

# Forefoot Fractures

*Brian Weatherford, MD*

*Illinois Bone and Joint Institute*



# Metatarsal Fractures

- Common injury
  - 35% of all foot fractures
- Most common foot injury in motorcycle trauma
- Direct or Indirect Mechanism
- 5<sup>th</sup> Metatarsal most common fracture site



# Metatarsal Fractures

- Majority of isolated fractures = nonoperative treatment
- Fracture location
  - Relative to metatarsal bone
    - Base
    - Shaft
    - Neck
    - Head
  - Relative to foot
    - First MT
    - Central MT (2-4)
    - Fifth MT

\*Abbreviation MT=Metatarsal

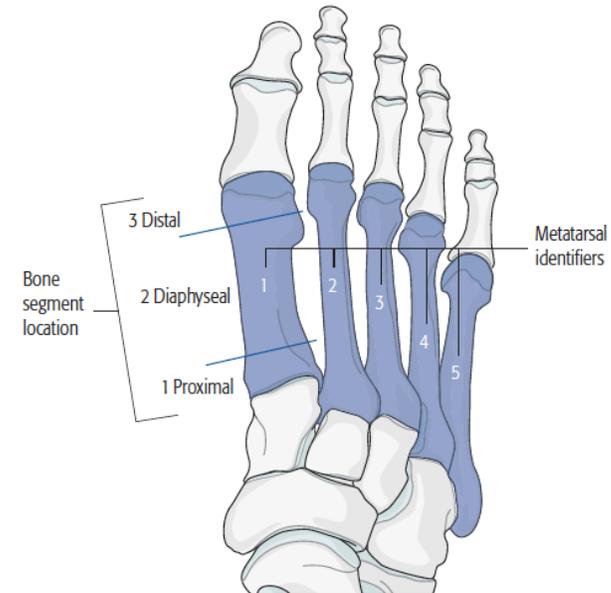


# Classification

- Location: 8 = Foot, 7=Metatarsal
- Limited use in clinical practice
- Separate classification for 5<sup>th</sup> Metatarsal base fractures

## Metatarsals 87

Bone: Foot, metatarsal 87



- The metatarsal bones are identified as follows: First metatarsal = 1, second metatarsal = 2, third metatarsal = 3, fourth metatarsal = 4, fifth metatarsal = 5.
- The metatarsal identifier is added (between two dots .\_.) after the bone code.
- The bone segment location is then added.
- Example: Foot, third metatarsal, proximal end segment = 87.3.1

Meinberg EG, Agel J, Roberts CS, Karam MD, Kellam JF. Fracture and Dislocation Classification Compendium-2018. J Orthop Trauma. 2018 Jan;32 Suppl 1:S1-S170.

# First Metatarsal Fractures

- Rare
- 1.5% of MT fractures
- Shorter and Wider than other metatarsals
  - Preferred ray for push off
- Attachments
  - Tibialis Anterior: Plantar medial MT base
    - Elevation of MT base
  - Peroneus Longus: Plantar lateral MT base
    - Depression/Plantarflexion first MT head



# First Metatarsal Fractures

- Mechanism
  - Direct blow
  - Indirect: Rotational with fixed/plantarflexed foot
  - Rule out associated injuries → LISFRANC!
- Evaluation
  - Pain with push off
  - Neurovascular status
    - Hematoma or compartment syndrome
    - Avulsion of deep branch dorsalis pedis



Plantar arch ecchymosis concerning for associated midfoot injury

# First Metatarsal Fractures: Imaging

- AP, Oblique and Lateral X-rays
  - Weight bearing if possible
    - Physiologic stress
  - Stress view
    - Consider if patient unable to tolerate WB X-ray
- Advanced imaging
  - CT scan: Articular involvement
  - MRI: No clear indication



Weight bearing lateral view of first metatarsal fracture demonstrates angulation with dorsal displacement of metatarsal head

# First Metatarsal Treatment Options

- Isolated fractures
  - No defined amount of displacement or instability
  - Individualize based on patient factors
- Operative Indications
  - Absolute: Open
  - Relative:
    - Articular displacement
    - Associated with midfoot injury
    - Plantar displacement of MT head

**TABLE 62-13 First Metatarsal Fractures**

## Nonoperative Treatment

### Indications

Isolated fracture

No instability on stress radiographs

Minimal displacement

### Relative Contraindications

Complex fractures of the forefoot/midfoot

Instability on stress radiographs

Plantar displacement of the metatarsal head  
Open fractures

Schildauer TA, Coulibaly MO and Hoffman, MF. Fractures and Dislocations of the Midfoot In: Tornetta P, Ricci WM, eds. Rockwood and Green's Fractures in Adults, 9e. Philadelphia, PA. Wolters Kluwer Health, Inc; 2019. Table 62-13

# First Metatarsal: Nonoperative Treatment

- Protected weightbearing x 4-6 weeks
- Cast vs Boot
- Some advocate for initial period of non-weight bearing (3-4 weeks)
  - Limited/no data to support this approach
- Advance activity at 4-6 weeks based on patient comfort and radiographic healing

# First Metatarsal: Operative Treatment

- Fracture pattern
  - Simple/length stable
    - Percutaneous wires vs compression plating
  - Complex/length unstable
    - Open reduction and plating
- Soft tissue status
  - Crush injury, compartment syndrome, open fracture
    - Consider temporizing external fixator vs percutaneous wires



# First Metatarsal Case Example

- Isolated closed injury. First metatarsal fracture associated with midfoot fracture dislocation and first MTP dislocation



# Case Example



# Case Example



# Central Metatarsal Fractures

- 10% of all MT fractures
- Contiguous
  - 3rd MT fracture associated with 2<sup>nd</sup> or 4<sup>th</sup> MT fracture 63% of the time
- Most common location for stress fracture



# Central Metatarsal Fractures

- Mechanism
  - Direct blow
  - Indirect: Rotational with fixed/plantarflexed foot
  - Rule out associated injuries → LISFRANC!
- Evaluation
  - Pain with push off
  - Neurovascular status
    - Hematoma or compartment syndrome
    - Avulsion of deep branch dorsalis pedis

# Central Metatarsal Fractures: Imaging

- AP, Oblique and Lateral X-rays
  - **Weight bearing if possible**
    - Physiologic stress
- Advanced imaging
  - CT scan:
    - Articular involvement
    - Non-displaced/occult fractures
  - MRI:
    - Early detection of metatarsal stress fractures
    - Evaluation of associated ligamentous injuries
- \*CT and MRI are not dynamic
  - They do not assess foot under physiologic stress

Non-weightbearing



Weightbearing



Weight bearing X-rays demonstrate instability of the forefoot and previously missed midfoot instability

# Central Metatarsal Treatment Options

## Operative Indications

- Absolute: Open
- Relative indications
  - Articular displacement
  - Associated midfoot injury
  - Multiple displaced adjacent fractures
  - 10 degrees sagittal plane, 3-4 mm translation
    - No data to support these numbers
    - Individualize based on patient factors
  - **\*Plantar displacement of metatarsal head**
    - **Nonoperative treatment = painful metatarsalgia**



Second metatarsal base fracture associated with midfoot instability. Displacement on stress imaging.

# Central Metatarsals: Nonoperative Treatment

- Consider stress view for multiple adjacent fractures
- Weight bearing as tolerated
- Stiff soled shoe vs Boot
- Advance activity at 4-6 weeks based on patient comfort and radiographic healing

# Central Metatarsals: Operative Treatment

- Fracture pattern
  - Simple/length stable
    - Percutaneous wires vs compression plating
  - Complex/length unstable
    - Open reduction and plating
- Soft tissue status
  - Crush injury, compartment syndrome, open fracture
    - Consider temporizing external fixator vs percutaneous wires

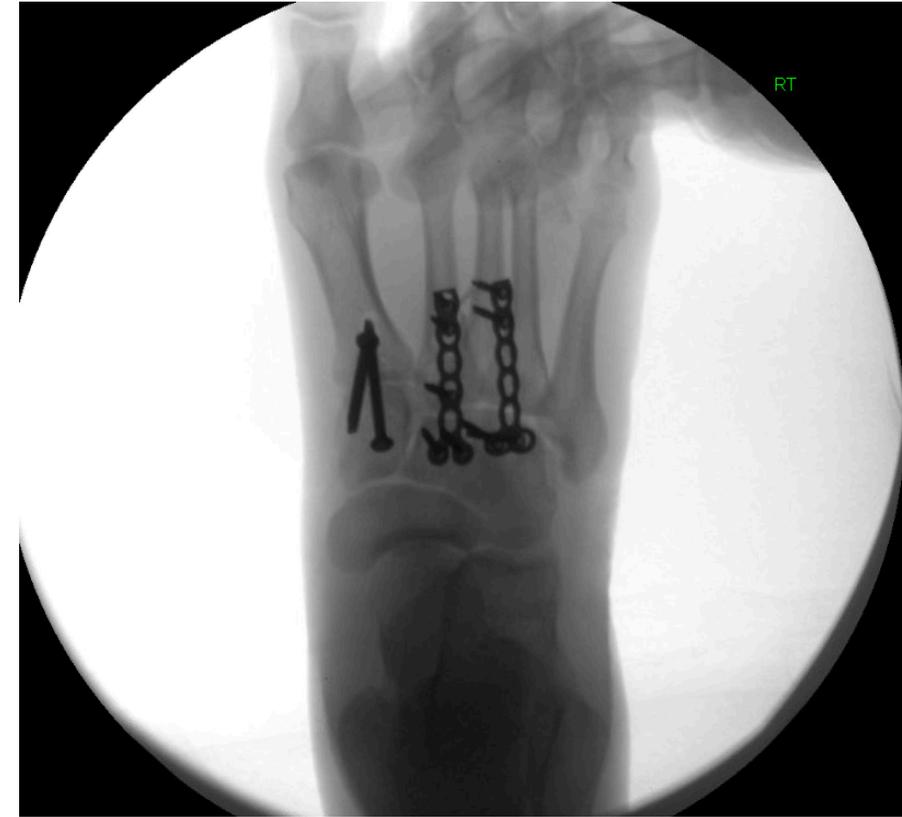


# Case Example

21-year-old female with multiple injuries after motor vehicle collision. Right intra-articular displaced second and third metatarsal fractures as part of midfoot injury. Displaced 3<sup>rd</sup> and 4<sup>th</sup> metatarsal head/neck fractures

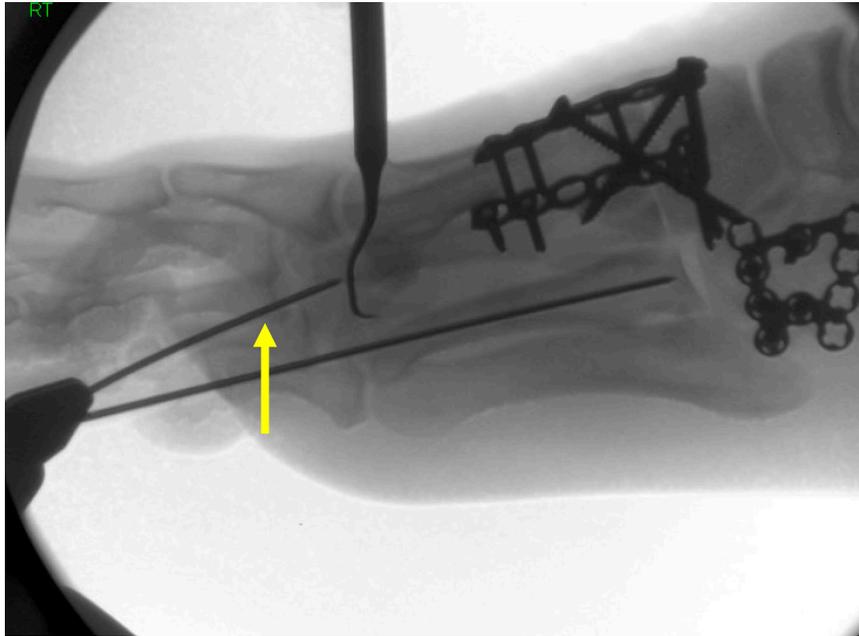


# Case example



The metatarsal base fractures are addressed first through combined dorsomedial and dorsolateral approaches in combination with treatment of midfoot instability.

# Case Example



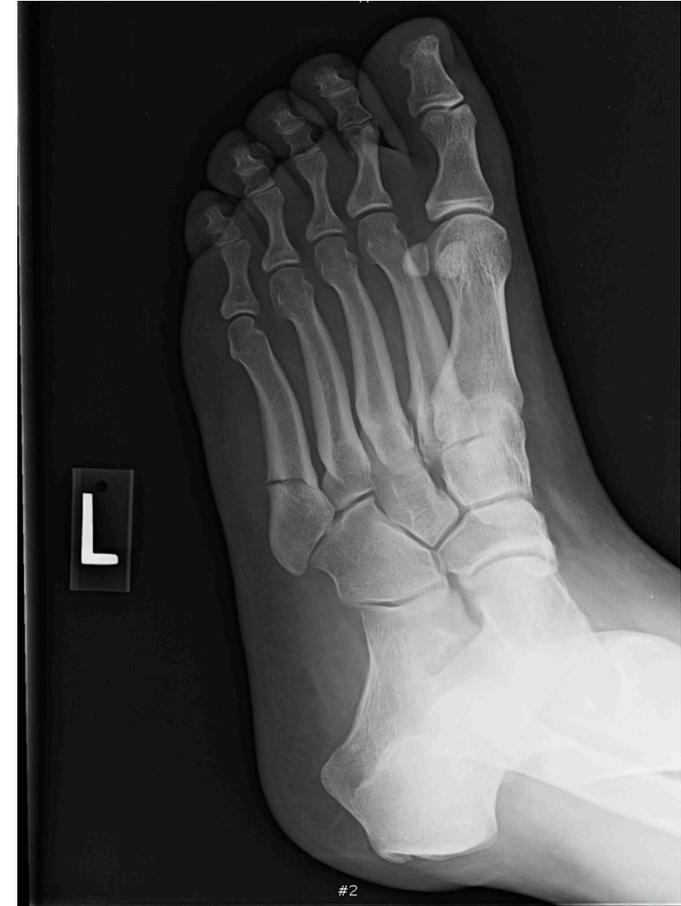
Percutaneous reduction of the metatarsal head and neck fractures. A dental pick can be used to manipulate the fragments. The Kirschner wire typically needs to engage the plantar proximal phalanx to achieve the appropriate starting point. Wires are removed at 6 weeks in the office.

# Case Example



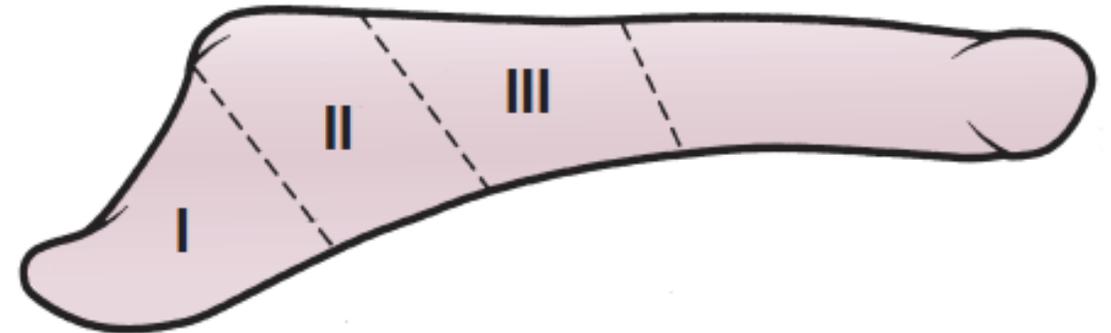
# Fifth Metatarsal Fractures

- 68% of all metatarsal fractures
- Proximal (base) vs distal spiral fracture (dancer's fracture)
- Proximal metadiaphyseal = vascular watershed region
  - Increased risk of nonunion
- Commonly from indirect inversion mechanism



# Fifth Metatarsal Base Fractures: Classification

- Zone 1: Avulsion fracture
  - Lateral band of plantar fascia
- Zone 2: Metaphyseal diaphyseal junction
  - “Jones” fracture
- Zone 3: Proximal shaft fracture
  - Stress fracture



**FIGURE 62-37** Three zones of proximal fifth metatarsal fracture. Zone 1: Avulsion fracture. Zone 2: Fracture at the metaphyseal-diaphyseal junction. Zone 3: Proximal shaft fracture.

Schildauer TA, Coulibaly MO and Hoffman, MF. Fractures and Dislocations of the Midfoot In: Tornetta P, Ricci WM, eds. Rockwood and Green's Fractures in Adults, 9e. Philadelphia, PA. Wolters Kluwer Health, Inc; 2019. Figure 62-37

# Fifth Metatarsal Evaluation

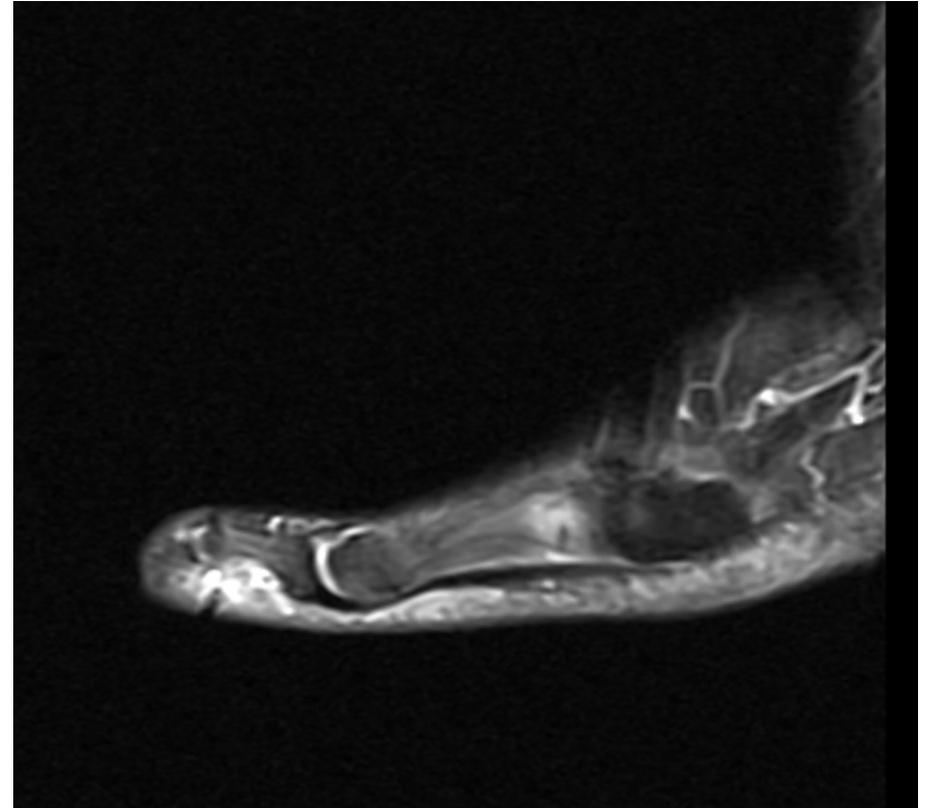
- Rule out prodromal symptoms
  - Antecedent lateral foot pain prior to fracture
  - Mechanism of injury?
    - Fracture without acute injury?
  - Differentiate stress fracture versus acute injury
- Assess for Cavovarus deformity
  - Increased load on fifth metatarsal
  - Increased risk of failure with nonoperative treatment or isolated fixation of fifth metatarsal fracture
  - Discuss correction at time of fifth metatarsal fixation
    - Calcaneal osteotomy
    - First metatarsal osteotomy



Standing clinical photo showing hindfoot varus of the right foot

# Fifth Metatarsal: Imaging

- AP, Oblique and Lateral X-rays
  - Weight bearing if possible
    - Assess associated deformity (Cavovarus)
- Advanced imaging
  - CT scan: Articular involvement
  - MRI: Useful for early detection of stress fractures



MRI sagittal section demonstrating developing 5<sup>th</sup> Metatarsal stress fracture

# Fifth Metatarsal Nonoperative Treatment

- Spiral fractures (Dancer's fracture) and Zone 1 base fractures
  - Weight bearing as tolerated in a stiff soled shoe vs boot
  - Advance activities at 4-6 weeks based on patient comfort



# Fifth Metatarsal Nonoperative Treatment

- Zone 2 (Jones fracture)
  - Non weight bearing 6-8 weeks
  - Weight bearing and activities based on radiographic healing



# Fifth Metatarsal Nonoperative Treatment

- Zone 3 (Stress fracture)
  - Non weight bearing 8-12 weeks
  - Weight bearing and activities based on radiographic healing



# Fifth Metatarsal Operative Treatment

- Indications:
  - Relative: Zone 2 and Zone 3 in collegiate or professional athlete
  - Symptomatic nonunion
- Zone 2 and Zone 3 fractures
  - Acute injury
    - Intramedullary solid screw
    - 4.5 mm or larger
  - Nonunion
    - Open debridement with bone grafting
    - Plate vs screw fixation



# Phalanx Fractures

- Proximal phalanx most commonly injured
  - 5<sup>th</sup> toe most common location
- Majority can be managed nonoperatively with immediate weightbearing
- Displaced fracture require reduction and taping



# Phalanx Fractures: Operative Indications

- Rare
- Open fractures
- Lesser toes
  - Articular displacement with gross joint instability
- Great toe
  - Articular displacement
  - No defined parameters
  - Greater importance to balance



# Special considerations: Compartment Syndrome

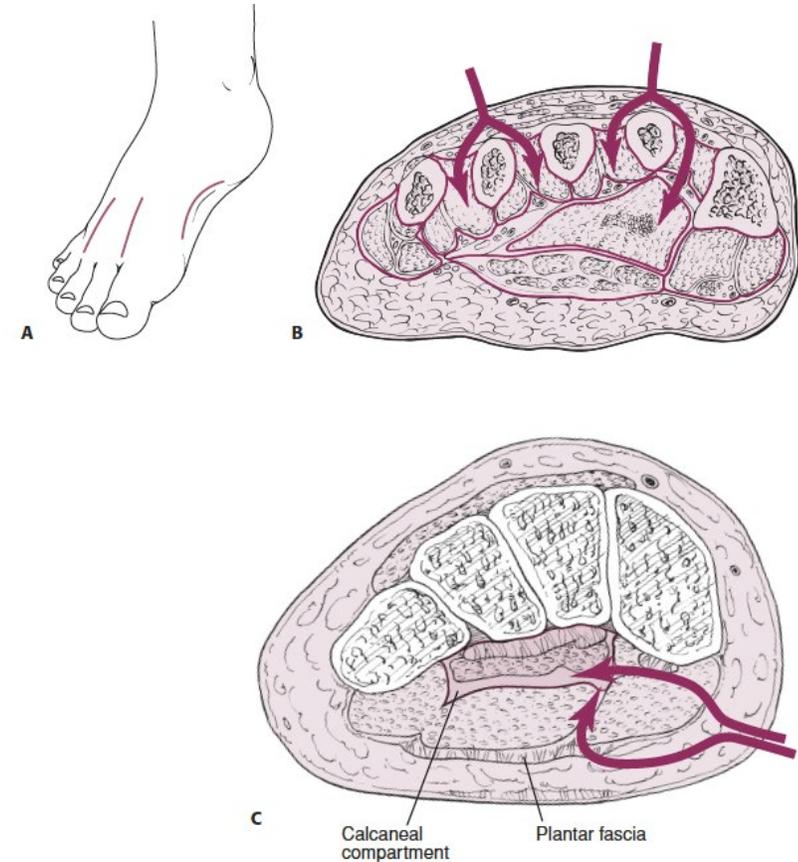
- Crush mechanism with forefoot injury = highest incidence
  - Thakur et al, JBJS 2012
- Treatment remains controversial
  - Observation vs Fasciotomy
- “Pie Crusting” technique
  - Less morbidity compared with open fasciotomy.
    - Dunbar et al, FAI 2007
  - Less effective at compartment release
    - Lufrano et al, FAI 2019



Crush injury with foot compartment syndrome, metatarsal fractures and Lisfranc injury. Treated with pie crusting, external fixation and percutaneous wires

# Special Considerations: Compartment Syndrome

- Decompressive fasciotomy
- Three incision technique
  - Medial
  - Dorsolateral
  - Dorsomedial
- Manoli and Weber
  - 9 compartments
  - Deep central (calcaneal)\*
    - Communicates via tarsal tunnel with deep posterior compartment of leg



Schildauer TA, Coulibaly MO and Hoffman, MF. Fractures and Dislocations of the Midfoot In: Tornetta P, Ricci WM, eds. Rockwood and Green's Fractures in Adults, 9e. Philadelphia, PA. Wolters Kluwer Health, Inc; 2019. Figure 62-56

# Special Considerations: Soft Tissue Management

- Bone/joint stability necessary to assist with soft tissue management
- Temporary bridging plates, Ex fix and/or Wires as needed
- Early Plastic Surgery Intervention
- Early and ongoing discussions of salvage vs amputation



Open foot crush injury treated with bridge plating and limited internal fixation followed by early Plastic Surgery intervention

# Summary

- Nonoperative treatment for majority of forefoot fractures
- Weight bearing or stress imaging to rule out instability
- Limited data to drive indications for operative treatment
- Crush injury with forefoot fracture = highest incidence of foot compartment syndrome



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