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

• 5th 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 5th Metatarsal base fractures

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

<table>
<thead>
<tr>
<th>Indications</th>
<th>Relative Contraindications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated fracture</td>
<td>Complex fractures of the forefoot/midfoot</td>
</tr>
<tr>
<td>No instability on stress radiographs</td>
<td>Instability on stress radiographs</td>
</tr>
<tr>
<td>Minimal displacement</td>
<td>Plantar displacement of the metatarsal head</td>
</tr>
<tr>
<td></td>
<td>Open fractures</td>
</tr>
</tbody>
</table>

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 2nd or 4th 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

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\textsuperscript{rd} and 4\textsuperscript{th} metatarsal head/neck fractures.
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


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 5th 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
  • 5th 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
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
References

- Petrisor BA, Ekrol I, Court-Brown C. The epidemiology of metatarsal fractures. Foot Ankle Int. 2006
- Lufrano R, Nies M, Ebben B, Hetzel S, O'Toole RV, Doro CJ. Comparison of Dorsal Dermal Fascial Fenestrations With Fasciotomy in an Acute Compartment Syndrome Model in the Foot. Foot Ankle Int. 2019