Development of a cadaveric Hallux rigidus model. Biomechanical testing

Diego Zanolli, Emilio Wagner, Pablo Wagner, Cristián Ortiz, Andrés Keller, Ruben Radkievich, Felipe Palma, Rodrigo Guzmán
Disclosure

- **No conflicts to disclose**
- Development of a cadaveric Hallux rigidus model. Biomechanical testing
  - Diego Zanolli, MD
  - Emilio Wagner, MD
  - Pablo Wagner, MD
  - Cristian Ortiz, MD
  - Andres Keller, MD
  - Ruben Radkievich, MD
  - Felipe Palma, PT
  - Rodrigo Guzmán, PT, PHD

- Our disclosures are in the AOFAS mobile App.
- We have no potential conflicts with this presentation
Introduction

- Theory: plantar fascia shortening is a starting factor for hallux rigidus development
  - Creates
    - Increased MTP stiffness
    - Decreases MTP range of motion
    - Progressive impingement at the metatarsal head dorsum
    - dorsal bone spur

Maceira E, Monteagudo M. FA Clinics, 2014
Development of a cadaveric Hallux rigidus model. Biomechanical testing
Objective

• To develop a biomechanical cadaveric model that restricts motion and stiffens the metatarsophalangeal (MTP) joint

Maceira E, Monteagudo M. FA Clinics, 2014
Methods

• 8 foot specimens
• 50% of stance phase force tension was applied to every tendon
• EHL was attached to actuator of tensile testing machine (Kinetecniks®, Santiago Chile)

Development of a cadaveric Hallux rigidus model. Biomechanical testing
Methods

• 10 cycles of Hallux dorsal and plantarflexion by pulling of the EHL tendon
  – Control group
  – Shortened fascia group:
    • 6 mm plantar fascia Shortening (triple non absorbable suture)

Development of a cadaveric Hallux rigidus model. Biomechanical testing
Methods

• Outcomes measured for control group and shortened plantar fascia group

  – Hallux MTP stiffness
    • resistance to Hallux motion, Newtons/Degree of motion
  – Hallux range of motion (ROM)
    • using 8 high definition cameras and luminous markers on the Hallux
Results

• Decreased **MTP range of motion** in shortened plantar fascia group:
  • 21.2 degrees vs 23.7 degrees (p≤0.05)

Table:

<table>
<thead>
<tr>
<th>cond</th>
<th>N</th>
<th>min</th>
<th>p25</th>
<th>p50</th>
<th>p75</th>
<th>max</th>
<th>mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8</td>
<td>10.03</td>
<td>14.195</td>
<td>21.255</td>
<td>33.4</td>
<td>42.04</td>
<td>23.72125</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>8.47</td>
<td>17.1</td>
<td>18.03</td>
<td>21.24</td>
<td>45.01</td>
<td>21.22714</td>
</tr>
</tbody>
</table>

P = 0.039

Development of a cadaveric Hallux rigidus model. Biomechanical testing
Results

• No statistical difference in **MTP joint stiffness** control group (3.3 N/d) vs shortened fascia group (3.7 N/d) (p>0.05) (underpowered)

\[
\begin{array}{|c|c|c|}
\hline
\text{cond} & \text{Mean} & \text{Std. Dev.} \\
\hline
1 & 3.325 & 2.2926903 \\
2 & 3.7142858 & 2.5115923 \\
\hline
\end{array}
\]

P = 0.072

Development of a cadaveric Hallux rigidus model. Biomechanical testing
Discussion

• No biomechanical hallux rigidus cadaveric model exists

• This model
  – recreates Hallux rigidus decreased ROM
  – tendency to recreate Hallux rigidus increased joint stiffness (underpowered)
Discussion

• Shortening the plantar fascia in a foot specimen, decreases range of motion and increases stiffness at the MTP

• This model may be useful in future studies relative to Hallux Rigidus

Development of a cadaveric Hallux rigidus model. Biomechanical testing
References

