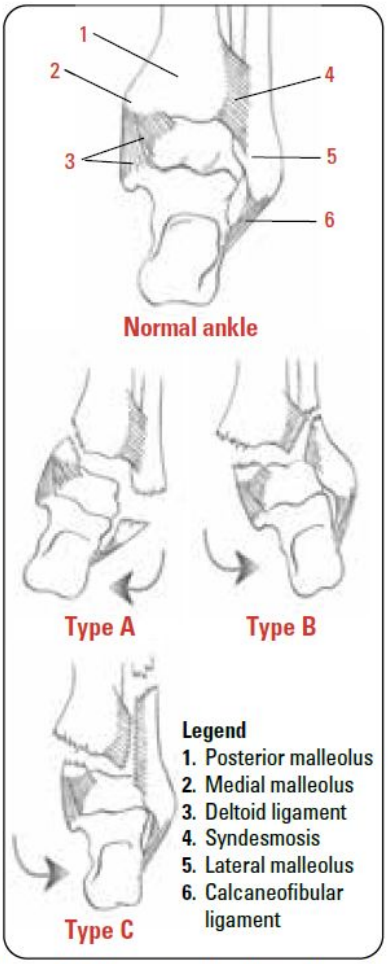


Figure 46. Ring principle of the ankle and Danis-Weber classification

Extra:

Treatment
- non-operative
  - indication: non-displaced, Danis-Weber Type A
  - NWB in below knee cast, or weight bearing as tolerated in walking boot
- operative
  - indications
    - fracture-dislocation: restore vascularity, minimize articular injury, reduce pain and skin pressure
    - most of Danis-Weber Type B, and all of Type C
    - any talar displacement
    - displaced isolated medial or lateral malleolar fracture
    - trimalleolar (medial, posterior, lateral) fractures
    - displaced and large posterior malleolar fractures
    - persistent medial clear space widening despite attempt at closed reduction and immobilization
    - open fracture/open joint injury
  - ORIF

Complications
- risk of poor wound healing and deep infections (up to 20%) in patients with DM, particularly if concomitant peripheral neuropathy
- postoperative stiffness
- malunion
- post-traumatic arthritis

Figure 45. Tibial shaft fracture treated with IM nail and screws

Tibial shaft fractures have high incidence of compartment syndrome and are often associated with soft tissue injuries

Tibial Shaft Fracture

- most common long bone fracture and open fracture

Mechanism
- low energy pattern: torsional injury
- high energy: including MVC, falls, sporting injuries

Clinical Features
- pain, inability to weight bear, deformity
- open vs. closed
- neurovascular compromise

Investigations
- x-ray: full length AP and lateral views
  - AP, lateral and oblique views of ipsilateral knee and ankle

Treatment
- non-operative
  - indication: closed and minimally displaced or adequate closed reduction
- long leg cast x 6-8 wk, convert to functional (patellar tendon bearing) brace after
- operative
  - indication: displaced or open
  - if displaced and closed: ORIF with IM nail, plate and screws, or external fixator
  - if open: antibiotics, I&D, external fixation or IM nail, and vascularized coverage of soft tissue defects

Specific Complications (see *General Fracture Complications*, OR7)
- significant incidence of compartment syndrome and neurovascular injury
- knee pain (>50% anterior knee pain with IM nailing)
- malunion, nonunion
- lack of soft tissue coverage secondary to open fracture may require further surgery for muscle flap coverage and can lead to poor outcome

Danis-Weber Classification
- Based on level of fibular fracture relative to syndesmosis

Type A (infra-syndesmotic)
- Pure inversion injury, tibiofibular syndesmosis remains intact
- Avulsion of lateral malleolus below plafond or torn calcaneofibular ligament
- ± shear fracture of medial malleolus

Type B (trans-syndesmotic)
- External rotation and eversion (most common)
- ± avulsion of medial malleolus or rupture of deltoid ligament
- Spiral fracture of lateral malleolus starting at plafond

Type C (supra-syndesmotic)
- Pure external rotation
- Avulsion of medial malleolus or torn deltoid ligament
- ± posterior malleolus avulsion with posterior tibio-fibular ligament
- Fibular fracture is above plafond
- Frequently tears syndesmosis

Ottawa Ankle and Foot Rules (see Emergency Medicine, ER16)

X-rays are only required if:

Pain in the malleolar zone AND any of: bony tenderness over posterior or tip of lateral malleolus; OR bony tenderness over posterior or tip of medial malleolus; OR inability to weight bear both immediately after injury and in the ER

Quiz

MCQ

Q1: A 6-year-old came through the ER after he sustained a 3-meter fall from a cliff, he was cleared except for a solitary left femur midshaft fracture, how would you manage such injury?

A. External fixation.
B. Rigid IM
C. Flexible IM
D. Screws and plate.

Q2: Which type of fracture is shown on the image?

A. Gelazzi
B. Distal radial
C. Monteggia
D. Scaphoid fracture

Q3: Which of the following is the best treatment for an elderly with an intracapsular fracture?

A. IM nail
B. hemiarthroplasty
C. DHS
D. percutaneous in situ fixation

Q4: A 17-year-old football player had an direct injury to his shoulder. X ray showed dislocated shoulder anteriorly. What concomitant sign can you see clinically?

A. Deltoid atrophy
B. claw hand
C. Wrist drop.
D. Thenar atrophy

Q5: Which of the following is the best management option for a clavicular fracture with skin tenting?

A. Immobilization and arm sling
B. Immobilization and figure of 8
C. Closed reduction and k-wires fix
D. ORIF and plate and screws

SAQs

Q1: List 4 Associated MSK injury with femoral shaft fracture ?

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Q2: Which nerve might be affected in a distal humeral fracture (Holstein-Lewis)?

Radial nerve

Answers

Q1	Q2	Q3	Q4	Q5
C	A	B	A	D

THANK YOU

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