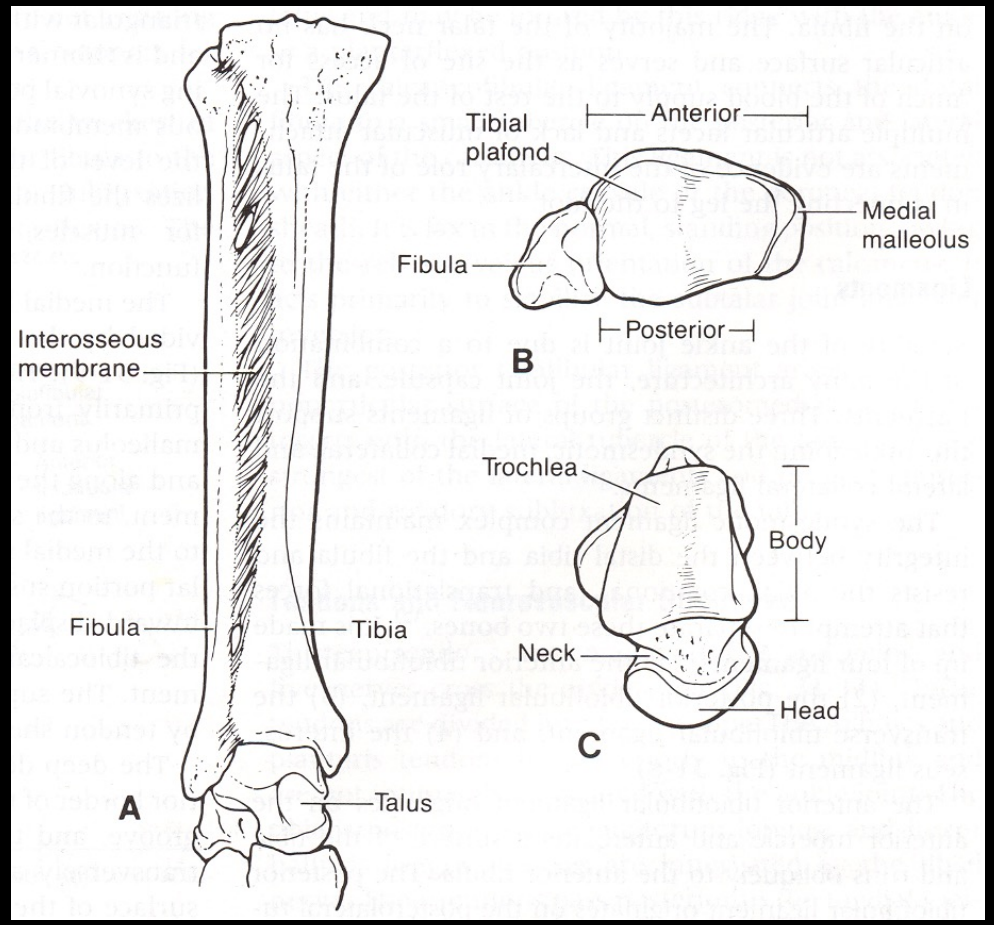
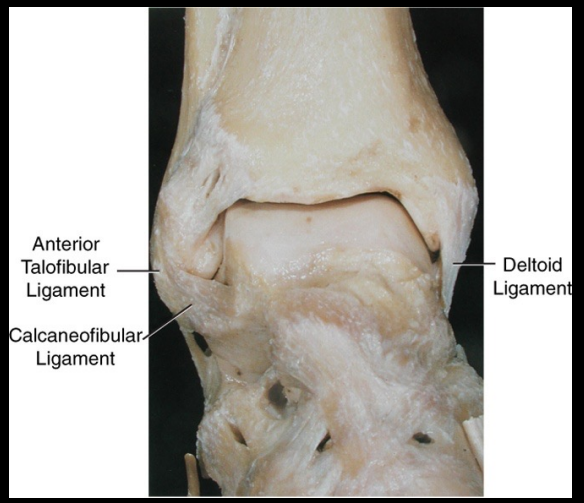
Ankle Fractures

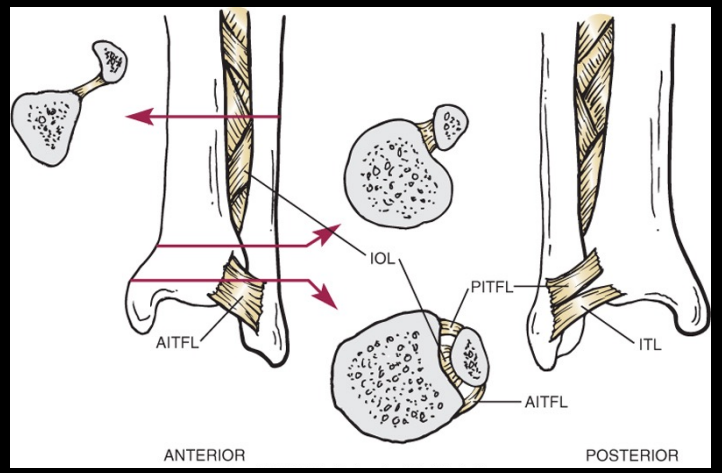
Bethany Gallagher, MD

Anatomy Review





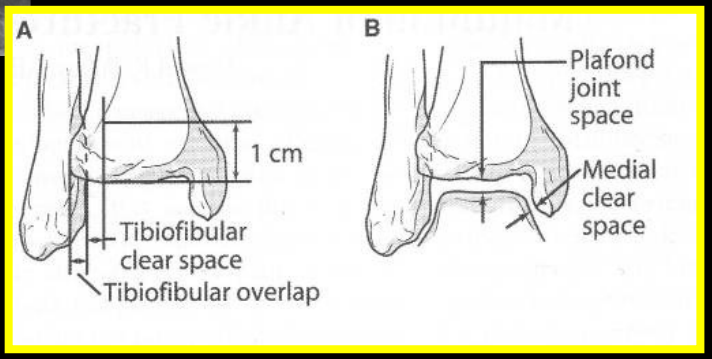
Medial and Lateral ligament complex



Syndesmosis Ligament

Xray Review

- **Normal AP xray**
  - **Medial clear space**
    - **3-4mm**
  - **Tibia/Fibula overlap**
    - **10mm**
  - **Tibia/Fibula clear space**
    - **5mm**
- **Mortise**
  - **Tibia/Fibula overlap**
    - **1mm**



Clinical Exam

- **History**
  - **Mechanism**
  - **Timing**
  - **Co-morbidities**
  - **Associated injury**
- **Physical Exam**
  - **Deformity**
  - **Soft-tissue injury**
  - **Nerve/vascular compromise**

Imaging

- **AP/Mortise/Lateral Ankle**
  - ✓**May consider tibia film if concerned about high fibula fracture**
- **?Stress Xray?**
  - ✓**WB xray**
- **Advanced Imaging**

Stress Xray

- **Indications**
  - ✓**To evaluate DELTOID ligament**
- **MORTISE view**
- **Foot must be DORSIFLEXED**
- **Apply EXTERNAL ROTATION force on foot with tibia stabilized**

Gravity Stress Xray

- **<u>Lateral</u> side down**
- **Equivalent to manual stress x-ray to recognize deltoid injury**

Weightbearing Xray

- **May change management**

WB X-ray

Advanced Imaging

- **When to order**
  - ✓**CT for ALL trimalleolar ankle fracture**
    - **Assist with surgical planning**
  - ✓**MRI**
    - **Minimal role in the acute ankle fracture**

ED/Acute Management

- **Address open wounds**
  - ✓**IV antibiotics**
  - ✓**Soaked gauze over wound**

Gustillo Type	Antibiotic
Type I and II	Cefazolin
Type III	Cefazolin + aminogylcoside
Heavy contamination	Cefazolin+ aminoglycoside+ penicillin

ED/Acute Management

- **Closed reduction**
  - ✓**Conscious sedation versus intraarticular block**
- **Imagine holding foot by the great toe for reduction**
  - ✓**Mold the splint**
- **X-rays after immobilization**

ED/Acute Management

- **Splint application**
  - ✓**Well padded**
  - ✓**Stirrups and posterior slab**
- **SPLINTS AND CASTS ARE NOT BENIGN**

ED/Acute Management

- **Extremely unstable**
- **Patient Unstable**
- **Severe soft-tissue compromise**

NEEDS EXTERNAL FIXATION!!!

Mechanism of Injury

- Abduction or Adduction (Eversion or Inversion)
- Foot position at the time the force is applied (pronated or supinated)
- Most common is a rotational injury to a supinated foot

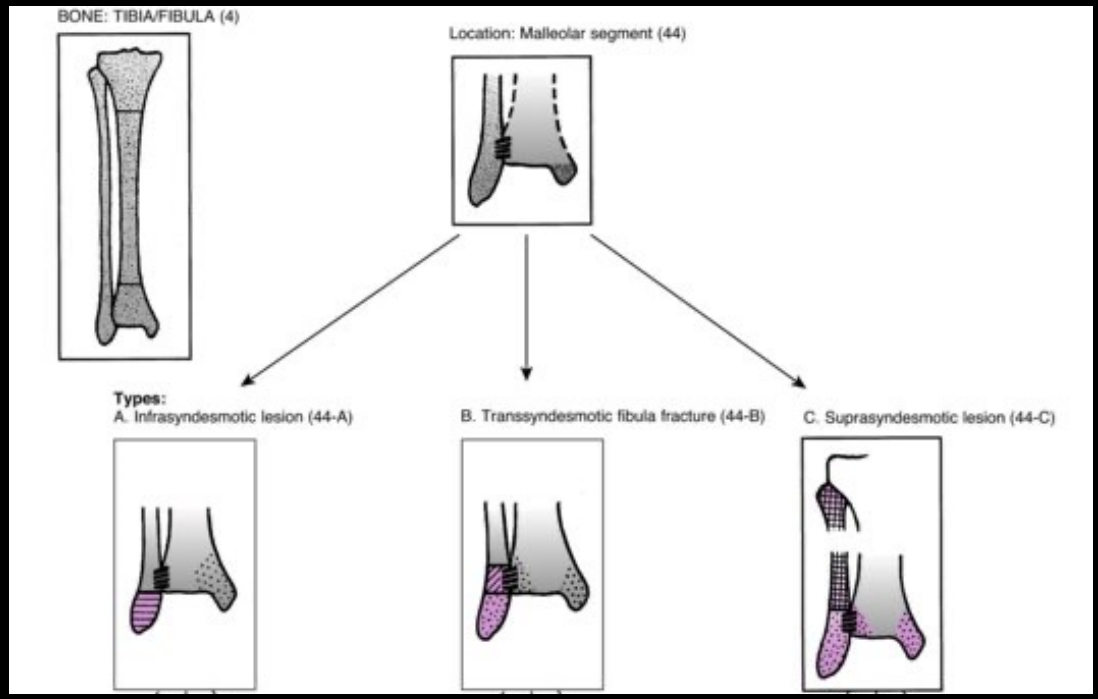
Classification

- **Danis-Weber**
  - ✓Based on location of the fibula fracture
    - Infrasyndesmotic (A)
    - Transsyndesmotic (B)
    - Suprasyndesmotic (C)
- **Lauge-Hansen**
  - ✓Named by position of foot (pronation or supination)
  - ✓And force applied (external rotation, abduction, adduction)

Weber/AO-OTA Classification

Original Danis-Weber

- Type A: Below plafond
- Type B: At level of plafond
- Type C: Above plafond

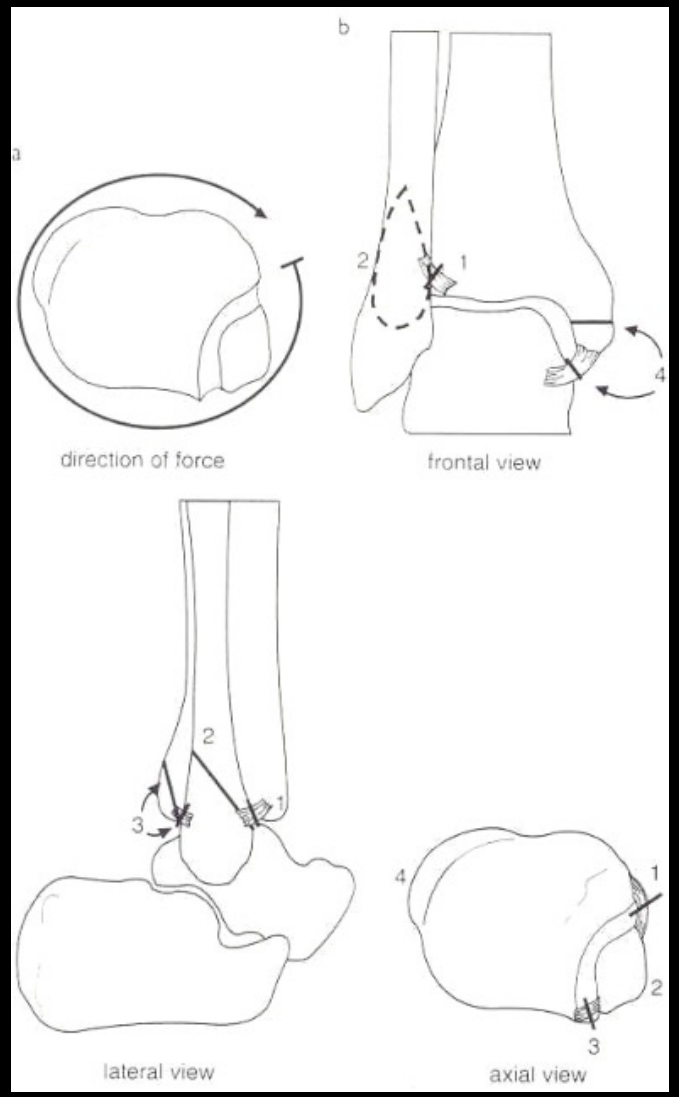


Meinberg A, Agel J, Roberts C, et al. Fracture and Dislocation Classification Compendium – 2018, J Orthop Trauma 32(1);Suppl, Jan 2018

Lauge-Hansen

- Based on position of foot at time of fall
- Assists in treatment planning
  - ✓Determining stability for nonoperative management
  - ✓Determine operative plan and fixation techniques

Supination-External Rotation



- Stage 1 – AITFL
- Stage 2 – Oblique fibula fx (posterior superior to anterior inferior)
- Stage 3 – PITLF or posterior malleolus
- Stage 4 – Deltoid or medial malleolus

SER II

Intact medial stability

Typically a posterosuperior to anteroinferior fibula fracture

SER IV - Bony

Medial malleolus fracture

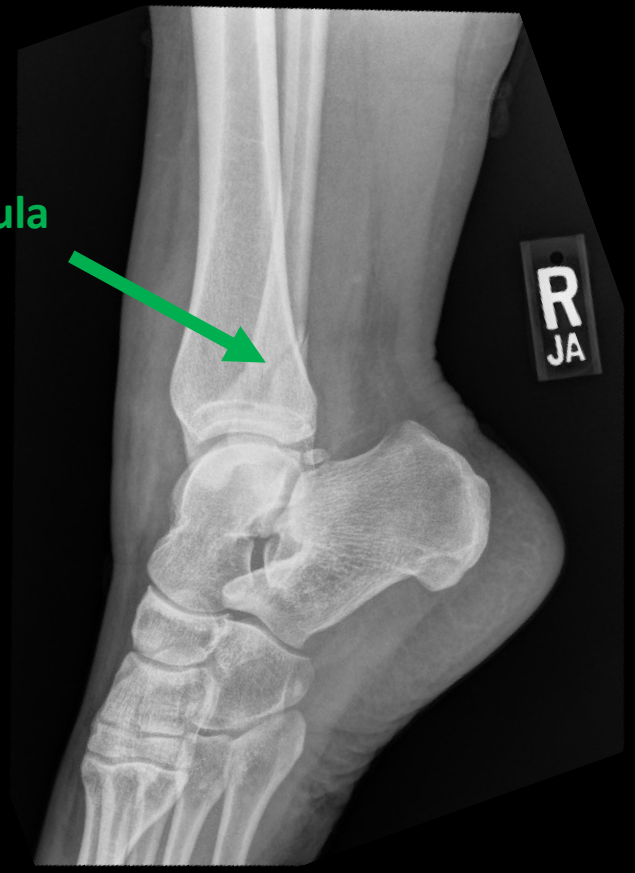
Small posterior malleolus fracture

Classic fibula fracture pattern, posterosuperior to anteroinferior

SER IV - Ligamentous

Static medial clear space widening

Classic fibula fracture



Why We Care

- 1. Fibular fractures associated with a stable ankle mortise heal without significant functional consequence.
  - ✓Keep the talus under the tibia

- 2. Fibular fractures associated with an unstable ankle mortise heal with significant functional problems…assuming that this instability will cause talar shift

SER II vs SER IV

- SER IV that reduce to symmetric plafond
  - ✓Can treat SER IV ankles w/o surgery
    - NEED CLOSE FOLLOW-UP
    - HIGHER risk for displacement and nonunion

Non-Op Clinic Follow-up

SER II

- **Initial visit**
  - ✓ **Initial X-ray**
    - **WB if patient walks in**
    - **Gravity Stress X-ray**
  - ✓ **Compression stocking and CAM boot**
- **1wk**
  - ✓ **Repeat WB X-ray**
  - ✓ **Partial WB with CAM boot and crutches**
- **6wk**
  - ✓ **Repeat Xray**

SER IV

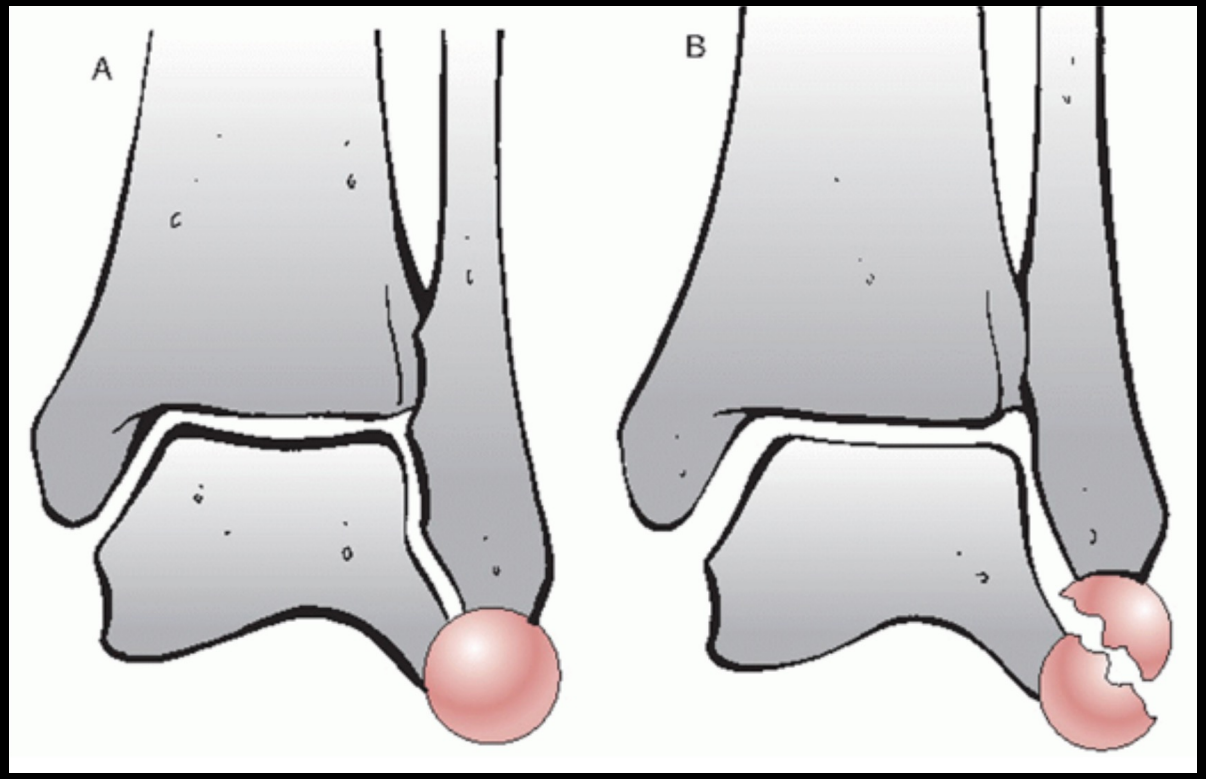
- **Initial visit**
  - **Initial X-ray**
    - **Gravity Stress X-ray**
  - **Molded Cast**
    - **Repeat X-ray in cast**
  - **NWB**
- **1wk**
  - **Repeat X-ray in cast**
- **2wk**
  - **Change Cast**
    - **Repeat X-ray in cast**
- **6wk**
  - **Repeat Xray**
  - **Transition to Boot**
  - **WB**

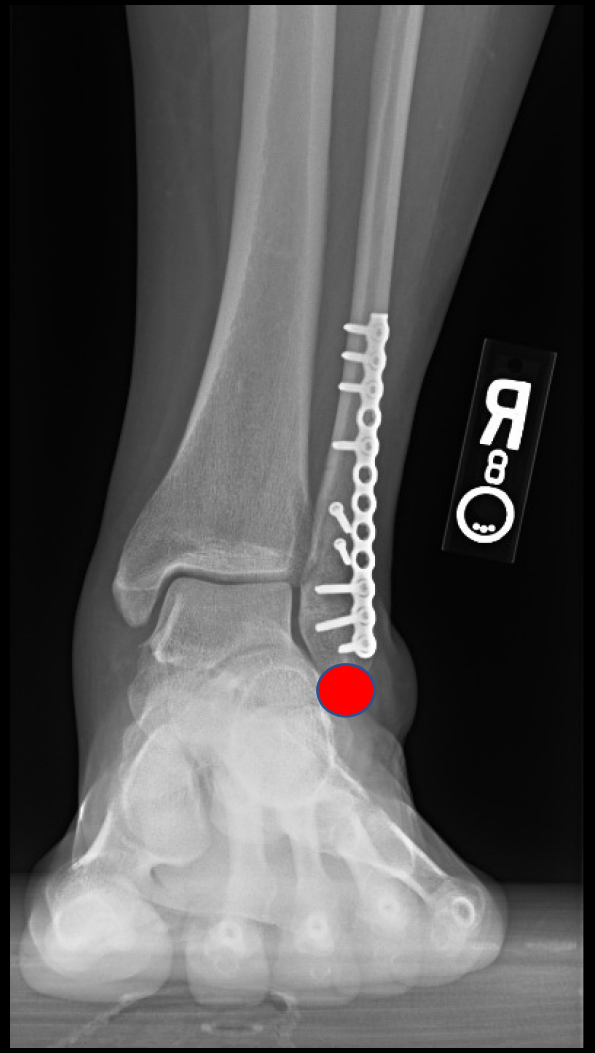
If Diabetic Neuropathic: NWB in TCC with weekly f/u for 10-12 wks

Surgical Treatment Checklist

- **Address fibula**
  - ✓Ensure adequate length obtained (use contralateral side, dime sign)
  - ✓Antiglide versus neutralization plate/lag screw
  - ✓May require bridge plating if very comminuted
- **Posterior malleolus**
  - ✓If present, consider fixation depending on size
- **Medial malleolus**
  - ✓If present, likely fixation
    - Fully threaded bicortical screws versus partially threaded
- **Stress ankle**
  - ✓Stress for syndesmotic stability

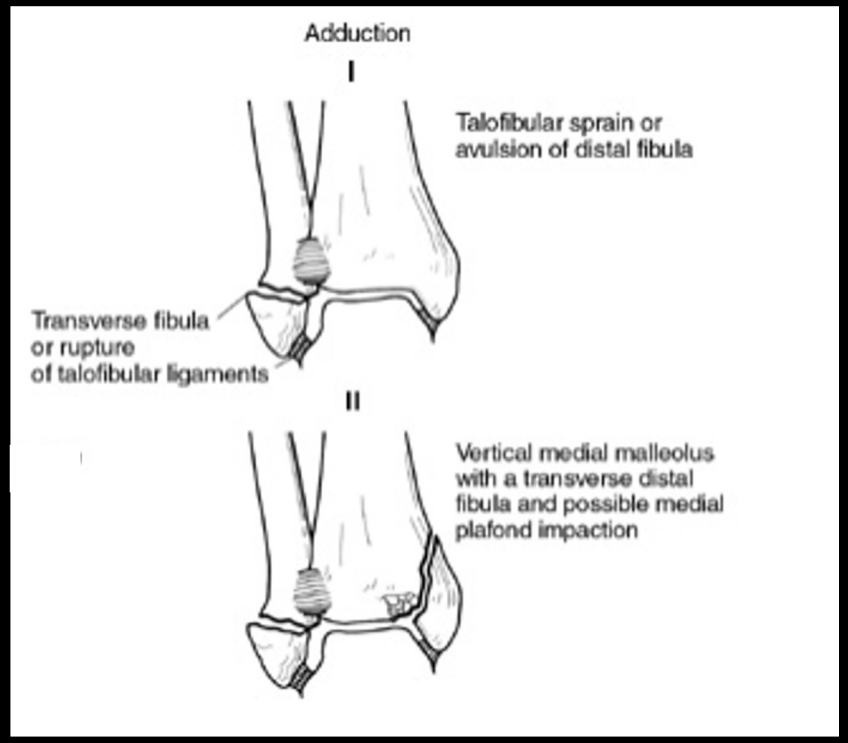
Dime (or “Ball”) Sign





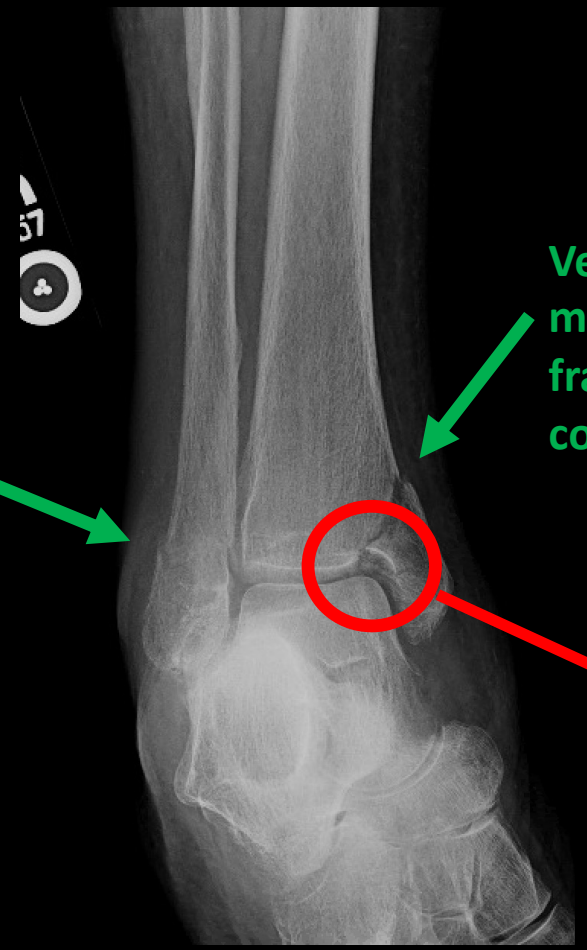
- **Round recess comprised of distal tip of fibula and lateral process of talus**

Supination - Adduction



- **Stage 1: Transverse Weber A/B distal fibula fracture**
  - ✓Tension sided failure
- **Stage 2: Vertical medial malleolus fracture**
  - ✓Often times with MEDIAL impaction
  - ✓Compression sided failure

Supination - Adduction



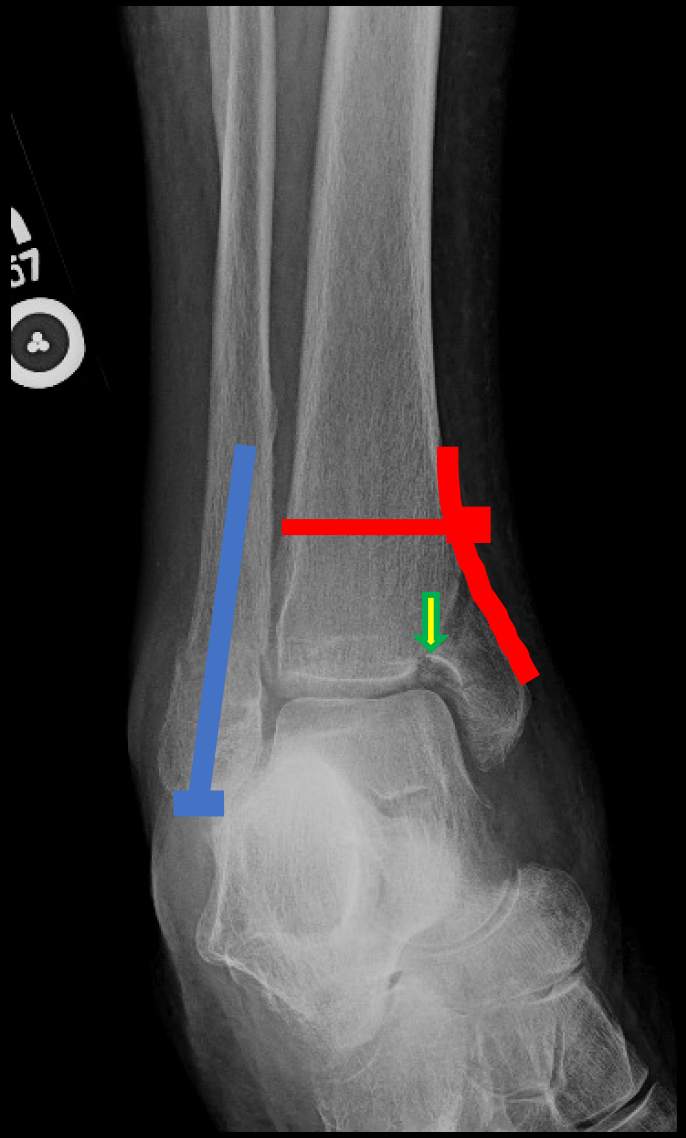
Transverse fibula fracture. Fails in tension.

Vertical medial malleolus fracture. Fails in compression.

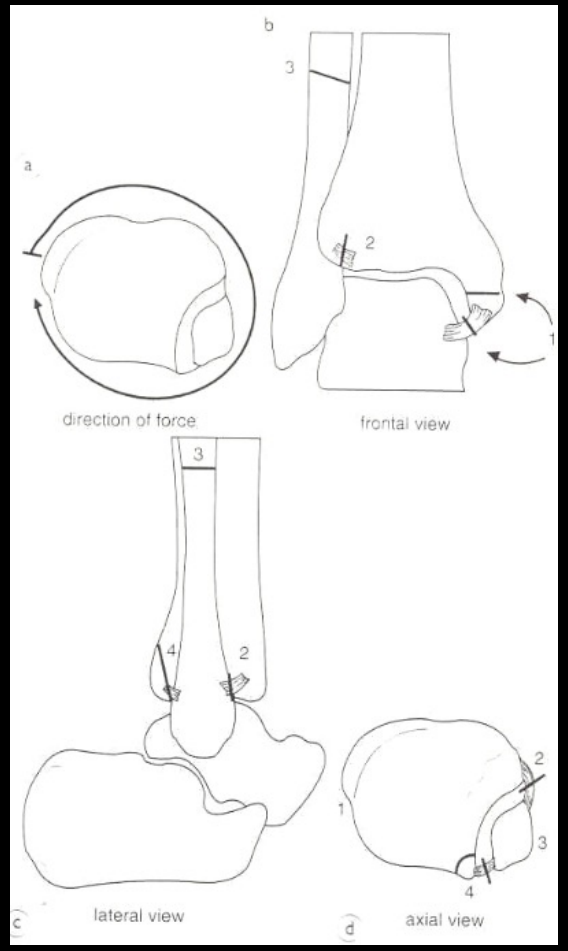
BEWARE: Anteromedial impaction

SAD Treatment

- Stage 1: Intramedullary screw versus plate to compress
- Stage 2: Address impaction, antiglide plate for medial malleolus

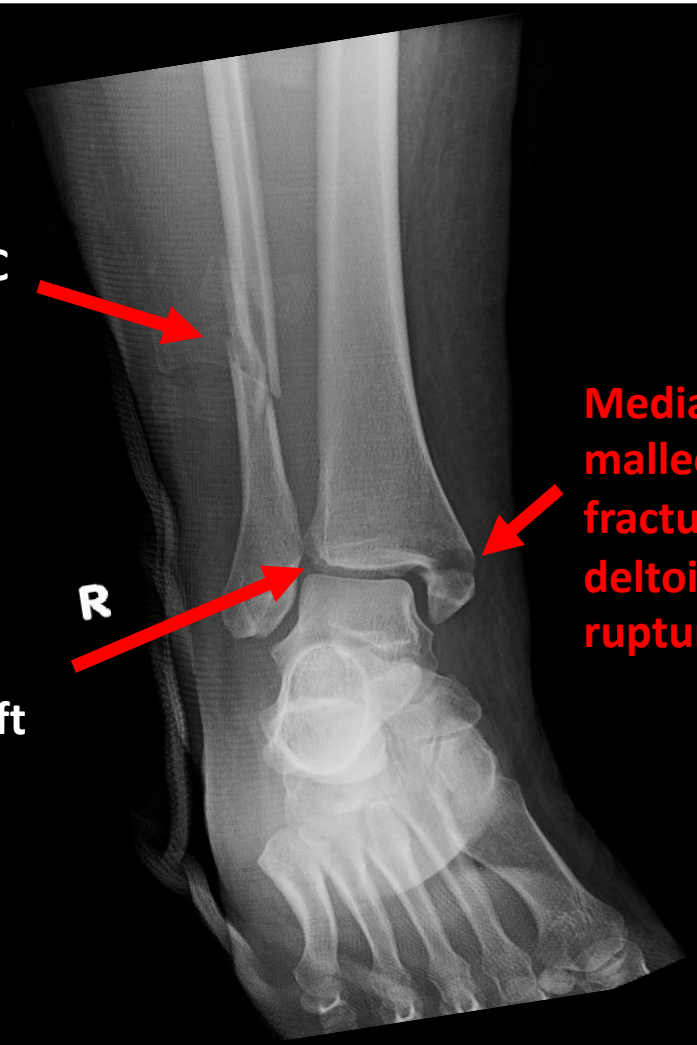


Pronation External Rotation



- Stage 1: Deltoid or medial malleolus fracture
- Stage 2: AITFL and IO membrane
- Stage 3: Spiral Weber C fibula fracture
- Stage 4: PITFL or posterior malleolus fracture

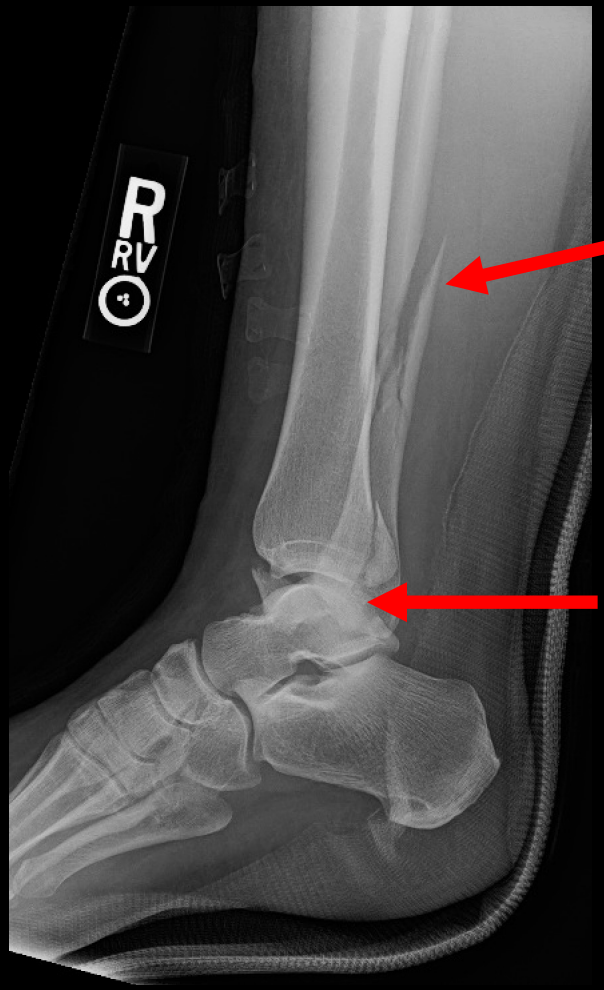
Pronation External Rotation



Weber C fibula fracture

Medial malleolus fracture (or deltoid rupture)

talar shift



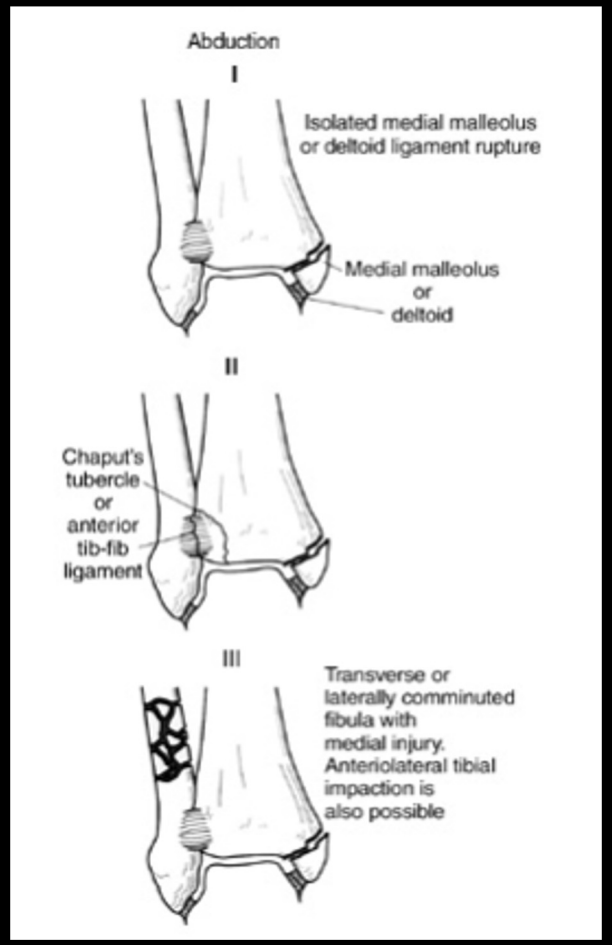
Oblique fibula fracture

Posterior malleolus fracture (can also be PITFL injury)

Pronation External Rotation

- Syndesmotic disruption expected
- Goals
  - ✓Fibular length and rotation
  - ✓Congruent ankle mortise
  - ✓Syndesmotic stability with either posterior malleolus fixation or syndesmotic fixation

Pronation Abduction



- Stage 1: Transverse medial malleolus or deltoid injury
- Stage 2: PITFL or PM fracture
- Stage 3: Compression bending fibula fracture

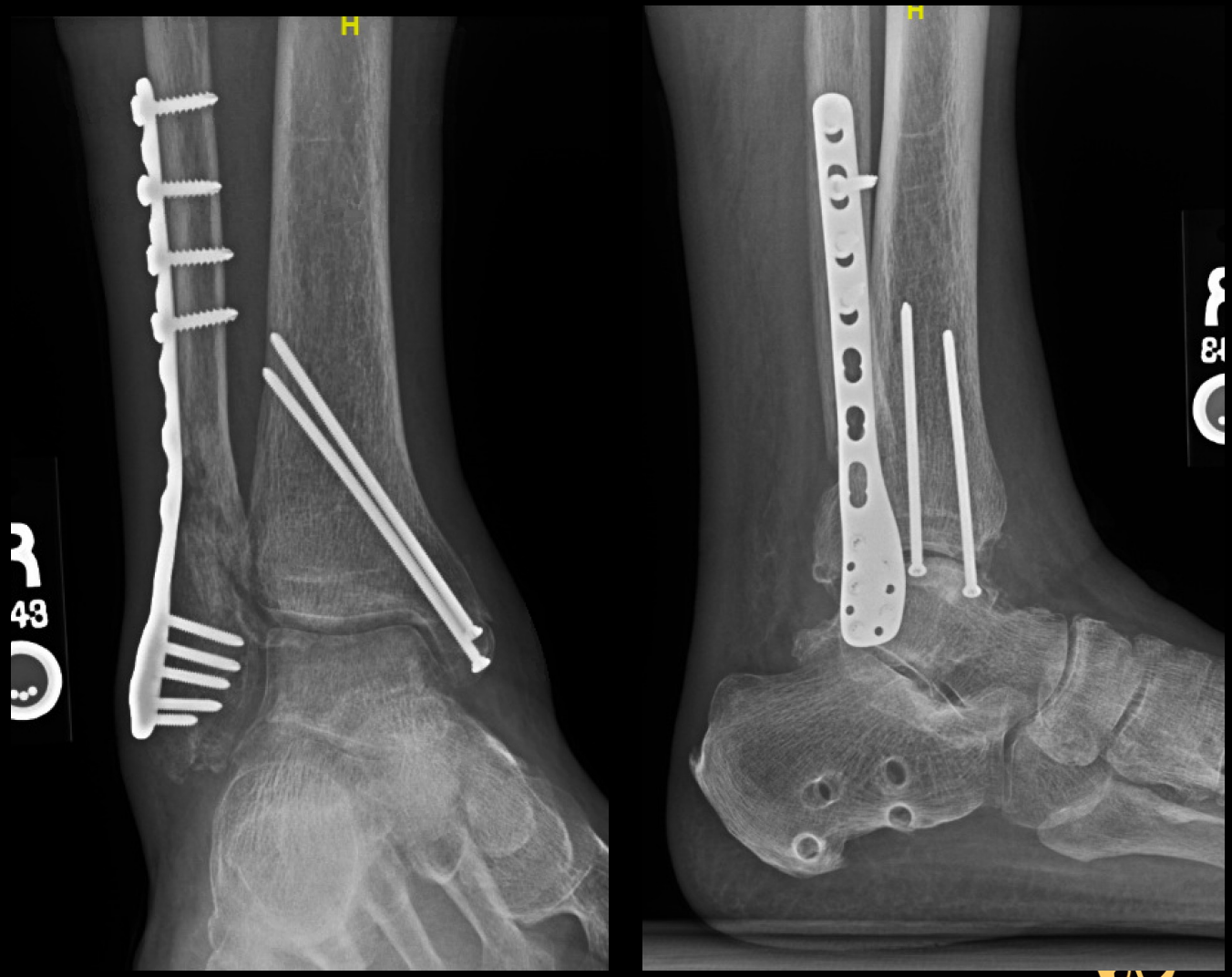
Pronation Abduction

Beware specific articular pathology

VANDERBILT Orthopaedics

Pronation Abduction

- **Medial malleolar fixation**
  - ✓This drives stability, fix FIRST
- **Fibular comminution**
  - ✓Length stable construct
- **Syndesmosis**
  - ✓Stress last



Posterior Malleolus

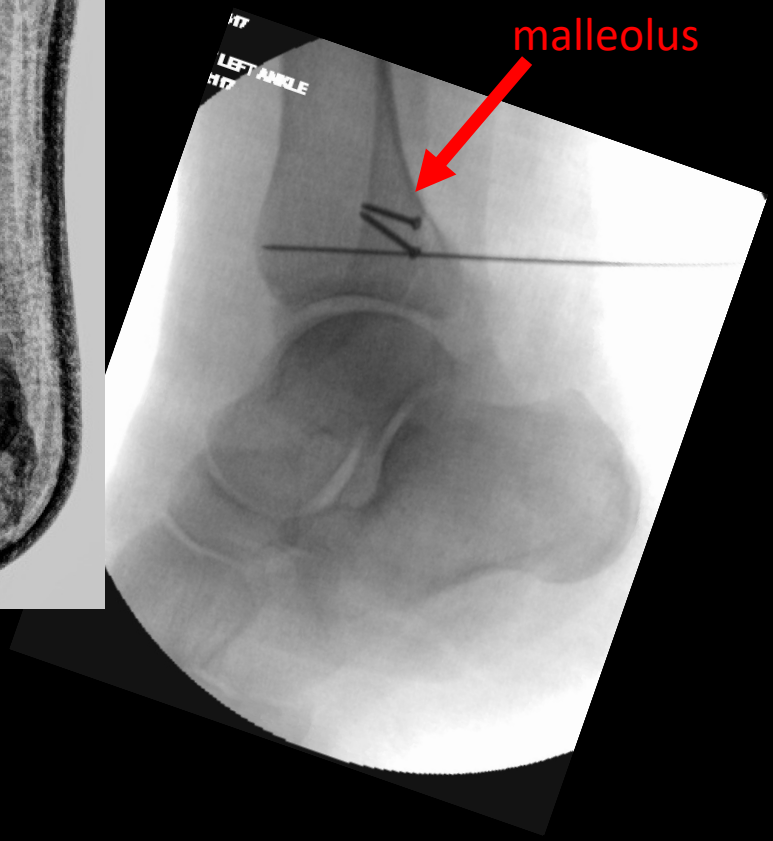
- **Function**
  - ✓**Stability: Prevents posterior translation of talus and enhances syndesmotic stability**
    - **Origin of PITFL**
  - ✓**Weight bearing: Increases surface area of ankle joint**

Posterior Malleolus

- Difficult to assess on lateral
- External rotation lateral view
- CT scan very helpful

Radiographic Evaluation

- Classic indication for fixation: >25% joint surface on lateral
- Problem: Lateral view can inadequately visualize posterior malleolus size and involvement
  - ✓Associated with PITFL, and subsequently, lateral malleolus
  - ✓Obliquely oriented
  - ✓Involves incisura



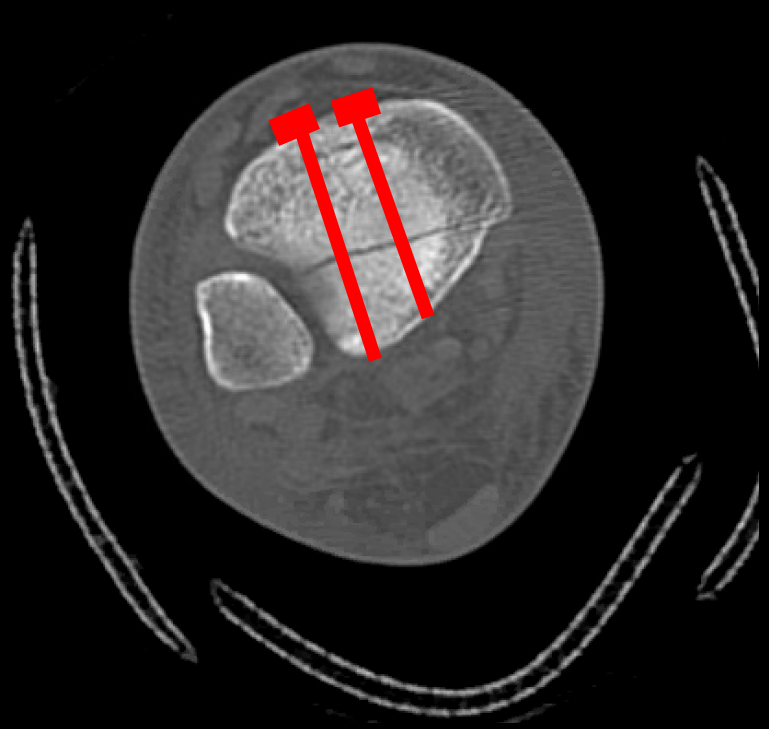
Posterior Malleolus – Indications for Fixation

- **Stability**
  - ✓**Posterior translation of talus**
  - ✓**ER of talus (syndesmotic widening)**
    - **May obviate need for syndesmotic fixation**
- **Studies show improved outcomes with operative fixation**
  - ✓**Decreased ankle instability through syndesmosis**

Posterior Malleolus – Indications for Fixation

- **Stability**
  - ✓Posterior translation of talus
  - ✓ER of talus (syndesmotic widening)
    - May obviate need for syndesmotic fixation
- **Articular congruence**
  - ✓Excessive stress → post traumatic arthritis
  - ✓Contact stress changes significantly with PM size >33% (Hartford Corr 1995)

Fixation Options



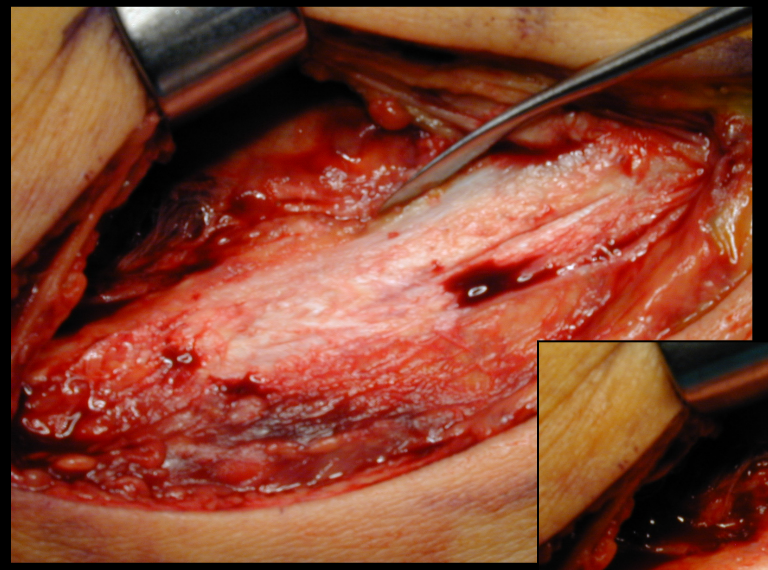
Maisonneuve Fracture

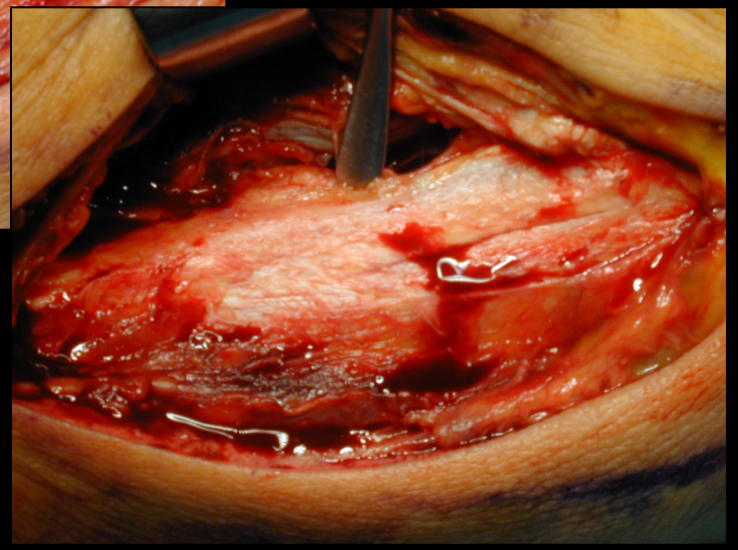
NOT JUST A MEDIAL MALLEOLUS FRACTURE!!!

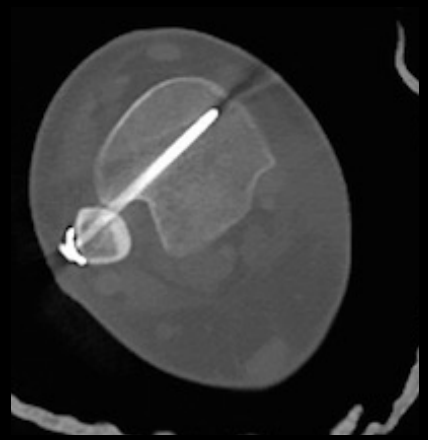
- **Twisting injury**
- **Energy through medial structures**
  - ✓**Through the syndesmosis**
  - ✓**Travels proximal through interosseous membrane**
  - ✓**Exits high fibula**

Intraoperative Assessment

- **Direct visualization**
  - ✓To reduce malreduction
- **Stress in OR**
  - ✓Cotton test
  - ✓ER test
  - ✓Important to stress in the sagittal plane







Operative Stabilization

- **Flexible Fixation**
- **Screw Fixation**

- **Equivocal functional outcome**

Predictors of Short-Term Functional Outcome Following Ankle Fracture Surgery

By Kenneth A. Egol, MD, Nirmal C. Tejwani, MD,
Michael G. Walsh, PhD, Edward L. Capla, MD, and Kenneth J. Koval, MD

- At 1 year, most patients doing well
- Significant difference in functional recovery at 1 year compared to 6 months
- Younger age, male sex, absence of diabetes, and lower ASA class predictive of functional recovery at 1 year

Patient Risk Factors for Adverse Outcome

- Advanced age
- Osteoporosis
- ***Diabetes***
- ***Peripheral vascular disease***
- Female sex
- High ASA class
- Smoking
- Alcohol use
- Lower level of education

Posttraumatic Ankle Osteoarthritis After Ankle-Related Fractures

Monika Horisberger, MD, Victor Valderrabano, MD, PhD,* and Beat Hintermann, MD†*

- **Mean latency time between injury and end stage OA was 20.9 years**

- **OA correlated with**
  - ✓**Fracture severity**
  - ✓**Complications**
  - ✓**Older age at time of injury**

Horiseberger M, Valderrabano V, Hintermann B. Posttraumatic ankle osteoarthritis after ankle related fractures. J Orthop Trauma. 2009 Jan;23(1):60-7.

Complications

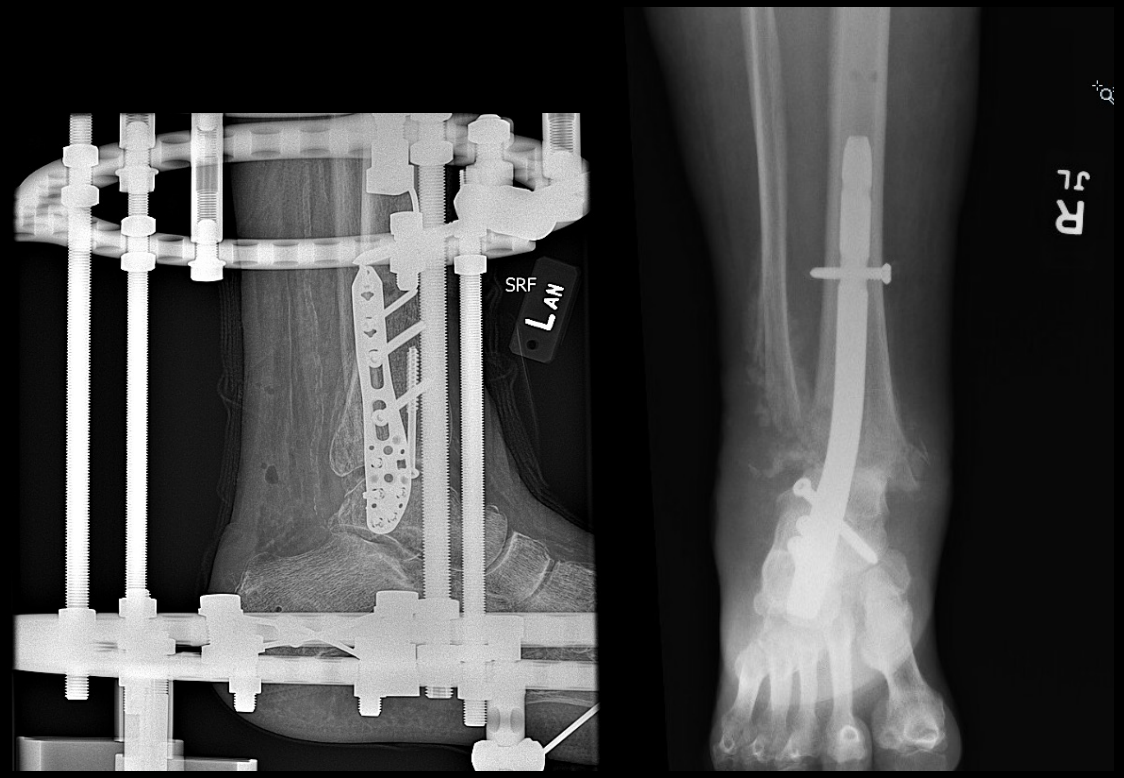
- **Perioperative**
  - ✓ Malreduction
  - ✓ Inadequate fixation
  - ✓ Intra-articular hardware penetration
- **Early Postoperative**
  - ✓ Wound edge dehiscence/necrosis
  - ✓ Infection
  - ✓ Compartment syndrome
- **Late**
  - ✓ Stiffness
  - ✓ Distal tibiofibular synostosis
  - ✓ Malunion
  - ✓ Nonunion
  - ✓ Post-traumatic arthritis
  - ✓ Hardware related complications
  - ✓ Complex regional pain syndrome type I

Diabetic Ankle Fractures

- **Problem:**
  - ✓ High complication rates with wounds and fixation stability
  - ✓ Patients often lack protective sensation
  - ✓ Poor bone quality
- **Solution:**
  - ✓ Unstable ankle fractures are still best treated with anatomic restoration of the ankle mortise and stable internal fixation
  - ✓ Continue to minimize soft tissue trauma
  - ✓ Double the fixation and non weight bearing in neuropathic patients
    - Costigan et al, FAI 2007
  - ✓ "Recruit" tibial bone to help with fibular fixation

Diabetic Ankle Fractures

- **Postoperative care**
  - ✓**SLC for 6-12 weeks, NWB for 12 weeks**
- **In debilitated, low demand, neuropathic patients, may require extreme measures to keep talus under tibia**



Thank you!!