Simulated Weight Bearing and Articular Injury From Transarticular Screws in a Ligamentous Lisfranc Injury Model

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I (and/or my co-authors) have something to disclose.

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- Optimal treatment of Lisfranc injuries is controversial
- Morbidity from transarticular screws may lead to symptomatic arthritis, complications from broken hardware and further surgery
- Articular injury from transarticular screws has been shown
- Other treatment options, such as dorsal locked plating offer unique advantages over transarticular screw fixation
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Objectives

- Create a cadaveric ligamentous Lisfranc injury model
- Measure articular injury from transarticular screw placement before & after simulated weight bearing
- Compare rigidity of screw fixation and dorsal locked plating by measuring diastasis and total relative rotation between several bony landmarks
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Methods

• Ten fresh frozen cadavers (20 specimens)
• Randomized to transarticular screw fixation vs. dorsal locked plating
• Cyclic loading of specimen
• Rotation and diastasis between 4 points measured (C1, C2, M1, M2)
• Digital photographs were used to calculate articular surface damage (%)
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20 cycles in native state → In situ/anatomic screw vs plate fixation → 20 cycles in disrupted state → Lisfranc Fixation → 20 cycles with fixation → 1,000 cycles

- Hardware removal
- Photos taken
- Lisfranc Injury Created
- Lisfranc arthrotomies completed
- Photos taken
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Results

- After ligament sectioning, significantly increased motion was seen in our model to suggest successful creation of Lisfranc injury
- A significant increase (44%, p<0.0001) in articular injury from transarticular screw fixation occurred after simulated weight bearing

<table>
<thead>
<tr>
<th>Surface</th>
<th>% injury Pre-</th>
<th>% injury post-</th>
<th>Relative Increase in Articular injury</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>2.97%</td>
<td>4.26%</td>
<td>43.51%</td>
<td>0.0387</td>
</tr>
<tr>
<td>M1</td>
<td>2.96%</td>
<td>3.99%</td>
<td>34.71%</td>
<td>0.0083</td>
</tr>
<tr>
<td>C2</td>
<td>3.41%</td>
<td>4.92%</td>
<td>44.24%</td>
<td>0.0292</td>
</tr>
<tr>
<td>M2</td>
<td>3.13%</td>
<td>4.81%</td>
<td>53.89%</td>
<td>0.0047</td>
</tr>
<tr>
<td>All Surfaces</td>
<td>3.11%</td>
<td>4.49%</td>
<td>44.22%</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>
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Results

- After surgical fixation, plated specimens had a higher total relative rotation between C1 and M2 (+2.3°, p=0.008), and between C1 and C2 (+2°, p=0.02)
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Results

- After surgical fixation, plated specimens had a greater increase in diastasis between C1 and M2 (0.8 mm vs. 0.3 mm, p = 0.019)

<table>
<thead>
<tr>
<th>Increase in Diastasis</th>
<th>Plate</th>
<th>Screw</th>
<th>Statistical difference between groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average (SD)</td>
<td>Range</td>
<td>Average (SD)</td>
</tr>
<tr>
<td>C1 - M2 interface</td>
<td>0.8 (0.9) mm</td>
<td>0 to 3.2 mm</td>
<td>0.3 (0.3) mm</td>
</tr>
<tr>
<td>C1 - M1 interface</td>
<td>0.1 (0.2) mm</td>
<td>0 to 0.7 mm</td>
<td>0.3 (0.3) mm</td>
</tr>
<tr>
<td>C2 - M2 interface</td>
<td>0.2 (0.3) mm</td>
<td>0 to 0.9 mm</td>
<td>0.1 (0.1) mm</td>
</tr>
<tr>
<td>M1 - M2 interface</td>
<td>0.2 (0.4) mm</td>
<td>0 to 1.0 mm</td>
<td>0.3 (0.4) mm</td>
</tr>
<tr>
<td>C1 - C2 interface</td>
<td>0.6 (0.5) mm</td>
<td>0.2 to 1.6 mm</td>
<td>0.1 (0.2) mm</td>
</tr>
</tbody>
</table>
Conclusions

• Articular injury from transarticular screws increased after simulated weight bearing

• Based on our results, transarticular screws appear to be slightly more rigid than dorsal locked plating
  – Further investigation is warranted to determine the clinical significance of this small difference

• Dorsal locked plating alone may be insufficient to restore stability to the Lisfranc complex and an additional ’Lisfranc’ screw may be beneficial
  – Previous assumptions may be incorrect
  – This would still be an ‘extra-articular’ construct

• While each fixation strategy has its own advantages, the lack of articular injury with dorsal locked plating should be considered when deciding between these treatments
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References