- A 35-year-old morbidly obese male presents with global right ankle pain and significant swelling after a misstep over one of his cats on the stairs. He is unable to bear weight, but the skin is intact.

- Describe the x-rays you see

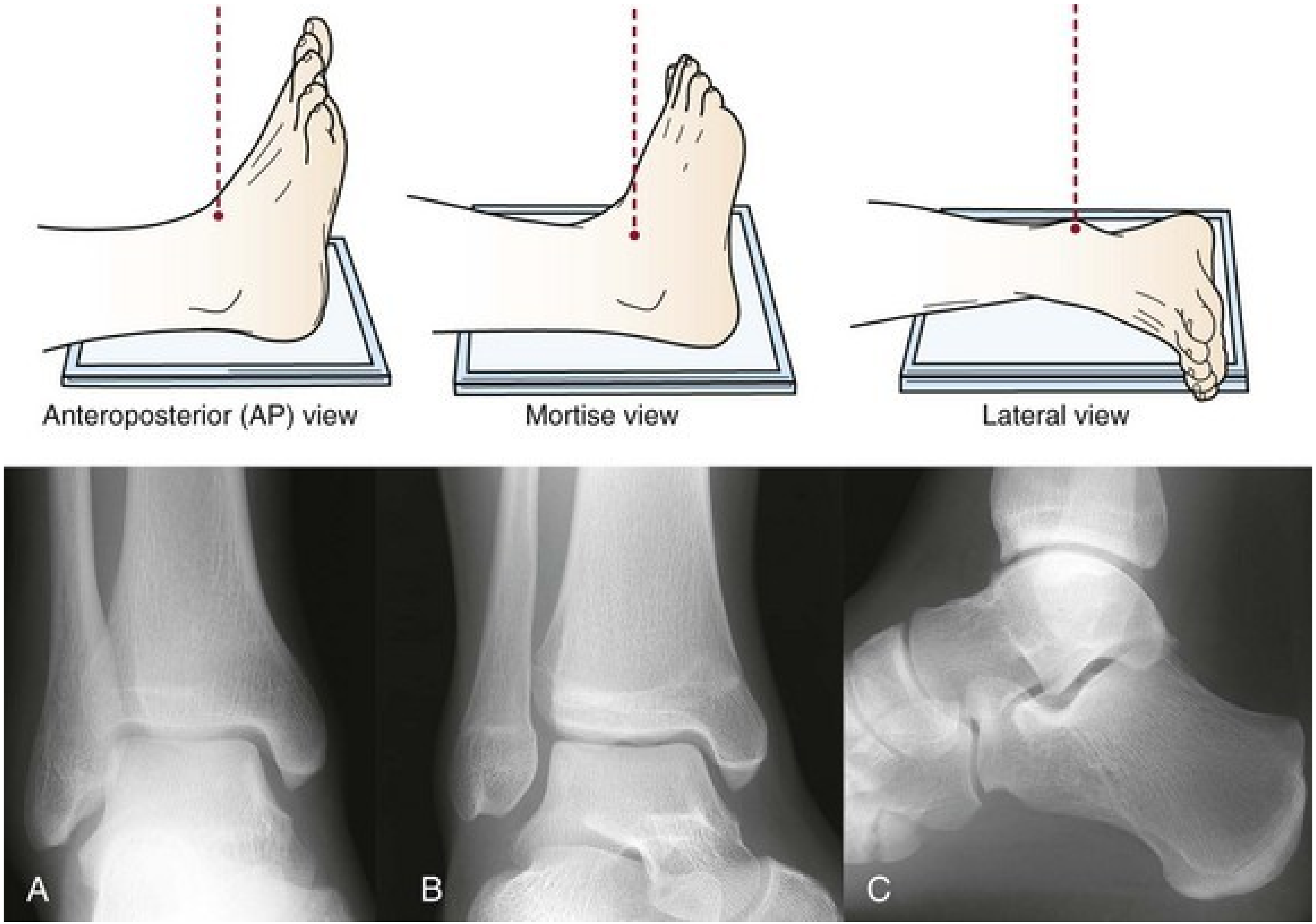
- Those are AP & Lat views x-rays of the ankle, showing <u>bimalleolar</u> ankle fracture with <u>lateral talar shift.</u>

- Describe the fracture orientation you see, and accordingly classify the fracture according to Lauge-Hansen Classification

1. **Medial** malleolus **transverse** fracture
2. **Lateral short oblique** fibula fracture extending from anteroinferior to posterosuperior

- According to fracture characteristics, this is a **supination external rotation** fracture

- How would you radiologically approach ankle injuries ?


Anteroposterior (AP) view
Mortise view
Lateral view
A
B
C

Anteroposterior View

- Quantitative analysis
  - Tibiofibular overlap

    <6mm is abnormal = syndesmotic injury
  - Tibiofibular clear space

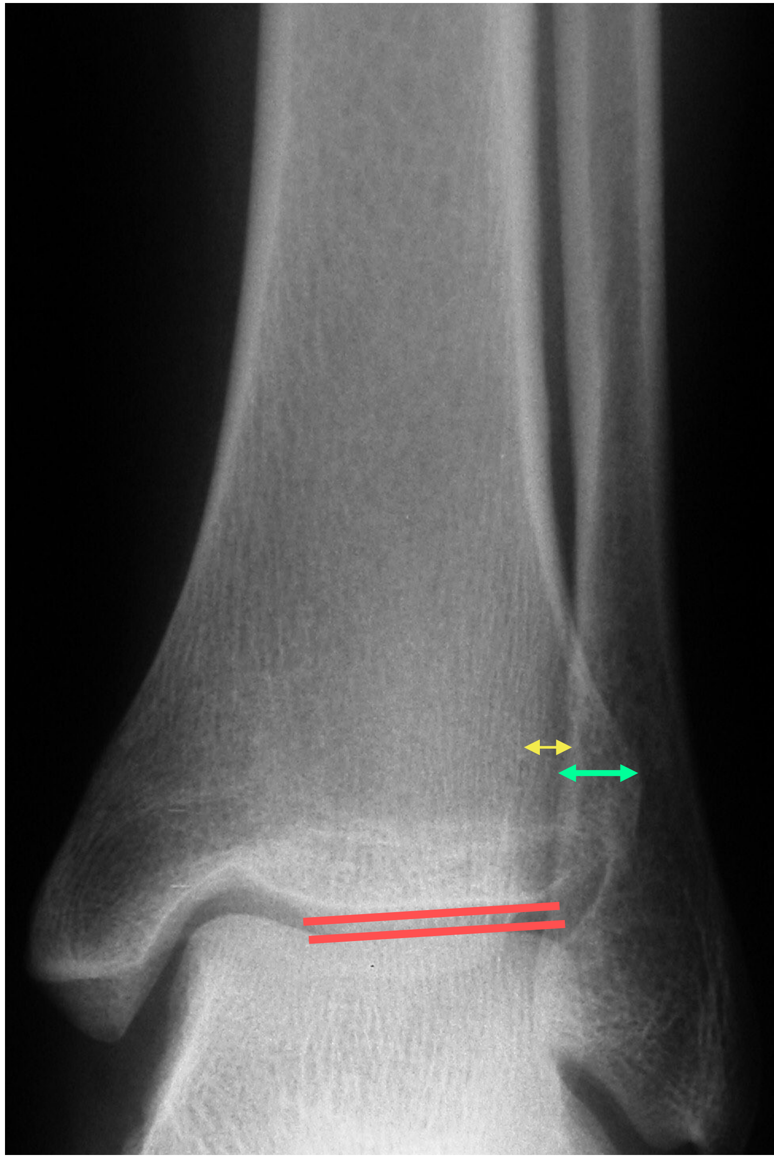
    >5mm is abnormal = syndesmotic injury
  - Talar tilt:

    >2mm is considered abnormal

    line drawn parallel to articular surface of distal tibia

    second line drawn parallel to talar surface

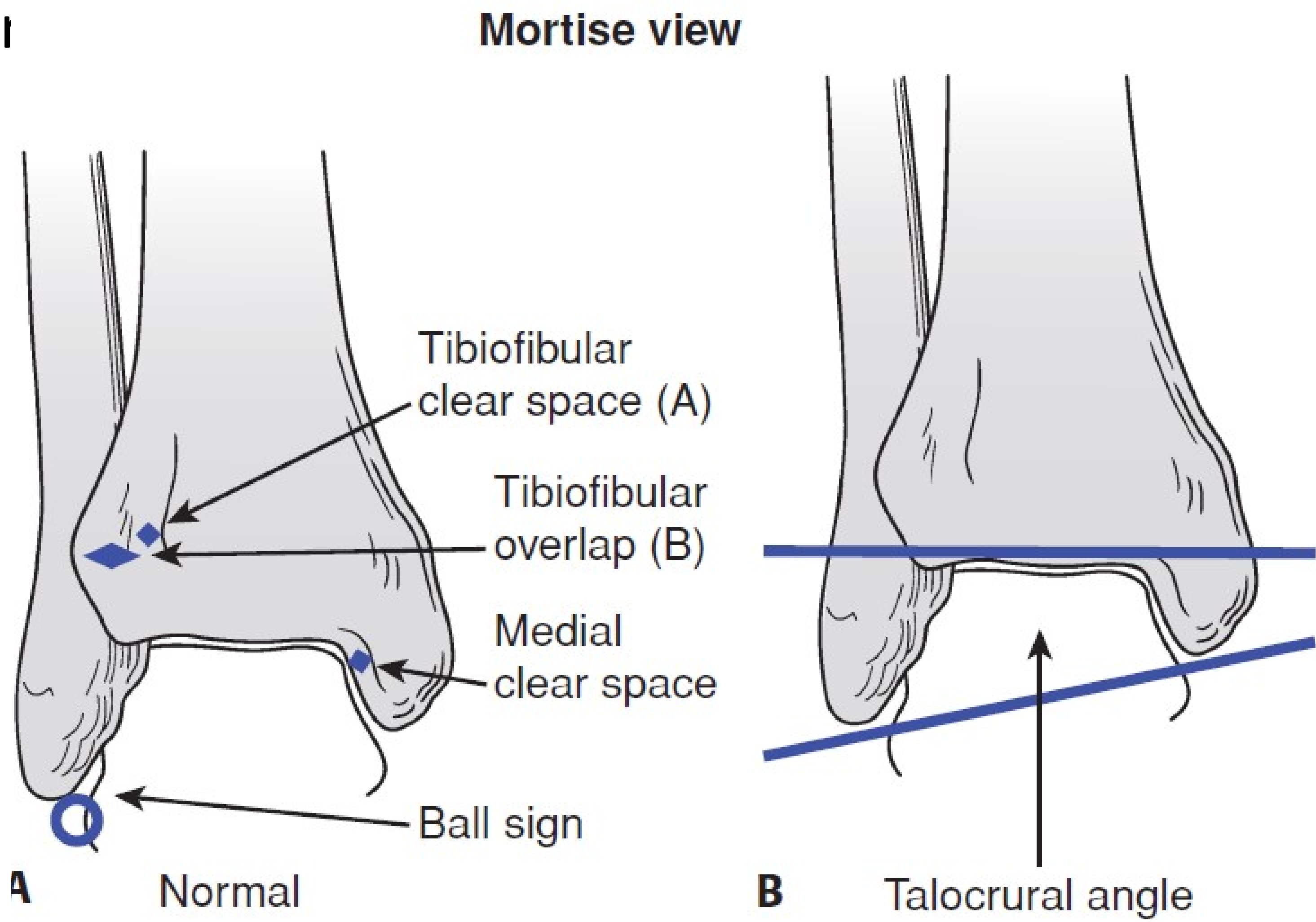
    should be parallel to each other



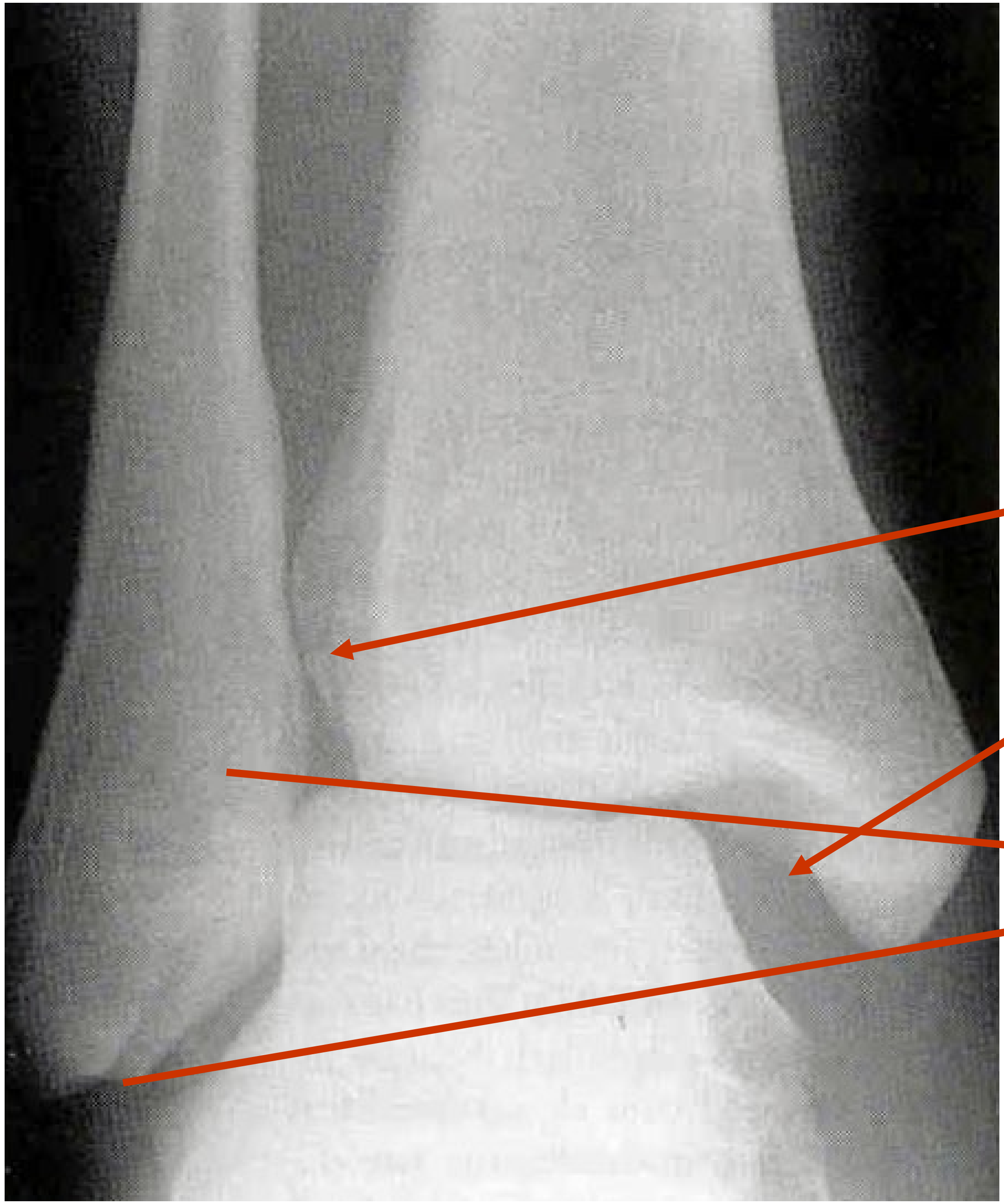
Consider a comparison with radiographs of the normal side if there are unresolved concerns of injury

Mortise View

- Foot is internally rotated and AP pı
  is performed
- Abnormal findings:
  - medial joint space widening >4mm
  - talocural angle <8 or >15 degrees (comparison to normal side is helpful)
  - tibia/fibula overlap <1mm
- The "ball" sign is an unbroken curve connecting the recess in the distal tip of the fibula and the lateralprocess of the talus



Syndesmotic Injury with Deltoid Ligament Rupture



Lateral View

- Posterior mallelolar fractures
- Anterior/posterior subluxation of the talus under the tibia
- Angulation of distal fibula
- Talus fractures
- Associated injuries

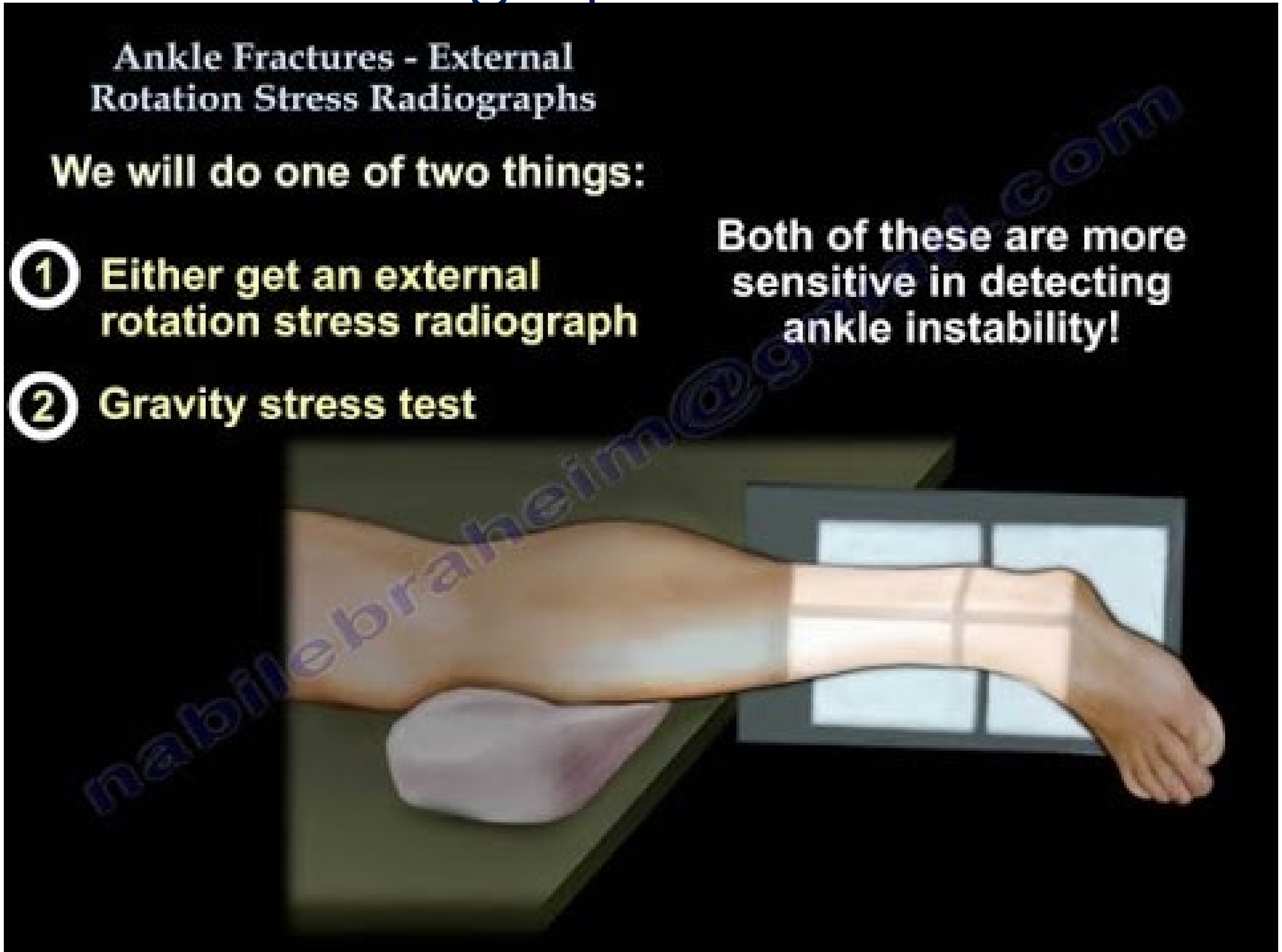
Stress Radiograph

- Medial tenderness, ecchymosis, swelling are poor predictors of deltoid incompetence

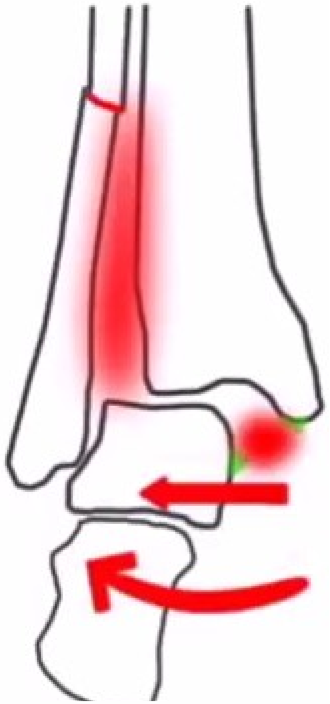
- Stress radiographs necessary for Weber B fractures to decide between operative (SER IV) vs. non-operative (SER II) treatment

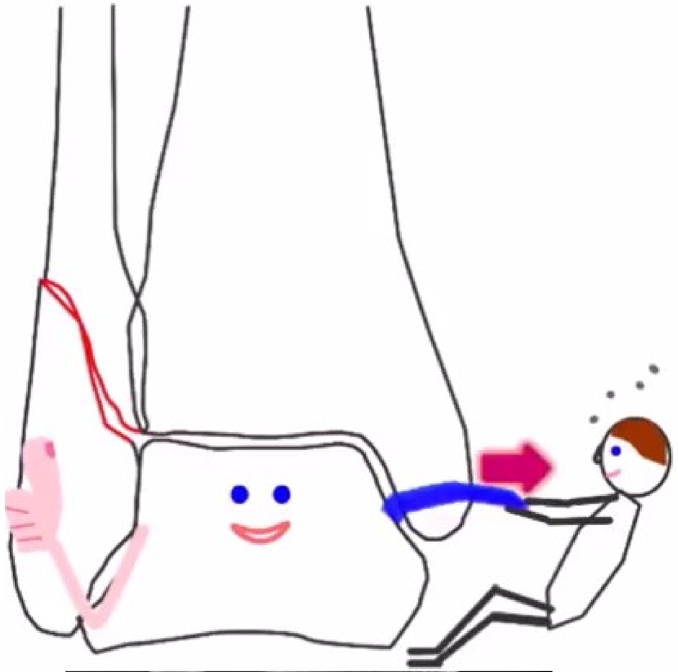
    - McConnell, 2004

Stress Radiograph



WB FILMS FOR UNSTABLE ANKLE FRACTURE





Weight-bearing radiographs are the best method of evaluating stability of isolated distal fibula fractures.

What are Radiographic signs of instability ?

- Abnormal valgus or varus tilt
- Increased mortise width associated with shortening/displacement of fibula
- Talus subluxation
- Fracture of posterior or medial malleolus




What other radiological studies would you request ?

Ct :- help determine joint involvement
-pre operative planing
-hindfoot and midfoot evaluation

Mri : -tendon and ligaments injury assessment

Describe Lauge-Hansen Classification

Lauge-Hansen Classification

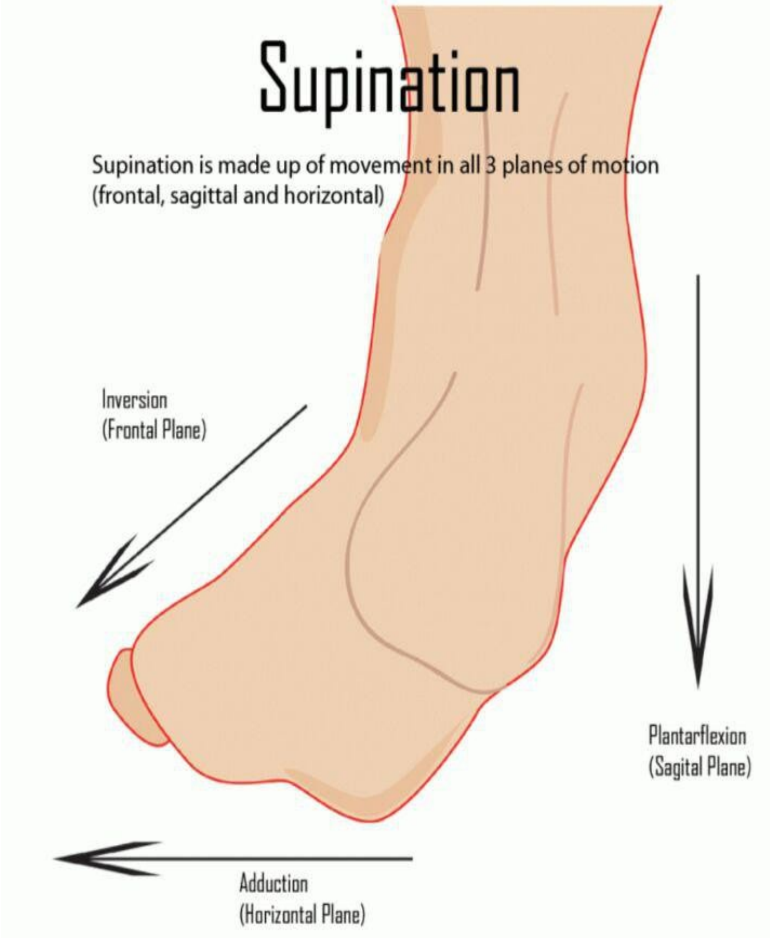
1. Supination–external rotation -SER
2. Supination-adduction -SAD
3. Pronation External Rotation -PER
4. Pronation-abduction -PAB

- **Golden rule : Tension side fails first**

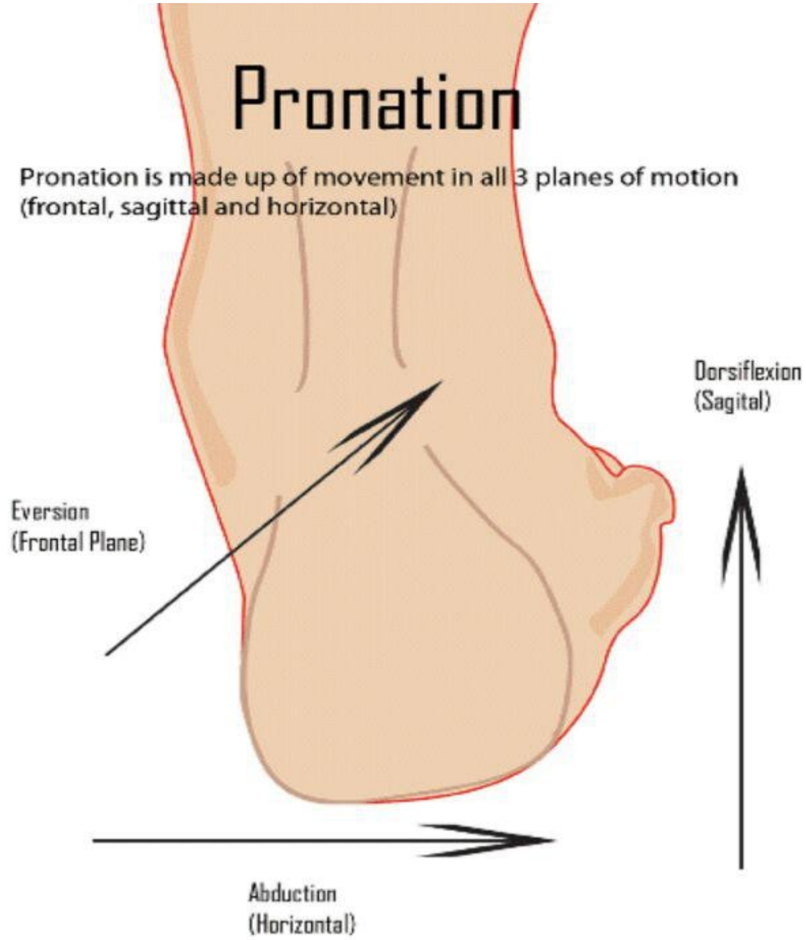
Terminology used in Lauge-Hansen

- 1st Word : position of foot at time of injury
- Supination/pronation—position of the foot as it rotates around the subtalar joint

Supination



Pronation



Terminology used in Lauge-Hansen

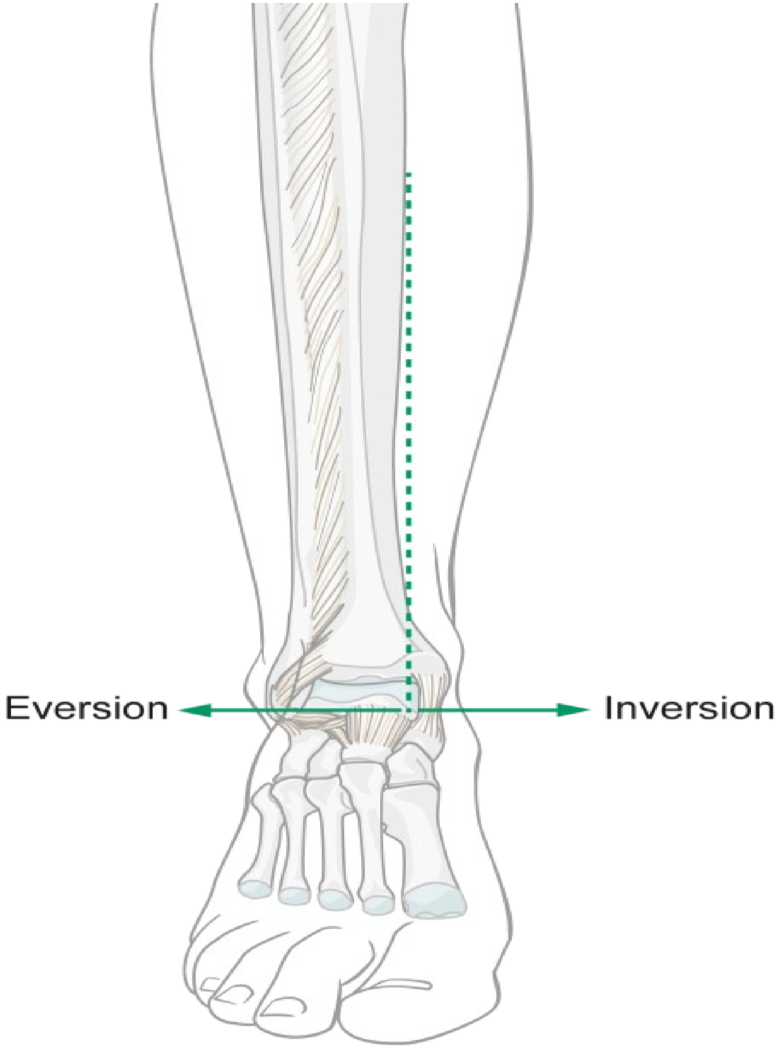
2nd Word : Direction of force

<u>ER / IR</u>

- Rotation of the <u>talus</u> around axis of the <u>tibia</u>

<u>Adduction/abduction</u>

- Rotation of the <u>talus</u> around <u>its long axis</u>

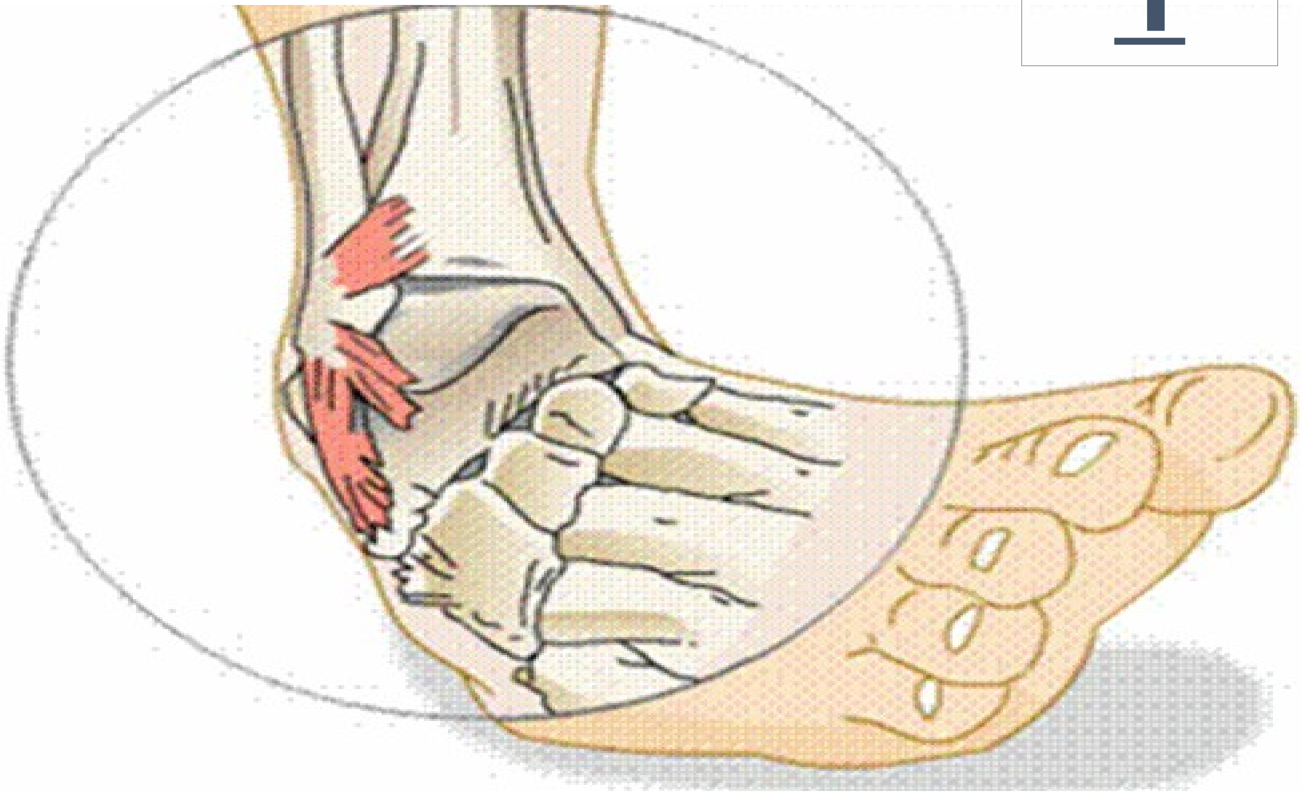


Supination Adduction

1

Supination Adduction

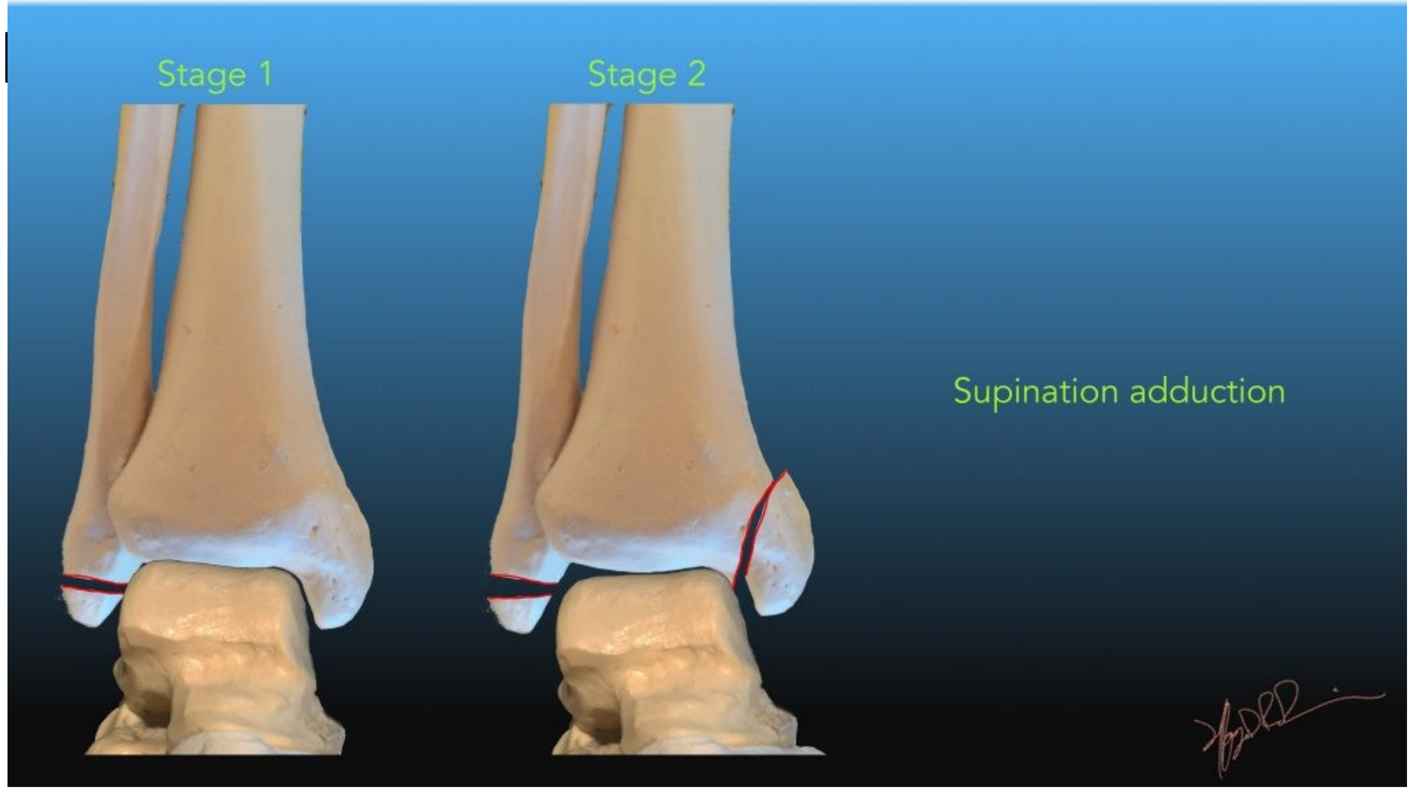
foot force



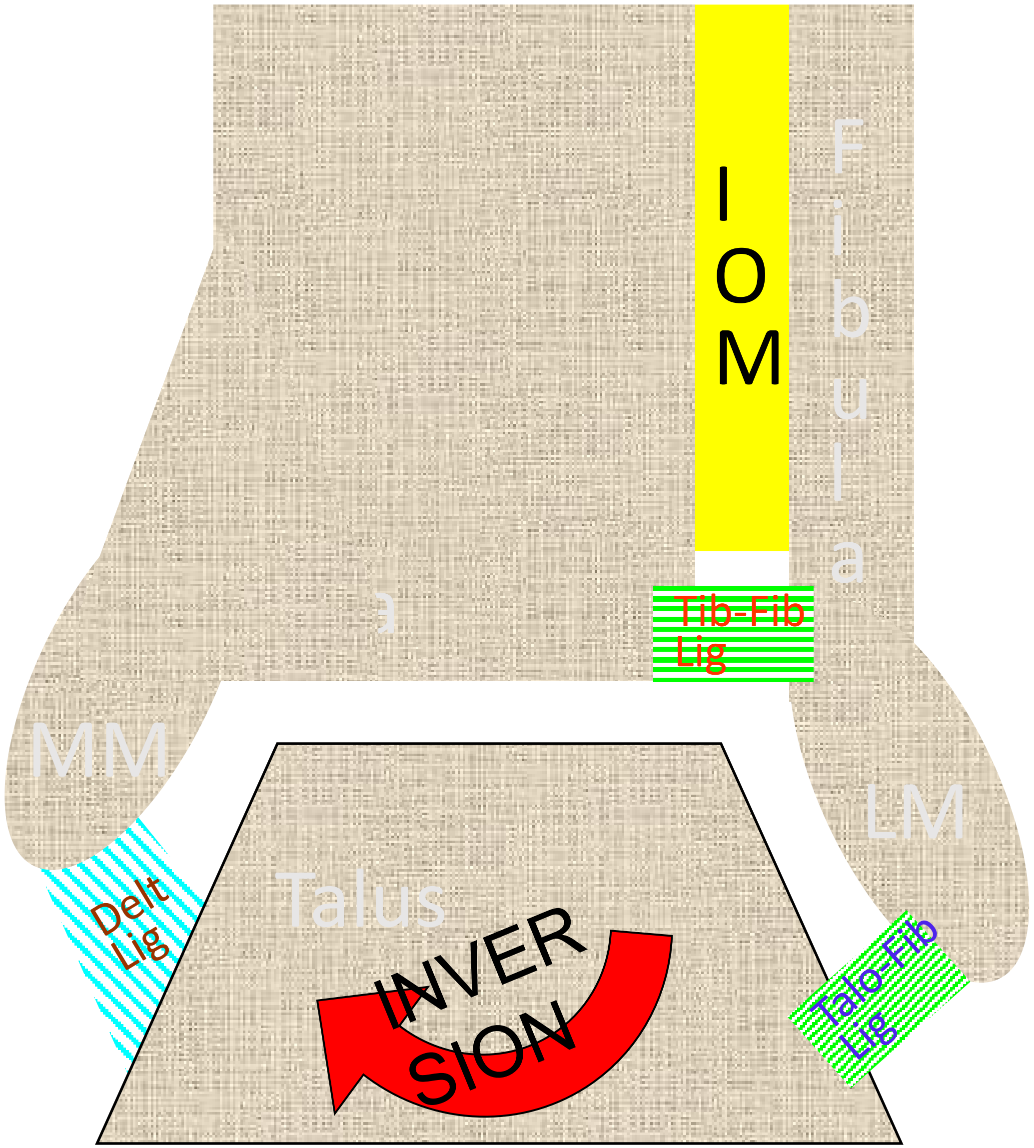
Golden rule = tension side fails first

Supination-adduction

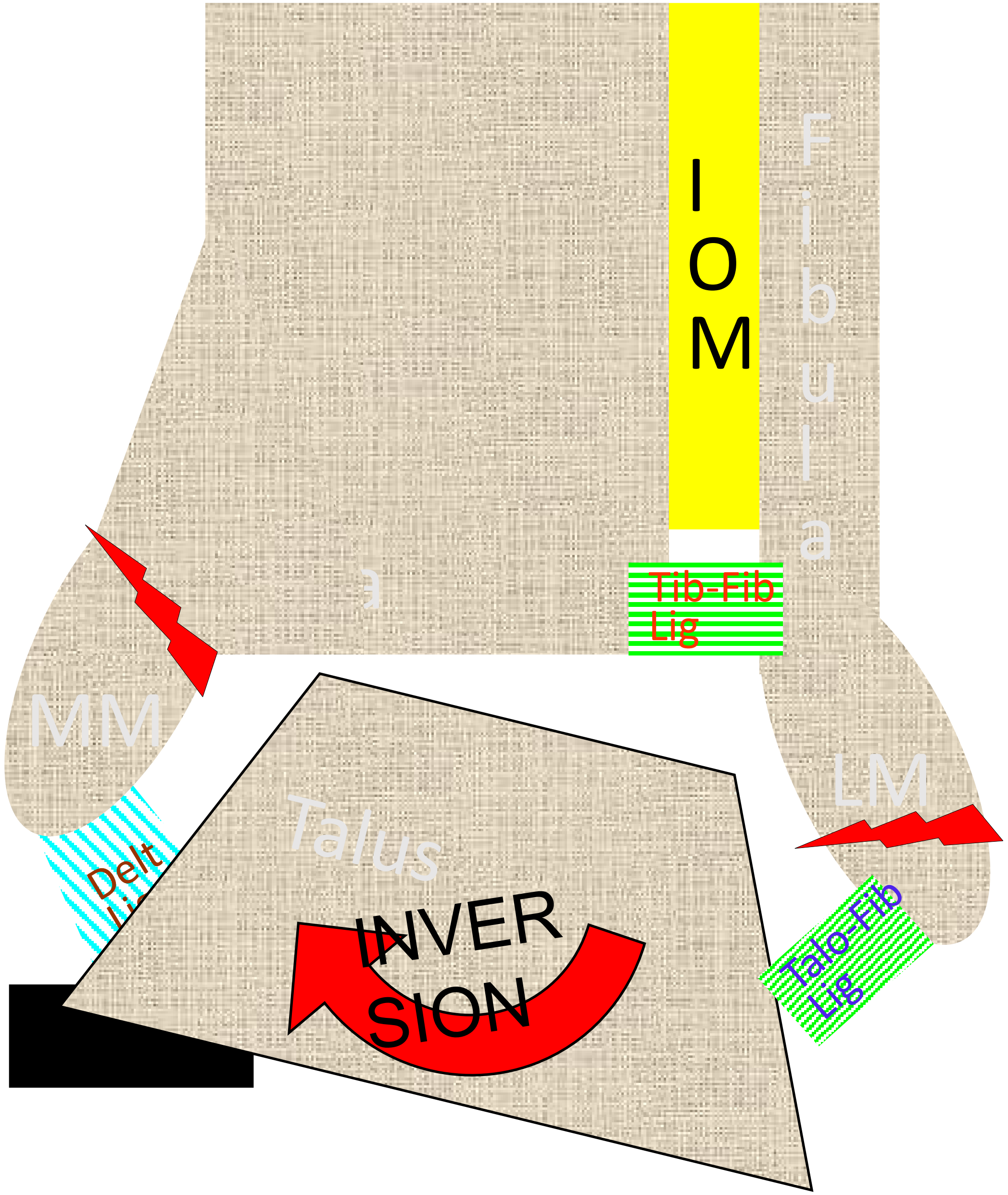
- • Stage I—transverse distal fibula fracture at or below level of ATFL or lateral ligament injury
- • Stage II—oblique or vertical fracture of medial malleolus



Mechanism of injury



Mechanism of injury



Supination External Rotation

foot

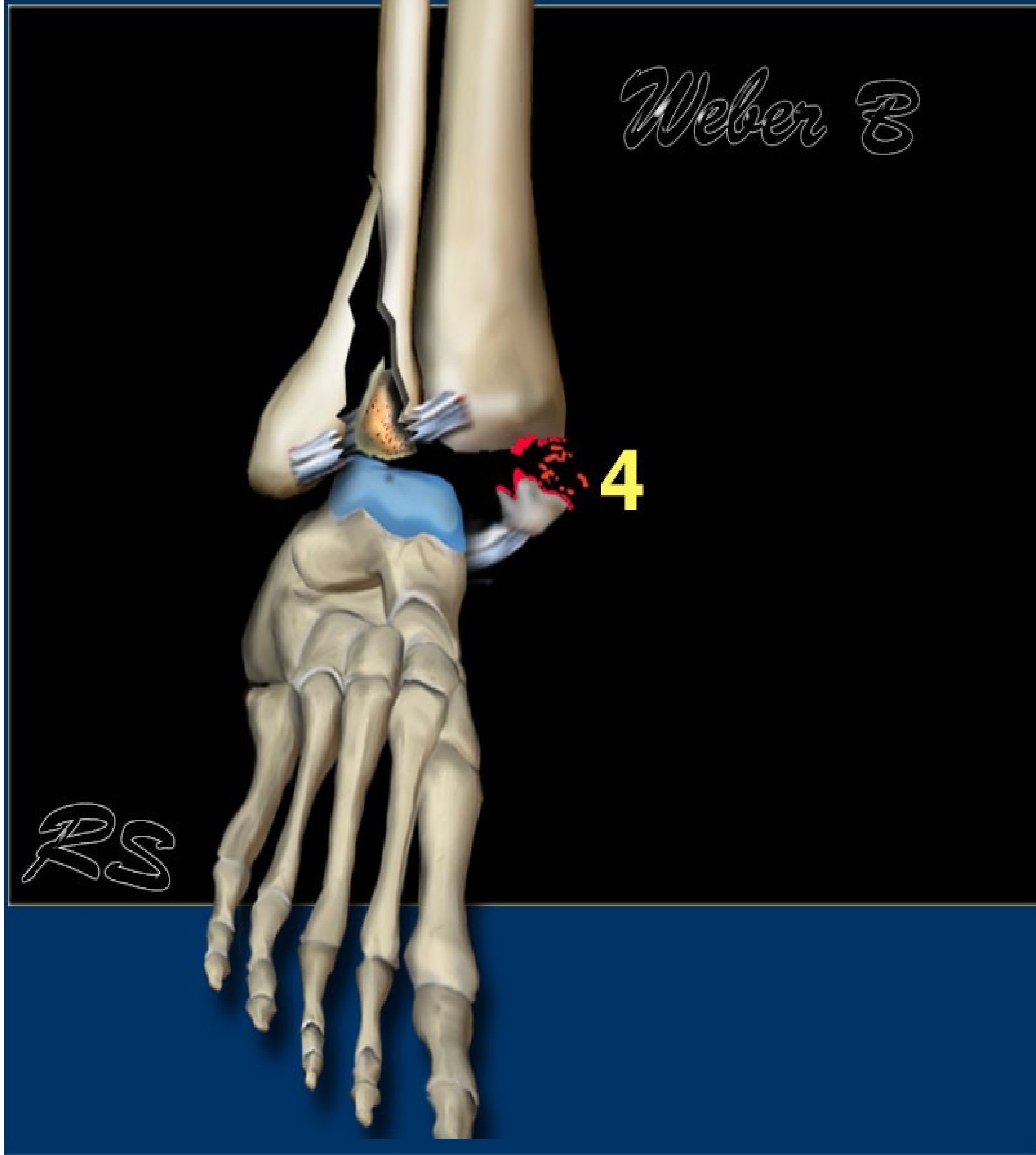
force

2

Golden rule = tension side fails first

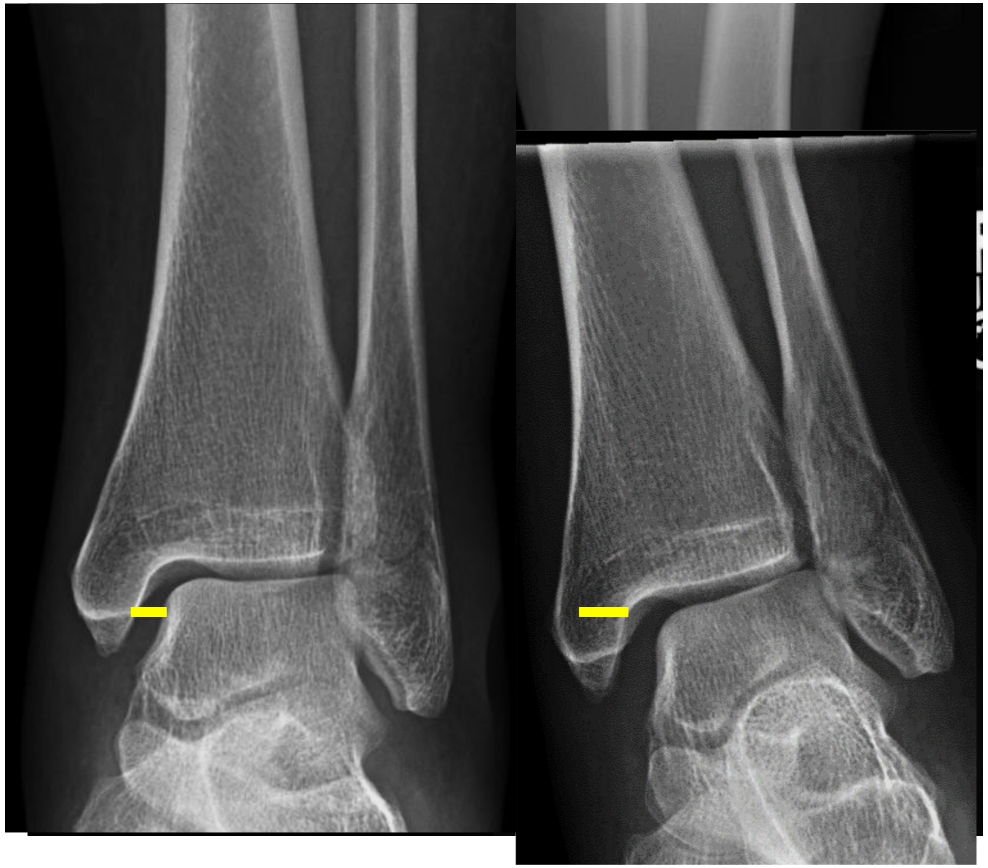
Supination–external rotation

- Stage I—rupture of (AITFL)
- • Stage II—oblique or spiral fracture of distal fibula
- • Stage III—rupture PITFL or avulsion fracture of posterior malleolus
- • Stage IV—transverse or oblique fracture of medial malleolus or deltoid disruption
- • Stress test typically performed to identify stable (SER-II) versus unstable (SER-IV)



SER – Supination External Rotation

- Most common
- Oblique Fibular Fracture
  - Anteroinferior to posterosuperior
- Transverse Medial Malleolar fracture
- SER II – Stable
  - Deltoid intact
- SER IV – Unstable
  - Stress Radiograph



Pronation-abduction

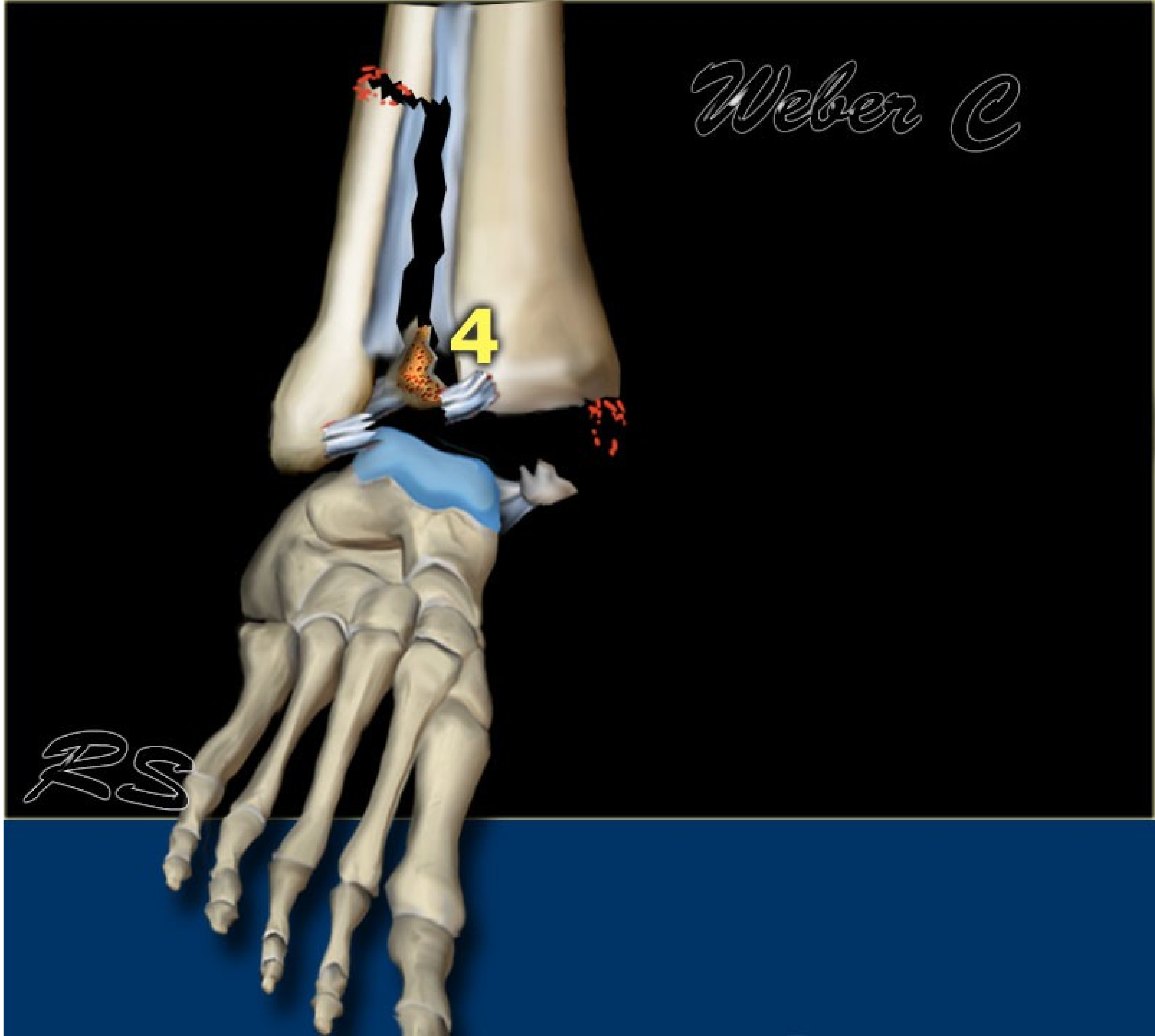
- Stage I—rupture of deltoid ligament or transverse fracture of medial malleolus
- • Stage II—rupture of the AITFL or avulsion of anterolateral tibia chaput tubercle
- Stage III—transverse or comminuted fracture of fibula above level of syndesmosis

PAB – Pronation Abduction

- Comminuted Fibula
- Obvious syndesmotic injury
- Transverse Medial Malleolar Fracture
- ORIF
  - Must include syndesmotic fixation

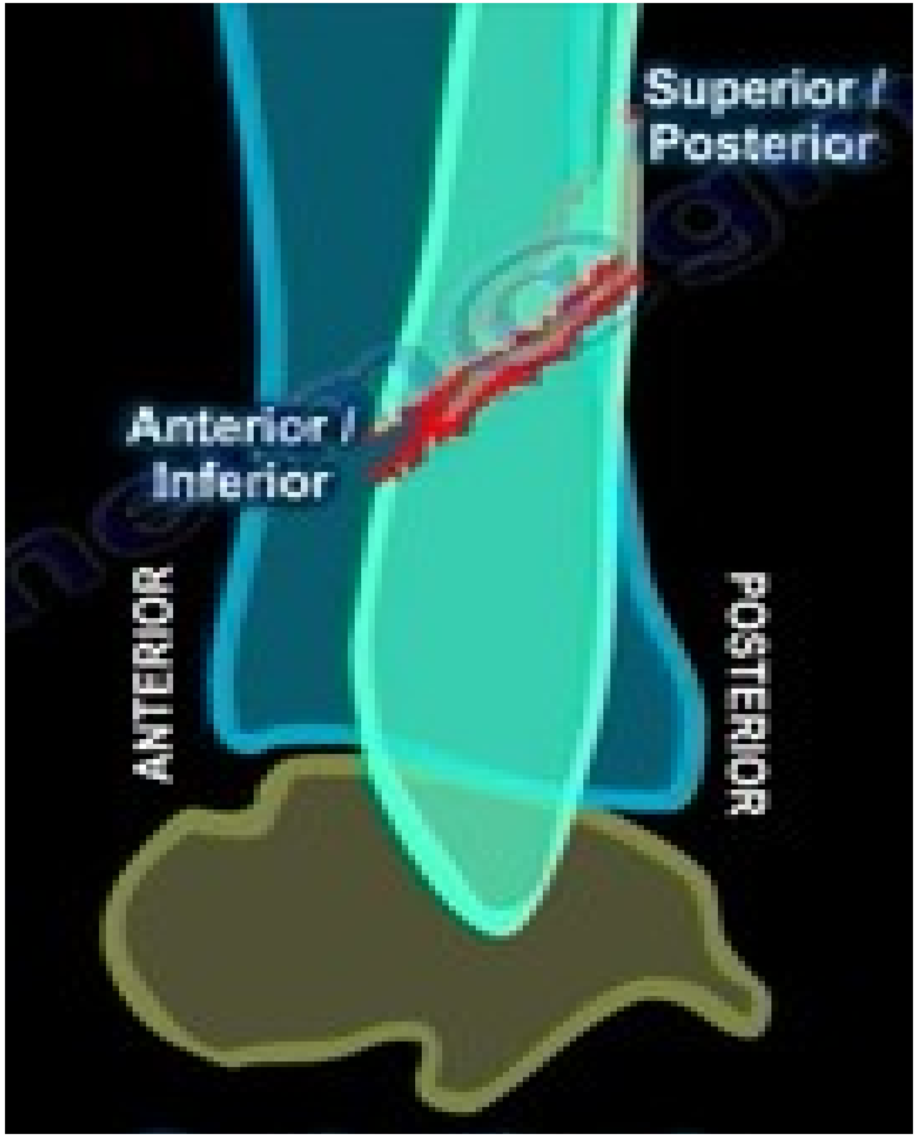
Pronation-external rotation

- Stage I—medial malleolus fracture
- • Stage II— rupture of AITFL or avulsion fracture chaput tubercle
- • Stage III—fracture of fibula above level of syndesmosis
- • Stage IV—rupture of PITFL or avulsion fracture of posterior malleolus

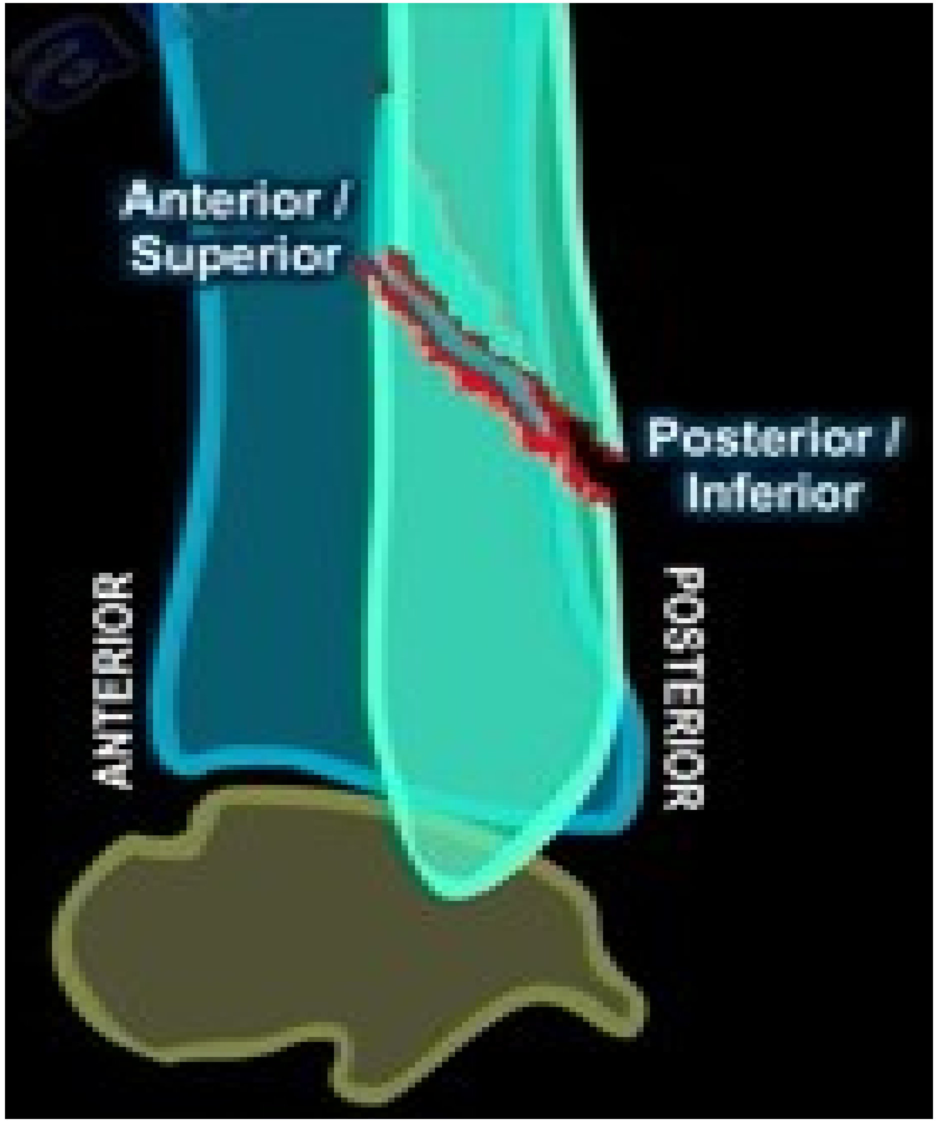


PER – Pronation External Rotation

- High fibular Fracture
- Anteriosuperior to posteroinferior
    - NOT comminuted
- Transverse Medial Malleolar Fracture
- High rate of syndesmotic injury

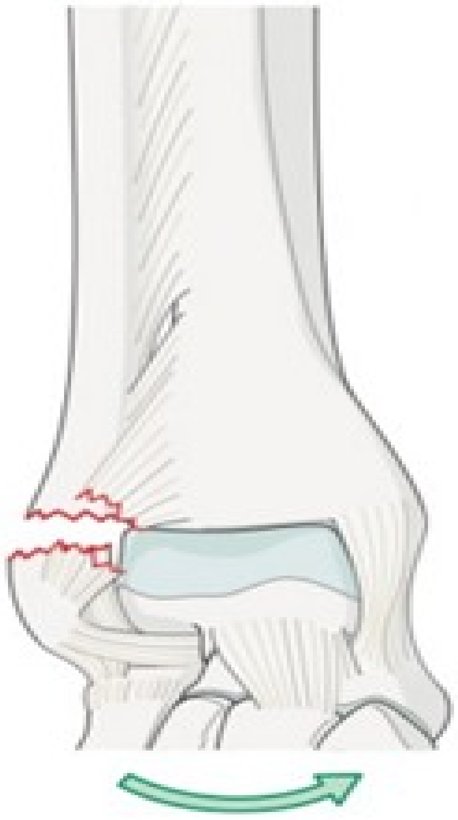


Supination / External Rotation

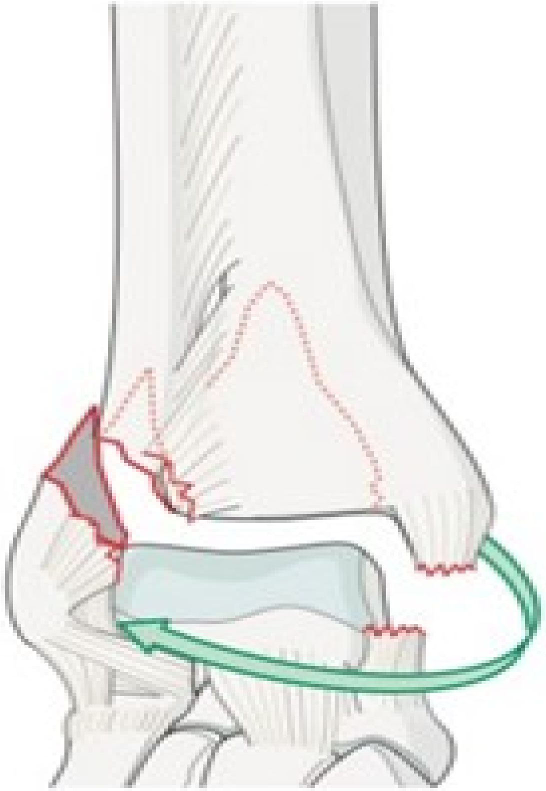


Pronation /
External Rotation

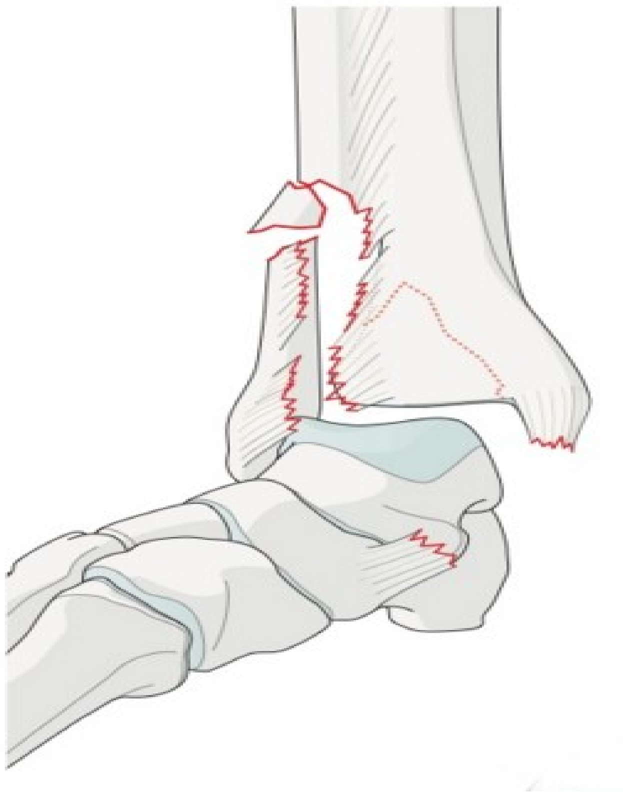
Classification simplified



Weber A
SAD



Weber B
SER / PAB



Weber C
PER

What are the principles of management for ankle fractures ?

All ankle fractures are potential soft-tissue disasters

Clinical examination—soft tissues, nerves, vessels, and general examination of patient

timing

- 1st 6-8 hours or wait till resolution (wrinkle sign)
- All ankle fractures are potential soft-tissue disasters
- **Span**
- **Scan**
- **Plan**

Treatment in general

Nonoperative

- **short-leg walking cast/boot**
  - indications
    - isolated nondisplaced medial malleolus fracture or tip avulsions
    - isolated lateral malleolus fracture with < 3mm displacement and no talar shift
    - bimalleolar fracture if elderly or unable to undergo surgical intervention
    - posterior malleolar fracture with < 25% joint involvement or < 2mm step-off

Operative

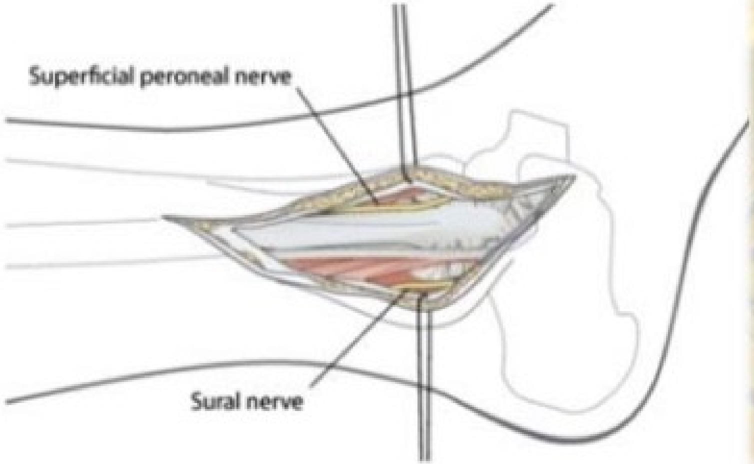
- **open reduction internal fixation**
  - indications
    - any talar displacement
    - displaced isolated medial malleolar fracture
    - displaced isolated lateral malleolar fracture
    - bimalleolar fracture and bimalleolar-equivalent fracture
    - posterior malleolar fracture with > 25% or > 2mm step-off
    - open fractures
    - malleolar nonunions

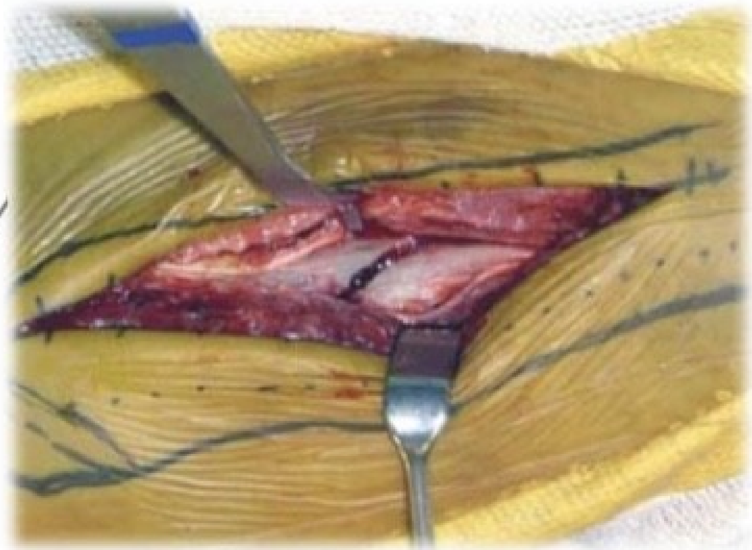
Describe the surgical approach and general techniques for malleolar ankle fractures

Lateral malleolus

1. Approach

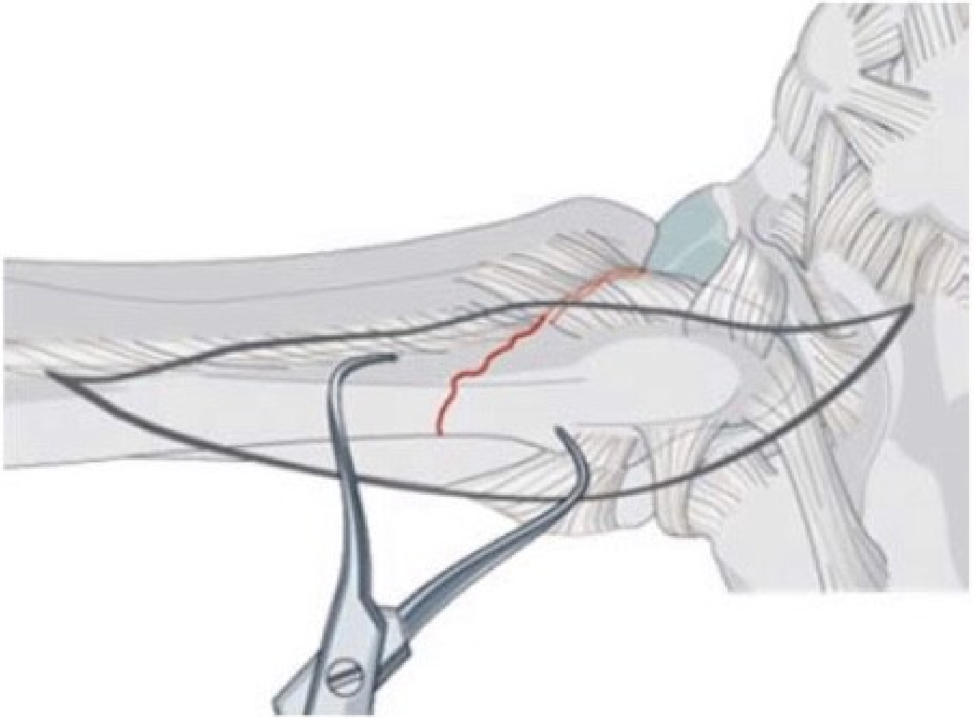
A 10-15 cm straight lateral incision over the distal fibula is made.





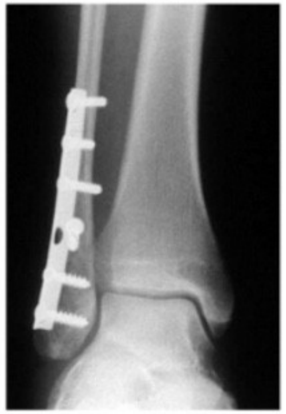
2. Reduction

The fracture is reduced anatomically. Reduction of both length and rotation are important.



3. Fixation (options)

- A 3,5 mm cortex screw is inserted as a **lag screw**. A **neutralization (protection) plate** is added.



- Other options for fixation are **tension band wiring** and…

- …intra medullary fixation of the fibula with a **large screw**.

The distal screws in the fibula do not penetrate the joint. The position must be checked with the image intensifier.

Medial malleolus

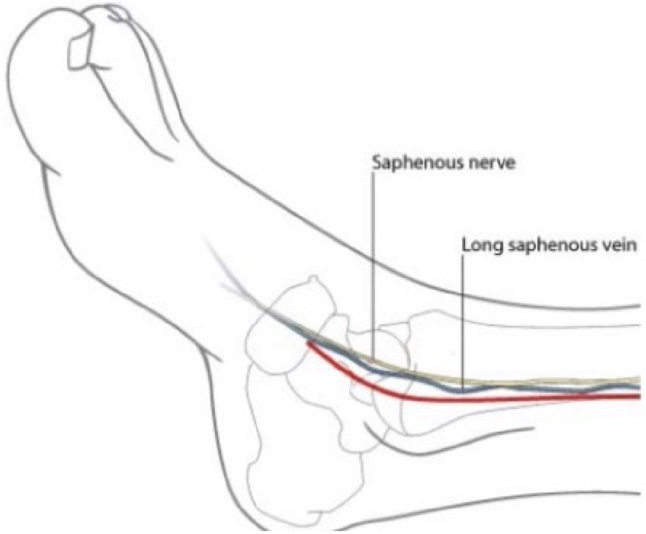
1. Approach

- Incision

The incision starts 2 cm distal to the anterior tip of the medial malleolus and curves towards the anterior edge of the medial malleolus and in the direction of the middle of the distal tibia.

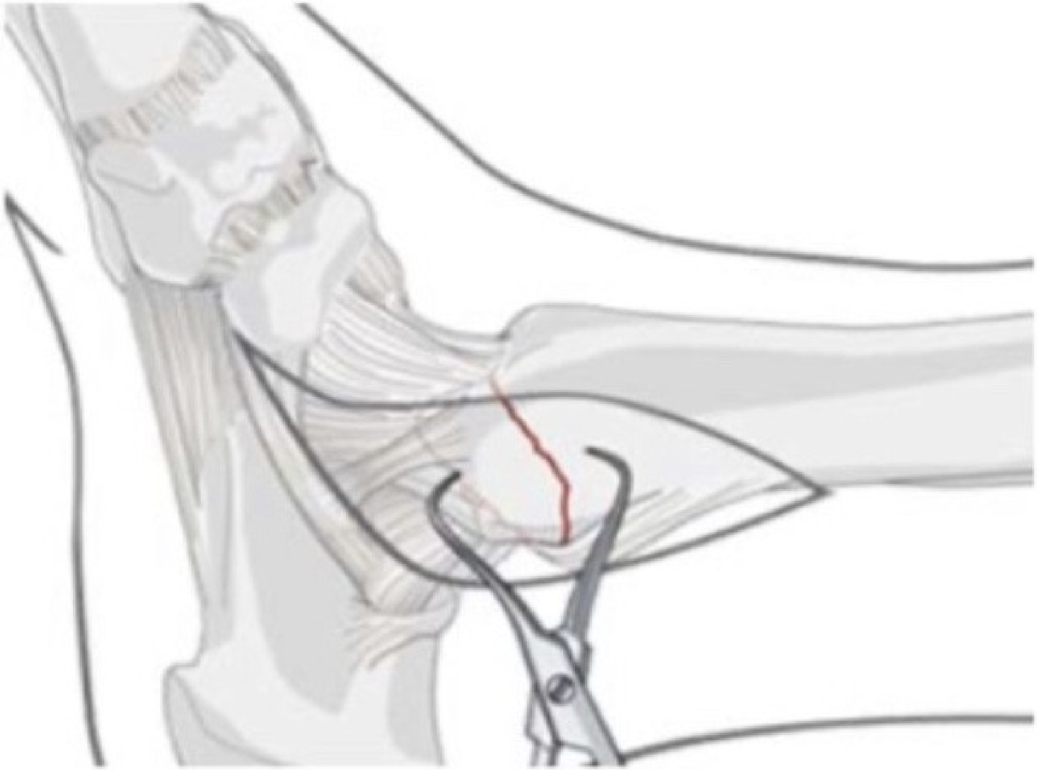
The saphenous vein and nerve are retracted with a vessel loop.

The fracture is exposed and any interposed soft tissue that may preventing reduction is removed.



Reduction

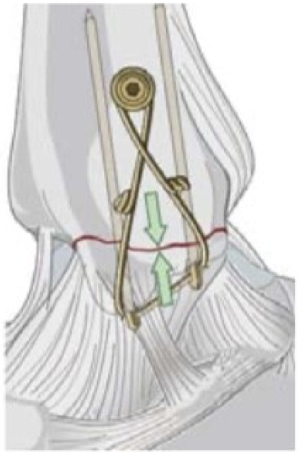
fracture is reduced anatomically.



3. Fixation

- The medial malleolus is fixed with two **partially threaded cancellous bone screws 4,0 mm**.

- If the quality of the bone is not so good, or the fragment is small, a **tension band wiring** can be used.



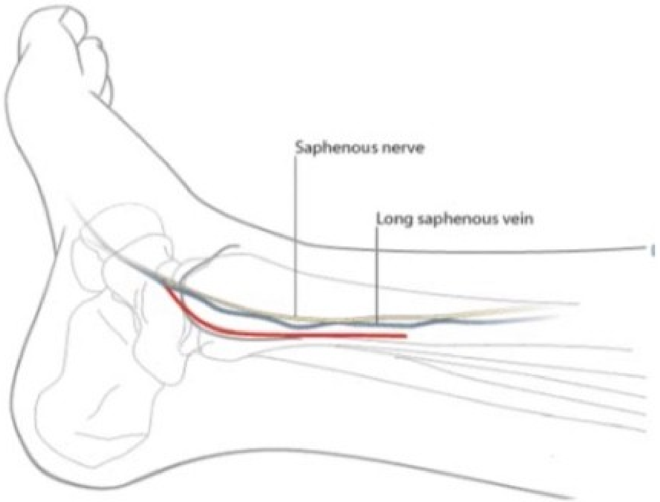
- If the fragment is large and the fracture plane is vertical, as in some type A fractures, the fracture is fixed with a **medial buttress plate**.

Posterior malleolus

1. Approach

This approach is indicated in cases of posterior comminution and/or posterior extension of a medial malleolar fracture.

- The incision starts 1 cm distal and 1 cm anterior to the middle of the tip of the medial malleolus. The incision curves proximally and posteriorly over the tip of the medial malleolus and then follows the direction of the posterior crest of the distal tibia.



Note
Be careful not to damage the saphenous vein and nerve, especially distally.

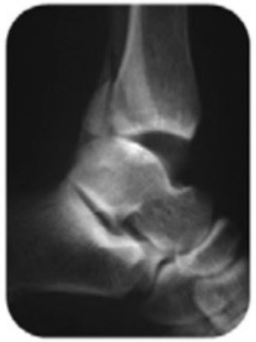
Reduction

The fracture is reduced anatomically.

3. Fixation

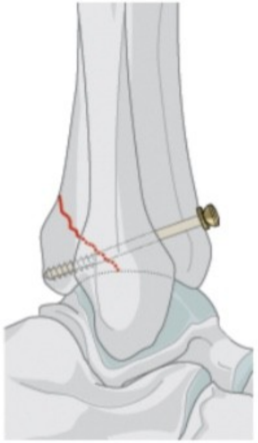
Posterior malleolar fractures of significant size are usually associated with B fracture patterns.
Fracture fixation of the posterior malleolus should be undertaken:

- After the medial and lateral malleoli have been reduced and fixed anatomically.
- If there is persistent posterior subluxation of the talus.

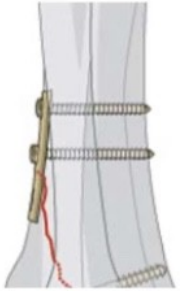


- If the posterior fragment bears more than 20-25% of articular surface.

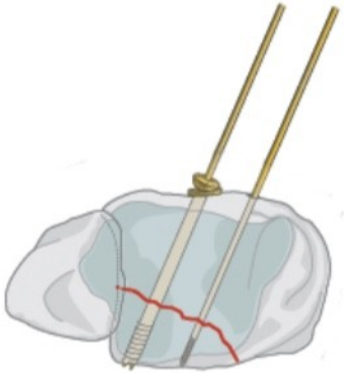
- Antero-posterior screw fixation is usually with **one or two partially threaded cancellous bone screws**, after reduction and temporary K-wire stabilization.



- In large, long fragments, fixed via a posterolateral approach, a **small buttress plate (1/3rd tubular plate 3.5)** can be added.



- **Cannulated screws** can be used if they are available in the OR.



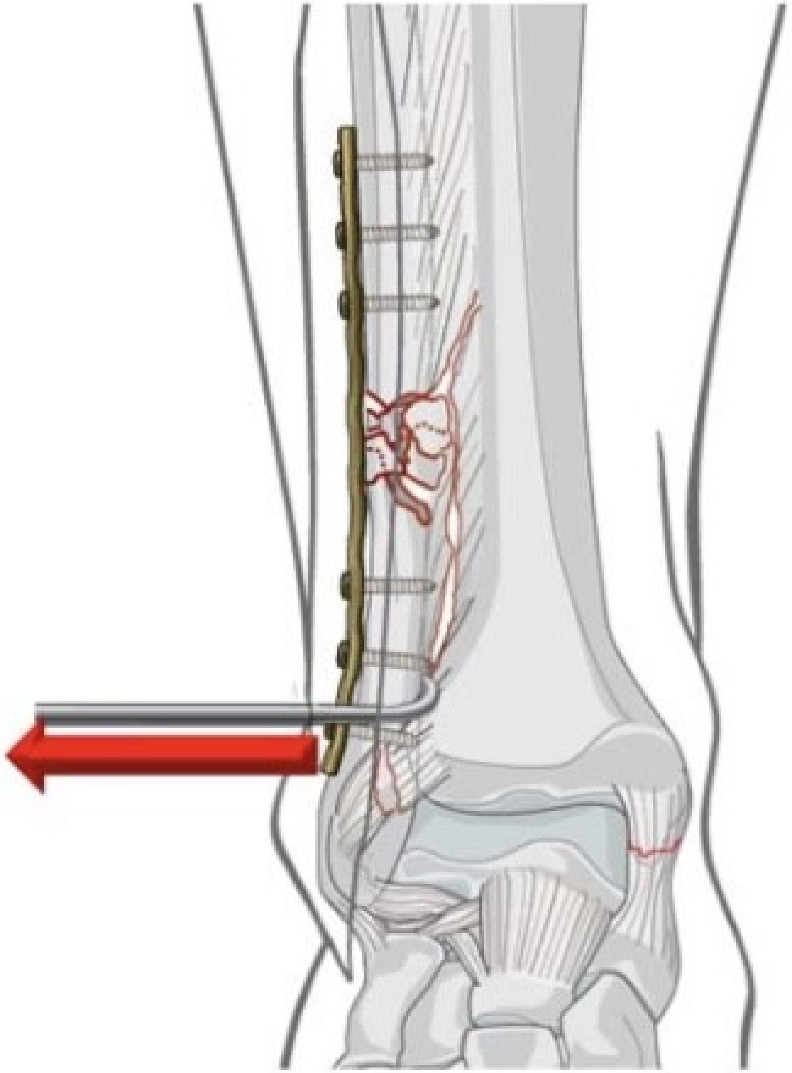
Syndesmotic Injury

- Signs of Syndesmotic Injury
  - Positive Squeeze Test
  - Posterior Malleolar Fracture
  - Wide Medial Clear Space
    - Without any obvious Fractures
    - Need Tib/Fib Xray
  - Proximal Fibular Fracture
  - Medial clear space widening with ER stress test
- Radiographically
  - Wide Tib/Fib Clear Space >6mm
  - Lack of Overlap of the Tibia and Fibula on Mortise

Syndesmosis

1. Stability testing

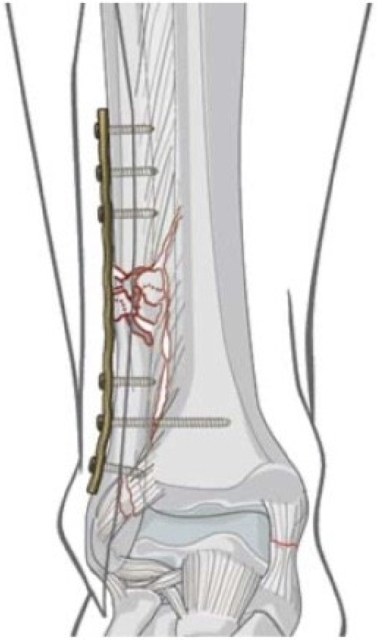
After plating of the fibular shaft in type C fractures, if there is no anterior tibial tubercular fracture, then stability of the syndesmosis is tested by attempting to distract the fixed fibula from the tibia, using a bone hook.



2. Fixation

Fixation of the syndesmosis is only necessary if the hook test is unstable.

- The fully threaded positioning screw(s) must grip in all 3 cortices.
- In certain fracture types 2 screws must be used (Maisonneuve injury).
- The position screw should be above, not through, the inferior tibio-fibular syndesmosis.
- The position screw may be inserted through the fibular plate.



3. Removal of position screw (syndesmosis screw)

- Remove the position screws in young and active patients after 8-12 weeks.
- In very unstable fractures (Maisonneuve injuries), in smokers, or in patients with diabetes, wait a least 12 weeks.
- If not removed, the screw may eventually break.

Aftercare

- Apply a plaster of Paris back-slab to the lower leg with the foot in neutral position.
- Start physiotherapy on postoperative day 1, with active range of motion exercises out of the splint, reapplying splint after exercise.

- Allow immediate partial weight bearing (10-15kg) to cooperative patients.
- Apply a short leg cast once a good range of motion is obtained.
- Remove sutures and make X-ray after 2-3 weeks.
- Weight bearing once full bone and ligamentous healing is assured (6-10 weeks), depending on fracture pattern.
- Eventually remove the syndesmosis screws after 8-12 weeks if bone healing is satisfactory.

Take-home messages:

- Always target normal anatomy (Articular Fracture !!) (contralateral reference)
- Mechanism of injury = key to successful reduction
- Timing = soft tissue condition ; **Span Scan & Plan**
- Plan your surgery according to injury type & extent