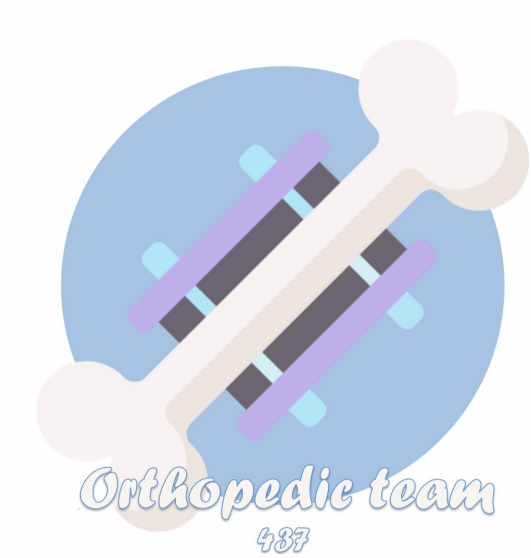
COMMON ADULTS FRACTURES



Lecture objectives:

1. Clavicle fracture
2. Humerus (proximal & shaft)
3. Both 'bone' forearm 'fracture'
4. Distal 'radius' fracture
5. Hip fracture
6. Femur 'shaft' fracture'
7. Tibial 'shaft' fracture'
8. Ankle' fracture

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References: Dr's slides & 436 team, Toronto Notes'2020'

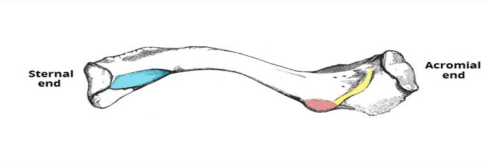
[COLOR INDEX : IMPORTANT | GOLDEN NOTES | NOTES | EXTRA] EDITING FILE LINK

UPPER EXTREMITIES

I- CLAVICLE FRACTURE

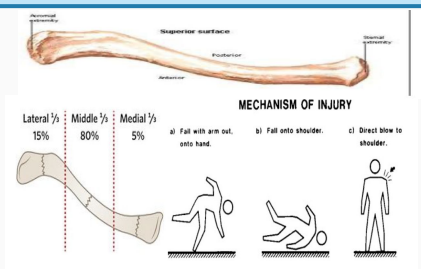
Anatomy

- 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.(80% as you see in the picture.)



Clinical Findings

- 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)

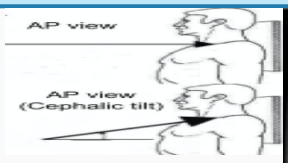
Imaging

X-Ray:

1. AP chest, to check there is no Pneumothorax
2. Clavicle special view (focused on clavicle) (30°cephalic tilt),

This X-Ray shows Middle third clavicle fracture with minimal displacement.

We have fragments here. (This X-ray shows a short oblique middle third fracture).



Treatment (next slide)

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 (non-operative management) from 6-8 weeks.
- Few fractures should be treated surgically with open reduction[1] and internal fixation with screws and plates:

1- Skin is tented (See pic), why? because of concern for an impending open fracture

2- Severe displacement: 100% displacement + 2 cm overlap.

What is the other name for overlap? Shortening.

العظام تتداخل = تقصر

Tented skin that might cause skin necrosis and become an open fracture, here we need to perform surgical management

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

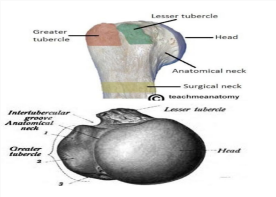
Anatomy

Has four anatomic parts:

1. **Head** and anatomical neck is between the tuberosities and between tuberosities there is bicipital groove .
2. **Greater tuberosity GT** (Muscles attached: Supraspinatus "abduction" + infraspinatus "external rotation, lateral abduction" + pectoralis minor "Internal rotation")
3. **Lesser tuberosity LT** (Muscle attached: Subscapularis "internal rotation")

Didisector groove runs between GT & LT (See extra 2 pics) ->

4. **Shaft.**
5. **Anatomical neck vs. Surgical neck** and the head while surgical neck is between the tuberosities and the shaft. Why is it called surgical neck? Because this is the location of many fractures that require surgery



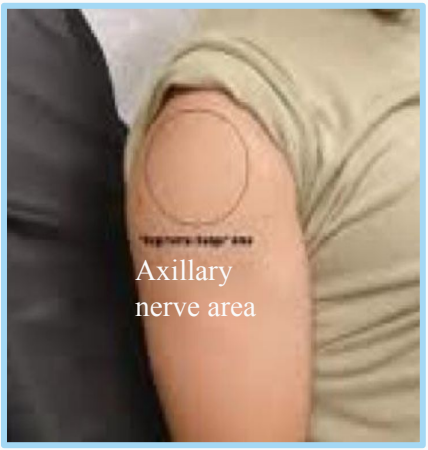
General Notes

- **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:

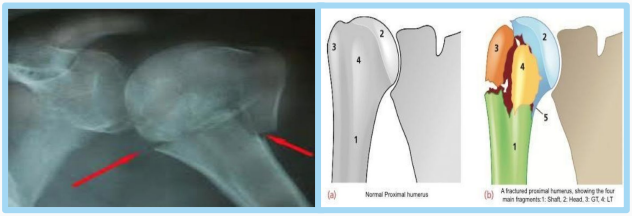
1. **Expose the shoulder very well.**
2. **Look for fracture signs** (swelling, tenderness, erythema, inability to move, ecchymosis).

3. **Check the skin.** To know if it is an open or closed fracture (unlikely to have an open fracture of proximal humerus bc it's deep).
Examine the axilla, most of times they forget to examine it because pt has a lot of pain or they simply forget.
4. **Peripheral N/V exam, to make sure there is no neurological or Vascular injury.**
5. **Axillary nerve: lateral skin patch (See pic) (most common nerve to be affected) sensory over the deltoid, in case of motor deficit: inability to abduct the arm.**
6. **Examine cervical spine (the area is supplied by axillary nerve).**
you have to examine joint above (cervical spine) and joint below (the elbow)



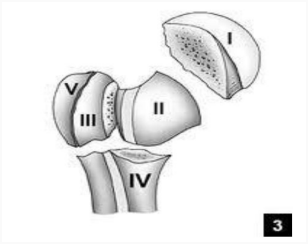
Imaging

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



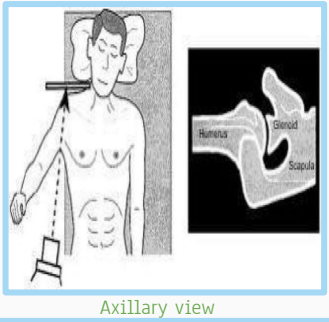
Classification:

- 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
- 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 non- displaced humerus fracture (one-part fracture).
If not displaced, we don't count the fragments.

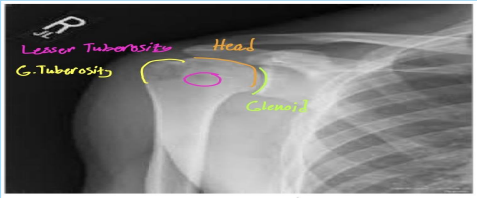


X-Ray: to make sure proximal humerus is not displaced, if displaced and you plan to do surgery you have to do CT

- 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 categories the fracture and see how many fragment.
If fracture extends into the joint
- **CT scan for displaced fractures**



Axillary view



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.

The articular surface of the head is strighten up and medially so we call this an ice cream cone

Treatment

If fracture is not displaced:

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

If the fracture is displaced: intra-articular

- **Surgery is indicated.**
- **ORIF is indicated (plate and screws).**
- **Shoulder Hemiarthroplasty تغيير نصفي للمفصل is indicated in some cases. (if it is a very comminuted fracture/unreconstructable)**

Replace Humerus but keep Glenoid

3- HUMERUS SHAFT FRACTURE كسر جسم عظمة العضد

General Notes

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

Clinical Findings

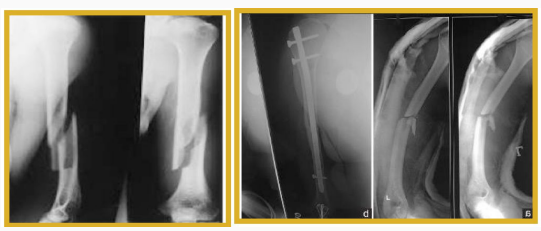
Symptoms: pain, swelling, weakness ± shortening, motion/crepitus at fracture site
Physical exam:

- **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:

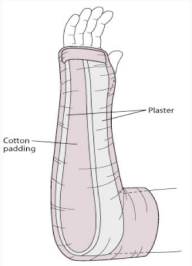
- **Spiral fracture in mid shaft at the junction of middle & distal thirds**
- **Displacement**
- **Alignment with no angulation**



Treatment

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

1. - Close reduction. at the ER.
2. - Functional brace x 4-6 weeks + NWB.
3. - 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:

- Segmental fracture, big fragment in the middle. (Two fractures or more with a free segment between)
- Open fracture.
- 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
- Bilateral fracture, **why?** Patient can't function with 2 casts (inhumane).
- Floating elbow (Fracture of forearm and humerus) difficult to control. So basically like segmental, the elbow being the free segment

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).

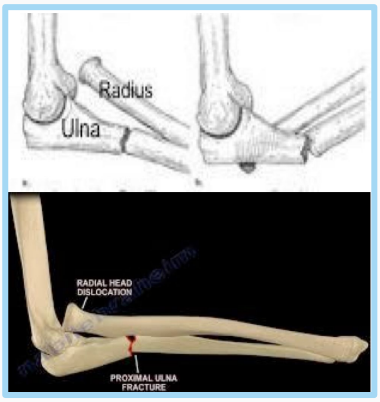
Radius and ulna articulate proximally and distally, by the proximal and distal radioulnar joint (DRUJ) to allow forearm rotation.

General Notes

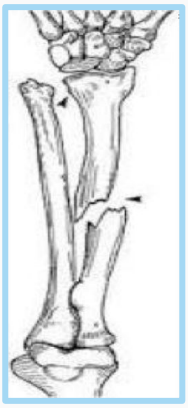
Fractures are often from fall or direct blow.

It very unlikely to fracture only one bone without disruption of their articulation. Types:

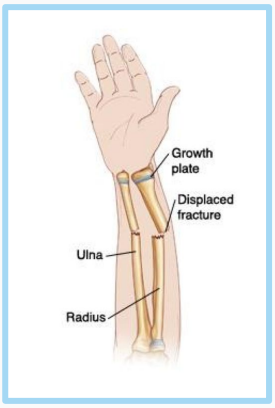
1. **Both bone fracture:** Means radius and ulna are broken. Right pic "extra"
2. **Monteggia fracture[2]:** Means proximal or middle third ulna shaft fracture with dislocation of radius(head) proximally (at elbow). Ulna is the fractured in the middle third big bone, radius is the dislocated at the elbow. Mechanism: direct blow on the posterior aspect of the forearm, hyper-pronation or fall on the hyperextended elbow. Clinical Features: decreased rotation of forearm ± palpable lump at the radial head. Left pics
3. **Galeazzi fracture[3]:** Means distal or middle third shaft radius fracture with disruption of DRUJ. Radius is fractured, ulna is dislocated from DRUJ (Distal radioulnar joint) Mechanism: hand FOOSH (Fall on An Outer Stretched Hand) with axial loading of pronated forearm or direct wrist trauma. Pic middle



Monteggia



Galezzi



Both Bones Forearm Fracture

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.**

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).**

Monteggia

Galezzi

Treatment

1. **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.

2. **Monteggia fracture:**

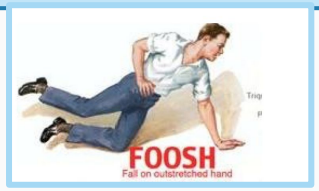
ORIF ulna and close reduction of radial head if closed failed go for open.

3. **Galeazzi fracture:**

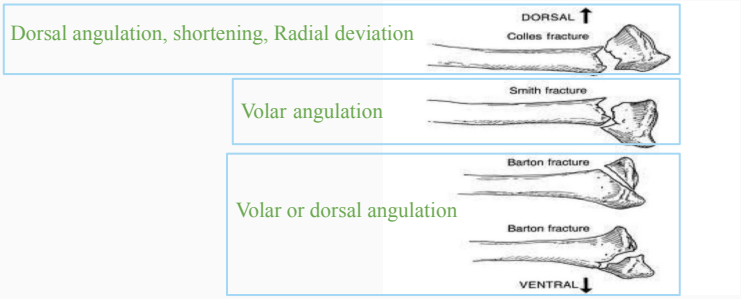
ORIF radius and close reduction of DRUJ. This x-ray shows Galeazzi fixation because the radius is مصلحة

5- DISTAL RADIUS FRACTURE

General Notes



- **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- <u>Extra-articular fractures:</u> A. Colles fracture[4](dorsal angulation,shortening and radial deviation), B. Smith's fracture (shortening and volar angulation), (reverse colles) [5]
  <u>2- Intra-articular fractures :</u> A. Volar Barthon's fracture, B. Dorsal Barthon's fracture, C. Others it's due to a fall on extended pronated wrist



Types:

<u>Extra-articular</u> - Colles' Fracture: Dorsal angulation shortening and radial deviation.
When we talk about colles' we need to mention these 3: Extra-articular + dorsal angulation + distal radius fracture. .

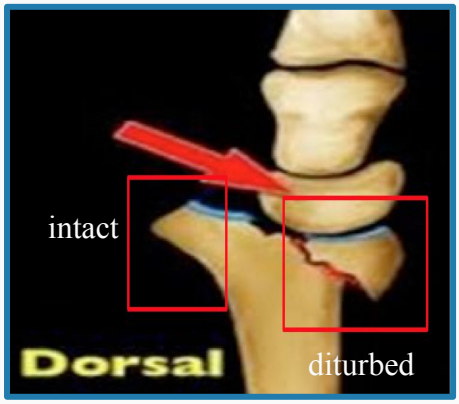
Dinner fork deformity

<u>Extra-articular</u> - Smith's fracture: Volar angulation (displacement) and shortening. (reverse Colles')

Shovel deformity

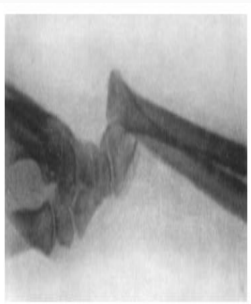
<u>Intra-articular</u> (radiocarpal joint)- Volar **Barton's fracture** it equals type 3 smith's fracture "involving distal radius intra-articularly"

<u>Intra-articular</u> (radiocarpal joint) - Dorsal **Barton's fracture seen on Lateral x-ray**



Imaging

X-ray and do CT if fracture extends into joint.
PA not AP because 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 AP there is overlap (no fracture is seen).
If extended into joint we ask for CT.



Smith Barton's Colles **Colles**

Treatment

Extra-articular fractures:

Start with analgesia, Closed reduction and below elbow cast "to avoid elbow stiffness"

Application. After fracture reduction we do **X-Ray** to decide the definitive treatment, if the fracture is in accepted position then continue in the cast, if the fracture is not in accepted position > do surgery for the patient. I will not tell you about the accepted position (too much information for you).

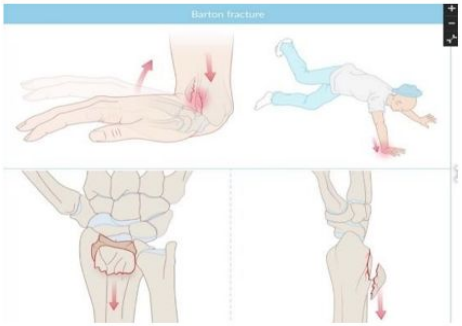
- Immobilization for 6-8 weeks.
- ROM exercises after cast removal.
- Surgery (ORIF): if reduction is not accepted

- before patient go home we have to give him checklist for compartment syndrome (not responding to the analgesia and pain is out of proportion to the injury)
To assess their limbs to rule out compartment syndrome.

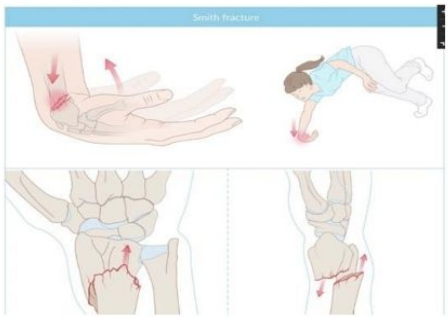
Intra-articular fracture:

A step **more than 2 mm or displacement** is an indication for surgery.
ORIF with plate and screws.

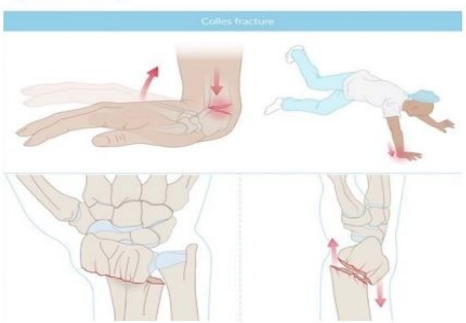
Barton's



Smith's



Colles

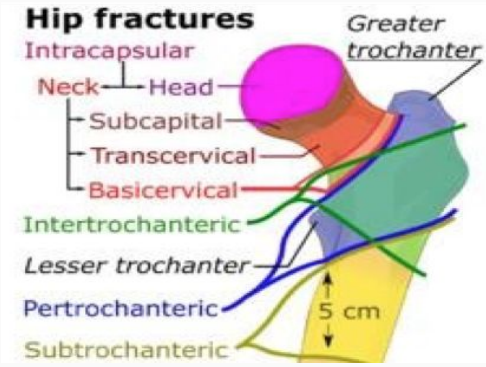


LOWER EXTREMITIES

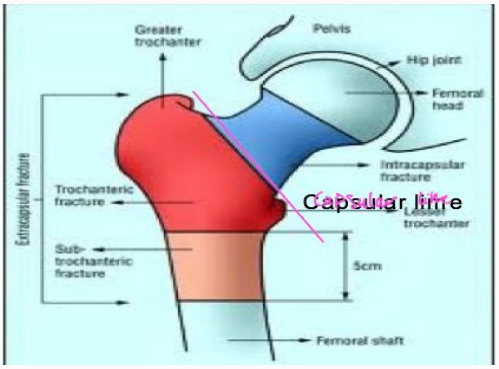
I- HIP FRACTURE (OLD PATIENTS:>60 YRS)

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 but stick with what's written here.. 60 is old

Anatomy

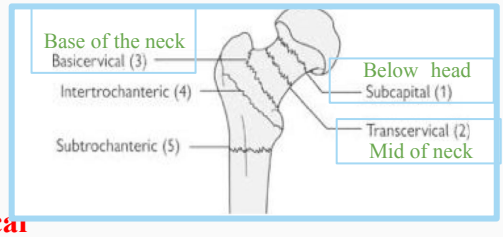


<- This pic at the left is extra but the doctor mentioned all the labeled areas within it so it's better to understand it.
Pic at the right is from -> doctor's slides.



General Notes

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**.
- **Other causes of fall (stroke, MI) should be rolled out during clinical**
- **evaluation;** you should ask the patient about the cause of falling down, because this can be the only manifestation of MI or 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-capsular, extra-capsular or displayed , non displaced

◆ **Intra-capsular :**

- Subcapital (directly below the femoral head) (Femoral head and neck junction)
- Trans-cervical (mid portion of femoral neck)

◆ **Extra-capsular :**

- Basicervical (base of femoral neck)
- Intertrochanteric
- Subtrochanteric

o AVN risk is higher with **intracapsular fracture**.

o Displaced vs non-displaced.

Clinical Findings

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

#Common associated injuries:

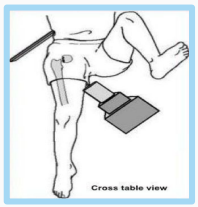
1- Distal radius fracture.
2- Proximal humerus fracture.
3- Subdural hematoma If they hit their head

Imaging

X-Ray:

3 views are needed:

1. **AP pelvis.**
2. **AP hip**
3. **Lateral xray of the same hip** **how can we get lateral hip X-Ray? cross table**

cross table lateral, the patient rises the normal leg, and the image is taken from down

MRI is sensitive for military occult fractures.

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,** why? a study showed that **morbidity and mortality are higher after 48 h.**
- **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 in the future)**
  - **If fracture is intra-capsular:**

Non displaced: percutaneous in situ Screws fixation (in situ it means no reduction).

1. **Displaced:** Hemiarthroplasty "Old", I do not want to do ORIF because although theoretically it works in 65%, 35% will have AVN and they will need another surgery

Non-displaced: (if not displaced the **treatment is percutaneous in-situ screw fixation**


Hemiarthroplasty


Percutaneous in-situ screw fixation

- **If fracture is Extra-capsular:** the chance of AVN is minimum less than 5%

1. **Stable:** Close reduction and DHS.الستيبل المقصود فيه الفراكتشر مو حالة المريض
2. **Unstable:** Cephalo-Intramedullary device "Nail". **(Cephalomedullary nail)** with big screws that connect them to the femoral head. **MCQs!!!!!!!!**

#Fracture instabilities signs:

- Large LT (lesser trochanter) fragment displaced on its own.
- Extension to subtrochanteric region.
- 4 parts fracture.

Remember that they are old patients and if you have one shot in your gun, you want it be accurate (you do want to take the patient multiple times to the OR)

if young patient always fix even if displaced (if you done hemiarthroplasty he will live for long time and will need to repeat for multiple time and eventually total hip replacement)

DHS (Dynamic hip screw)
The plate is out and the screw is inside
Used for simple fractures

IM nail (intramedullary nail)
the screw passes through the nail and goes inside the bone
Used if the fracture was comminuted or 4 parts fracture

Complications

1. Nonunion
   - 2% (IT intertrochanteric fractures) very rare.
   - 5% (non-displaced neck fracture)
   - 30% (displaced neck fracture)
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)

Examples: **What is the type of this fracture?**

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

Basicervical

Subcapital transcervical

Intertrochanteric

2- FEMORAL NECK FRACTURE

General Notes

o It is a completely different entity from similar fractures in elderly (>60 years).
o High energy trauma mechanism.
o ATLS protocol.

Complications

o **2.5% associated femoral shaft fracture. (**that's why you need to get **long femur X-ray)**
o Nonunion: 30% (most common complication in younger patient).
o AVN: 25-30%

Treatment

Intracapsular fractures		**Extracapsular fractures** (age is not important)	
Displaced	**Nondisplaced**	**Staple**	**Unstapled**
OLD(HEMIARTHROPLASTY)? YOUNG? closed reduction open reduction and fixation with cannulated screws **In young.** the same as nondisplaced **No** hemiarthroplasty for young patients	closed reduction and percutaneous in situ Screw fixation (cannulated screws).	DHS	Cephalomedullary nail

3- FEMORAL SHAFT FRACTURE

General Notes

Most common:

1. High energy mechanisms (MVC, fall from a height, gunshot wound)
2. Young patients (male, < 30 years).
3. ATLS protocol.

Less common:

1. Low energy mechanism (torsional forces)
2. Old patients.
3. Spiral type fracture.

Associate musculoskeletal injuries:

1. Ipsilateral femoral neck fracture (10%. Missed in 30-50%). Missing a femoral neck fracture is associated with a high morbidity because you will treat the femoral shaft fracture with femoral nail and ask the patient to walk on it, if the neck was also fractured it will displace and the patient will come back to you complaining of pain, you will tell him it's fine, it's because the surgery and for a long time of neglectance the head will die and you now must do hip replacement surgery which is major. **So, in short, if you have a femoral shaft fracture always look for femoral neck fracture by x-ray and it doesnt show and suspected is high do CT.**
2. Knee ligaments injuries: 50%
3. Meniscal tear 30%
4. Floating knee injury: less common ipsilateral tibia and femur fractures at the same time.
5. Vascular/nerve injuries: rare
6. Contralateral femur shaft fracture (worse prognosis among above).

Associated non-MS injuries:

1. Fat embolism. tolungs
2. ARDS.(Acute respiratory distress syndrome)
3. Head injuries.
4. Abdominal injuries.

Clinical Findings

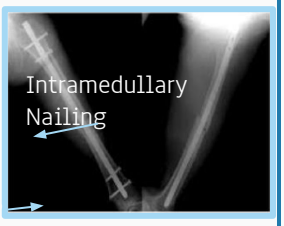
- **ATLS.**
- **Fracture symptoms and signs.**
- **Skin integrity.** (to rule out open fracture)
- **N/V exam.**
- **Compartment assessment.**
- **Knee swelling or ecchymosis.** Rule out knee ligament injury

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**

Treatment

1. ATLS: ABC resuscitation. If we cannot get patient to OR soon we can use Skeletal traction to immobilized and get the patient into the OR.
2. Skeletal traction (proximal tibial pin) for pain control if surgery will be Delayed
3. 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 because of the time needed until he/she is stable, also nailing takes time and you want to intervene fast so you go for EF (then if the patient is stable do definitive fixation and IM nailing).
   - If patient is **stable** Closed reduction & IM nailing.



Complications

1. Malunion:
   a. Most common.
   b. More common with proximal fracture (subtrochanteric fracture) because many muscles are acting on this site.
   c. Rotational, angulation and shortening (or combination of those)
2. Nonunion: rare
3. Infection.
4. VTE. Always give prophylaxis.

4- TIBIA SHAFT FRACTURE

General Notes

o It is a subcutaneous bone (high suspicion for skin injury). Not a lot of muscles are covering it
o Most common large long bone fracture. And open bone fracture
o It can be secondary to low or high energy mechanism.
o It carries the highest risk of compartment syndrome. (cause it is small space and less distal muscles)

o 20% of tibial fracture can be associated with ankle intra-articular fracture.

o Classified based on:

A. Location and morphology:

- **Proximal third**
- **Middle third**
- **Distal third**

B. Displaced vs. Non-displaced:

Clinical Findings

- Skin integrity. To rule out open fracture.

- Assess compartments of leg: needs serial exam.

- Serial N/V exam.

Imaging

X- **rays**:

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

CT SCAN IF FRACTURE EXTENDS INTO JOINTS ABOVE OR BELOW.

المربعات الحمراء هي الكسر

<- pic left shows: comminuted tibial and fibular fractures + ankle fracture

Treatment

Indications for non-surgical treatment:

1. NO displacement: < 10° angulation on AP/lateral x rays.
2. < 1 cm shortening.
3. Not comminuted.

C/I:

1. Displacement.
2. Open fracture.
3. Compartment syndrome.
4. Floating knee.

Close reduction and cast immobilization:

1. Above knee backslab and U-shape slab if surgical treatment is chosen (the fracture is not open which means it is not an emergency but at the same time leaving the patient until the surgery is not a good option so I will apply the slab to immobilize the fracture until OR is ready)
2. 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 treatment:

1- Most common modality of treatment.
2-Most commonly **IM** nail fixation. Sometimes plates and screws

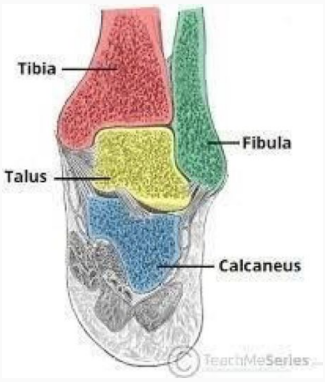
Complications

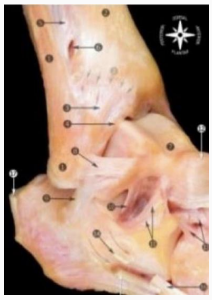
o Non-union: most common complication
o Delayed union
o Infection: open fracture
o DVT/PE

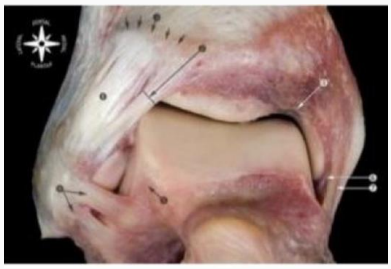
5- ANKLE FRACTURE 3. (Low energy (torsional): malleoli fracture)

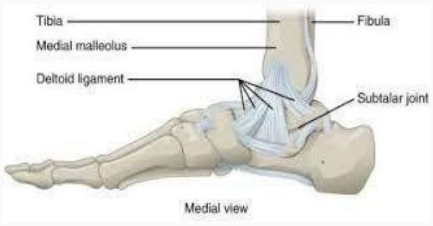
Anatomy

o Medial and lateral malleoli, distal tibia and talus.
o Highly congruent joint (stable)
o Fibula is held to distal tibia by syndesmotic ligament.
o Medial malleolus is held to talus by deltoid ligament.
o Lateral malleolus is held to talus by LCLI (lateral collateral ligament)





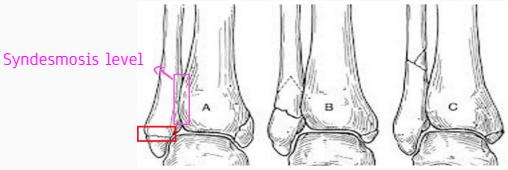


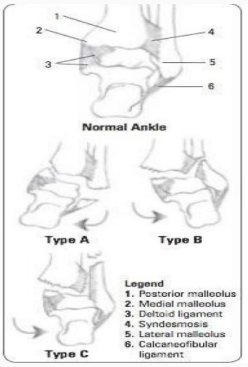


General Notes

Classification:

1. Stable v.s. Unstable fracture: Lateral displacement of talus (in unstable: medial side is clear joint space becomes wider) Bimalleolar fracture
2. Medial, lateral or bimalleolar fracture.
3. Lateral malleolus: Weber A (below level of syndesmosis),
   B (at level of syndesmosis),
   C (above level of syndesmosis)





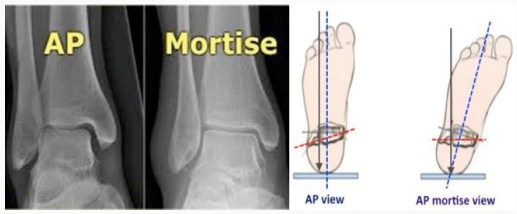
Clinical Findings

- 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).
- Valgus deformity in medial malleolus fracture.


Imaging

X-Ray:

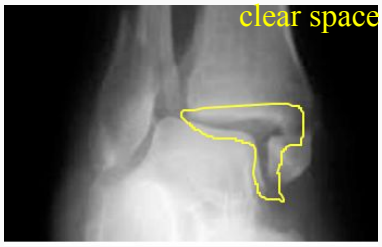
1. AP
2. Lateral
3. Mortise view AP+15º internal rotation (special view)
4. Long leg x-rays: if only medial malleolus is broken.



Bimalleolar fracture= unstable and needs surgical management

CT SCAN IF FRACTURE EXTENDS TO ARTICULAR DISTAL TIBIA SURFACE.

Unstable: > 4mm lateral translation



Stable: okay space treated with cast

Treatment

Intact medial malleolus:

Weber A: No surgery

1. Splint + NWB X 6 weeks.
2. Early ROM.

Weber B/C: Plate -/+ syndesmotic screw

1. If medial joint line widen (unstable): ORIF, if the tibia and fibula are displaced I will put the syndesmotic screw between them, it is called **syndesmotic screw** because it acts as a syndesmotic ligament (hold the bones together until syndesmosis heal).
2. If not: Call Orthopedic for stress film x-rays to see if it's open or not

If both malleoli are broken: ORIF (ORIF both bones -/+ syndesmotic screw)

When do we have to put the syndesmotic screw? if there is lateral translation of the talus intraoperative (if the talus is still moving with stress after fixation (syndesmosis is open, and we put screws. so, after fixation in weber B or C/ bimalleolar fracture, we do stress test and accordingly we put syndesmotic screws or not.

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

Non-Operative Treatment Compared with Plate Fixation of Displaced Mid-Shaft Clavicular Fractures. A Multicentre, Randomized Clinical Trial
J Bone Joint Surg. Am. 2007; 89(1),1-10
Purpose: To compare non-operative treatment with plate fixation in displaced mid-shaft clavicular fractures.
Results: Constant shoulder scores and DASH scores were significantly improved in the operative fixation group at all time-points ($p = 0.001$ and $p < 0.01$, respectively). The mean time to radiographic union was 28.4 weeks in the non-operative group compared with 16.4 weeks in the operative group ($p = 0.001$). At one year after the injury, the patients in the operative group were more likely to be satisfied with the appearance of the shoulder ($p = 0.001$) and with the shoulder in general ($p = 0.002$) than were those in the non-operative group.
Conclusions: Operative fixation of a displaced fracture of the clavicular shaft results in improved functional outcome and a lower rate of malunion and nonunion compared with non-operative treatment at one year of follow-up.

Treatment
- medial and middle-third clavicle fractures
  - for nondisplaced fractures, simple sling x 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 x 1-2 wk
  - displaced (CC ligament injury): ORIF

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

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

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"* OR6, pathological fracture, "floating elbow" (simultaneous unstable humeral and forearm fractures)
  - ORIF: plating (most common), IM rod insertion, external fixation

Specific Complications (see *General Fracture Complications*, OR7)
- 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

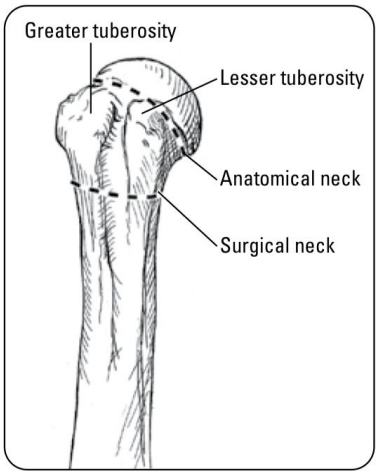


Figure 15. Fractures of the proximal humerus

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

Monteggia Fracture

- fracture of the proximal ulna with radial head dislocation and proximal radioulnar joint injury
- more common and better prognosis in the pediatric 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 post-operative ROM if elbow completely stable, otherwise immobilization in plaster with elbow flexed for 2-3 wk
- pediatrics: 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

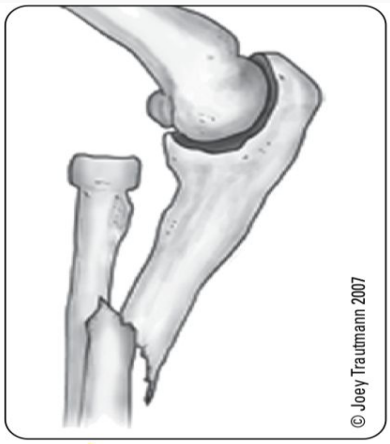


Figure 19. Monteggia fracture

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%)

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
  - ORIF of radius; afterwards, assess DRUJ stability by balloting distal ulna relative to distal radius
  - if DRUJ is stable and reducible, 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

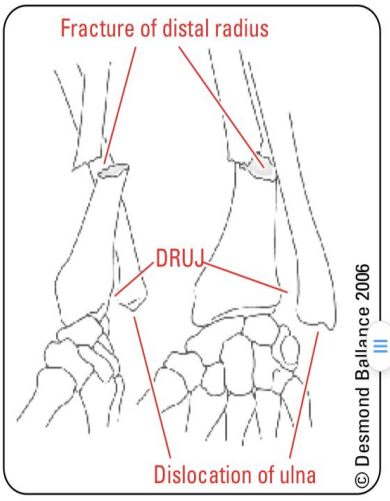


Figure 21. Galeazzi fracture

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 views of the 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

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

- operative
  - indication: failed closed reduction, or loss of reduction
  - percutaneous pinning, external fixation, or ORIF

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 views of the 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 usually highly 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

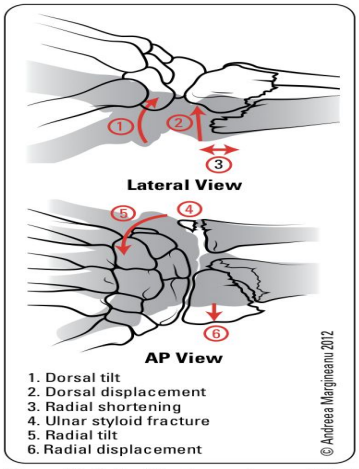


Figure 22. Colles' fracture and associated bony deformity

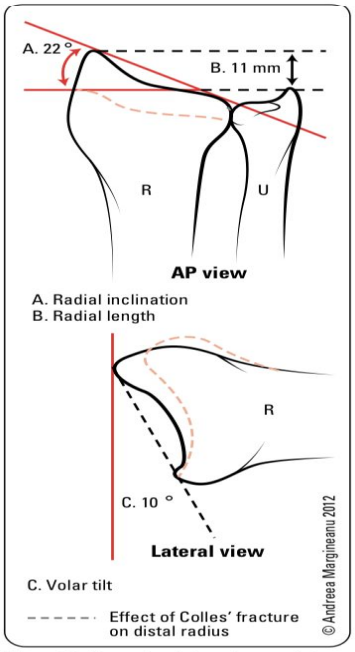


Figure 23. Normal wrist angles+ wrist angles in Colles' fracture
Note the relative shortening of the radius relative to the ulna on AP view in Colles' fracture

Hip Fracture

General Features

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

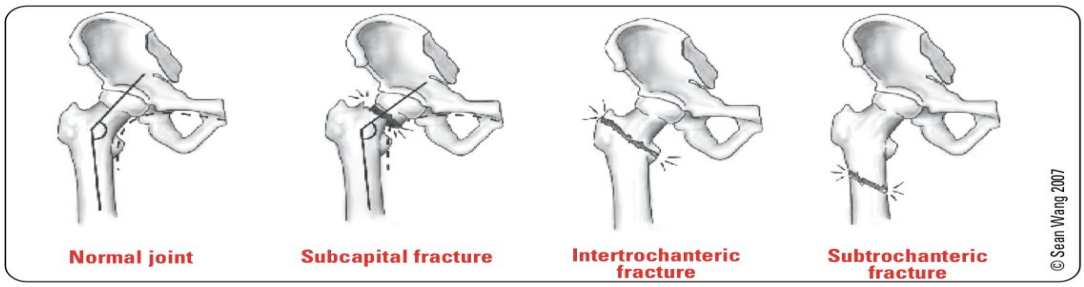


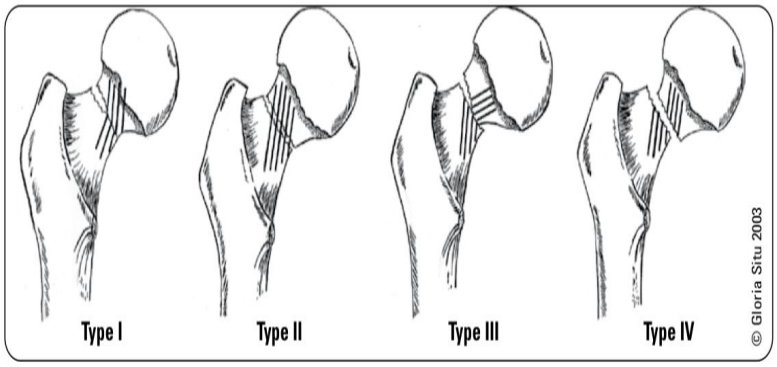
Figure 35. Subcapital, intertrochanteric, and subtrochanteric hip fractures

Table 20. Overview of Hip Fractures

Fracture Type	Definition	Mechanism	Special Clinical Features	Investigations	Treatment	Complications
Femoral Neck (Subcapital)	Intracapsular (See *Garden Classification*, Table 21)	Young: MVC, fall from height Elderly: fall from standing, rotational force	Same as general	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 including 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	Ecchymosis at back of upper thigh	X-Ray: AP pelvis, AP/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	Ecchymosis at back of upper thigh	X-Ray: AP pelvis, AP/lateral hip and femur	Closed/open under fluoroscopy, then plate fixation or 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	Malaligned	Internal fixation to prevent displacement (valgus impacted fracture)
II	None	Complete	Neutral	Aligned	Internal fixation to prevent displacement
III	Some	Complete	Varus	Malaligned	Young: ORIF Elderly: hemi-/total hip arthroplasty
IV	Complete	Complete	Varus	Aligned	Young: ORIF Elderly: hemi-/total hip arthroplasty



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

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.

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 (Table 6)
- Winquist and Hansen classification

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

Treatment
- non-operative (uncommon)
  - indication: non-displaced femoral shaft fractures in co-morbid patients
  - long leg cast
- operative
  - ORIF with anterograde IM nail (most common) or retrograde IM nail
  - external fixator for unstable patients or polytrauma with open fractures
  - early mobilization and strengthening

Complications
- blood loss
- fat embolism leading to ARDS
- 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

Distal Femoral Fracture

- fractures from articular surface to 5 cm above metaphyseal flare

Mechanism
- direct high energy force or axial loading
- three types: extra articular, partial articular, complete articular

Clinical Features
- extreme pain
- knee effusion (hemarthrosis)
- neurovascular deficits can occur with displaced fracture

Investigations
- X-ray: AP and lateral views
- CT, angiography if diminished pulses

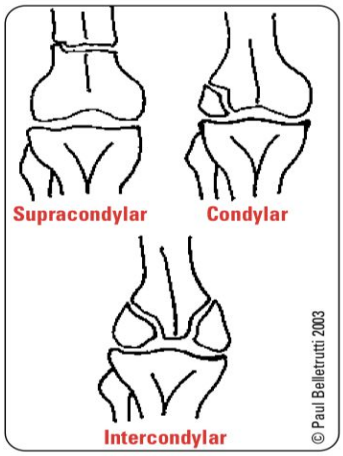


Figure 37. Distal femoral fractures

Treatment
- non-operative (uncommon)
  - indication: non-displaced extra-articular fracture, poor surgical candidate
- hinged knee brace
- operative
  - indication: displaced fracture, intra-articular fracture, non-union
- ORIF or retrograde IM nail if supracondylar and non-comminuted
- early mobilization and strengthening

Specific Complications (see *General Fracture Complications*, OR7)
- femoral artery tear
- popliteal artery injury
- nerve injury
- extensive soft tissue injury
- angulation deformities

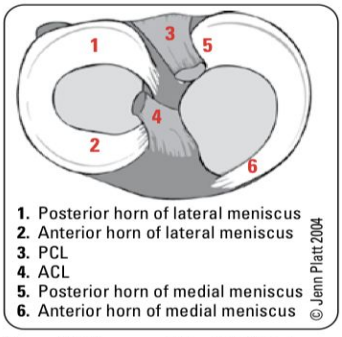


Figure 38. Diagram of the right tibial

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
- open vs. closed
- neurovascular compromise

Investigations
- X-ray: AP and lateral views
  - full length, plus knee and ankle

Treatment
- non-operative
  - indication: closed and minimally displaced or adequate closed reduction
- long leg cast x 8-12 wk, functional 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)
- high incidence of neurovascular injury and compartment syndrome
- poor soft tissue coverage (critical to outcome)

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

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

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's position and motion relative to leg

Treatment
- non-operative
  - indication: non-displaced, no history of dislocation
  - below knee cast, NWB, or aircast WBAT
- operative
  - indications
    - any fracture-dislocation: restore vascularity, minimize articular injury, reduce pain and skin pressure
    - most of type B, and all of type C
    - trimalleolar (medial, posterior, lateral) fractures
    - talar tilt >10°
    - medial clear space on X-ray greater than superior clear space
    - open fracture/open joint injury
  - ORIF

Complications
- high incidence of post-traumatic arthritis
- high risk of poor wound healing and deep infections (up to 20%) for patients with DM

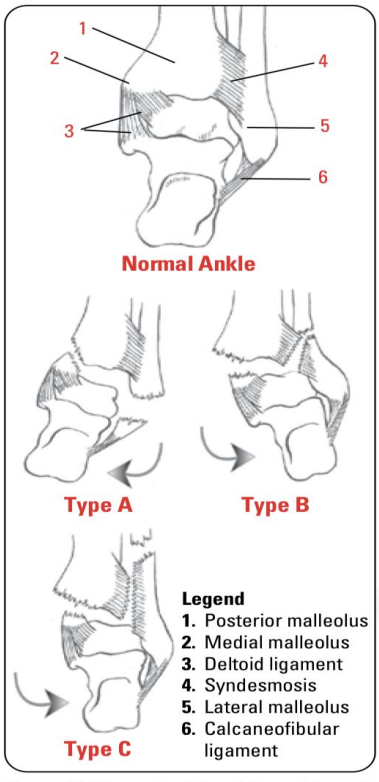


Figure 46. Ring principle of the ankle and Danis-Weber classification