Hip Fractures

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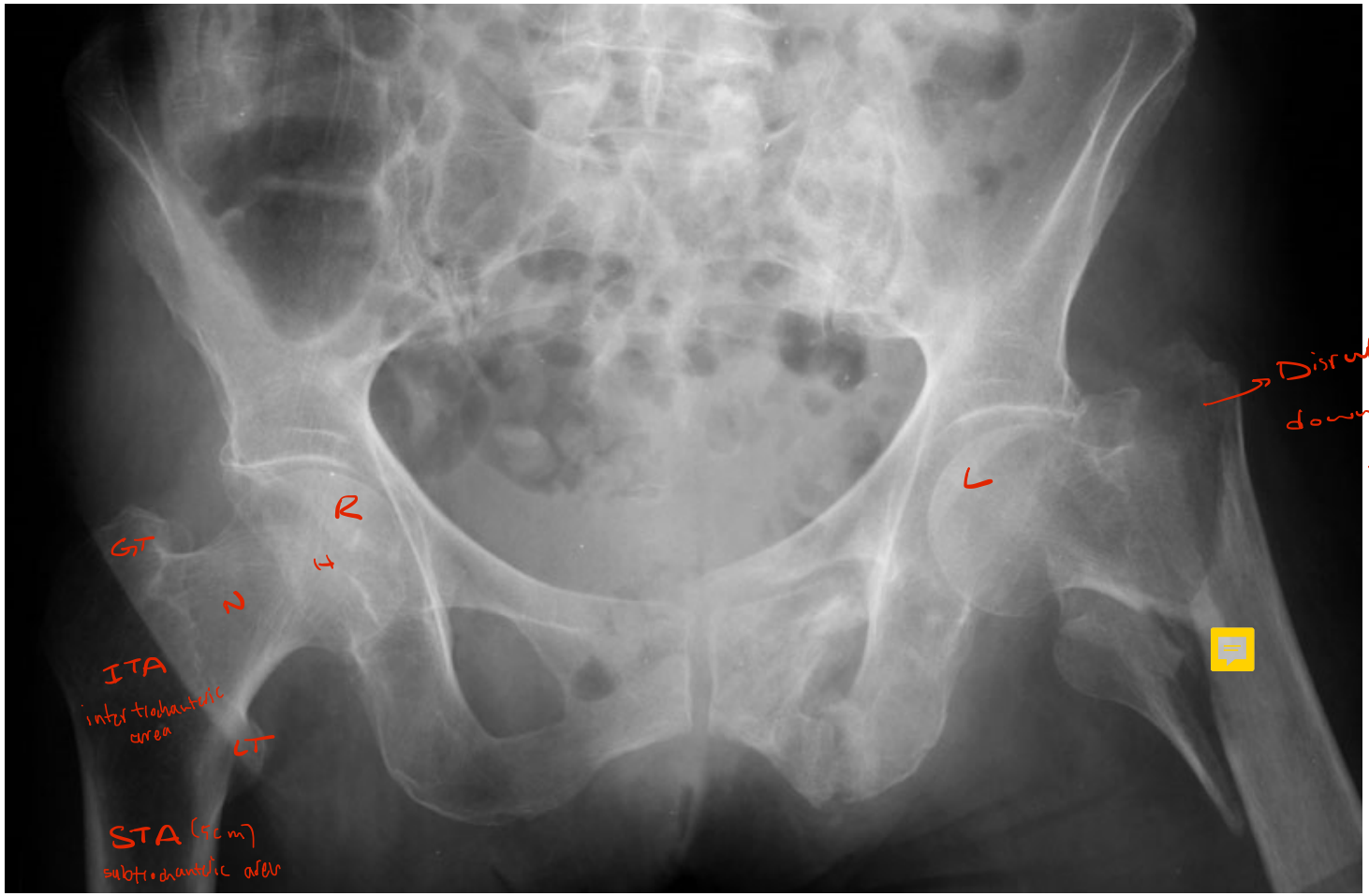
Learning Objectives

- Identify anatomy of the proximal femur
- Identify vascular supply of the proximal femur
- Clarify the mechanisms of injury
- Identify the signs & symptoms of PF fractures
- Classification of PF fractures
- Identify the principles of management

70 years old female has a hx of falling down on her left side, Presented to ER with sever pain, inability to bear wt on left side and with deformity (shortening and external rotation)

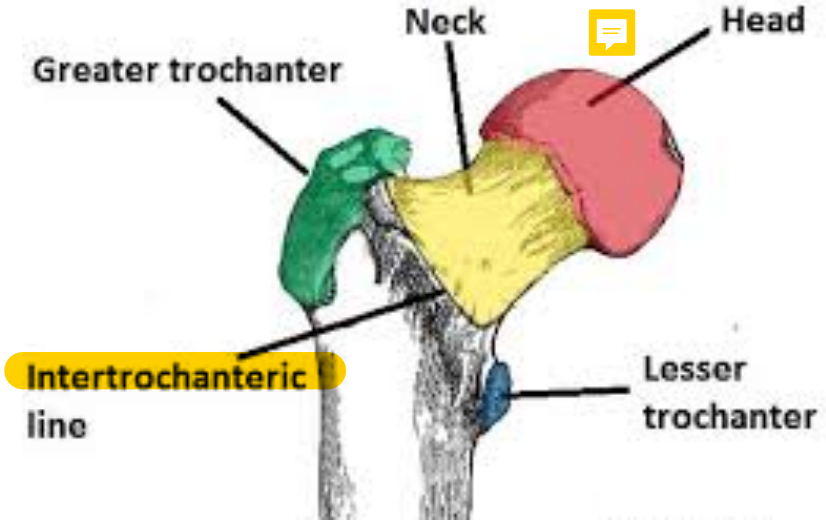


This is a fracture at intertrochanteric area on left side

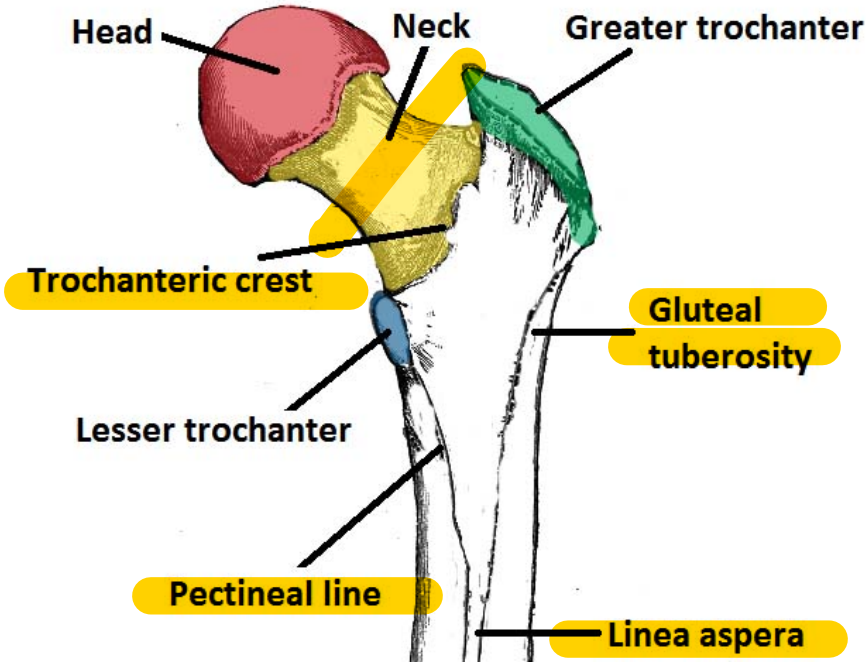
Normally, any bone segment has 2 major surfaces (anterior and posterior) in the coronal plane

- Intertochanteric line is only found on AP projection, while in PA we have trochanteric crest instead and also there is 2 lines in this surface (pectineal and linea aspra)

- Femoroacetabular articulation (Hip joint) has a capsule, which extends from supraacetabular area proximally (above the acetabular edge) on the anterior and posterior surfaces, the difference is on the distal extension: Distally on the ant surface it ends at the intertrichanteric line (all the femur head and neck anteriorly are considered intracapsular structures), while on the post surface it ends on the middle of the neck (the head and proximal half of neck posteriorly are intracapsular while the distal part is extracapsular)



AP



PA

Distal part of neck anteriorly can be managed as intra/ extra capsular

On plain X-ray the lesser trochanter is viewd on the posteromedially aspect of the femur, anteriorly you'll only view a small protrusion of this structure, but when there is external rotation, lesser trochanter will be so prominant anteriorly

We always describe the fracture as deformity, in order to describe the displacement of the fracture, we describe it based on the planes that present on or bodies:

- Coronal plane: plane seen on AP view, any deformity in coronal plane will either drop medially (varus) or laterally (valgus)

-Sagittal Plane: Plane seen on lateral view, describe the deformity as flexion/extension, Anterior/posterior

- Axial Plate: Medial/Lateral Rotation, Internal/External Rotation, Shortening/Lengthening

ANATOMY OF NECK OF FEMUR

- Neck connects head with shaft and is about 3.7 cm long.
- It makes angle with the shaft 130+/- 7 degree(less in female due to their wider pelvis).

It facilitate movements of hip joint.

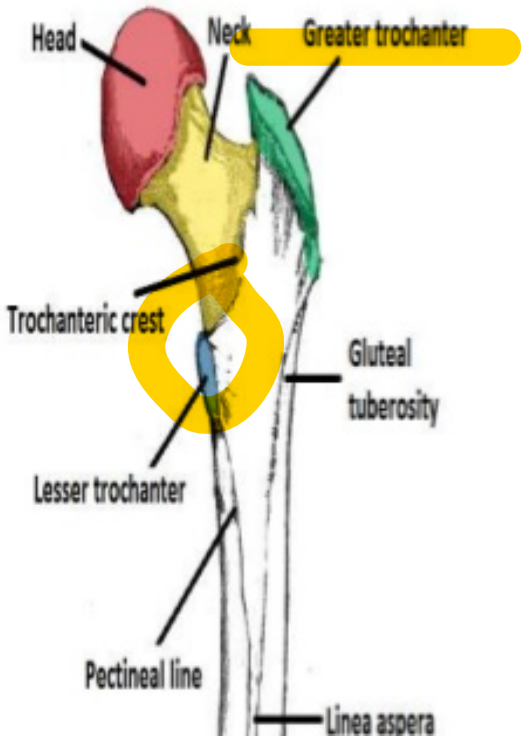
- It is strengthened by calcar femorale (bony thickening along its concavity).

Present on posteromedial aspect of femoral neck, it has an imp role in stability

Femur neck shaft angle on medial side

↓

When there is collapse in this angle it means varus



Why do Fractures Displace?

1) Energy of Trauma
2) Muscle act around the segment got contracted and push the bone toward its side
3) Position of gravity

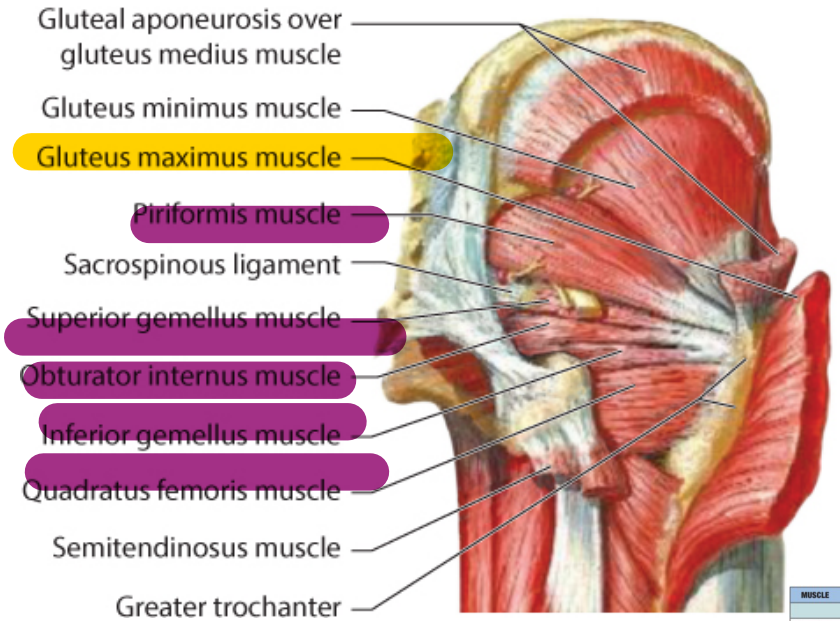
Groups of muscles working on proximal femur:

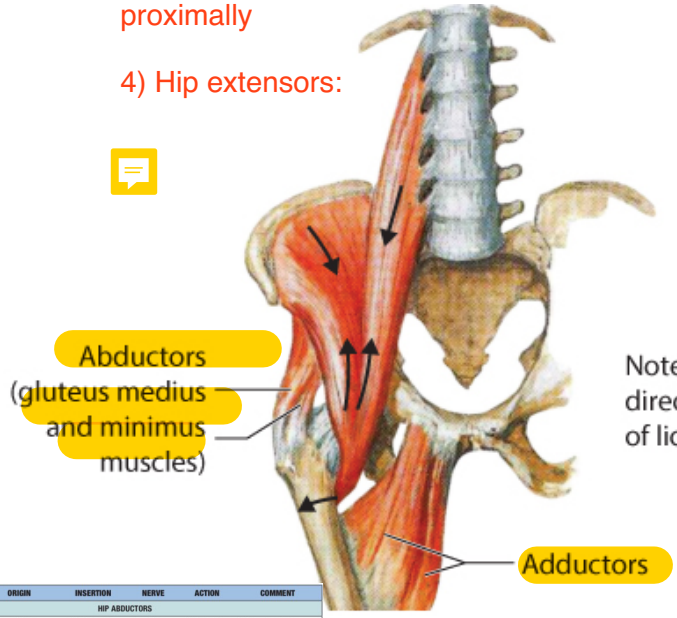
1) Iliopsoas Group (Iliacus and psoas muscles): They originate from the iliac fossa in spine and they will get attached to lesser trochanter, they flex the hip. So, any fracture somewhere there at or distal to lesser trochanter this means the proximal segment by the effect of this muscle group will be deviated forward.

2) Adductors: Originate from the pubic remi and go below the lesser trochanter

3) Abdutors: They are inserted on greater trochanter area proximally (Magnus, Longus, Brevis)

4) Hip extensors:





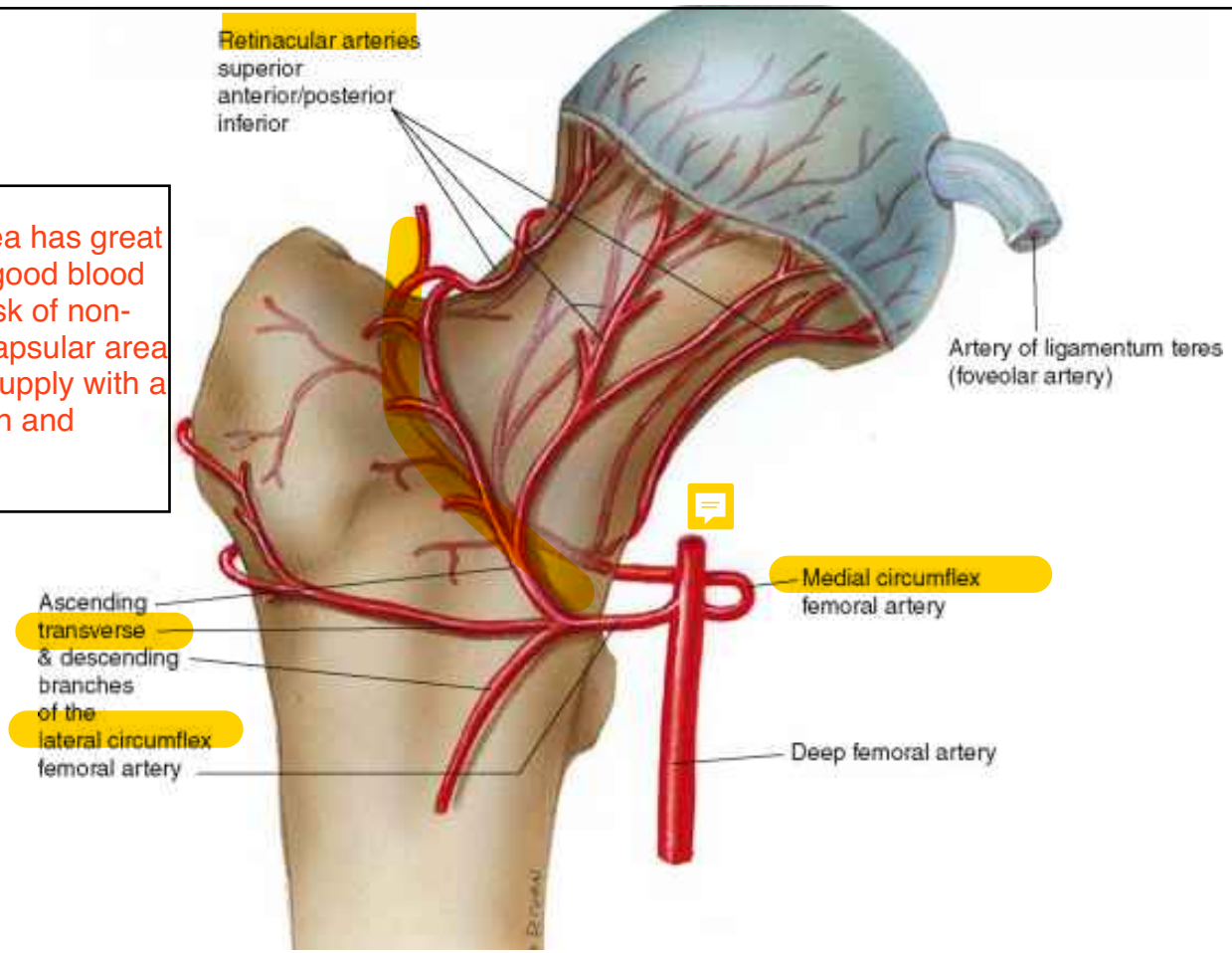
Note: Arrows indicate direction of action of liopsoas muscle.

MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
HIP ABDUCTORS					
Tensor fasciae latae	Iliac crest, ASIS	Iliotibial band/ proximal tibia	Superior gluteal	Abducts, flex, IR thigh	A plane in anterior approach to hip
Gluteus medius	Ilium b/w ant. and post. gluteal lines	Greater trochanter (posterior)	Superior gluteal	Abducts, IR thigh	Trendelenburg gait if muscle is out
Gluteus minimus	Ilium b/w ant. and inf. gluteal lines	Greater trochanter (anterior)	Superior gluteal	Abducts, IR thigh	Works in conjunction with medius
HIP EXTENSORS AND EXTERNAL ROTATORS					
Gluteus maximus	Ilium, dorsal sacrum	ITB, gluteal tuberosity (femur)	Inferior gluteal	Extend, ER thigh	Must be split in posterior approach to hip
Obturator externus	Ischiopubic rami, obturator membrane	Trochanteric fossa	Obturator	ER thigh	Inserts at start point for IM nail
Short External Rotators					
Piriformis	Anterior sacrum	Superior greater trochanter	N. to piriformis	ER thigh	Used as landmark for sciatic nerve
Superior gemellus	Ischial spine	Medial greater trochanter	N. to obturator internus	ER thigh	Detached in posterior approach to hip
Obturator internus	Ischiopubic rami, obturator mem.	Medial greater trochanter	N. to obturator internus	ER, abduct thigh	Exits through lesser sciatic foramen
Inferior gemellus	Ischial tuberosity	Medial greater trochanter	N. to quadratus femoris	ER thigh	Detached in posterior approach to hip
Quadratus femoris	Ischial tuberosity	Intertrochanteric crest	N. to quadratus femoris	ER thigh	Ascending br. medial circumflex artery under muscle

-In order for any fracture to heal, it needs blood supply, the problem of the proximal femur is with its blood supply.

-External iliac terminates as femoral artery, which gives deep femoral artery that gives two branches (medial and lateral femoral circumflex arteries), those two branches comes around the intertrochanteric area in the proximal femur, they unite together forming anastomosis (anastomosis is the site where you have two vessels just connects at one point and interchangeably supply the same area, which means if you have any injury for any one of these at this level, there is no problems of blood supply; because the second artery will supply the same area, the healing process won't be affected, with a very low risk for non-union) ,
then they enter the capsule and separate to go toward the head as end arteries, which means if there is any disruption in the blood supply at this area this part (the femoral head) may die and end with avascular necrosis, and the fracture may not heal (non-union)

- Extracapsular area has great anastomosis with good blood supply - Minimal risk of non-union, while Intracapsular area has poorer blood supply with a chance of nonunion and avascular necrosis



Blood supply

Crock described the arteries of the proximal end of the femur in three groups

(a) an extracapsular arterial ring located at the base of the femoral neck;

(b) ascending cervical branches of the extracapsular arterial ring on the surface of the femoral neck (known as retinacular arteries)

(c) the arteries of the ligamentum teres

Mechanism of Injury

Bimodal Distribution

- Old patients: result from low energy trauma in osteoporotic bones
- younger patients following high energy trauma like motor vehicle accidents.

Presentation

- The clinical presentation of the proximal femur fractures can vary depending on the type, severity, and cause of the fracture.

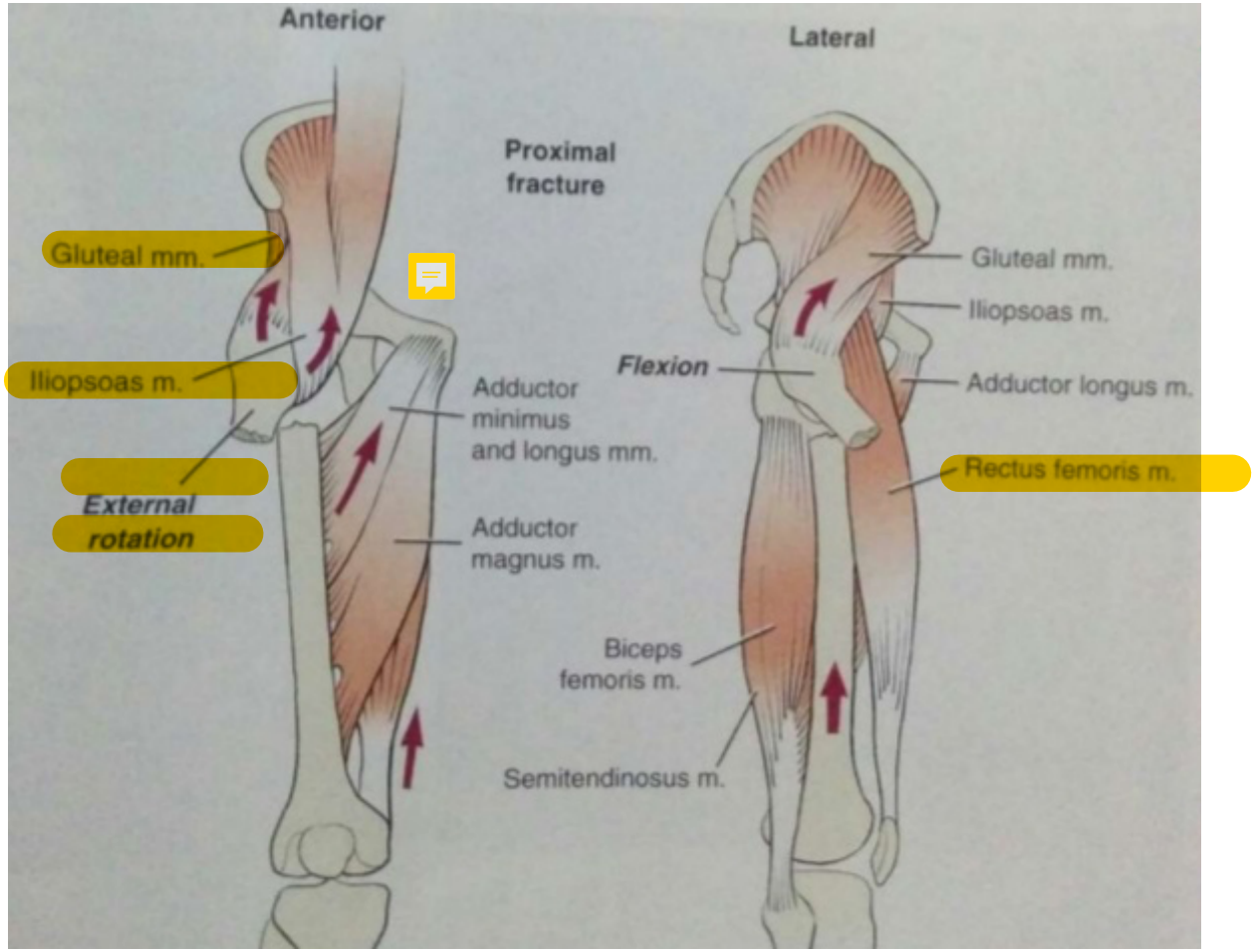
Pure traumatic injury on a normal bone are so painful, if we compare them to the pathological fractures in general.

Hip pain+ inability to bear weight: think of hip fracture

Pain

- displaced fractures: Patients usually cannot stand or ambulate.
- Non-displaced or impacted fractures: patients with may be ambulatory and experience minimal pain.

- Patients with a displaced proximal femur fractures exhibit the classic presentation of a shortened and externally rotated extremity. And abduction There may be tenderness to palpation in the area of the greater trochanter. Ecchymosis may be present and should be noted.


Anterior
Lateral
Proximal fracture
Gluteal mm.
Iliopsoas m.
External rotation
Adductor minimus and longus mm.
Adductor magnus m.
Flexion
Gluteal mm.
Iliopsoas m.
Adductor longus m.
Rectus femoris m.
Biceps femoris m.
Semitendinosus m.

- Range-of-motion testing of the hip will be painful and ***should be avoided***.

- Neurovascular injury is rare after hip fracture, careful evaluation is nevertheless mandatory.

Special Attention

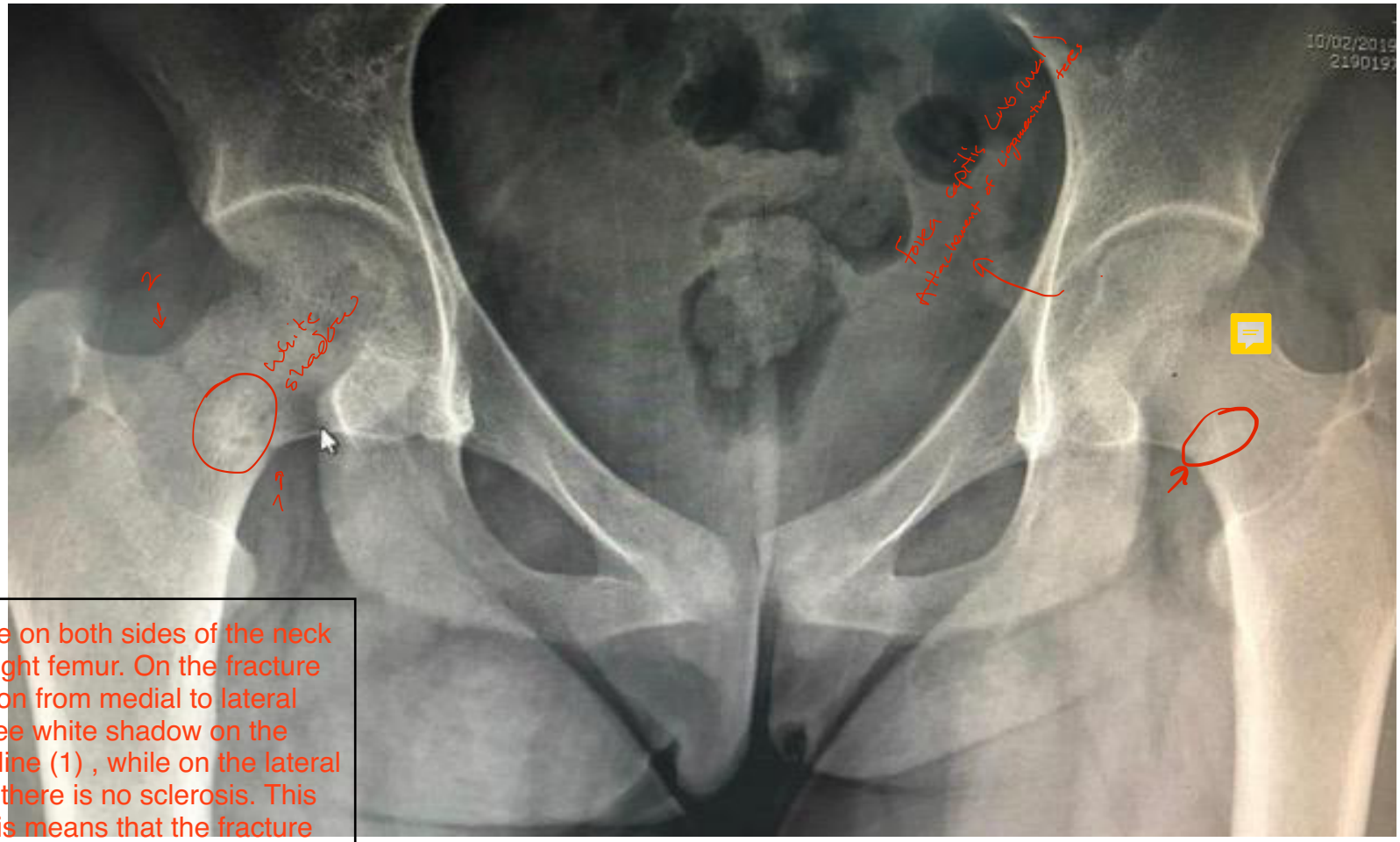
- Thigh or groin pain without any history of trauma. These patients should be suspected to have with a ***stress fracture of the proximal femur***. They should be enquired about any recent changes in the type, duration, or frequency of physical activity.

Those pts will have prodromal symptoms, they'll get complaining for a long period of time and that complaint is increasing or suddenly occurs at one period of time

- In patients in whom no significant history about activity or trauma is available, ***pathological fracture*** must be considered.

Pt presented with severe hip pain in the last 2 days before she came to the ER, the pain was gradual over the last 2 months but was aggrevated on the past two days, it was bilateral more on the right side, the last two days she was unable to bear weight and she became wheelchair dependent due to the pain only. Her hx has a problem with vit D.

Diagnosis ?

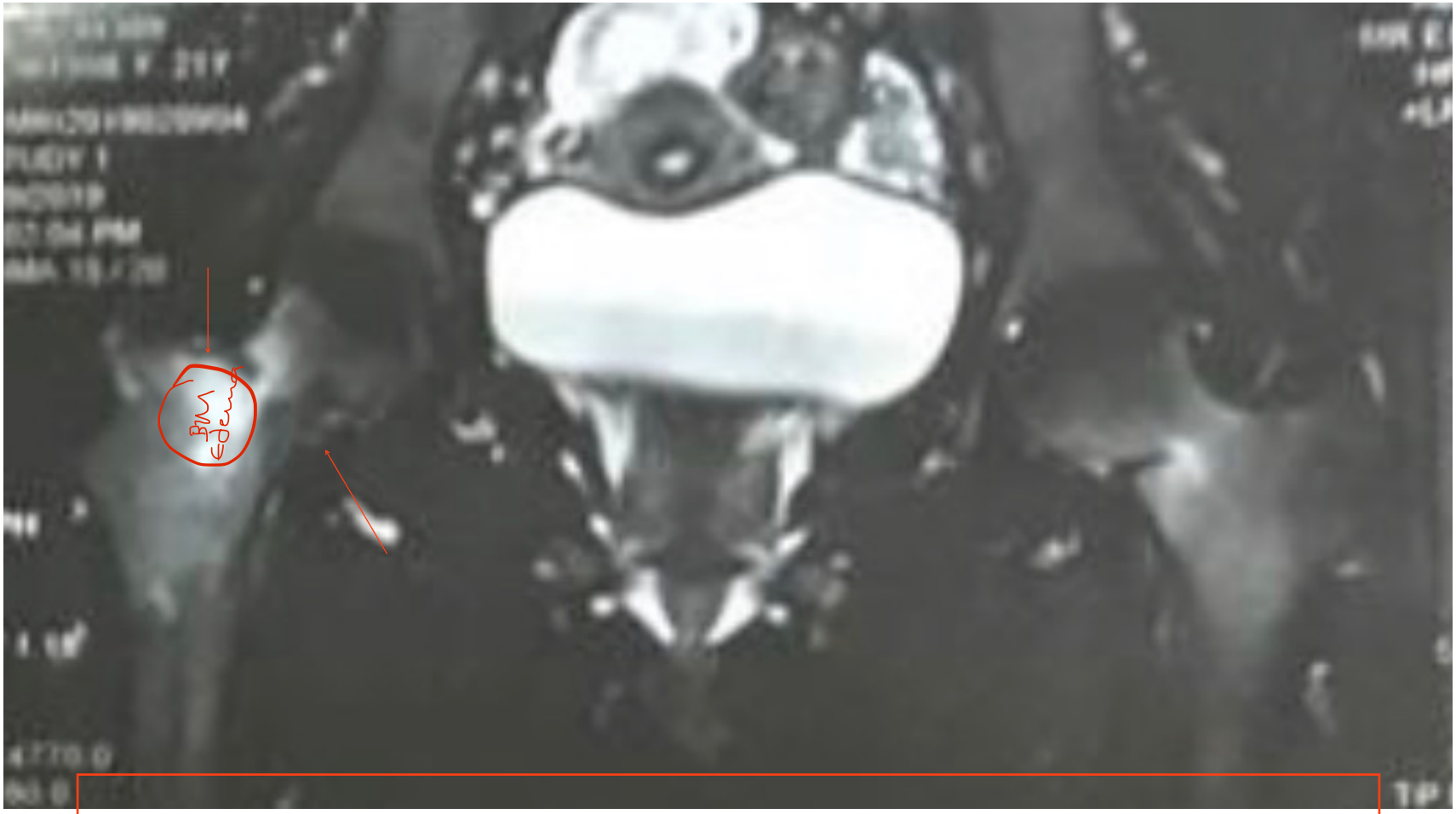


Fracture on both sides of the neck of the right femur. On the fracture extension from medial to lateral you'll see white shadow on the medial line (1) , while on the lateral line (2) there is no sclerosis. This sclerosis means that the fracture started on the medial side has a hx of certain period of timeand there is a host rxn in the form of healing

Stress fracture

- If you suspect a fracture but it's not clear on X-ray, we perform another investigation as a tool to identify if there is a problem. CT scan is one option to identify fracture line in the proximal femur if you suspect it and is not apparent on plane X-ray.

- If you suspect a fracture like stress fracture you'll see BM edema on MRI

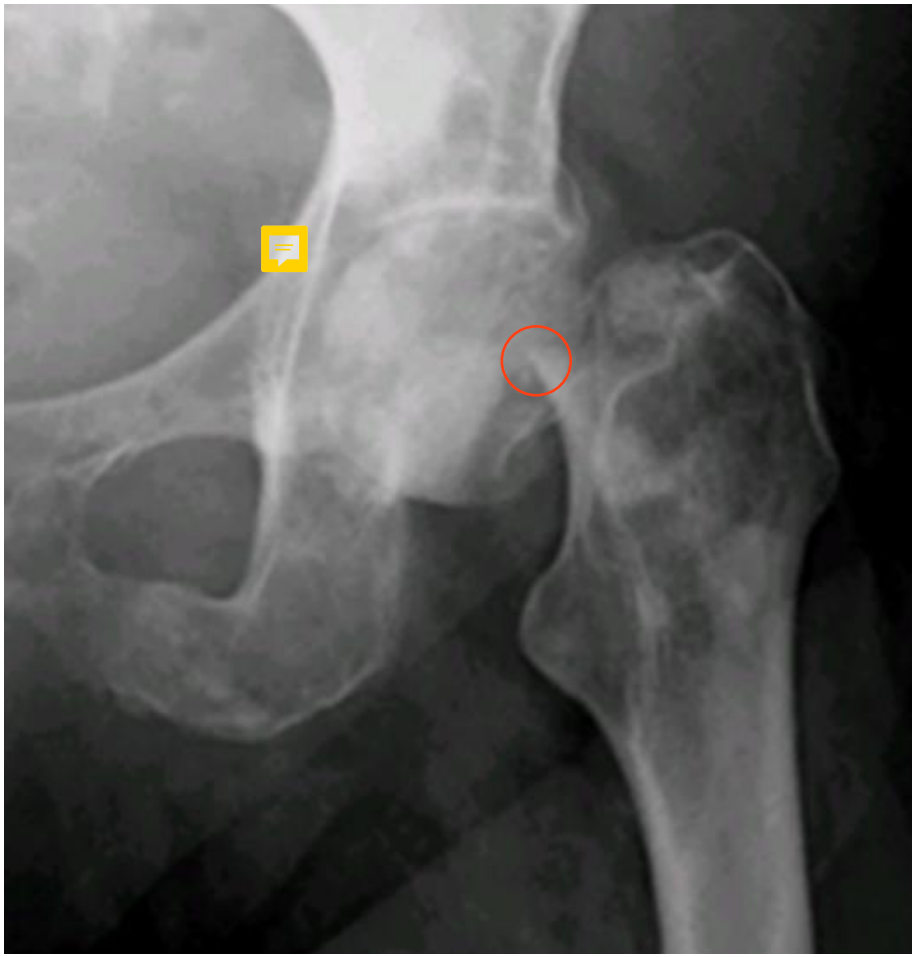


On the right side, the medial aspect is black and has low signal intensity, which means there is sclerosing (long time standing injury), the white matter indicates the bone marrow edema which indicates that this fracture is new (we don't see BM edema in chronic injuries after they heal)

70 year old pt with a known breast CA, she has simple hx of falling down, she was unable to move or stand after the falling down, she has mild to moderate pain, the limb is shortened and completely externally rotated and abducted

Diagnosis ?

First thing we identify if there is a fracture, then we identify which anatomical segment the fracture presents in, then we say whether the fracture is displaced or not, if displaced we describe the deformity

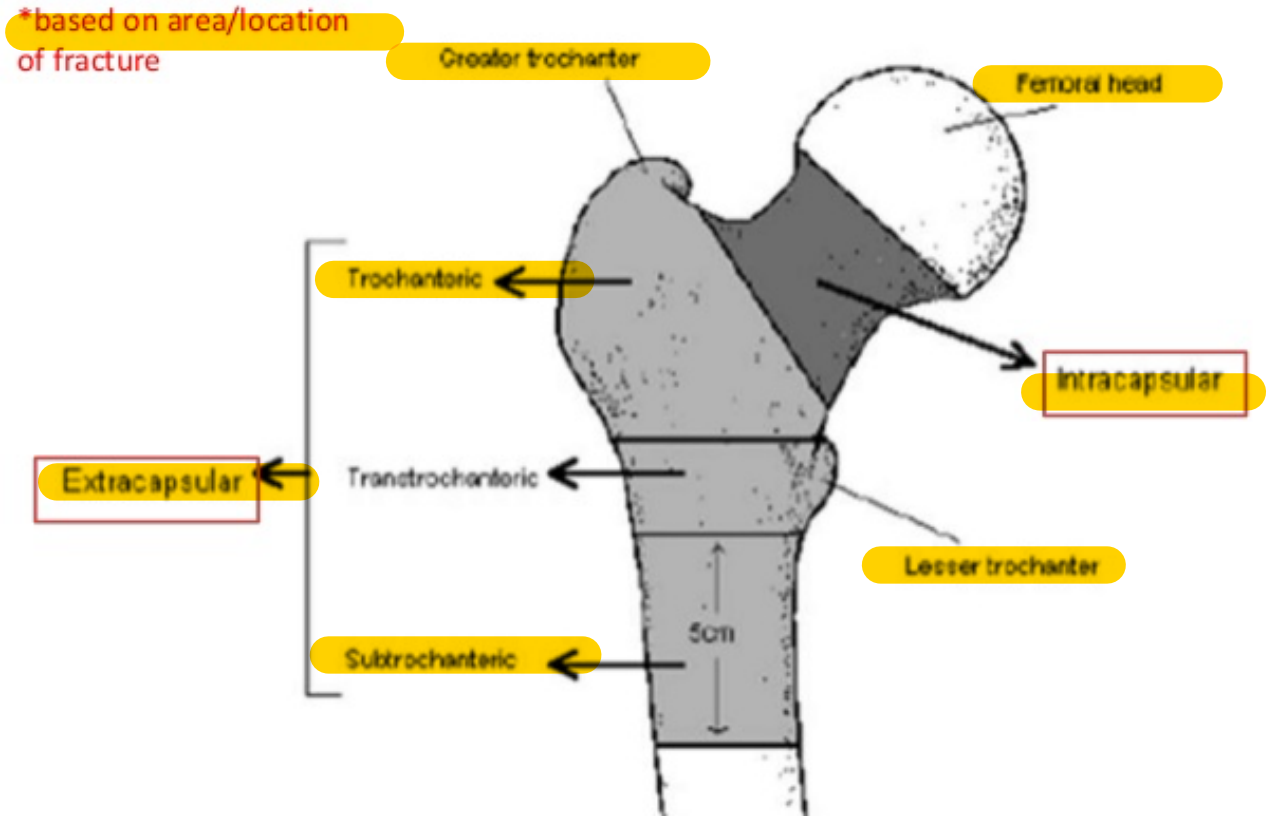


There is a femur neck fracture with multiple lytic lesions on the lesser and greater trochanters with osteoblastic leasions (breast mets produce mixed features)

The fracture is proximally migrated (greater trochanter is at the level of acetabular edge and lesser trochanter is higher than the ischeal tuberosity) which appears as shortened limb,
Also there is external rotation; because of the prominant appearance of lesser trochanter

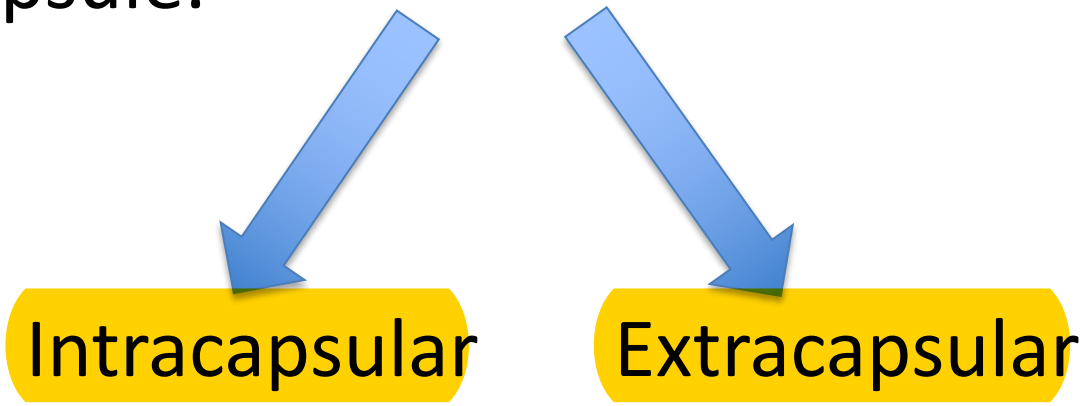
Quick Recap: we talked about high and low energy traumas, we talked about vascularity and its association with bone healing, vascularity plays better role in intertrichanteric and part of subtrochanteric areas compared to femoral head and neck, the type of bone intertrochanteric area is cancellous bone (which has good healing ability) while most of the bone in head and neck is cortical bone (healing ability is abit worse compared to cancellous)

CLASSIFICATION of FEMUR FRACTURE



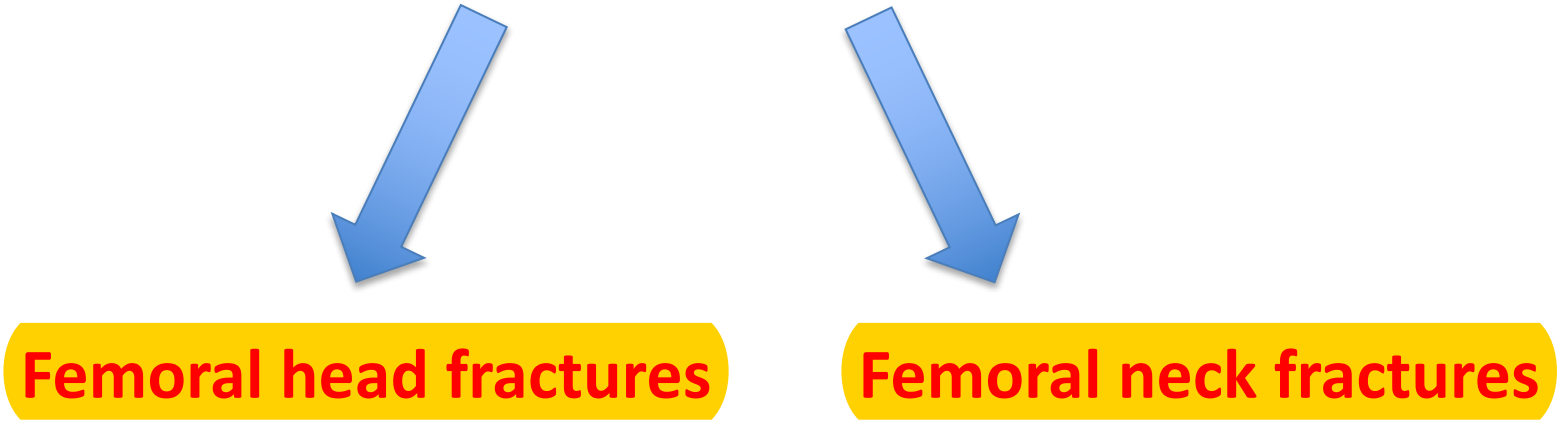
Classification of Proximal Femur Fractures

- Proximal femur fractures are divided into groups based on their location with regard to the capsule.



Intracapsular fractures

- within the lining of hip joint capsule, associated with injury to blood supply to head of femur. may result in avascular necrosis of femoral head.



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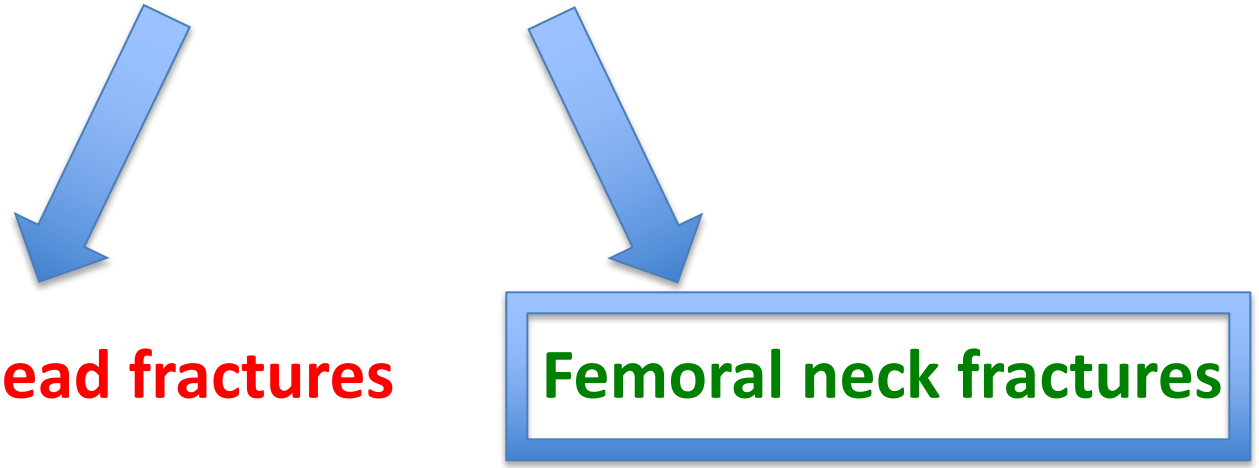


Femoral neck fractures

Depending on fracture location these are further classified as

Subcapital fracture – just below the head of femur

Transcervical fracture – through mid neck

Basi-cervical fracture – through base of neck

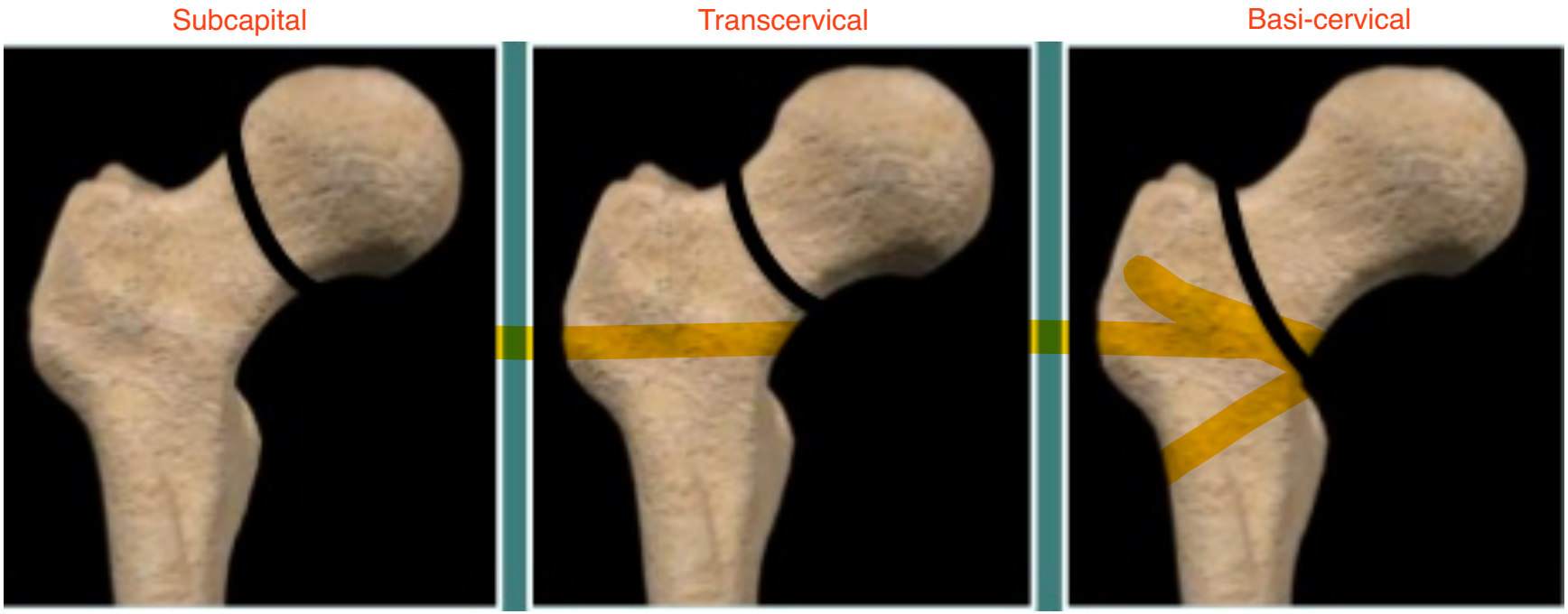
The fracture will the highest complication rate is the subcapital, due to:

1) poorer blood supply (end arteries)

2) Bad Bone quality (cortical bone)

3) Normal joints to move freely they need fluid (synovial fluid), hyaluronic acid is assist in the lubricant status of that fluid which is found within the synovial fluid (it prevents any clot formation), during the process of hematoma formation durning bone healing, this hyaluronic acid will prevent the clot formation, so it will delay bone healing.

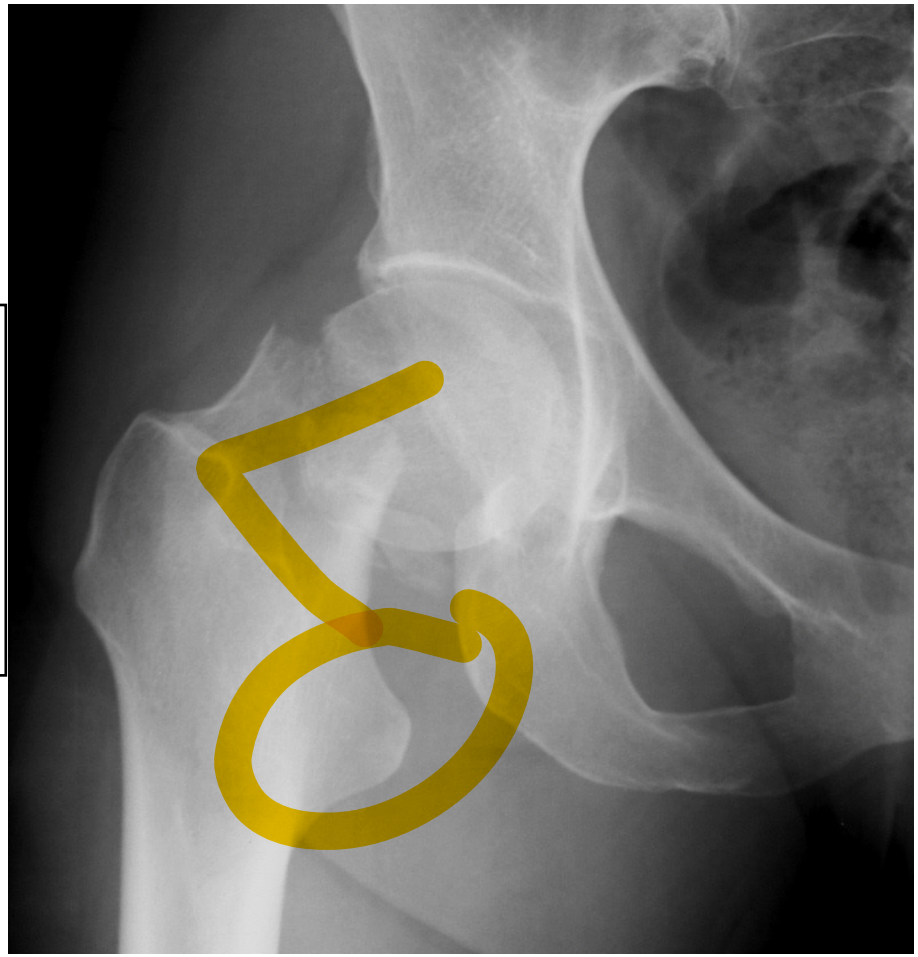
** This will result in higher nonunion rate



you have to provide the fracture with the best condition to improve healing; you have to go in femur neck fracture for anatomical reduction and absolute stability, this approach is valid in young patients because the rehabilitation process after fracture includes non-weight bearing and walking using assisted devices (needs 6 weeks until you can put weight bearing on it), if the patient is very old with sedentary lifestyle and already uses assisted devices then the best surgery is the first surgery (replace the hip by prosthetic implants) and to start weightbearing after the first day of operation

60 years old has a hx of falling down on right side, presented with severe hip pain, inability to bear weight, he has a visible deformity of external rotation with slight shortening

Diagnosis ?

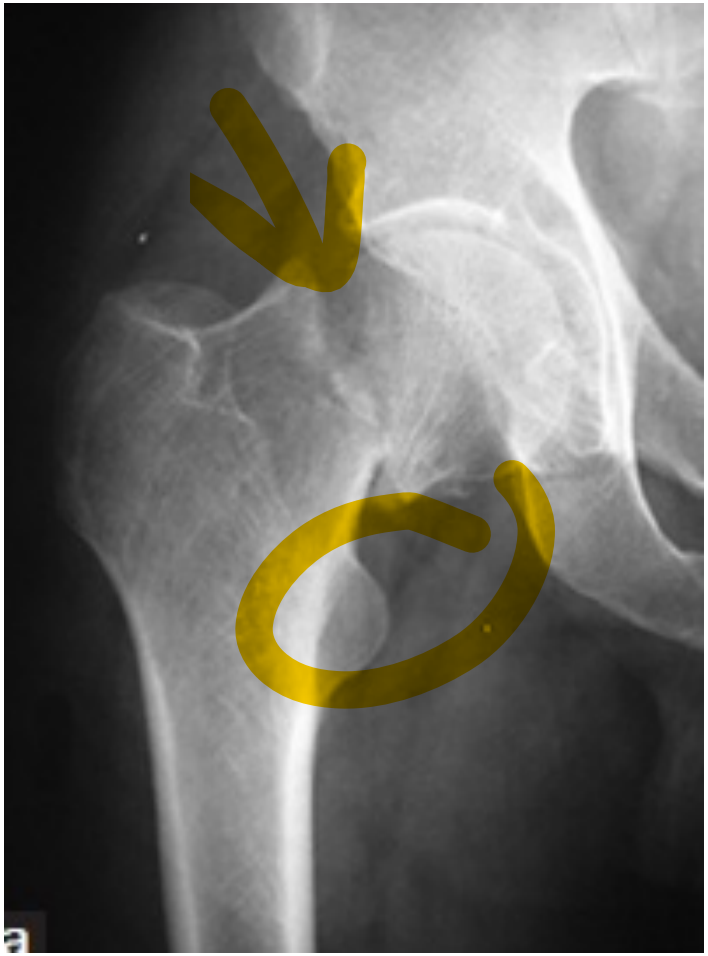


- Subcapital femur neck fracture.

- Slightly displaced, there is external rotation deformity presented by the prominance lesser trochanter, with varus dislocation

Presented to the ER right after falling down, inability to bear weight.

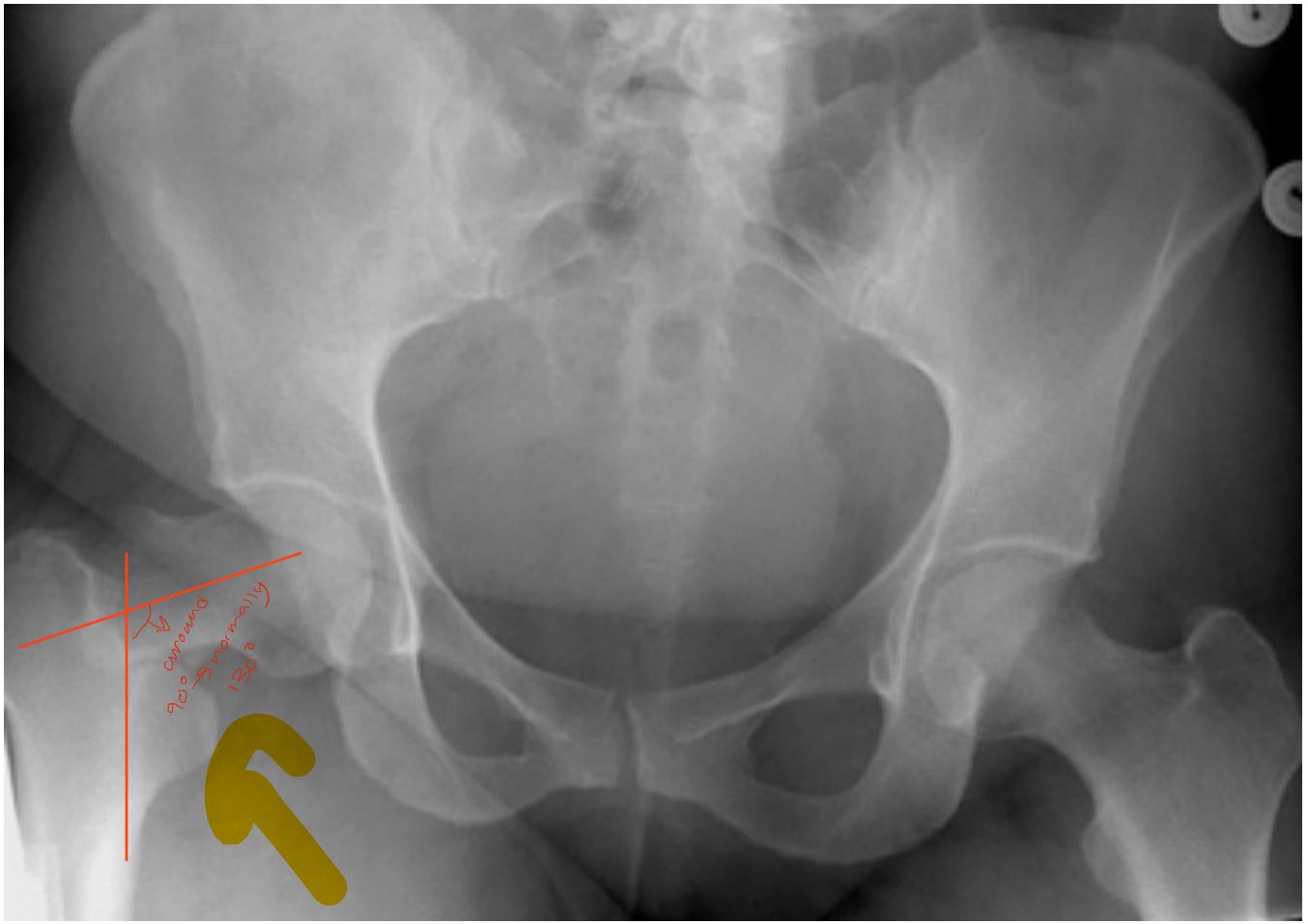
Diagnosis ?



Transcervical femur neck fracture

Same hx of the cases above, but this pt has significant deformity on the right side

Diagnosis ?



Base-cervical fracture on the base of femur neck, external rotation deformity, proximal migration, Varus stress (the neck shaft angle is reduced

This classification is only used in subcapital fractures

Garden's classification

Extracapsular fractures

Outside the capsule , do not cause the same degree of vascular damage as intra-capsular fractures and therefore can be treated differently.

Risk of nonunion is very rare, but there is a risk of malunioin

Intertrochanteric

Any fracture that extends between the greater and the lesser trochanter or touches any trochanter (type 5)

Subtrochanteric

Below lesser trochanter, not touching any trochanter

Intertrochanteric fracture classification

Types 1-4 (OBLIQUE)

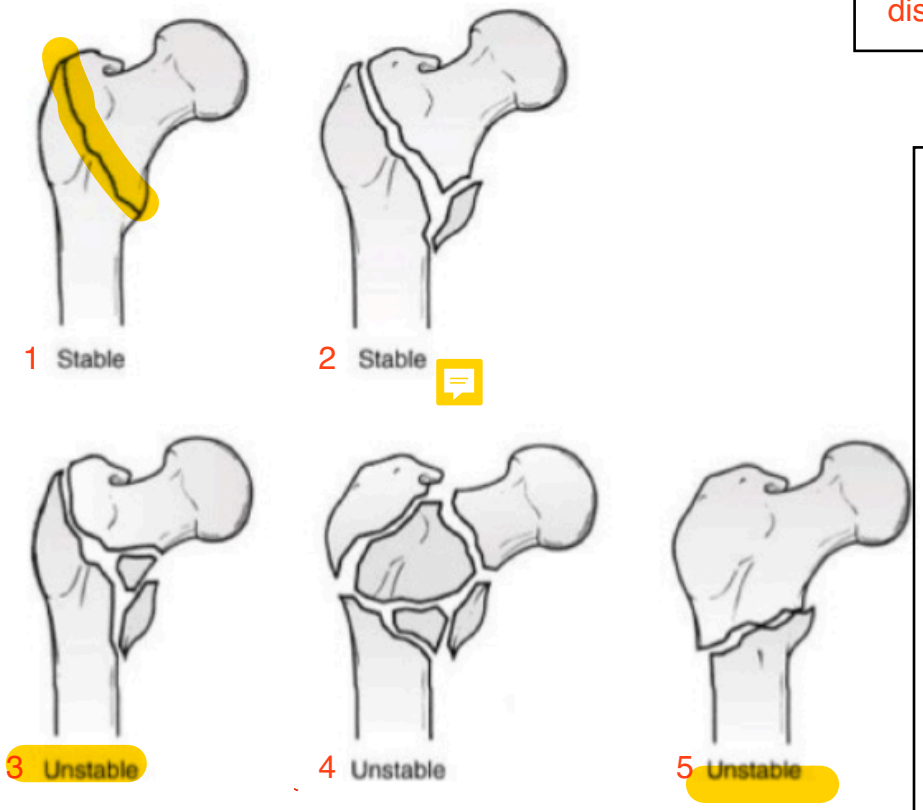
the fracture starts classically from the lateral side up of greater troch to ends down in the lesser troch medially

Type 5 (REVERSE OBLIQUE)

Starts from lesser trochanter medially and end low on the lateral side

Unstable fractures need implants/ devices to prevent displacement

Evans Classification

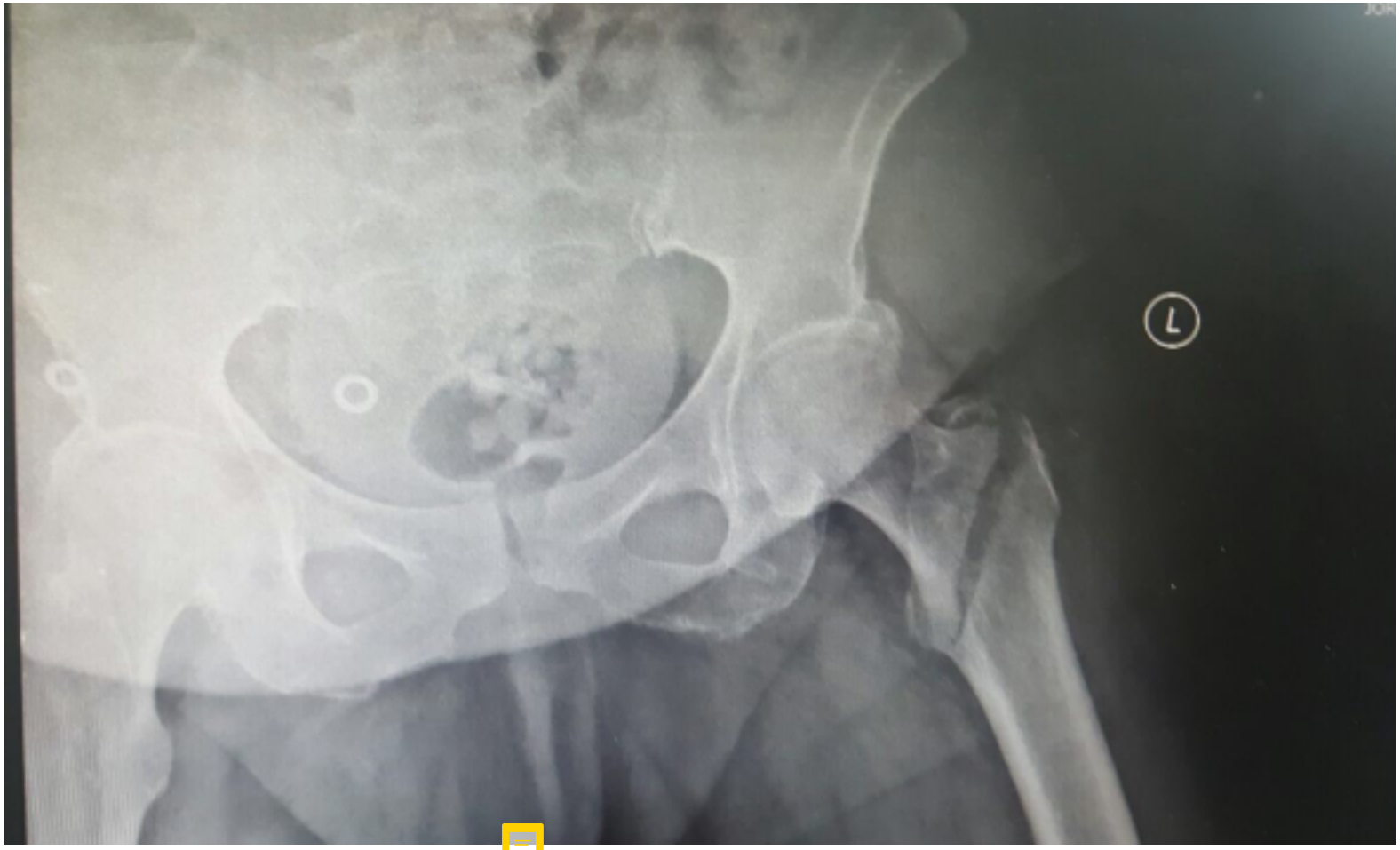


This classification is According to STABILITY. Stability means if I put back the fracture parts toward each other as it was before it will stay stable even with bearing weight without any displacement

Normally when we stand, normal weight bearing comes from medial side on the head and pass obliquely, so it does compresses forces in the intertrochanteric fracture, if the fracture is simple (1+2) with one fracture line or very small segment of lesser trochanter, then the pieces will stick together, while if there is multiple segments and the calcar area on the lesser trochanter is completely fractured in a huge peice or multiple fragments, then if you out a weight on this area then displacement will occur with no stability

This pt has a hx of falling down on the left side of the hip, presented with severe pain, inability to bear weight, the whole limb is slightly abducted and externally rotated

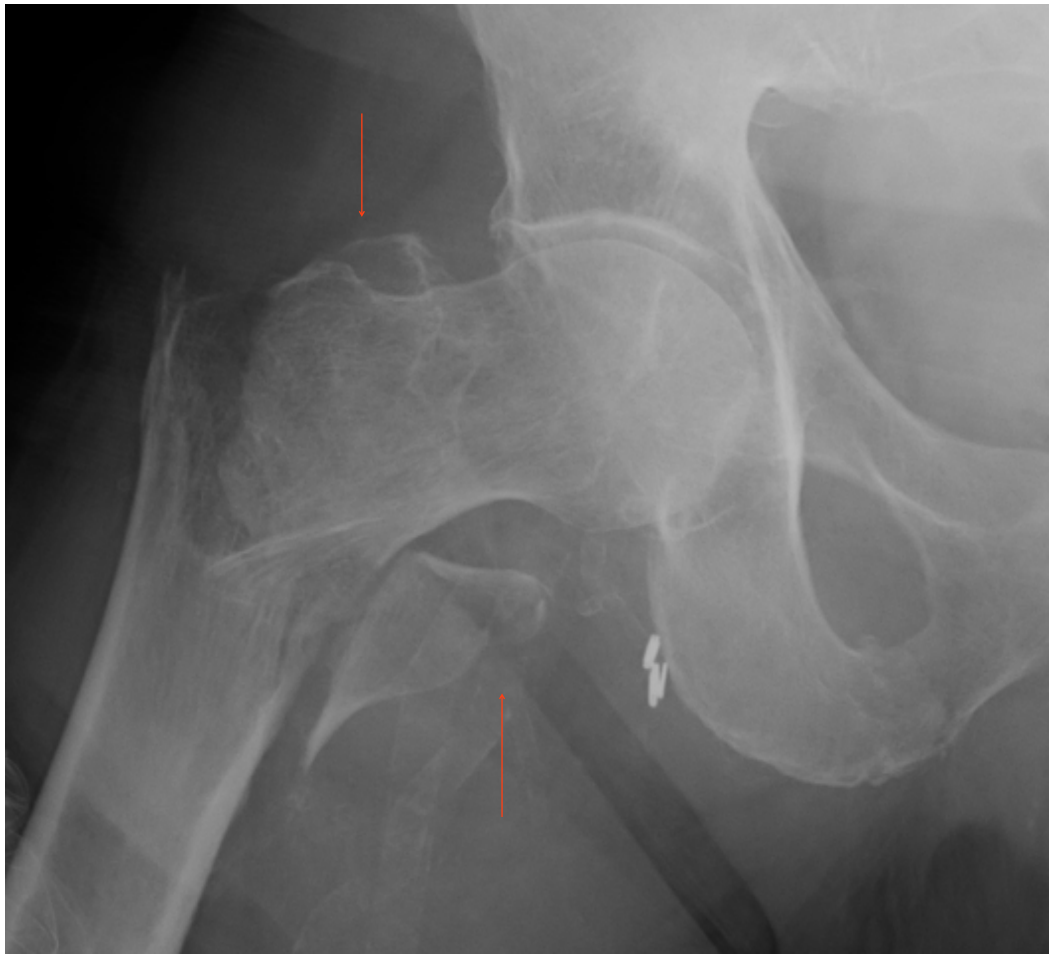
Diagnosis ?



Intertrochanteric Fracture, stable (because lesser trochanter is not separated and there is one fracture line extending from greater trochanter to lesser trochanter downward)

The pt has hx of falling down from few steps, presented with Right sided hip pain with severe deformity in the lower limb (shortening), inability to bear weight

Diagnosis ?



Unstable intertrochanteric fracture (multi-fragmented fracture, the lesser trochanter has a huge piece on the medial side involving part of the cortex, the greater trochanter is not apparent its shadow is just behind the femur neck)

Young pt who was a victim of RTA, presented with severe deformity in the right lower limb, he was comatosed, unable to complain of pain, but the deformity is so visible

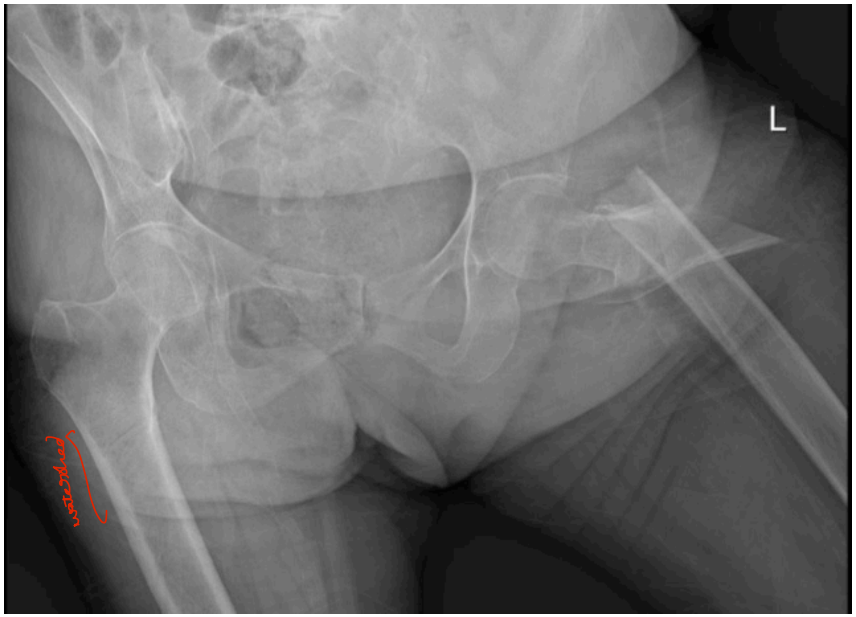
Diagnosis ?

This fracture goes parallel to the axis of body bearing weight so it will displace due to sheering forces

Unstable reverse oblique intertrochanteric fracture

25 year old patient with a hx of severe RTA trauma, has severe pain, severe deformity on left side

Diagnosis ?



Subtrochanteric Fracture,
The whole proximal femur is completely reverse upside down. Subtrochanteric area has strong bone so in order to get fractured it needs high energy trauma, it has cortical bone compared to cancellous bone in intertrochanteric area, bad healing process, this area has watershed area of blood supply, so it has hight risk of nonunion

Principles of Management

Femur neck fracture

FIX

In young adults, active patients

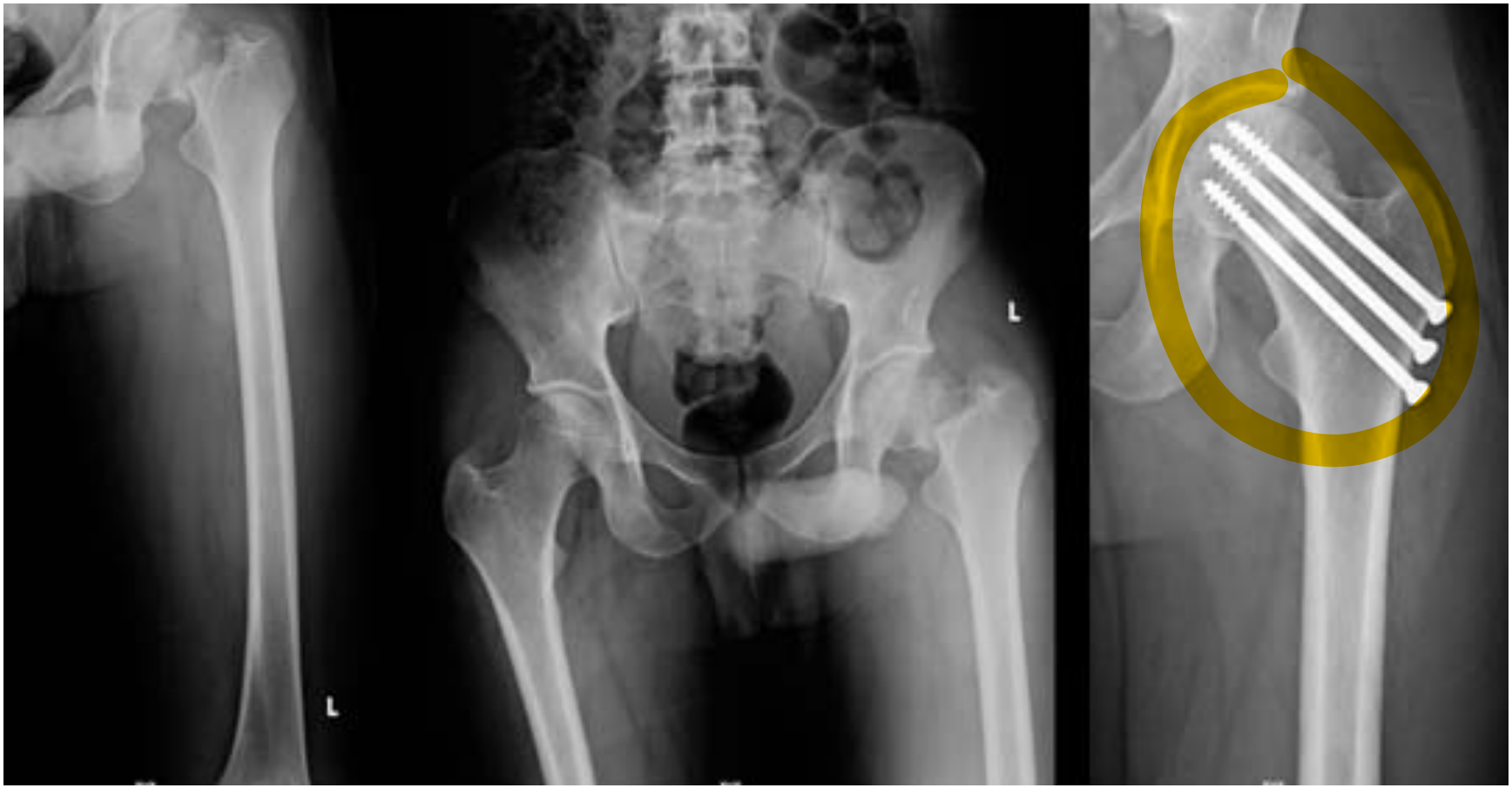
OR

REPLACE

In Low sedentary style, elderly patients

25 year ols, has hx of femur neck fracture, transcervical, we reduce the fracture and fix it with three screws

FN # 25-year-old



Here, subcapital fracture and there is a replacement with implant, allow full weight bearing immediately when the pt is able after surgery

FN # 70-year-old

Monopolar PHR

Extracapsular and extra-articular

Inter,/ subtrochanteric fractures

- Aim: Restore length, alignment & rotation

  NO anatomical reduction

Without extensive soft tissue dissection, this fracture forms abundant callus in 6 weeks

We do indirect reduction, or we use IMN, screws, here the healing will be secondary healing with callus formation

Intertroch. Treatment DHS

Type 2 fracture, lateral cortex is intact, the fracture extends from greater troch to lesser troch, just small piece of lesser troch not extensive. In stable Fractures we use DHS

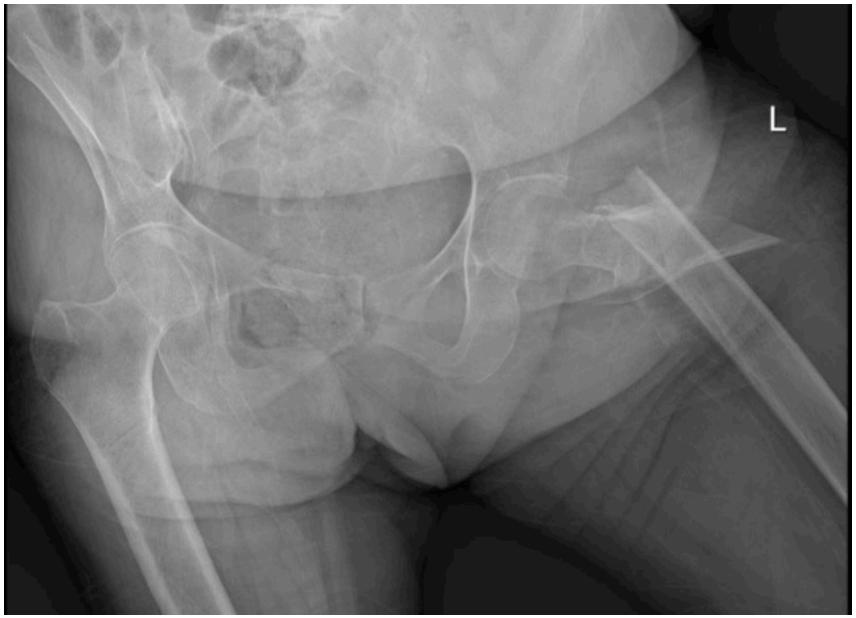
Dynamic hip screw

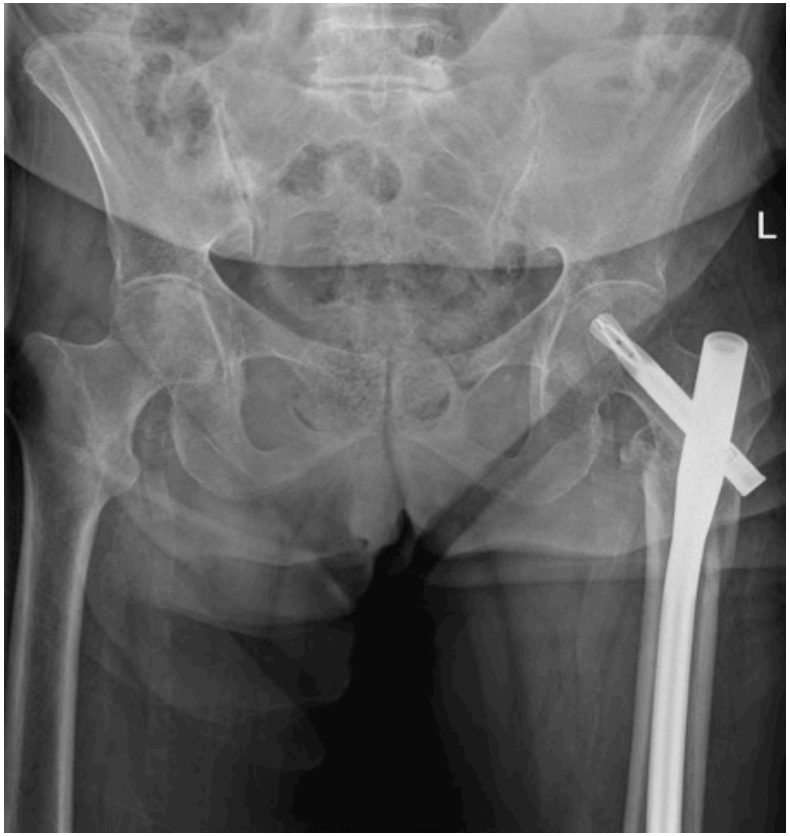
Intertroch. Treatment IMN

In reverse oblique fractures or any unstable fracture we use IMN

Intramedullary nail

Subtroch. Treatment





Complications

General

- DVT
- PE
- Pneumonia
- Bed sores

Lacal

- AVN
- Non / Mal-union
- Failure of fixation
- Posttraumatic arthrosis

Those are common in femur neck fractures

Common in intertrochanteric/ subtrochanteric fractures

Can happen in any of these fractures if you don't follow basic principles of fracture fixation

Common in femur neck fractures

Subcapital femur neck fracture, fixed with these screws, head of femur is completely white on follow up, completely avascular.

?

Femur neck fracture with complication of nonunion

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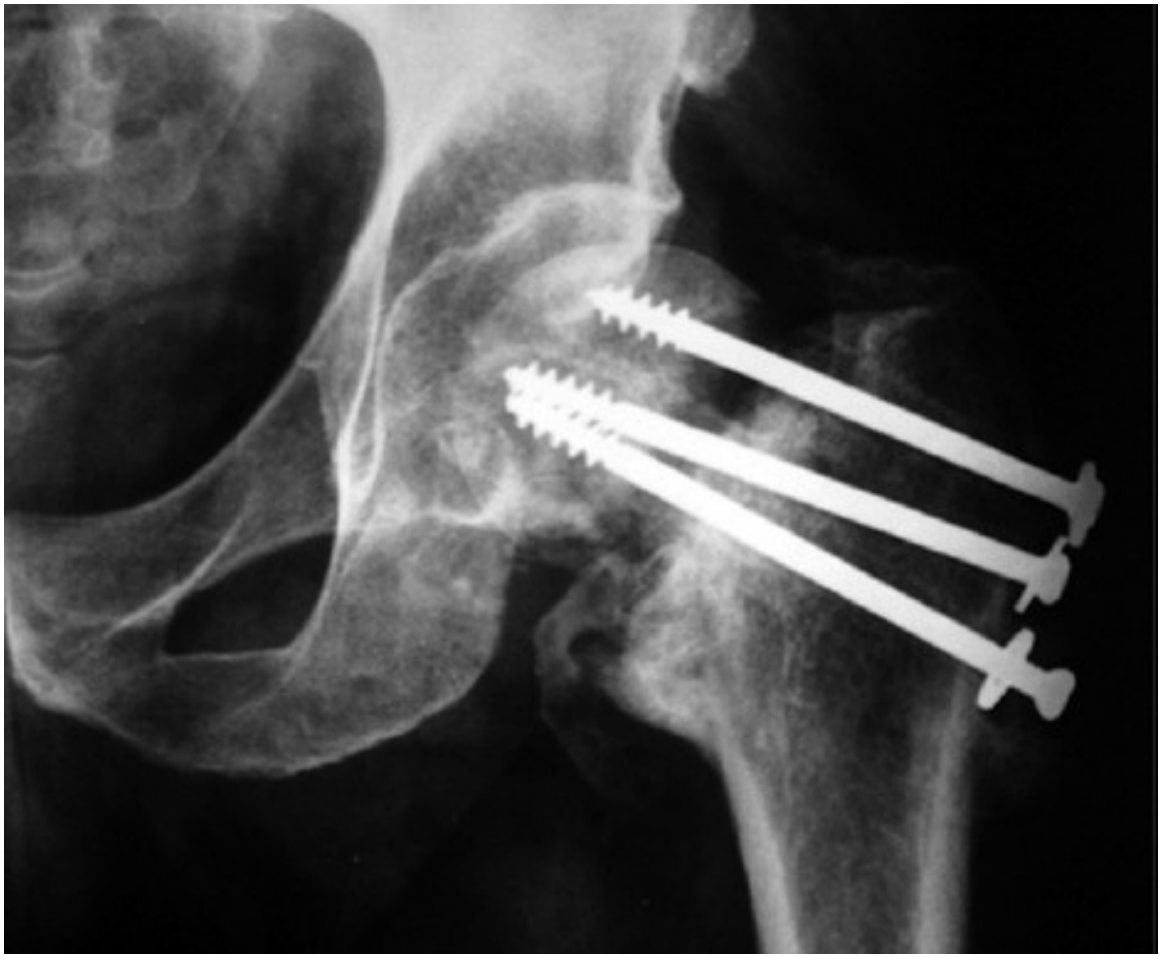

This is one of the technical issues, in subtrochanteric area there is watershed area, if you put stress on the lateral side and put screws below lesser trochanter, then another fracture might occur due to the mechanical weight bearing (compression and tensile forces)

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Your screw should never reach the watershed area, you should remain high up in the trochanteric ridge

Soft tissues (muscles and tendons) should not be disrupted during surgery, otherwise after fixation your hip will be out (Hip Dislocation)

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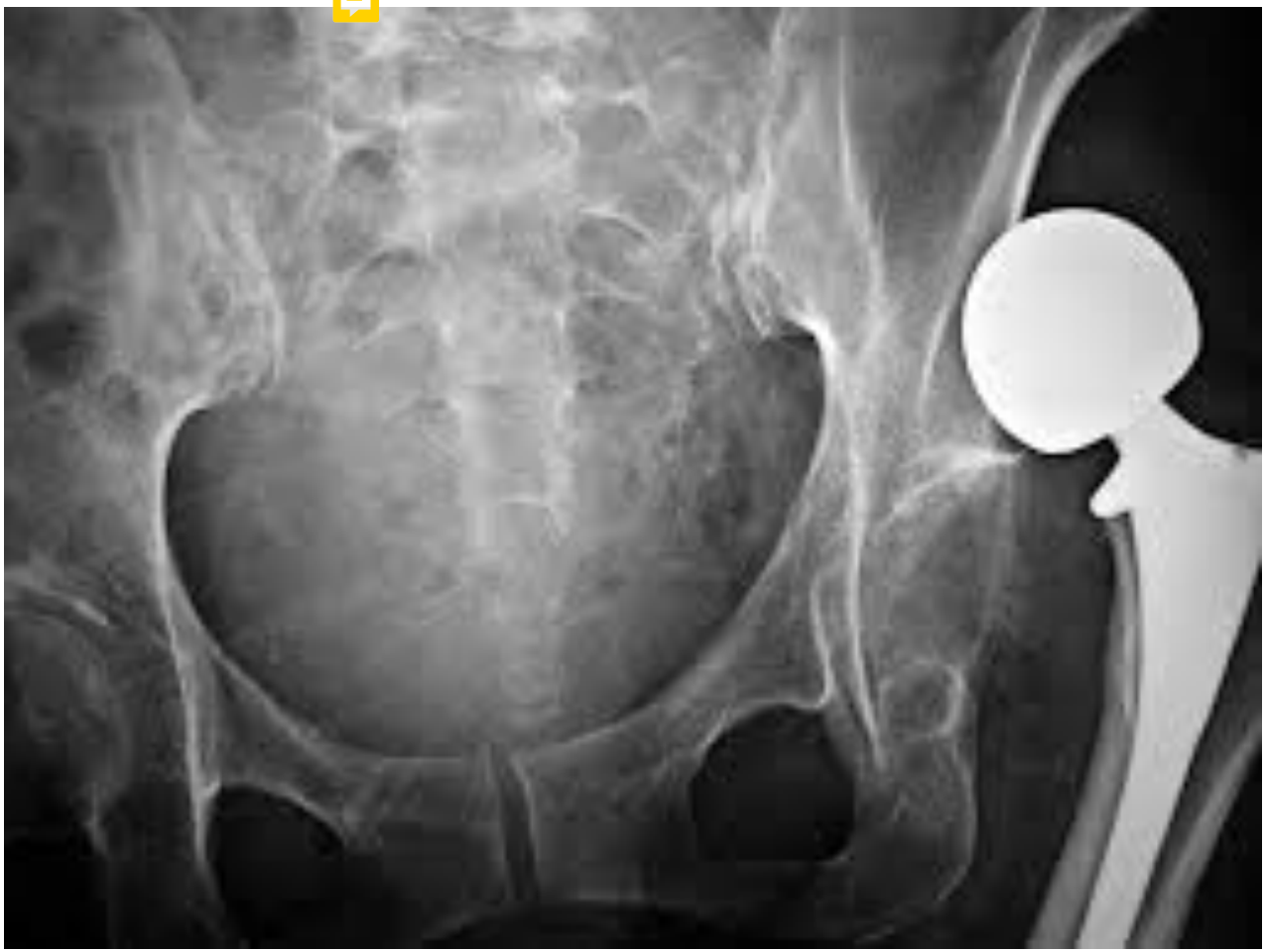

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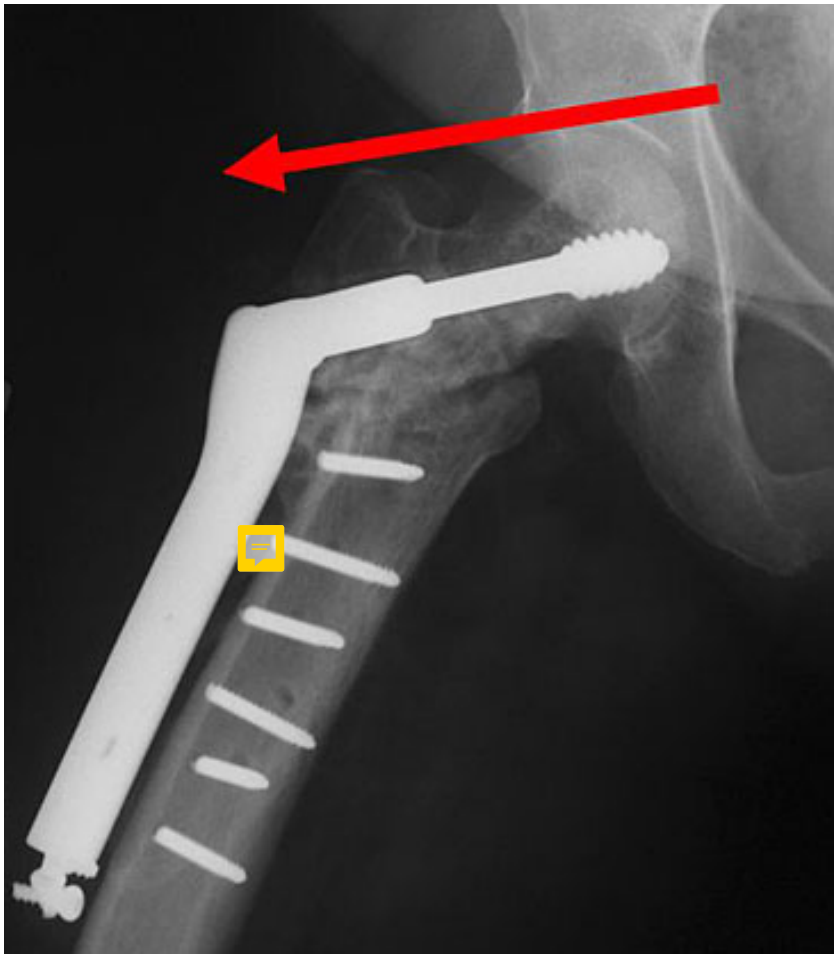

Reverse oblique fracture treated wrongly with this device, once the pt starts to put weight, shearing forces will develop and screws will be disrupted