Lisfranc Fracture: Past Principles & New Perspectives

APMA Annual Scientific Meeting 2018

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University of Maryland School of Medicine
Consultant: Orthofix

Consultant: Smith and Nephew
“We Have Arrived...”
“We Have Arrived...”
What we know...

- **QUENU & KUSS, 1909**: FIRST CLASSIFICATION SYSTEM / FOUNDATION FOR CURRENT SCHEMES

- **ANATOMIC REDUCTION**: FIRST ADVOCATED IN 1950’S / FURTHER EMPHASIZED IN 1980’S

- **ARNTZ & HANSEN, 1988**: ORIF / RIGID INTERNAL FIXATION / BECAME STANDARD OF CARE

- **OSSEOUS-LIGAMENTOUS VS. PURELY LIGAMENTOUS INJURY**
  - INTERCUNEIFORM / NAVICULAR / CUBOID / METATARSAL EXTENSION
Is there prognostic value??

N=68 pts
AOFAS 88.4
Type A, C carry worse prognosis compared to Type B
<table>
<thead>
<tr>
<th>Low Energy</th>
<th>High Energy</th>
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<tbody>
<tr>
<td>&lt; 2mm diastasis without arch collapse</td>
<td>With intra articular involvement</td>
</tr>
<tr>
<td>2-5mm diastasis <strong>without</strong> arch collapse</td>
<td>(+) Comminution + Intra-articular</td>
</tr>
<tr>
<td>- Perform stress evaluation</td>
<td></td>
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<tr>
<td>- If unstable → <strong>ORIF</strong></td>
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<tr>
<td>2-5mm diastasis with arch collapse</td>
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<tr>
<td>- <strong>ORIF</strong></td>
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</table>
Anatomy / Biomechanics

• INHERENT BONE STABILITY

• ROMAN ARCH CONFIGURATION:

• Dorsally based TRAPEZOID 2ND MT KEYSTONE provides PLANTAR STABILITY to midfoot

• Ligamentous support
  – Dorsal / Plantar
  – Intra-osseous Lisfranc ligament

Rettedal et al. J Foot Ankle Res 2013
Secondary Stabilizers

- Plantar Fascia
- Peroneus Longus
- Adductor Muscle
- Intrinsic musculature
Neurovascular Bundle

• Terminal branches of *dorsalis pedis* artery

• Deep peroneal nerve dives deep

• *(Tethered)* distal to metaphysis of second metatarsal
Angiology
Excessive lateral torsion violence to the foot and ankle: a case report and algorithm for treatment.

Jacob Wyman, DPM, MS, AAFAS, Levester Kirksey, MD, MBA

1. Clinical Fellow, Baltimore, MD
2. Vascular Surgeon, Heart and Vascular Institute, Cleveland Clinic Foundation, Cleveland, OH

Assessing Vascular Status and Risk of Latent Ischemia with Ankle Fracture: A Case Report and Algorithm for Treatment

William Gissane

JBJS 1951

Tibial Artery (retromalleolar) at junction with Lateral Plantar artery or Posterior Tibial Artery (retromalleolar)
Presentation

• Clinical
  – Assess for NV status
  – Assess for compartment syndrome
  – Assess swelling

• Radiographic
  – XRAY
  – CT
  – MRI

• “Delayed Stress Test”:  
  – If uncertain:
    – BOOT IMMOBILIZATION / WBAT /
      REPEAT WB XR IN 7-10 DAYS
Gravity Stress Evaluation

Safavi et al. Cureus 2017
Some Statistics

- Exceedingly rare (0.1 - 0.9% of all fx)
  ~ 1/55,000

- Dorsolateral displacement of 2nd metatarsal base is 1-2mm = reduction of 13.1 - 25.3% TMT contact area
  - Yamamoto et al. JOT 1992

- 20-40% of patients are not treated in a timely manner
  - Mostly with polytrauma
Mechanism of Injury

• DIRECT:
  – CRUSH INJURIES
  – INDUSTRIAL ACCIDENTS
  – SIGNIFICANT SOFT TISSUE INJURY

• INDIRECT:
  MORE COMMON
  – HYPERDORSIFLEXION / AXIAL LOAD +/- ROTATIONAL FORCES:
    MVA / FALL FROM HEIGHT / FORCED ABDUCTION: CUBOID FX

  – HYPERPLANTARFLEXION / AXIAL LOAD +/- ROTATIONAL
    FORCES: SPORTS / GROUND LEVEL FALL / MORE SUBTLE:
    MIDFOOT “SPRAIN”
Car Accidents and Forefoot Injuries

Smith et al. Traffic Inj Prev 2005

- Foot + pedal vs. floor board interaction assessed
- 54 cadaver limbs

- 0, 35-50 degree plantarflexion assessed

- 65% injured at speeds of 28 - 36 mph and 13-27 mph
  - (no worse)

- Lisfranc fracture dislocation and metatarsal fractures noted at all PF positions

- Fewer injuries when pressing on brake at 0 degrees PF
Treatment Options

• **MIDFOOT “SPRAIN”: Stable by definition**
  - WBAT IN FX BOOT / ARCH SUPPORT
  - Prolonged recovery (~ 3 MO)

• **ORIF/TRANSARTICULAR SCREWS**
  - True open reduction required / Cortical (non lag screws)
  - Screws can lead chondral damage
  - 2 - 4.8% of cartilage (Alberta et al. FAI 2005)
  - Rigid fixation preferred with trans-articular screws (Hansen et al. FAI 1990)

• **PERCUTANEOUS REDUCTION**
  - Soft tissue interposition
  - Difficult to correction rotational displacement (coronal plane)
  - K-WIRE FIXATION
  • Not rigid and high risk for latent displacement
Controversy

- **ORIF VS. PRIMARY ARTHRODESIS**
- **SCREW REMOVAL / TIMING:**
  ~ 12 - 16 weeks, 4-9 months
- **FIBROUS ANKYLOSIS (if screws left in)**
- **Risk late displacement @ 9-12 MONTHS**

- **BRIDGE PLATES:**
  Avoids further chondral damage / PEDS ; GOLD STANDARD IN UK
  - 90% patient satisfaction compared to screws (80%)
  - Comparable outcome after
  - Van Koperen et al. JFAS 2016

- **PERCUTANEOUS PINNING** for minimal displacement and with accuracy of reduction
  - Puna et al. Foot Ankle Clin 2017

- **SUTURE BUTTON DEVICE**
  - Role in isolated injuries / athletes (?) Similar MECHANICAL STABILITY
  - Greater diastasis compared to screw fixation
It's about getting the job done...
Plates, Screws, or Both?

Lau et al. JFAS 2016

- 6 year retrospective cohort
- \( n = 62 \)

- Combined fixation vs. bridge plating: 3x increased risk of severe DJD

- Plate fixation causing more PLANUS foot type

- Logistic regression:
  - Based on QUALITY OF REDUCTION
  - Hardcastle classification not predictive of outcome
Some Agreement

• AOFAS above 75 after surgery

• Anatomic reduction = 35% OA compared to 80% with non-anatomic reconstruction
  – Adib et al. 2011

• DJD is present regardless 35-94%
  – Buzzard et al. CORR 1998
  – Sangeorzan FAI 1990
  – Kuo et al. JBJS 2000

• Reoperation rate of 75 - 79% (ORIF) vs. 17-20% (Arthrodesis)
  – Henning et al. FAI 2009
  – Ly et al. JBJS 2006

• Small fragment 3.5 / 4.0mm screws preferred
• Only 3 papers (101 patients) met the “quantitative synthesis” / meta-analysis (initial: 1192 reviewed)

• Nonanatomic alignment can occur in either group (OR 1.48)

• HWR more in ORIF group p < 0.001

• No difference in requiring revision surgery (OR 0.36)
  - Loss of correction
  - Hardware failure
  - Post traumatic arthritis
• ORIF 20 vs. 22 PA
• Mean 43 month follow up
• AOFAS 68.6 vs. 88
  – p < 0.005
• Deformity and DJD with ORIF group (15 patients)
• Decreased pre operative function in the ORIF group (65% vs. 92%)
  – p < 0.005
Level 1 prospective RCT (5 year)

n=40 patients 24 - 53 month follow up

Increased HWR ORIF group (78.6% vs. 16.7%)

PA group with 94% fusion / 17% additional surgery

No difference in physical functioning (SF-36 / SMFA)

All patients did worse with function at 3 months compared to 6, 12, 24 months
n=28 patients retrospective study

- 12 PA group; 16 ORIF group

- Use of 4.5mm screws

- 6 weeks PWB in surgical shoe

- FWB @ 10 weeks

- ORIF screws removed at 12 weeks

- K wires removed at 6 weeks

- Baltimore painful foot score assessed
  - Higher subjective score ORIF group
  - No difference with partial arthrodesis

- Recommendation for ORIF (or) “partial arthrodesis” (1,2,3 TMT)

- Poor anatomic reduction leads to increased surgery in ORIF group

Table 2

<table>
<thead>
<tr>
<th></th>
<th>Partial Arthrodesis</th>
<th>Complete</th>
<th>ORIF</th>
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<tbody>
<tr>
<td>Baltimore Painful Foot score</td>
<td>66% G-E (4/6)</td>
<td>33% (2/6)</td>
<td>68% (11/16)</td>
</tr>
<tr>
<td>Revisional surgery</td>
<td>17% (1/6)</td>
<td>17% (1/6)</td>
<td>12% (2/16)</td>
</tr>
<tr>
<td>Radiological results</td>
<td>66% (4/6) anat.red.</td>
<td>66% (4/6)</td>
<td>75% (12/16)</td>
</tr>
<tr>
<td>Pseudarthrosis</td>
<td>33% (2/6)</td>
<td>33% (2/6)</td>
<td>/</td>
</tr>
<tr>
<td>RSD</td>
<td>0% (0/6)</td>
<td>50% (3/6)</td>
<td>33% (2/6)</td>
</tr>
</tbody>
</table>
Comparison of Arthrodesis and Non-fusion to Treat Lisfranc Injuries

Yu-sen Qiao, MD¹, Jun-kun Li, MD¹, Hao Shen, MD¹, Hai-yan Bao, MD¹, Ming Jiang, MD¹, Yan Liu, MD¹, Wasim Kapadia, BASc², Hong-tao Zhang, MD, PhD¹, Hui-lin Yang, PhD¹

Department of Orthopaedics, the First Affiliated Hospital of Soochow University, Soochow, China and ²Department of Chemical Engineering, University of Waterloo, Waterloo, Ontario, Canada

- 8 arthrodesis vs. 7 ORIF
- AOFAS (94 vs. 88.58 p = 0.034)
- 1 year follow up only
- Increased abduction deformity in ORIF group
Who has looked at this?

**Table 1**

<table>
<thead>
<tr>
<th>Author</th>
<th>Study Design</th>
<th>Fixation Type</th>
<th>No. of Patients</th>
<th>True N&lt;sup&gt;a&lt;/sup&gt;</th>
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<tbody>
<tr>
<td>Arntz et al&lt;sup&gt;6&lt;/sup&gt;</td>
<td>PCS</td>
<td>ORIF</td>
<td>40</td>
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<tr>
<td>Mulier et al&lt;sup&gt;12&lt;/sup&gt;</td>
<td>PCS</td>
<td>ORIF vs primary arthrodesis</td>
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<tr>
<td>Kuo et al&lt;sup&gt;17&lt;/sup&gt;</td>
<td>RR</td>
<td>ORIF</td>
<td>48</td>
<td>42</td>
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<tr>
<td>Ly &amp; Coetzee&lt;sup&gt;18&lt;/sup&gt;</td>
<td>PRC</td>
<td>ORIF vs primary arthrodesis</td>
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<td>41</td>
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<td>Rajapakse et al&lt;sup&gt;19&lt;/sup&gt;</td>
<td>RR</td>
<td>ORIF</td>
<td>25</td>
<td>17</td>
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<tr>
<td>Teng et al&lt;sup&gt;20&lt;/sup&gt;</td>
<td>RR</td>
<td>ORIF</td>
<td>11</td>
<td>11</td>
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**Table 2**

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<th>Procedure</th>
<th>Kuo et al&lt;sup&gt;17&lt;/sup&gt;</th>
<th>Ly &amp; Coetzee&lt;sup&gt;18&lt;/sup&gt;</th>
<th>Rajapakse et al&lt;sup&gt;19&lt;/sup&gt;</th>
<th>Teng et al&lt;sup&gt;20&lt;/sup&gt;</th>
<th>Mean AOFAS</th>
<th>Significance</th>
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<tbody>
<tr>
<td>ORIF</td>
<td>80.2</td>
<td>68.6</td>
<td>70.3</td>
<td>71.0</td>
<td>72.5</td>
<td>NA</td>
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<tr>
<td>Arthrodesis</td>
<td>NA</td>
<td>88.0</td>
<td>NA</td>
<td>NA</td>
<td>88.0</td>
<td>NA</td>
</tr>
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What is the **LEAST** fixation I can get away with?

**Mayne et al. Injury 2017**

- Cadaveric study (Thiel ebalmed)

- No need to stabilize 1\textsuperscript{st} or 3\textsuperscript{rd} ray if intermetatarsal ligament 3 and 4 are intact

- **Homerun screw + 4/5 K-Wire sufficient for fixation** (after division of lisfranc ligament)

- No further displacement noted with this construct

- Also advocate for **distal to proximal screw insertion**
Greater than 10 YEAR FOLLOW UP
Marin-Pena et al. Injury 2012

- Poor overall association of radiographic findings and clinical scores

- N = 35 retrospective chart review (closed reduction vs. Perc pinning / ORIF)

- Although not statistically significant, observation of initial reduction with improved clinical results

- Latent diastasis is possible with premature hardware removal
New Developments?

ACFAS Clinical and Scientific Research Grant

2016 Recipients:

• Erin Klein, DPM, MS, FACFAS
• Sarah Haller, DPM, AACFAS
• Lowell Weil, Jr. DPM, MBA, FACFAS
• Lowell S. Weil, Sr. DPM, FACFAS
• Adam E. Fleischer, DPM, MPH, FACFAS

Cost-effectiveness Analysis of Primary Arthrodesis versus Open Reduction Internal Fixation for Primarily Ligamentous Lisfranc Injuries

Primary Arthrodesis preferred with respect to cost

JFAS 2018
Incision placement

- Medial incision between first and second metatarsals
- Centered over 4\textsuperscript{th} metatarsal
Pearls of ORIF

• **2-INCISION APPROACH**

• Adduct / derotate (establish cortical ridge of 1st TMTJ

• Fixate medial to lateral

• **ANTEROGRADE SCREW ALONG DORSAL CORTICAL RIDGE**

• **RETROGRADE SCREW LATERAL / PARALLEL TO RETROGRADE SCREW**

  3.5mm CORTICAL SCREWS (COUNTERSINK)

• **Pointed reduction clamp / preserve ROMAN ARCH (AIM UP) → 3.5MM CORTICAL LAG SCREW**

• **BRIDGE PLATES FOR COMMINUTION** (2.0-2.4mm RECON PLATES)

• **TRAP SCREW**: 3RD MT BASE TO INTERMEDIATE CUNEIFORM

• IF POOR PURCHASE 2ND MT BASE to KEYSTONE

• **4TH & 5TH TMT** reduce indirectly / 1.6MM K-WIRES
Pearls of Midfoot Fusion

- **Contraindicated**: skeletal immaturity, active infection, simple incomplete ligamentous injury (non multi-planar)

- Typically **medial** and **middle** columns

- **Avoid** under-correction / forefoot rotation - suppination

- **Generous incisions** for exposure and protection of neuro-vasculature

- Consider **prepping lateral base of metatarsals**

- Peroneal tendon release PRN

- **PF first ray** (Hubchur maneuver)
Realignment Midfoot Osteotomy

NC / TN subluxation secondary to load failure

Lamm et al. In Press
Correction of Midfoot Abduction Deformity

C. Wedge removed

D. Angulation corrects abduction deformity but residual translation remains

E. Lateral forefoot translation corrects alignment

Normalized MAD

Lamm et al.
“Interesting Cases”
Case #1: 21 yF with acute ligamentous Lisfranc fracture dislocation / comminution

PMH: HIV
My preferred ORIF Construct

6 month follow up
Without Comminution
Case #2: 60 yF reports of claustrophobia in casting and inability for NWB
Immediate WB after Lisfranc ORIF
Lisfranc ORIF with Ex Fix
Intra operative reduction and fixation
Immediate Post Op Clinical
Post Operative -- 3 months
Post Operative 1 year
Case #3: 66 yM status post MVC restrained driver with Lisfranc fracture dislocation, compartment syndrome, and hemoperitoneum. No other polytrauma
Preoperative
Preoperative
Fasciotomies Performed

- Interrossei 40’s
- Medial 40’s
- Lateral 50
- Plantar superficial /Deep: 60’s
Closed Reduction Percutaneous Pinning
Staged Metatarsal Pinning
3 Month Post Operative
Lisfranc Fracture Dislocation with Neuroarthropathy
Conclusions

• **No true consensus** exists between ORIF or Fusion with lisfranc fracture dislocation

  • If fusing, **avoid 4,5 cuboid articulation**

• For ORIF, “**homerun screw**” acceptable if inter-metatarsal ligament 3,4 intact

  • **Anatomic reduction** the most important prognostic factor

    • Most patients will get arthritis

• Although rare, **compartment syndrome** can be limb threatening if left untreated
Thank You