Ankle Fractures: Controversies & Challenges

Assessment of injury, classification

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Disclosure

Consultant

- Arthrex
- Tornier

- Ankle fractures involve a spectrum of injury patterns from simple to complex, such that these injuries are not always "just an ankle fracture.

Case 1

- 58 year old WM comes with 2 weeks history of trivial trauma.
- Presentation in the clinic walking without any support.
- Pain level 2/10

- Is it normal???
- Am I missing something here??

Case 2

- 38 year old WM fell in the backyard and got ankle fracture.
- Came to the ER walking with pain level 1/10.

- Doesn't sound Normal??

Case 3

- 47 year old female with ORIF ankle fracture [1 year ago], still complaining about 7/10 pain with ambulation.

- Fracture seems to be healed but what next??

Ankle Fractures

- **Why Should I worry about ankle fractures?**
- 1 mm of lateral translation of the talus reduced surface contact area in the ankle joint by 42%; lateral translation of 2mm by 64%.

Ramsey P.L., Hamilton W.: J Bone Joint Surg Am 1976; 58: 356-357

2 mm of shortening or lateral shift of the fibula, or external rotation > 5 degrees, increases contact forces in the ankle joint leads to early ankle arthritis.

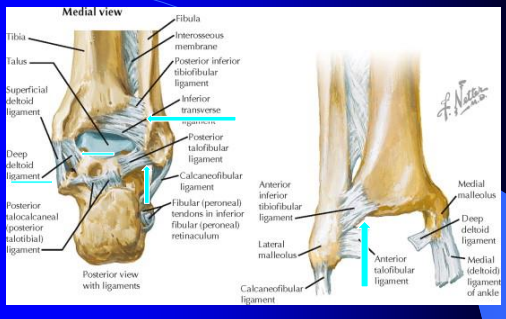
- **Thordarson D.B., Motamed S.,et al J Bone Joint Surg Am 1997; 79: 1809-1815**

- Significant loss of tibiotalar contact with posterior malleolar fractures involving greater than 33% of the joint surface.

- Hartford JM et al. CORR 1995; 320: pp. 182-187

The ankle joint is subject to enormous forces across a relatively small surface area of contact, with up to 1.5 times body weight with gait and greater than 5.5 times body weight with more strenuous activity.

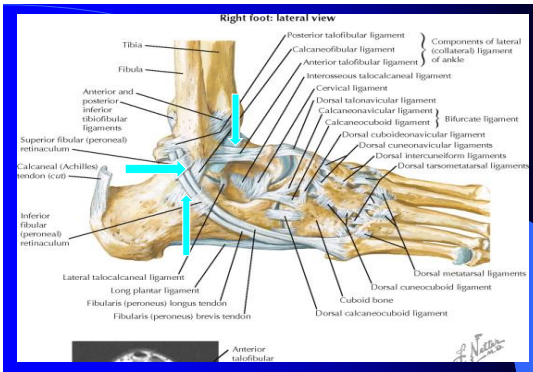
- Lets recall our basic Anatomy structures in the next couple of slides.



Jon C. Thompson Netter's Concise Orthopaedic Anatomy, CHAPTER 10, 337-383

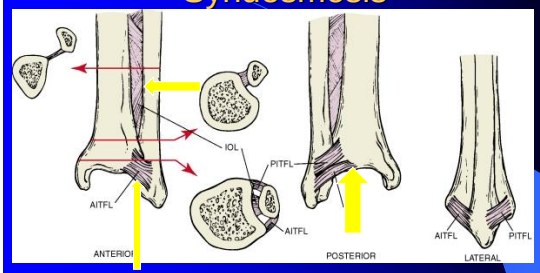
Posterior Tibial Tendon Injury

- During Injury
- Irritation secondary to Tension Bend wiring/screws
- Progressive tear and flattening of foot.



Jon C. Thompson Netter's Concise Orthopaedic Anatomy, CHAPTER 10, 337-383

Syndesmosis



Carr JB, Trafton PG *Skeletal trauma: fractures, dislocations, ligamentous injuries*, 2nd ed., 1998, WB Saunders

Classification System

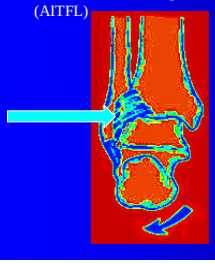
- The two most commonly used classification systems are the **Lauge-Hansen and Danis-Weber ([AO] Müller) systems.**
- The Lauge-Hansen system is based on the suspected injury mechanism. Fractures are categorized by a **combination of foot position and direction of force.**

  Lauge-Hansen W. Arch Surg 1940; 56: pp. 259-317
- The Danis-Weber system is based on the **level of the fibula fracture** and is divided into three types. This system is easier to remember and has more relevance to operative decision making.

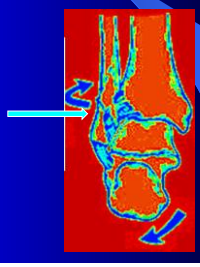
  Weber BG. Die Verletzungen des oberen Sprunggelenkes
- Mast and Teipner first combined these in 1980

Supination-External Rotation

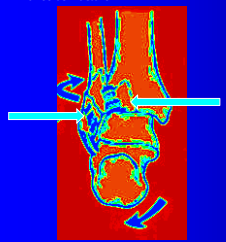
- **SER I** failure of the anterior-inferior tibiofibular ligament (AITFL)



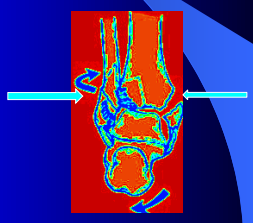
SER II a spiral oblique fibula fracture at or just above the ankle mortise



SER III failure of the posterior-inferior tibiofibular ligament (PITFL) or posterior malleolus fracture



SER IV tension failure of the deep deltoid ligament or transverse avulsion fracture of the medial malleolus



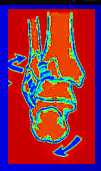
Supination-External Rotation

- Medial tenderness, swelling, and ecchymosis are poor predictors of deltoid incompetence.
- If no medial widening stess radiographs
- Gravity/External Rotation stress
- If stable be placed in a prefabricated fracture boot and allowed to weight-bear to tolerance; repeat weight-bearing radiographs are obtained 5–7 days later.

Michael Clare Foot and Ankle Clinics of North America 01/2009; 13(4):593-610.

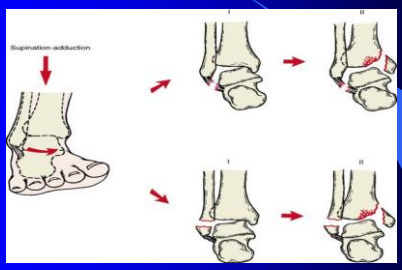
SER II a spiral oblique fibula fracture at or just above the ankle mortise

SER IV torsion failure of the deep deltoid ligament or transverse avulsion fracture of the medial malleolus



SER III failure of the posterior-inferior tibiofibular ligament (PITFL) or posterior malleolus fracture

Supination-Adduction Injury



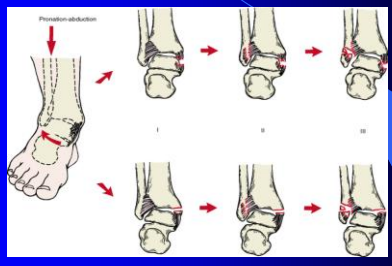
Lauge –Hansen Supination-Adduction Injury

Supination-Adduction Injury

- 10%–20% of ankle fractures
- Avulsion fracture of lateral malleolus/lateral ligament injury
  &
- vertical shear fracture of Medial Malleolous .
- Association with **medial Tibial plafond impaction injury**.

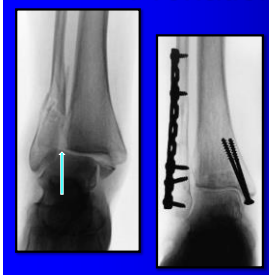
Michael Clare Foot and Ankle Clinics of North America 01/2009; 14(4):581-618

Pronation-Abduction



Lauge –Hansen Pronation-Abduction injury

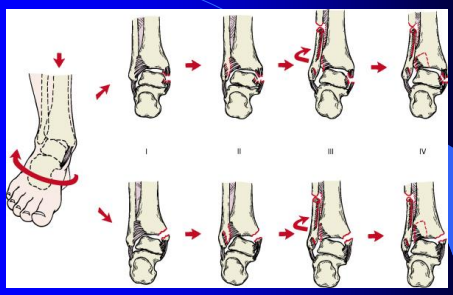
Pronation-Abduction



- Transverse avulsion fracture of the medial malleolus.
- (II) failure of the AITFL and PITFL
- (III) a transverse fibula fracture at or above the ankle mortise with communution.
- Check for syndesmois Integrity.
- **Lateral Tibial Plafond** should be inspected for any impaction.

Michael Clare Foot and Ankle Clinics of North America 01/2009; 13(4):593-610.

- Mast J.: In Müller M.E., Allgöwer M., Manual of internal fixation. New York: Springer-Verlag, 1991.

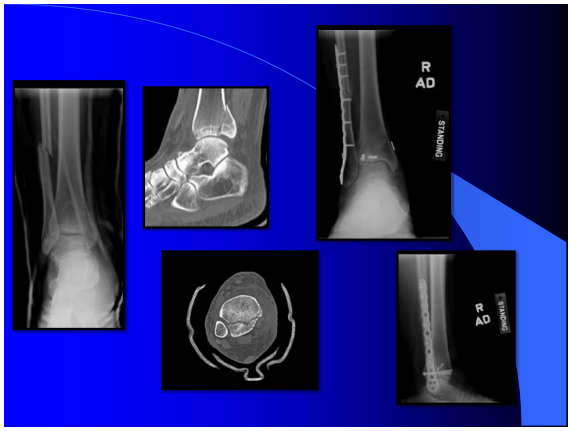


Lauge –Hansen Pronation-External Rotation injury

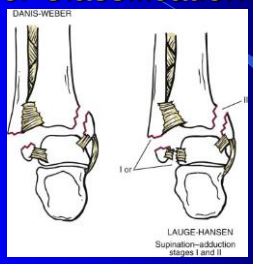
Pronation-External Rotation

- (I) Tension failure of the deep deltoid ligament or transverse avulsion fracture of the medial malleolus
- (II) failure of the AITFL
- (III) a spiral oblique fibula fracture above the ankle mortise
- (IV) failure of the PITFL or posterior malleolus fracture
- Commonly associated with instability of the syndesmosis.

Michael Clare Foot and Ankle Clinics of North America 01/2009; 13(4):593-610.



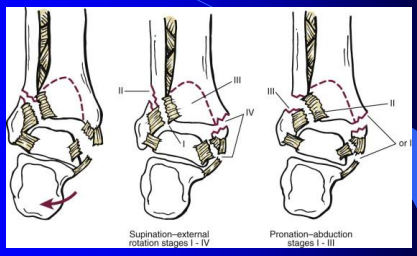
Weber Classification System



Type A: Infrasyndesmotic Injury

Carr JB, Trafton PG: Jupiter JB, Levine AM, Trafton PG, editors: *Skeletal trauma: fractures, dislocations, ligamentous injuries*, 2nd ed, 1998.

Type B: Transsyndesmotic Injury



Carr JB, Trafton PG: Jupiter JB, Levine AM, Trafton PG, editors: *Skeletal trauma: fractures, dislocations, ligamentous injuries*, 2nd ed, 1998.

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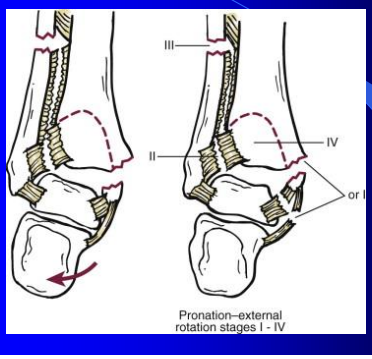


Type C: Suprasyndesmotic Injury

Assessment of the Injury

History Of Injury

Smoking **Diabetes**

History of primary Rx.

Level of Pain

Past Medical History :

Cardiac Disease.

Neuropathy ??: Diabetes, Alcohol, Thyroid, Nerve Injury/Neuromascular Disorder

Recalling our cases

Case 1

Alcoholic Neuropathy

Case 2

Diabetic Neuropathy

Evaluation of the Patient

- Skin Condition.
- Vascularity/ Capillary Refill
- R/o Compartment Syndrome.
- Check nerve status on the uninjured leg.
- Wrinkle Sign??

Stable Fracture

- Immobilization in AO splint.
- Elevation.
- Surgery in 10-14 days.

- surgical treatment for an ankle fracture [except irreducible dislocation/open fracture] is certainly not an emergency and can therefore be completed as an elective procedure in 10-14 days.

Unstable Fracture/Fracture Dislocation.

- Attempt Close reduction & splinting followed by re-xray.
- If unreduced take in the OR for closed reduction & Ex-Fix Application vs Definitive Fixation.
- If open fracture/ poor skin condition. – Closed Reduction-External Fixator & Debridement

Presentation in the clinic at 3 weeks of injury[in the splint] without any reduction.

Reduction Attempted in the cast-room.

Patient was taken to the OR on the same day for the ORIF

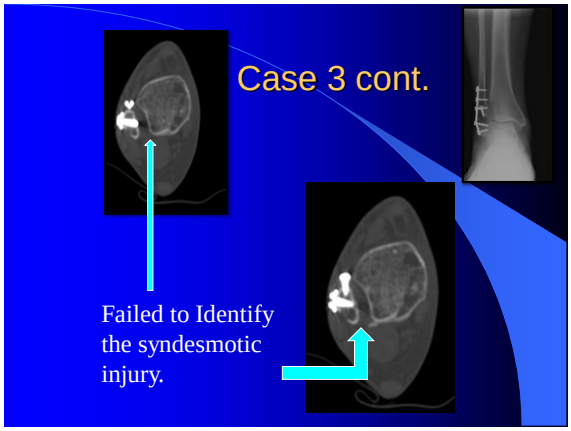
Radiographic Evaluation

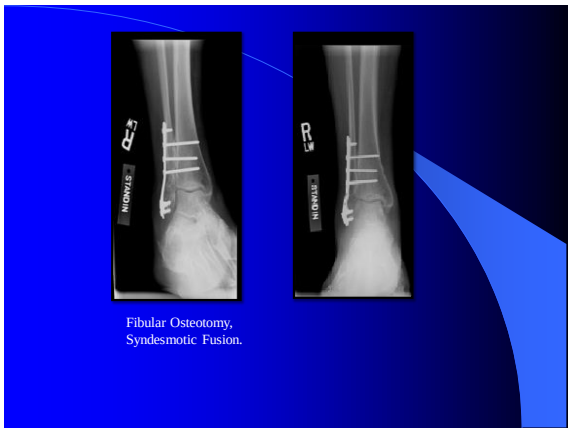
- Xrays

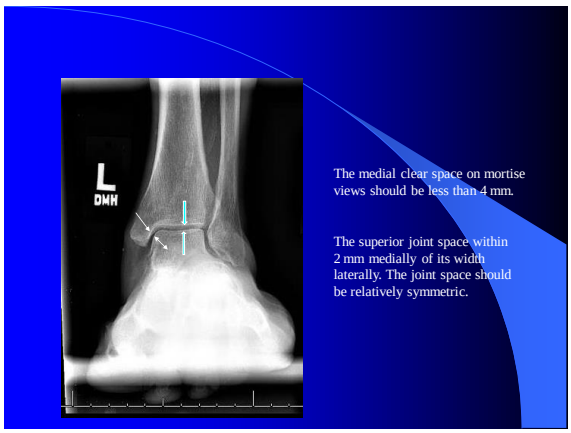
  3 views [AP/ Mortise/ Lateral view of the injured and opposite ankle].

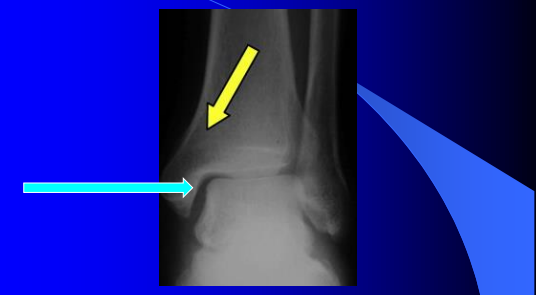
  Knee xrays if suspicious about maisonneuve injury.

- CT Scan

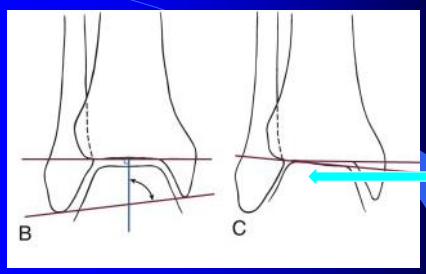

Case 3 cont.
Failed to Identify the syndesmotic injury.


Fibular Osteotomy, Syndesmotic Fusion.


L
DMH
The medial clear space on mortise views should be less than 4 mm.
The superior joint space within 2 mm medially of its width laterally. The joint space should be relatively symmetric.



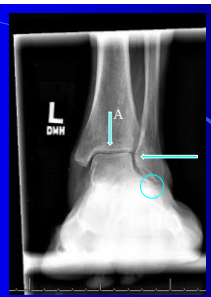
Medial Clear Space > 4mm



The talar tilt angle (<2 mm).

The talocrural angle is 83 degrees ± 4 degrees and normally within 2 degrees of the opposite ankle.

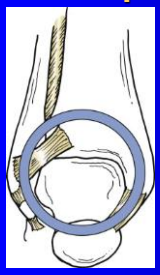
Mann's Surgery of the Foot and Ankle. Walling, Art, et al Pages 2003-2040

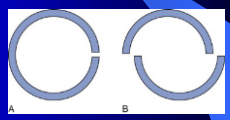


1 Parallel joint space.
2, Spike of fibula pointing to the level of the subchondral bone of the tibia.
3, Unbroken curve between the lateral talar articular surface and recess of the distal fibula. The subchondral bone that forms the Shenton line should be intact.
Weber BG, Simpson LA: Corrective lengthening osteotomy of the fibula. *Clin Orthop Relat Res* 199:61-67, 1985.)

- Shenton's line.
- **Fibular Length and Rotation**
- Restoration of fibular length and rotation is critical in reestablishing a stable ankle mortise, and can be assessed with xray "Shenton's line"

Operative versus Nonoperative Treatment





Single Break: Stable
Double Break: Unstable

Mann's Surgery of the Foot and Ankle. Walling, Art et al. Pages 2003-2040

Neer CS: Injuries of the ankle joint: evaluation. Conn State Med J 1953; 17: pp. 880

Radiographic criteria can be misleading because they are based on a two-dimensional static picture of a three-dimensional dynamic joint.

Timing of the Surgery

- Abrasions should be cleansed and dressed. when practical, within a few hours if abrasions are present. After 12 to 24 hours, deep or dirty abrasions can contraindicate surgery until they have resolved
- Early closed reduction and elevation with a compressive dressing and splinting are important in preventing edema and the development of fracture blisters.
- Fracture blisters adjacent to planned skin incisions do not appear to cause wound problems unless they are blood filled.

Giordano CP et al. CORR 1994; 307: pp. 214-221

- In the presence of intradermal edema (peau d'orange), marked subcutaneous edema, or fracture blisters : Delay until wrinkle sign, epithelialization of the abrasion.

Syndesmotic Injury

- Thank You.

Modalities of treatment in Ankle injuries

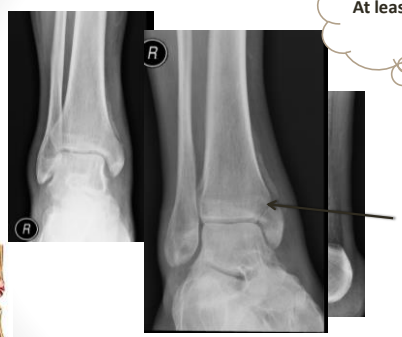
Dr. Rajesh Simon
Consultant, Lakeshore Hospital, Kochi, Kerala

DISCLOSURE

- **I have no financial interest, affiliation or any other relation ship for any commercial product or any disclosure to be made.**

Roentgenogram

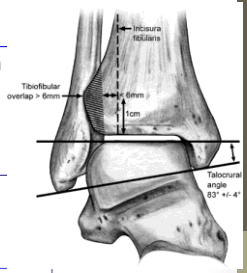
At least 3 views



- ***Mortise view***

Evaluation: Radiographic
Antero-posterior View

- Tibiofibular overlap > 6mm
- Talar tilt
- Talocrural angle:83º +/-4

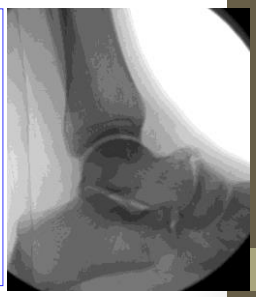


? Comparison Radiograph

Supra syndesmotic injury

Evaluation: Radiographic
Lateral View

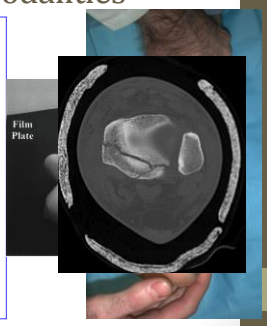
- Posterior Malleolus
- Talar subluxation
- Distal fibular translation &/or angulation
- Syndesmotic relationship
- Associated or occult injuries
  - Lateral process talus
  - Posterior process talus
  - Anterior process calcaneus



Evaluation: Radiographic

Other Imaging Modalities

- Stress Views
  - Gravity
  - Manual
- CT
  - Articular involvement
  - Posterior malleolus
- MRI
  - Ligament and tendon injury
  - Talar dome lesions
  - Syndesmosis injuries



Understand the patho-anatomy of the Fracture before treatment.

Infra syndesmotic

Trans syndesmotic

Supra syndesmotic

AO Danis Weber classification

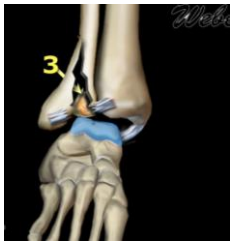
Infrasyndesmotic

Supination Adduction

AO Danis Weber classification

Transsyndesmotic

Supination External rotation



AO Danis Weber classification

Suprasyndesmotic

pronation external rotation

Understanding the injury helps in reversing the injury and helps to achieve closed temporary reduction

Immediate reduction necessary

- **Splintage in situ slab**

Success of treatment

- Anatomical integrity of ankle
- Correct length of fibula
- Exact position of fibula in fibular notch
- Integrity of syndesmotic ligaments

2mm of shortening or lateral shift
↓
increases contact forces
↓
OA ankle

1 mm lateral talar displacement reduces tibiotalar contact surface up to 46 %
Ramsey and Hamilton JBJS 1976

Definitive treatment

Decision Making

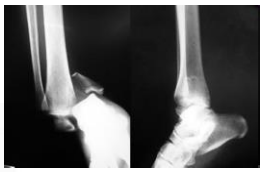
Understanding the fracture stability

Fibular fractures

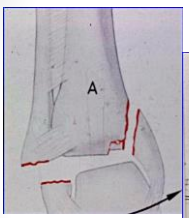
1. With a stable ankle mortise usually heals uneventfully.
2. With an unstable ankle mortise heal with significant functional problems…because instability allows for talar shift.

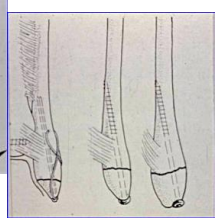
Disaster to operate

Weber A-Supination Adduction



Lateral malleolus

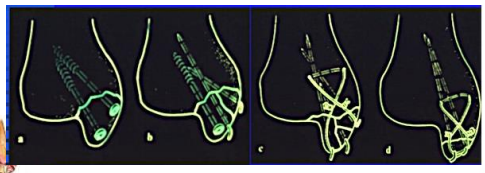




TBW
Cancellous screw

Medial malleolus

- **Type of fixation depend on size of medial malleolus**
  - **Standard fixation is two 4mm cancellous screws**
  - **TBW for small fragments**

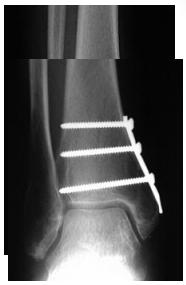


Weber A-Supination Adduction

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

Weber A-Supination Adduction

- Consider anteromedial approach
- Marginal impaction reduction +/- grafting
- Medial antiglide plate



Specific articular pathology associated with SA

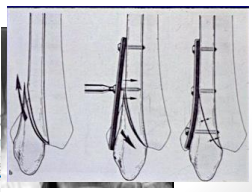
Weber B (Supination External Rotation)

- **Unstable fractures**
  - **Reduction of fibula = reduction of joint**

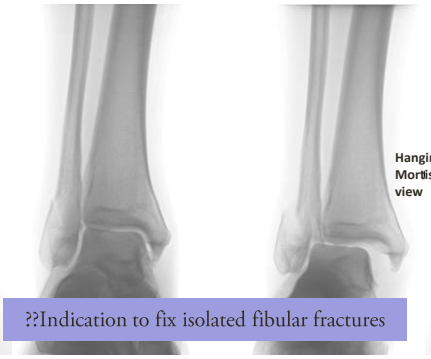
Options

Lag screw and neutralisation plate

Antiglide plate and lag screw



To fix or not How To Decide?



Hanging Mortise view

??Indication to fix isolated fibular fractures

Decision Making

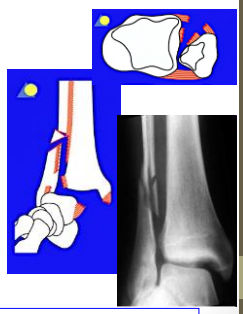
- **Does a Positive Ankle Stress Test Indicate the Need for Operative Treatment?**
  - MRI to evaluate all patients with lateral malleolar fracture and positive stress test
  - If deep deltoid partially intact→ nonop treatment
  - Good clinical outcomes.

K J Koval et al
OTA Annual Meeting. Foot & Ankle Section. 2006.

Base your decision to operate on your findings and the risk:benefit ratio in isolated fibular fracture Weber 2/ SER types

Type C (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



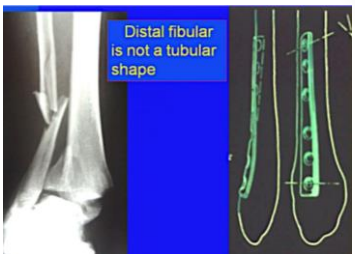
HIGHLY UNSTABLE…SYNDESMOTIC INJURY COMMON

Type C (Pronation External Rotation)

- **Final Objective**

  Restore:
  - Fibular length and rotation
  - Ankle mortise
  - Syndesmotic stability
- ***Options***
  - **Lag screw and neutralization plate**
  - **Compression plating**
  - **Bridge plating**

Remember



1/3rd tubular plate usually recommended

LCP in osteoprotic comminutions

Plate should be twisted – Mal rotation

Posterior malleolus

Hartford's experiment

Size	Decrease tibio talar contact area
25%	4%
33%	13%
50%	22%

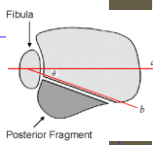
Hartford et al 1995 Tibiotalar contact area: contribution of posterior malleolus and deltoid ligament CORR, 320, 182-7

Posterior Malleolus Fractures: Radiographic Evaluation

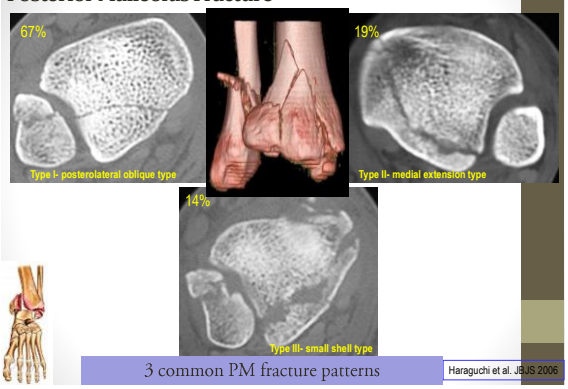
- **Indication for fixation: > 25%** joint surface on lateral view
- Fracture pattern:
  - Variable
  - Difficult to assess on standard lateral radiograph
    - Fracture orientation not purely in coronal plane
    - Larger laterally than medially & obliquely oriented

Suggested X-rays

- External rotation lateral view [Decoster *FAI* 2000]
- CT scan [Haraguchi JBJS 2006]



Posterior Malleolus Fracture



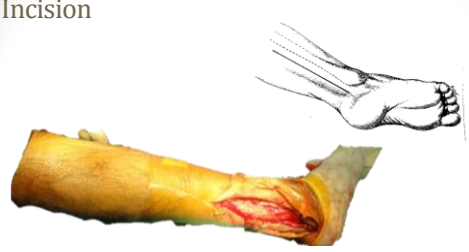
3 common PM fracture patterns

Haraguchi et al. JBJS 2006

Posterior Malleolus Fractures: **Indications for Fixation**

- Stability
  - Posterior translation of talus
  - ER of talus [syndesmotic widening]
- A step off or gap more than 2-3mm after reduction of the lateral and medial fragments

Incision



Post mall fixation- Between Peronei and FHL

Fibula fixation Ant to Peronei

Post op

Thanks Dr. Sunil/ Dr. Sarang

Take home message

- Understand the patho anatomy and treat accordingly
- Ankle instability is key indication for surgery
- Regain Length and alignment of fibula
- Assess the Posterior malleolus and Syndesmosis
- Know surgical technique and proper implant


Thank you

The Syndesmosis "What, When, and How"

Anish R. Kadakia MD
Assistant Professor
Northwestern University
Department of Orthopedic Surgery

Historic radiographic criteria

- Radiographic evaluation of the tibiofibular syndesmosis
  Harper & Keller *Foot Ankle* 1989
  - Radiographs taken of 12 mounted fresh cadaver lower extremity specimens
  - "Normal" radiographic criteria reported
    - Tibiofibular clear space (AP & mortise views) < 6 mm
    - Tibiofibular overlap (mortise view) > 1 mm

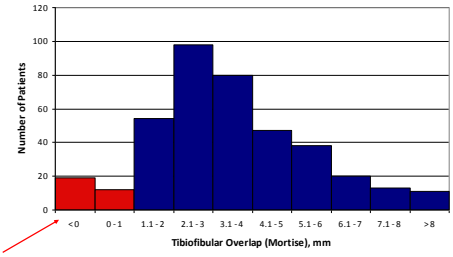
Materials & methods

1415 consecutive pts aged 18 – 65 with complete series of ankle radiographs evaluated at University of Michigan's foot & ankle clinic
(Shah AS, Kadakia AR et. al. Foot Ankle Int. 2012)

392 pts (218 F, 174 M) with normal ankle radiographs included

83 sets of bilateral normal radiographs compared

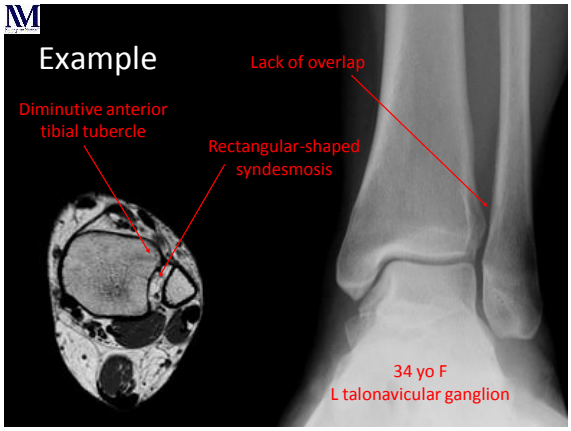
Tibiofibular overlap (mortise)



4.9% pts < 0 mm

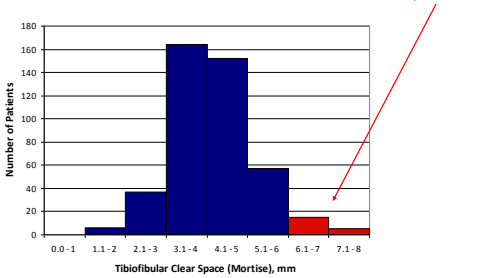
7.7% pts < 1 mm

Example



Tibiofibular clear space (mortise)

4.3% pts > 6 mm



Comparison radiographs

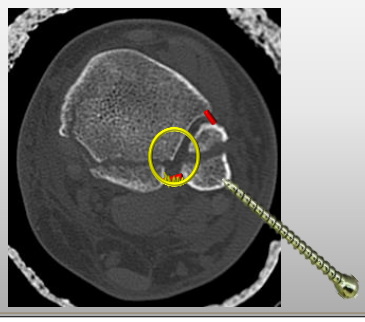
- In our series, mortise tibiofibular clear space is the most useful measurement when comparing to contralateral radiographs
  - 75% of contralateral radiographs within 1 mm
  - **95% of contralateral radiographs within 2 mm**
- Measure of tibiofibular clear space relatively independent of ankle rotation

Pneumaticos et al *Foot Ankle Int* 2002

When should we fix it?

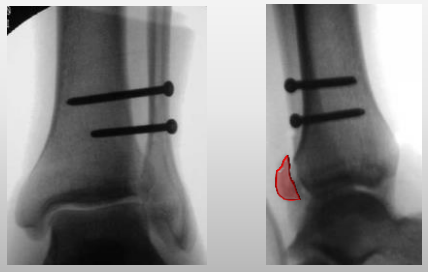
1. Absolute values are not reliable given the variability noted.
2. Use contralateral mortise radiograph for comparison, side-to-side difference in tibiofibular clear space of 2 mm suggests syndesmotic disruption.
3. Overlap does not guarantee an intact syndesmosis!
4. If Normal ankle has 8mm of overlap and injured ankle has 4mm of overlap => INJURY

Mal-reduced PL fragment = Malreduced syndesmosis

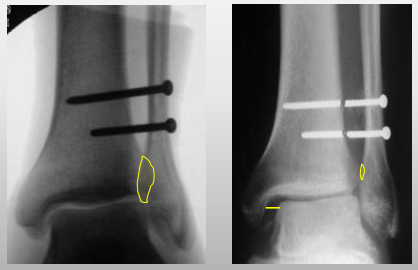


Syndesmotic Fixation w/ Mal reduced Post Mall

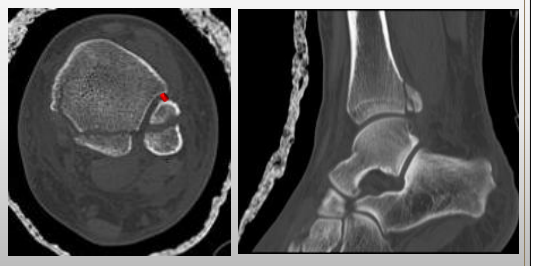
(Moore et al. Foot Ankle Int. 2006)



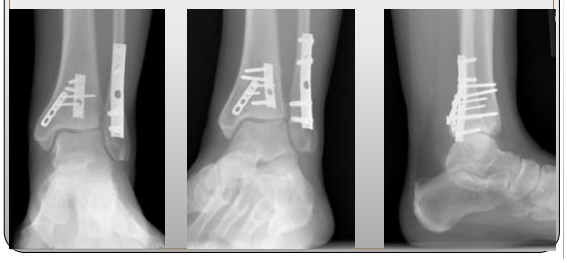
79 days PO



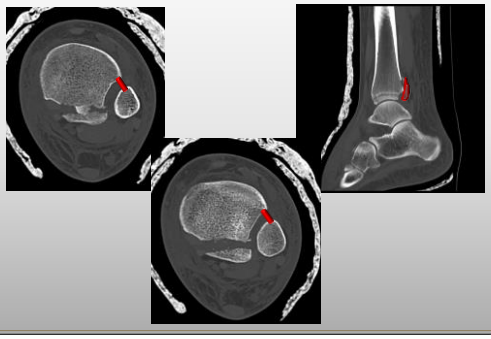
ORIF Post Mall can be enough

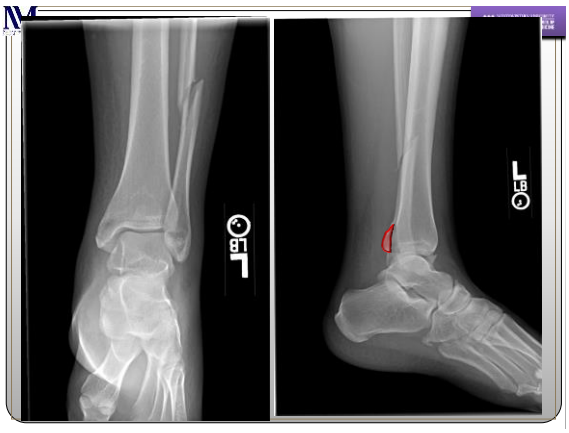


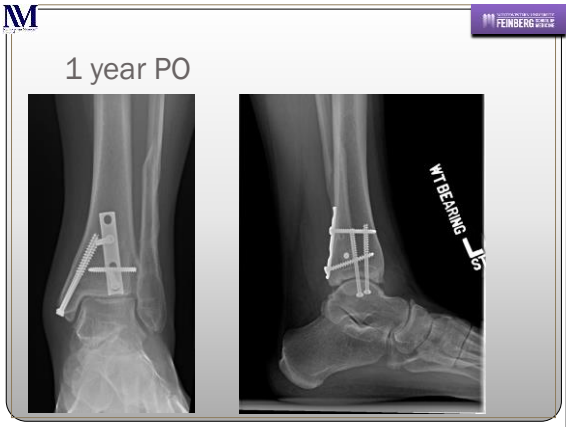
Final PO



Rarely – require additional ORIF syndesmosis

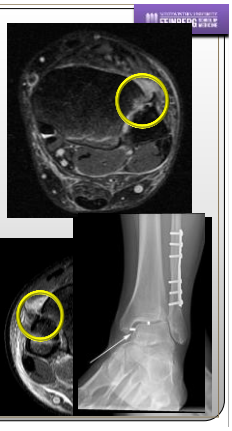






Logical Protocol

- 2mm Side to Side Difference
- Medial Clear Space Widening with Prox fibular Fracture
- Medial Clear Space widening w/o Fibular Fx
- Medial Clear Space widening after ORIF fibula
- MRI confirmation of Syndesmotic Injury
- Posterior Malleolus Fracture
  - Obtain CT or MRI to assess displacement
    - Anatomic => Can ORIF syndesmosis alone
    - Displaced => ORIF Posterior malleolus
    - Anterior Tib/Fib wide => ORIF Posterior Malleolus AND Syndesmosis



HOW?

Old Controversies

- **3.5mm or 4.5mm?**
  - No biomechanical advantage of the 4.5mm screw
    (Thompson MC and Gesink DS, Foot Ankle Int. 2000)
- **3 or 4 cortices?**
  - No significant difference in outcome at a mean f/u of 8.4 years
    (Wikeroy AK. J Orthop Trauma. 2010)
  - No significant difference in outcome at a mean f/u of 150 days
    (Moore JA. Foot Ankle Int. 2006)
- **Hardware Removal?**
  - No clinical superiority noted with removal of HWR

New Controveries

- **Plate and Screws**
  - May decrease risk of fibular fracture
- **Plate and Locked Screws**
  - May decrease mal-reduction as screws cannot "drive" the fibula into a mal-reduced position
- **Plate with 1 screw and 1 Suture button**
  - Suture button may allow superior reduction as cannot "drive" the fibula
  - Suture button may "back-up" screw fixation

- **NO Data to support these claims**

Suture Button Fixation

- Why?
  - Eliminate need for hardware removal?
  - May allow more physiologic movement – theoretically conducive toward soft tissue healing.
    - Excessive motion however – is detrimental

Sagittal Plane Relevance

- **Fibula is more unstable in the sagittal plane after sectioning of the syndemosis**

(Candal-Couto JJ. et. al. Injury, 2004)

- Sectioned the AITFT/IOL/PITFL
  - Hook test performed in both planes
    - Mean Displacement
      - Coronal – 1.5mm
      - **Sagittal – 8.8mm**
- Additional sectioning of Deltoid
  - Mean Displacement
    - Coronal – 3.2mm
    - **Sagittal – 11.7mm**

Sagittal Plane Relevance

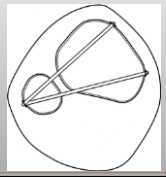
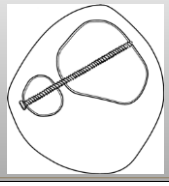
- Biomechanical evaluation

(Klitzman R. et. al. Foot Ankle Int. 2010)

- Single suture button vs. single tri-cortical screw
  - **Increased motion of the fibula in the sagittal plane with the suture button compared to intact**
    - NOT restoring the primary instability pattern
- Fibula will follow the posterior malleolus and leads to mal-reduction when considering this as a uni-planar injury.
  - May appear closed on the AP
  - However, can be posterior subluxated.

What about 2 Suture Buttons?

- Biomechanical Comparison
  (Soin SP et. al. Foot Ankle Int. 2009)
  - 2 diverging suture buttons
  - Single 3.5mm screw
- NO Difference in the fibular movement in any plane.

Reduction – Most Critical Aspect

- Where do I apply the clamp?

Forceps Reduction of the Syndesmosis in Rotational Ankle Fractures

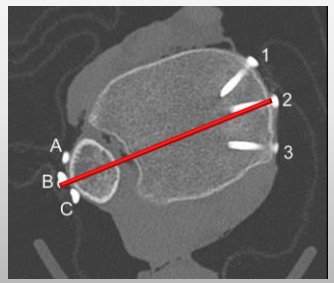
A Cadaveric Study

Phinit Phisitkul, MD, Thomas Ebinger, MD, Jessica Goetz, PhD, Tanawat Vaseenon, MD, and J. Lawrence Marsh, MD

Investigation performed at the University of Iowa Hospitals and Clinics, Iowa City, Iowa

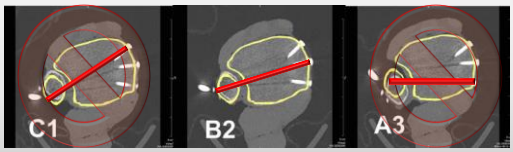
- Anatomic axis of the syndesmosis
  - Lateral Malleolar Ridge
  - Central point of the medial tibial cortex
  - 1cm Proximal to the joint

Reduction

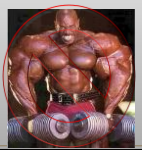


Reduction

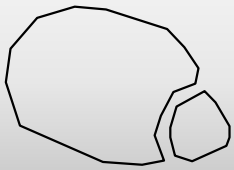
- Oblique placement will lead to malreduction



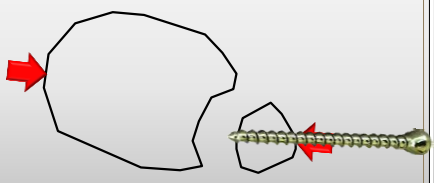
- Adding PM fracture made things worse for A3
- Do NOT have to "crush" it.
  - Over-compression of the articular surface can occur.



Why this can lead to malreduction

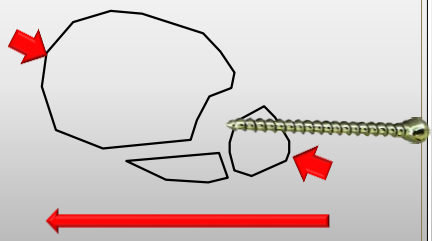


Posterior Lip Intact

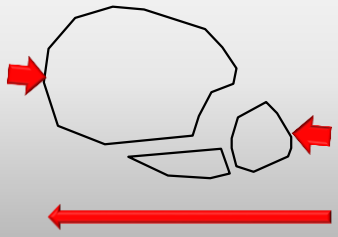


Slight malrotation may "self correct" s/p HWR

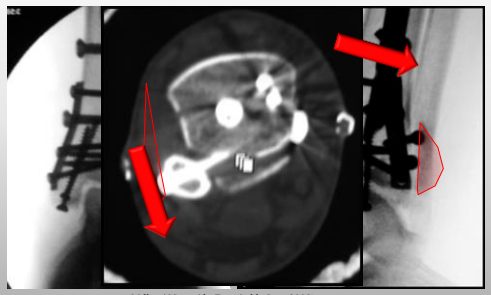
Poster Mall Fx + Sagittal Instability = Bad News



Poster Mall Fx + Sagittal Instability + Bad Clamp = Worse



Slightly "over-reduced" – (Will NOT correct s/p HWR)



(Miller AN, et. Al. Foot Ankle Int. 2009)

Summary

- How?
  - No clearly superior method
  - **Critical Points**
    - **Location – Approximately 2cm above plafond**
      - Superior stability compared to 3.5cm above plafond
      - Minimize risk of placement within the tib-fib joint.
      - May risk injury to peroneal artery – clinical relevance unknown
    - **Reduction is critical – open and observe reduction if needed. (Unfortunately, still risk of malreduction)**
    - If screw – no smaller than 3.5mm
    - If suture button – utilize 2 in diverging fashion.
      - Single suture button allows more motion than normal

My preferred method

- **With Fibular ORIF**
  - Single 3.5mm tri-cortical screw with quad-cortical drill hole
- **Without Fibular ORIF**
  - 4 hole plate with 2 central holes for syndesmotic screw
    - 2 3.5mm screws
- **PO protocol**
  - NWB 6 weeks
  - WBAT in CAM walker weeks 6-12
  - WBAT in ASO weeks 12 until HWR (weeks 16-20)
  - Screws may break

Thank You

Posteriorly Unstable & Osteoporotic Ankle Fractures

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Disclosures

- Consultant
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  - *Techniques in Foot & Ankle Surgery - LWW*
- Editorial Board / Reviewer
  - FAI /JBJS / CORR / Orthopaedia.com / FootEducation.com
- Research Funds
  - Arthrex and Wright Medical – 2008/9

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Objectives

- What is different ?
- Do standard methods of stabilization work?
- What are special concerns ?

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Posteriorly Unstable Ankle Fractures

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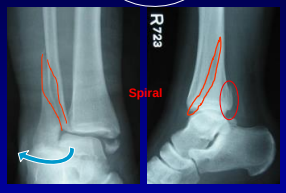
Instability

Instability



Spiral

SAD

SER

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What is the mechanism, direction of forces ?

"Hyperplantarflexion"

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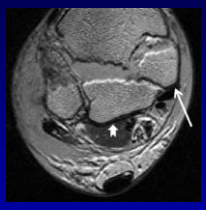

Hinds et al http://fai.sagepub.com/content/early/2014/10/01/1071100714553470

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In which direction is this ankle fracture most unstable ?

Instability

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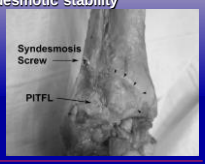
Biomechanical Study

- Gardner MJ et al
- Clin Orthop Relat Res 2006 Jun;447:165-71
- Fixation of PM fractures provides greater syndesmotic stability
  - 10 cadaver PER with PM fragment model
  - Fixation of PM – 70 % stability restored
  - Fixation of Syndesmosis – 40 % stability restored
  - External rotation tested – not posterior instability



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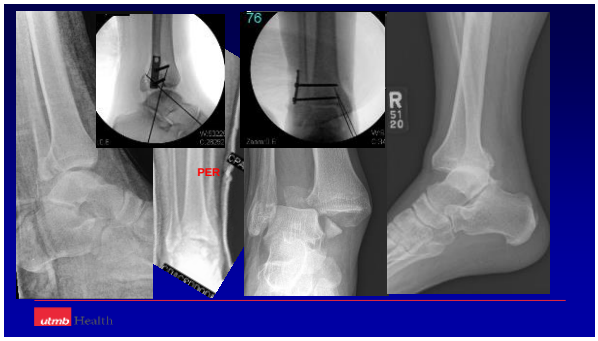
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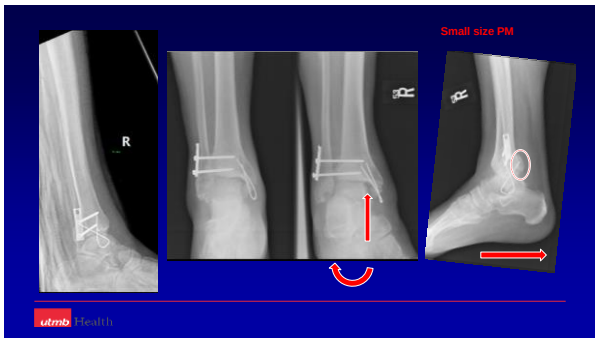
Small size PM
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Size does not matter

Instability does !!

*as does the **direction and plane** of instability !!*

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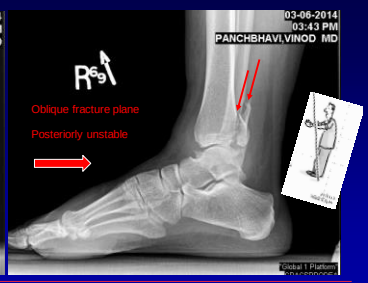

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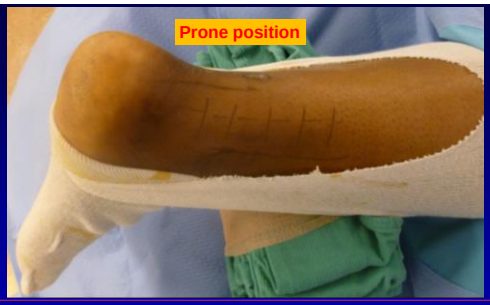

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Deep fascia
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Sural nerve
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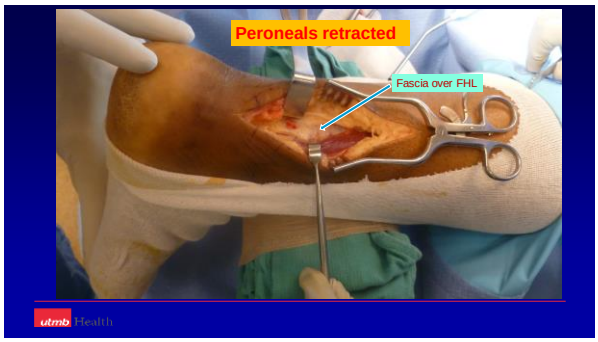
Peroneals retracted
Fascia over FHL
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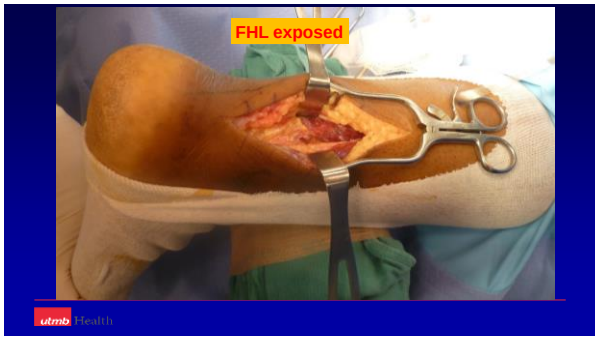

FHL exposed
utmb Health

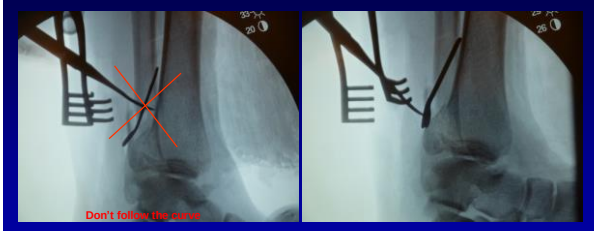

FHL retracted
utmb Health


Fracture & PM exposed
utmb Health

Buttress plate contour

utmb Health

Buttress plate contour

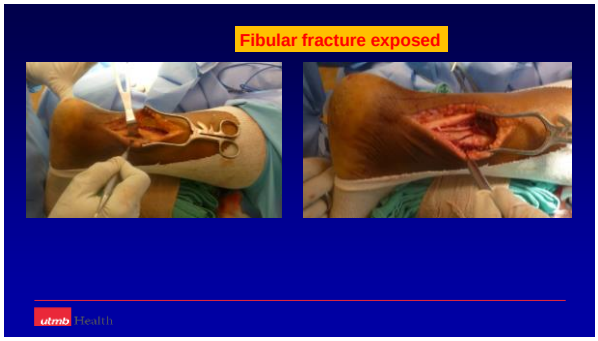


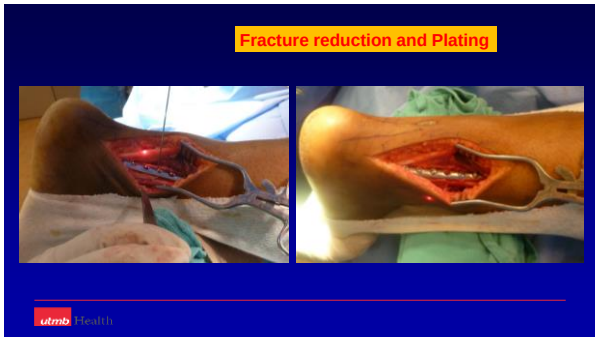
utmb Health

Buttress plate contour

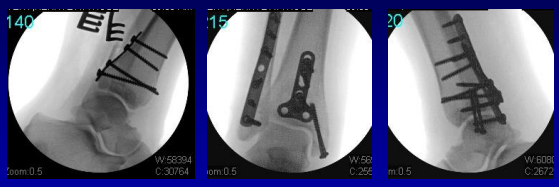
utmb Health


Get a 'true' lateral image
Zoom:0.5
W:58394
C:30764
utmb Health


Fibular fracture exposed
utmb Health


Fracture reduction and Plating
utmb Health

PM unobstructed by fibular plate

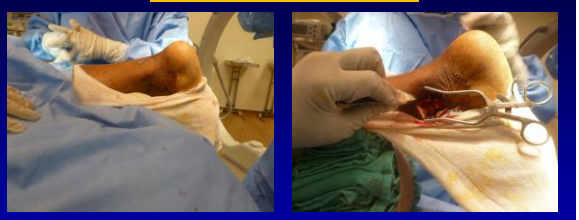


utmb Health

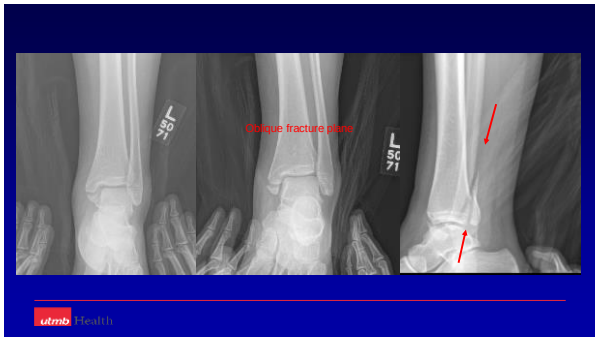
Prone position easier for PM / LM

utmb Health

Prone position ‘strange’ for MM



utmb Health



Sloppy lateral with platform for leg

utmb Health

utmb Health

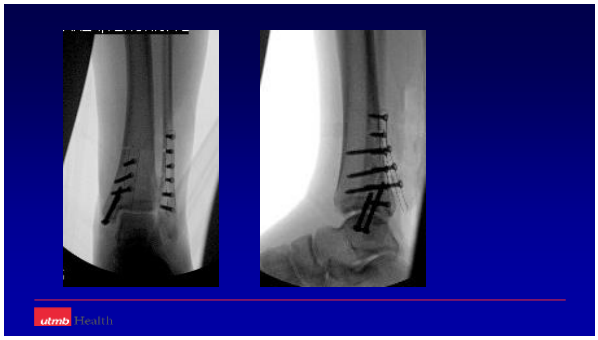
utmb Health

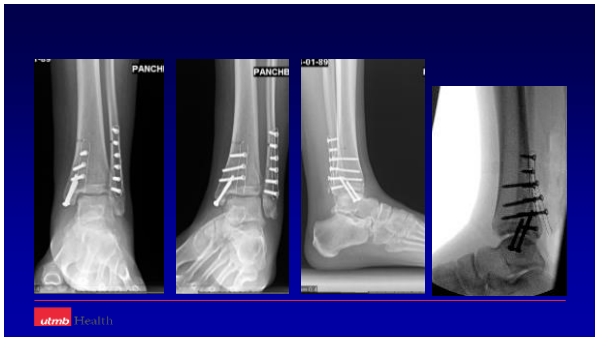
Position not so ‘strange’ for MM

utmb Health

utmb Health

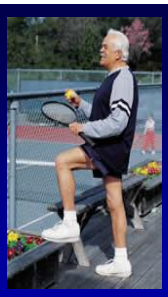
utmb Health





Osteoporotic Ankle Fractures

Living longer and more active



utmb Health

What are the special issues ?

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Don't bear weight

You must be kidding !!

- Co morbidities
  - Poor balance / Dementia
  - Diabetes, PVD
- Poor soft tissue envelope
- Poor bone quality

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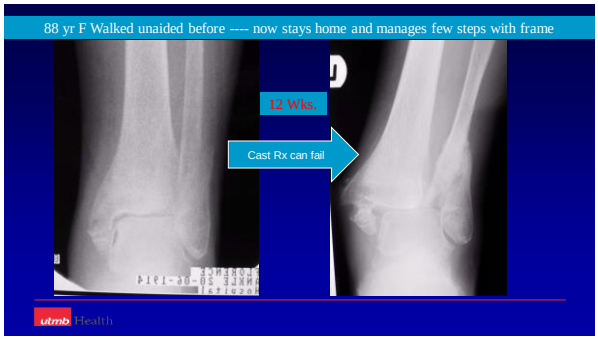
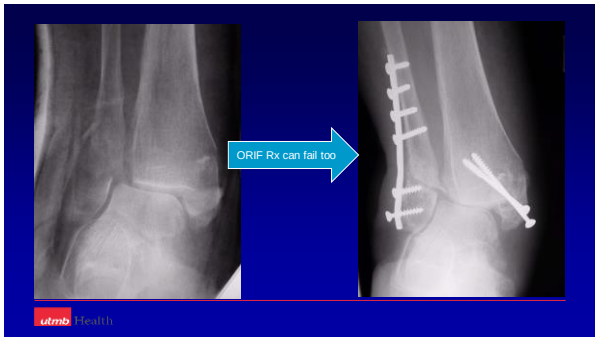
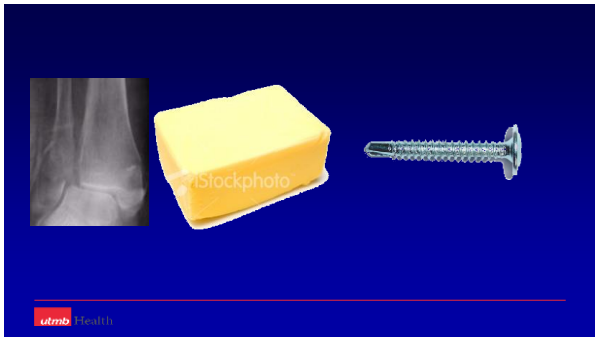

88 yr F Walked unaided before ---- now stays home and manages few steps with frame
12 Wks.
Cast Rx can fail
utmb Health


ORIF Rx can fail too
utmb Health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ORIF – standard fixation – can fail

What should we do different ??

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Augmented ORIF

Hook Plate and Tibia-Pro-Fibula Screws

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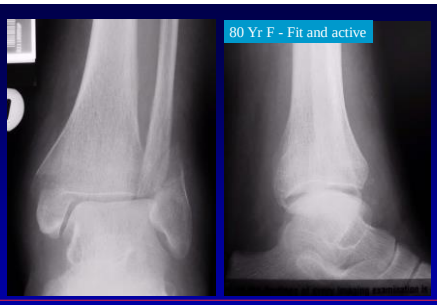

80 Yr F - Fit and active

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'Wrinkle ready' for ORIF at 2 wks.

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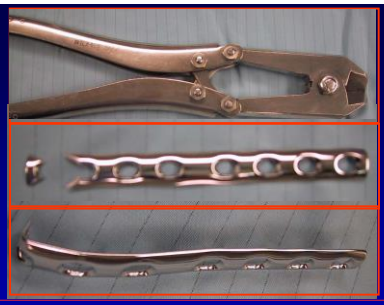

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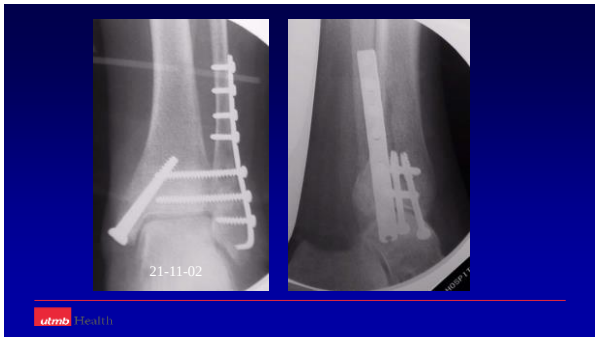
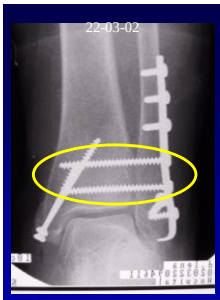
The 'wrong' bend
The 'Right' Curves
utmb Health


21-11-02
utmb Health


16-03-02
76 yrs. F
utmb Health

utmb Health



- Syndesmosis screws even if syndesmosis is intact
- Not to repair syndesmosis
- But to get additional purchase in tibia

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utmb Health

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Avoid SC dissection
Avoid creating flaps
Longer incision better
Avoid self retainers

utmb Health

Panchbhavi VK, Mody MG, Mason WT: Combination of Hook Plate and Tibia Pro-Fibular Screw Fixation of Osteoporotic Ankle Fracture. *Foot Ankle Int.* **26**(7) 510- 515: 2005

	Standard Tx	HP+TPFS Tx
n =	15	16
Malunion	1	0
Wound breakdown	2	0
AOFAS	57 » 83	55 » 81
Olerud Molander	37 » 43	42 » 50

- N=31 (55-90) Av – 71 years
- FU – 18 months

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How stable should be the fixation??

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Enough to allow the elderly bear full weight

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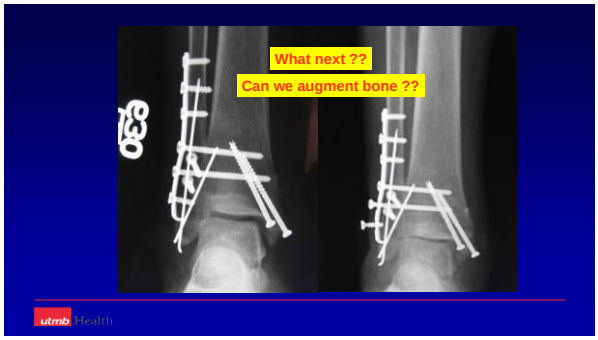

What next ??
Can we augment bone ??


Augmenting bone with CaSO4 + CaPO4

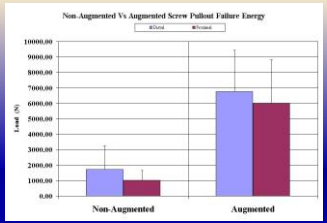
utmb Health

Screws pull out shatters bone……..leaves bone almost intact

Augmented with CaSO4+CaP04

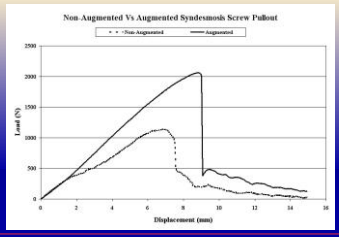
utmb Health

Panchbhavi VK, Valluraupalli S, Morris R, Patterson R:
The Use of Calcium Sulphate and Calcium Phosphate Composite Graft to Augment Screw Purchase in Osteoporotic Ankles *Foot Ankle Int.* **29**(6) 2008



utmb Health Department of Orthopedic Surgery and Rehabilitation

Panchbhavi VK, Valluraupalli S, Morris R, Patterson R:
The Use of Calcium & Calcium Phosphate Composite Graft to Augment Screw Purchase in Osteoporotic Ankles
Foot Ankle Int. **29**(6) 2008



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Summarizing…Principles

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Study the fracture plane and direction of instability

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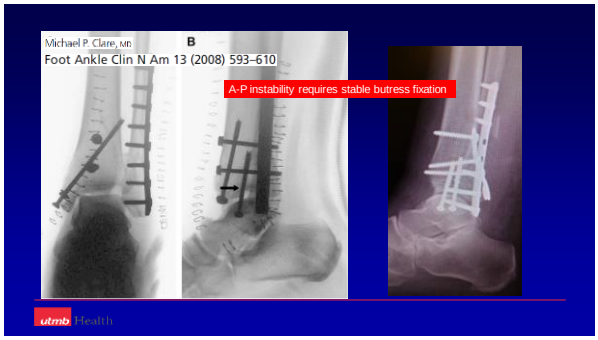
Michael P. Clare, MD
Foot Ankle Clin N Am 13 (2008) 593–610
B
A-P instability requires stable butress fixation
utmb Health


Osteoporotic fractures require augmented fixation
utmb Health


Thank You
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Emerging Truth from Controversies

Dr Sampat S Dumbre Patil
Noble Hospital, Magarpatta,
Pune, Maharashtra, India.

Controversies in ankle fractures

- Timing of fixation.
- Use of tourniquet.
- Med malleolar fixation
- Posterior malleolar fixation.

Timing of Surgery.

- Dictated by soft tissue condition
- Joint spanning fixator helps
- Wait for skin wrinkles to appear

International Orthopaedics
March 2013, Volume 37, Issue 3, pp 489-494
The timing of ankle fracture surgery and the effect on infectious complications; A case series and systematic review of the literature

- A delay in surgery is associated with significant rise in infectious wound complications
- These fractures should preferably be treated within 24 hours

Timing

- Reduce deformity as early as possible
- Span – Scan – Plan
- Fix within 24 hrs. or wait for a week
- Consider mechanism of injury

Blisters

- No conclusive data to help management
- Early surgical intervention prevents blister formation
- Blisters allowed to resolve prior to surgery

Tourniquet

- Concern in PVD and DM
- Increase in pain and swelling after use of tourniquet
- ROM restored early in non tourniquet group

Konrad G et al - clinic orthop relat res. 2005 apr.

Clin Orthop Relat Res. 2005 Apr;(433):189-94.
Tourniquets may increase postoperative swelling and pain after internal fixation of ankle fractures.
Konrad G, Markmiller M, Lenich A, Mayr E, Rüter A

- Level 1 (randomized controlled trial).
- Increased postop swelling & pain
- Better ROM
- Recommended not using a tourniquet

Rational Sequence of Fixation in Trimalleolar Fractures

- Posterior malleolar fixation
- Medial exploration and fixation
- Restoration of fibular length
- Assessment of mortise stability

Zhongguo Gu Shang. 2008 Apr;21(4):300-1.
[Surgical treatment of pronation and supination external rotation trimalleolar fractures].
[Article in Chinese]
Xu YQ1, Zhan BL, He FX, Wei HD.

ORIF started with posterior,
then medial and lateral malleolus
and lastly the distal tibiofibular syndesmosis fixation in a sequence

Rational sequence of fixation in trimalleolar fractures.

- Sequence depends on mechanism of injury and comminution
- Achieving fibula length is helpful
- If fibula is comminuted - medial malleolus can be reduced first

Fixation of fibula

- Infrasyndesmotic- Screw / TBW / Plating
- Transsyndesmotic- Plate / Screw /TBW
- Suprasyndesmotic - Plating

Fibula fixation with nail- or plate?

Fibular Fracture Fixation
Anti-glide Plate / Lateral plate

- Plate on post aspect
- Peroneal tendon irritation
- Low profile

Lateral Malleolus Fixation with Deltoid Ligament Repair

- Deltoid ligament does not require routine exploration or repair
- Explored if:

- Difficultly in reduction of fibular fracture
- Interposition of ligament, periosteum, PT tendon

J Orthop Trauma. 2014 Sep 2. [Epub ahead of print]
Deltoid Ligament Repair vs. Syndesmotic Fixation in Bimalleolar Equivalent Ankle Fractures.
Jones CR1, Nunley JA 2nd

- Conclusion

Repairing deltoid vs. repairing syndesmosis

Subjective, functional and radiological outcomes are comparable

Strategies Trauma Limb Reconstr. 2012 Aug;7(2):73-85. doi: 10.1007/s11751-012-0140-9. Epub 2012 Jul 6.
The diagnosis and treatment of deltoid ligament lesions in supination-external rotation ankle fractures: a review.
Stufkens SA1, van den Bekerom MP, Knupp M, Hintermann B, van Dijk CN.

There is no evidence found for suturing but exploration is thought to be beneficial in case of interposition of medial structures.

Medial Malleolar Fixation

- Tension Band Wiring
- One screw, one k wire
- Two screws
- Plate

Int Orthop. 2014 Jan;38(1):83-8. doi: 10.1007/s00264-013-2168-y. Epub 2013 Nov 20.
A comprehensive analysis of patients with malreduced ankle fractures undergoing re-operation.
Ovaska MT1, Mäkinen TJ, Madanat R, Kiljunen V, Lindahl J.

Fixation of an associated medial malleolar fracture with other than two parallel screws were also associated with re-operation.

Injury. 2014 Sep;45(9):1365-7. doi: 10.1016/j.injury.2014.05.031. Epub 2014 Jul 3.
A clinical evaluation of alternative fixation techniques for medial malleolus fractures.
Barnes H1, Cannada LK2, Watson JT1.

The headless compression screw is a beneficial alternative to the conventional methods of medial malleolus fixation

Foot Ankle Int. 2014 May;35(5):471-7. doi: 10.1177/1071100714524553. Epub 2014 Feb 13.
Comparison of surgical techniques of 111 medial malleolar fractures classified by fracture geometry.
Ebraheim NA1, Ludwig T, Weston JT, Carroll T, Liu J

- Transverse #s - TBW and lag screws- similar rates of union. TBW - less revision surgery / fewer complications
- Oblique fractures- effectively treated with lag screws
- Vertical #s - superior outcomes with buttress plating

Medial Malleolar Fixation - TBW

TBW loop thr. bone

TBW loop around post screw

Medial Malleolar Fixation - 2 Screws

Buttress plate required for
large fragment with vertical fracture

Traditionally partially threaded screws are recommended for medial malleolar fixation

Bone Joint J. 2013 Dec;95-B(12):1662-6. doi: 10.1302/0301-620X.95B12.30498.
Screw fixation of medial malleolar fractures: a cadaveric biomechanical study challenging the current AO philosophy.
Parker L1, Garlick N, McCarthy I, Grechenig S, Grechenig W, Smitham P

Better fixation with
3.0 mm partially threaded or
4.5 mm fully threaded screws
engage the physeal scar

Posterior Malleolar Fixation

Indications for fixation

- Post fragment >25%.
- Persistent subluxation of joint

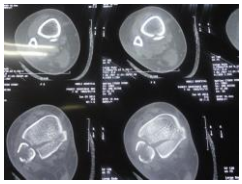
Better to fix posterior malleolus for syndesmotic stability and articular congruency.

Posterior Malleolus Fixation

- When a posterior malleolar fracture is present, we recommend anatomic reconstruction, regardless of the size of the fracture fragment, to recreate the incisura; this obviates the need for syndesmotic screws
  - Clin Orthop Relat Res. 2010 April; 468(4): 1129–1135.

Post Malleolus

- Posterolateral fragment (Volkmann's triangle) attached to fibula - Reduction of fibular fracture helps

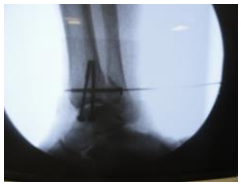


Separate screw fixation for medial malleolus

Posterior Malleolus Fixation

Anterior to Posterior

Posterior to Anterior



Chin Med J (Engl). 2013 Oct;126(20):3972-7.
Advances and disputes of posterior malleolus fracture.
Fu S1, Zou ZY, Mei G, Jin D.

- Direct posterior malleolus fixation is suitable to stabilize syndesmotic injury.
- Direct reduction and buttress plate fixation of posterior malleolus fracture through the **posterolateral approach.**

Incision

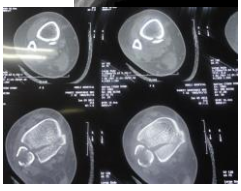
Fibula plating Ant to peronei

Posterolateral approach for posterior malleolus

Posterior malleolus exposure

Plating posterior malleolus

Case study






Conclusion

- Timing – dictated by soft tissues
- Use of tourniquet – concerns in PVD & DM
- Medial exploration if soft tissues impinge
- Posterior malleolus - anatomic reconstruction

Management of malunited ankle fractures

Dr.Rajiv Shah
Foot & Ankle Surgeon
President, IFAS
India

Disclosures ?

None

What are the available modalities?

- Revision fixation
- Realignment with osteotomy

- Ankle replacement
- Fusion = ankle arthrodesis

Revision fixation

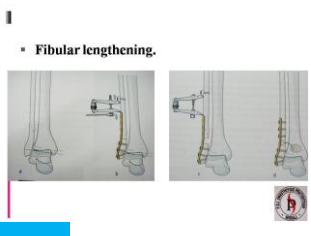
Revision fixation

- Duration may not matter!
- While there is no optimal time to perform reconstructions the fact is that…

Patients continue to improve up to 7 years post reconstruction!

Principles of revision surgery

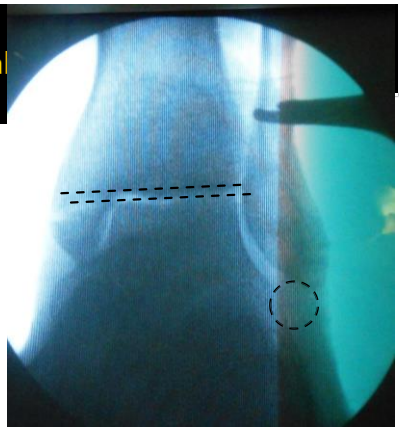
- Fibular lengthening
- Correction of talar tilt
- Fixation of medial malleolus
- Syndesmotic fixation
- Ligament reconstruction
- Releases
- Arthroscopy



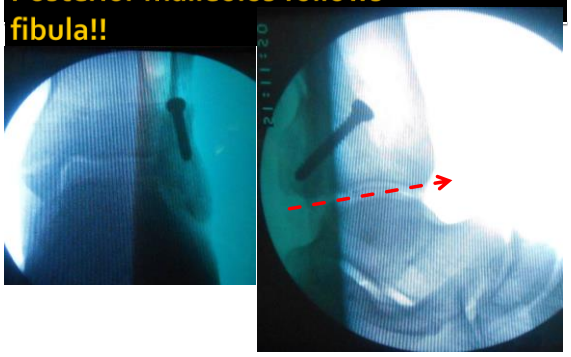
Delayed Presentation: 8 weeks!

Fibula first..

Radiological analysis..



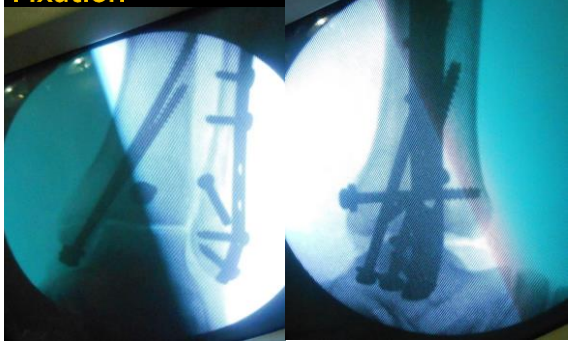
Lag screw fixation of fibula
Posterior malleolus follows fibula!!

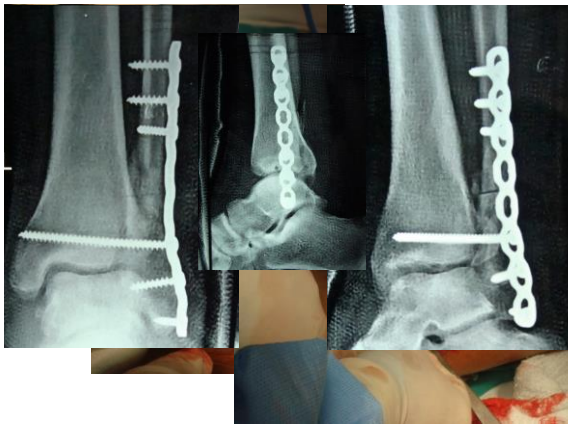


Neutralization Fibula Plate

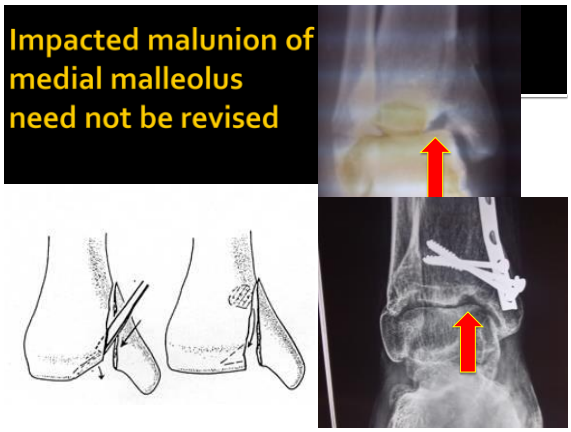
Everything falls back automatically

Final Fixation

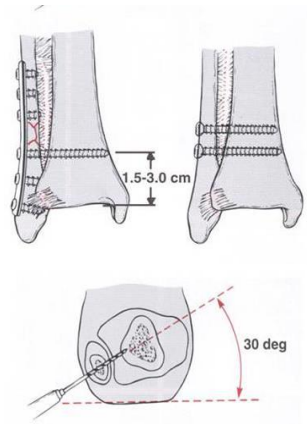




Impacted malunion of medial malleolus need not be revised




syndesmotic injuries


1.5-3.0 cm
30 deg

Realignment with Osteotomy

- **Varus ankle:**
- Medial open wedge supramalleolar
- Lateral close wedge supramalleolar
- Lateral displacement hindfoot osteotomy

- **Valgus ankle:**
- MCO if mild valgus
- Medial close wedge supramalleolar
- Lateral open wedge supramalleolar

- **+/-Ligament reconstruction**

TAR

When to replace the joint?

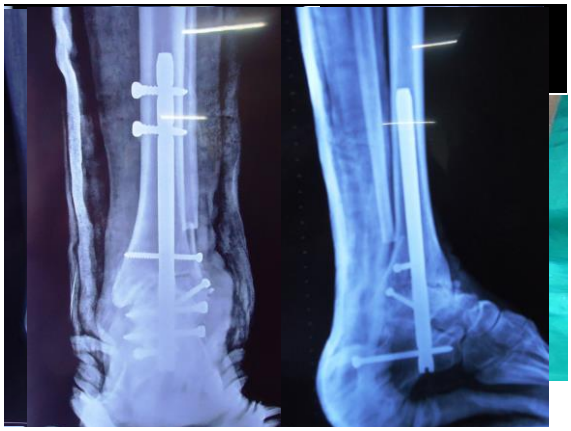
- There is minimal deformity
- No infection
- No neuropathy
- No vascular compromise
- No AVN
- Good soft tissue envelope

Arthrodesis

- Fusion – young patient with global arthritis, gross deformities, infection, neuropathy, gross instability & bone loss

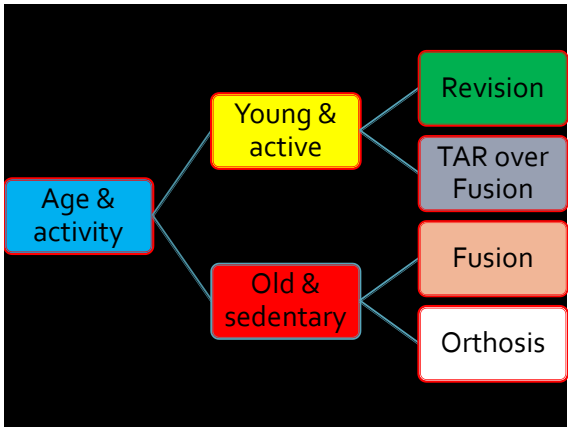
Malunited ankle fracture
Transfibular Arthrodesis

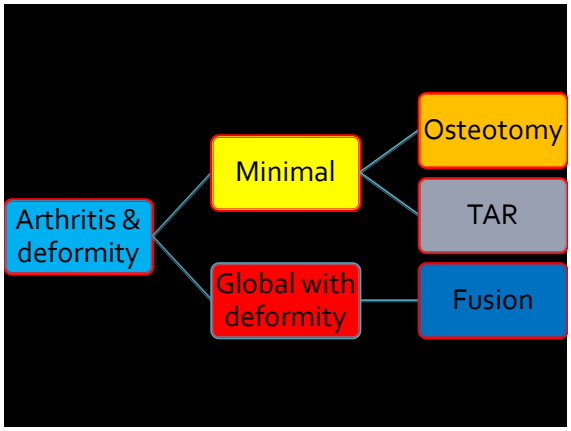
Extension of fusion complex for associated fracture



Neuropathic ankle fracture fusion, The Gold standard!

Algorithm


Age & activity
Young & active
Old & sedentary
Revision
TAR over Fusion
Fusion
Orthosis


Arthritis & deformity
Minimal
Global with deformity
Osteotomy
TAR
Fusion

Infection diabetes

Fusion

Revision fixation??

Coronal plane malunion malunion in valgus

Leave it alone

Sagital plane malunion malunion in varus

Revise

That's all
Thank you…

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