Ankle Fracture Update

OTA Resident Core Curriculum Lecture Series
Updated November 2010

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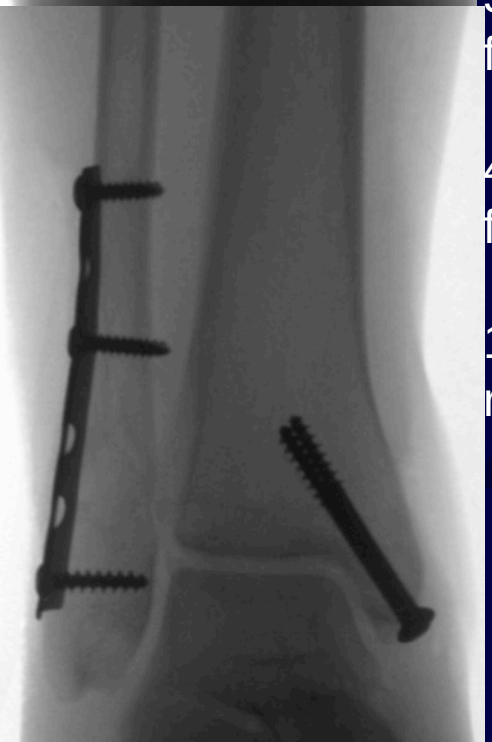


Objectives

Following this session, you should be able to:

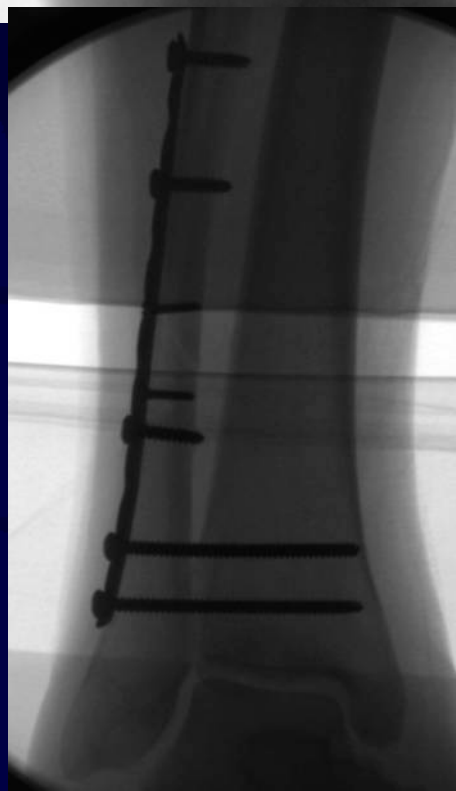
1.State the indication to fix isolated fibular fractures.

2.Define the specific articular pathology associated with SA and PAB fractures.

3.List the 3 common posterior malleolar fracture patterns.

4.State the indication to fix posterior malleolar fractures.

1.Enumerate the ways to ensure syndesmotic reduction.



Recommendations to Improve Retention of this Material

1. Write down the objectives

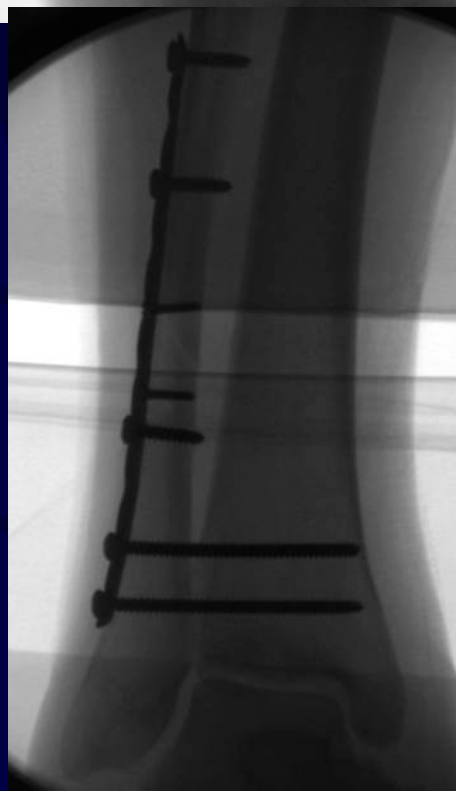
2. Search for the answers to the objectives in the powerpoint talk [hint- look for blue boxes]

3. Test yourself at the end by reviewing the objectives

4. Watch the show on "normal view" and look at the notes at the bottom of the slides. They will provide guidance to the progression of logic and sources of information. Classic references are listed throughout. Annotated recent references are listed at the end.

Outline

- Evaluation: Clinical & Radiographic
- Classification: Lauge-Hansen
- Specific Problem Areas: Posterior Malleolus and Syndesmosis
- Surgical Goals
- Outcome



Evaluation:
Clinical

HISTORY

Mechanism

Timing

Soft-tissue injury

Bone quality

Comorbidities

Associated Injuries

PHYSICAL EXAM

Skin

Nerves

Vasculature

Pain

Deformity

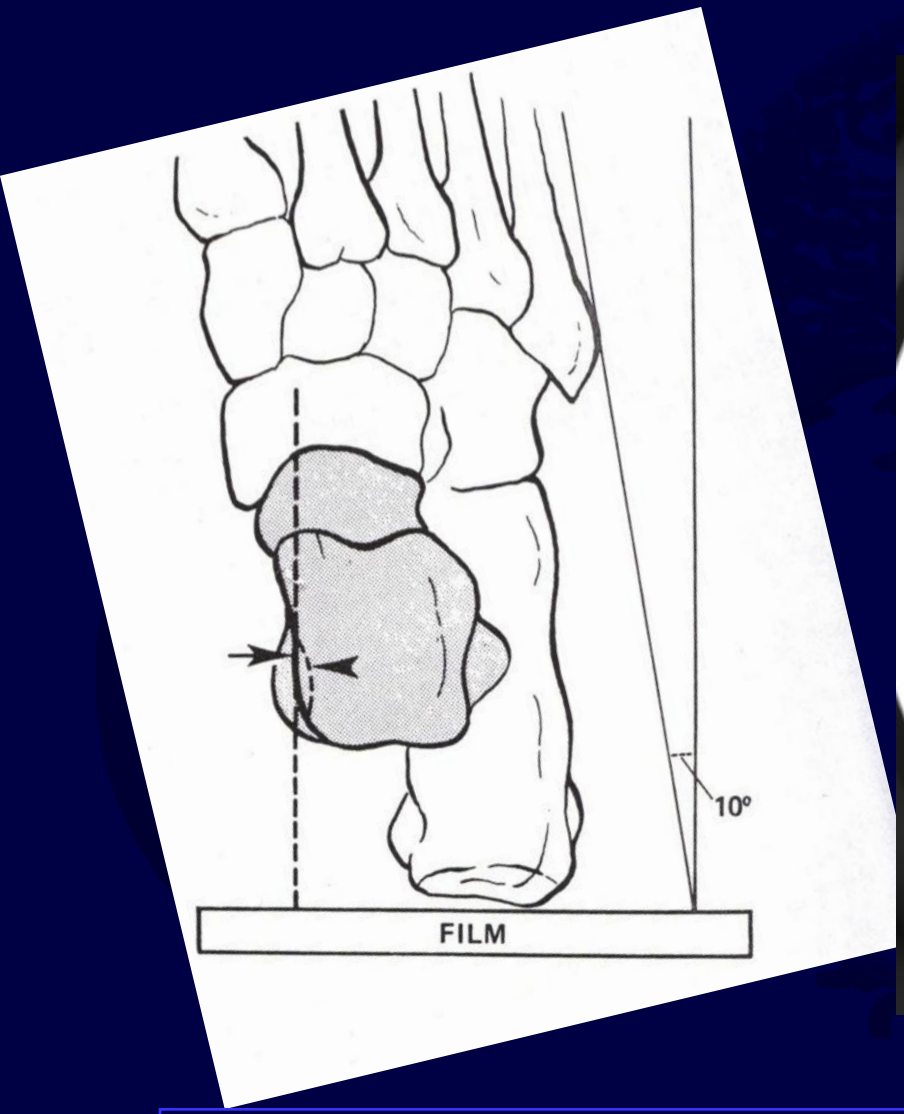
Evaluation: Radiographic
Anteroposterior View

- Tibiofibular overlap ~ 10mm
- Tibiofibular clear space <5mm
- **Talar tilt**

Comparison Radiograph?

Evaluation: Radiographic

Mortise View

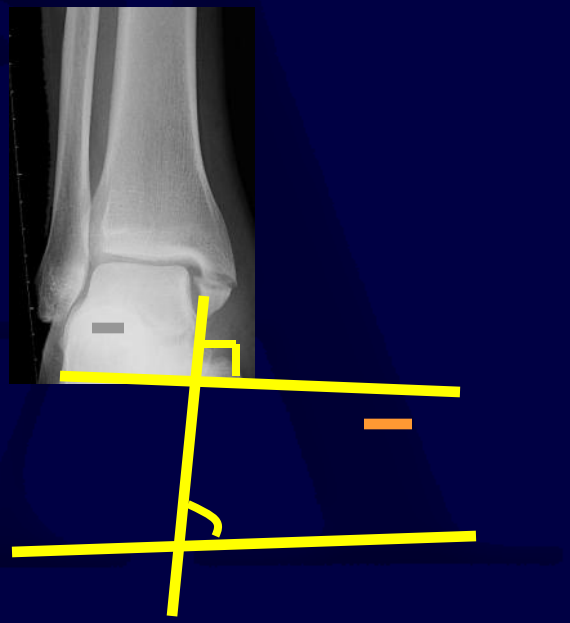


10 degrees internal rotation of 5th MT with respect to a vertical line

Goergen JBJS 1977

Evaluation: Radiographic
Mortise View

- Medial joint space
- Talocrural angle: <8 or >15 degrees
- Tibia/fibula overlap:>1mm



Comparison Radiograph?

Evaluation: Radiographic

Mortise View

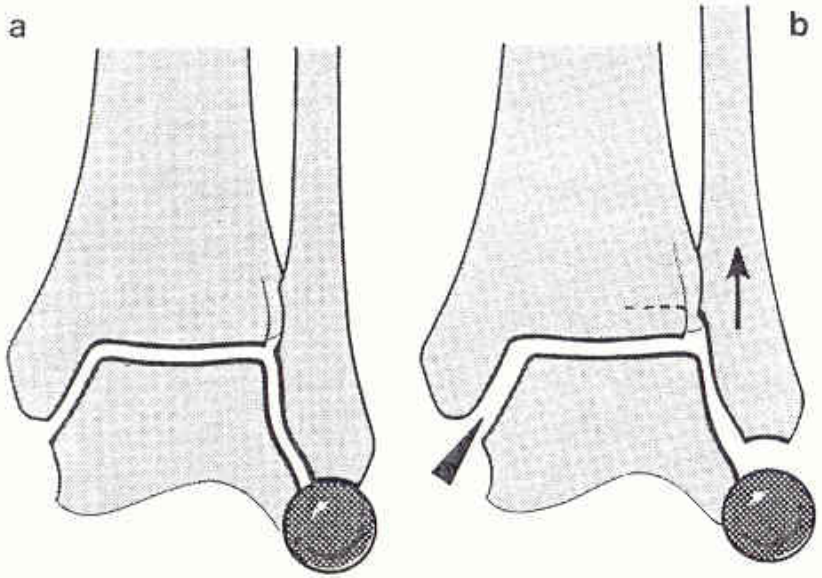
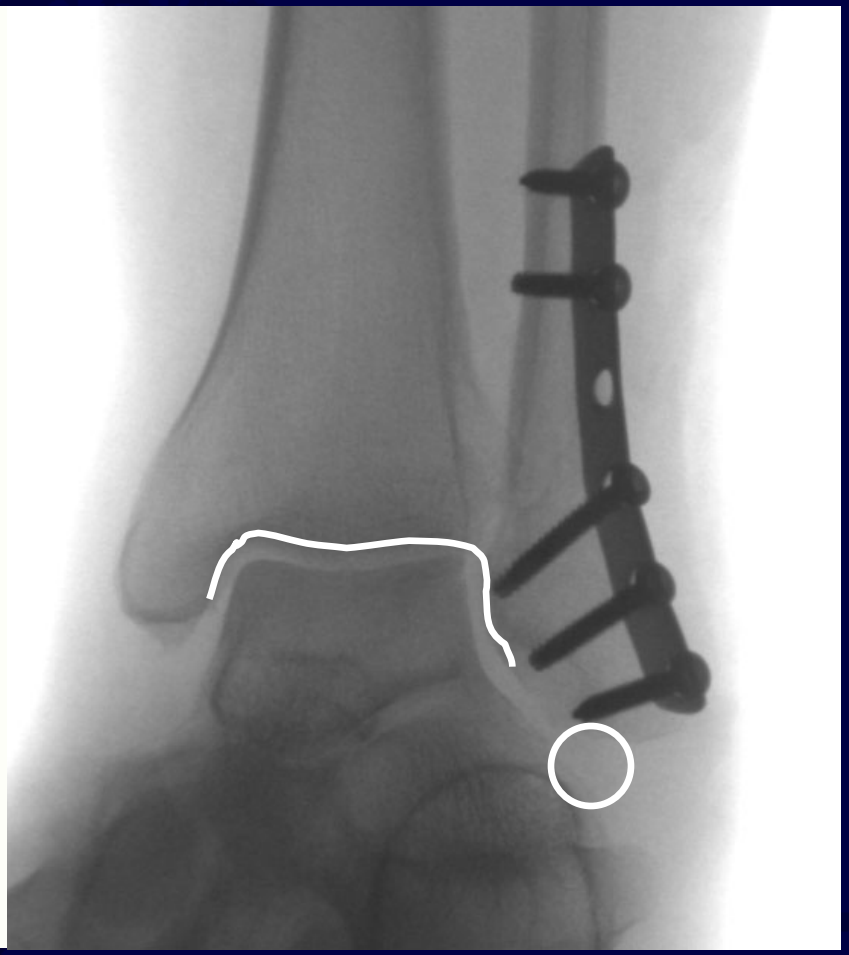


Fig. 3 a and b. The radiology of the sprung mortice
a. Sprung mortice:
1. Irregular width of joint space; widening medially;
2. "Spike" of fibula too proximal;
3. *Broken line* from the lateral part of the articular surface of the talus to the distal fibula
b. Normal ankle joint



FIBULAR LENGTH: 1. Shenton's Line of the ankle
2. The dime test

Weber SICOT 1981

Evaluation: Radiographic
Lateral View

PM

Talar subluxation

Distal fibular translation &/or angulation

Syndesmotic relationship

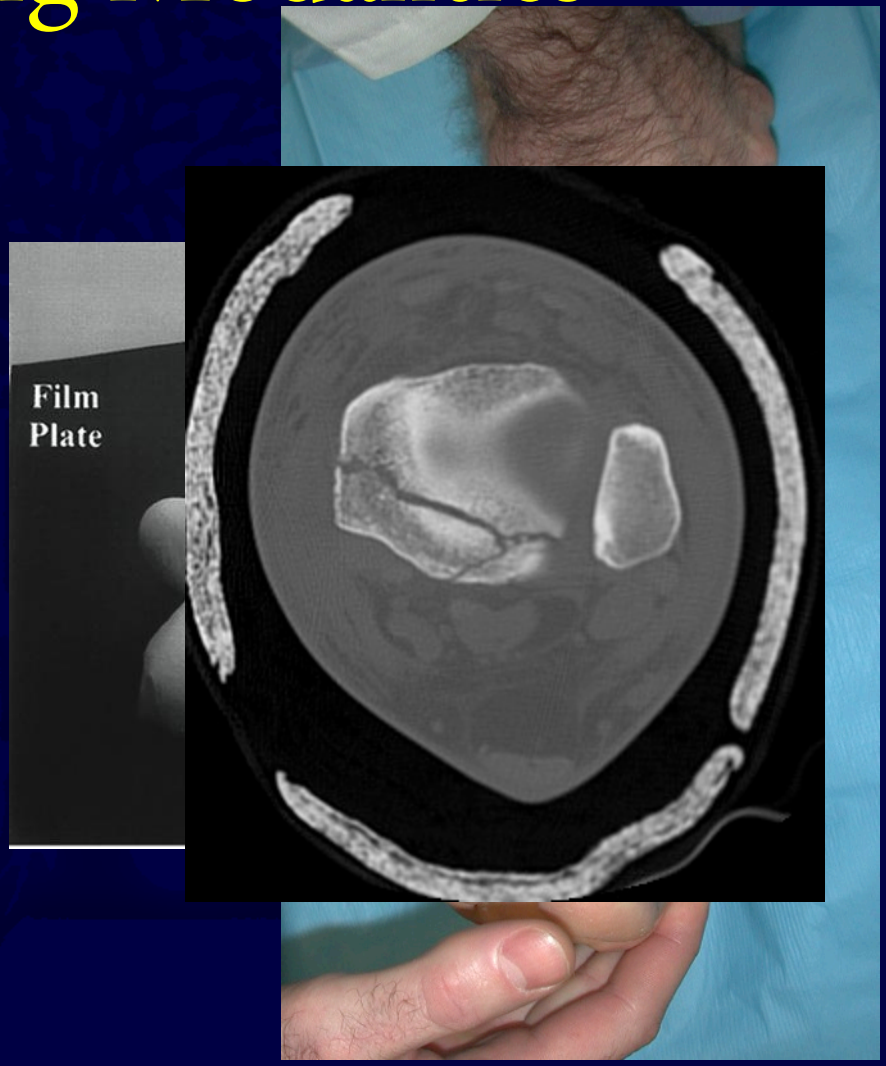
Associated or occult injuries
- Lateral process talus
- Posterior process talus
- Anterior process calcaneus

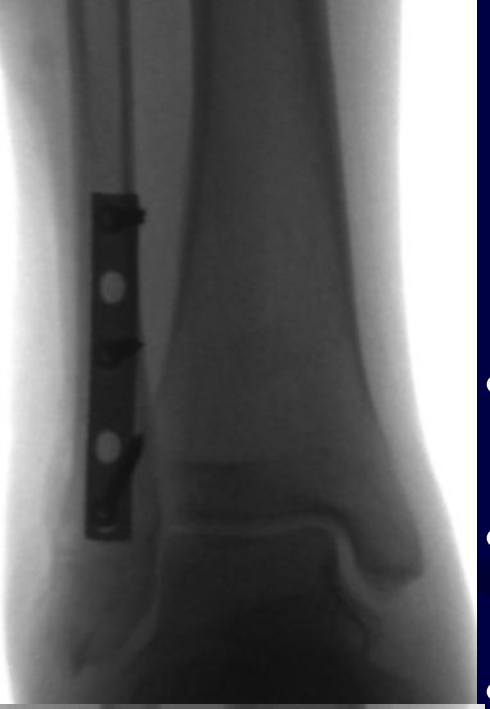
Evaluation: Radiographic
Other Imaging Modalities

Stress Views
- Gravity
- Manual

CT
- Articular involvement
- Posterior malleolus

MRI
- Ligament and tendon injury
- Talar dome lesions
- Syndesmosis injuries





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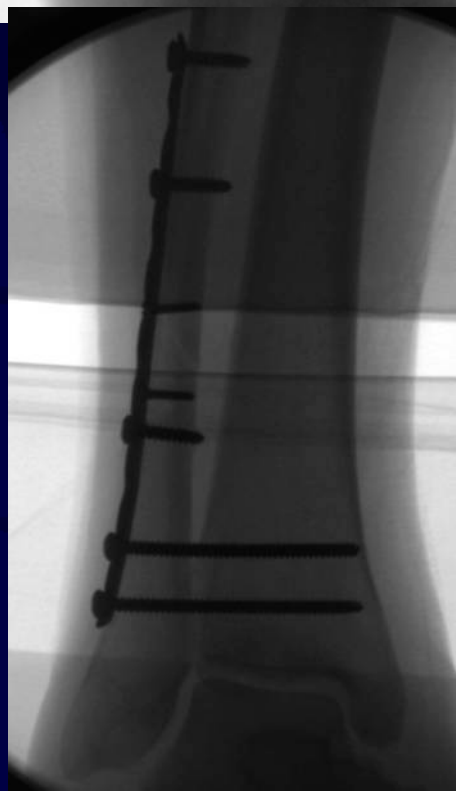


Lauge-Hansen

Cadaveric study

First word: position of foot at time of injury

Second word: force applied to foot relative to tibia at time of injury

Types:

- SER
- SA
- PER
- PA

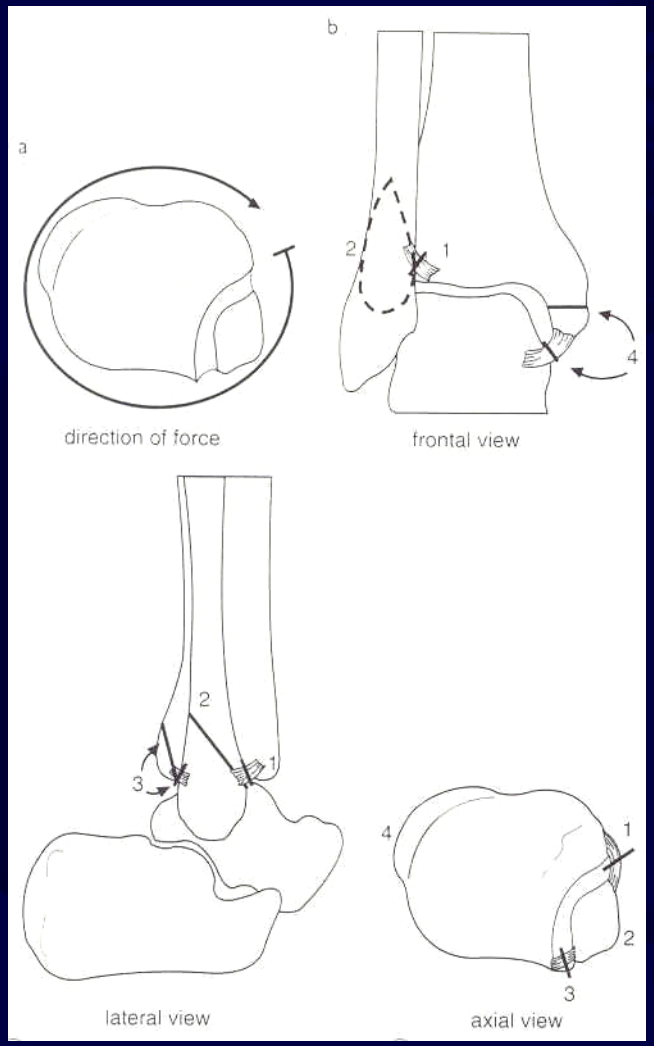
Lauge-Hansen

Several stages per type

Imperfect system:

- Not every fracture fits exactly into one category
- Even mechanism→specific pattern has been questioned
- Inter and intraobserver variation not ideal
- Still useful and widely used

Supination-External Rotation



Stage 1- AITFL

Stage 2- Fibula fx

Stage 3- PITFL or PM fx

Stage 4-Deltoid or MM fx

70% of ankle fractures

Supination-External Rotation
Stage 2: Stable

Stage 2

Lateral Injury: classic posterosuperior→anteroinferior fibula fracture

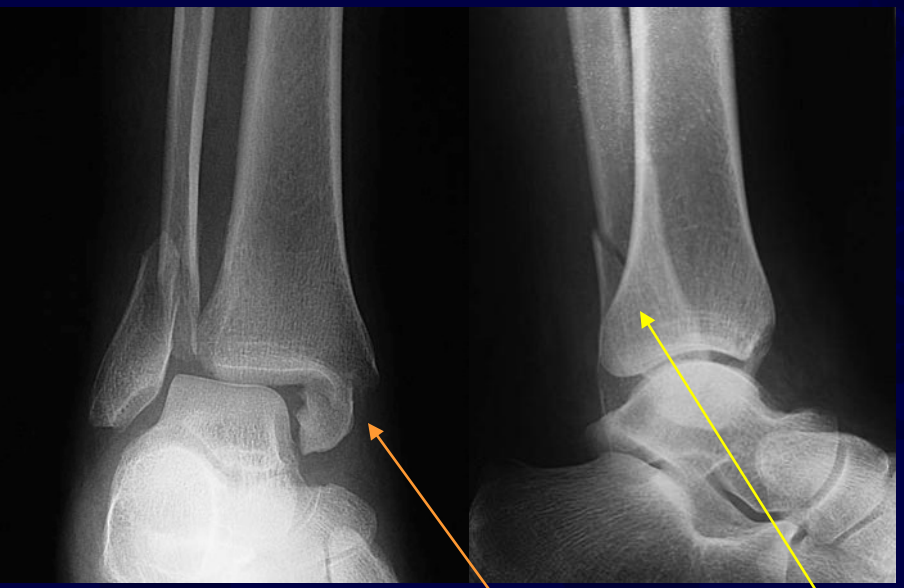
Medial Injury: Stability maintained

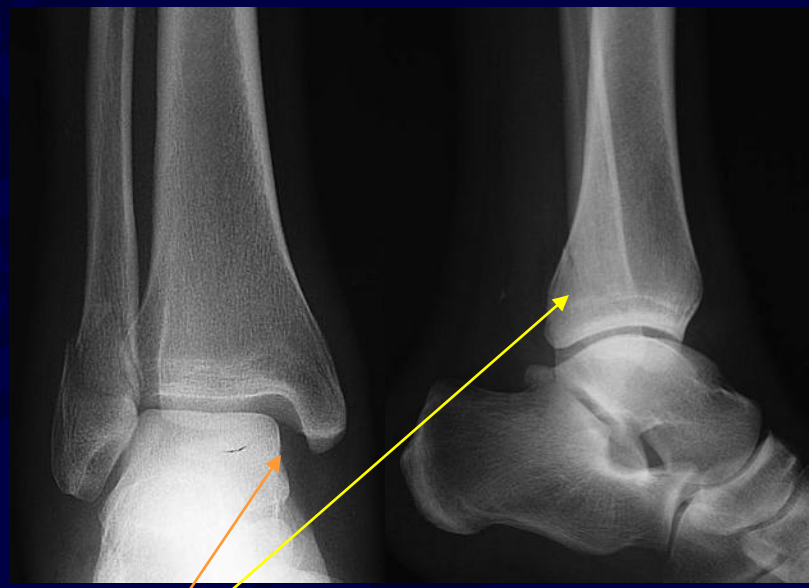
Standard: Closed management

Kristensen Acta Orthop Scand 1985

Stage 4

Supination-External Rotation
Stage 4: Unstable





Lateral Injury: classic posterosuperior→anteroinferior fibula fracture

Medial Injury: medial malleolar fracture &*/or deltoid ligament injury

Standard: Surgical management

*Tornetta JBJS 2000

SER-2 vs SER-4: How to Decide?

GOAL: TO EVALUATE DEEP DELTOID [i.e. INSTABILITY]

METHOD:

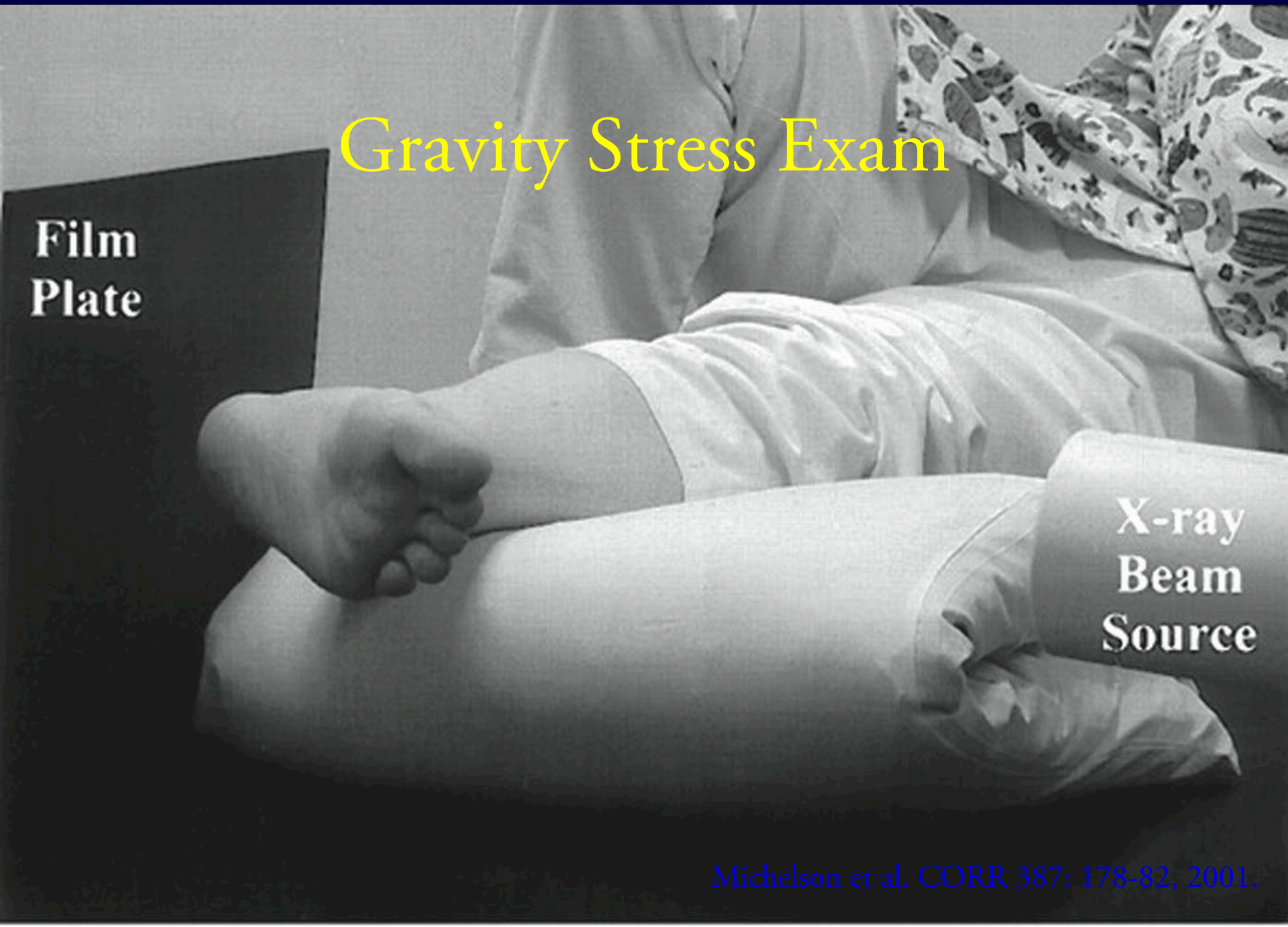
~~MEDIAL TENDERNESS~~

~~MEDIAL SWELLING~~

~~MEDIAL ECCHYMOSIS~~

STRESS VIEWS- GRAVITY OR MANUAL

Gravity Stress Exam



Michelson et al. CORR 387: 178-82, 2001.

Manual Stress Exam

versus

- Both are effective
- Gravity stress requires XR education.
- Manual stress requires time and more radiation exposure.

Schock et al. JBJS 89B: 1055-59, 2007.

SER-2 vs. SER-4: How To Decide?

HANGING MORTISE

Indication to fix isolated fibular fractures

Decision-Tree:

Understand the Logic

Assumptions:

1. Fibular fractures associated with a stable ankle mortise heal without significant functional consequence.
2. Fibular fractures associated with an unstable ankle mortise heal with significant functional problems…because instability allows for talar shift.

Decision Tree:
Understand the Logic

Stress View

Splintage

Decision-Tree:

Understand the Logic

Does a Positive Ankle Stress Test Indicate the Need for Operative Treatment?

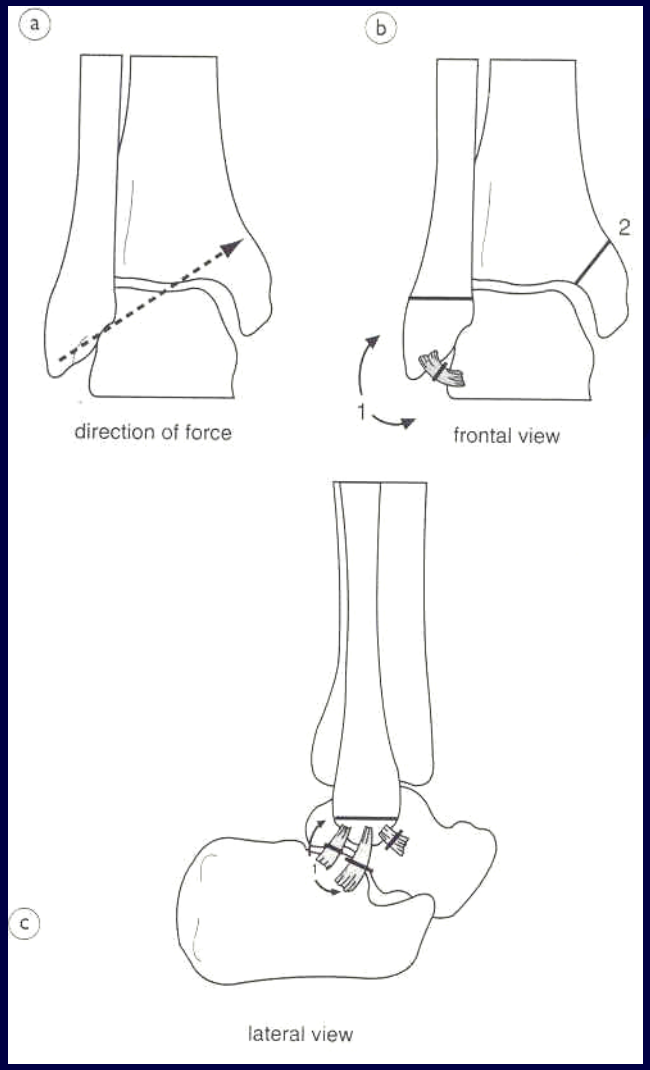
- MRI to evaluate all patients with lateral malleolar fracture and positive stress test (n=21).
- If deep deltoid partially intact→ nonop treatment
- Good clinical outcomes.

OTA Annual Meeting. Foot & Ankle Section. Paper #24, 2006.

Indication to fix isolated fibular fractures

Choose a technique to evaluate stability. Base your decision to operate on your findings and the risk:benefit ratio.

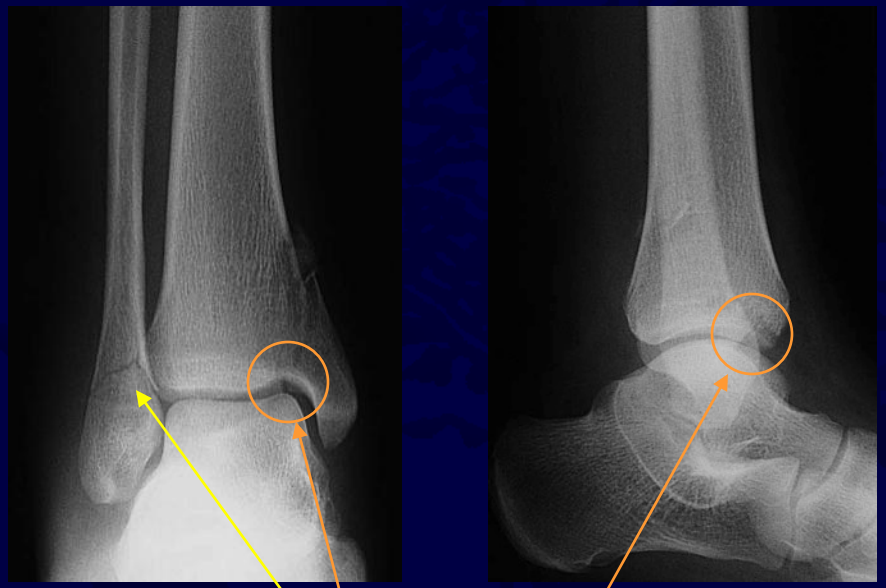
Supination Adduction



Stage 1: transverse Weber A or B fibula

Stage 2: vertical medial malleolus

Supination Adduction: Stage 2



Lateral Injury: transverse fibular fracture at/below level of mortise

Medial injury: vertical shear type medial malleolar fracture
BEWARE OF IMPACTION

McConnell J Orthop Trauma 2001

Supination Adduction: Stage 2

Important to restore:

– Ankle stability

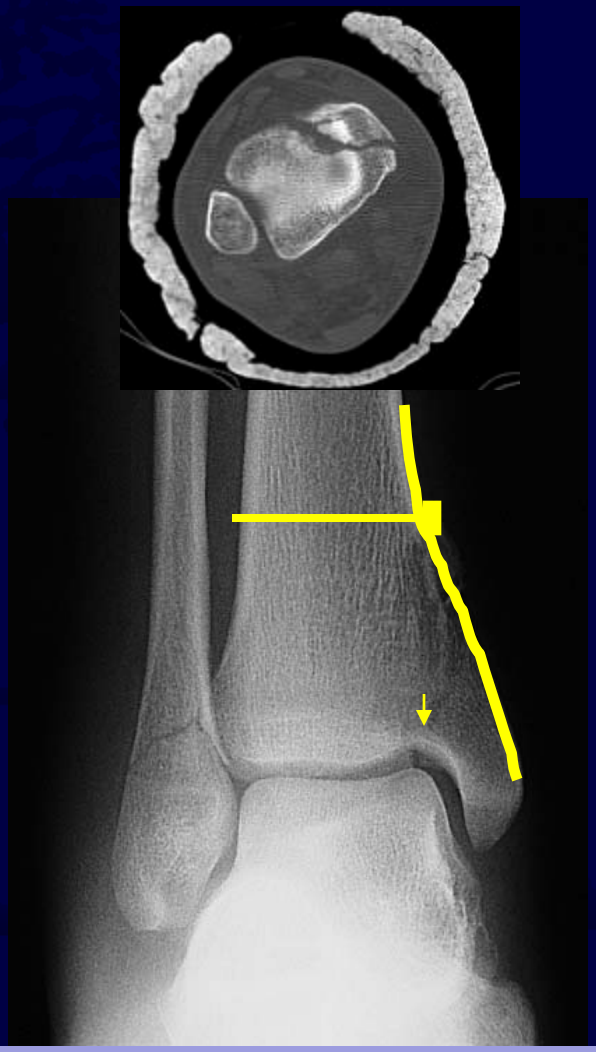
– Articular congruency- including medial impaction

SAD

Consider anteromedial approach

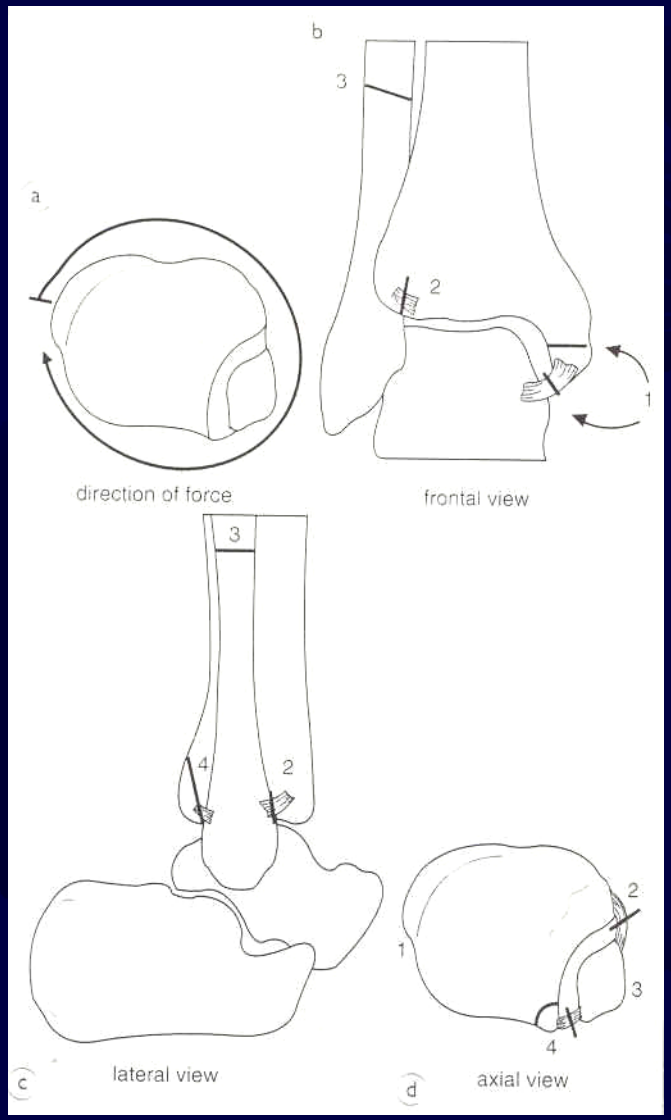
Marginal impaction reduction +/- grafting

Medial antiglide plate



Specific articular pathology associated with SA

Pronation-External Rotation



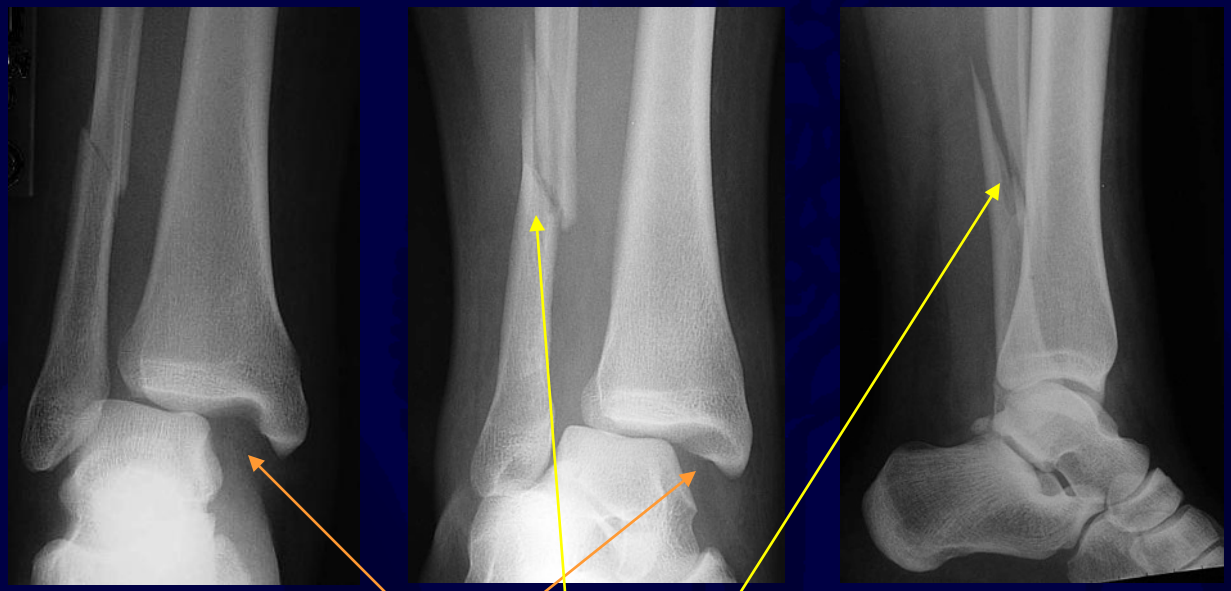
Stage 1 - deltoid or medial malleolus

Stage 2- AITFL and IO membrane

Stage 3 – spiral Weber C fibula

Stage 4 – PITFL or posterior malleolus

Pronation External Rotation: Stage 4



Medial injury: deltoid ligament tear &/or transverse medial malleolar fracture

Lateral Injury: spiral proximal lateral malleolar fracture

HIGHLY UNSTABLE…SYNDESMOTIC INJURY COMMON

PER

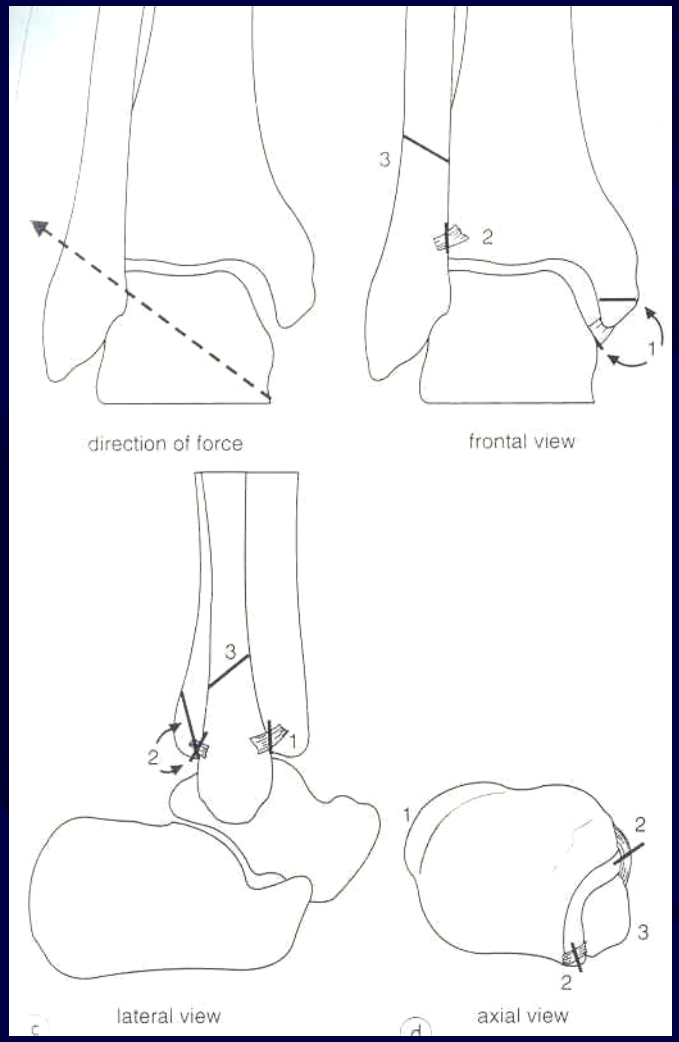
Tibia radiograph

Syndesmostic disruption expected

Restore:

- Fibular length and rotation
- Ankle mortise
- Syndesmotic stability

Pronation-Abduction

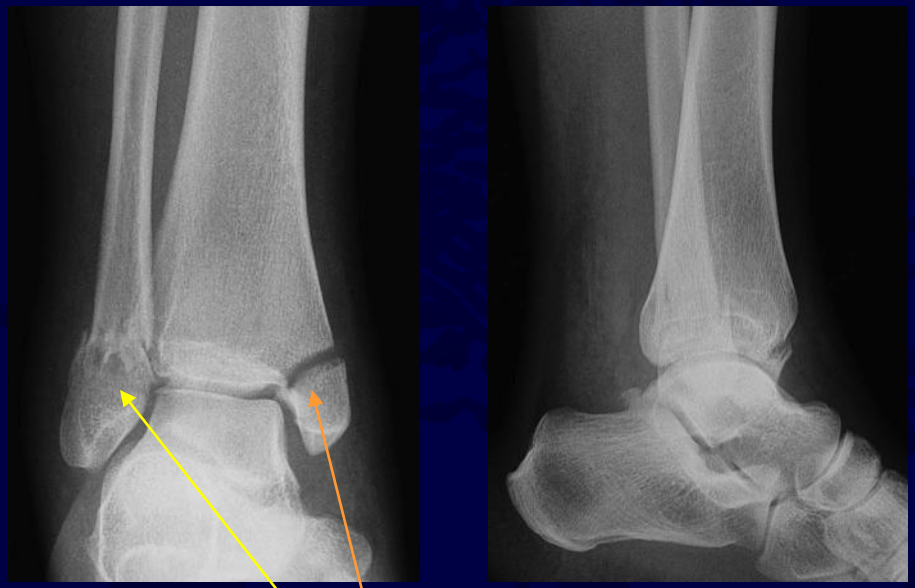


Stage 1 – transverse MM

Stage 2 – PITFL or PM fracture

Stage 3 – compression bending fibula fracture

Pronation-Abduction



Medial injury: tranverse to short oblique medial malleolar fracture

Lateral Injury: comminuted impaction type lateral malleolar fracture

PAB

Medial malleolar fixation drives stability. Go there 1st.

Fibular comminution → length stable construct?

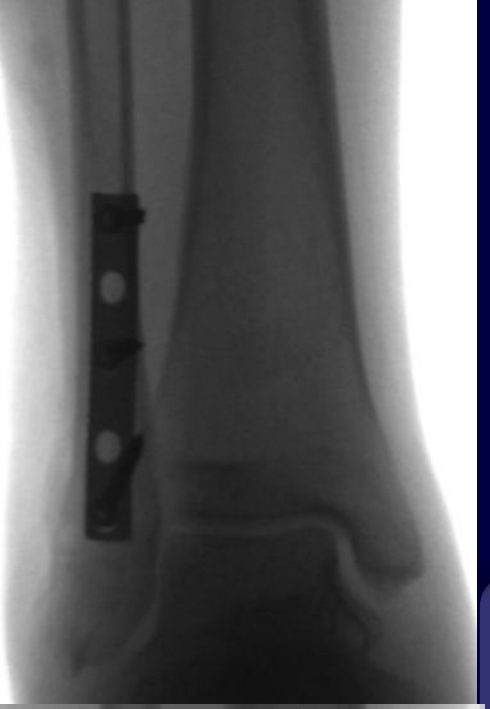
Stress the syndesmosis last

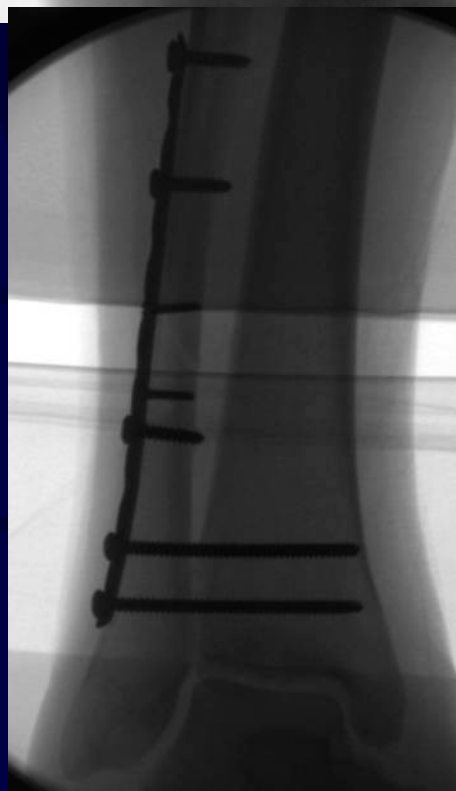
JBJS 89A: 276-81, 2007

PAB

Specific articular pathology associated with PAB

PAB:
Specific Articular Pathology



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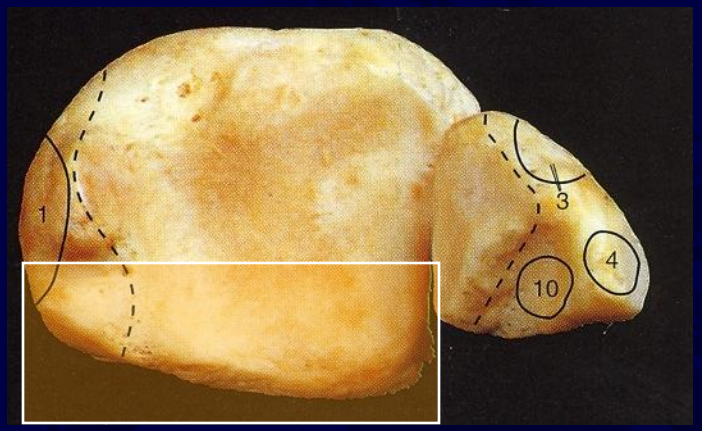
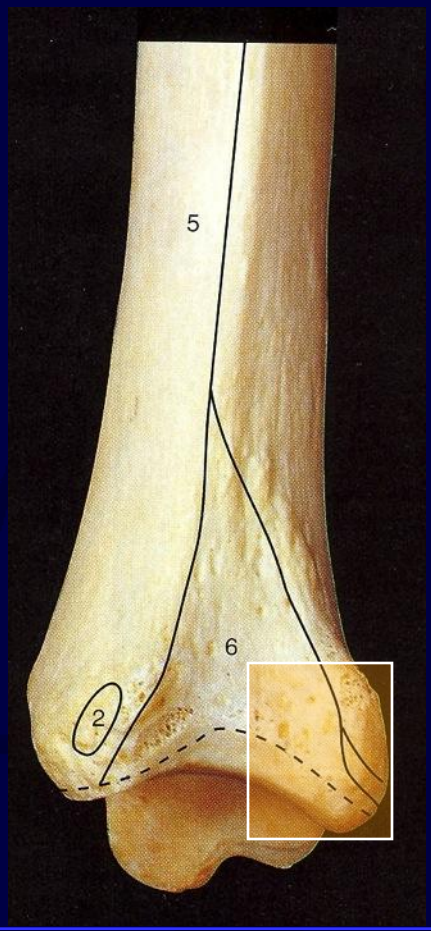
- Surgical Indications and Goals
- Outcome

Posterior Malleolus Fractures





Function:

Stability- prevents posterior translation of talus & enhances syndesmotic stability

Weight bearing- increases surface area of ankle joint

Posterior Malleolus Fractures: Radiographic Evaluation

Fracture pattern:

- Variable

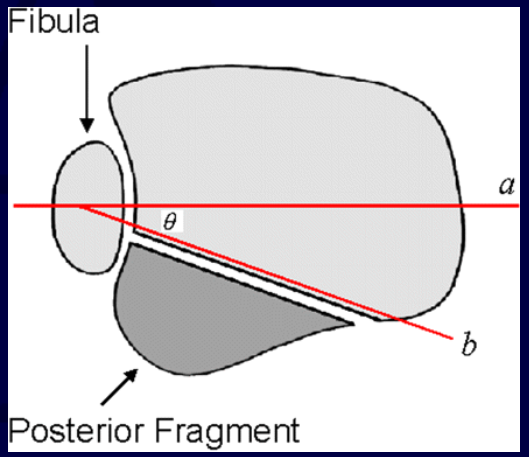
- Difficult to assess on standard lateral radiograph
  - External rotation lateral view [Decoster *FAI* 2000]
  - CT scan [Haraguchi JBJS 2006]

Posterior Malleolus Fracture: Radiographic Evaluation

Indication for fixation: > 25% joint surface on lateral

Problem: Fragment size hard to determine on lateral view

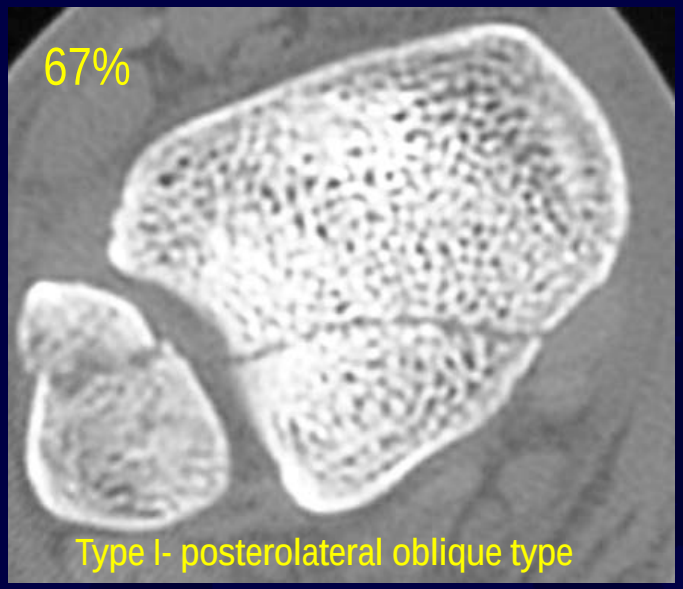
- Reason: Fracture orientation not purely in coronal plane
- Nearly always associated with the pull of the posterior tib-fib ligament
  - larger laterally than medially
  - obliquely oriented
  - involves the incisura

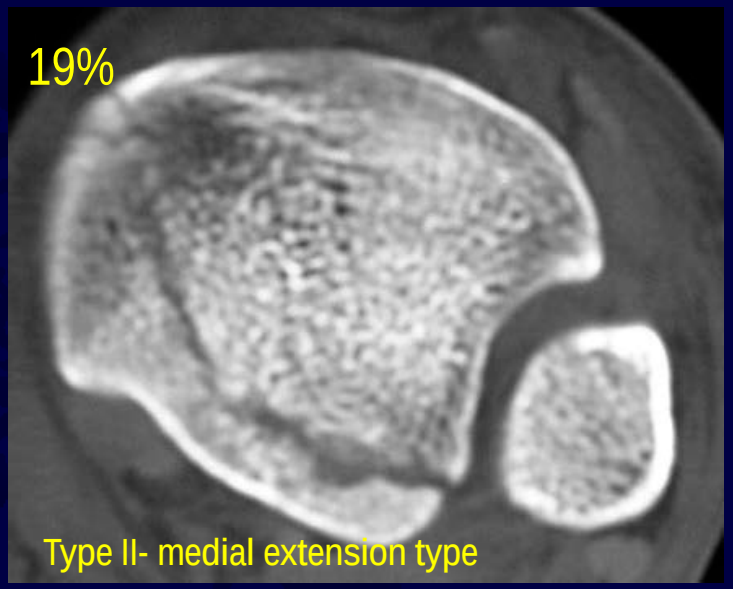


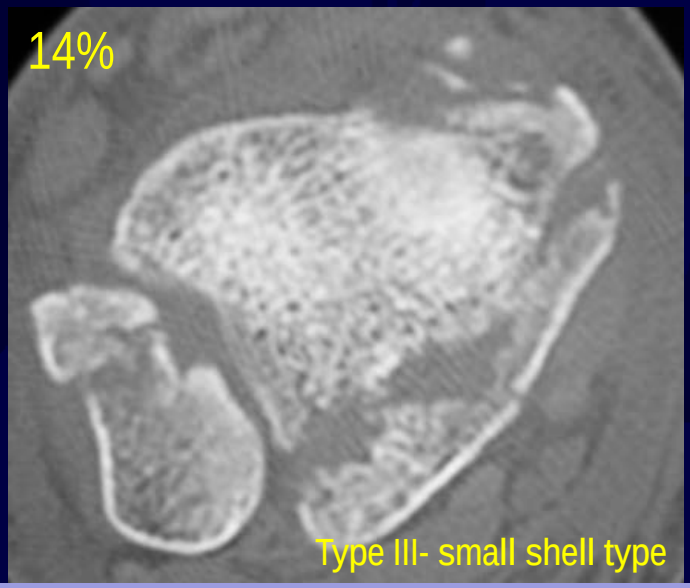
Haraguchi et al. JBJS 2006

...but other fracture patterns have also been defined

Posterior Malleolus Fracture







3 common PM fracture patterns

Haraguchi et al. JBJS 2006

Posterior Malleolus Fractures: Indications for Fixation

Stability

- Posterior translation of talus*
- ER of talus [syndesmotic widening]

Articular congruence

- Stress = Force/Area
- Excessive stress→posttraumatic arthritis
  - Maximize area for stress distribution**

*fibula and anterior tibiofibular ligament act as primary restraint [Raasch JBJS 1992]

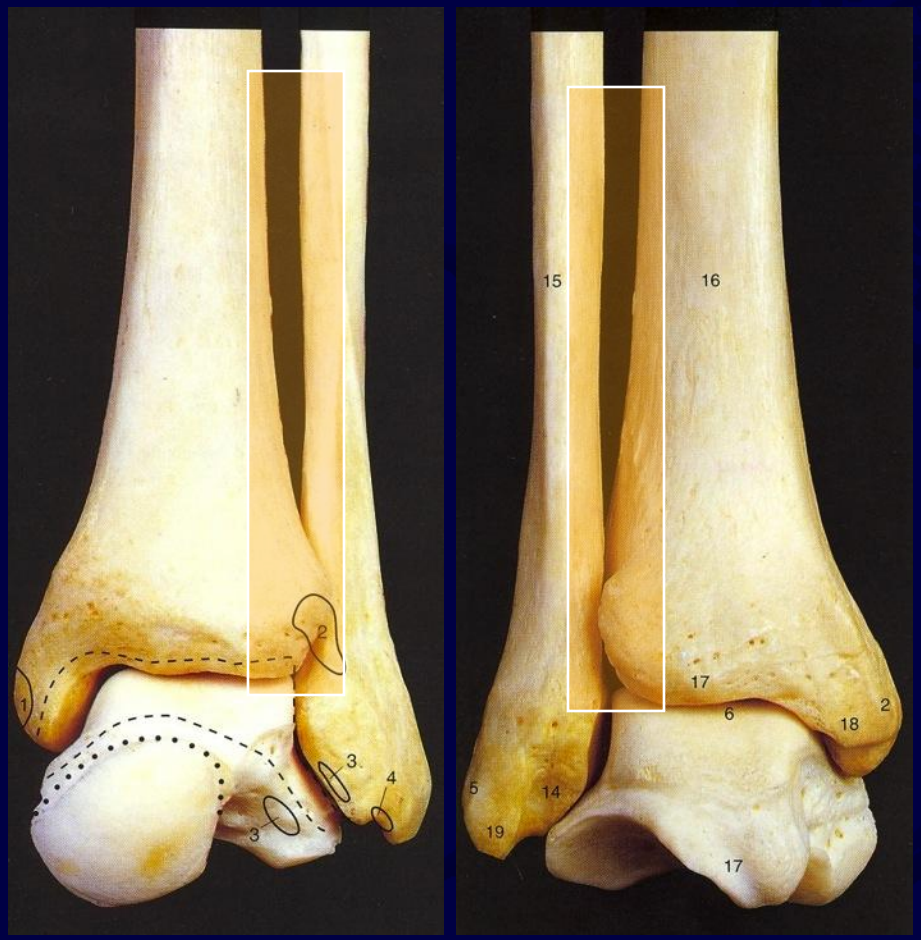
**contact stress changes significantly with posterior malleolar size >33% [Hartford CORR 1995]

Posterior Malleolus Fracture: Fixation

Screws

Plates

Syndesmotic Injury



FUNCTION:

Stability- resists external rotation, axial, & lateral displacement of talus

Weight bearing- allows for standard loading

Syndesmosis

IF INSTABILITY PRESENT → OPERATIVE INTERVENTION

OBTAINING & MAINTAINING ANATOMIC REDUCTION REDUCES LONG TERM DISABILITY & IMPROVES sMFA

Leeds JBJS 1984

Weening JOT 2005

Syndesmosis:
Instability

How do you determine if instability is present?

– Manual Stress Test

When do you perform the manual stress test?

– After you have fixed the other indicated components of the fracture

Syndesmosis

IF INSTABILITY PRESENT→ OPERATIVE INTERVENTION

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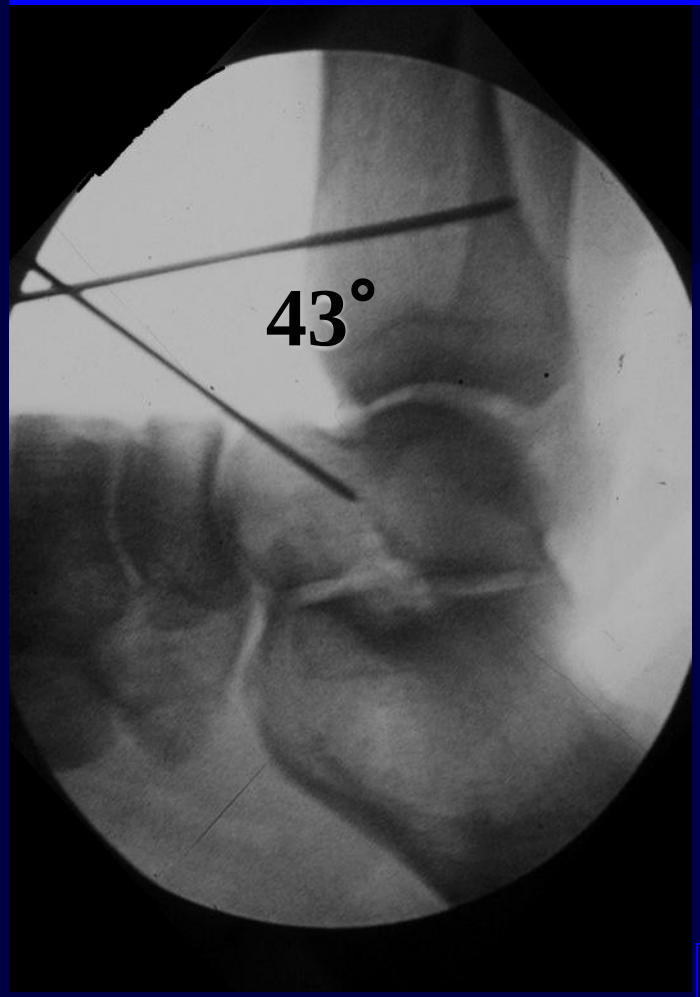
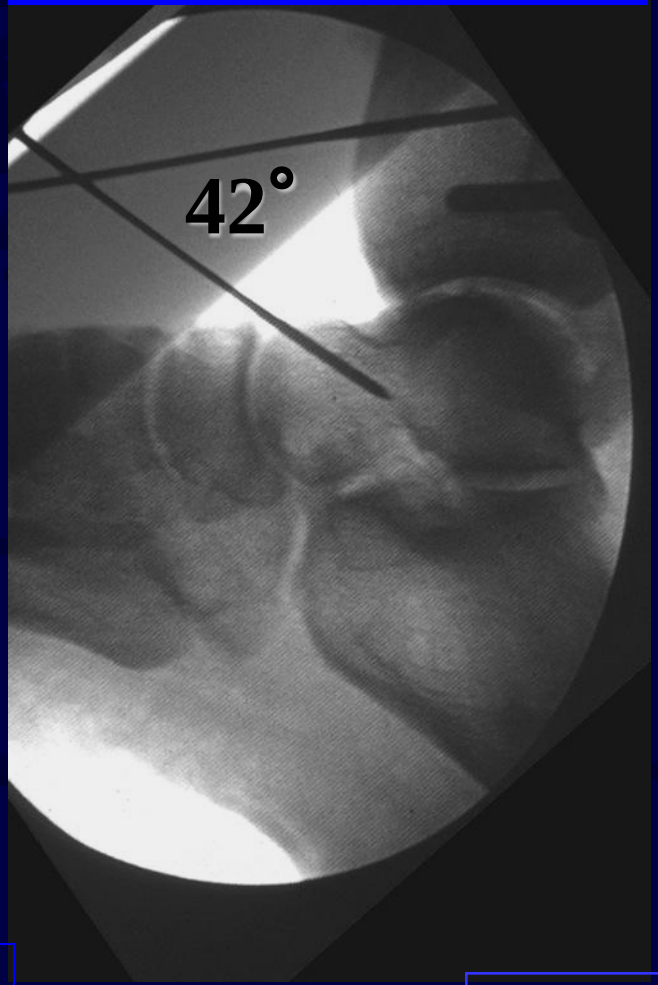
Weening JOT 2005

Syndesmosis:
Obtaining a Reduction

Before Fixation



After Fixation



DF unnecessary

Tornetta JBJS 2001

Syndesmosis:
Obtaining a Reduction

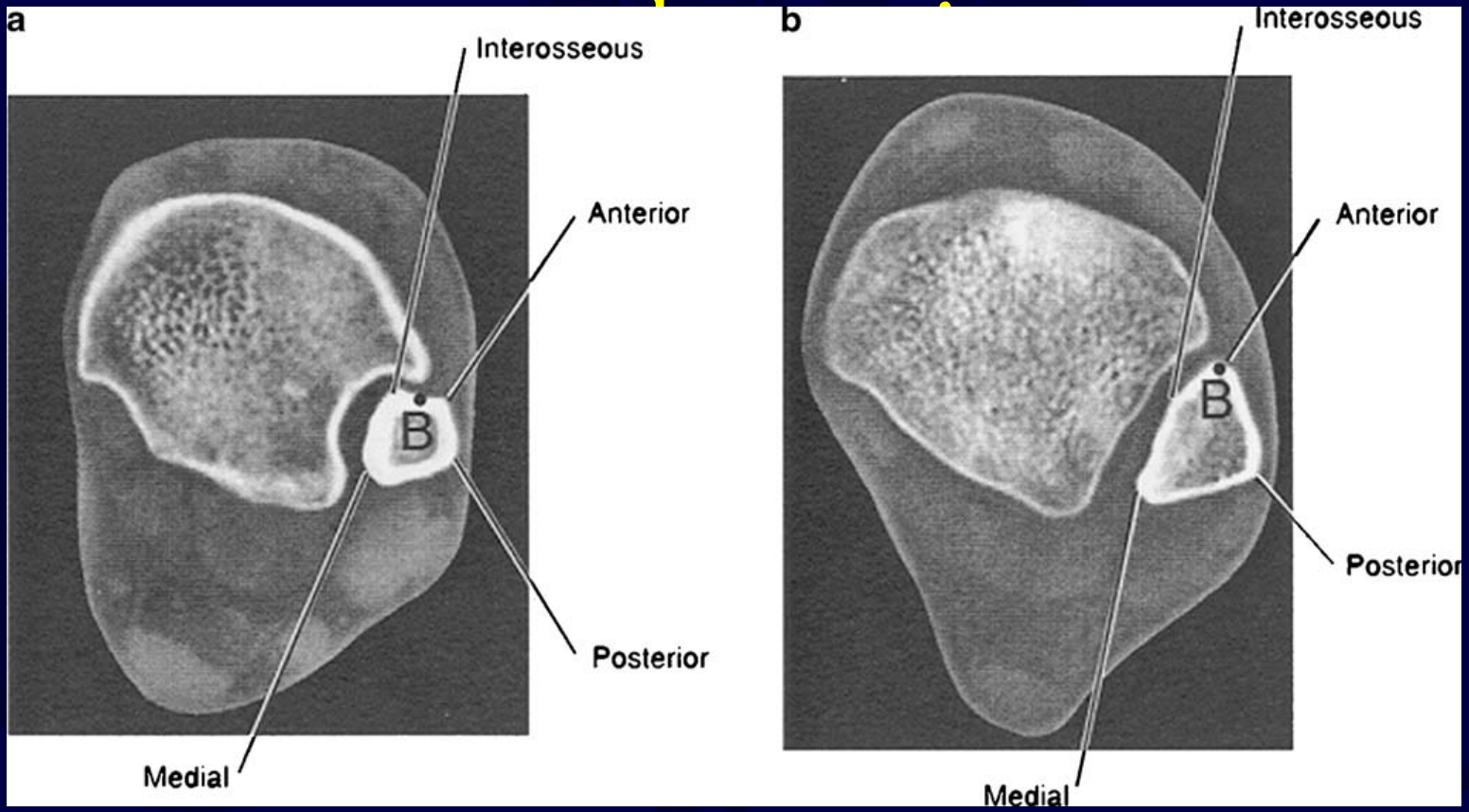
Incidence of malreduction based on CT scan "standard": >50%

- *Gardner et al. FAI* 27: 788-92, 2006.

Ways to ensure appropriate reduction:

- Direct visualization
  - *FAI* 30: 419-26, 2009
- Radiographic imaging in multiple planes
  - *Injury* 35: 814-18, 2004.

Problem?
The CT definition of an anatomic



Elgafy et al. Skeletal Radiology 39: 559-64, 2010

Syndesmosis

IF INSTABILITY PRESENT→ OPERATIVE INTERVENTION

OBTAINING & MAINTAINING ANATOMIC REDUCTION REDUCES LONG TERM DISABILITY & IMPROVES sMFA

Leeds JBJS 1984

Weening JOT 2005

Syndesmosis:
Maintaining a Reduction

Single Screw
3 cortices

Single Screw
4 cortices

2 Screws
6 cortices

2 Screws
8 cortices

Syndesmosis:
Maintaining a Reduction

3.5 mm vs 4.5 mm screw(s)

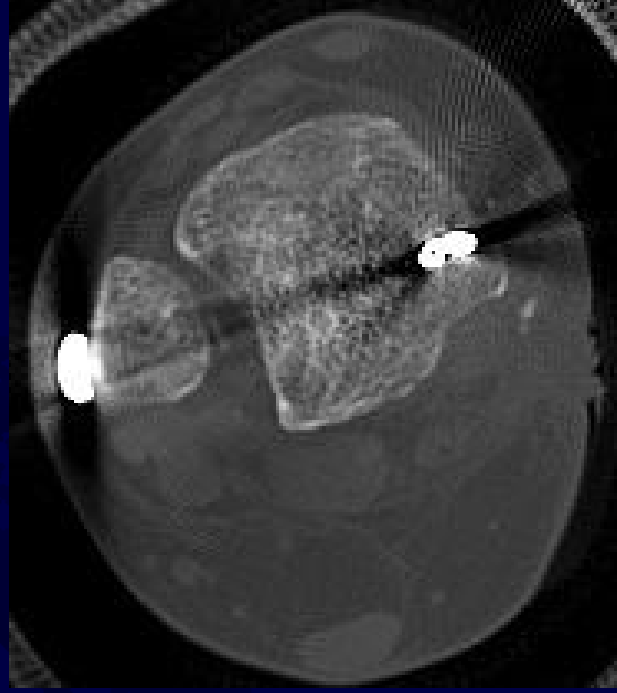
3 cortices vs 4 cortices

Retain vs Removal

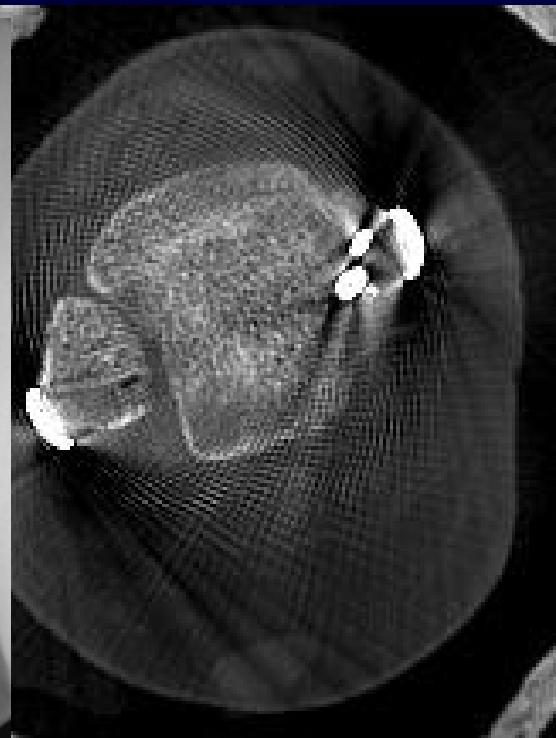
Metallic vs Bioabsorbable

NO CONSENSUS









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Surgical Goals

1.1 Aims of the AO Method

Rapid Recovery of the Injured Limb

This is accomplished by:

Anatomic reduction of the fracture fragments particularly in joint fractures.

Stable internal fixation designed to fulfill the local biomechanical demands.

Preservation of the blood supply to the bone fragments and the soft tissue by means of atraumatic surgery.

Early active painfree mobilization of muscles and joints adjacent to the fracture. In this way the development of "fracture disease" is prevented.

The fulfilment of these four conditions is the prerequisite for a perfect internal fixation. Such fixation will result in the best healing not only of the bone but also of all components of the injury.

AO Manual, 2nd Edition

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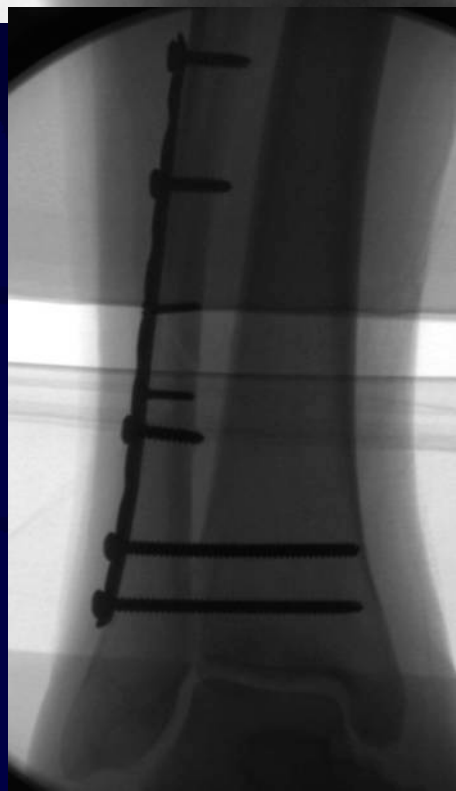


Outcome

Egol JBJS 2006

At one year following surgery, patients are generally doing well

Most have few restrictions and little pain

There is a significant improvement at one year compared to six months

Younger age, male sex, absence of diabetes, and lower ASA class are predictive of functional recovery at one year

Outcome

Horisberger et al. J Orthop Trauma 2009

Fracture severity influences the rate of development and the latency time to endstage ankle arthritis.

The occurrence of postop complications has a negative influence on long-term results.

The patient's age at the time of injury correlated negatively with the OA latency time (i.e. if you are older when you sustain an ankle fracture, you are more likely to develop end-stage OA sooner than if you had been younger).

Outcome

- Ganesh et al. JBJS 87A: 1712-1718, 2005
- Egol et al. JBJS 88: 974-979, 2006
- SooHoo et al. JBJS 91A: 1042-1049, 2009

Specific findings in the history noted to have an adverse effect on outcome include:

- Advanced age
- Osteoporosis
- Diabetes mellitus
- Peripheral vascular disease
- Female sex
- High American Society of Anesthesiology (ASA) class

Outcome

Bhandari et al. J Orthop Trauma 18: 338-45, 2004.

Social factors noted to be independent predictors of lower physical function postoperatively

- Smoking
- Alcohol use
- Lower level of education

Complications

Perioperative
- Malreduction
- Inadequate fixation
- Intra-articular hardware penetration

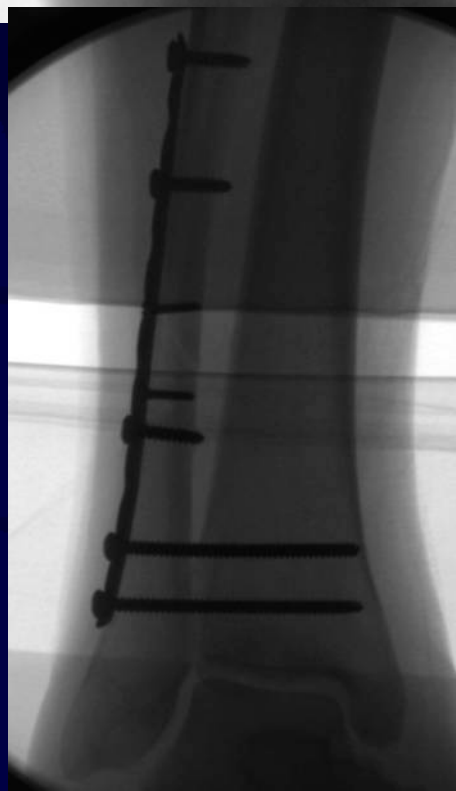
Early Postoperative
- Wound edge dehiscence/necrosis
- Infection
- Compartment syndrome

Late
- Stiffness
- Distal tibiofibular synostosis
- Malunion
- Nonunion
- Post-traumatic arthritis
- Hardware related complications
- Complex regional pain syndrome type 1

Leyes Foot Ankle Clin 2003

Outline

- Evaluation: Clinical & Radiographic
- Classification: Lauge-Hansen
- Specific Problem Areas: Posterior Malleolus and Syndesmosis
- Surgical Goals
- Outcome
- Special Scenario: The Diabetic Ankle Fracture



Diabetic Ankle Fractures

Problems:

- Diabetes mellitus is a common medical condition that is increasing in prevalence
- Both closed and open management of ankle fractures in diabetics have higher complication rates

Solution:

- So do we change the indications and goals of treatment?

Wukich, Kline. JBJS 90: 1570-78, 2008
Chaudhary et al. JAAOS 16: 159-70, 2008

Diabetic Ankle Fractures

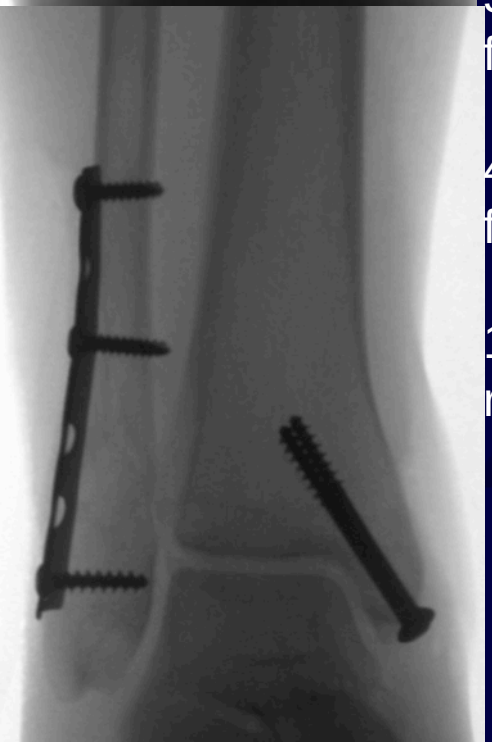
Answer- NO

- Unstable ankle fractures in diabetics are still best treated with anatomic restoration of the ankle mortise and stable internal fixation, but…

- Because the soft tissue complications are higher, increased care must be given to atraumatic soft tissue techniques (limb at level of heart, careful of SQ incisions)

- Because the osseous complications are higher, increased care must be given to empowering fracture fixation constructs (screws from fibula into tibia, double stacked 1/3 tubular plates)

- Postoperative care varies in that immobilization, non-weightbearing mobilization, and subsequent protected weightbearing all take a longer course (SLC 6-12 weeks, NWB 12 wks)



Summary

At this point, you should be able to:

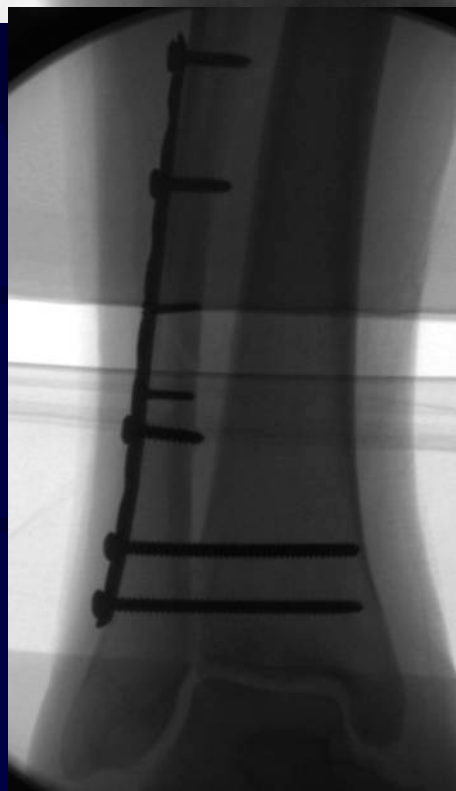
1.State the indication to fix isolated fibular fractures.

2.Define the specific articular pathology associated with SA and PAB fractures.

3.List the 3 common posterior malleolar fracture patterns.

4.State the indication to fix posterior malleolar fractures.

1.Enumerate the ways to ensure syndesmotic reduction.



Thank You

Anotated Bibliography of Recent Articles of Interest

SooHoo NF, Krenek L, Eagan MJ, Gurbani B, Ko CY, Zingmond DS: Complication rates following open reduction and internal fixation of ankle fractures. *J Bone Joint Surg Am* 2009;91(5):1042-1049. **Prognostic Level II. California's discharge database was queried for patients that had undergone ORIF of an ankle fracture over a ten year period with complications reviewed and discussed. Open injuries, diabetes, and peripheral vascular disease were strong risk factors for short-term complications.**

Strauss EJ, Frank JB, Walsh M, Koval KJ, Egol KA: Does obesity influence the outcome after the operative treatment of ankle fractures? *J Bone Joint Surg Br* 2007;89(6):794-798. **Retrospective review evaluating the number of comorbities, incidence of complications, time to fracture union, fracture type, and level of function between obese and non-obese patients with ankle fractures. At two years postop, obesity did not seem to have an effect on the incidence of complications, time to fracture union, or level of function.**

White BJ, Walsh M, Egol KA, Tejwani NC: Intra-articular block compared with conscious sedation for closed reduction of ankle fracture-dislocations. A prospective randomized trial. *J Bone Joint Surg Am* 2008;90(4):731-734. **Therapeutic Level I. Prospective, randomized trial comparing conscious sedation and intraarticular block for analgesia and the ability to allow for ankle fracture reduction and application of a splint. No difference in analgesia or allowance for reduction was noted. The intraarticular block allowed for a shorter average time for reduction and splinting.**

Anotated Bibliography of Recent Articles of Interest

Boraiah S, Paul O, Parker RJ, Miller AN, Hentel KD, Lorich DG: Osteochondral lesions of talus associated with ankle fractures. *Foot Ankle Int* 2009;30(6):481-485. **Level IV. Retrospective case series evaluating the incidence and effect of osteochondral lesions of the talus in ankle fractures that were operatively treated. All patients were assessed preoperatively by MRI and functional outcome was measured at a minimum of 6 months using Foot and Ankle Outcome Scoring. Osteochondral lesions were noted in 17% of cases but showed no statistically significant effect on outcome.**

Koval KJ, Egol KA, Cheung Y, Goodwin DW, Spratt KF: Does a positive ankle stress test indicate the need for operative treatment after lateral malleolus fracture? A preliminary report. *J Orthop Trauma* 2007;21(7):449-455. **Retrospective review of patients who had a positive ankle stress test after an isolated Weber B lateral malleolar fracture. An MRI was ordered to evaluate the status of the deep deltoid ligament. If the deep deltoid was partially torn, patients were treated non-operatively. At a minimum 12 month followup, all fractures had united without evidence of medial clear space widening or post-traumatic arthritis.**

Schock HJ, Pinzur M, Manion L, Stover M: The use of gravity or manual-stress radiographs in the assessment of supination-external rotation fractures of the ankle. *J Bone Joint Surg Br* 2007;89(8):1055-1059. **Gravity and manual stress tests were compared in supination external rotation ankle fractures. Gravity-stress was determined to be as reliable and perceived as more comfortable than manual-stress.**

Anotated Bibliography of Recent Articles of Interest

Siegel J, Tornetta P III: Extraperiosteal plating of pronation-abduction ankle fractures. *J Bone Joint Surg Am* 2007;89(2):276-281. **Therapeutic Level IV. Retrospective review of consecutive patient series managed with extraperiosteal plating of fibular fractures in pronation-abduction type injuries. Extraperiosteal plating was found to be an effective method of stabilization that led to predictable union.**

Miller AN, Carroll EA, Parker RJ, Boraiah S, Helfet DL, Lorich DG: Direct visualization for syndesmotic stabilization of ankle fractures. *Foot Ankle Int* 2009;30(5):419-426. **Level III. Case control. An established protocol for treatment of ankle fractures with syndesmotic injury was evaluated retrospectively. Patients that underwent stabilization of the syndesmosis with direct visualization were compared with historic controls that underwent indirect fluoroscopic syndesmotic visualization. All patients had postoperative CT scans. Based on their definition of an anatomic syndesmotic reduction, malreductions were significantly decreased in the direct visualization group.**

Herscovici D Jr, Scaduto JM, Infante A: Conservative treatment of isolated fractures of the medial malleolus. *J Bone Joint Surg Br* 2007;89(1):89-93. **Retrospective evaluation of patients with conservative treatment of isolated medial malleolar fractures. High rates of union and good functional results were noted with conservative treatment.**

Thank You

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Return to Lower Extremity Index

Return to index