Comparing the Fixation Stability of the Dorsal Lisfranc Plate to Transarticular Screws: A Biomechanical Study in Cadaveric Feet

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Disclosure

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- Treatment of low-energy, ligamentous Lisfranc injuries requires anatomic reduction through ORIF, commonly with transarticular screws across the 1\textsuperscript{st} and 2\textsuperscript{nd} tarsometatarsal joints and the Lisfranc joint.
- Concerns regarding iatrogenic cartilage injury & hardware removal difficulty with screws.
- Recent dorsal plating techniques stabilize the Lisfranc joint without risk of iatrogenic cartilage injury and allow for easier hardware removal.
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- Biomechanical studies comparing two dorsal tarsometatarsal (TMT) plates vs. transarticular screws under physiologic loading conditions (Alberta et al. 2005)
  - No difference in stability to axial loading

- Limitations of this study:
  - Use of only TMT fixation, without any fixation across the Lisfranc joint
  - With this fixation construct, there is a lack of transverse stability in the mediolateral plane of the Lisfranc joint that was not tested
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- A novel dorsal Lisfranc plate has been developed that theoretically allows for both axial and mediolateral stability.
- **Objective:** To compare the fixation stability of the dorsal Lisfranc plate to transarticular screws in a ligamentous Lisfranc cadaveric model.
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**METHODS**

- Thirteen matched pairs of frozen cadaver legs were fixed in 15° of ankle plantarflexion, to correspond with the foot position during the toe-off phase of the gait cycle when the midfoot experiences the maximum amount of load.

- We biomechanically tested the stability of the Lisfranc joint complex pre-injury, after a ligamentous Lisfranc injury, and after fixation.
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**METHODS**

- For each cadaver, we simulated both the **abduction force** and **axial load** experienced by the 1st metatarsal during the toe-off phase of gait.
- The medial forefoot experiences an abduction force of 5% of the body weight during toe-off, if we assume a 200 lb. patient, we estimated the ground reaction force to be a maximum of 44.5 N.
- For axial load, we utilized a maximum axial load of 230 N, as previously described.
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METHODS

- 2D & 3D motion of the first and second metatarsal and medial and middle cuneiform were recorded using a motion capture system.

- We compared the 2D & 3D motion between all points of interest under axial and abduction loading in all three tested states. We then compared the motion between the contralateral sides for each pair of legs.
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RESULTS

- Under **Abduction Loading** conditions:
- No significant differences in mediolateral or 3D motion between the Lisfranc plate and transarticular screws.

<table>
<thead>
<tr>
<th>Joints (M = metacarpal C = cuneiform)</th>
<th>Mediolateral Motion*</th>
<th>P-value</th>
<th>3D Motion*</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1M-1C</td>
<td>0.2 (0.6)</td>
<td>0.32</td>
<td>0.0 (0.4)</td>
<td>0.83</td>
</tr>
<tr>
<td>2M-2C</td>
<td>0.0 (0.2)</td>
<td>0.89</td>
<td>-0.1 (0.4)</td>
<td>0.42</td>
</tr>
<tr>
<td>1M-2M</td>
<td>-0.1 (0.3)</td>
<td>0.30</td>
<td>0.0 (0.1)</td>
<td>0.35</td>
</tr>
<tr>
<td>Lisfranc joint: 2M-1C</td>
<td>0.3 (0.8)</td>
<td>0.45</td>
<td>0.3 (0.7)</td>
<td>0.16</td>
</tr>
</tbody>
</table>

*Average differences between plate and screw conditions with SD in parentheses. Positive values represent diastasis and negative values represent compression.
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RESULTS

• Under Axial Loading conditions:
  • No significant differences in shear or 3D motion between the Lisfranc plate and transarticular screws.

<table>
<thead>
<tr>
<th>Joints (M = metacarpal, C = cuneiform)</th>
<th>Shear Motion*</th>
<th>P-value</th>
<th>3D Motion*</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1M-1C</td>
<td>0.2 (0.5)</td>
<td>0.16</td>
<td>-0.1 (0.9)</td>
<td>0.82</td>
</tr>
<tr>
<td>2M-2C</td>
<td>-0.1 (0.4)</td>
<td>0.63</td>
<td>-0.7 (1.8)</td>
<td>0.21</td>
</tr>
<tr>
<td>1M-2M</td>
<td>0.0 (0.4)</td>
<td>0.97</td>
<td>0.0 (0.2)</td>
<td>0.99</td>
</tr>
<tr>
<td>Lisfranc joint: 2M-1C</td>
<td>0.3 (0.1)</td>
<td>0.21</td>
<td>0.0 (0.6)</td>
<td>0.80</td>
</tr>
</tbody>
</table>

*Average differences between plate and screw conditions with SD in parentheses. Positive values represent diastasis and negative values represent compression.
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CONCLUSIONS

• No difference in stability between the dorsal Lisfranc plate and transarticular screw fixation under physiologic loading conditions.

• First biomechanical study to evaluate the mediolateral stability of the Lisfranc joint after fixation in a cadaveric model.

• First study to evaluate the stability of the dorsal Lisfranc plate under physiologic loading conditions.


