PLEASE ON THE FOLLOWING LINK TO WATCH THE LECTURE ONLINE:-

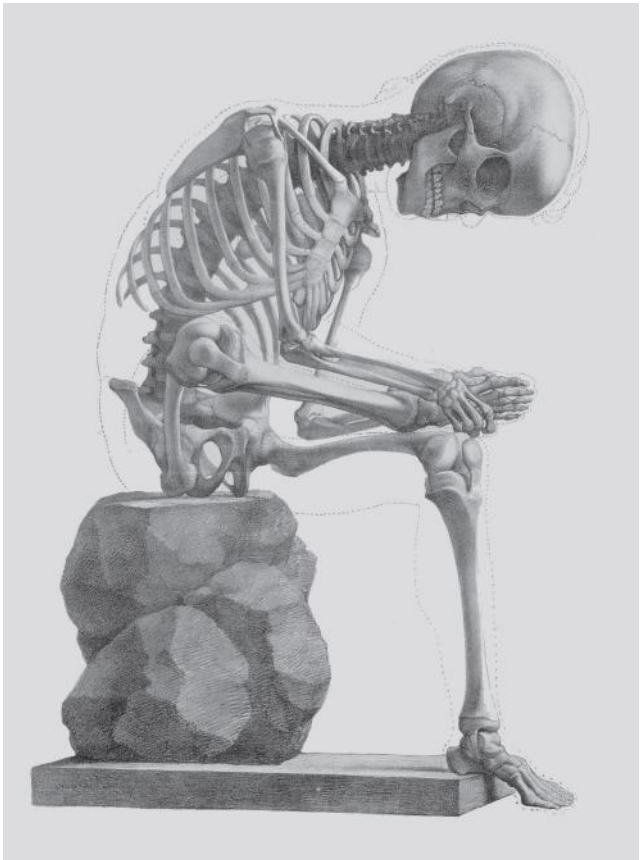
https://www.youtube.com/watch?v=84iF1OfvGUA&list=PLuBRb5B7fa_cjuGL06zhWXRxCDRoGpJlh&index=2

CALCANEAL FRACTURES

calcaneal fractures.

1916: “a man who breaks his heel bone is done…….”

Frederic Jay Cotton (1869–1938)



Abdullah Alkhawaldah MD, RMS Jordan.

Foot And Ankle surgery

Objectives

- Explain anatomy and classification systems of calc. fractures.
- Discuss management options.
- Identify the complications and how to avoid.

Calcaneus Fractures

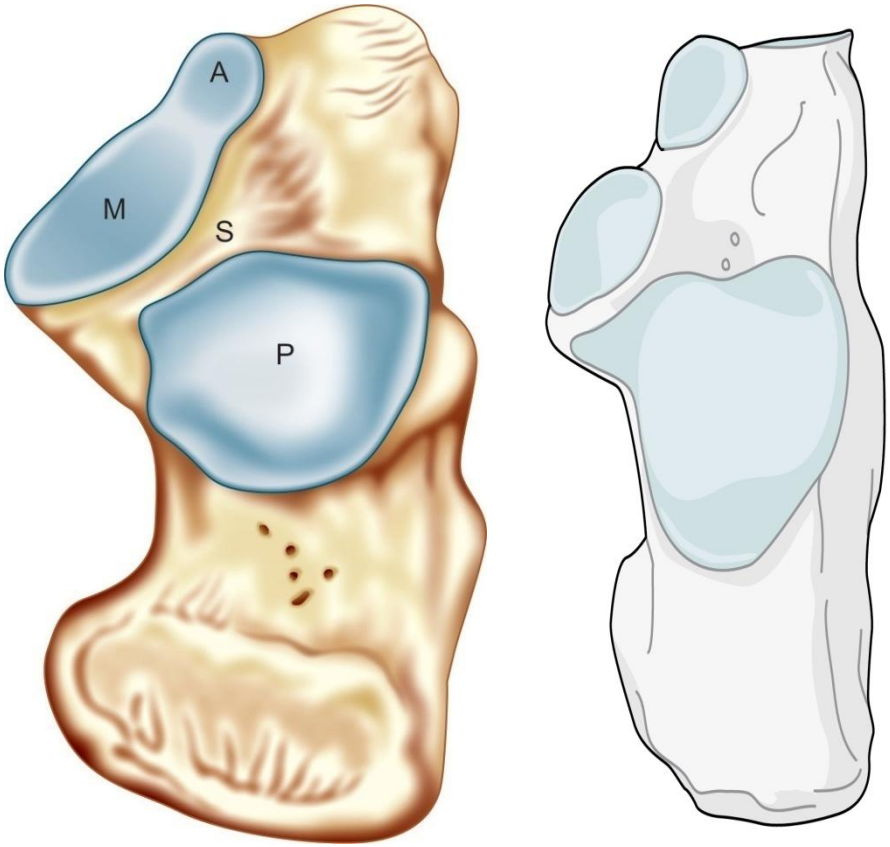
- Most common tarsal bone to be fractured
- 1-2% of all bone fractures
- Typically from an axial load: Fall from height

Calcaneal Fractures

- 90% of calcaneus fractures occur in individuals in their peak earning years
  - Age 21-45
  - Majority are male laborers
  - Substantial implications for workforce and economy
- LIFE ALTERING EVENT

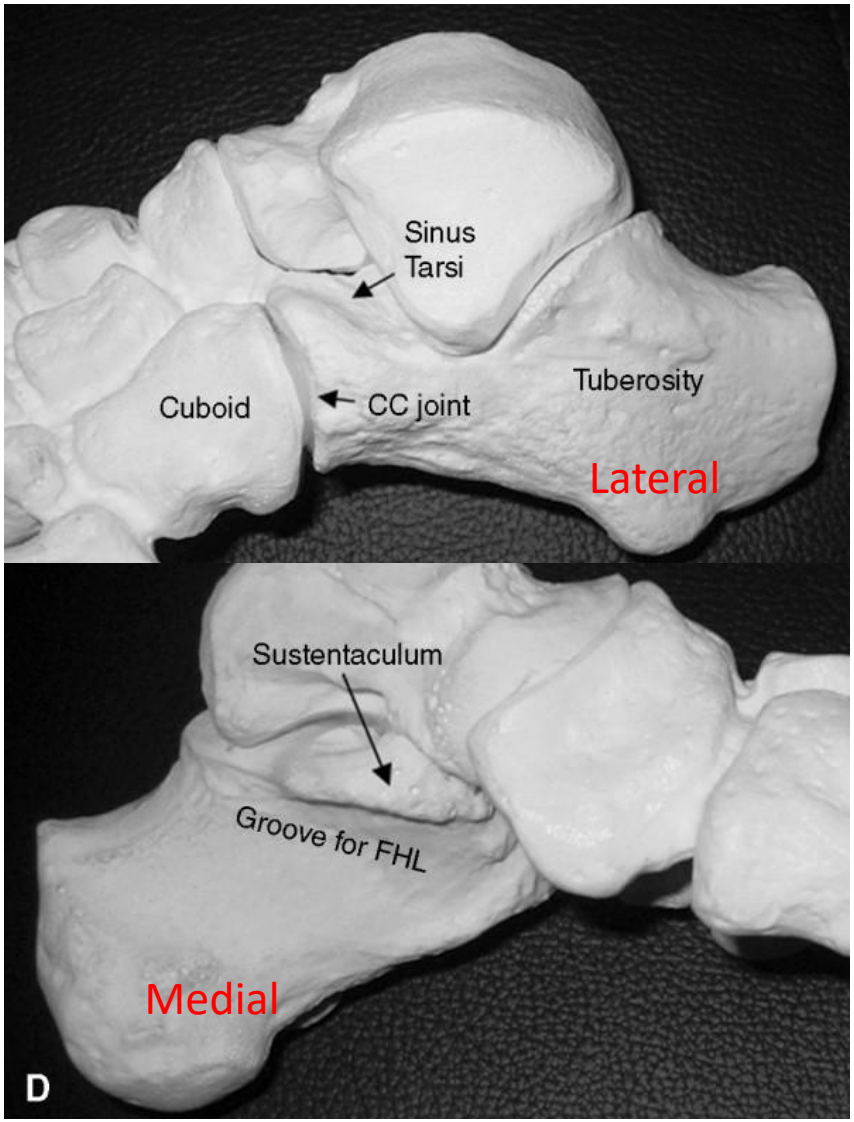
the calcaneus

- The calcaneus is an oddly shaped bone



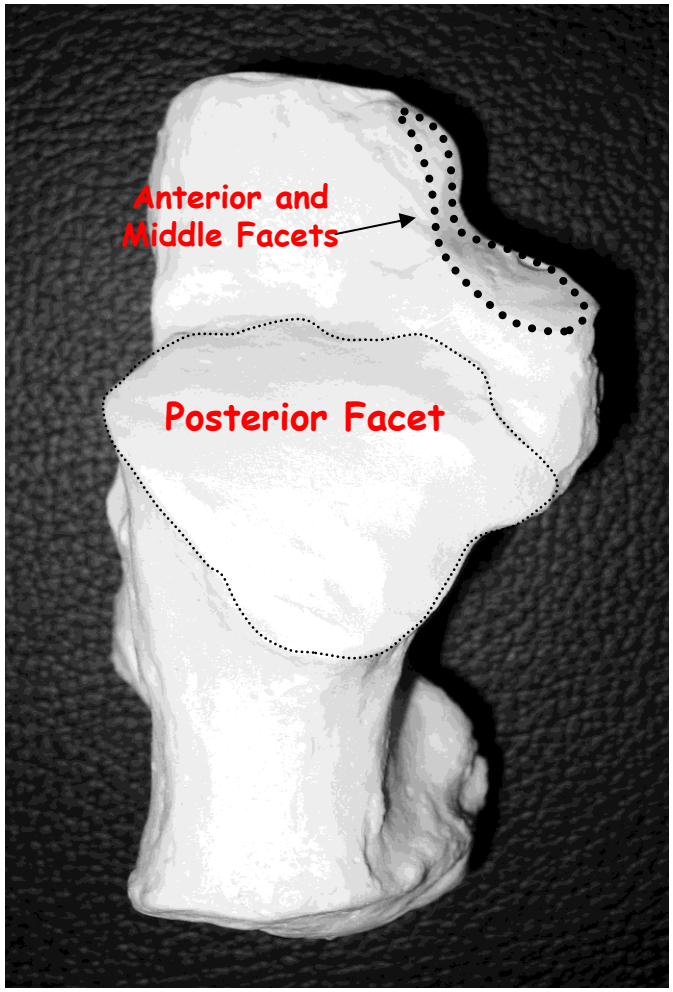
Anatomy

- Tuberosity
  - Serves as attachment for Achilles tendon and plantar fascia
- Anterior Process
  - Articulates with cuboid (CC joint)
  - Origin for extensor digitorum brevis muscle belly
- Sustentaculum tali
  - Supports middle facet of talus
  - Fulcrum for FHL Tendon
  - Close relationship with posterior tibial vessels and terminal branches of tibial nerve



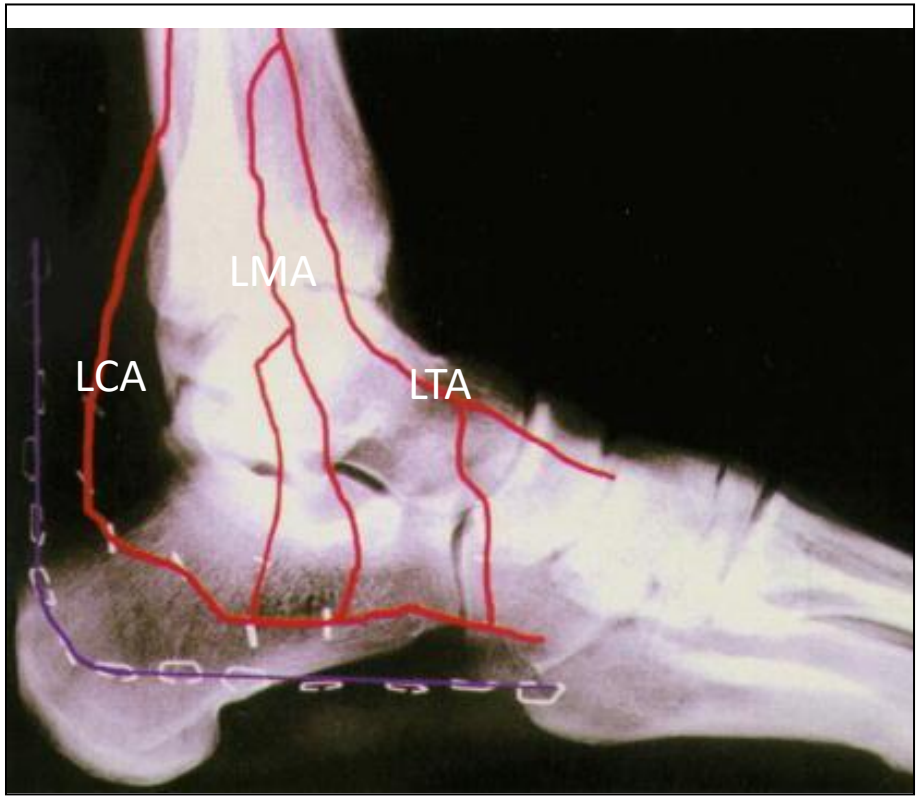
Anatomy

- Posterior Facet
  - Supports the talar body
- Anterior and Middle Facets
  - Form the sustentaculum tali
    - "Constant fragment"
  - Bear more weight per unit area than the posterior facet
- Normal function of the subtalar joint relies on restoration of the relationship of these joints

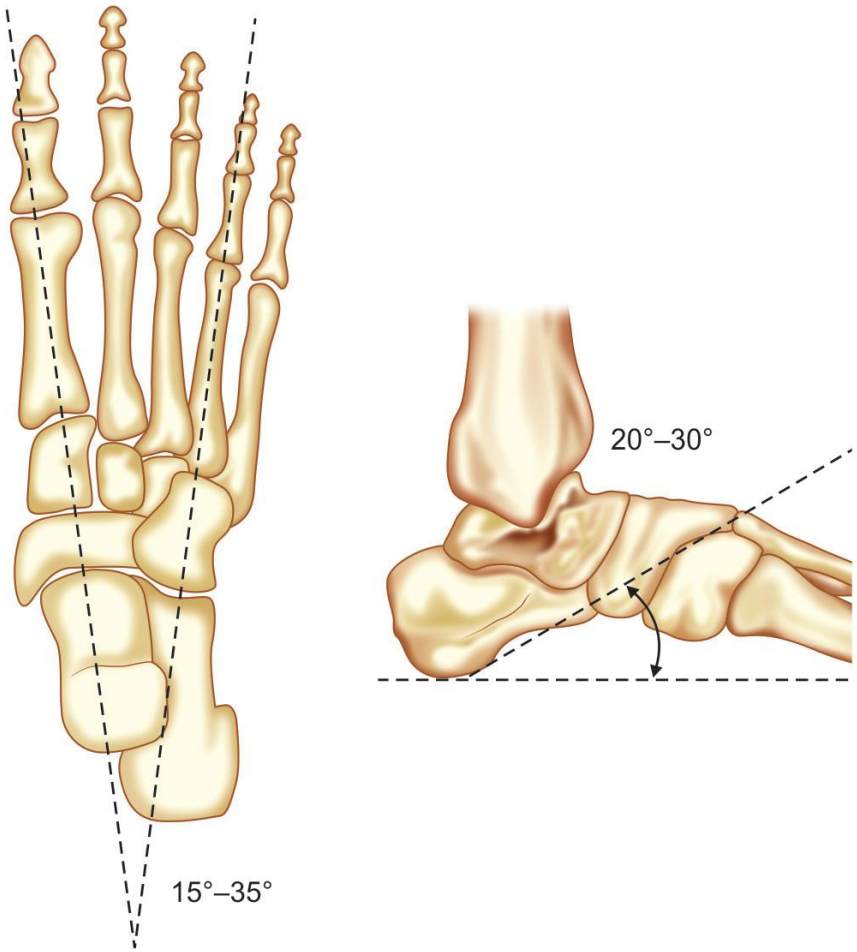


Anatomy

- Vascular supply
  - *Lateral calcaneal artery* (LCA)
    - Terminal branch of the peroneal artery
    - *Dominant blood supply to the corner of the lateral extensile approach*
  - Lateral malleolar artery (LMA)
    - Branch of Anterior tibial artery
  - Lateral tarsal artery (LTA)
    - Branch of Dorsalis Pedis

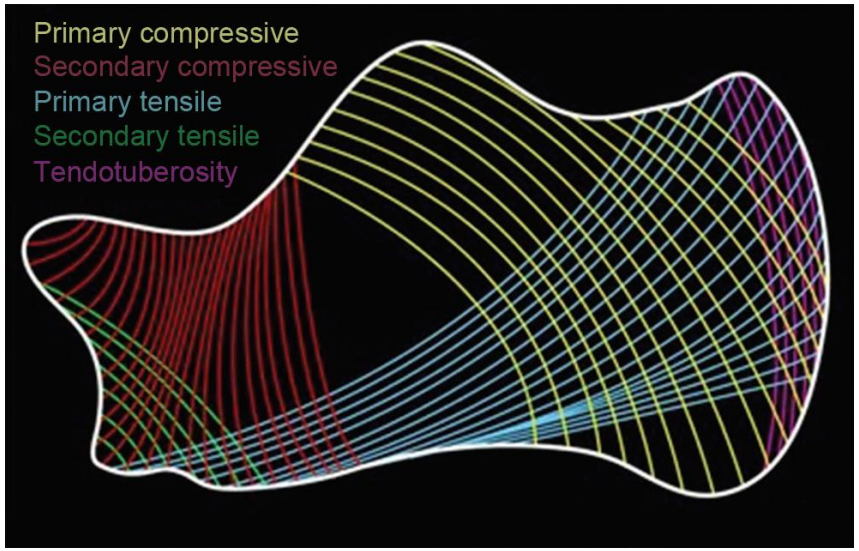


Borrelli J Jr, Lashgari C. Vascularity of the lateral calcaneal flap: a cadaveric injection study. J Orthop Trauma. 1999 Feb;13(2):73-7

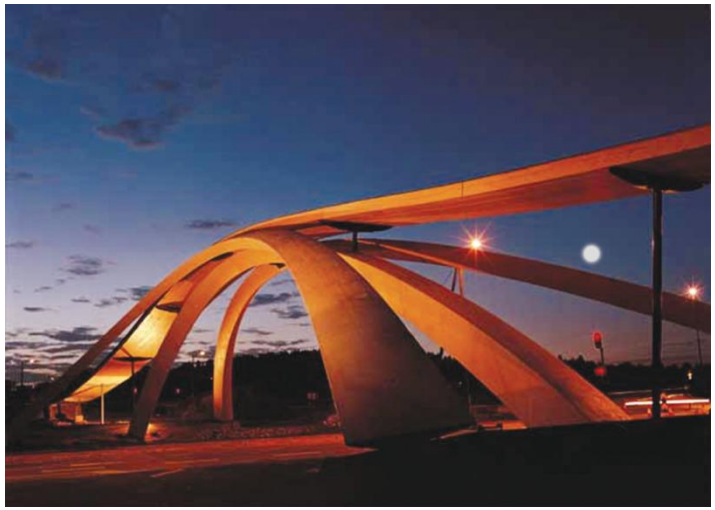

15°–35°
20°–30°

The secondary tensile trabeculae support the arch of the foot and is thought to represent the tensile forces required to maintain the longitudinal arch of the foot or in other words counter the pull of the plantar fascia

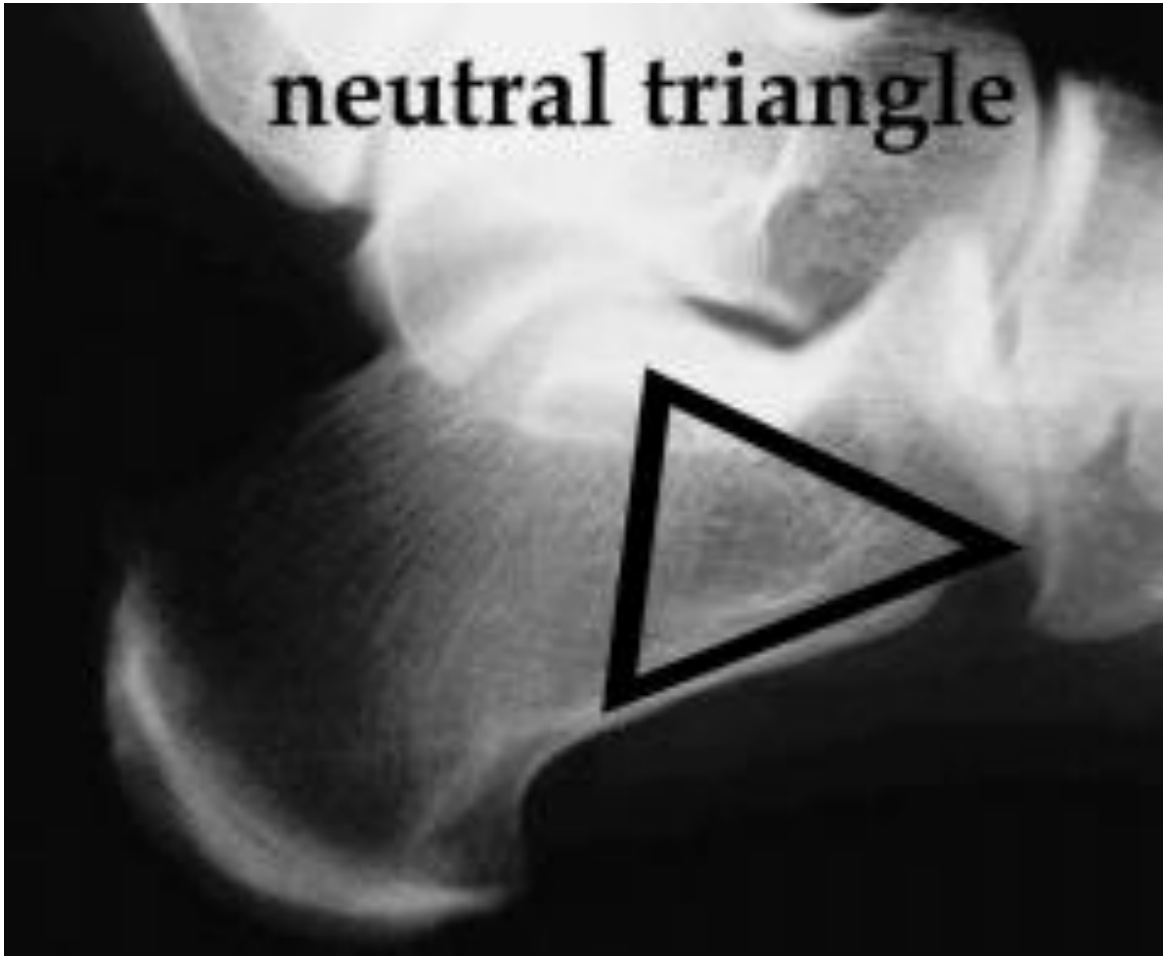
The principal compressive trabeculae run from the posterior subtalar joint to the point of the heel and is the primary load bearing column



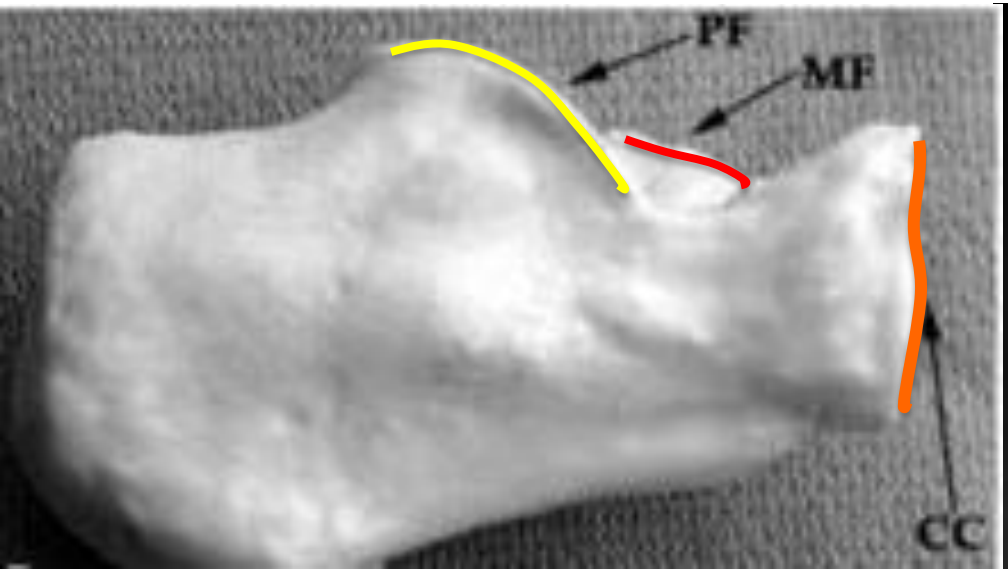
The secondary compression group run from the posterior subtalar joint to the posterior surface and possibly represents the load borne during heel strike phase of gait



principal tensile trabeculae starting at the insertion of the achilles tendon and spanning down in the same axis into the bone


neutral triangle

Lateral view



Radiographic Measurements

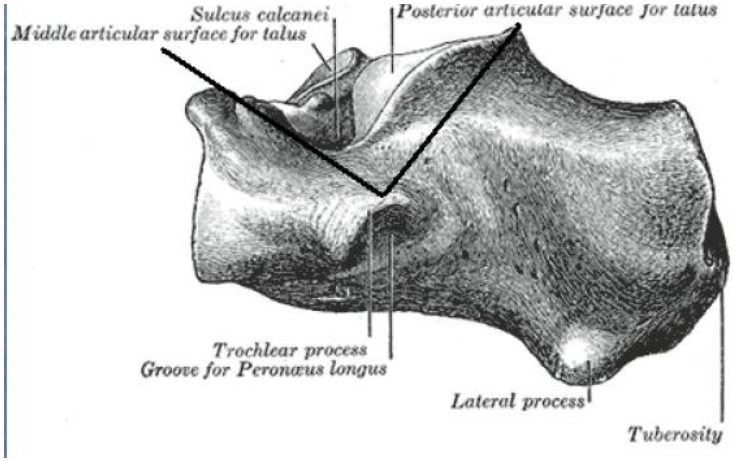
- Bohler's Angle
  - Tip of posterior tubercle to the tip of the posterior facet
  - Tip posterior facet to the tip of the anterior process
  - Normal 25-40^{o}
  - Decreased angle indicates joint depression – "flattening"

Radiographs

- Bohler's Angle
  - Apex of
    - Posterior Tuberosity
    - Posterior articular surface
  - Apex of
    - Anterior Process
    - Posterior articular surface
- Normal 20°-40°

Radiographs

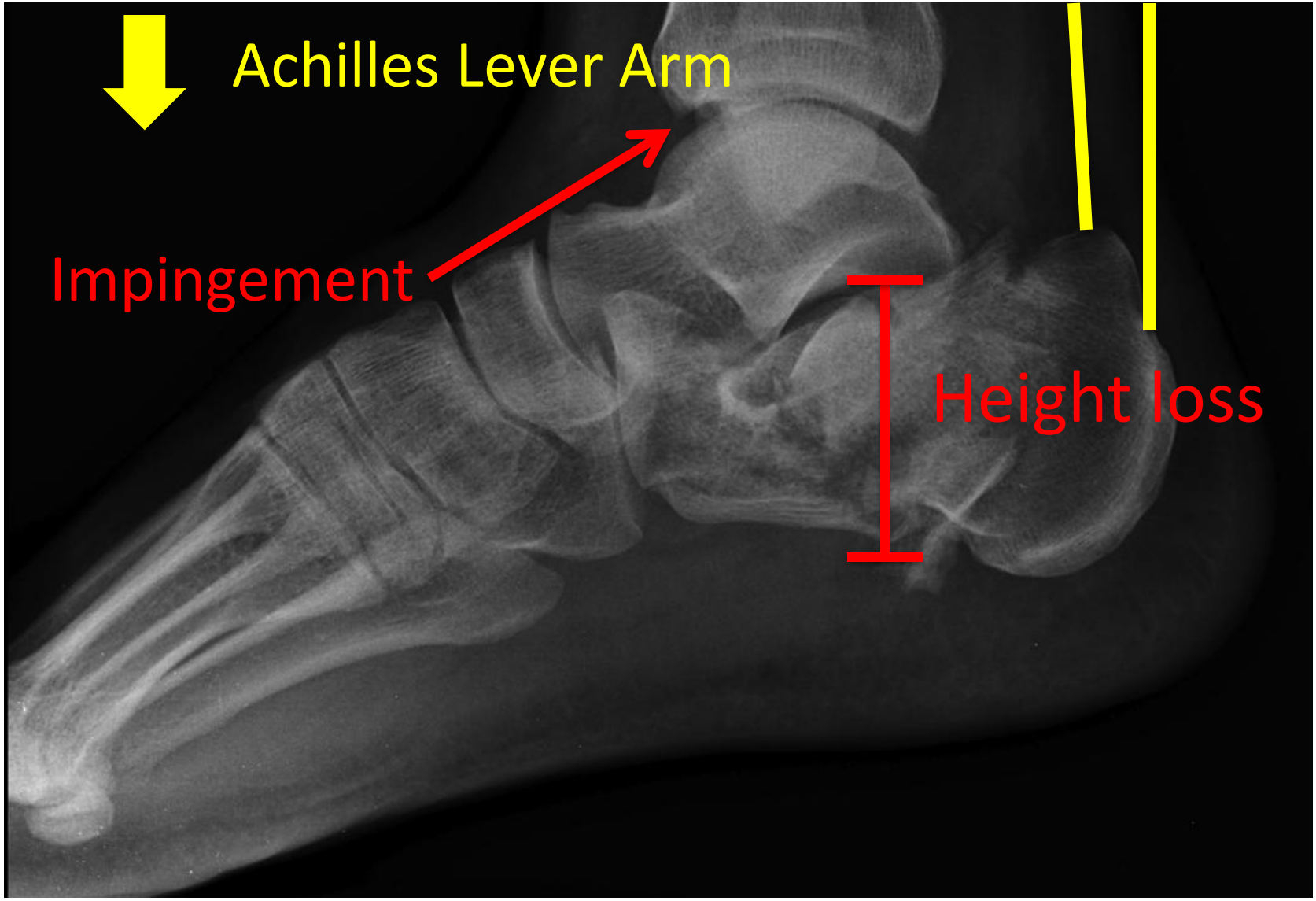
- Angle of Gissane
  - Lateral Border of Posterior Facet
  - Anterior Aspect Lateral Calcaneus
  - Normal 100°-130°



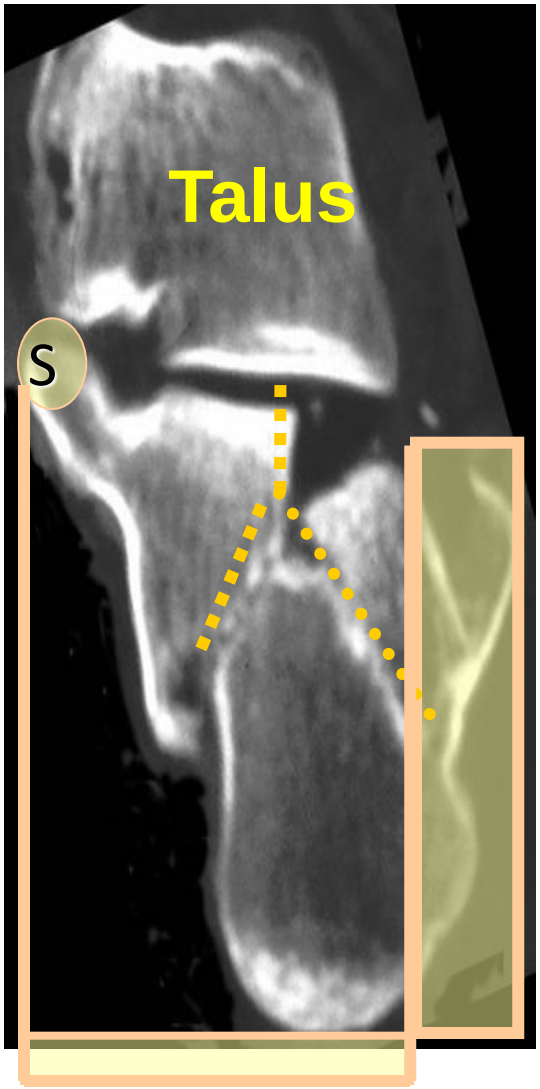
Radiographic Measurements

- Critical Angle of Gissane
  - Normal 120-145 – degrees
  - Change in angle – indicates change in relationship between posterior, medial, and anterior facets


LENGTH


Achilles Lever Arm
Impingement
Height loss

Fractures of the calcaneus

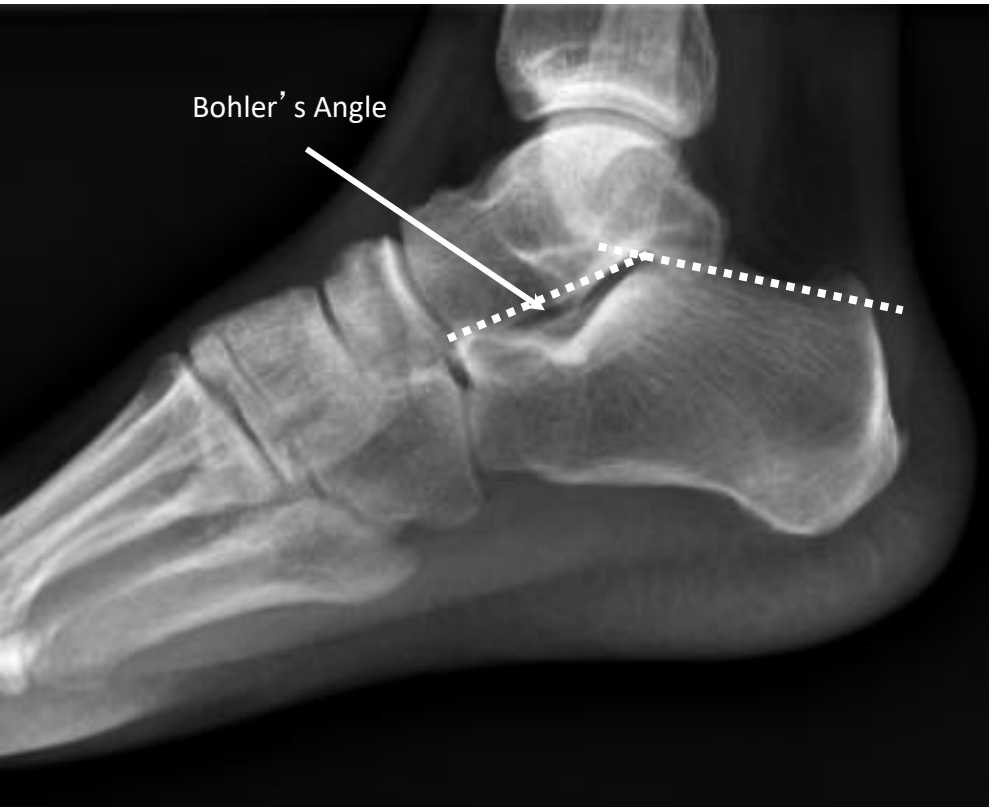


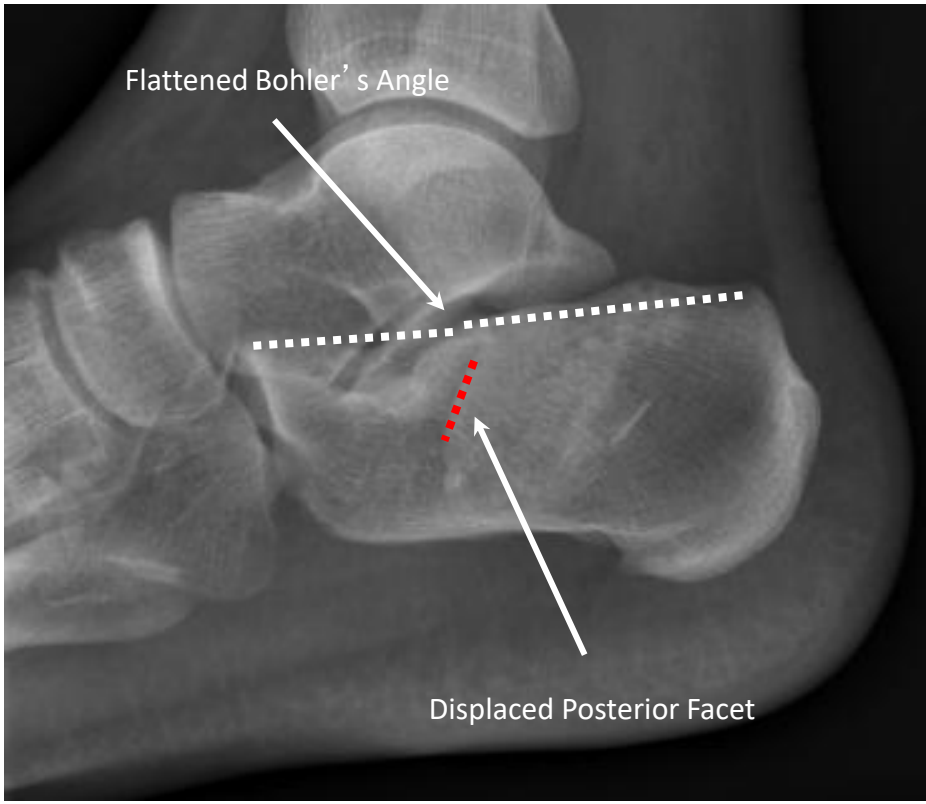
Shoe wear
Peroneal Irritation
Subfibular impingement
Sural Neuritis

AP Foot

- Assess
  - CC joint involvement
  - Lateral column length
  - Talonavicular joint

Lateral


Bohler's Angle


Flattened Bohler's Angle
Displaced Posterior Facet

Classification

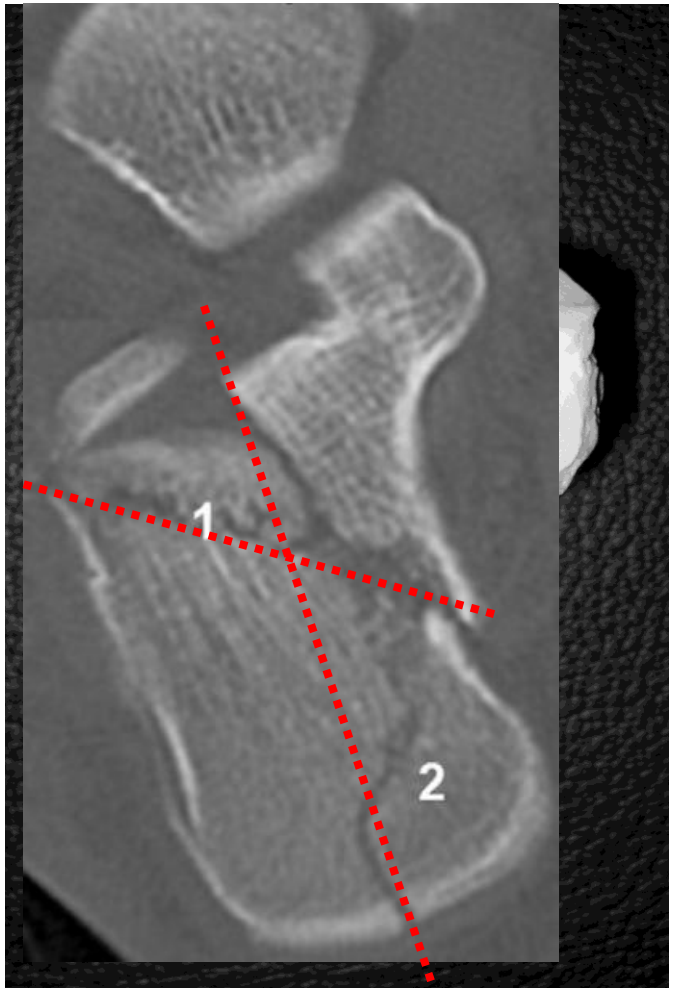
- Essex-Lopresti
- tonque-type fractures
- depression-type fractures
- Sanders classification

Mechanism of Injury

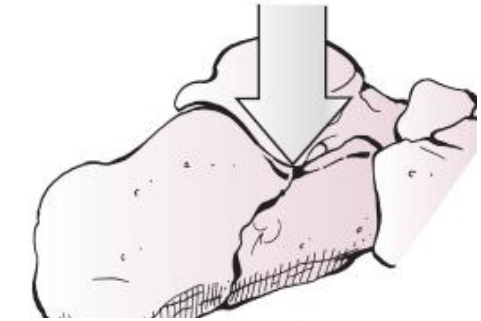
- High energy axial load (MVC, fall from height)
- Lateral process of talus driven into angle of Gissane like a wedge
  - Creates primary fracture line from anterolateral to posteromedial
  - Secondary fracture line depends on direction of force
    - Posterior=joint depression
    - Axial=tongue type
  - Factors influencing fracture pattern
    - Position of foot
    - Direction of force
    - Bone quality

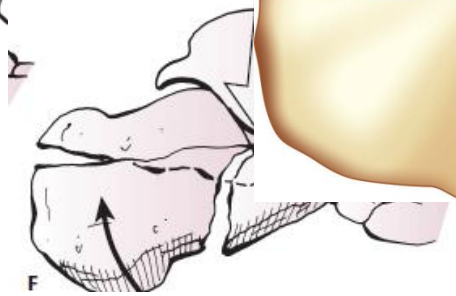
Fracture Pattern

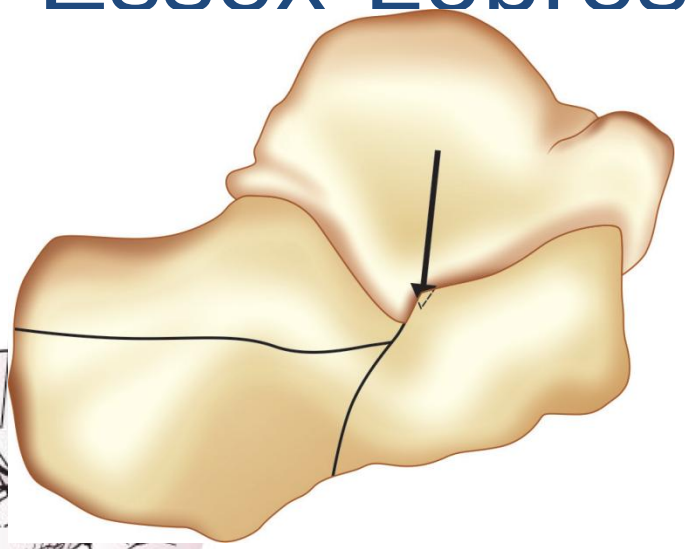
- Primary fracture line
- Begins at the angle of Gissane and exits inferomedially
- Posterolateral fragment (PLF)
  - Tuberosity and lateral wall
- Anteromedial fragment (AMF)
  - Anterior and middle facets
  - Sustentaculum
  - Residual posterior facet
- Further divided by secondary fracture lines..



Essex-Lopresti

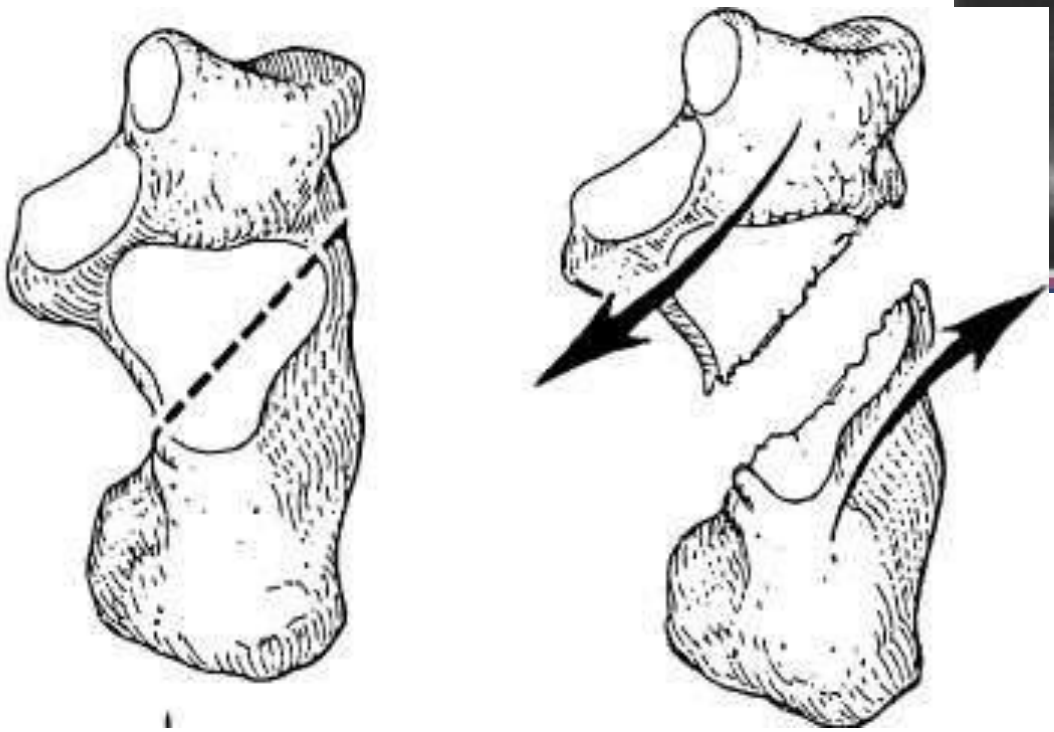


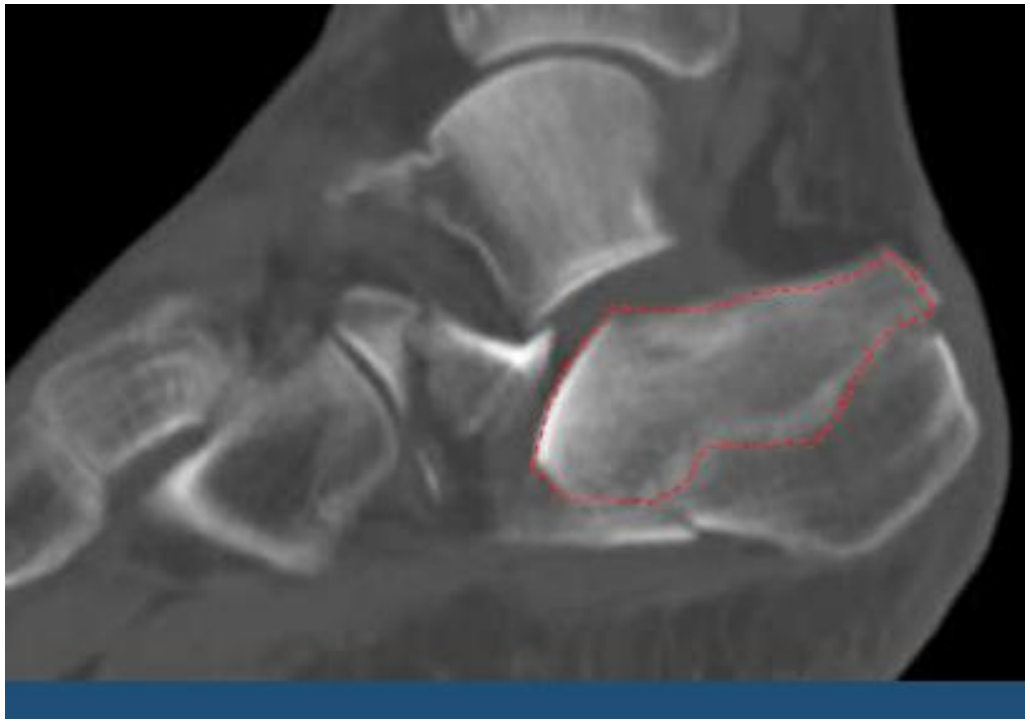




Tongue Type

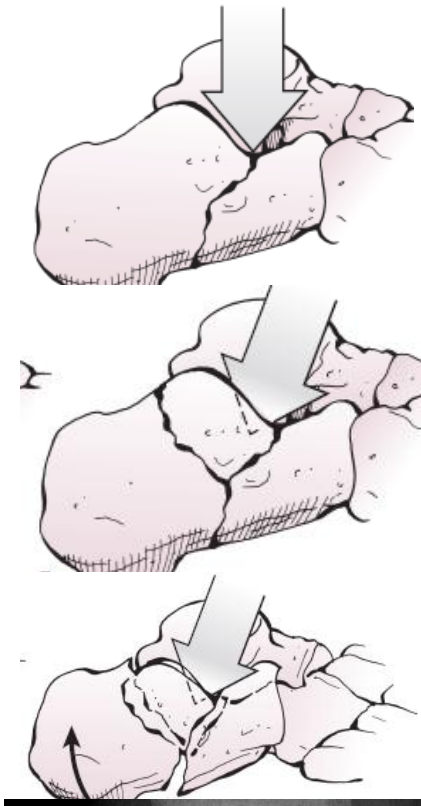
Posterior facet remains attached to the calcaneus tuberosity

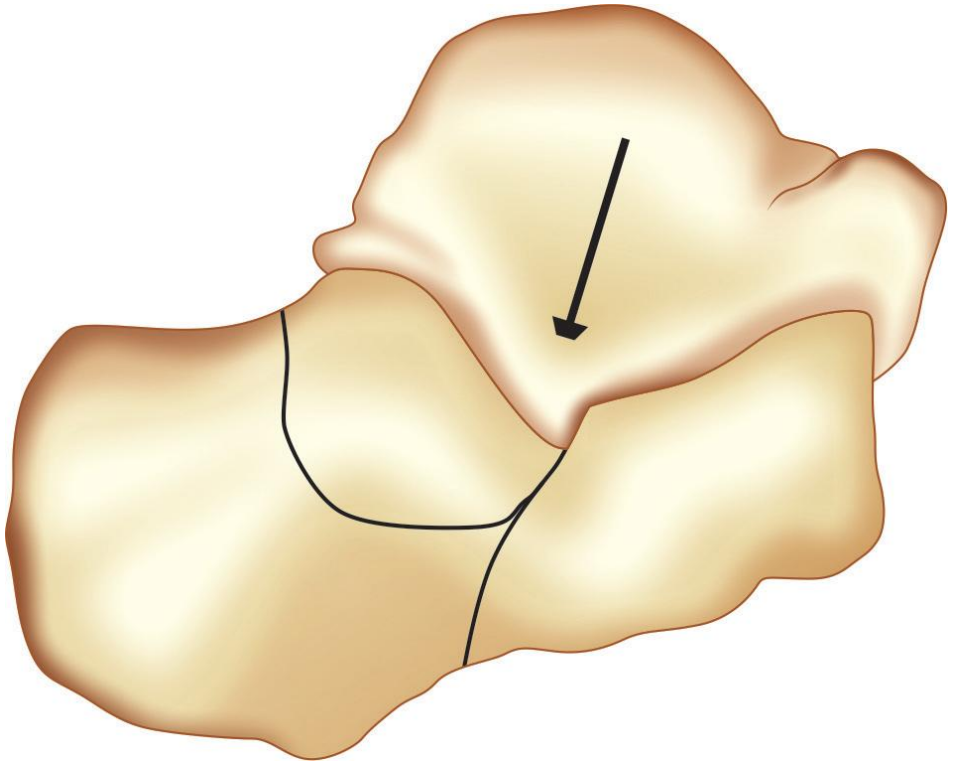


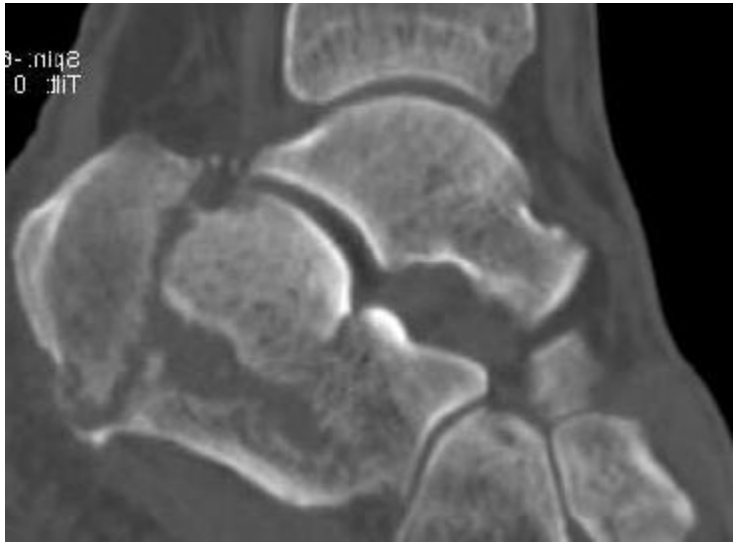


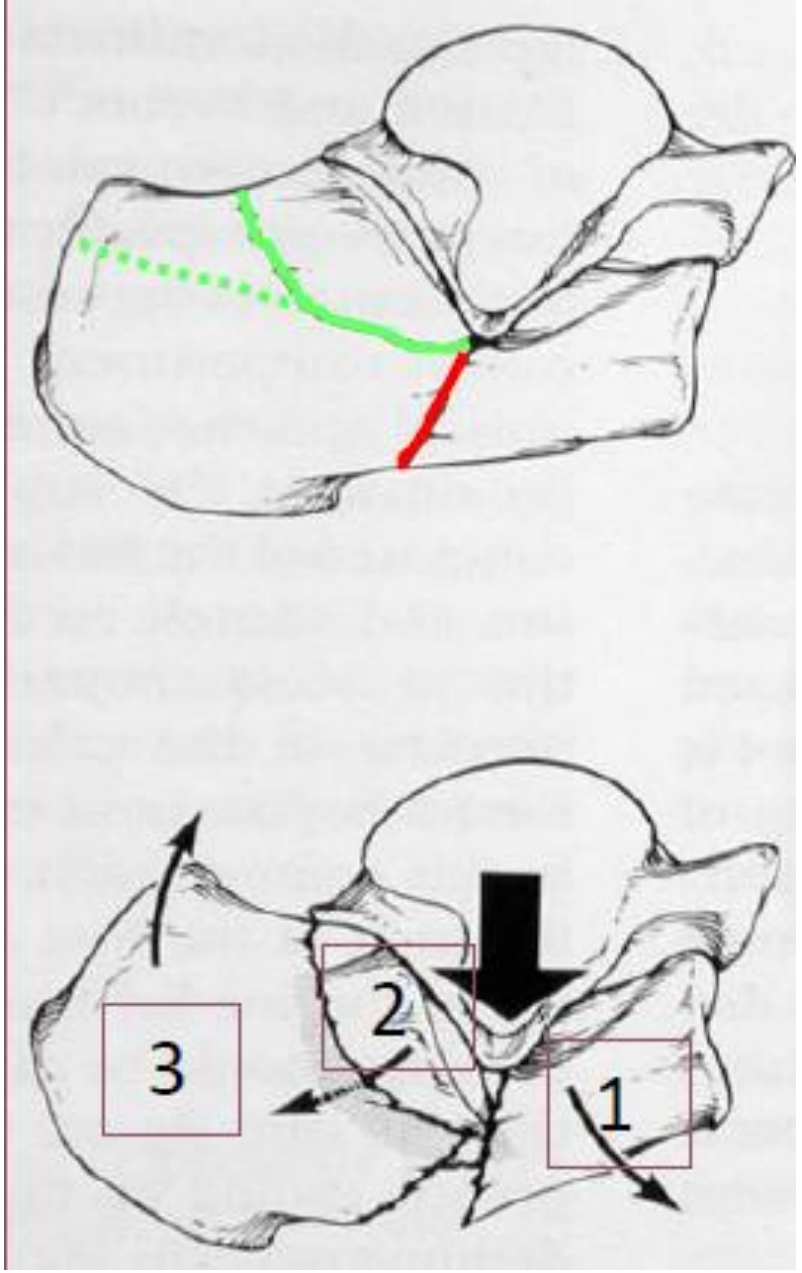
Joint Depression

‚Posterior facet impacted into the body of the calcaneus

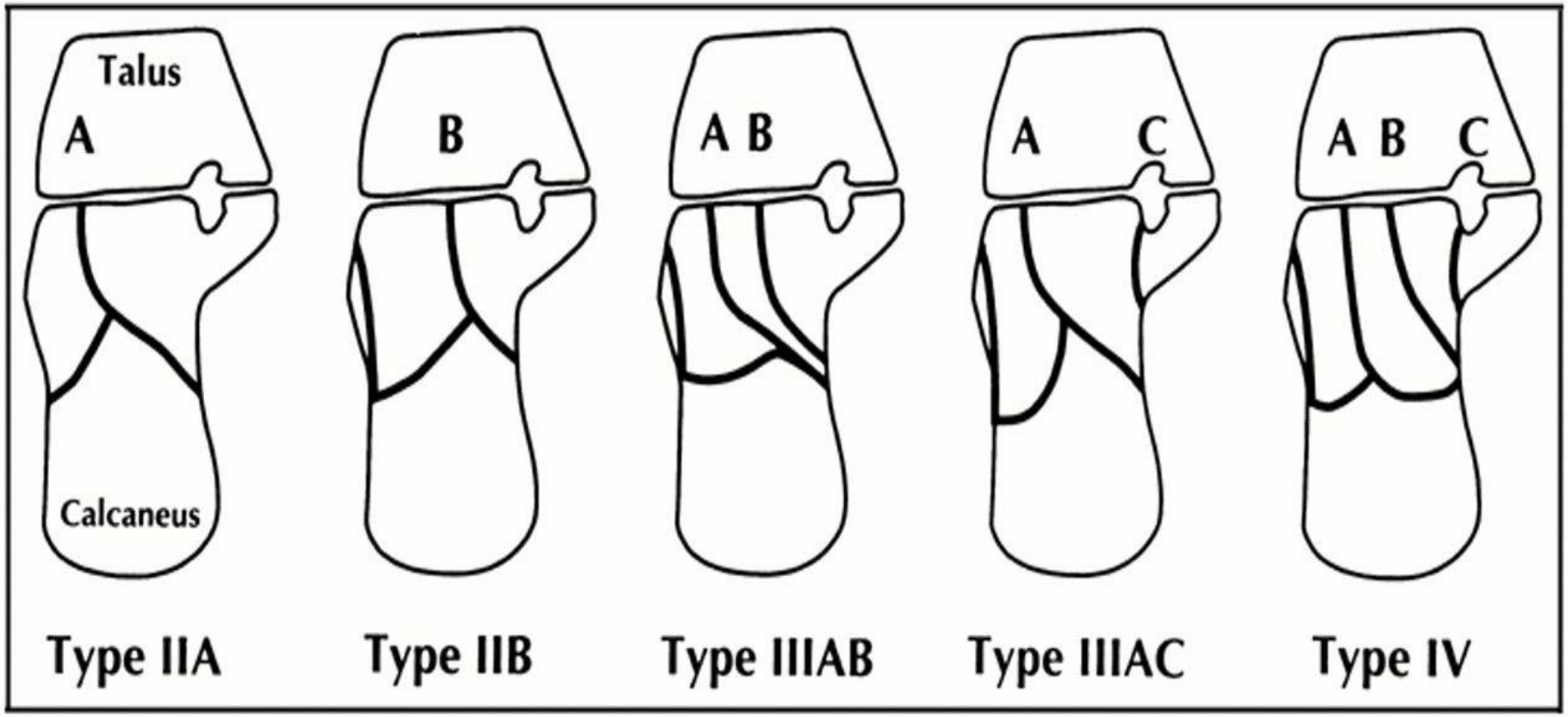






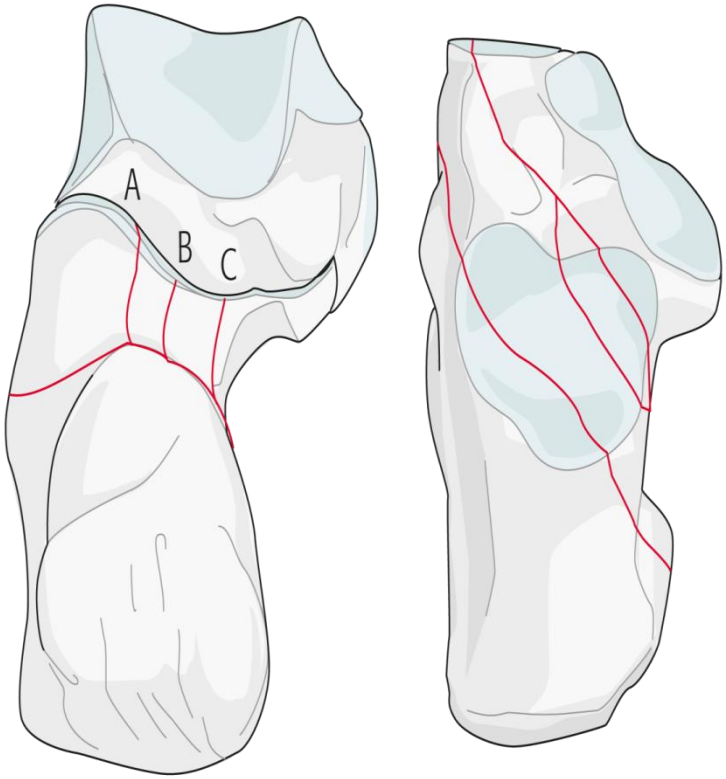

3
2
1

The Sanders classification system



Fractures of the calcaneus

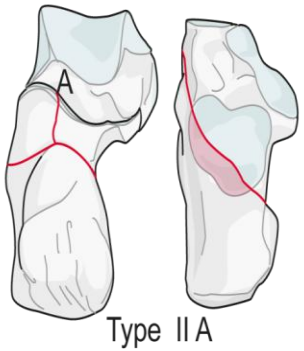
- CT classification



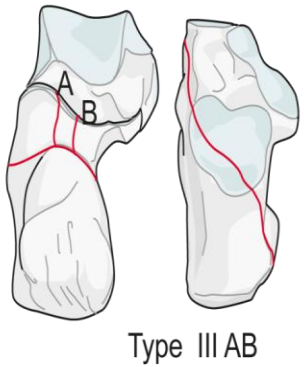
Sanders classification

Type II

(2-part fracture)



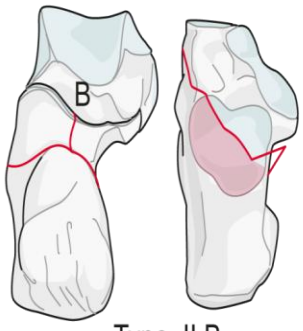
Type II A



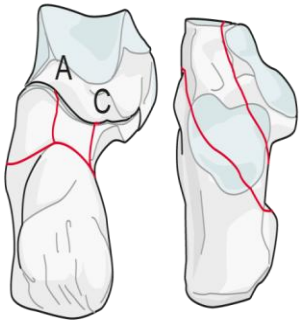
Type III AB

Type III

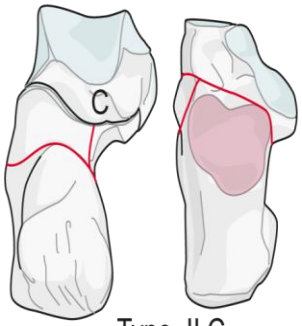
(3-part fracture)



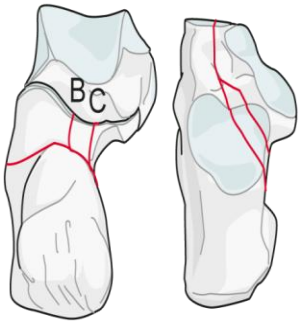
Type II B



Type III AC



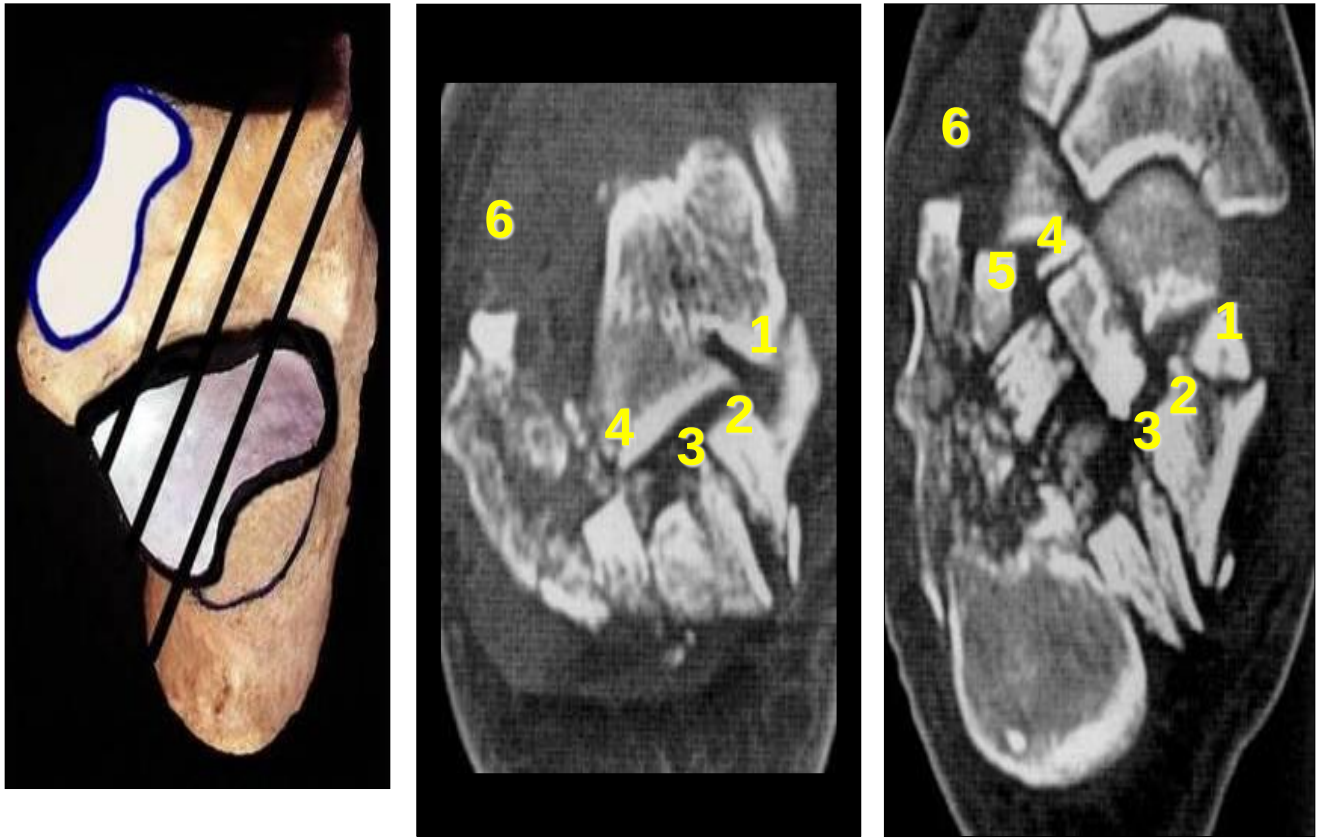
Type II C



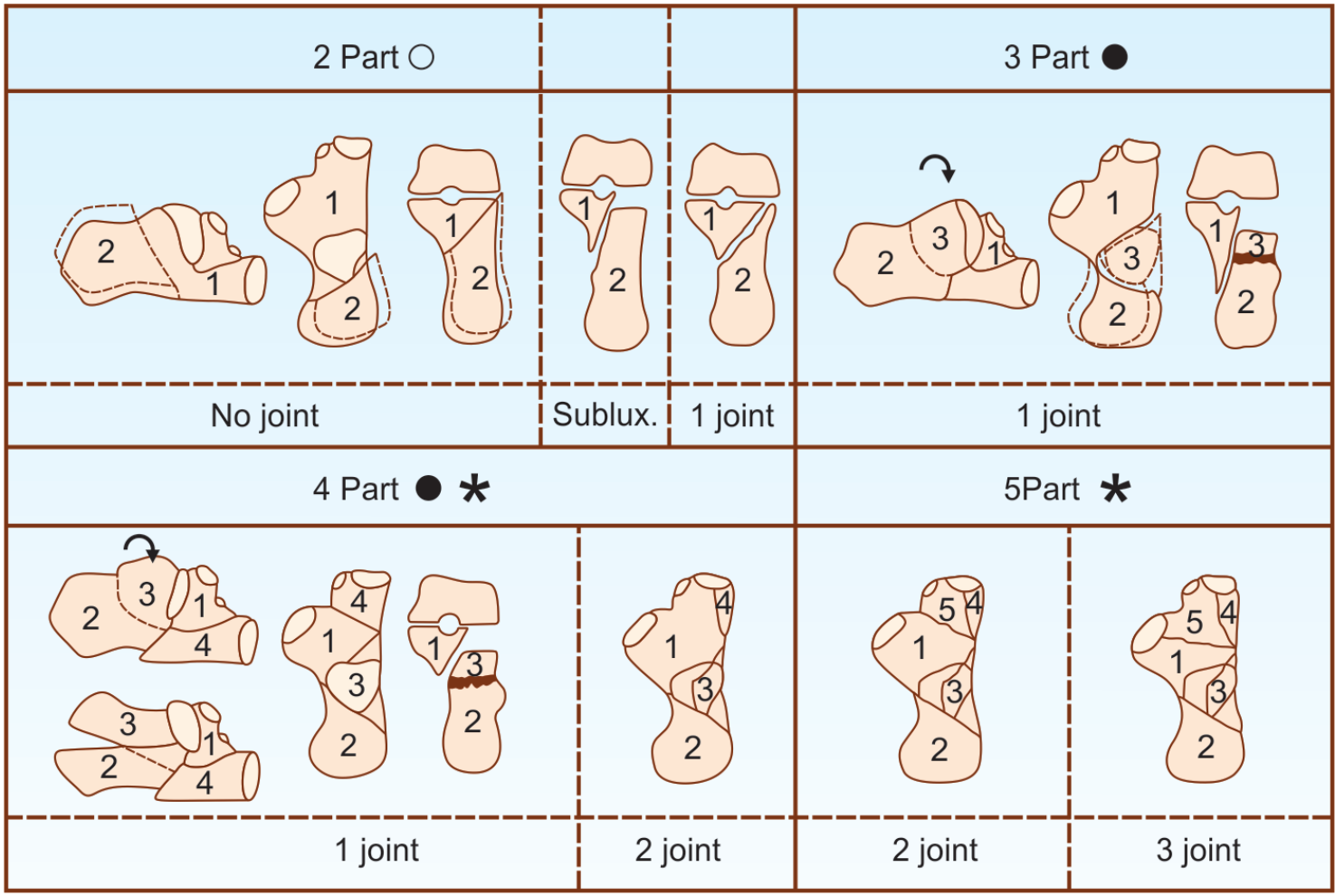
Type III BC

Fractures of the calcaneus

- Type IV (or more)



The maximum score that can be achieved with this classification is 12



1 = sustentacular fragment, 2 = tuberosity fragment, 3 = subtalar joint fragment, 4 = anterior process fragment, and 5 = anterior subtalar joint fragment

number of joints involved (posterior subtalar, calcaneocuboid and anterior subtalar joint)

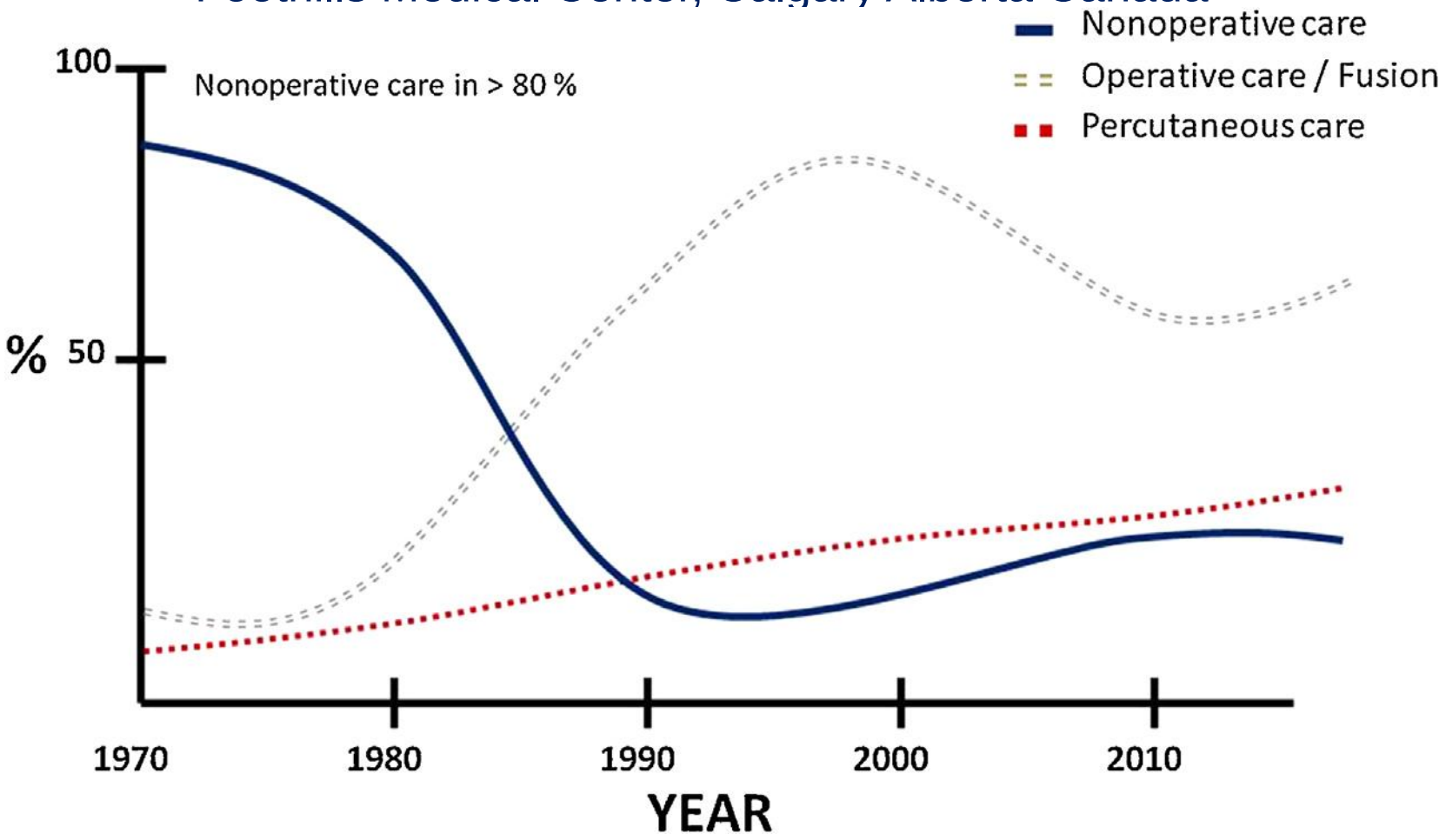
open fractures

Consistent Features

- There is significant variability in the fracture pattern of displaced intra-articular calcaneal fractures however there are three consistent features…

1. The sustentaculum typically remains attached to the talus
2. The anterior process translates dorsally
3. The tuberosity translates laterally, displaces superiorly (pull of Achilles), rotates into varus and shortens into the fracture

Trends in management of DIACFs over the last four decades in Foothills Medical Center, Calgary Alberta Canada



Sharr PJ, et al. Current management options for displaced intra-articular calcaneal fractures: Nonoperative, ORIF, minimally invasive reduction and fixation or primary ORIF and subtalar arthrodesis

“It takes five years to learn when to operate and twenty years to learn when not to.”

Surgical timing

- Surgery must be performed within 3 weeks of injury
- Wait until soft tissue stabilizes

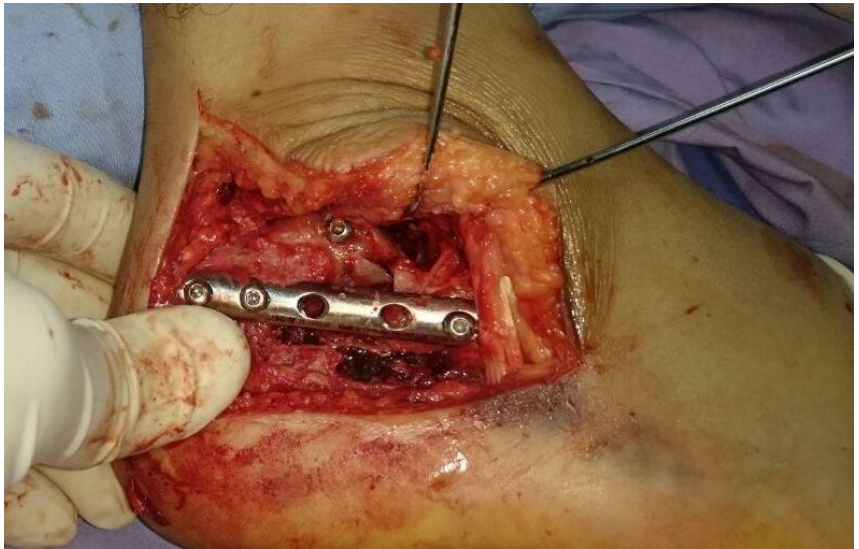
Fractures of the calcaneus

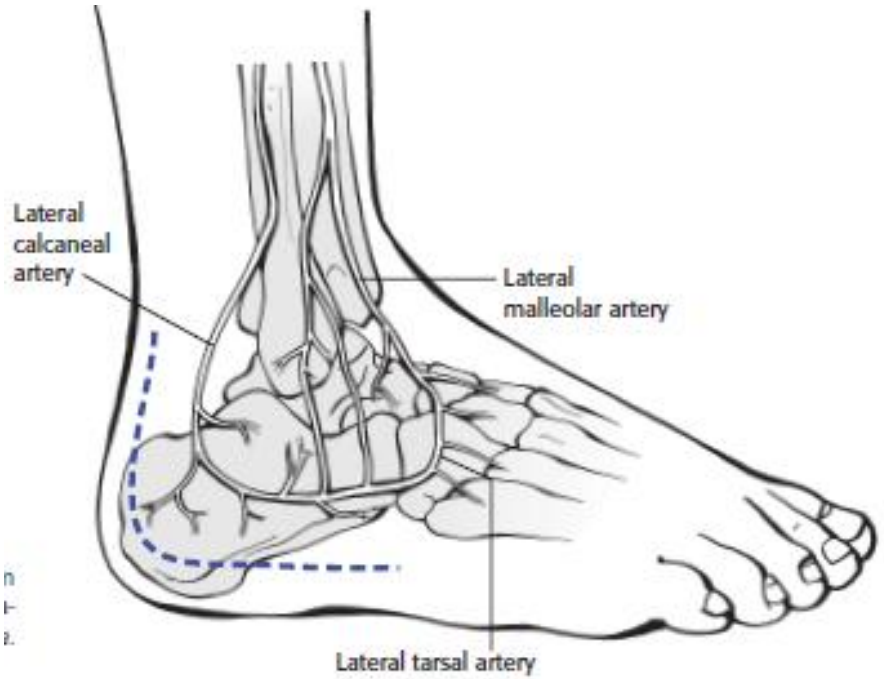
Lateral blisters

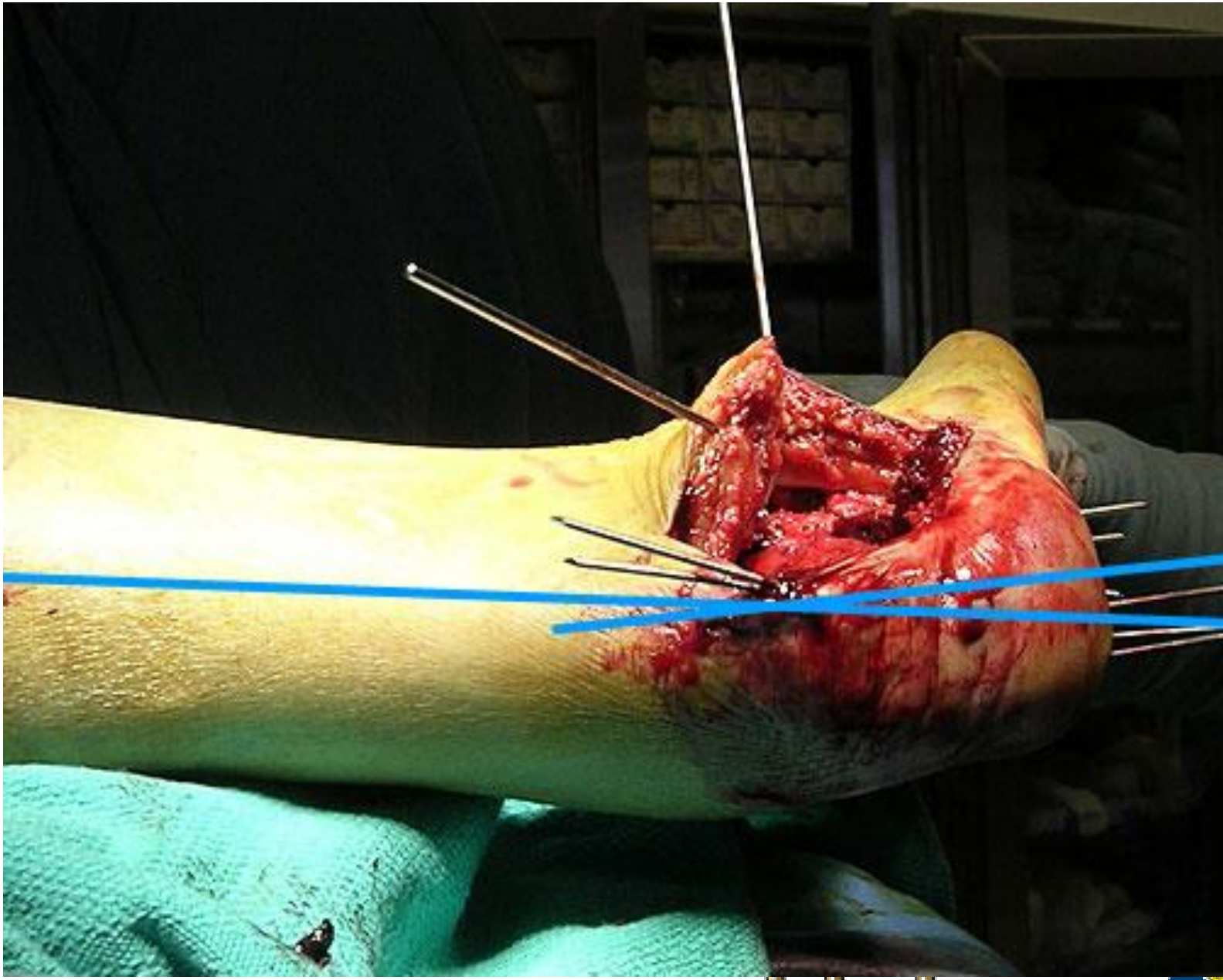
Wrinkle test

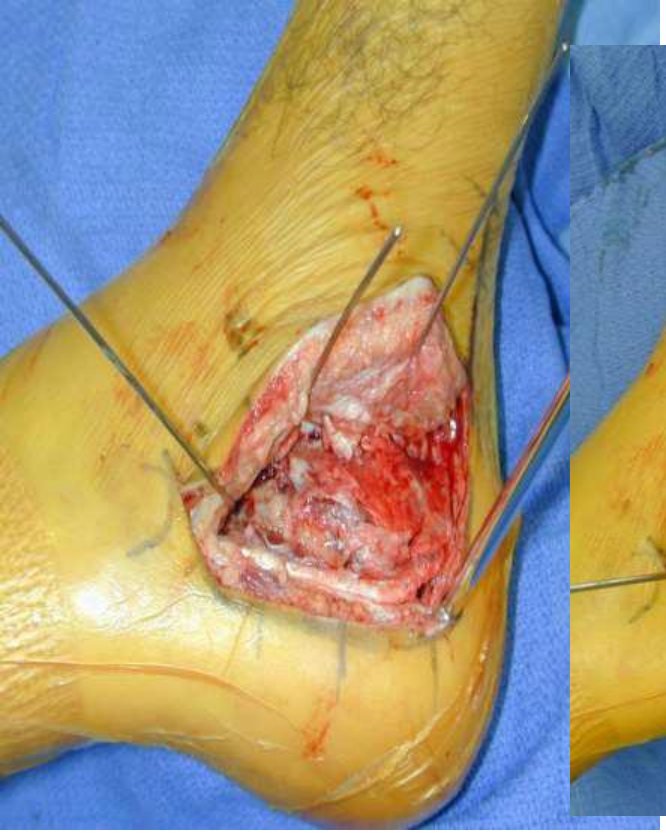
Approaches and surgical techniques

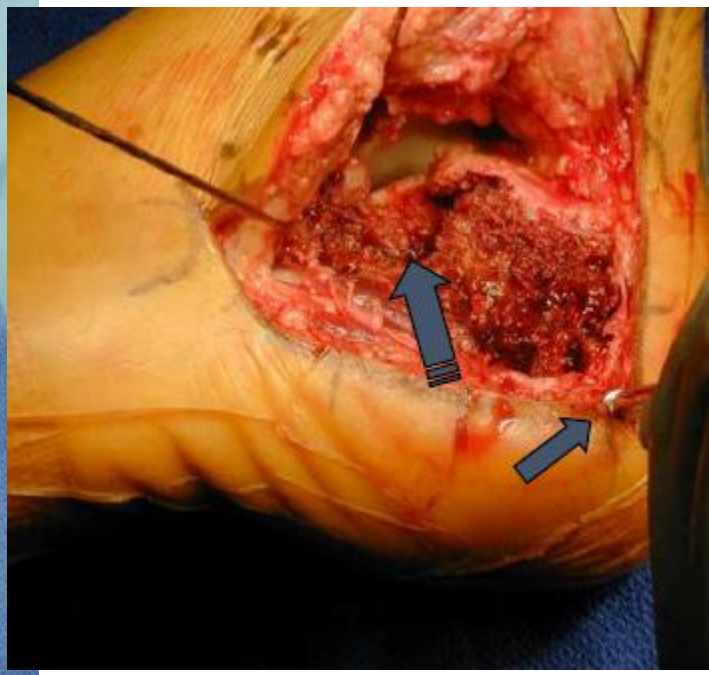
The extended lateral approach Gold standard









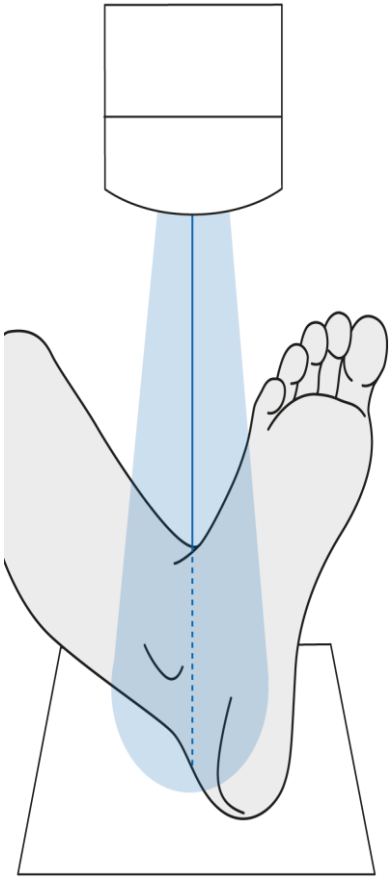


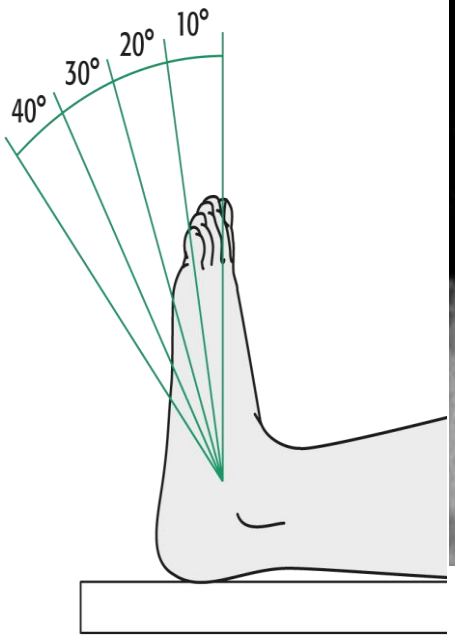
- Check peroneal tendons
- Drain
- Layered closure

1. Periosteum/SQ one layer
2. Skin

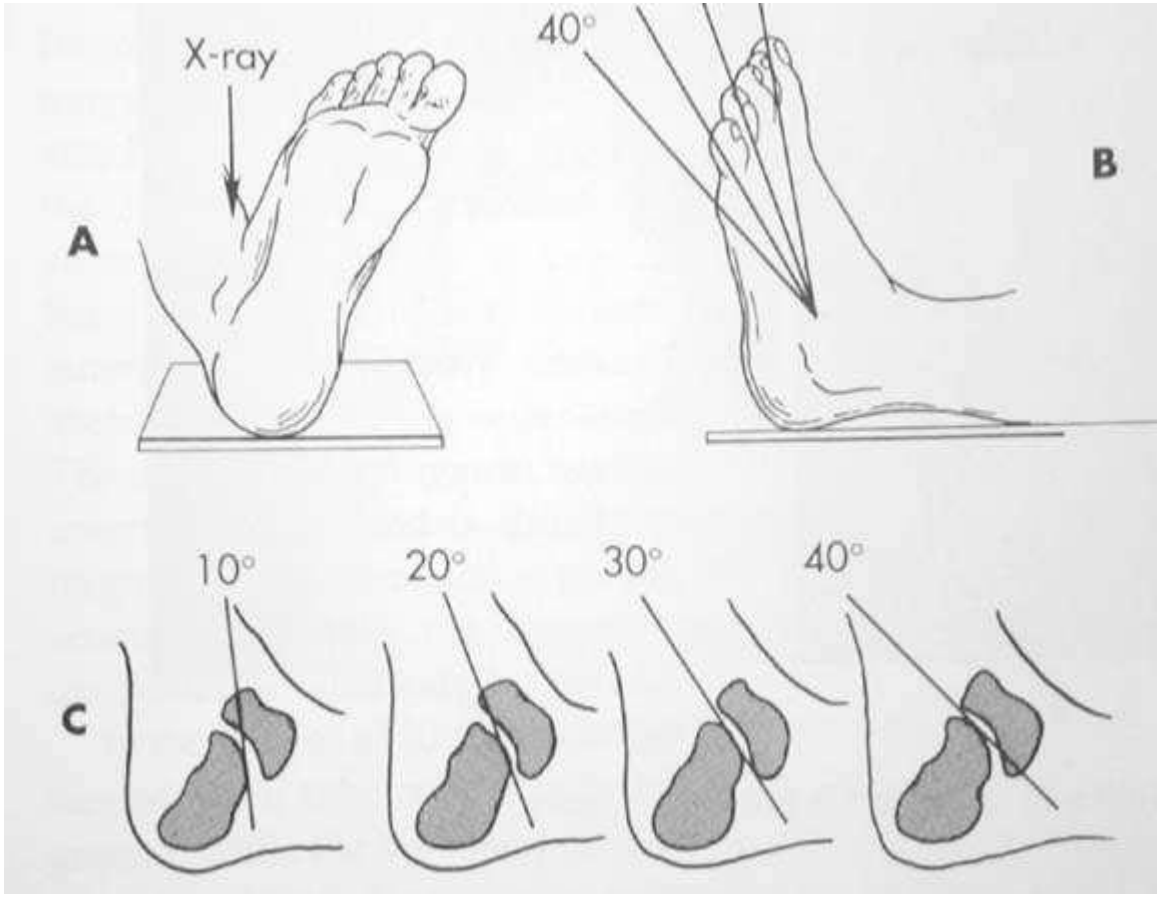
- Atraumatic technique
- Advance flap toward apex
- Allgower-Donati sutures
- Splint in neutral

Fractures of the calcaneus





Broden's view


X-ray
A
40°
B
10°
20°
30°
40°
C

Complications

Wound healing complications 24.9%

third (29%) of the complications following the ELA were classified as major

Operative Versus Nonoperative Treatment of Displaced Intra-Articular Calcaneal Fractures: A Meta-Analysis of Randomized Controlled Trials

Wei Zhang, MD, Feng Lin, MD, Erman Chen, MD, Deting Xue, MD, and Zhijun Pan, MD

First Author	Gender Ratio (Male/Female)		Unilateral/Bilateral Ratio		Operative Approach	Mean Follow-up times (mo)	Internal Fixation
	Operative	Nonoperative	Operative	Nonoperative			
Griffin[19]	64/9	63/15	NA	NA	Lateral	24.0	Plate and screw
Agren et al[10]	29/13	30/10	39/3	38/2	Lateral	120.0	Plate and screw
Kashani[23]	62/22	48/8	14/70	12/44	NA	NA	NA
Nouraei[11]	NA	NA	50/11		Lateral	36.0	Plate and screw
Sharma[16]	10/5	11/4	NA	NA	Lateral	28.1	Plate and screw
Buckley[22]	391/34		163/43	174/44	Lateral	24.0–96.0	Plate and screw and wires
Thordarson and Krieger[12]	NA		NA	NA	Lateral	15.4	Plate and screw

Conclusions: This meta-analysis documented that when surgery was performed correctly, better shoe wear and improved walking ability could be expected. These outcomes seemed to be based on the surgeon's ability to obtain an acceptable reduction. Benefits were tempered by the increase in wound complications associated with this intervention.

STA

International Journal of Surgery 12 (2014) 475–480

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Original research

Open reduction and internal fixation with conventional plate via L-shaped lateral approach versus internal fixation with percutaneous plate via a sinus tarsi approach for calcaneal fractures – A randomized controlled trial

Shengli Xia*, Yaogang Lu, Huizhong Wang, Zuming Wu, Ziping Wang

Department of Orthopaedics, Zhoupu Hospital of Pudong, Shanghai 201318, China

Conclusion: Compared with L-shaped lateral approach treatment of displaced intra-articular calcaneal fractures, sinus tarsi approach for the reduction and internal fixation with percutaneous plate seems to be more safe and effective, with satisfactory clinical therapeutic effects and without postoperative complications.

Displaced Intra-Articular Calcaneal Fractures Treated in a Minimally Invasive Fashion

Longitudinal Approach Versus Sinus Tarsi Approach

Tao Zhang, MD*, Yanling Su, MD, MPH*, Wei Chen, MD, PhD, Qi Zhang, MD, PhD, Zhanpo Wu, MD, PhD, and Yingze Zhang, MD

Investigation performed at the Department of Orthopaedic Surgery, Third Hospital of Hebei Medical University, Shijiazhuang, Hebei, Republic of China

Conclusions: Outcomes are similar for the minimally invasive longitudinal and sinus tarsi surgical approaches in the treatment of Sanders type-II and III displaced intra-articular fractures of the calcaneus, with the benefit of a lower complication rate and shorter operative time for the minimally invasive technique. For Sanders type-IV fractures, however, the sinus tarsi approach appears to be the treatment of choice.

Level of Evidence: Therapeutic Level I. See Instructions for Authors for a complete description of levels of evidence.

Benefits of the minimally-invasive techniques

Advantages

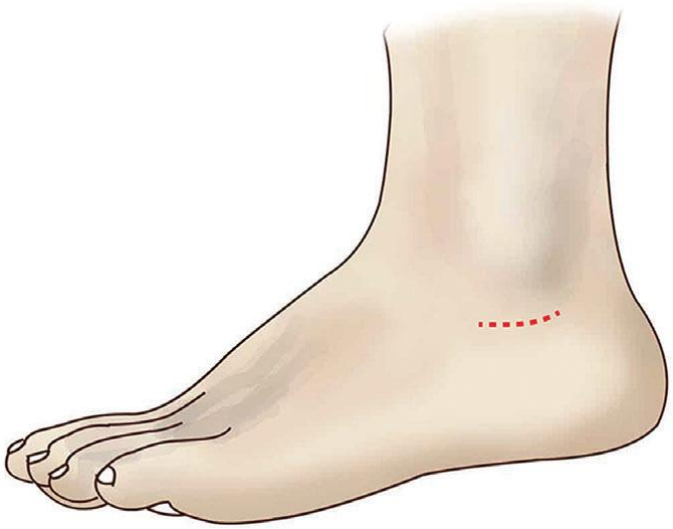
- Early surgery is possible ,
- Early mobilization
- Minimization of surgery time
- Much less post-operative wound healing complications and infections
- Good opportunities for anatomical reconstruction

Disadvantages

- Higher radiation exposure
- within the first three days ,up to 2 weeks
- Time for surgical preparation
- **Maximal Intensive Preparation**
- No direct visualization of the fracture
- The ”learning curve”

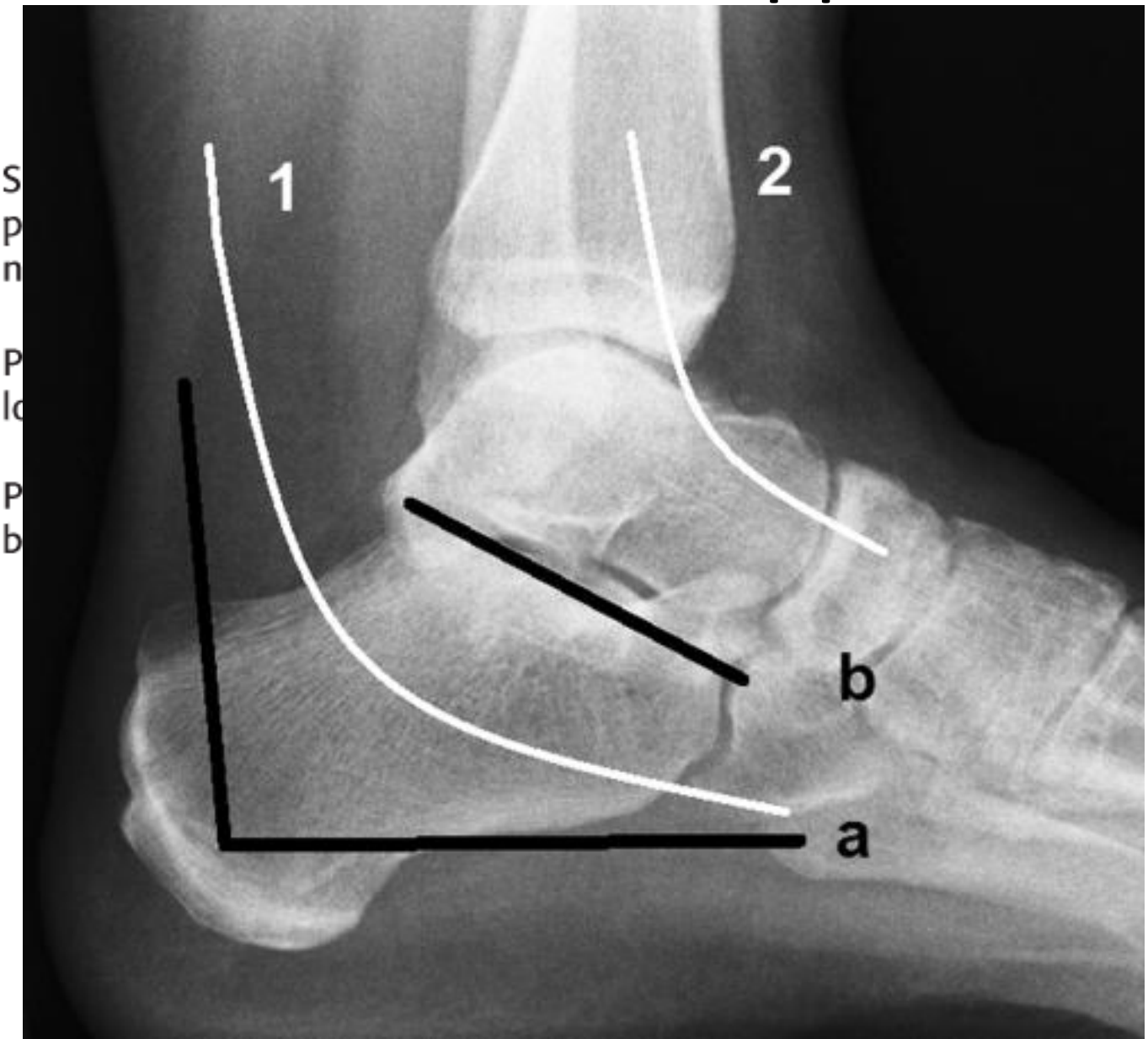
The incidence of postoperative wound healing complications following the STA (4.9%) and no major complications were noted.

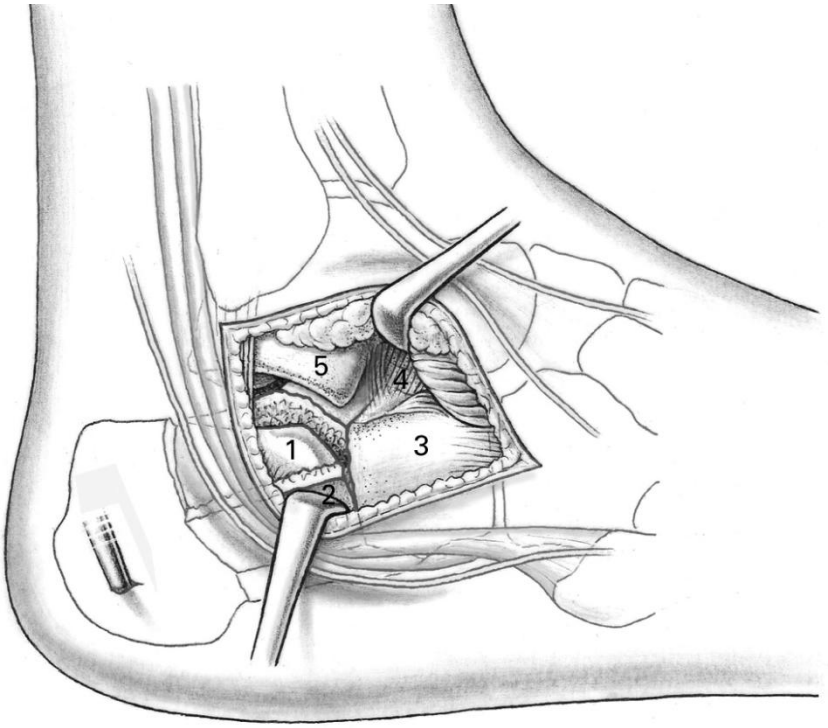
Surgical approach

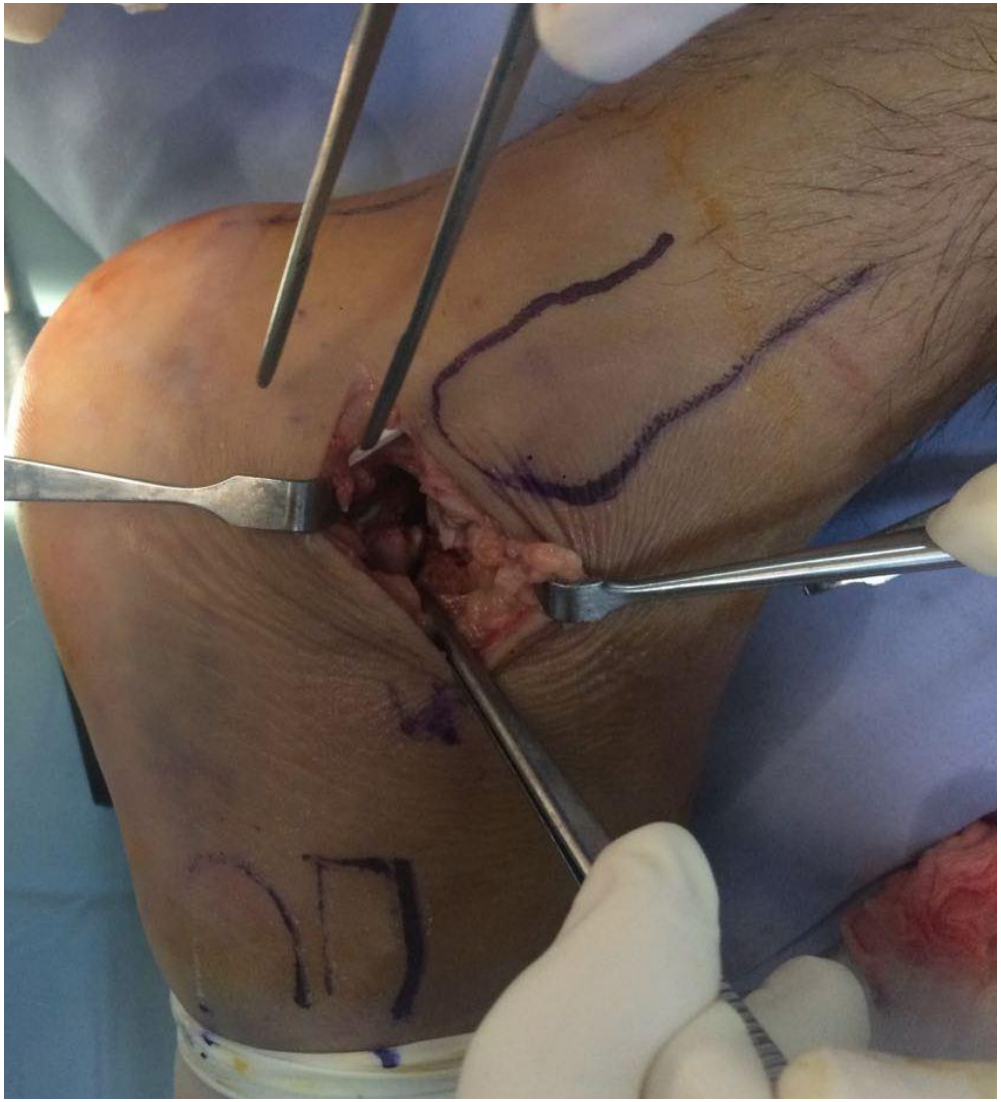


Clinical Comparison of Extensile LateralApproach and Sinus Tarsi Approach Combined with Medial Distraction Technique Hai-chao Zhou et al

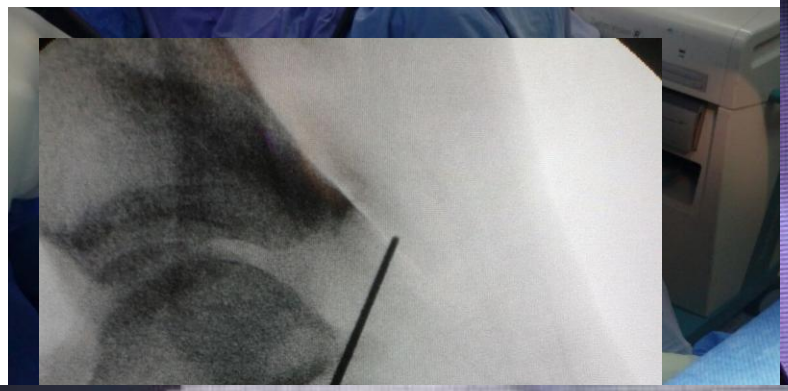
Sinus tarsi approach

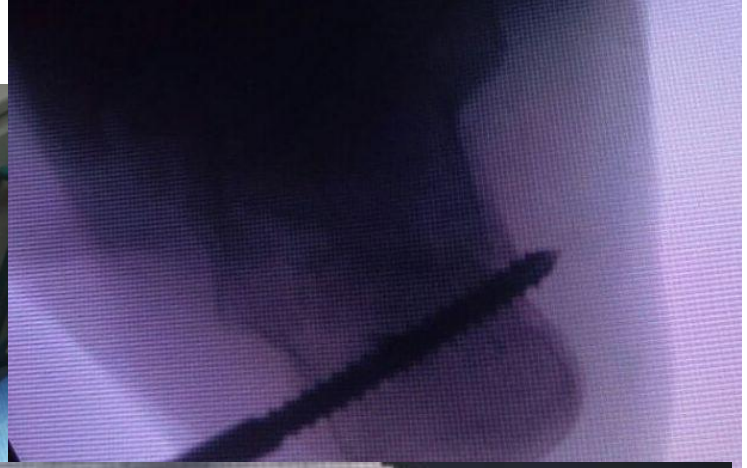






Limited open reduction and internal fixation of displaced intra-articular fractures of the calcaneum M. Weber et al





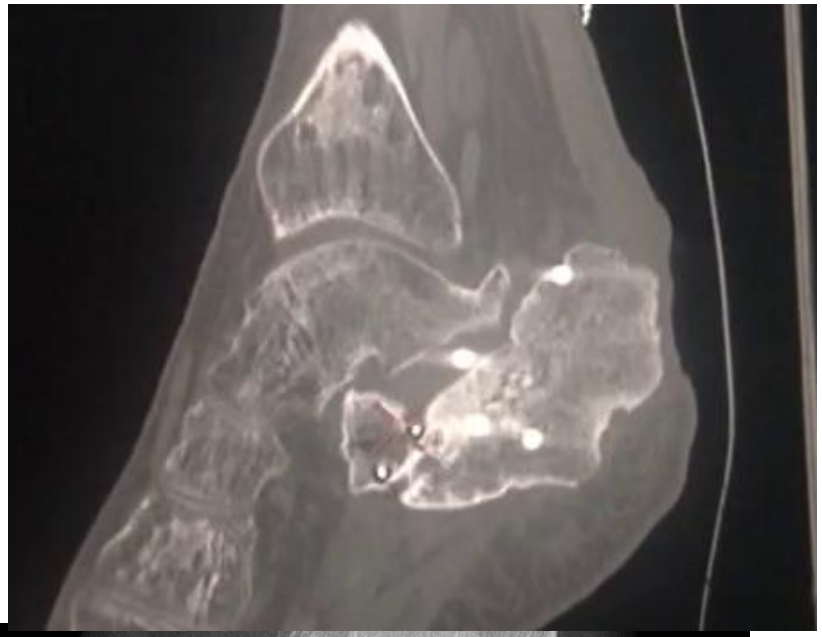

FLR
BoneE

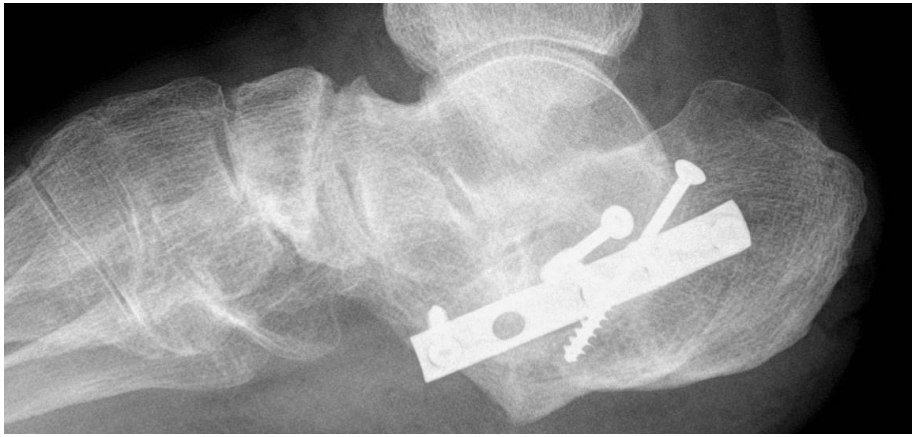






(OID)Open internal Decoration





Complications

- Infection
- Arthritis
- Sural neuritis
- Tendonitis
- Hindfoot varus

Fractures of the calcaneus

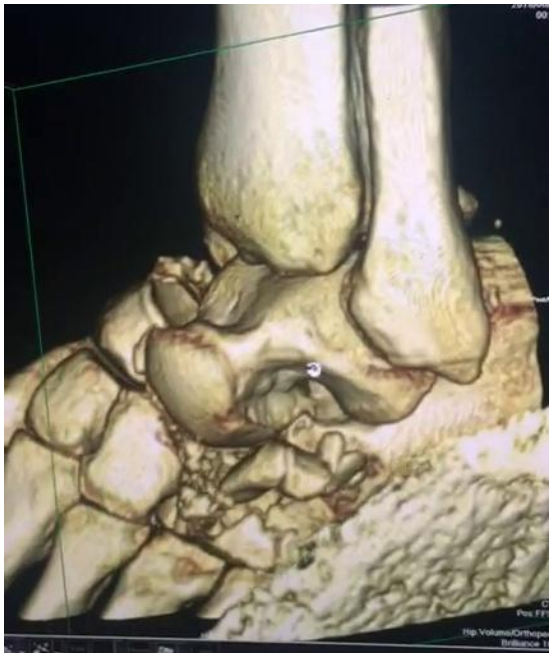
- Postoperative blisters
- Apical wound necrosis

Take home messages

- STA has become an effective and reliable method to treat DIACF. with Reduced complications
- DIACFs continue to be technically demanding injuries to manage
- Achieve excellence in your reductions ORIF or MIS or fusion

MIDFOOT FRACTURE DISLOCATIONS

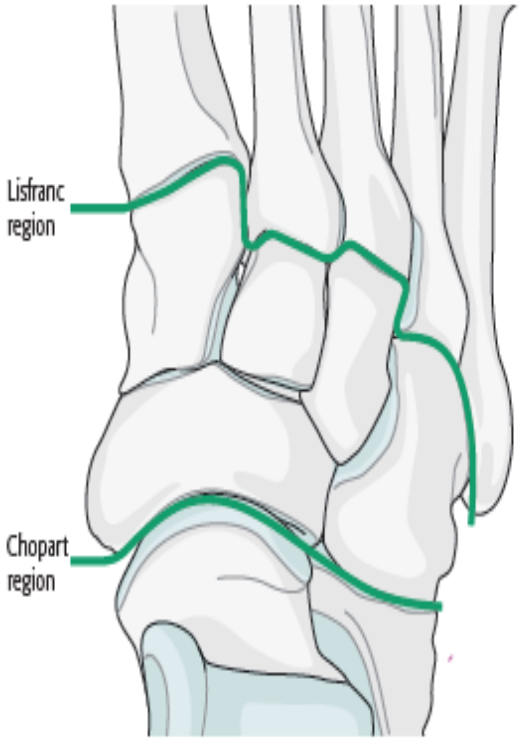
Abdullah Alkhawaldah MD, FACS
RMS Jordan. Foot And Ankle surgery



objectives

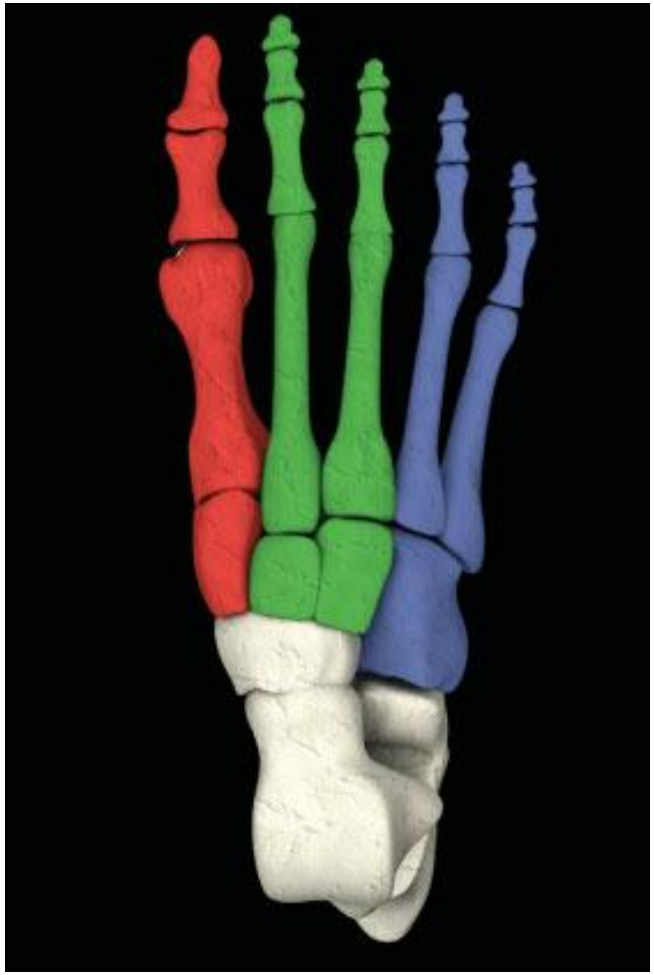
- Review anatomy and biomechanics of midfoot.
- Outline assessment and management of midfoot fracture dislocations.
- Discuss surgical management fixation Vs arthrodesis.

anatomy



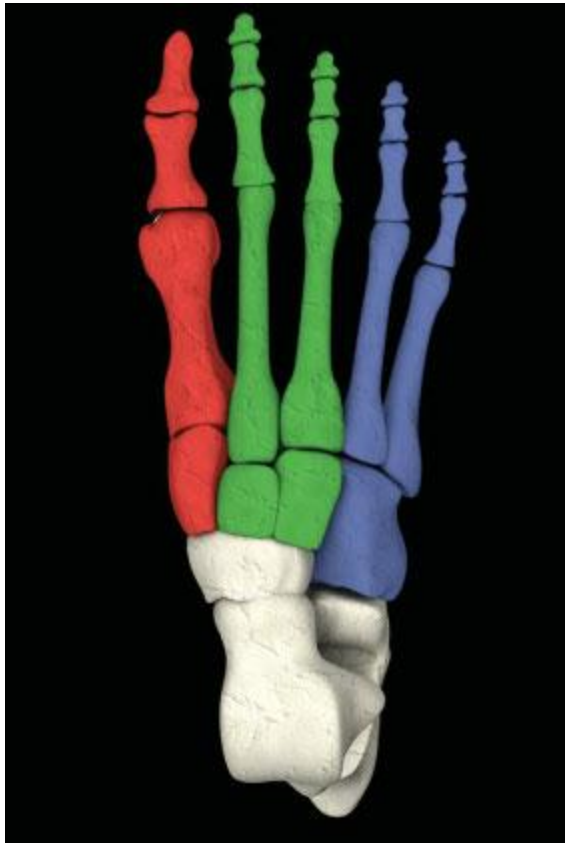
Lisfranc and Chopart regions of the foot.

Manual of Fracture Management Foot and Ankle (AO Trauma: Rammelt S, Swords M, Dhillon MS, Sands A: Thieme Publishers). (2020).



Lisfranc Injury Imaging and Surgical Management Llopis et al

Functional Anatomy

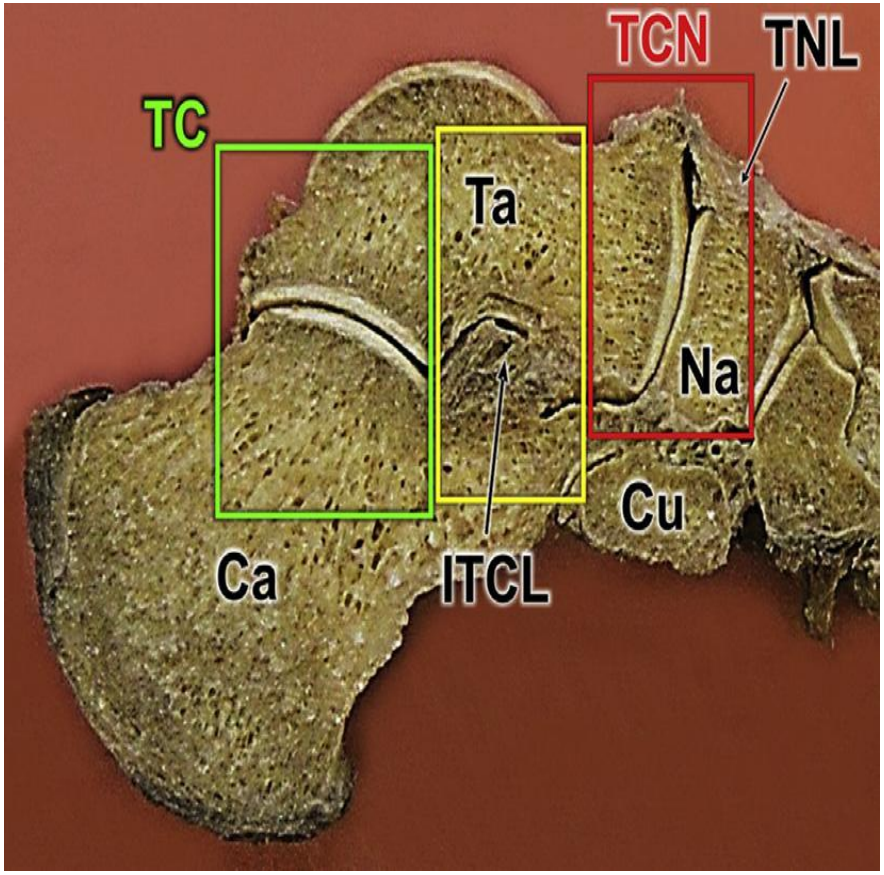


Column Theory
Medial column (Yellow) First TMT and NC joints
Limited mobility at first TMT
Mobile segment is the talonavicular joint

Intermediate column (Red) 2nd , 3rd TMT joints and NC joints
Rigid (no motion

Lateral Column (Green) 4th and 5th TMT joints
Mobile
Essential Shock absorber

The stiff middle column acts as a rigid lever arm, with the medial and lateral columns providing appropriate adjustment as WB gait



Jan Bartoníčeket al Ankle Clinics, Volume 23, Issue 3, 2018,

William R. et al AJR:211, August 2018

Treatment Principles

- MUST Restore alignment
- Protect talonavicular motion
- Protect 4,5 TMT motion

- Motion of other joints not essential for function

Treatment Principles

Hindfoot: Protect ankle, subtalar, and talonavicular joints

Midfoot: restore length and alignment of medial and lateral “columns”

Forefoot: Even weight distribution across metatarsal heads

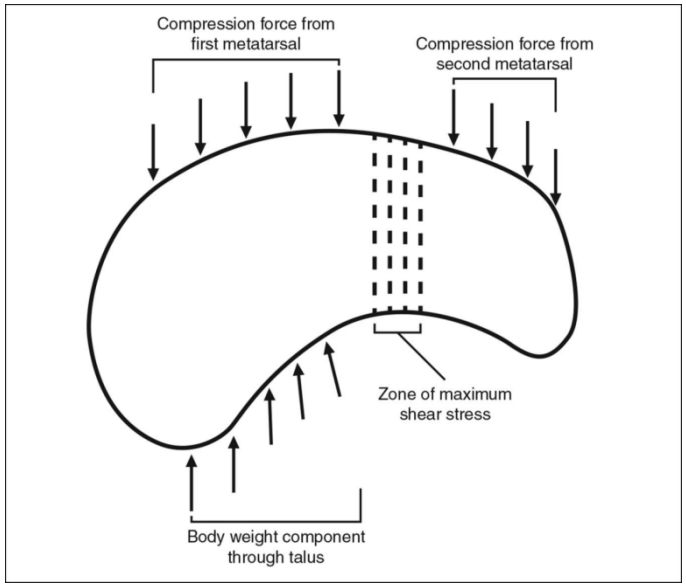
GOAL IS A STABLE, PLANTIGRADE FOOT

Navicular fractures

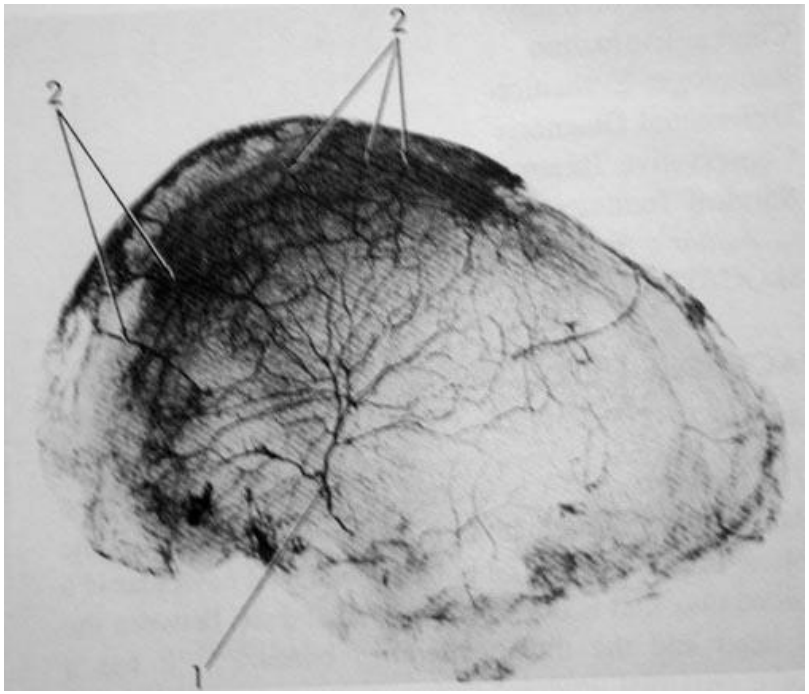
- Avulsion (tuberosity)
- Stress
- Body

Navicular Fractures

- Blood supply: because of the large articular surfaces, vessels can only enter dorsally, plantarly, and thru tuberosity
- Medial and lateral thirds have good blood supply
- Central third is largely avascular
- # of vessels decreases with age



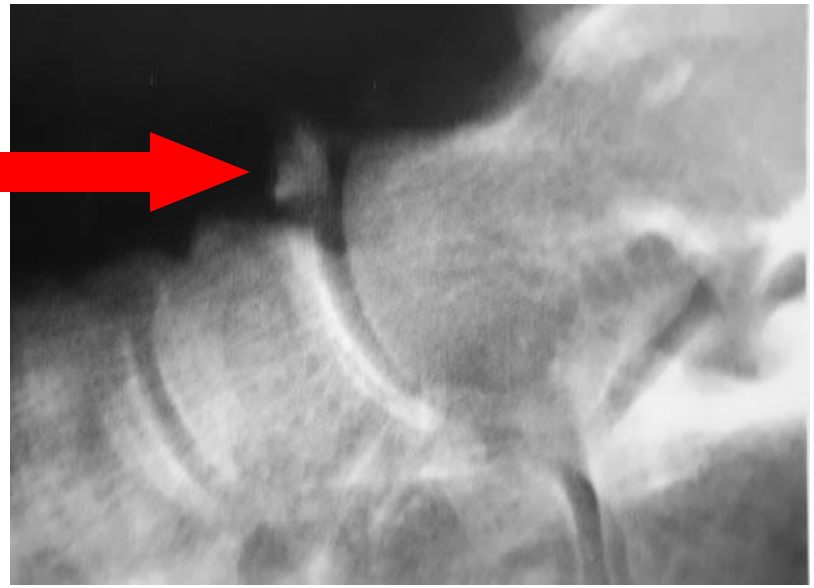
MAJ Uma E. Ramadorai, DO, et al J Am Acad Orthop Surg 2016



Sarrafian SK. Anatomy of the foot and ankle. 2nd edition

Navicular Fractures

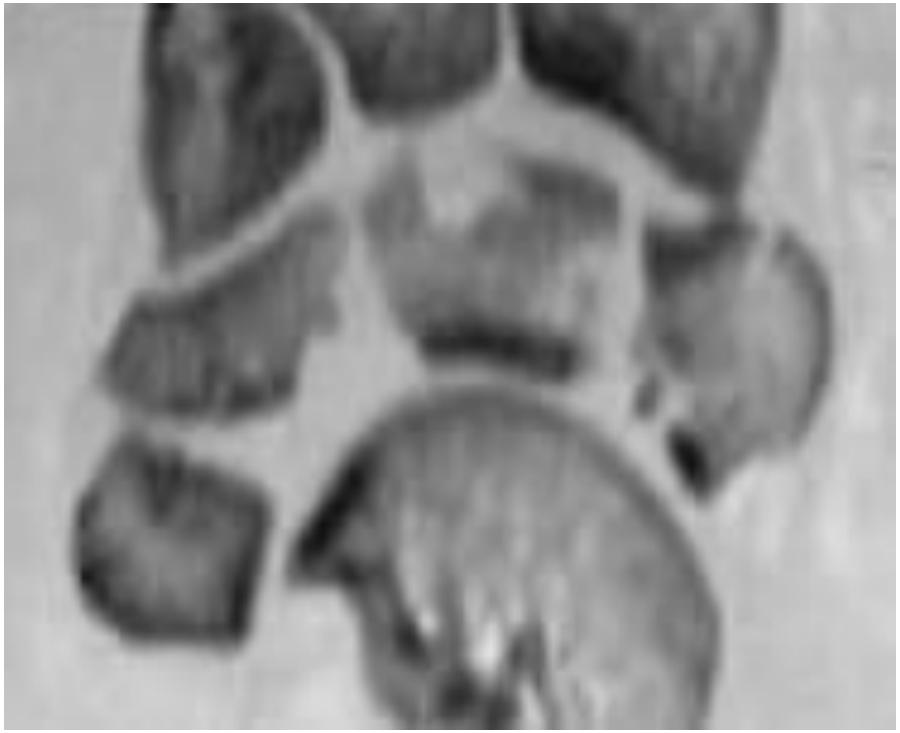
- Avulsion fractures: usually dorsal lip (essentially severe sprain)
- Treatment:
  - Immobilization & progressive weight bearing
  - Excision of fragment only if painful

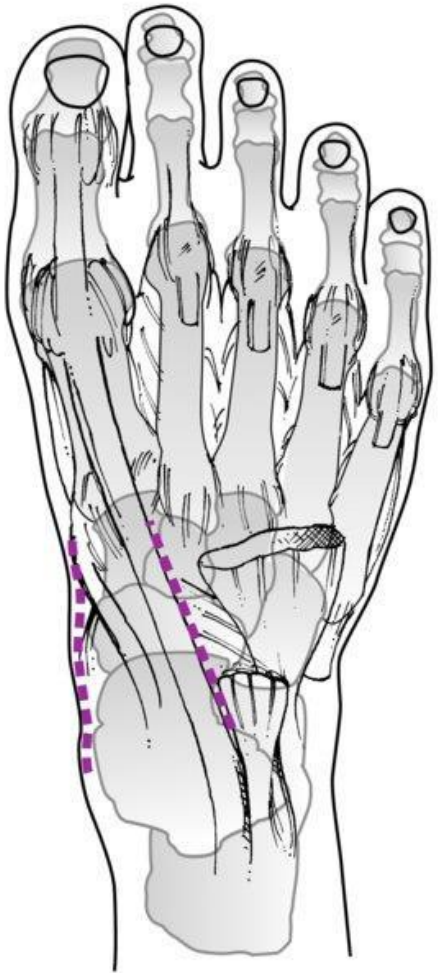


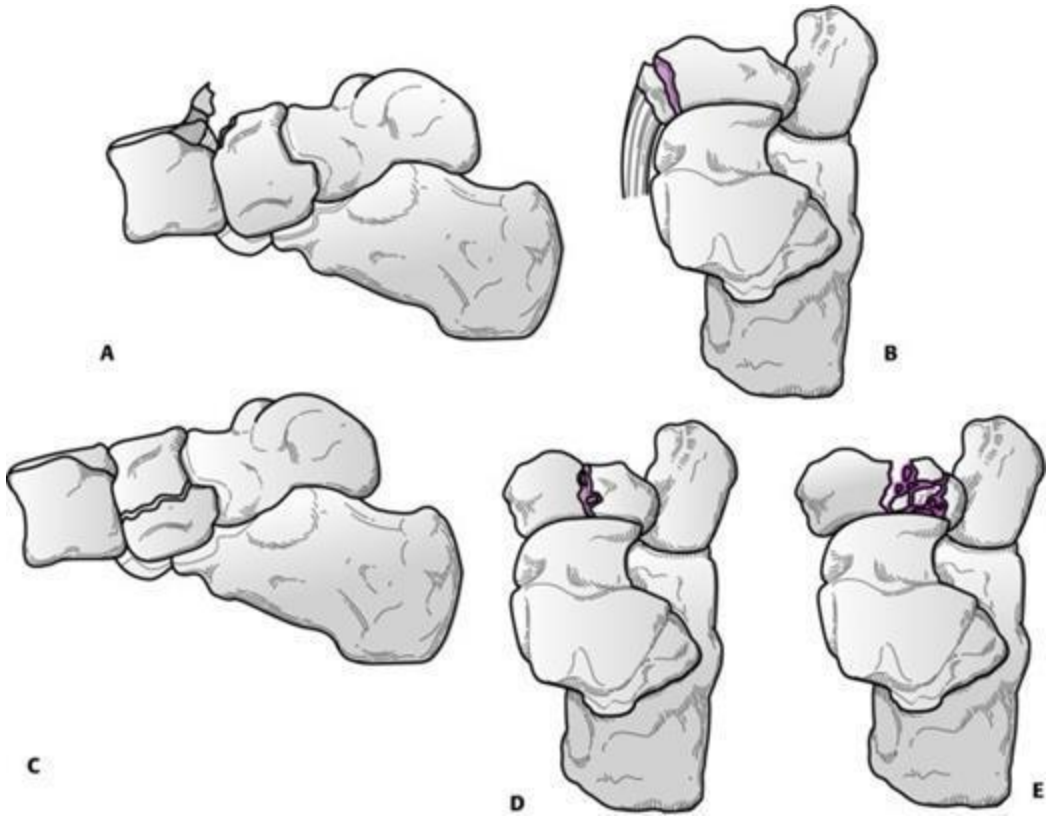
Navicular fractures

- Surgical approach chosen based on fracture pattern
- Dorsal medial, dorsal lateral, or both
- Minimize stripping to avoid avascular necrosis (AVN)

CT scan—mandatory



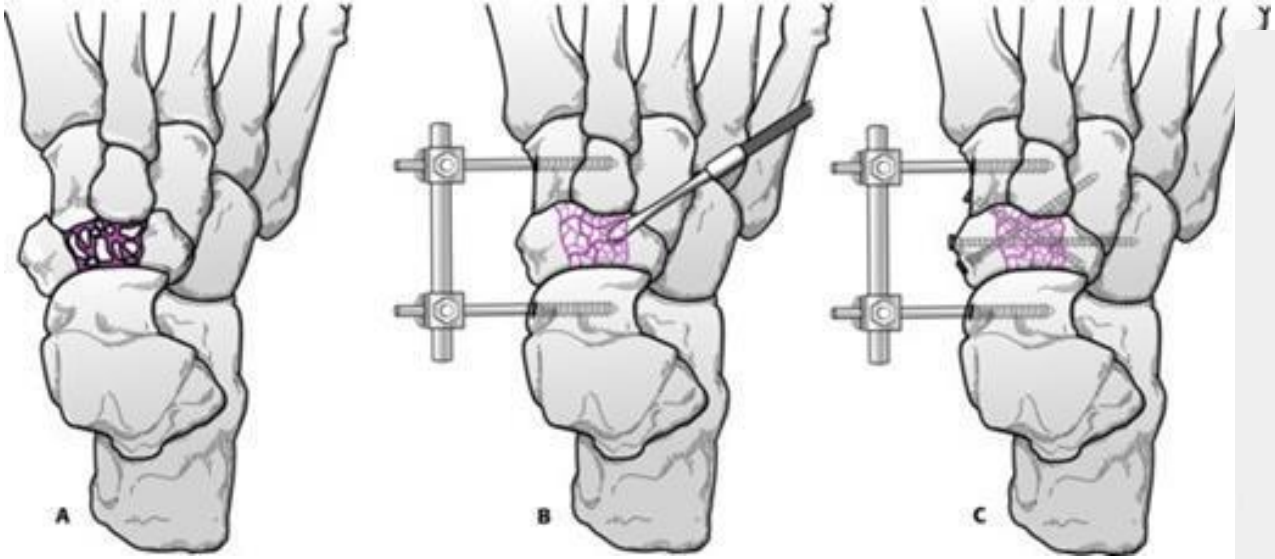


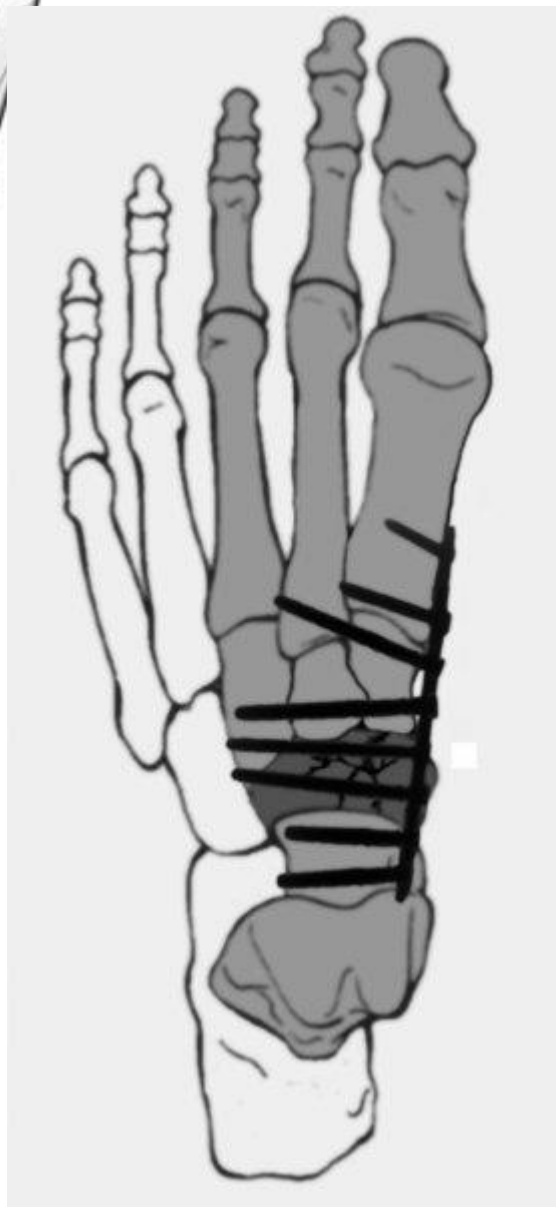

A
B
C
D
E

ORIF of the tuberosity of the navicular

ORIF of a body fracture of the navicular

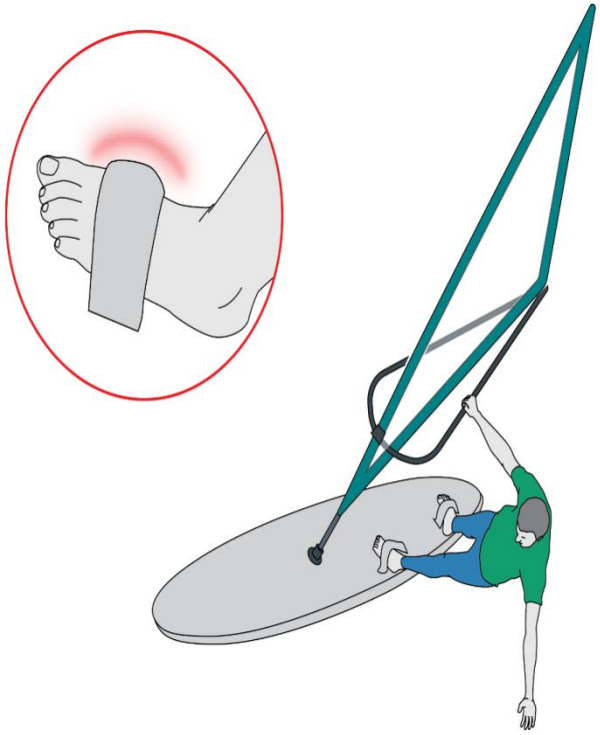
ORIF of the body fracture using cuneiforms

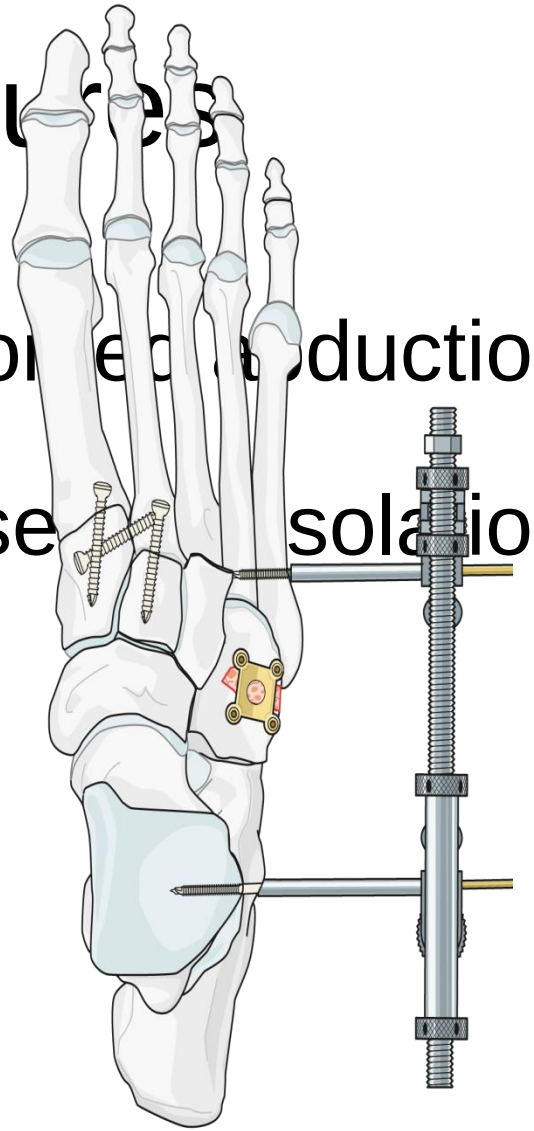

A
B
C

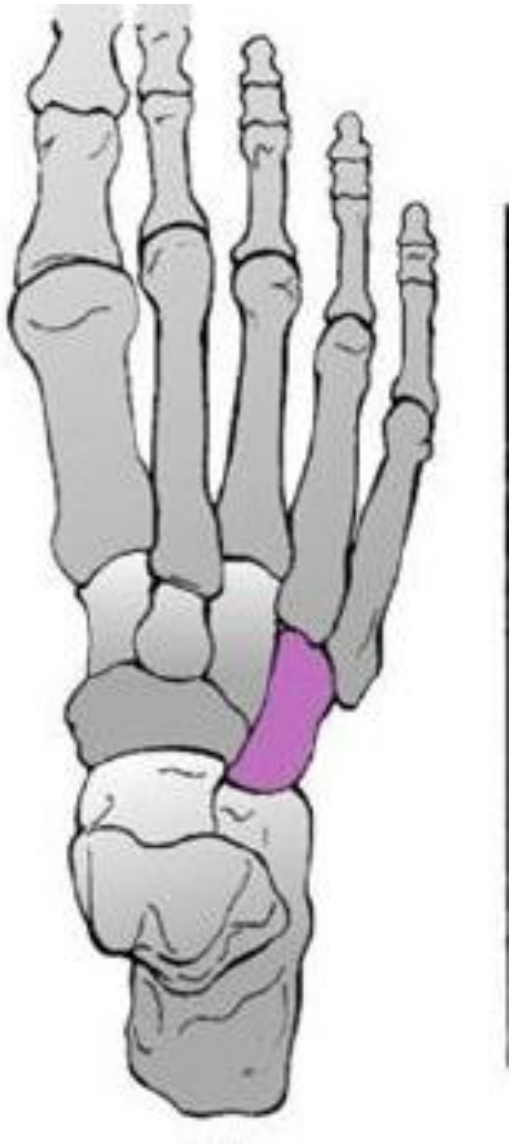


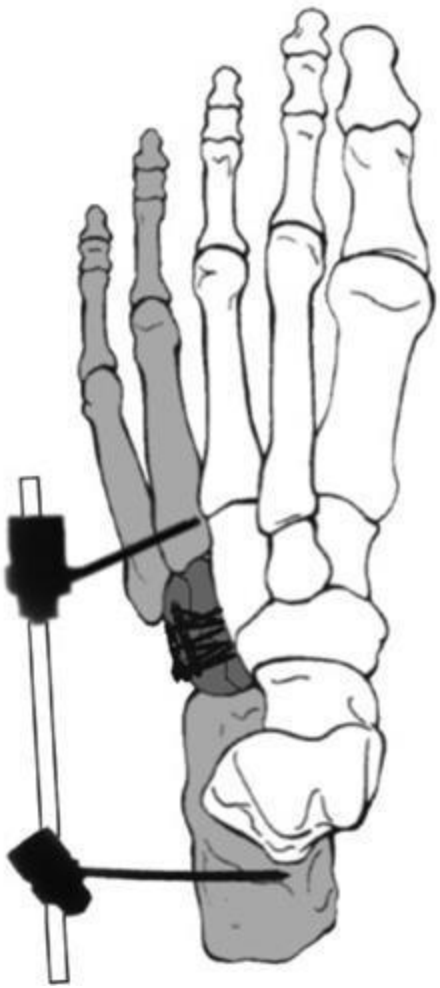
Cuboid fractures

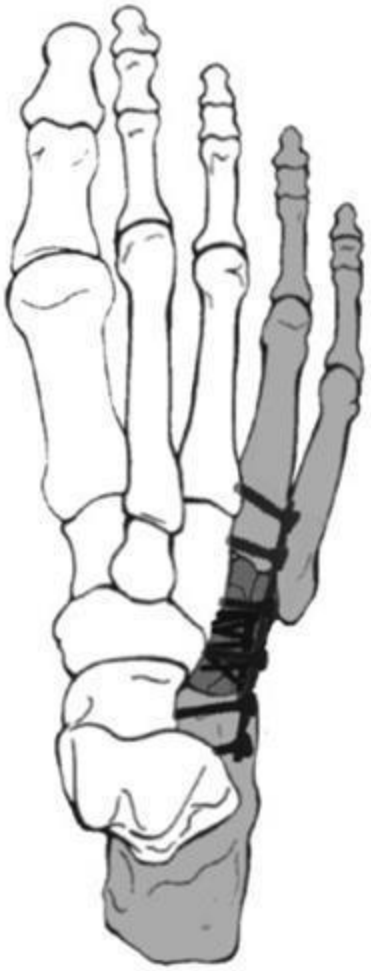
- Forefoot abduction
- Rarely seen in isolation



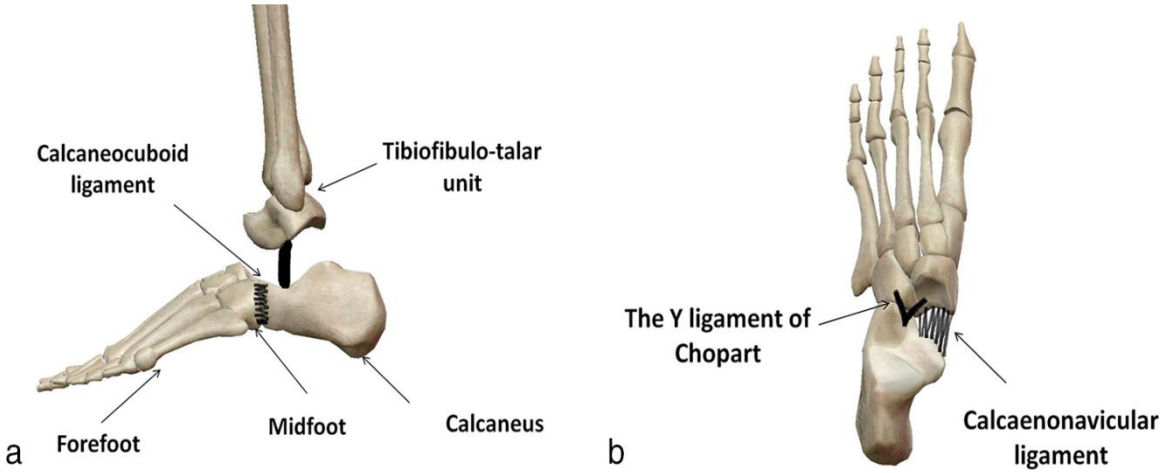


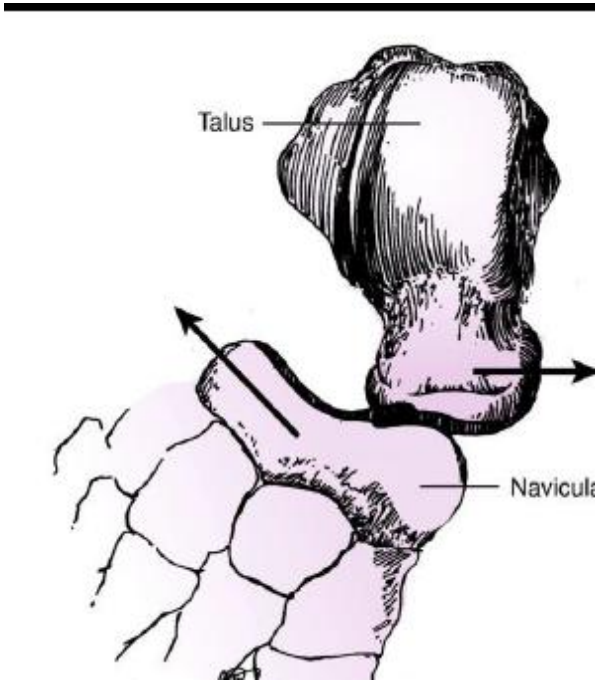






Swivel dislocation





Ghanem I.,et al Journal of Children's Orthopaedics 2019 13:2, 134-146

INJURIES OF THE MIDTARSAL JOINT

B. J. MAIN and R. L. JOWETT, LONDON, ENGLAND

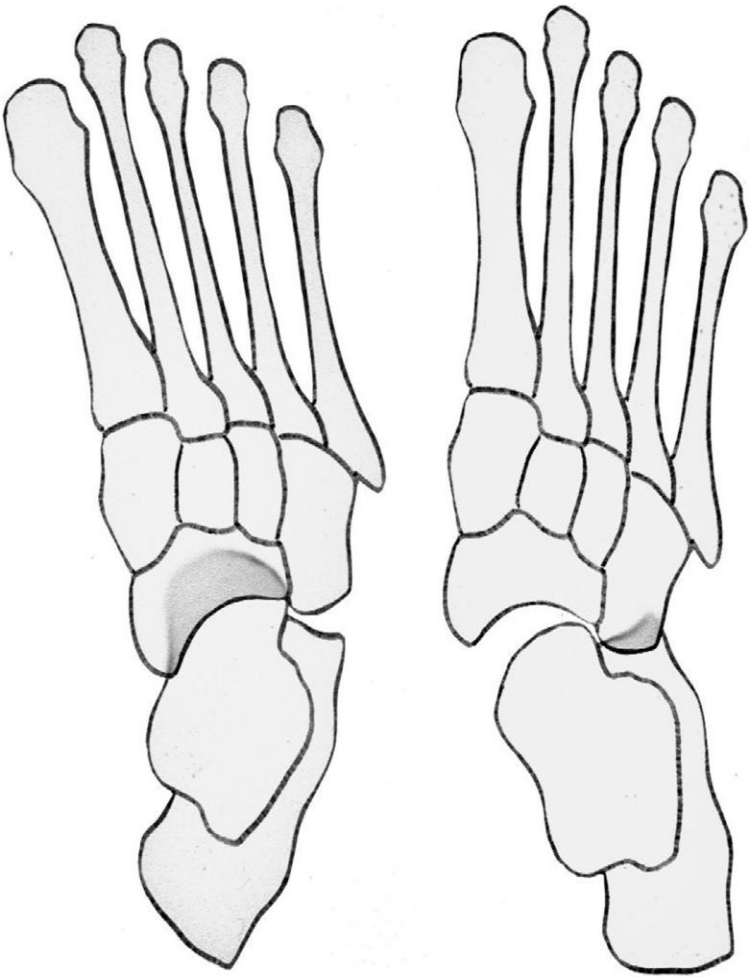
From the Royal National Orthopaedic Hospital, London

Injuries involving the midtarsal joint, which are frequently misdiagnosed, have been studied to clarify the mechanism, classification and treatment. The necessity for routine antero-posterior, lateral and oblique radiographs is emphasised. Seventy-one injuries have been classified according to the direction of the deforming force: medial, longitudinal compression, lateral, plantar and crush types are described. Included in the medial and lateral types is a hitherto undescribed tarsal rotation or "swivel" injury. The mechanism whereby longitudinal compression causes fractures of the body of the navicular is described, and two varieties having different prognoses are defined: one due to purely longitudinal compression and the other due to longitudinal compression with a medial component.

VOL. 57-B, No. 1, FEBRUARY 1975

the generic classification of Main and Jowett2
with respect to the supposed
mechanism of injury

ASSESSMENT



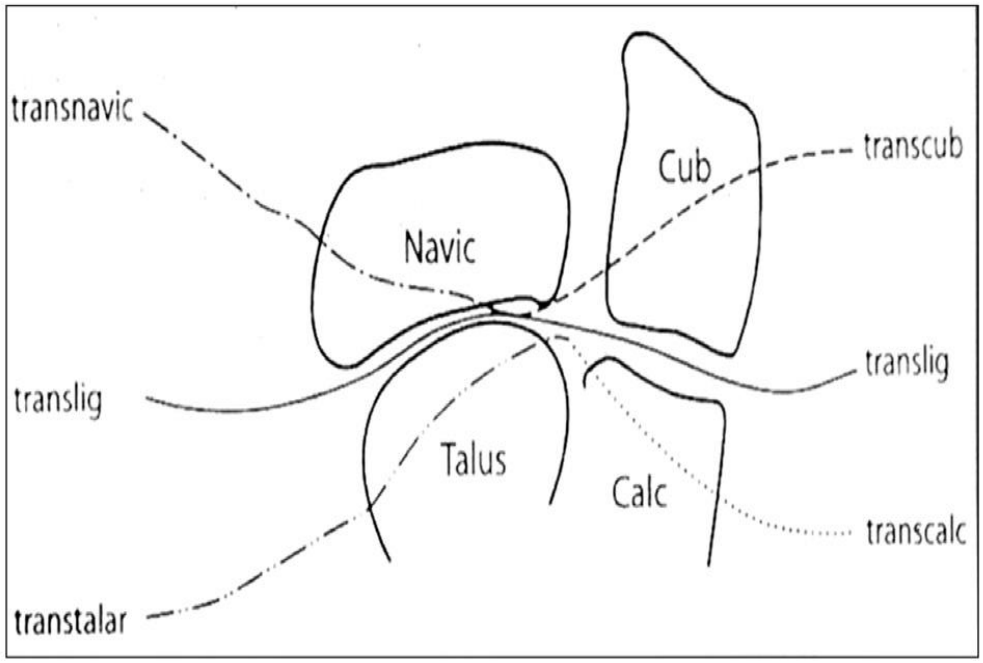
Rammelt S, et al

Zwipp classification

35

1

14



Rammelt S, et al

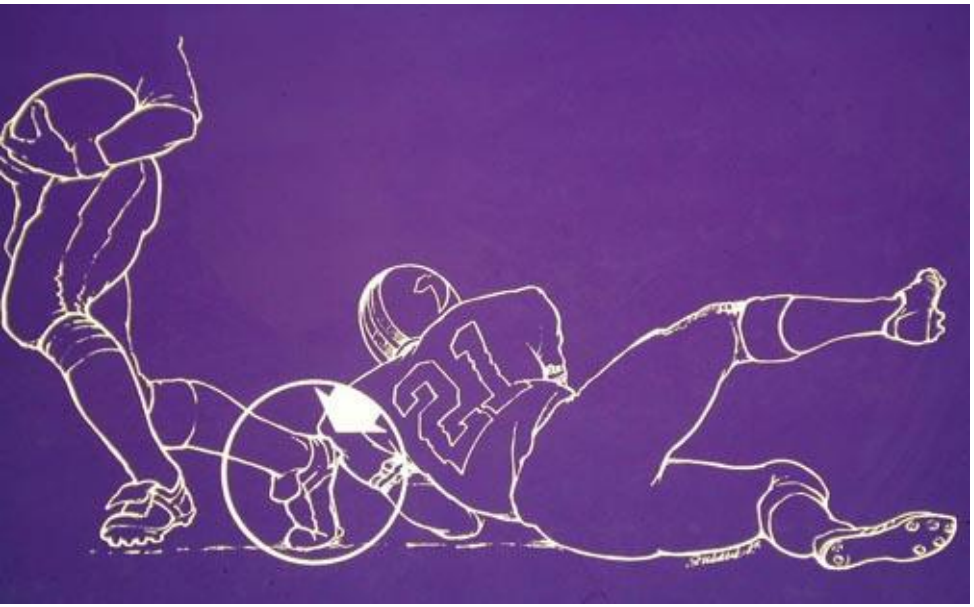
Almost 50% had injuries of 2 or more bones at the Chopart joint

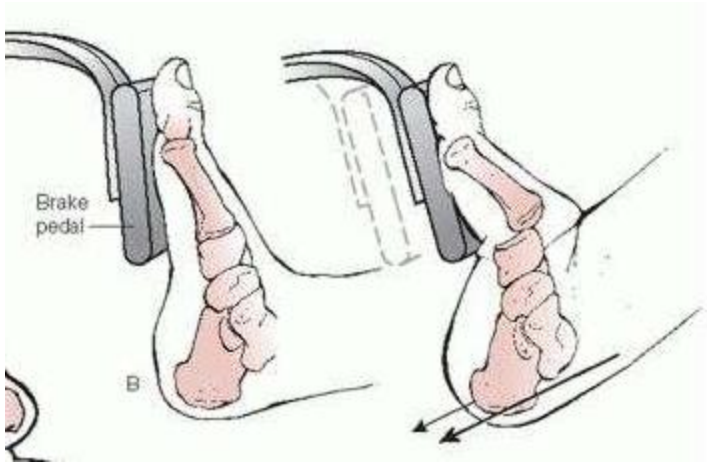

a
b

LISFRANC INJURIES

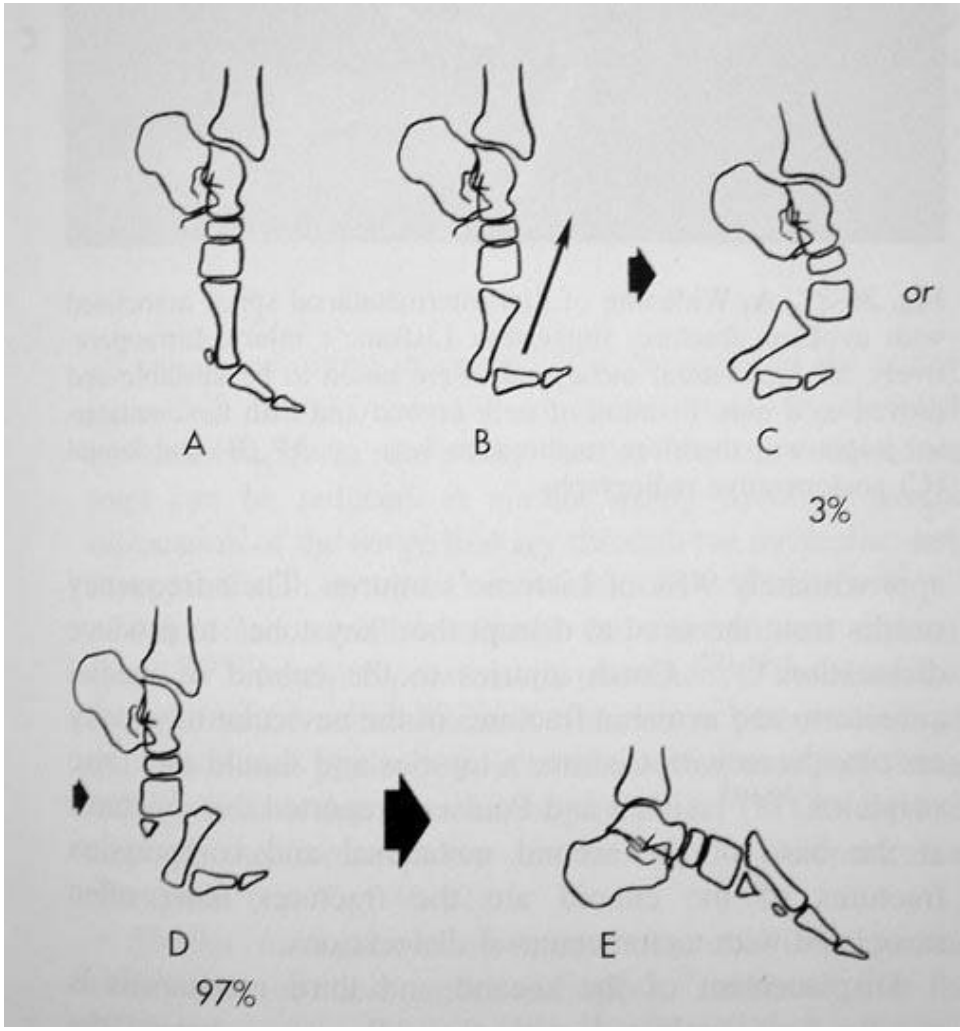
Lisfranc injuries: mechanism of injury—indirect

- Forced abduction[illegible]oot
  - Second metatarsal (MT) bas[illegible]–
  - Compress[illegible]–
- Axial load to plantar[illegible]oot
  - Mostly dorsal displacement of[illegible]–
- [illegible]ed




Brake
pedal
B

- Indirect Mechanism of Injury
  - **Loading of plantarflexed foot**
    - Failure of weak dorsal ligaments
  - Most common mechanism
    - sports injuries
    - Football/Rugby
      - Tackled from behind



Mechanism of injury—direct (crush)

- Dorsum of foot:
  - Often multiple MT fractures
  - Plantar or dorsal displacement of MT bases
- Associated with:
  - Soft-tissue injury (open)
  - Vascular compromise (eg, compartment syndrome)

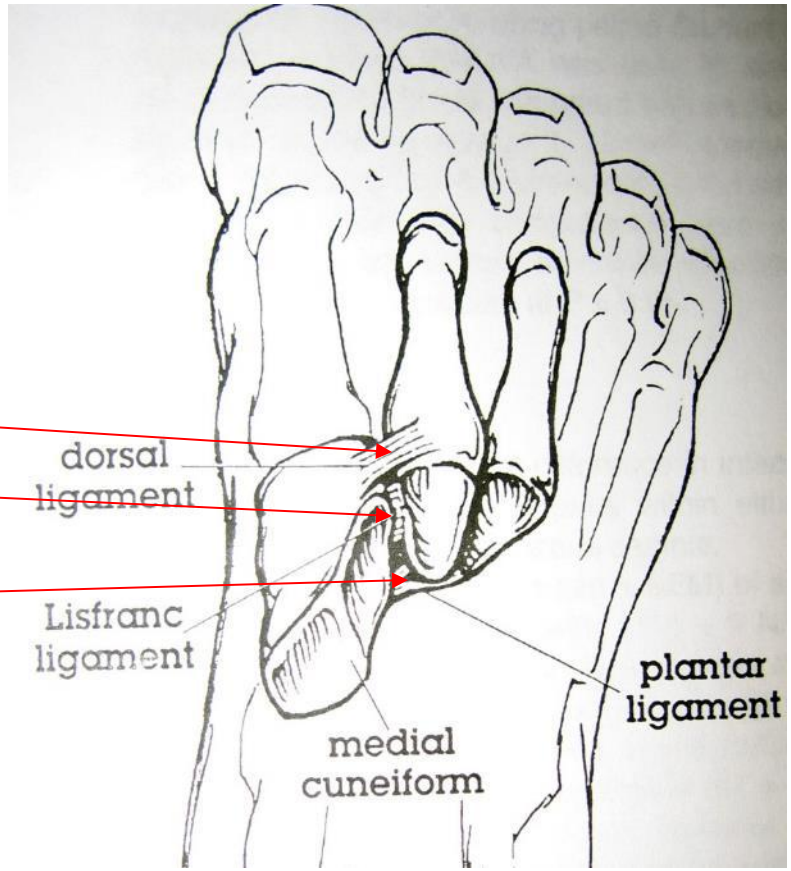
Mechanism of injury—direct (crush)

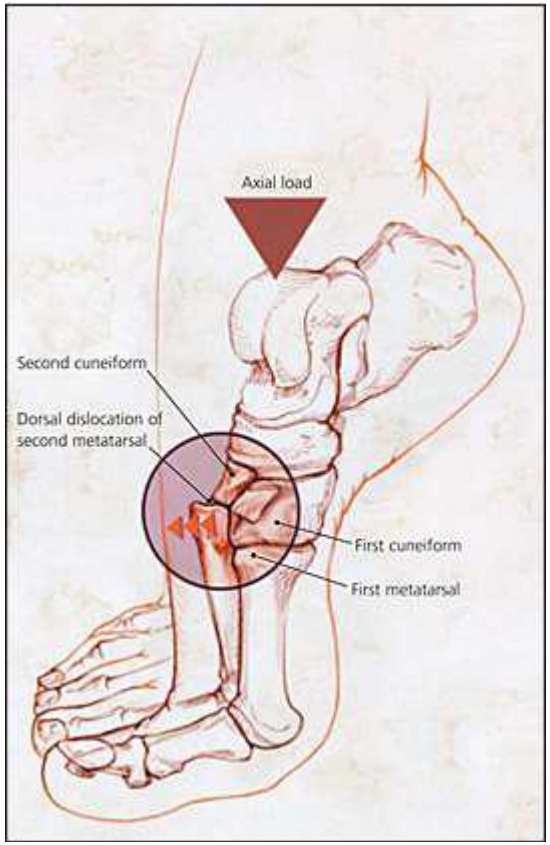
Ligamentous Anatomy

- **Medial cuneiform – 2nd metatarsal ligament complex**

  (Solan et al. Foot Ankle Int 2001: 22(8) and de Palma et al. Foot Ankle Int 1997: 18(6))

  - Dorsal ligament
  - Interosseous (Lisfranc ligament)
  - Plantar ligament (inserts into 2nd and 3rd metatarsal bases)

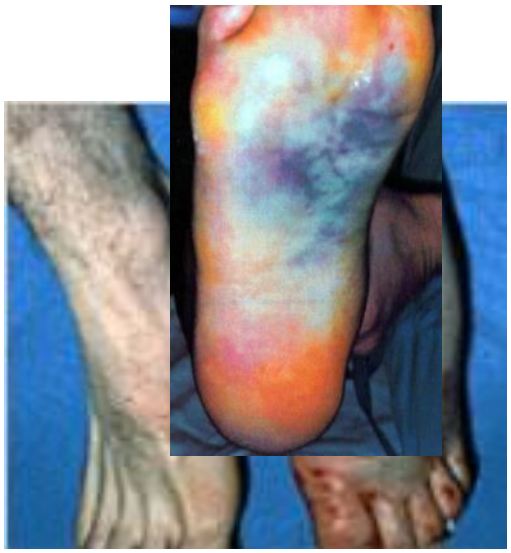



Axial load
Second cuneiform
Dorsal dislocation of second metatarsal
First cuneiform
First metatarsal

Diagnosis

- Direct Mechanism of Injury
  - Loading or crushing of dorsum of foot

  - Significant soft tissue injury
    - Compartment syndrome



  - Open injuries

Diagnosis

- Clinical Evaluation
  - Plantar midfoot ecchymosis
  - Gap between 1st and 2nd phalanges
  - Tarsometatarsal tenderness
  - Pain at TMT joint 2°
    - PROM metatarsal heads
    - Weightbearing
    - Single limb rise

Diagnosis

- Marked tenderness
- Intense pain
- Excessive swelling
- Plantar bruise

Beware!

- Risk of foot compartment syndrome
- Consider decompression and timing of surgery

X-ray evaluation

- Up to 40% overlooked initially
- Oblique (30º internal): TMT 3, 4, 5

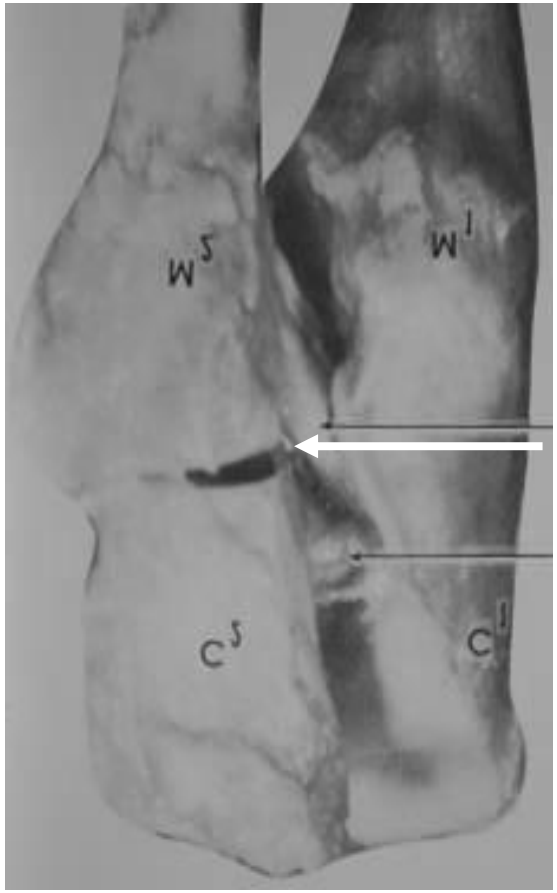
Medial and lateral border MT3 to Cun3 –

Medial border MT4 to cuboid –

X-ray evaluation

- Up to 40% overlooked initially
- AP: TMT 1, 2
  - Medial and lateral border MT1 to Cun1 –
  - Medial and lateral border MT2 to Cun2 (“fleck sign”) –

X-ray evaluation



Lateral with dorsal displacement

X-ray evalu

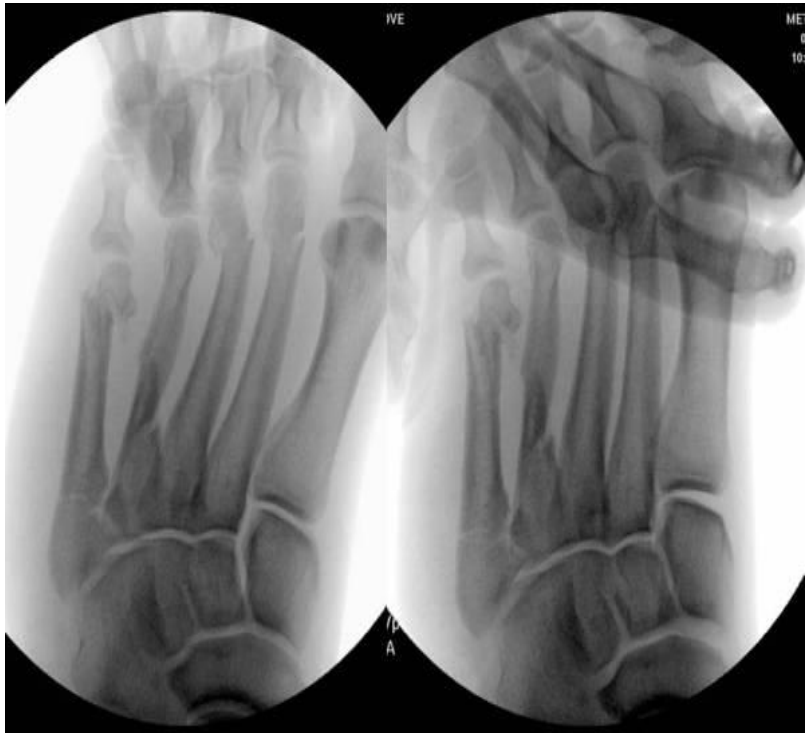
- Lateral: uninterrupted line of the dorsal MT base to tarsal bones

AP: MT alignm

X-ray evaluation

Obvio

Stress



Radiographs - WB

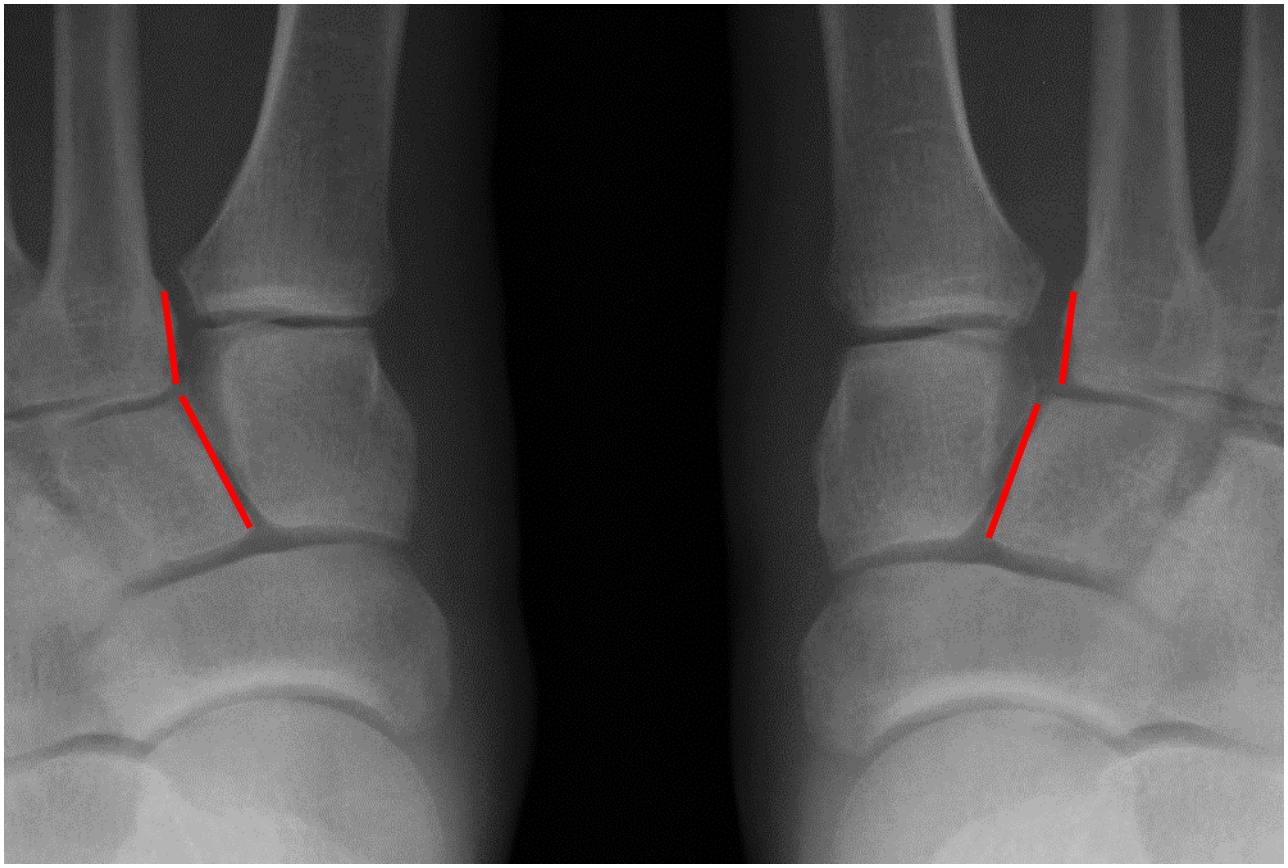
- AP view – 15° cephalad tilt
  (Stein RE. Foot Ankle, 1983)
- **MUST BE WEIGHTBEARING**
- Middle Column
  - Medial border 2nd metatarsal
  - Medial border middle cuneiform
  - IM space between 1st and 2nd metatarsals is equal to space between the medial and middle cuneiforms

Radiographic Evaluation - WB

- 30^{o} oblique view (Stein RE. Foot Ankle 1983)
  - Lateral border 3rd metatarsal continuous with lateral border lateral cuneiform
  - Medial border 4th metatarsal continuous with medial border cuboid
  - IM space b/w 2nd and 3rd metatarsals equal to space b/w middle and lateral cuneiforms

Radiographic Findings

- Subtle – WEIGHTBEARING IS CRITICAL!



Radiographic Findings

- Fleck Sign

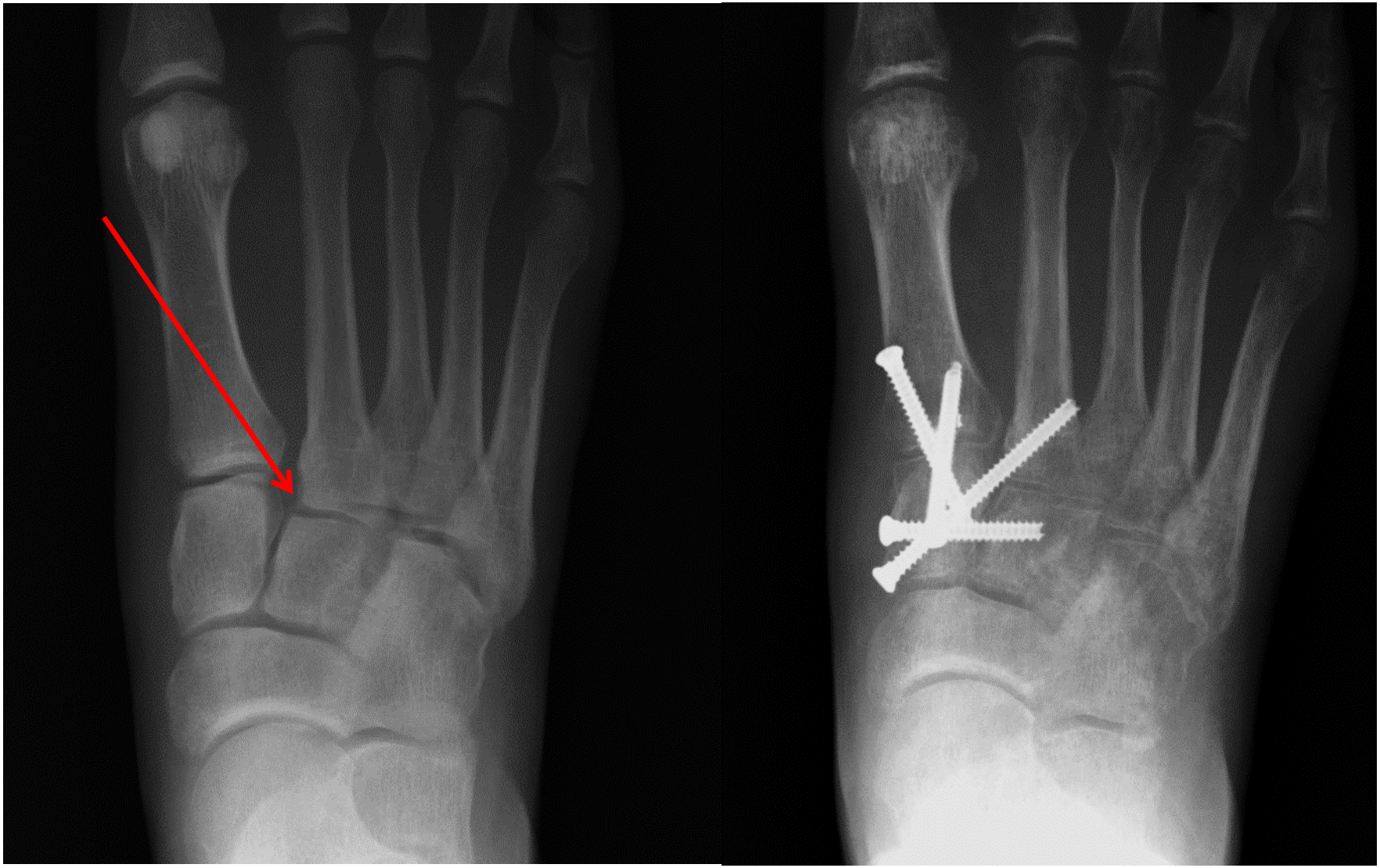
Radiographic Findings

- Fracture/Dislocation

Radiographic Findings

- Complete Dislocation

ORIF = Treatment of Choice?



Limitations of plain x-rays

- May not reveal
  - Articular surface involvement –
  - Subluxation (1 mm) –
- Pain may preclude weight bearing and/or stress views

CT evaluation is essential

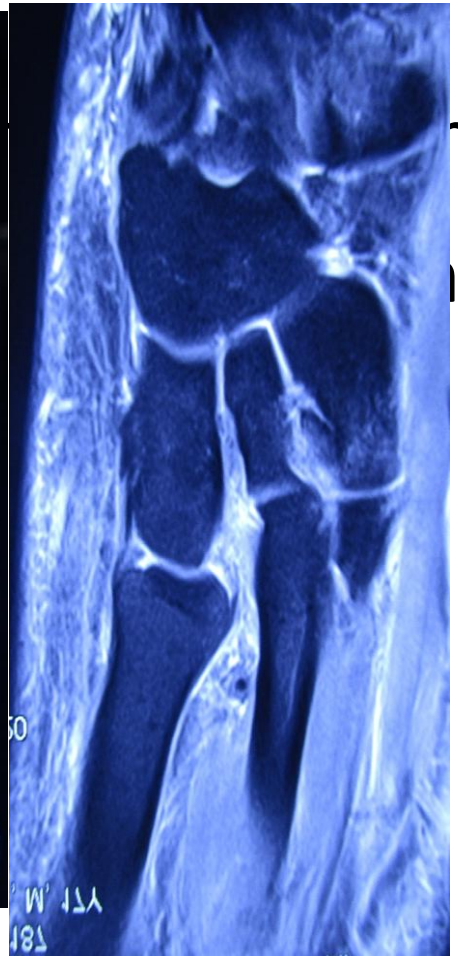
- Axial
- 2-D and 3-D reconstructions:

Avulsions –

p nt –

o es –

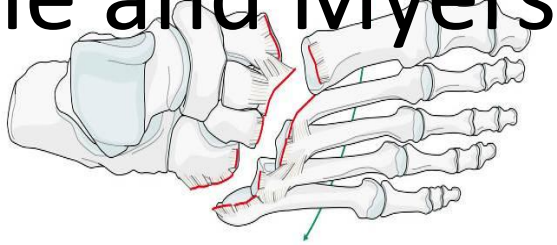
MRI evaluation

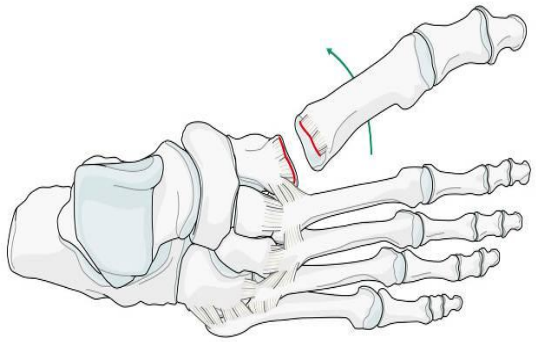


- nt
- ne

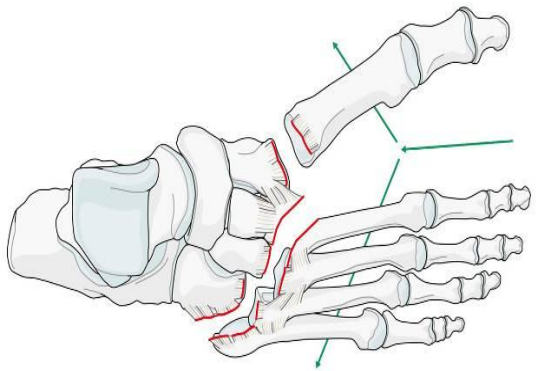
Classification—Queno and Kuss (modified by Hardcastle and Myerson)

- A: Total incongruity
- B: Partial incongruity
- C: Divergent

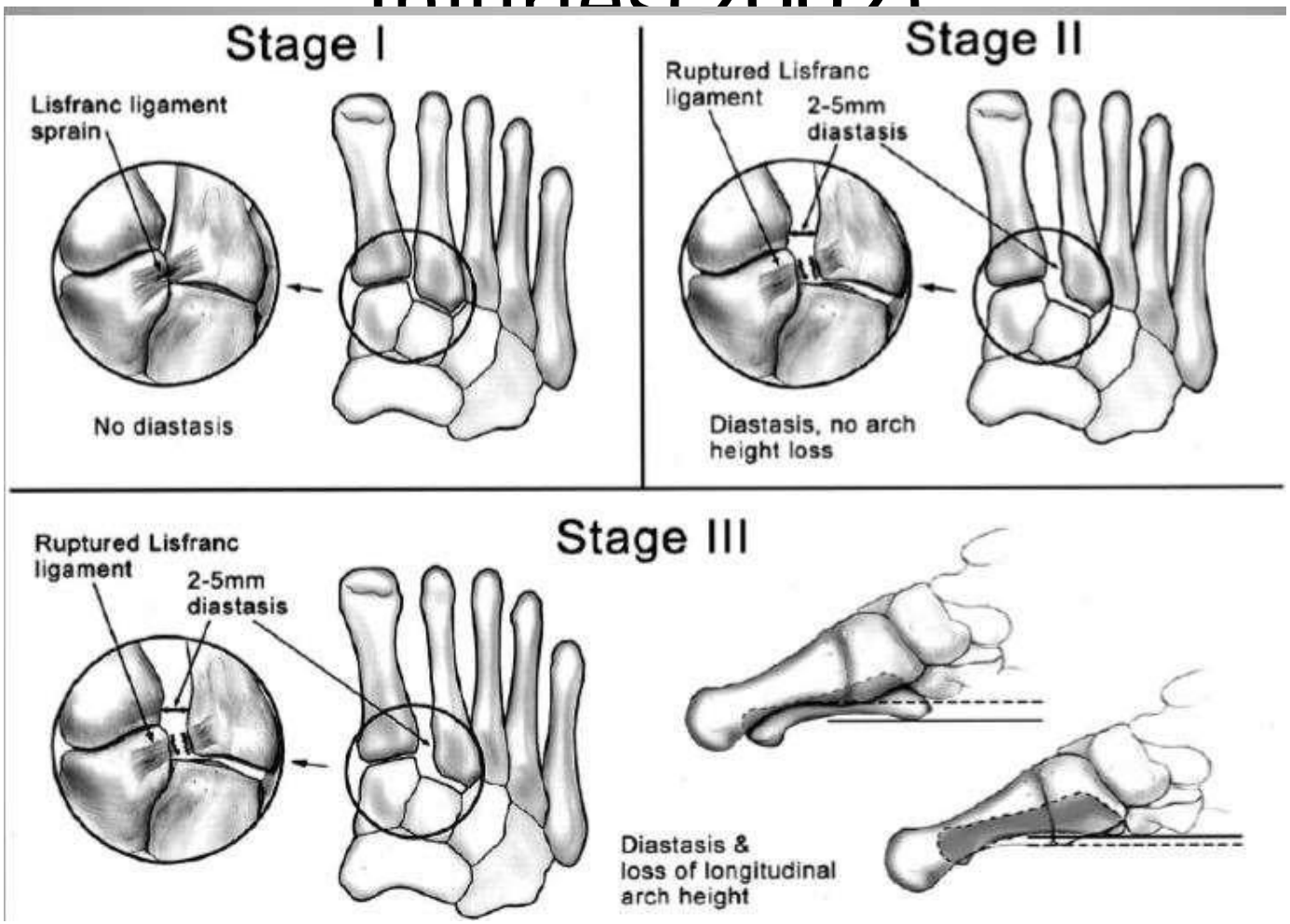




- Not useful for prognosis
- Does not direct treatment
- Descriptive classification



Nunley and Vertullo Athletic Injuries(2002)



3-stage diagnostic classification.

Stage I - A tear of dorsal ligaments and sparing of the Lisfranc ligament

Stage II - Direct injury to the Lisfranc ligament with elongation or rupture(Radiographic diastasis of 1 to 5 mm greater than the contralateral foot)

Stage III - A progression of the above, with damage to the plantar TMT ligaments and joints, along with potential fracture

Injury directs treatment

- Nonmobile joints: medial column
  - Stability for weight bearing –
  - Stable fixation +/- bridging is acceptable –
- Mobile joints: lateral column
  - 4th and 5th tarsometatarsal joints –
  - Maintain (restore) mobility –

Nonoperative treatment

- Undisplaced/stable injuries: 6–8 weeks nonweight bearing
- Expect prolonged recovery: 6–12 months

Timing of surgery

- solves
- inkles
- ability

Initial Management

Closed reduction Minimize risk of skin compromise

Provisional Fixation Indications: Inability to maintain reduction

High energy patterns

Multiply injured patient

Ex-Fix

Percutaneous screws or wires

High-energy injuries

- Temporary fixation with spanning external
  xator

Small spanning external fixator

- Medial—talar neck t arsal

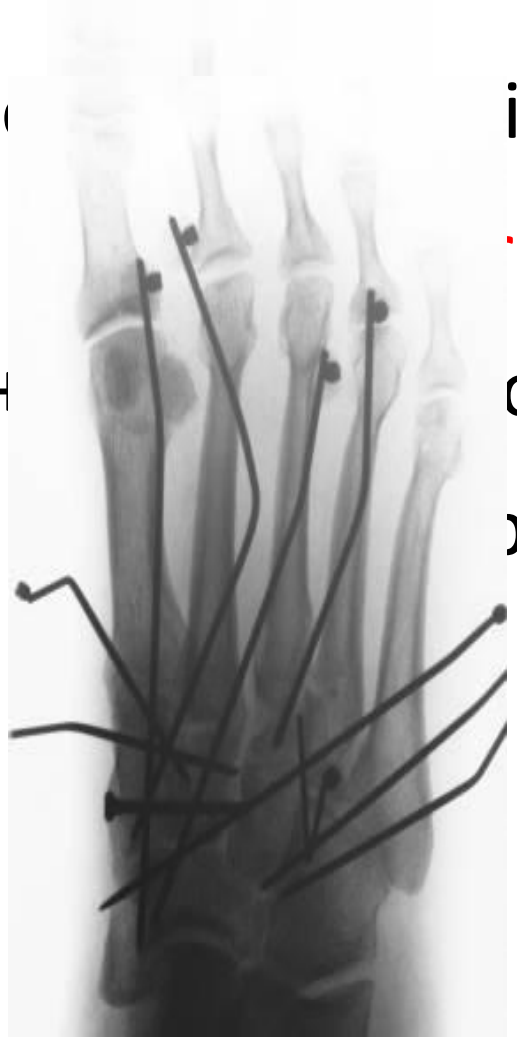
Small spanning external fixator

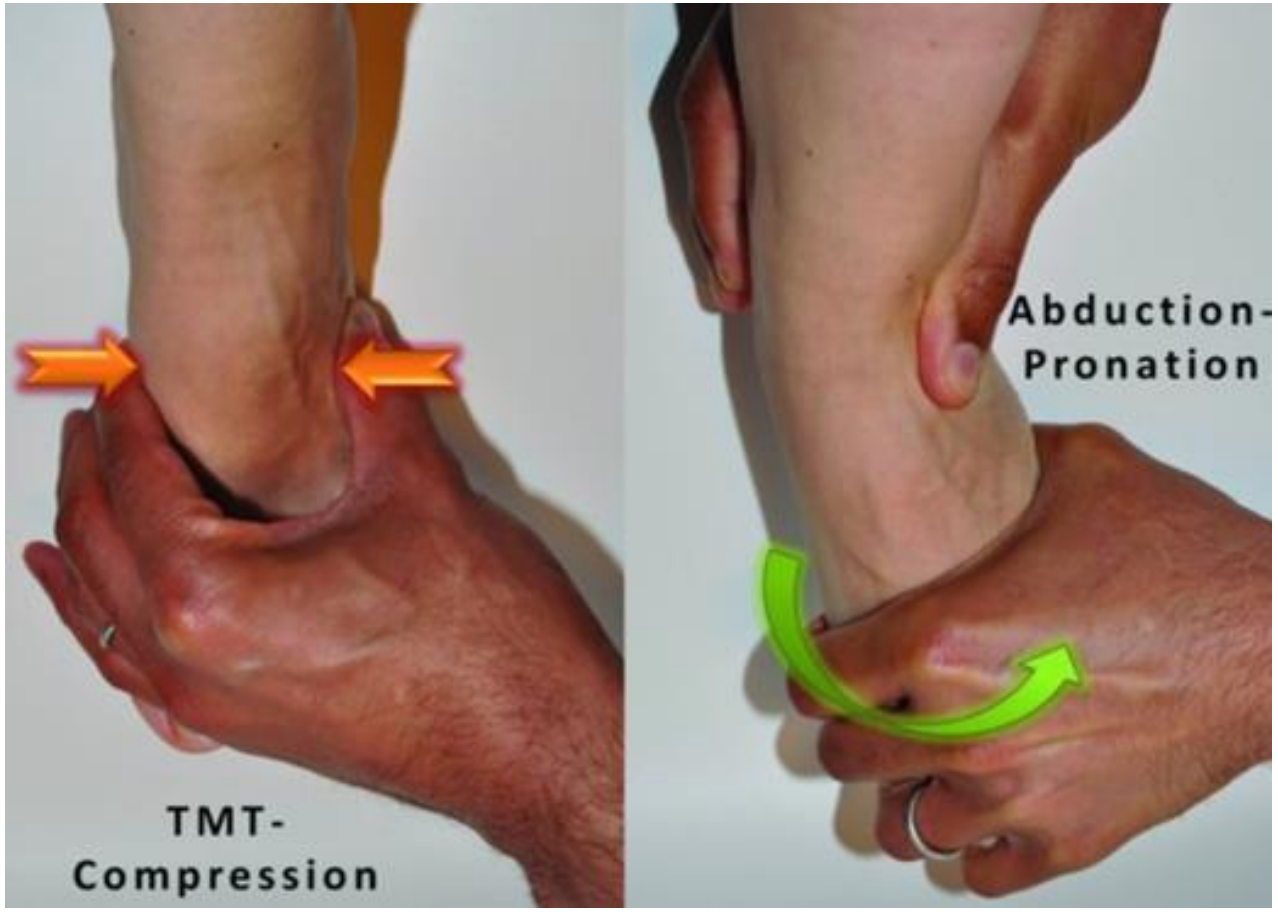
Lateral—calcaneus to 5th metatarsophalangeal joint

Treating Lisfranc injuries

Anatomical and stabl ired:

- Increased fai es
- Multiple screw (- on
- Screw ble




TMT-
Compression
Abduction-
Pronation

A: Normal. B: Pathologic. *1, medial column line; 2, widening of the first TMT joint space; 3, subluxation by lateral translation of the base of the first metatarsal. The white circle identifies the "positive medial column sign."*

Technical tips—setup and approach

- Before tourniquet up:
  - Mark out DP pulse
  - Fluoroscopy, guide pin—mark out incisions
- Dorsal longitudinal incisions
  - Dorsomedial incision: M1C1, M2C2
  - Dorsolateral incision: M3C3, M4-cuboid

Intraoperative technique

Dangers:

- Deep/superficial peroneal nerves
- Extensor hallux longus (EHL)
- Vascular anastomosis:
  - Between 1st and 2nd MTs
  - Dorsalis pedis\plantar arteries

ORIF technique

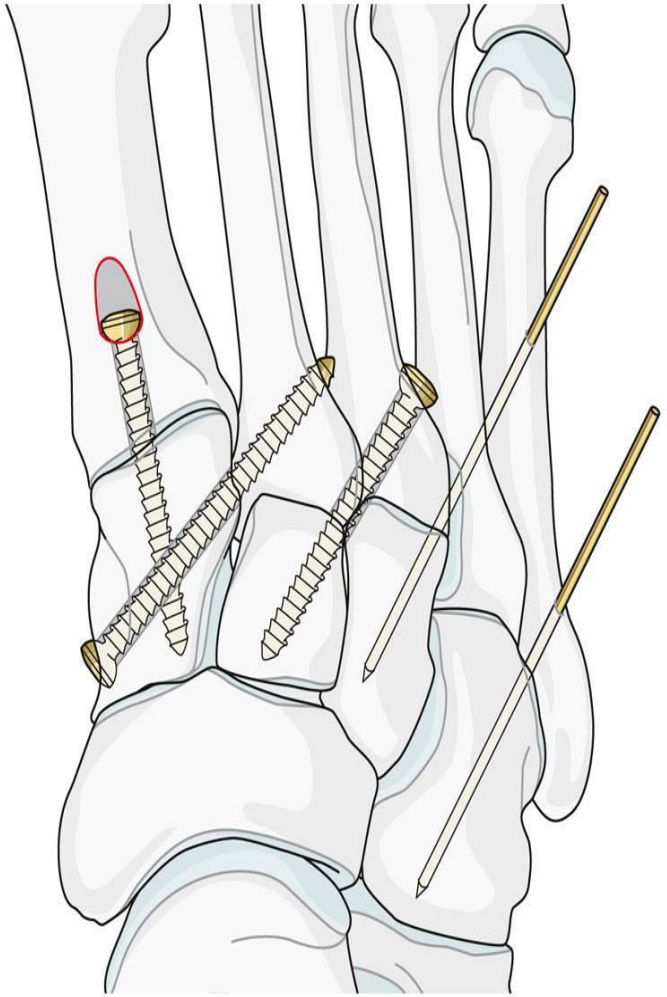
Reduction sequence

- 1st, 2nd MTs, then 3rd, 4th, 5th
- Remove entrapped ligament, small chondral/bony fragments
- Provisional fixation (stiff K-wires)
- Confirm accurate reduction with x-rays (AP, lateral, oblique)

ORIF technique

- 3.5/4.0 cortical screws for the medial column
- K-wires

Useful for 4th/5th – TMT joints

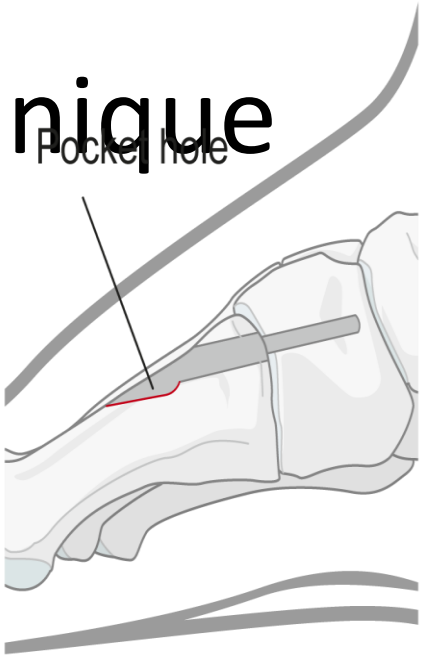


Intraoperative technique

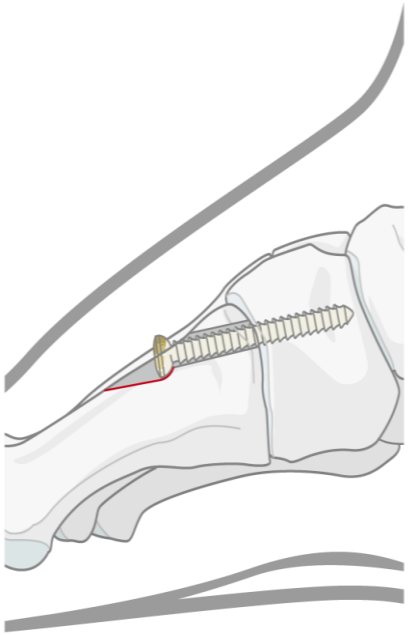
Intraoperative technique

Operative technique

- A “pocket hole” is made along the dorsal base of the first metatarsal



- This allows the screw head to engage the cortex without breaking the dorsal cortex



Intraoperative technique

ORIF examples

ORIF examples

Technical tip

- Use spanning plates for a multifragmentary fracture or

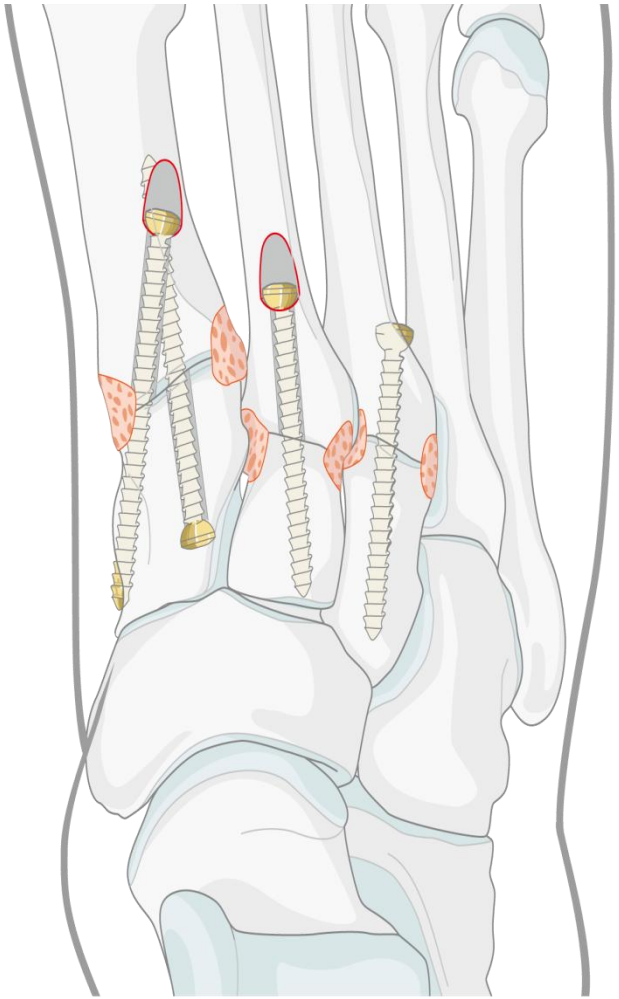
Postoperative t

- Sutures 2 weeks
- Physical therapy (if no K-wires) 4–6 weeks
- Full weight bearing at 6–8 weeks with arch support after K-wire removal
- Hardware removal (?) at 4–6 months

Lisfranc: current controversies

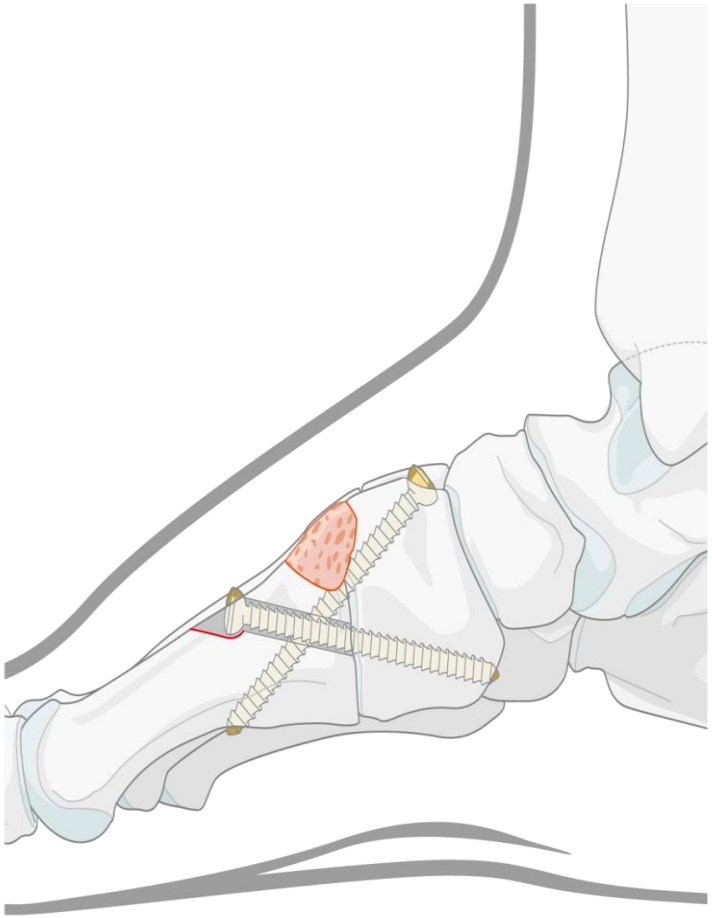
- Emerging trends of bridging plates versus transarticular screws
- Role of primary fusion for purely ligamentous injuries

Pure ligamentous injuries



- No fracture at the base—postinjury arthrosis is more likely
- Immediate primary fusion of the 1st, 2nd, and 3rd TMT is considered by some to be preferred

Pure ligamentous injuries



- Supplementary bone graft should be used if fusion is performed, to facilitate fusion (shear strain relief grafting—"spot weld").

Complications

Early	Late
	Deformity – Malunion – Posttraumatic arthritis
	Skin necrosis
	Vascular compromise
	Compartment syndrome
	Infection
	AVN MTH 2
	Fixation failure
	Residual pain
	Primary amputation
	RSD

Outcomes for acute Lisfranc injuries

- Posttraumatic OA
  - 25–50%
- Factors associated with poor outcome
  - Worker's compensation
  - Delay in diagnosis and treatment, > 6 months
  - High energy
  - Associated ipsilateral limb injury
  - Total displacement
  - Pure ligamentous injury
  - Nonanatomical reduction

Conclusion

- care must be taken to address all bony and ligamentous components of the injury.
- Gross dislocations and fracture-dislocations must be reduced as early as possible
- Surgical treatment aims at

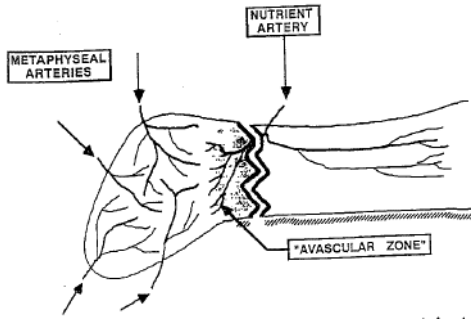
joint reconstruction ,

axial alignment ,

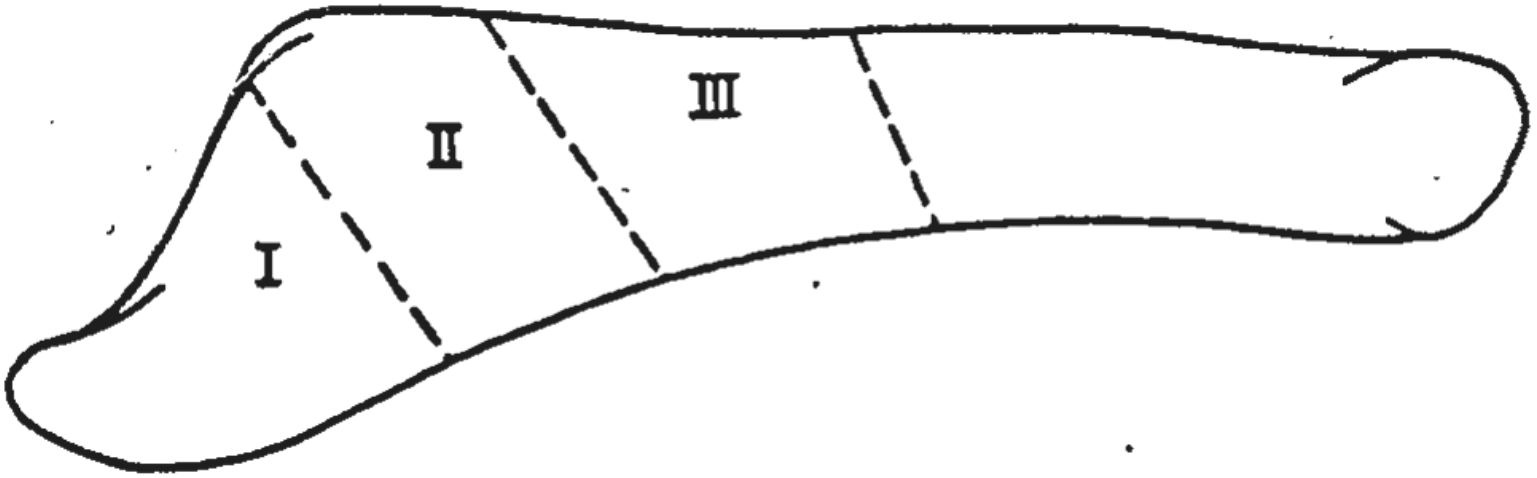
restoration lateral and medial foot columns

5th Metatarsal Fractures

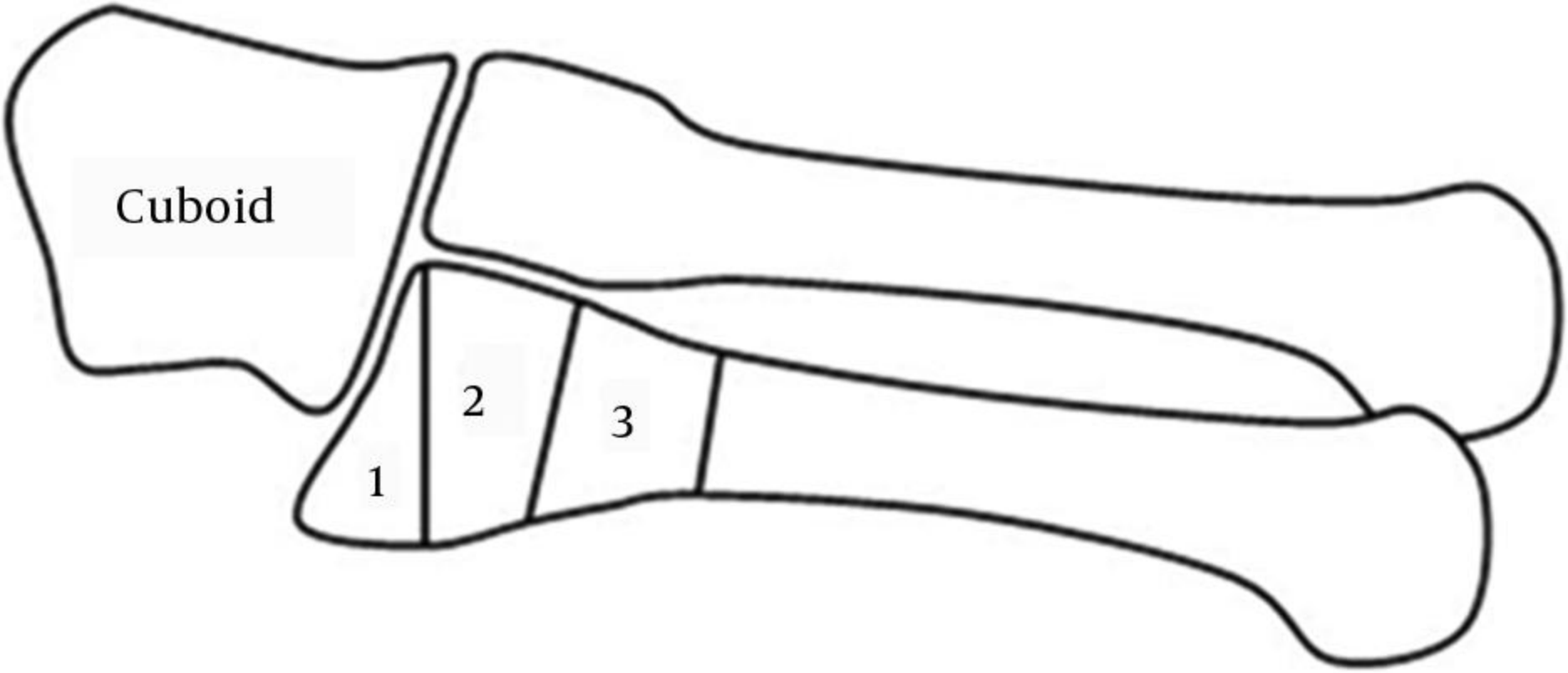
5th Metatarsal Zones



- Zone I Tuberosity avulsion fracture
- Zone II Jones fracture (metaphyseal-diaphyseal junction)
- Zone III Diaphyseal stress fracture

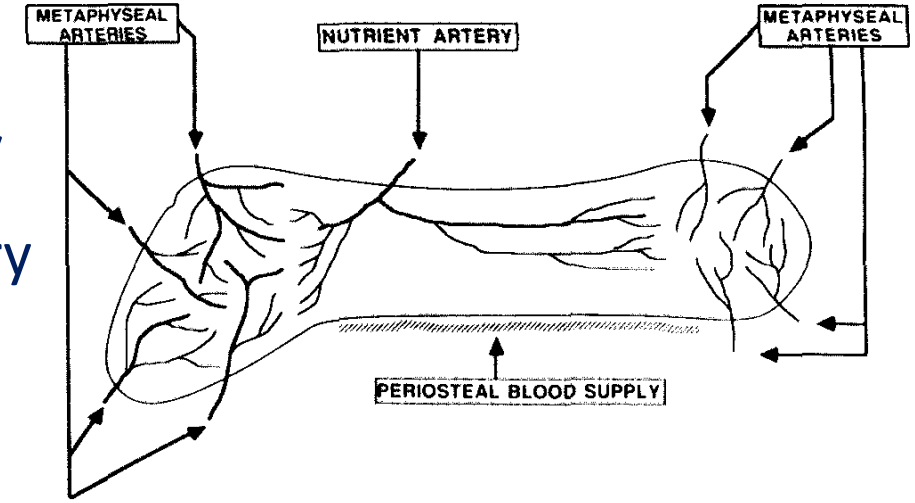


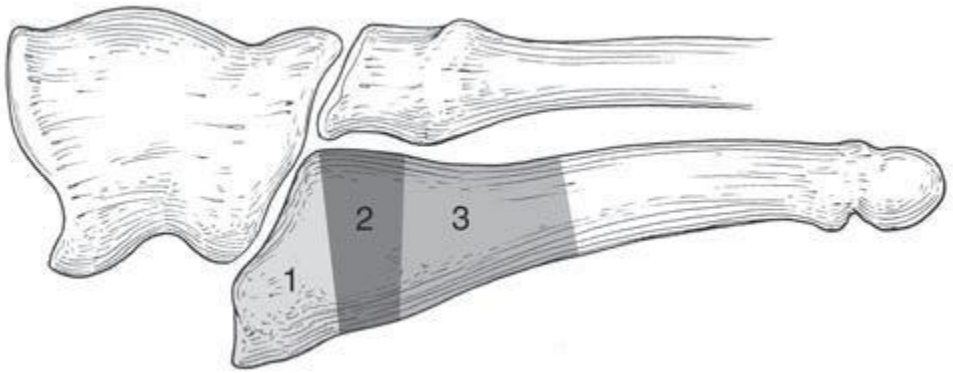
Lawrence and Botte's Classification of Proximal Fifth Metatarsal Fractures (Zone 1, 2 and 3)



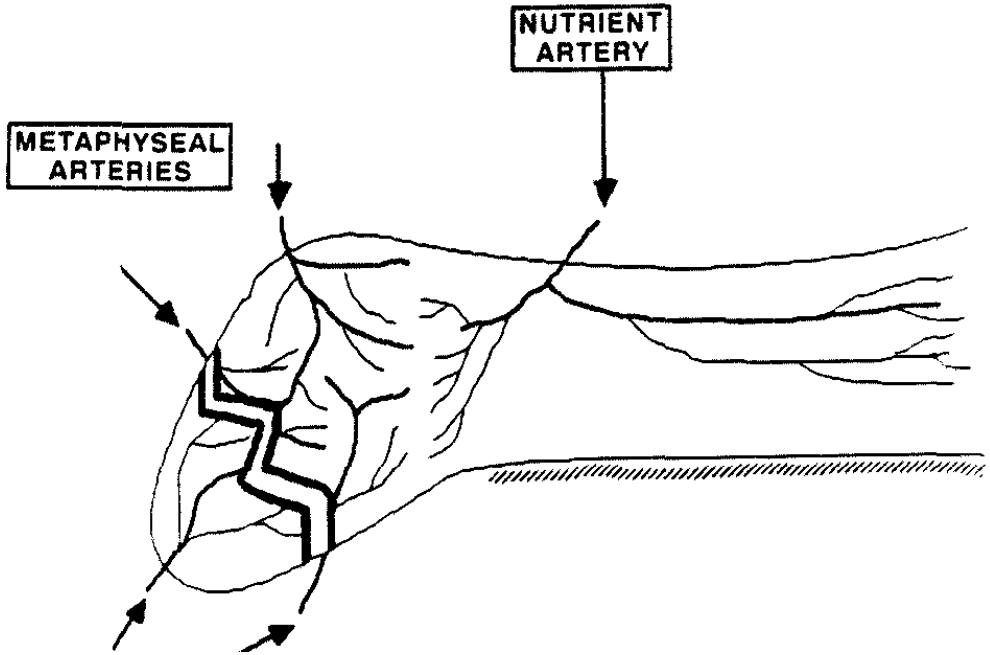
zone 1, tuberosity; zone 2, metaphysealdiaphyseal junction (Jones); and zone 3, diaphyseal stress.

- Vascular Supply
  - Single nutrient artery enters junction prox/middle third
- Watershed at metaphyseal-diaphyseal junction
  - **Lawrence**, 1993





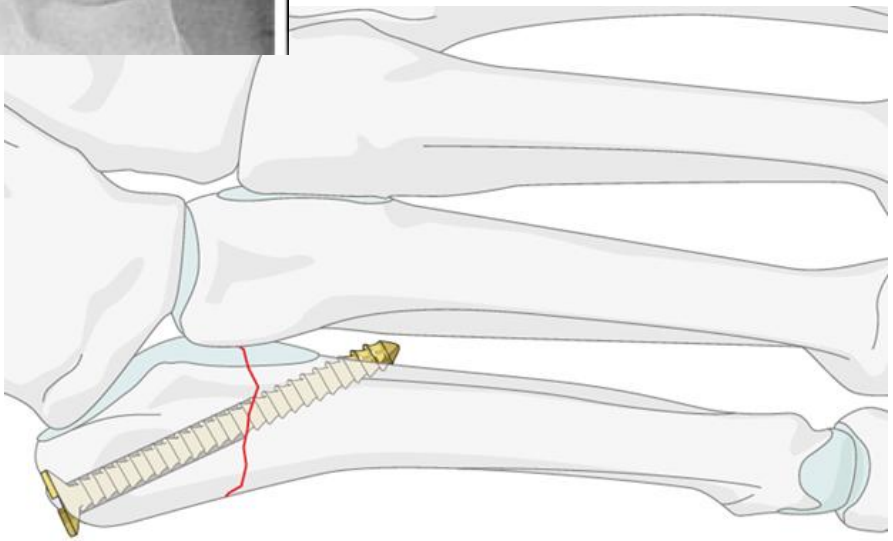
Tuberosity avulsion fractures’’ (Zone 1)



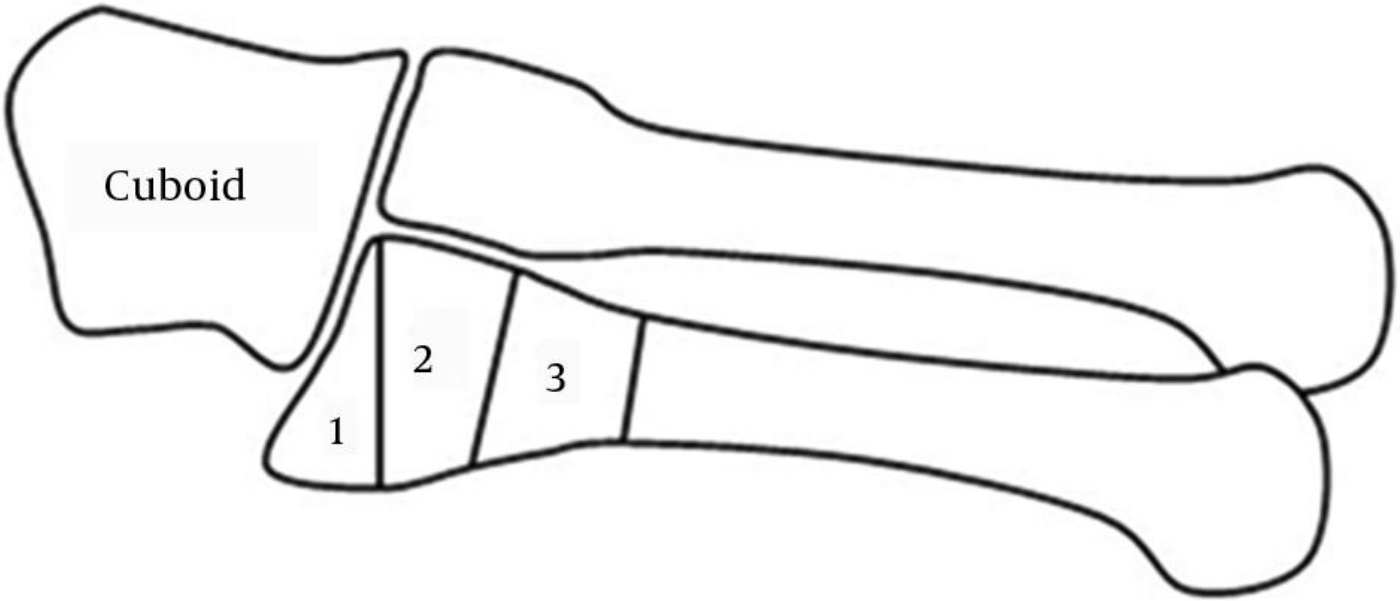
- excellent blood supply on either side of the fracture fragment

- general recommendation of Lawrence and Botte it is widely agreed that displaced fractures (>2 mm) and fractures involving more than 30% of the cuboid-metatarsal articulation of the
- tuberosity should be treated operatively

S. Rammelt et al



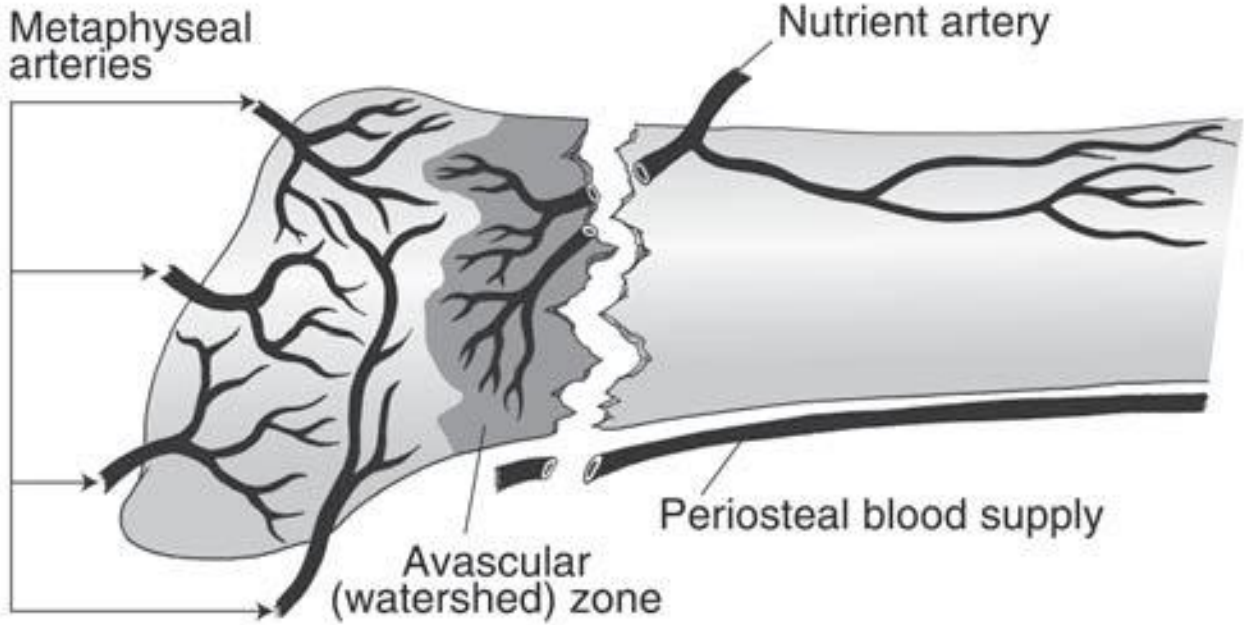
‘‘Jones’ fractures’’ (Zone 2)

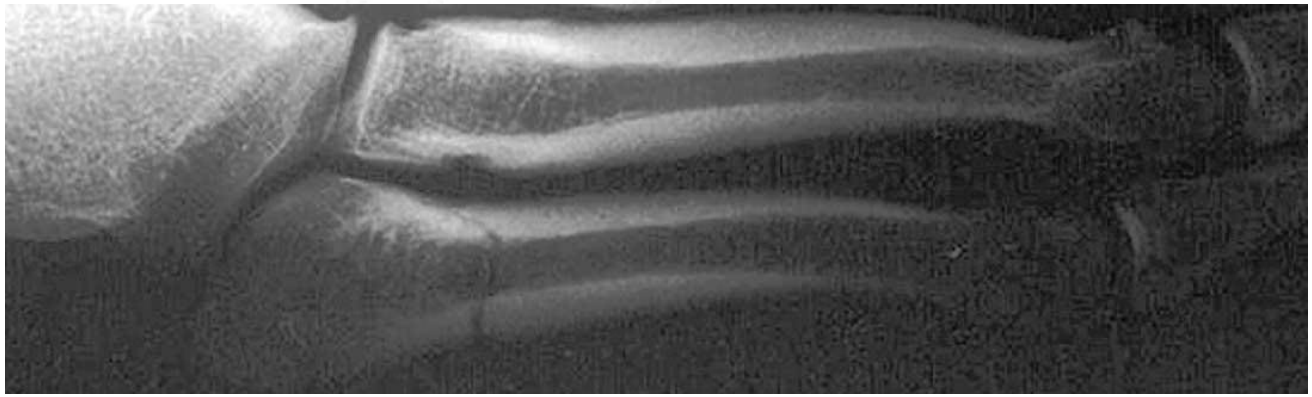


the evidence available recommends functional treatment

also for fractures in Zone 2

Theoretical schematic of proximal diaphyseal fracture, showing interruption of the nutrient artery, with potential creation of a zone of relative avascularity

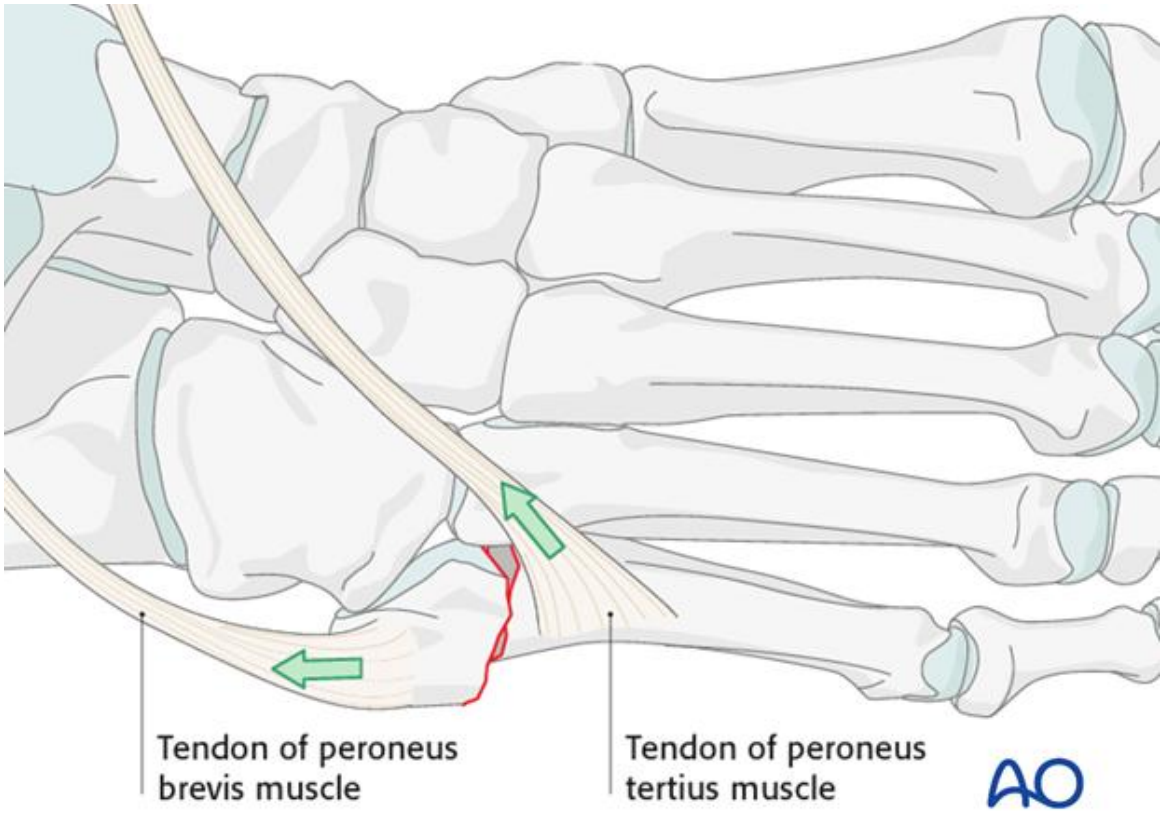




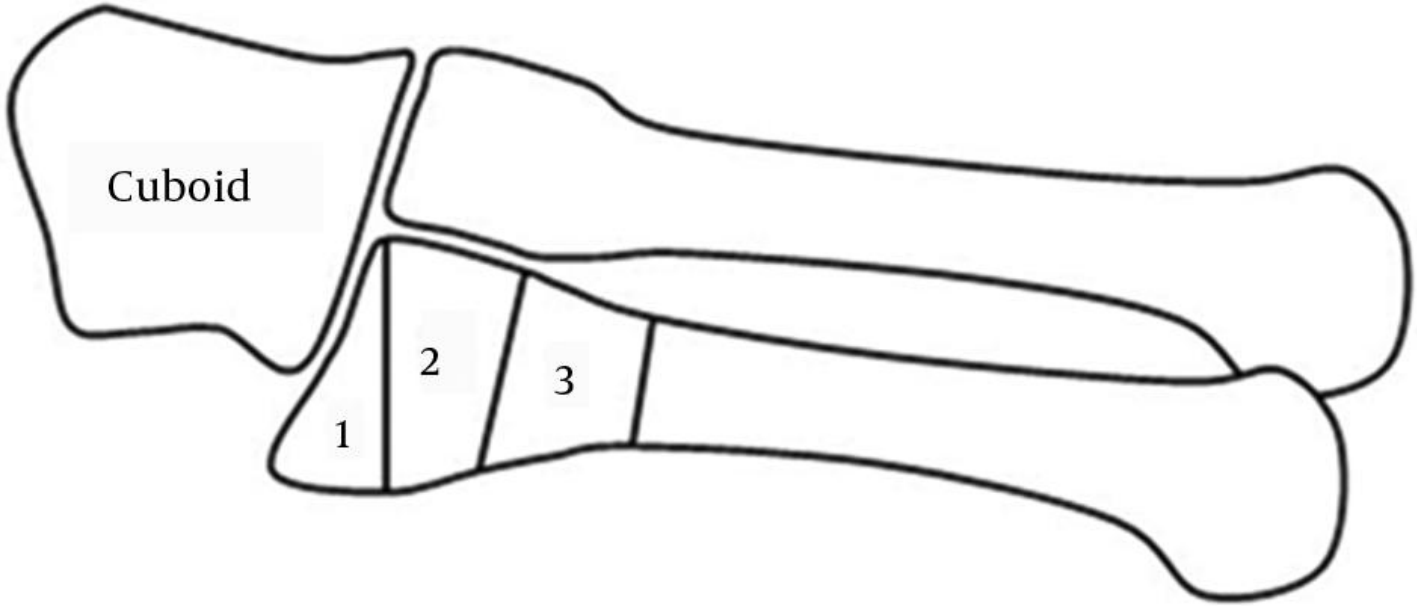
Zone 2 / Acute Jones

- Acute - NWB cast x 6wks **If Athlete**

  ORIF with SCREW



‘‘Diaphyseal stress fractures’’ (Zone 3)



fixation seems to be the

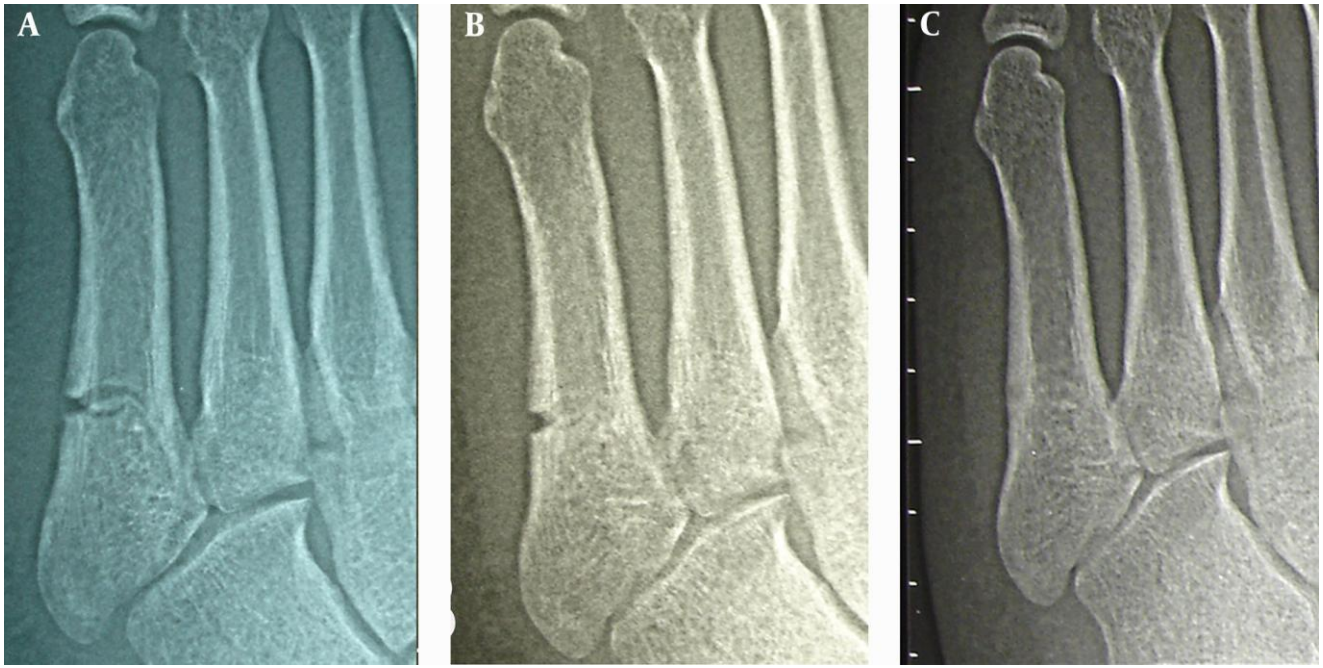
- treatment of choice for fractures at the distal end of the fourthfifth
- intermetatarsal articulation or fractures just distally.

Zone 3 / Stress Fractures

- Repetitive distraction force
- Incorrect training

- Prolonged healing time and risk of refracture
  - **Recommend IM screw in athletes**
    - **DeLee**, 1983

healing occurs in a medial-to lateral direction at the fracture site. Provided that the healing process is progressing satisfactorily, callus for mation at the fracture site without intramedullary sclerosis should be evident by 6 to 8 weeks



A Case of Lawrence and Botte Zone 3 Fracture
Treated Conservatively With a Cast

Look for foot deformities in stress fractures

Sauer

The Surgery Journal Vol. 3 No. 1/2017

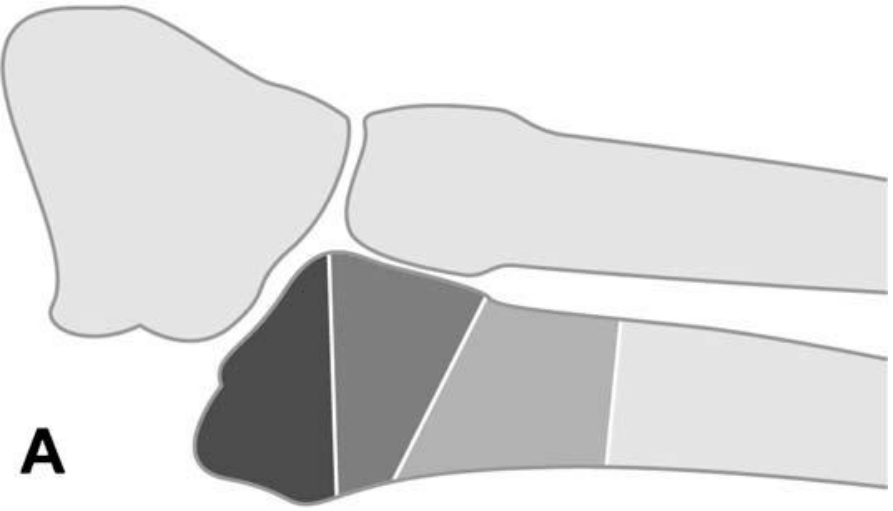
Elite Athletes – Fix Early

- Immediate surgery with IM screw in high performance athlete
- 50% of fractures treated non-operatively either didn't heal or refractured
    - **Quill** , 1995

Surgical treatment

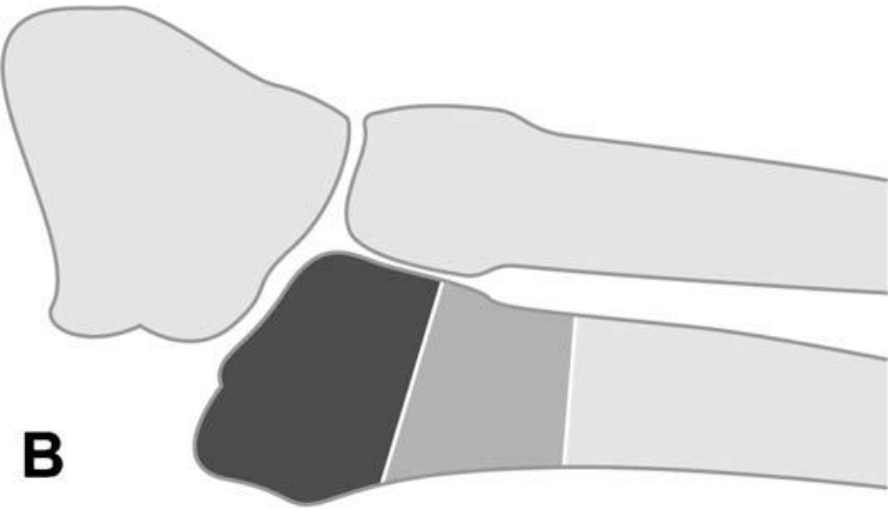
Reaming of the medullary canal

before screw insertion is advised to ensure tight fit of the screw to the endosteum



A

- Tuberosity Avulsion Fracture (Zone 1)
- Jones‘ Fracture (Zone 2)
- Diaphyseal Stress Fracture (Zone 3)



B

- Metaphyseal Fracture
- Meta-diaphyseal Fracture

Torg Classification of Proximal Fifth Metatarsal Fracture by Radiographic Appearance[4]

Type	Age of Fracture	Characteristics
I	Acute	Narrow fracture line, no intramedullary sclerosis
II	Delayed union	Widened fracture line with intramedullary sclerosis
III	Nonunion	Medullary canal obliterated

Type I fractures

can be treated conservatively with non-weight bearing

in a short leg cast for a period of 3 to 12 weeks

Type II fractures can be treated conservatively or operatively

depending on the functional demand

Type III factures

should be managed operatively.

Oblique radiograph of a Torg type II proximal fifth metatarsal fracture

with a widened lateral fracture gap and early intramedullary sclerosis,

indicating delayed union. The intramedullary canal is narrow

Complications of proximal fifth metatarsal fractures

include delay union,
- non-union,
- refracture, soft tissue

complications and
- implant impingement

S. Rammelt et al

The choice of treatment for nonunions depends on the periosteal reaction. If there is a strong periosteal reaction, sufficient stability is achieved with either medullary screw or plate fixation. If there is considerable intramedullary sclerosis and no periosteal reaction, curettage of the sclerotic bone and autogenous corticocancellous bone grafting is advocated

- Delayed union and nonunion have been correlated with use of screws <4.5 mm.23
- Undersized inlay grafts
- incomplete reaming of the sclerotic canal have also been correlated with failure,
- early return to vigorous activity likely plays

a role in delayed union and nonunion.

Refracture after surgical treatment of a Jones fracture can occur after healing and screw removal; thus, it is recommended that the screw be left in until the end of the patient's athletic career.13 The recommended management for fracture following screw removal consists of rereaming and fixation with a larger screw.24 Pain from a prominent screw head after fixation can be managed with shoe modifications.11 Awareness that the dorsolateral branch of the sural nerve is within 2 to 3 mm of the eventual position of the screw head can help avoid injury to the nerve during screw insertion

- Low healing potential (watershed area)
- Look for foot deformities in stress fractures
- Revision—intramedullary screw with cortical thickening
- Resection and bone grafting for complete nonunion (obliteration of medullary canal)