Diagnosis and Treatment of Lisfranc Injuries of the Foot

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Disclosures

• I have nothing to disclose.
Objectives

• Demonstrate the mechanism of Lisfranc injuries of the foot.

• Examine non-operative and operative treatment of Lisfranc injuries.

• Discuss Lisfranc injuries in the athlete and return to play criteria.
Lisfranc injury

- Defined as any bony or ligamentous injury that involves the tarsometatarsal joints of the foot
- Failure to recognize these injuries can result in disability, deformity, and dysfunction.
- Must have high index of suspicion.
Lisfranc injury

- Jacques Lisfranc de St. Martin
  - 4/2/1790 - 5/13/1847
  - French surgeon and gynecologist
  - Described injury to midfoot in 1815 in soldiers on horses who fell from horse and had foot caught in stirrups during Napoleonic wars
  - Injuries led to vascular compromise of foot and required amputation through midfoot joints (easier than cutting bone)
Anatomy

- Includes all articulations between the tarsal bones and the bases of the 5 metatarsals.

- Bony stability by a Roman arch configuration of the 5 metatarsal bases and a recessed second metatarsal base as the Keystone.

- This creates a stable, rigid lever arm for ambulation.
Anatomy - Ligaments

- Interosseous > Plantar >> Dorsal ligaments

- Interosseous ligaments joint bases of second through fifth metatarsals only.

- Lisfranc ligament: thick oblique ligament from the base of the second metatarsal to the plantar aspect of the medial cuneiform. STRONGEST

- No transverse metatarsal ligament between the first and second metatarsals - explains some patterns
Anatomy - Ligaments
Etiology

- One in 50-55,000 per year in the United States.

- **20% are missed** or overlooked especially in poly-traumatized patient’s and purely ligamentous injuries.

- 43% MVA, 10% sports injuries, 13% crush injuries, 24% from falls, jumps and twisting injuries.

- Second most common foot injury in collegiate football players
Etiology

- Higher energy injuries often associated with significant bony injuries and compartment syndromes of the foot.

- Forceful torsion of the forefoot, significant axial loads with the foot in equinus or high energy crush injuries.

- **Direct injury**- crush injury. Depending on location of force, metatarsals can undergo plantar or dorsal dislocation.
Etiology

- Axial load applied to plantarflexed foot. Rupture of the weaker dorsal ligaments.

- Sports injuries by **indirect** injury.

- Can have plantar metatarsal base fractures and plantar capsule rupturing allowing metatarsal bases to displace dorsally leading to instability.

- Predominantly ligamentous pattern.

- Often see smaller avulsion type fractures ("fleck sign") off metatarsal bases.
Etiology

- Cleated athletes, twisting moment can create injury

- Individuals can be predisposed due to a relatively short second metatarsal relative to the foot or decreased depth of the second metatarsal mortise

- NFL cadaveric testing showed second ray needs to be engaged in the turf and hyperdorsiflexion of the MTP joint present

- Increase in injuries due to synthetic turf, less rigid shoes, bigger/stronger athletes?
Lisfranc Classification

Describe patterns of injury but do not help with treatment recommendations or prognosis.

Lisfranc Classification-subtle ligamentous injuries

**Classic injury:** typically must injure Lisfranc ligament and plantar ligament from first cuneiform and 2\(^{nd}\) and 3\(^{rd}\) MT bases

Proximal or **medial column variant** seen more often in high level football players.

Force extends through intercuneiform joint of medial and middle cuneiforms and exits naviculocuneiform joint.

Causes longitudinal instability
Injury Assessment

- History consistent with injury pattern
- Swelling over midfoot
- Plantar Ecchymosis - pathognomonic
- Pain with manipulation/stressing of TMT joints
- Unstable medial column with proximal variant
- Difficulty with push off or heel rise
- Inability to walk/weight bear
Imaging

- **Mandatory**: Standing AP, lateral, 30 degree oblique radiographs
- **Comparison views** of opposite side
- Look for **signs of injury**:
  - Loss of longitudinal arch height
  - Diastasis or subluxation of TMT or inter-metatarsal joints
  - Fractures of metatarsal bases
  - Cuboid fractures (nutcracker)
  - Avulsion fracture second metatarsal base ("fleck sign")
  - If negative but concerned, follow up weight bearing films 1 week
Imaging

• Stress Radiographs – painful and not as common (requires anesthesia)

• CT Scans: help define alignment, fractures, plantar comminution, diastasis. (Static study)

• MRI: helpful if normal x-ray and CT but clinical suspicion high
  – Rupture or grade 2 sprain of plantar ligament between cuneiform and 1st and 2nd MTs = UNSTABLE
  – Normal ligament = STABLE
Imaging Normal

- The first metatarsal aligns with medial cuneiform medially and laterally on AP and oblique views.
- The first intermetatarsal space corresponds with the first intertarsal space on AP and oblique views.
- The medial border of the second metatarsal aligns exactly with the medial edge of the middle cuneiform on AP view.
- The second intermetatarsal space aligns with the corresponding intertarsal space between the middle and lateral cuneiforms.
• The third intermetatarsal space is continuous with the intertarsal space between the lateral cuneiform and cuboid.

• The medial border of the fourth metatarsal forms a continuous line with the medial edge of the cuboid.

• On the lateral view, evaluation of the tarsometatarsal joints should demonstrate a non-interrupted line along the dorsal surface of the tarsal bone proximally and the corresponding metatarsal base distally. Any dorsal displacement is abnormal.
Imaging Normal

- Weight bearing lateral radiograph

- Normal shows **positive** value regarding position of fifth metatarsal plantar to medial cuneiform.

- Flattening of midfoot arch places medial cuneiform plantar to fifth metatarsal. A **negative** value.
  - (Faciszewski, T et al JBJS Am 1990;72:1519-1522.)
Imaging Abnormal
Imaging Abnormal
## Treatment Algorithm

<table>
<thead>
<tr>
<th>Step</th>
<th>Study</th>
<th>Result</th>
<th>Recommendation</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Physical examination</td>
<td>Plantar bruising, painful piano key test, midfoot swelling</td>
<td>Obtain weight-bearing radiographs unless injury is obvious with non-weight-bearing images</td>
<td>Weight-bearing radiographs are always useful, but oblique views may be helpful for the tentative patient</td>
</tr>
<tr>
<td>2</td>
<td>Radiography</td>
<td>Loss of arch on comparative weight-bearing lateral radiograph, widening between the first and second metatarsal bases on comparative AP views, fleck sign</td>
<td>ORIF is indicated with positive results. External rotation views are necessary when there is uncertainty based on plain radiographs or the patient cannot bear weight. When uncertainty remains, MRI is useful.</td>
<td>Any measurable subluxation is an indication for ORIF. When in doubt, proceed with further tests. On MRI, edema indicates midfoot injury, and subluxation confirms Lisfranc injury.</td>
</tr>
<tr>
<td>3</td>
<td>MRI</td>
<td>Edema at the tarsometatarsal joint, bone bruise, subluxation, or ligament tear</td>
<td>If edema but no ligament tear or subluxation, then CT is recommended. Perform ORIF in the presence of subluxation or a clear ligament tear.</td>
<td>MRI is more sensitive to edema in subtle injuries. CT may better illustrate subluxation, but MRI may show both.</td>
</tr>
<tr>
<td>4</td>
<td>CT</td>
<td>1 mm of subluxation</td>
<td>Strong evidence for Lisfranc injury when edema is noted on MRI and subluxation on CT. ORIF is indicated.</td>
<td>MRI with edema and no ligament tear combined with normal CT requires stress examination under anesthesia, with possible ORIF</td>
</tr>
<tr>
<td>5</td>
<td>Stress examination</td>
<td>Subluxation</td>
<td>ORIF</td>
<td>When negative, treat as a sprain</td>
</tr>
</tbody>
</table>

Treatment – Stable Injuries

Initial treatment is 2-8 weeks of non-weight bearing or protected weight bearing either in a short leg cast or walker boot.

Serial radiographs taken to ensure no changes which warrant surgery

Recovery can be 2-4 months depending on injury pattern

Return to sport with orthosis/taping based on criteria
Treatment: Unstable Injuries - Surgery

- Any diastases or subluxation

- Open injuries or compartment syndrome.

- Severe dislocations urgently reduced

- Often associated with significant swelling necessitating delaying surgery for 10-14 days until soft tissue envelope stabilized.

- **Anatomic Reduction**: 50-95% G/E result compared to 17-30% non anatomic
Treatment: Open Reduction Internal Fixation

- Traditional gold standard is interosseous trans-articular solid screw fixation to hold reduction while the ligament heals.

- For proximal or medial column ligamentous variant injuries, it is essential to perform fixation across the 2 medial cuneiforms as well as between the medial cuneiform and second metatarsal base.

- Bridge plating becoming popular
  - Avoids damage to articular cartilage
  - Avoids broken hardware in joint
Treatment: Primary arthrodesis

- Ly TV, Coetzee JC. JBJS 2006
  - Primarily ligamentous
  - Prospective randomized series
  - ORIF (20) vs arthrodesis (21)
  - 5 pts ORIF eventually had fusion
  - Fusion group: 92% of preinjury level
  - ORIF group: 65% of preinjury

- Henning JA, et al. FAI 2009
  - 40 patients
  - Prospective, randomized
  - ORIF vs primary arthrodesis
  - No difference in groups in SF-36, SMFA or final satisfaction ratings
  - Lower reoperation rate in primary fusion patients (hardware removal or conversion of ORIF to fusion)
Treatment: Missed injuries

- Arthrodesis for late/subacute presentations or cases of severe cartilage damage

- Cassinelli, SJ et al. FAI 2016
  - 8 patients, ave age 39.8, retro review
  - Low energy injuries
  - Time to surgery 15.1 (6.3-31.1) wks
  - All ORIF
  - Ave 3.1 year follow up
  - Delayed ORIF resulted in fair/good outcome scores and all returned to work or pre injury sports
Lisfranc: Operative Technique

• Regional block and general anesthesia.
• Dorsomedial incision between the first and second metatarsals. If necessary a second dorsal incision between the third and fourth metatarsals.
• Loose bodies removed, all soft tissue structures including ligaments preserved to assist with scar formation.
• All unstable joints are reduced and maintained with reduction clamps or K wires.
• Stabilize intercuneiform joint, first TMT joint, then Lisfranc joint with a “home run” screw
Lisfranc: Operative Technique

- Use of solid cortical screws (3.5-4.0 mm)
- Extra-articular screws for permanent fixation.
- Bridge plating
- Temporary K wire fixation for lateral column injuries
- Endobutton
Lisfranc Postoperative Management

- Non-weightbearing 6 weeks after injury for ORIF, 10 weeks for primary arthrodesis
- Robert Jones compression wrap with posterior splint 2 weeks.
- Removable boot or short-leg fiberglass cast for 4 weeks.
- Progressive weightbearing in removable boot with arch support and transitioning to normal shoewear by 3 months.
- If ORIF: Screws or plate removal at 4-6 months postoperatively for any hardware which crosses the TMT joint
Lisfranc Rehab – Progressing Plantarflexion Strength

Progress athlete to next level, once each exercise is completed pain free, with proper technique:

- Bilateral heel raises in standing
- Bilateral heel raise, single leg eccentric lower
- Single leg heel raise from standing
- Bilateral leaning heel raises, single leg eccentric lower
- Single leg leaning heel raises
- Single leg triple extension heel raises
- Mini-tramp low impact exercises:
  - Bilateral 2-legged jumps in place
  - ¼ turns in place
  - ½ turns in place
  - Jog in place
  - 3 hops uninvolved, 1 hop involved
  - 2 hops uninvolved, 2 hops involved
  - 1 hop uninvolved, 3 hops involved
- Agility ladder:
  - Various 2 foot sagittal frontal and transverse plane patterns
  - Hopscotch to involved side (2 feet to 1 foot)
  - Single leg A/P hops in place (All in place hops 1:2 work:rest ratio)
  - Single leg M/L hops in place
  - Single leg transverse plane hops in place
  - Single legs hops in agility ladder, multi-plane

(From Lorenz et al., IJSPT 8.2 (2013): 162.)
Lisfranc: Outcomes

- Significant injury to the midfoot. Anatomic reduction is critical.

- Despite this, patient’s often have residual pain or dysfunction.

- Teng AL, Pinzur MS, et al FAI 2002 showed that despite excellent restoration of normal anatomic relationships, the average AOFAS ankle-hindfoot score was 71 with most patients reporting discomfort with normal activities.

- Kuo,RS et al. JBJS 2000 48 patients with 4.5 yr follow up AOFAS score 77. 12 had DJD on xray, 6 required arthrodesis
• 28 NFL athletes with Lisfranc injury. 90% return to play an average 11.1 months
  (McHale KJ, Rozell JC et al AJSM 2016)

17 pro soccer and rugby players in Europe. 94% return average 25 weeks
With bony injuries longer.
(Deol RS, Roche A. AJSM 2016)

For athletes with moderate pain which necessitates arthrodesis of the midfoot there is a little data evaluating outcomes and ability to return to play.

A recent poll of 103 members of the AOFAS showed only 65% recommending patient’s return to high impact sports
Conclusion

- Lisfranc Injury is often missed
- Must be aware of mechanism and signs of this injury on exam.
- Can lead to disability, deformity and dysfunction if not treated.
- Anatomic reduction gives the best outcome.
- Must educate patients regarding the fact that they may have a well aligned foot that is stable, but may have stiffness and residual pain afterwards.
- They may require additional surgery in the future.
Thank You
References

• Cassinelli, SJ, Moss, LK et al. Delayed open reduction internal fixation of missed, low energy Lisfranc injuries. Foot Ankle Int. 2016;37(10) 1084-1090.


References

• Teng, AL, Pinzur MS et al. Functional outcome following anatomic restoration of the tarsal -metatarsal fracture dislocation. Foot Ankle Int. 2002;23(10):922-926.

• Vertullo, CJ, Nunley JA. Participation in sports after arthrodesis of the foot or ankle. Foot Ankle Int. 2002;23(7):625-628.

Confidentiality Statement

This M&M conference/case review session is being conducted solely for medical study purposes to reduce patient morbidity and mortality, and for purposes of improving the quality of patient care. All information shared and discussion that takes place during the course of this meeting is therefore privileged and confidential under the Illinois Medical Studies Act. In order to maintain this privilege and the confidentiality of this information, we ask that further discussion of this(these) case(s) not take place outside of the context of this M&M conference.
Case

TC    22 yr old college football player, foot planted and hit - 2007
Case
2009-10 follow up - 3 yrs post op
2015 College FB coach- *increased* pain 8 yrs post op
9 yrs post injury - arthrodesis
Case

ZM  17 yr old fullback tackled from behind. X-rays negative.
Case
Case
Case

DB- 6’2  280 lb tackle. Stepped on by another lineman. Scouted by mult Div 1 teams, Senior year
Case

Counseled extensively on injury and recommendation for surgery. Patient and parents did not want to miss Senior year and elected conservative treatment. Treated with boot and PT. McConnell taping and orthoses for return to football. Pain free at 4 months, playing intramural basketball without pain at 6 months. Multiple D1 offers for football.
Case
CL – Motorcycle MVA
Initial NWB views
Standing views
One year post op. C/O 1st TMT pain.
Using orthotics. Discussed possible fusion if worsens
Case

DJ: 49 yr old presents 2 weeks s/p twisting foot in pothole in parking lot. Seen in ER and dx with “sprain.” Told to wrap foot. Unable to walk.
Suspicion of Lisfranc warrants CT scan which shows fleck signs, mild widening. Nondisplaced cuneiform fx. To discuss treatment options.
4 weeks post injury
To discuss CT findings
Weight bearing view shows widening!

Vigilance!!!