Computed Tomographic Imaging of Foot and Ankle trauma

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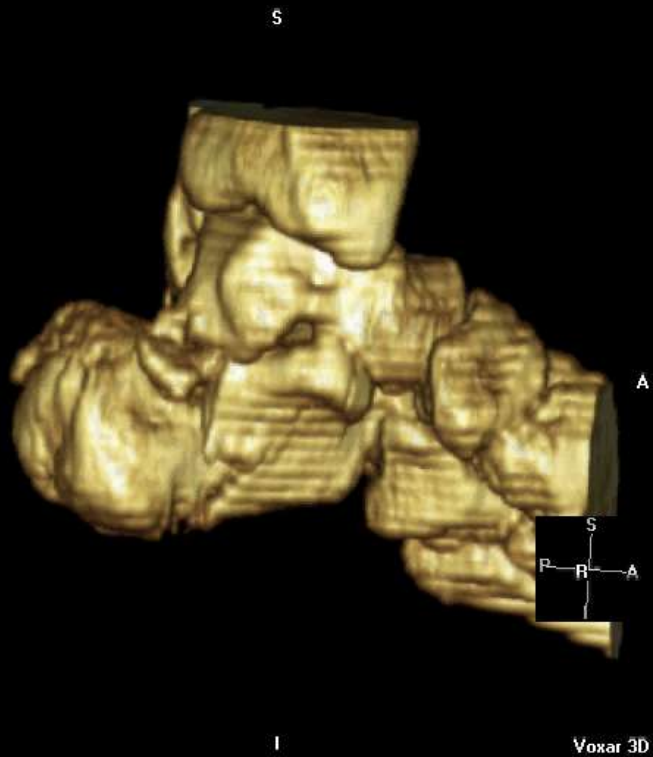


CT of Foot and Ankle Trauma

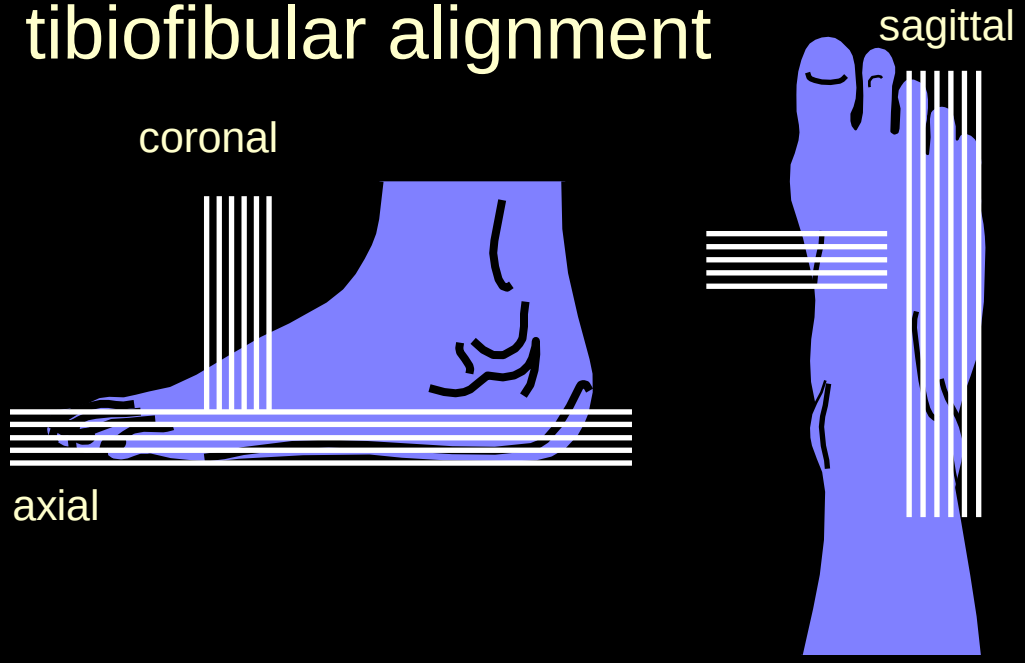
- Who
  - All complex intraarticular fractures
- What
  - Best CT scanner available
- When
  - Post reduction / resuscitation
- Where
  - Field hospital or tertiary care
  - DICOM
- Why
  - Staging and classification
  - To improve outcome

Technique

- Past
  - Scans obtained in coronal and axial planes
- Present
  - Scans can be obtained with 0.5mm thickness
  - Isovoxel or volumetric
  - Reformatted in any plane with equal reolution

Technique

- Axial plane
  - Tibial plafond, malleoli alignment, talus
- Coronal plane
  - Ankle mortise, tibiofibular alignment



Tibial Plafond Fractures

- Pilon (pestle) fracture
- Talus into tibia, like pestle into mortar
- MVA and falls

- Lauge Hansen
  - 1. Oblique medial malleolar
  - 2. Fracture anterior tibia
  - 3. Lower 1/3 of fibula fracture
  - 4. Transverse more proximal tibia fracture

Tibial Plafond Fractures

- **Classification: (Ruedi-Allgower):**
  - **type I: Pilon Frx**
    - malleolar frx with large posterior plafond fragments
  - **type II: Pilon Frx**
    - spiral extension frx
  - **type III: Pilon Frx**
    - central compression injuries w/ impaction of talus into distal tibia
      w/ or w/o concomitant fibular frx

- Subdivided into subgroups A-C depending on degree of displacement of articular surface & presence or absence of comminution and/or impaction;
  - **type A:**
    - minimal or no anterior tibial cortical communition, > 2 large tibial articular fragments, and
      usually a fibular fracture of transverse or short oblique at the level of the plafond
  - **type B:**
    - results from severe axial compression force, causing distal tibial bony impaction and comminution;

Tibial Plafond Fractures

- Found in polytrauma
  - Look at
    - Calcaneus
    - Tibial plateau
    - Pelvis
    - Spine

Tibial Plafond Fractures

- Well seen on plain films
- Extent seen best on CT
- Distinguish from trimalleolar
  - Pilon involves anterior tibia
  - Uncommon to have all 3 malleoli fractured in pilon fracture.

Talus Fractures

- Fractures divided into head, neck and body fractures
- Approximately 50 % of talar fractures involve the neck
- Most common body fractures are osteochondral, less common involve the lateral or posterior process

Talar Neck Fractures

Hawkins Classification
of Talar Neck Fractures

	Radiographic findings	Risk of AVN
Type I	Nondisplaced fracture line	0-13%
Type II	Displaced fracture, plus subluxation or dislocation of subtalar joint	20-50%
Type III	Displaced fracture, dislocation subtalar AND tibiotalar joints	69-100%
Type IV	Displaced fracture and disruption of talonavicular joint	high

Hawkin's Sign

- Subchondral osteopenia in the vascularized NWB talus at 6-8 wks
- Talar viability
- Presence does not r/o osteonecrosis

Complications

- Osteonecrosis
  - Type I: 0-13%
  - Type II: 20-50%
  - Type III/IV: 8-100%
- PT Arthritis 40-90%
- Malunion 0-25%

Snowboarder's Ankle
Snowboarder's Fracture

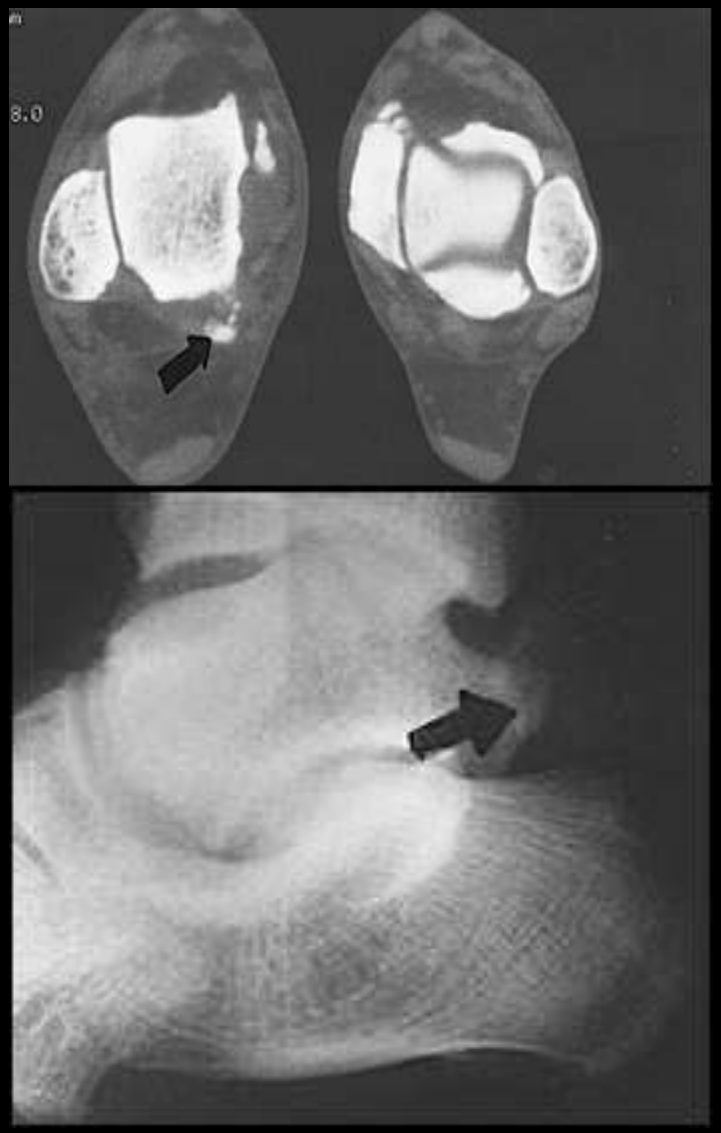
- Lateral process of talus Fx
- Dorsiflexion and hindfoot inversion on landing
- Difficult to see on radiographs, may need CT
- Unrecognized causes subtalar OA
- CT may be required to see and classify
  - Type 1. Chip off anterior inferior
  - Type 2a. Involves talofibular joint
  - Type 2b. Involves talocalcaneal joint
  - Type 3. Comminuted Fx

J Am Board Fam Pract. 1994 Mar-Apr;7(2):130-3

Medial talar tubercle fracture

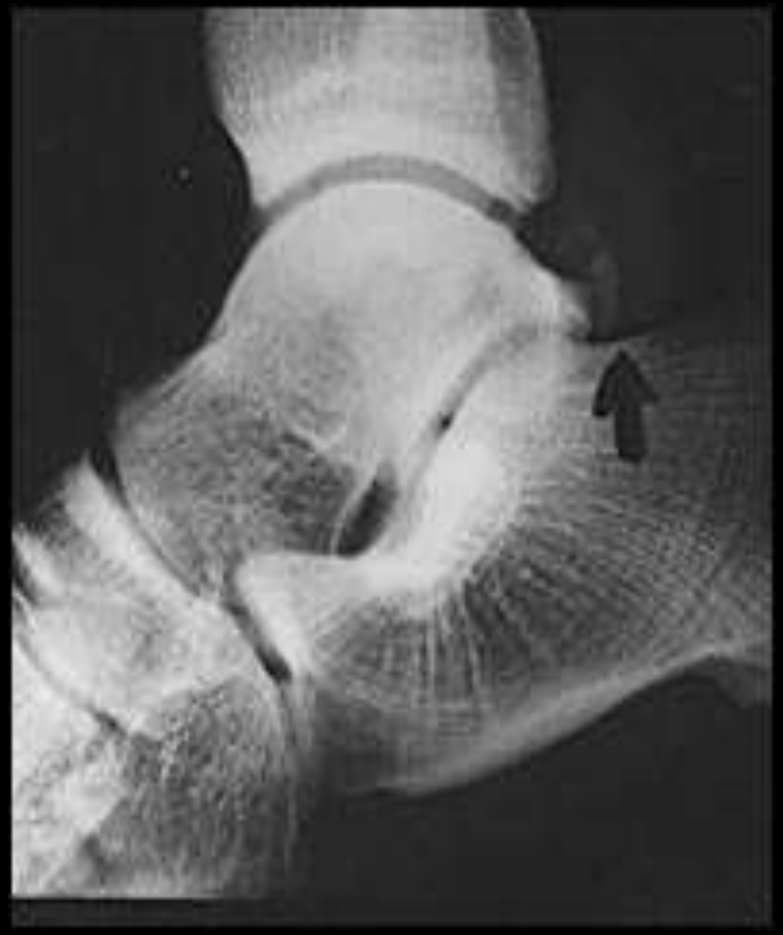
- Rare injury
-
- Dorsiflexion-Pronation-avulsion by deltoid lig

- Complications
  - FHL entrapment
  - Subtalar OA
  - Nonunion
  - Tarsal tunnel syndrome



Lateral talar tubercle fractures (Sheppards fracture)

- Inversion or hyperplantarflexion
- DDx- Os trigonum (normal/fractured)
- Complications
  - FHL entrapment
  - Subtalar OA
  - Nonunion



Posterior talar process fracture

- Involves both medial and lateral tubercles
- Should be considered differently as this higher frequency of association with subtalar dislocations
- Involves both ankle and subtalar joint
- ORIF
    - Displacement >3mm

Calcaneus Fractures

- Most common tarsal fracture
- Accounts for 2% of all fractures
- 70-75% Intraarticular
- 20-25% Extraarticular
- Historically poor prognosis
- No consensus on management due to lack of standard, unified classification system and understanding of fracture pathoanatomy
- High variability in fracture pattern based on magnitude and direction of impacting force, foot position, muscle tone, and bone mineralization

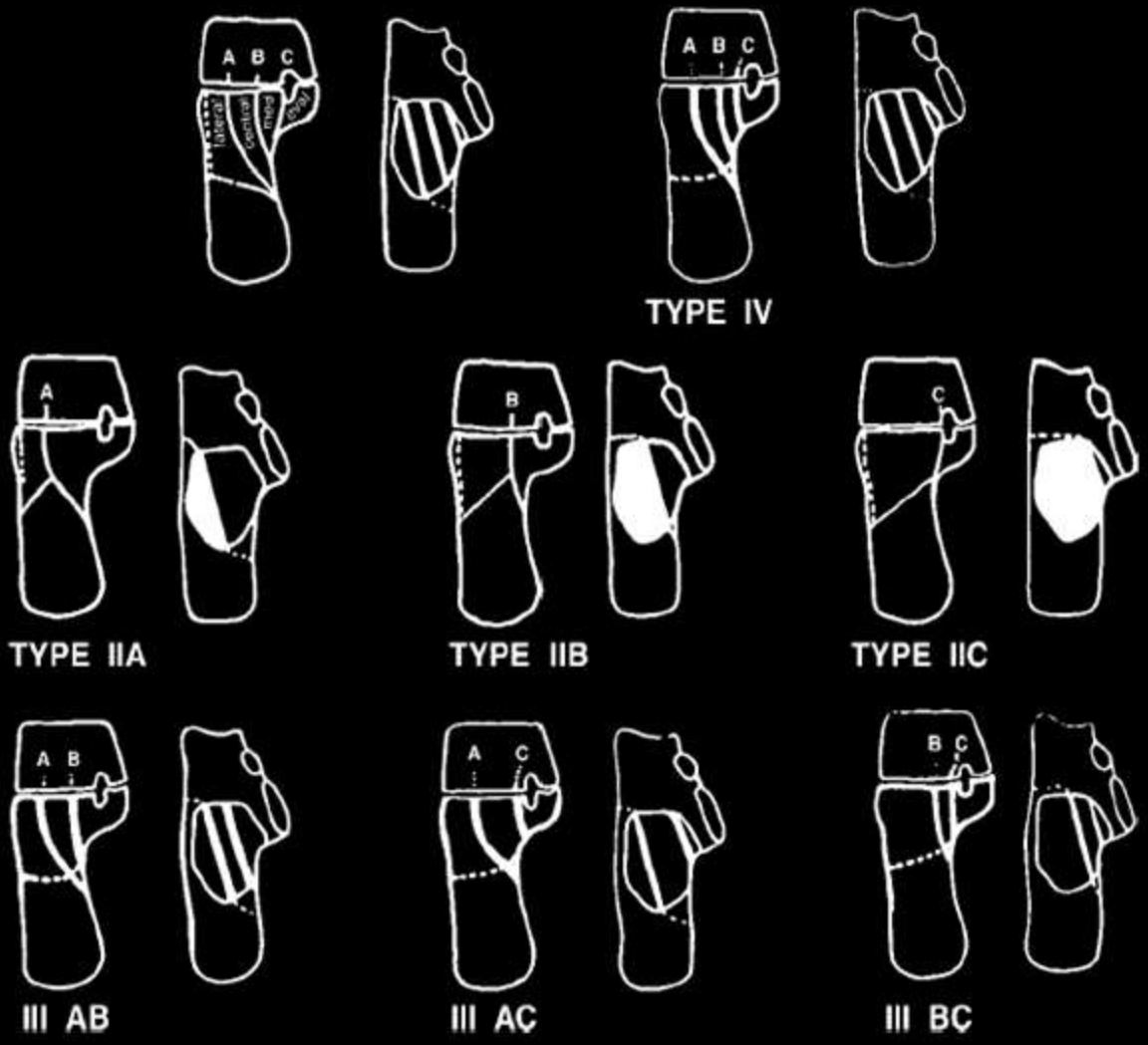
Modified Essex-Loprestie Classification

- Extraarticular fractures
  - Calcaneal tuberosity fractures
    - Beak type
    - Vertical
    - Horizontal
    - Medial avulsion
- Intraarticular fractures
  - Subtalar joint involvement
    - Undisplaced
    - Displaced
    - Comminuted
  - Calcaneocuboid joint involvement

Sanders Classification

- Most useful system for intraarticular fracture classification
- Improved interobserver variability
- Has both clinical and prognostic implications
- Type 1: Excellent results with conservative management
- Type 2 and 3: Excellent results with surgical management
- Type 4: Poor results with surgical managment

Sanders Classification (CT)



Intraarticular Fractures: Typical Osseous Features

- Loss of Height due to impaction and/or rotation of the more mobile tuberosity fragment
- Widening due to displacement of tuberosity fragment
- Posterior subtalar joint disruption
- Axial loading associated with TL burst fractures
- Superior peroneal retinacular avulsions

Calcific myonecrosis

- Relatively rare, late sequela of trauma
- Plate/Sheet-like calcifications are characteristic
- Only 1 case reported in the foot in the English literature
- May erode adjacent bone
- Spontaneous draining sinus-tracts and culture positive infections may develop
- Appropriate treatment: compartmental excision or debridement

Peroneal Tendon Injury in Calcaneal Fractures

- Mechanism: Talus driven downward toward calcaneus usually resulting a spliting of the calcaneus with lateral displacement of the portion containing the posterior facet.
- Forceful lateral calcaneal displacement may result in fibular avulsion at the attachment of the superior peroneal retinaculum.
- Acute complications: Dislocation peroneal tendons, entrapment by avulsed fibular fragment and impingement by fracture fragments.
- Chronic complications: Stenosing tenosynovitis resulting in pain and ankle instability from difficulty everting foot.

AJR 149: 125-129 July 1982

Fracture Blisters

- Most commonly arise over tibia, ankle, or elbow.
- May cause wound complication.

Navicular Stress Fracture

- Accounts for 14-35% of stress fractures.
- Track athletes account for 59% of these injuries
- Predisposing activities:
  - Stamping on ground, marching, long distance running. Commonly occurs in basketball players and runners.
- Usually oriented in the sagittal plane and is located dorsally in the central 1/3 of the bone.
- Classification (Based on CT):

  Type I: Dorsal cortical break

  Type II: Fracture propagates into navicular body

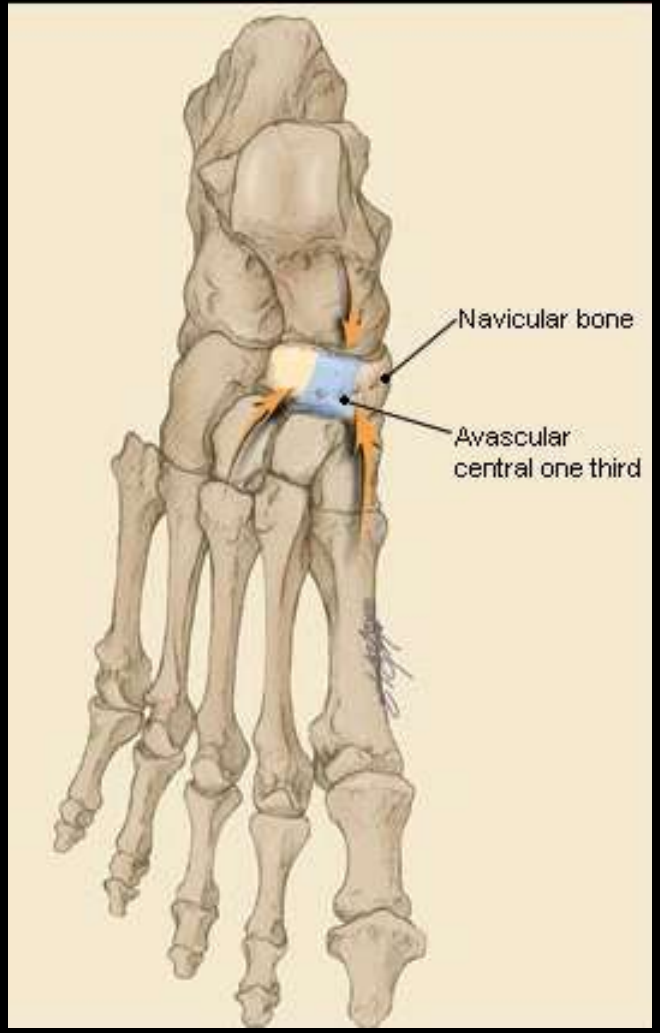
  Type III: Fracture propagates into other cortex

  (requires longest healing time and may require internal fixation).

Tarsal Navicular
Fracture

Dorsal view of the tarsal navicular bone.

The avascular central one-third is also the fulcrum of the impingement forces from the first and third metacarpal bones, as well as the talus.

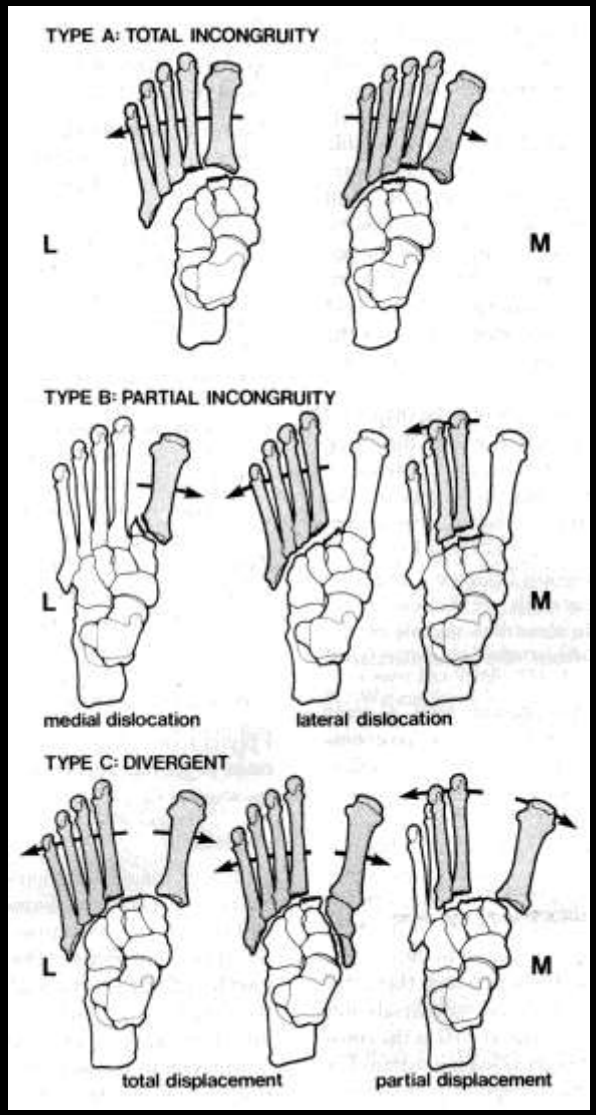


Navicular Stress Fracture

- Also seen in the right limbs of the greyhounds during high-speed running. The right limb is on the outside when racing in a counter-clockwise direction on circular tracks, and is subjected to asymmetric cyclic compressive loading.

Lisfranc Classification

- Controversial whether or not this has prognostic significance
- Probably better to fix fracture based on individual assessment
- Most importantly:
  1. Which column is disrupted
  2. Is the injury primarily bony or ligamentous



General Management Principles

- Assess soft-tissues and if necessary delay surgery
- There is almost no role of conservative management except in mild sprains
- Any fracture/dislocation with >2mm displacement should be treated surgically
- Any unstable fractures should be treated surgically
- Primary ligamentous injuries may do better with primary arthrodesis

Lisfranc - Outcome

- The key to a good outcome is anatomic reduction
- In the largest outcome study of 52pts:
  - Anatomic reduction group: 16% arthritis
  - Non-anatomic reduction group: 60% arthritis
- Ligamentous injuries tend to have a worse prognosis and primary arthrodesis may be warrented-40% with arthritis at 52mo f/u

Lisfranc - Early Complications

- Compartment syndrome of the foot
- Vascular compromise
- Infection
- Skin necrosis
- Loss of reduction

Lisfranc - Late Complications

- Post-traumatic arthrosis
- Persistent midfoot pain
- Stiffness
- Abnormal gait
- Abnormal shoe wear
- Reflex sympathetic dystrophy

Lisfranc

Fracture-Dislocation

- Best diagnostic clue: Lateral offset lateral aspect 1st metatarsal relative to medial cuneiform + medial aspect 2nd metatarsal relative to medial aspect intermediate cuneiform.

- Homolateral-1st to 5th metatarsal dislocated laterally

- Divergent- 1st metatarsal medially dislocated

Lisfranc

Fracture-Dislocation

- 67% related to car accidents
- Initial evaluation - 20% missed
- Delayed treatment- chronic instability

Injury. 2004 Sep;35 Suppl 2:71-6.

Lisfranc fracture-dislocation

- Two basic types
  - **Homolateral**
    - All of the metatarsals are dislocated to the same side
    - More common than divergent
    - Usually involves the 2nd through 5th dislocated laterally
    - May involve all 5 metatarsals
  - **Divergent**
    - Usually more severe than homolateral
    - May be associated with a fracture of the 1st cuneiform
    - Usually involves medial displacement of the 1st metatarsal and lateral displacement of 2nd-5th metatarsals
    - Occasionally may involve only medial displacement of only the 1st metatarsal
- **Fractures associated with Lisfranc dislocations**
  - Base of 2nd metatarsal
  - Cuboid
  - Fractures of shafts of metatarsals
  - Dislocations of the 1st (medial) and 2nd (middle) and cuneonavicular joints
  - Fractures of the tarsal navicular

BPOP

- Usually in hands>feet. Long bones, skull, jaw.
- Ages-20-30s
- Grows rapidly and has aggressive features on imaging and pathology.
- Related myositis ossificans, reactive periostitis, and subungual exostosis.

BPOP

- Radiographs: bony mass with well defined margins applied to the cortex of bone.
- CT: No medullary involvement or cartilage cap.
- MRI: dark on T1 and bright on T2

BPOP

- DDX:
  - Osteochondroma
  - Exostosis
  - Myositis ossificans
  - Low or high grade surface osteosarcoma
  - Periosteal chondroma

BPOP

- Lesion is benign but may recur locally in as many as 50% of cases.
- Tx: complete excision with clear margins.
- Case report of adjacent intermediate grade fibrosarcoma.