How to read x-rays

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Learning outcomes

At the end of this lecture you will be able to:

- Read x-rays systematically
- Describe fracture patterns
- Interpret healing of fractures

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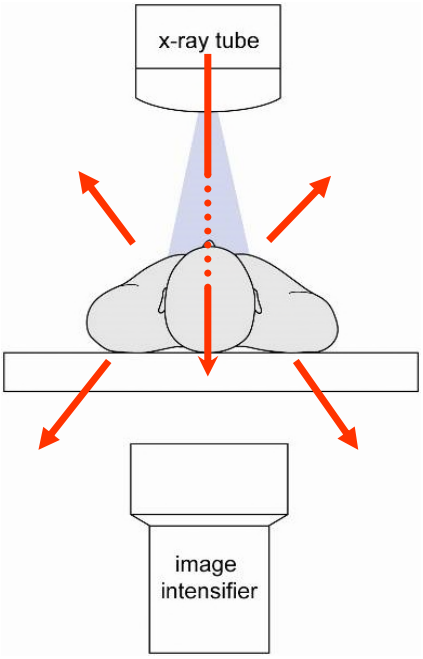
Physical facts of x-rays

Transmission, absorption, and scatter of 1,000 photons reaching the patient:

- ~ 800 absorbed by patient
- ~100–200 scattered
- ~ 20 transmitted to image intensifier



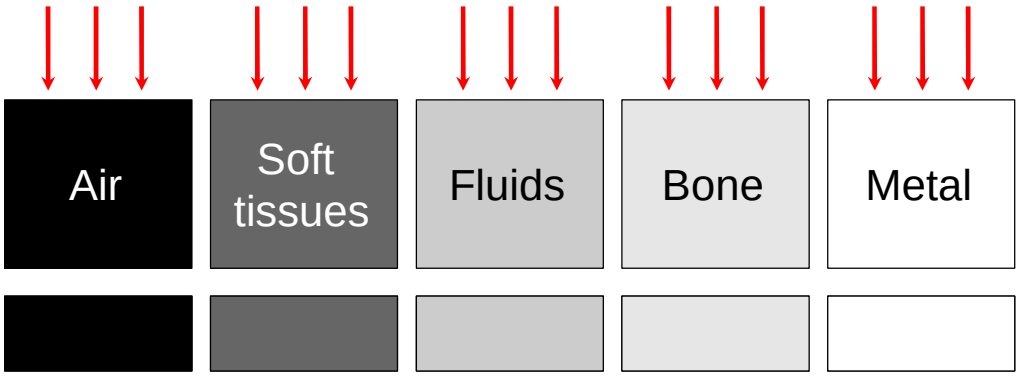
Radiation not absorbed by the patient is scattered. This scattered radiation can affect the team and surgeon.

In this example, the x-ray tube is emitting photons, which are either reflected or absorbed by the patient. Just a fraction of the x-rays pass through the patient to the image intensifier.

For every thousand photons reaching the patient, 100–200 photons are scattered. Just 20 reach the image detector. The rest are absorbed by the patient. This is the radiation dose.

X-ray projection depends on

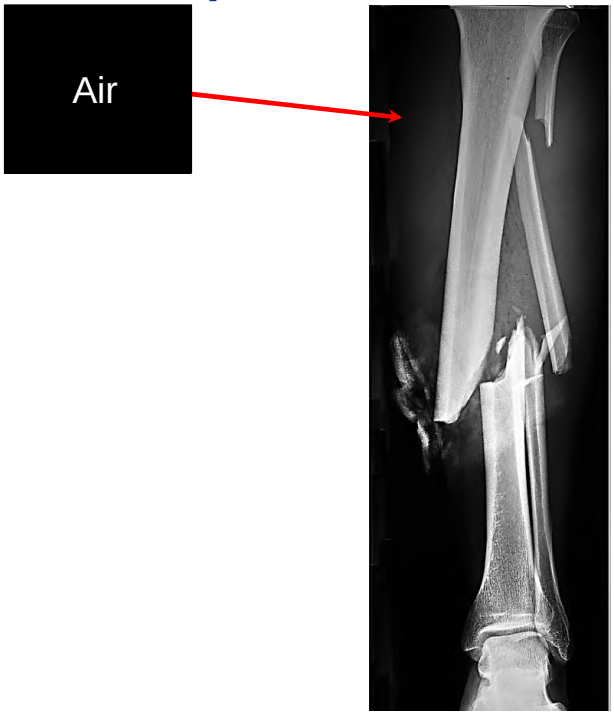
- Tissue volume penetrated
- Type of tissue/material



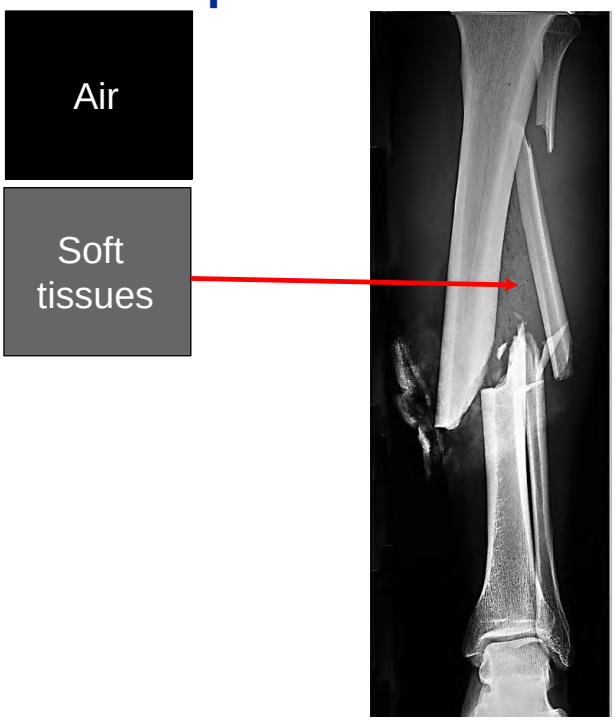
X-ray projection depends on the thickness of the tissue that is to be penetrated.
When there is no tissue to penetrate, the color of the picture will be black.
The greater the depth, the lighter the grey.

- Air is projected as black
- Soft tissues are grey
- Fluids are a lighter grey
- Bone is an even lighter grey
- Metal is projected as white

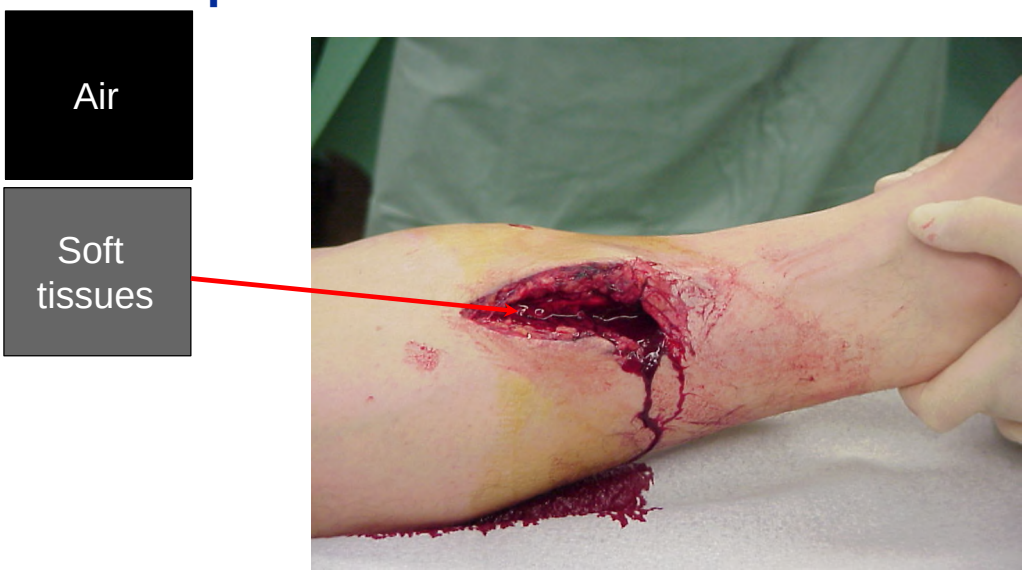
Projection in an open tibial fracture



Projection in an open tibial fracture



Projection in an open tibial fracture



Projection in an open tibial fracture

Air

Soft tissues

Bone: cortical cancellous

Projection in an open tibial fracture

Air

Soft tissues

Bone: cortical cancellous

Metal

Systematic reading of x-rays

- Name and date of birth of patient
- Side of extremity/body
- Date of x-ray

Information found on the x-ray are:

- Name and date of birth of the patient
- Side of extremity/body
- Date of x-ray

Systematic reading of x-rays

- Two views
  - AP
  - Lateral

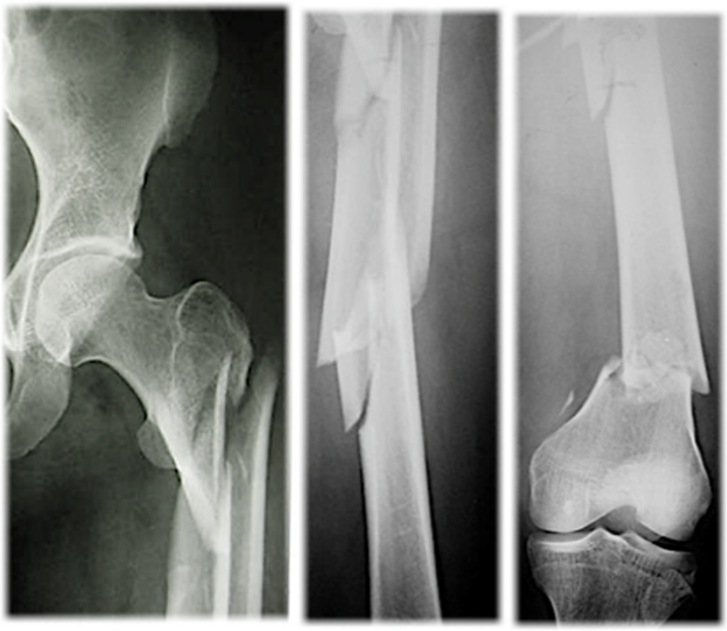
AP Lateral

- Two views help to fully describe the fracture in both planes.

Animation: It is easy to miss a fracture with just one view.

Systematic reading of x-rays

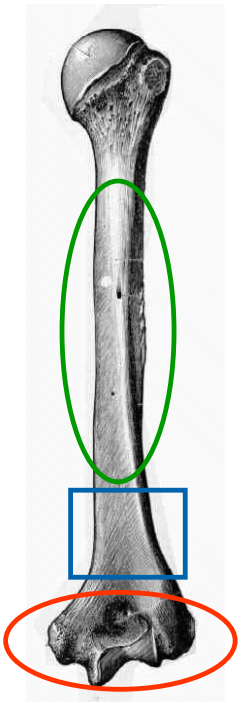
- Two joints
  - Adjacent



- X-rays of the two adjacent joints must be taken. Just a shaft view is not enough.
  - One of the two fractures could be missed in an x-ray not showing the entire bone.
  - Or, a joint injury could be missed with just one x-ray.
  - Both adjacent joints need to be seen.

Systematic reading of x-rays

- Identify bone
- Identify fractured part of the bone
  - Intraarticular fracture/ epiphysis
  - Metaphyseal fracture
  - Diaphyseal fracture



- Identify the bone.
- Identify the fractured part of the bone.
  - Intraarticular fracture/epiphysis
  - Metaphyseal fracture
  - Diaphyseal fracture

Systematic reading of x-rays

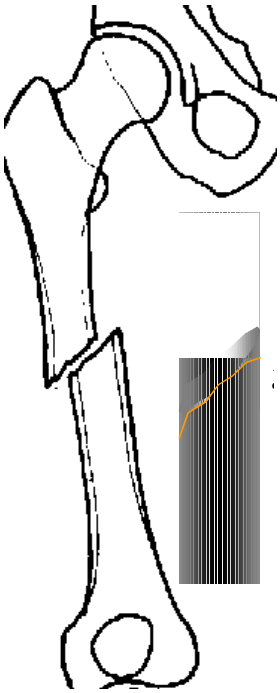
- Identify type of fracture
  - Simple:
    - Spiral
    - Oblique
    - Transverse
  - Wedge:
    - Butterfly segment
  - Complex:
    - Comminuted

- Identify the type of fracture.

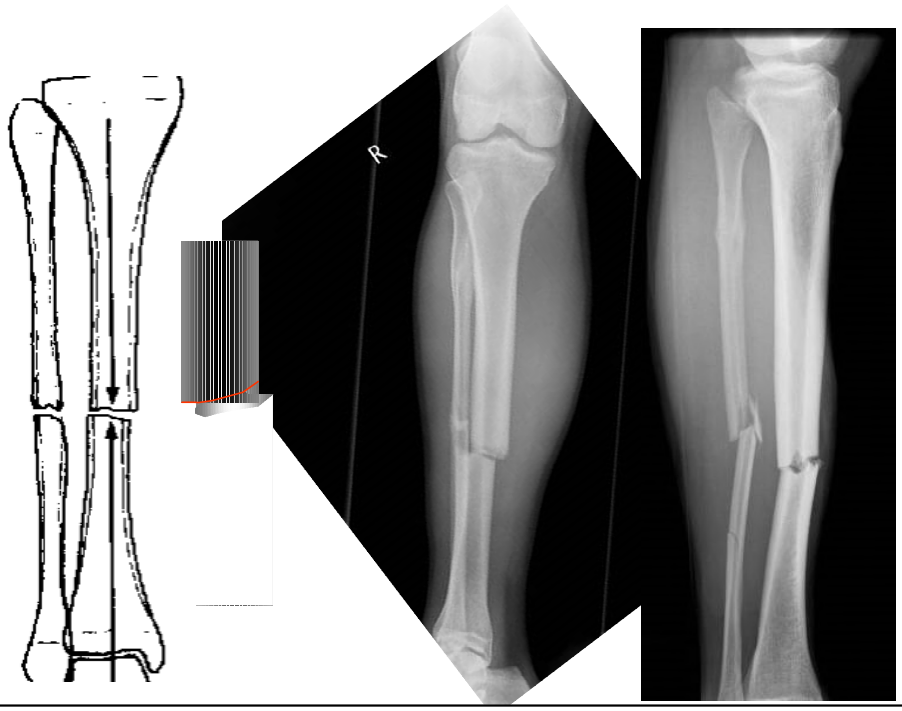
Examples will follow for each fracture pattern.

Example: Simple spiral fracture

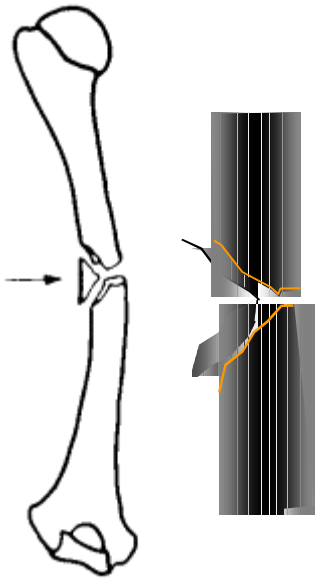
Example: Simple oblique fracture



Example: Simple transverse fracture

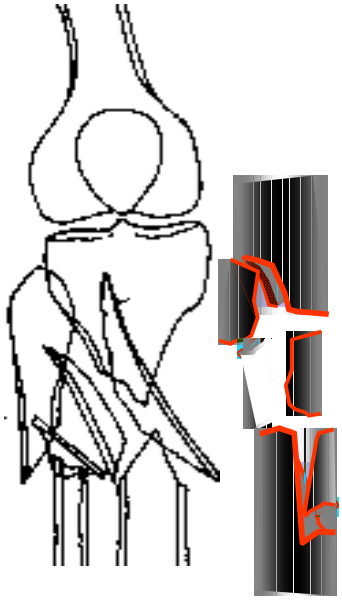


Example: Wedge fracture

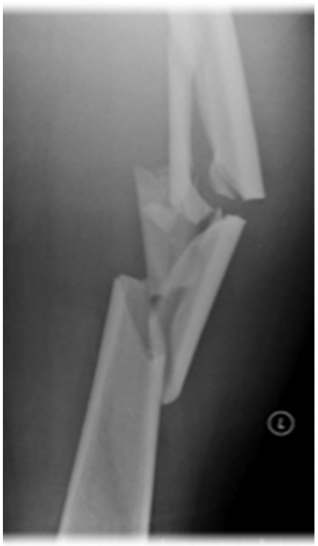


Butterfly segment

Example: Multifragmentary fracture (comminuted)



Multiple fragments



Which bone?

1. Femur

2. Tibia

3. Humerus

Which bone?

1. Femur

2. Tibia

3. Humerus ✓

Which part of the bone?

1. Intraarticular fracture

2. Metaphyseal fracture

3. Diaphyseal fracture

Which part of the bone?

1. Intraarticular fracture

2. Metaphyseal fracture

3. Diaphyseal fracture ✓

What is the fracture pattern?

1. Transverse

2. Spiral

3. Wedge

What is the fracture pattern?

1. Transverse

2. Spiral ✓

3. Wedge

Systematic reading of x-rays

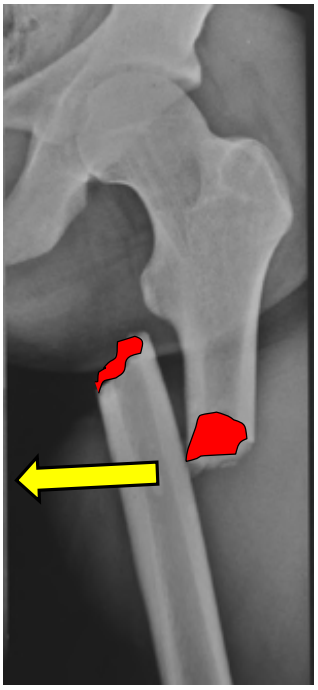
- Describe the fracture displacement:
  - Shortening
  - Angulation
  - Rotation

The x-ray shows a short oblique fracture of the left femur with:

- Medial dislocation
- Shortening of at least 3 cm
- Varus displacement

Systematic reading of x-rays

- Describe the fracture displacement:
  - Shortening
  - Angulation
  - Rotation



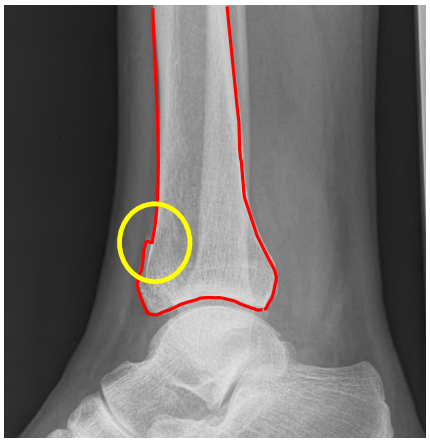
Usually with displacement

Describe slide.

More about reading x-rays

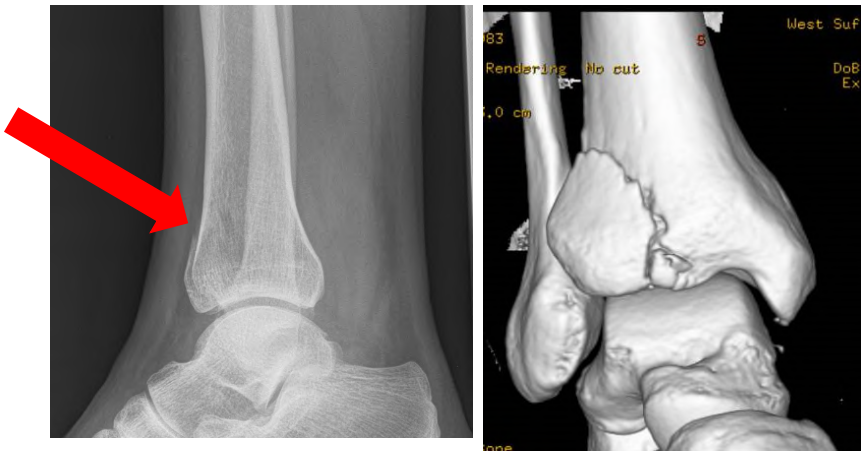
How to spot a difficult fracture?

- Follow the cortex of the bone
- Look for any defects



How to spot a difficult fracture?

- Look for any defects
- Get more information with a CT scan



How to spot a difficult fracture?

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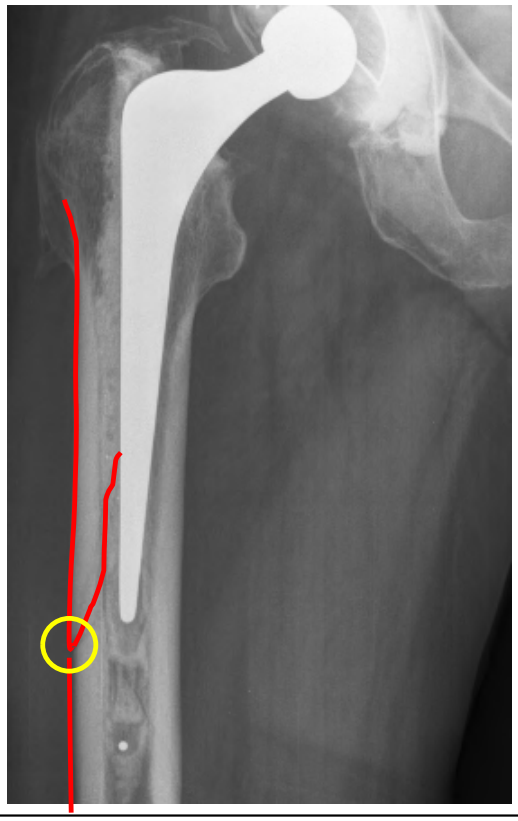
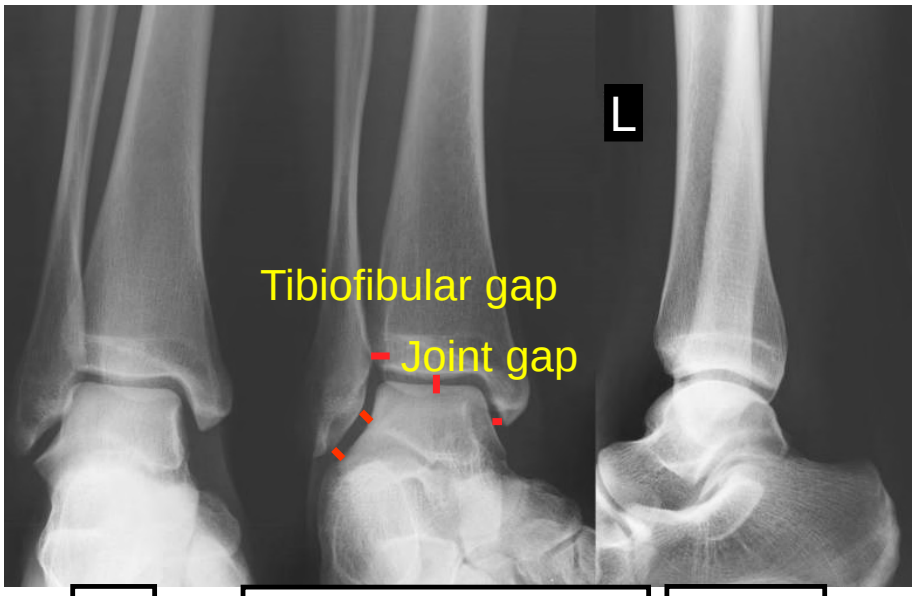


Articular fractures: normal aspect malleoli



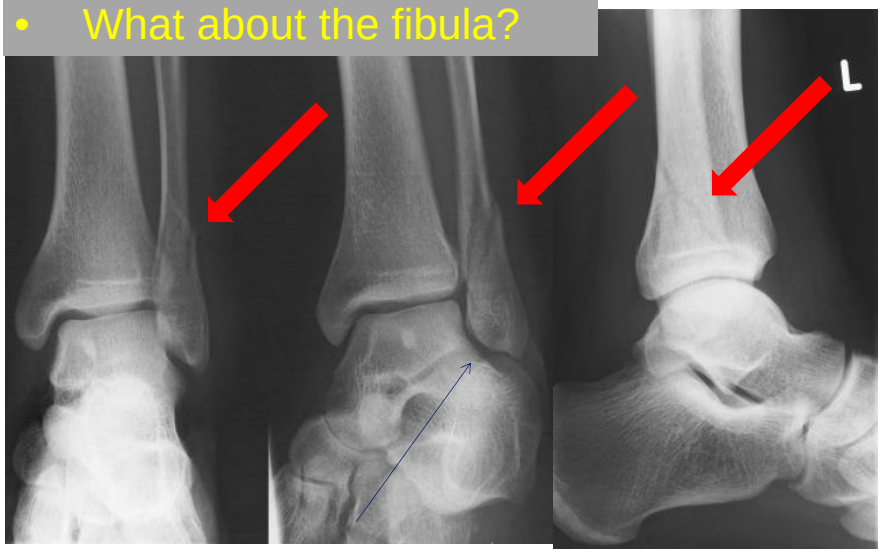
AP | 20° medial rotation | Lateral

This is the normal aspect of a maleollar joint.

- Tibiofibular gap is less than 6 mm.
- Joint gap is of equal width.
- Joint surfaces are parallel to each other.
- Talus is in correct position.

What about this case?

- What about the joint gap?
- What about the fibula?



AP | Medial rotation | Lateral

This x-ray shows a shortened fibula.

The joint gap between the lateral ankle and talus is no longer parallel.

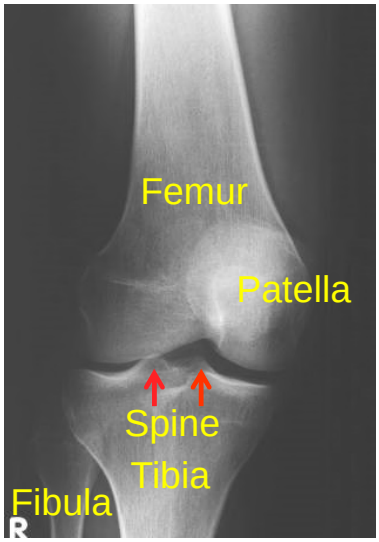
The fibula is rotated and fractured.

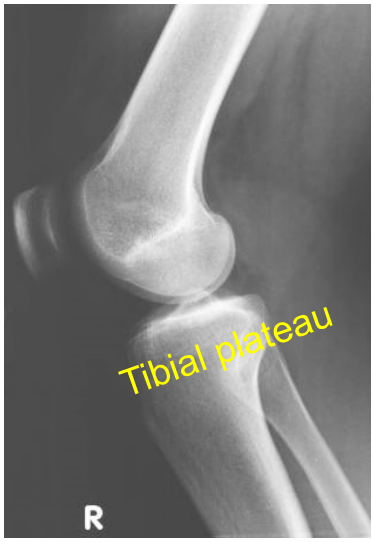
What about this case?

- What about the joint gap?
- What about the fibula?

- Fibula is shortened and rotated due to a dislocated fracture.
- Talus is subluxated laterally.
- Joint gap is no longer parallel and not of equal width.

Articular fractures: normal aspect knee





Here we see a normal knee joint.

- There is no fracture or arthrosis.
- The position of the tibia toward the femur is correct.
- The position of the patella is correct (not too high, not too low).
- The articular surface of the tibial plateau is intact and at the same level on both sides.

Can you describe this fracture?

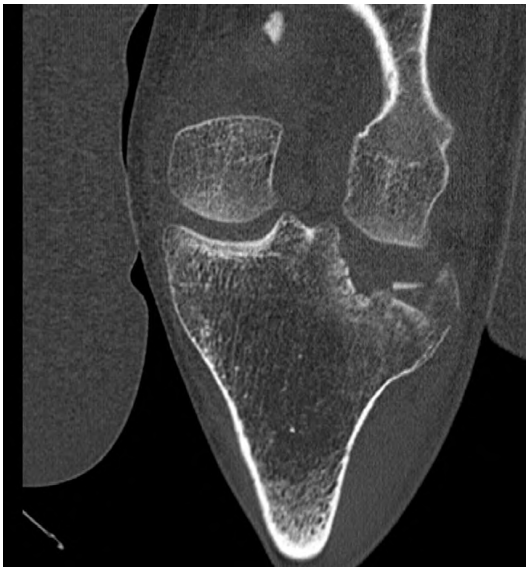
35-year-old woman fell while skiing

If we compare the medial and the lateral tibial head, we see that:

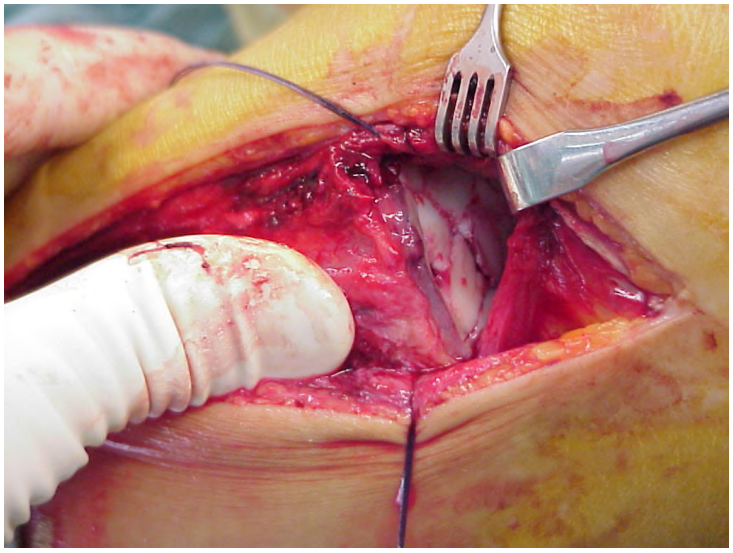
- There is an intact plateau medially.
- There are fractures lines and hyperdense zones medially (ie, compression fractures of cancellous bone).
- This is an indication for a CT scan to clearly visualize the whole fracture.

Get more information

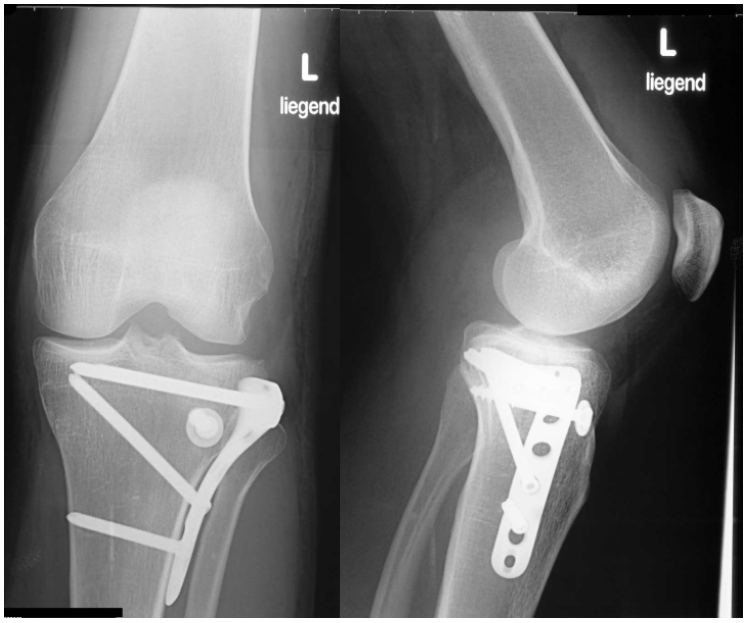
- CT scans



Intraoperative reduction of tibial plateau

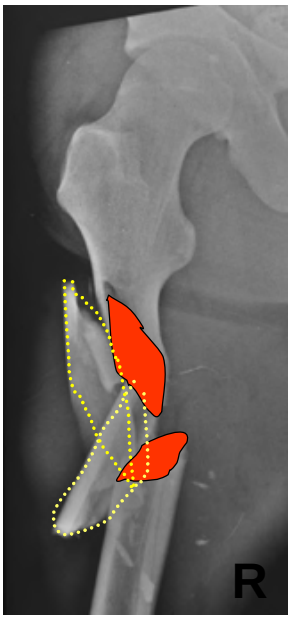


Surgical treatment



- L-plate 4.5
- Cancellous bone screw 6.5 *(lag screw)* with washer

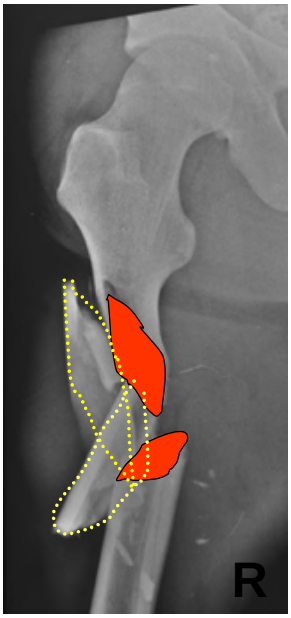
Can you describe this fracture?



Ask the audience.

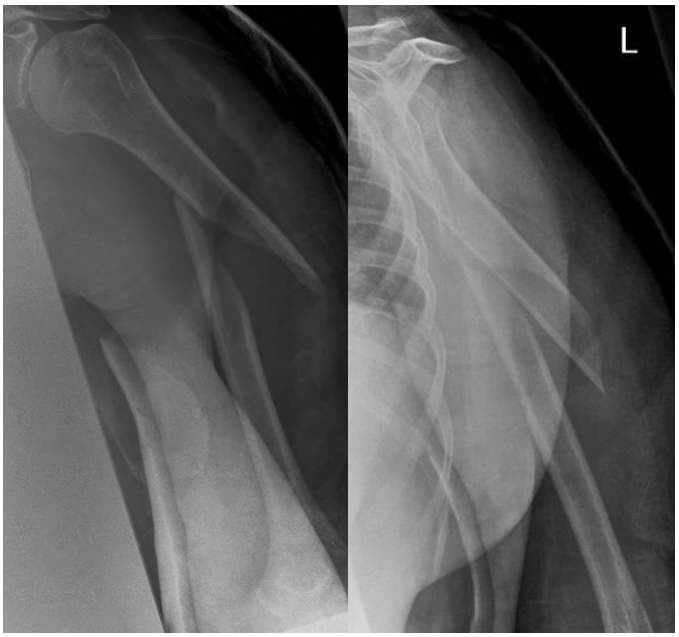
Can you describe this fracture?

- Right femoral fracture
- Subtrochanteric fracture
- Multifragmentary



Repeat the answers.

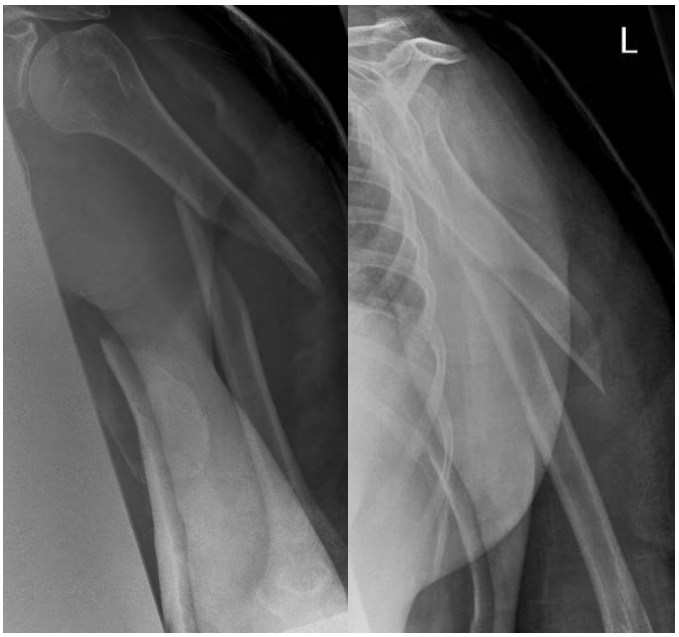
Can you describe this fracture?



Ask the audience

- Which bone?
- Which segment?
- Which fracture pattern? Which type of fracture?

Can you describe this fracture?



- Humeral
- Diaphyseal
- Spiral

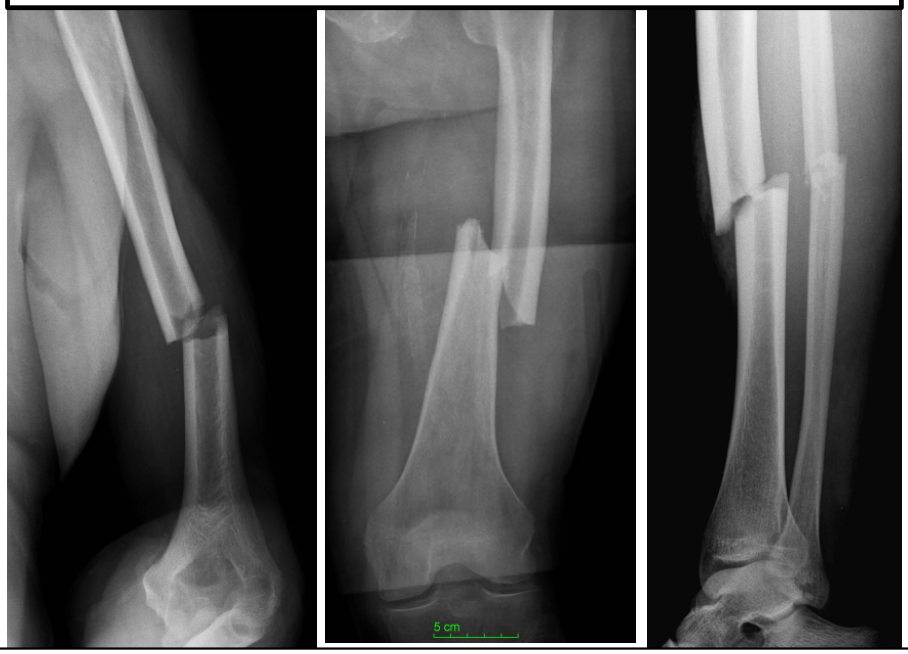
Repeat or confirm the answers.

Which bone is it?

Ask the audience.

Which bone is it?

Humerus	Femur	Tibia



Ask the audience.

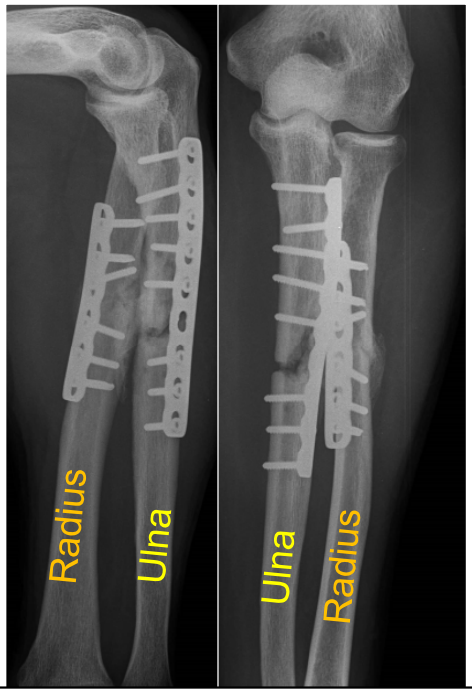
What do you see here?

- 8 weeks postoperatively
- What would you tell the patient?

This x-ray shows an osteosynthesis with plate and screws in a tibial fracture after 8 weeks.

- The fracture is still visible, which is normal after only 8 weeks, without axial malalignment.
- There is minimal callus formation on the lateral side.
- There is no screw loosening. The osteosynthesis is stable.
- Fracture healing is underway.

What do you see here?



- 8 months postoperatively
- What about the radial fracture?
- What about the ulnar fracture?

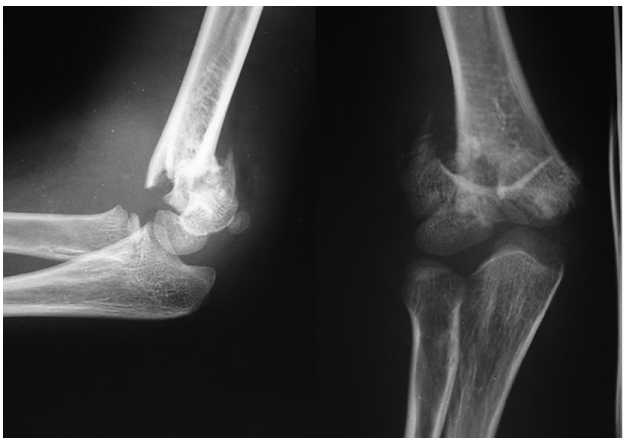
- The radial fracture is healing.
  - There is little callus on the radius.
- The ulnar fracture is still open.
  - There is a large gap in the ulna without any visible callus formation yet. This is called atrophic pseudarthrosis.
- There is no screw loosening. The plates are (still) stable.
- After 8 months no further healing can be expected.
- Reoperation of the ulna is indicated.

What do you see here?

- 3 months postoperatively
- What would you recommend to the patient?

- This fracture is stable and healing with callus formation.
- Recommend doing a follow-up plus x-ray in 1 year.

What do you see here?



- How old is the patient?
- What is your diagnosis?

- This is the x-ray of a child about 8 years of age with open epiphyseal lines.
- The patient has a dislocated supracondylar fracture of the humerus.

Summary

You should now be able to:

- Read x-rays systematically
- Describe fracture patterns
- Interpret healing of fractures

After this lecture you should be able to:

- Read x-rays systematically.
- Describe fracture patterns.
- Describe how a normal ankle and knee joint should look like.
- Spot difficult fractures.
- Read the “healing” of a fracture.