Disclosures

• None
History

- Jacques LisFranc
  - 1790 – 1847
Clinical Presentation

• Signs and symptoms
  – Ecchymosis
  – Edema
  – Midfoot pain
  – Compartment syndrome?

• High degree of clinical suspicion
  – Assume LisFranc injury until proven otherwise
Architecture

- **Roman arch**
  - Longitudinal
  - Transverse

- **Keystone**
  - Recessed 2nd metatarsal
  - Vassal’s principle

Soft Tissue

- **Interossei ligaments**
  - Strongest
  - No 1\textsuperscript{st} - 2\textsuperscript{nd} metatarsal ligament

- **Plantar ligaments**

- **Dorsal ligaments**
  - Weakest

- **Secondary stabilizers**
  - Plantar fascia
  - Peroneus longus tendon
  - Intrinsic muscles
### Midtarsal Joint Motion

<table>
<thead>
<tr>
<th>Joint Type</th>
<th>Sagittal</th>
<th>Frontal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; tarsometatarsal</td>
<td>3.5°</td>
<td>1.5°</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; tarsometatarsal</td>
<td>0.6°</td>
<td>1.2°</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; tarsometatarsal</td>
<td>1.6°</td>
<td>2.6°</td>
</tr>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt; metatarsal-cuboid</td>
<td>9.6°</td>
<td>11.1°</td>
</tr>
<tr>
<td>5&lt;sup&gt;th&lt;/sup&gt; metatarsal-cuboid</td>
<td>10.2°</td>
<td>9.0°</td>
</tr>
</tbody>
</table>

Epidemiology

**Demographics**
- 0.2% of fractures\(^1\)
- 1:55,000 per year\(^1\)
- ♂ 2-4x : ♀
- Third decade most common\(^2,3\)
- ED misdiagnosis\(^4\)
  - 20%

**Myerson\(^5\)**
- 76 reviewed cases
  - Polytrauma 81%
  - MVA 60%
  - Rest from falls and crush injuries

---

Mechanism of Action

• Direct injury

• Indirect injury

Classification

• **Quenu and Kuss (1909)**¹
  – Homolateral
  – Isolated
  – Divergent

• **Nunley & Vertullo (2002)**²
  • <2mm diastasis
  • 2-5mm diastasis, no collapse
  • 2-5mm diastasis and collapse

---
Classification

- **Hardcastle\(^1\)**
  - Myerson modification\(^2\)

Imaging

• Radiographs (3 views)
  – Metatarsal alignments
Imaging

- Radiographs (3 views)
  - Metatarsal re-alignment

Post-op 1mo

Post-op 3mo
Imaging

• **Radiographs (3 views)**
  – Dorsal displacement
Imaging

- **Plain radiographs**
  - Diastasis
    - Intermetatarsal
    - Intercuneiform
  - “Fleck sign”
  - Contralateral comparison
  - Stress views
    - Weightbearing
• **Advanced imaging**
  
  – Magnetic resonance imaging
    
    • **Look at T2 for inflammation**
      
      – Bone marrow edema
    
    • Ligamentous integrity
    
    • Alignment
    
    • For chronic midfoot pathology
Advanced imaging
- Computer tomography
  - Best visualization
  - Surgical planning
  - For acute presentation

Indications for Surgery

• Non-displaced
  – May underestimate soft tissue injury
  – Prolonged NWB
  – Ligament integrity?
  – *Percutaneous approach?*¹

• Displaced
  – Closed reduction
    • If impending NV compromise
  – ORIF or primary arthrodesis
  – *Anatomic realignment*²

¹ Bleazey et al., *Foot Ankle Spec* 6:3, 2013.
Incision Placement

- **Direct visualization**
  - **Incision placement**
    - Between EHB and EHL
    - Along 4th metatarsal
    - Medial utility incision
  - **Avoid structures**
    - Deep peroneal nerve
    - Deep plantar artery
  - **Remove soft tissue**
  - Assess joint injury
    - ORIF
    - Primary arthrodesis
  - **Anatomic reduction**
Forms of Fixation

- **Constructs**
  - K-wire
  - Screw and K-wire
  - Screw

Forms of Fixation

- **Bridge plate**
- **Endobutton**

**Comparison**
- $n = 62$
- Groups
  - Transarticular screw
  - Dorsal plate
  - Combination
  - Conservative

**Conclusions**
- No difference
- **Anatomic reduction**

Factors effecting TMT fusion rates

- $n = 88$
- Non-union rate 11.4%
- Fixation
  - All screws through plate only
    $p = 0.004$
- Graft
  $p = 0.006$
- Smoking
  $p = 0.002$
- Non-anatomic reduction
  $p = 0.005$

Buda, et al., Foot Ankle Int 2018 [Epub ahead of print].
Fixation Pearls

• **Proximal to distal**
  – Intercuneiform
  – 2nd metatarsal
  – 1st ray
  – 3rd ray
  – Lateral column

• **Pocket hole**

36yr old female in MVA

- Past medical history
  - Noncontributory

- Physical examination
  - Midfoot pain

- Labs
  - Blood alcohol 0.12%

Foot appearance
Case Scenario #1

• Imaging
  – Plain films
  – Computer tomography
Case Scenario #1

• **Sequential reduction (proximal to distal)**
  
  – Incision placement
    • Exposure
  
  – Intercuneiform
  
  – Medial column
    • Fusion versus stabilization
  
  – Keystone
    • Homerun screw
  
  – Lateral column
    • K-wire
Case Scenario #1

- **Sequential reduction (proximal to distal)**
  - Incision placement
    - Exposure
  - Intercuneiform
  - Medial column
    - Fusion versus stabilization
  - Keystone
    - Homerun screw
  - Lateral column
    - K-wire
Case Scenario #1

- **Sequential reduction (proximal to distal)**
  - Incision placement
    - Exposure
  - Intercuneiform
  - Medial column
    - Fusion versus stabilization
  - Keystone
    - Homerun screw
  - Lateral column
    - K-wire
Case Scenario #1

- **Sequential reduction (proximal to distal)**
  - Incision placement
    - Exposure
  - Intercuneiform
  - Medial column
    - Fusion versus stabilization
  - Keystone
    - Homerun screw
  - Lateral column
    - K-wire
Case Scenario #1

• **Sequential reduction** *(proximal to distal)*
  - Incision placement
    • Exposure
  - Intercuneiform
  - Medial column
    • Fusion versus stabilization
  - Keystone
    • Homerun screw
  - Lateral column
    • K-wire
Case Scenario #1

• Sequential reduction (proximal to distal)
  – Incision placement
    • Exposure
  – Intercuneiform
  – Medial column
    • Fusion versus stabilization
  – Keystone
    • Homerun screw
  – Lateral column
    • K-wire
Case Scenario #1

- **Sequential reduction (proximal to distal)**
  - Incision placement
    - Exposure
  - Intercuneiform
  - Medial column
    - Fusion versus stabilization
  - Keystone
    - Homerun screw
  - Lateral column
    - K-wire
Case Scenario #1

• **Sequential reduction** (proximal to distal)
  - Incision placement
    • Exposure
  - Intercuneiform
  - Medial column
    • Fusion versus stabilization
  - Keystone
    • Homerun screw
  - Lateral column
    • K-wire
Case Scenario #2

• 81yr old female
  – Injured left foot bending down to pickup ice
  – Has some pain
  – Usually has numbness in feet
  – Diabetes controlled with insulin

• Past medical history
  – DM nephropathy (dialysis M/W/F)
  – Coronary artery disease
  – Hip fracture (septic x3)
  – Morbid obesity
    • BMI 54
Case Scenario #2

- **Physical examination**
  - Mild edema in midfoot
  - Midfoot pain
  - Pedal pulses normal
  - Diminished sensation

- **Labs**
  - HbA1c 6.9%
  - Glucose 125
  - GFR elevated
  - Creatinine elevated
  - BUN elevated

- **Imaging**
  - Plain films
  - Computer tomography
Case Scenario #2

Align plate

Clamp plate

Anchor plate distally

Keep screw loose

Screw placement

Plate anchored
Case Scenario #2

Align plate

Intercuneiform screw

Intercuneiform screw

Intercuneiform screw

Reduce joint

“Home Run” guidewire
Case Scenario #2

Guidewire advanced

“Homerun” screw

Reduce metatarsals

IM guidewire

Intermetatarsal screw
Case Scenario #2

- Lag screws done
- Reduce plate
- Plate reduced
- Plate fixated
- Final construct
- Final construct
Case Scenario #2

- Final films
Case Scenario #3

- 46yr old female sustained low-energy midfoot injury 3mo ago
  - Underwent surgical repair by another surgeon with percutaneous fixation of LisFranc fracture
  - Started walking a month ago with persistent pain
  - Denies any constitutional signs of infection

Foot appearance
Case Scenario #3

• Original injury

Pre-op x-rays
Case Scenario #3

- Post-op films
Case Scenario #3

- Current films
Case Scenario #3

- Remove hardware
Case Scenario #3

• Joint exposure
Case Scenario #3

- Harvesting autograft
Case Scenario #3

- Pack and close donor site
Case Scenario #3

• Intercuneiform joint
Case Scenario #3

- Intermetatarsal joint
Case Scenario #3

- Fusion site preparation
Case Scenario #3

- Final construct
Case Scenario #3

• Final outcome
Dowel Fusion

- **Joint preparation** (*in situ*)
  - “Spot welding”
• 30yr old twisted right foot when wrestling
  – Past medical history
    • Closed head injury
  – Physical examination
    • Midfoot pain
    • Midfoot ecchymosis
  – Radiographs
    • Normal
Case Scenario #4

- 30yr old twisted right foot when wrestling
  - Past medical history
    - Closed head injury
  - Physical examination
    - Midfoot pain
    - Midfoot ecchymosis
  - Computer tomography
Case Scenario #4

- Incision placement
- Joint identification
- Trephine 2nd TMTJ
- Bone harvesting
- Plate placement
- Plate temporarily fixated
Case Scenario #4

Plate fixation
Plate fixation
Trephine 3rd TMTJ
Plate placement
Plate fixation
Plate fixation
Case Scenario #4
Case Scenario #4

Final post-op films
Surgical Goal

• **Anatomic reduction**

• **If not anatomic**
  – Poor outcome
  – Rapid progression to arthrosis
  – Requires revision surgery
  – *Lawsuit*
To Fuse or Not to Fuse?

- **Outcome comparisons**
  - Primary arthrodesis ($n = 21$)
    - AOFAS midfoot score: 88.0
      - $p < 0.005$
    - Level of activity: 92%
      - $p < 0.005$
  - ORIF ($n = 20$)
    - AOFAS midfoot score: 68.6
    - Level of activity: 65%
    - Revised to arthrodesis: 5

To Fuse or Not to Fuse?

<table>
<thead>
<tr>
<th></th>
<th>Study</th>
<th>n</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORIF / No arthrodesis</td>
<td>Mulier</td>
<td>16</td>
<td>68%</td>
</tr>
<tr>
<td></td>
<td>Ly and Coetzee</td>
<td>20</td>
<td>55%</td>
</tr>
<tr>
<td></td>
<td>Henning</td>
<td>14</td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td>Stavlas</td>
<td>257</td>
<td>75/100</td>
</tr>
</tbody>
</table>

|                       | Mulier*     | 12  | 50%       |
|                       | Ly and Coetzee | 21  | 100%      |
|                       | Henning     | 18  | 92%       |
|                       | Sangeorzan  | 16  | 69%       |


*- Includes partial arthrodesis
To Fuse or Not to Fuse?

- **Primary arthrodesis**
  - High incidence of post-traumatic arthritis
  - Improved results with arthrodesis\(^1-3\)

- **Rationale**
  - Medial column
    - Non-essential joint
  - One surgery and one recovery
  - Arthrodesis as second procedure complicated by sclerosis

Complications

- Risks and complications
  - Wound complications
  - Neuritis / CRPS
  - Painful hardware
    - When to remove?
  - Non-union
  - Mal-union
  - Stiffness
  - Post-traumatic arthritis
Post-Operative Course

• **Post-operative management**
  – NWB cast / removable boot x8-10wks
  – Kwires removed at 4-6wks
  – Gradual PWB at 10wks
  – Target 12-14wks in regular shoes
    • With orthotics
  – *Physical therapy?*
Personal Preferences

• **ORIF**
  – Low energy injury
  – Athlete
  – Young and healthy

• **Primary arthrodesis**
  – High energy injury
  – Patient issues
    • IVDA
    • Workman’s compensation
    • Obesity
    • Elderly
    • Diabetic
    • Neuropathic
    • Intra-articular comminution
Conclusions

• Complex injury with high morbidity

• Goals of surgery
  – Sequential reduction
  – Anatomic reduction

• ORIF vs primary arthrodesis
Thank You

Zeeshan S. Husain, DPM, FACFAS, FASPS
zee@alum.mit.edu