Assessment of New Measurements to Assess First Metatarsal Elevation In Hallux Rigidus Compared to Controls

Mackenzie T. Jones, BA; Austin E. Sanders BA; Rachael DaCunha, MD; Liz Cody, MD; Carolyn Sofka, MD; Joseph Nguyen, MPH; Jonathan T. Deland, MD; Scott J. Ellis, MD

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Disclosures

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Background

- Previous studies have presented conflicting findings regarding the relationship between an elevated first metatarsal and arthritis.
  - This may be due to the variety of definitions for metatarsus primus elevatus (MPE) and the radiographic techniques used to assess it.
- Previously proposed measurements primarily assess the elevation of the first metatarsal in relation to the second metatarsal or in relation to a ground plane.
- No prior study has taken into account the elevation of the first metatarsal in relation to the proximal phalanx.
Background

• We aimed:

1. To propose new measurements of MPE that assess elevation of the first metatarsal in relation to the proximal phalanx

2. To assess the reliability of both previous and new measurements in patients with and without hallux rigidus

3. To compare the elevation of the first metatarsal between hallux rigidus patients and a control population
Methods

- A retrospective chart review of prospectively collected registry data was conducted to identify
  - Test group: 65 patients with hallux rigidus
  - Control group: 65 patients diagnosed with Morton’s neuroma without evidence of first MTP joint arthritis or trauma.
- Five blinded raters of varying levels of training (two research assistants, a senior orthopedic resident, a foot & ankle fellow, and an attending radiologist)
- Seven radiographic measurements
  - Newly proposed: 1st MT Uncoverage Angle, 1st MT Midpoint Uncoverage Angle, Proximal Phalnx-1st Metatarsal Angle, 1st MT Longitudinal Uncoverage Angle
  - Previously established: Seiberg Index, Bouaicha’s Index, 1st MT Elevation Angle
Methods
Four new measurements

1\textsuperscript{st} Metatarsal Uncoverage Angle
1\textsuperscript{st} Metatarsal Longitudinal Axis Uncoverage Angle
1\textsuperscript{st} Metatarsal Midpoint Uncoverage Angle
Proximal Phalanx-1\textsuperscript{st} Metatarsal Angle

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Methods

- Inter- and intrarater reliability were calculated using Intraclass Correlation Coefficients (ICC) and categorized by Landis and Koch reliability thresholds.

- The measurements between the hallux rigidus and control populations were compared using an independent t-test.
# Results

## Interrater Reliability and Comparison Between Hallux Rigidus and Control Populations

<table>
<thead>
<tr>
<th>Radiographic Measurement</th>
<th>ICC³</th>
<th>Interrater Reliability Agreement⁴</th>
<th>Control Group Mean Values⁵</th>
<th>Hallux Rigidus Mean Values⁶</th>
<th>P-Value⁵</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Old</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seiberg Index¹</td>
<td>0.875</td>
<td>Almost Perfect</td>
<td>0.0</td>
<td>0.9</td>
<td>0.000</td>
</tr>
<tr>
<td>Bouaicha’s Index¹</td>
<td>0.952</td>
<td>Almost Perfect</td>
<td>4.0</td>
<td>5.5</td>
<td>0.000</td>
</tr>
<tr>
<td>First Metatarsal Elevation Angle¹</td>
<td>0.949</td>
<td>Almost Perfect</td>
<td>22.2</td>
<td>19.0</td>
<td>0.000</td>
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<tr>
<td><strong>New</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First Metatarsal Uncoverage Angle²</td>
<td>0.712</td>
<td>Substantial</td>
<td>24.7</td>
<td>26.8</td>
<td>0.019</td>
</tr>
<tr>
<td>First Metatarsal Midpoint Uncoverage Angle²</td>
<td>0.768</td>
<td>Substantial</td>
<td>41.6</td>
<td>46.5</td>
<td>0.000</td>
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<tr>
<td>First Metatarsal Longitudinal Axis Uncoverage Angle²</td>
<td>0.845</td>
<td>Almost Perfect</td>
<td>44.2</td>
<td>49.2</td>
<td>0.000</td>
</tr>
<tr>
<td>Proximal Phalanx - First Metatarsal Angle²</td>
<td>0.889</td>
<td>Almost Perfect</td>
<td>11.6</td>
<td>7.9</td>
<td>0.001</td>
</tr>
</tbody>
</table>

¹Previously described measurements that evaluate the relationship of the first metatarsal and second metatarsal
²Newly designed measurements that evaluate the relationship of the first metatarsal and proximal phalanx
³Intraclass Correlation Coefficient
⁴Reliability agreement categorization as described by Landis and Koch
⁵Mean values reported by the attending radiologist
Results

• Measurement Reliability
  • All seven radiographic measurements were found to have substantial to almost perfect interrater reliability (ICC=0.712 to 0.952).
  • The research assistants demonstrated substantial to almost perfect intrarater reliability (ICC=0.710-0.980).
Results

- Hallux Rigidus Compared to Controls
  - All seven measurements demonstrated significant differences in first metatarsal elevation between hallux rigidus and control populations ($p=0.000-0.019$).
  - Hallux rigidus group showed increased elevation.
Conclusions

- Confirmed the reliability of seven radiographic measurements used to assess for MPE, including three previously established and four newly described measurements.
- Observers across all levels of training were able to demonstrate reliable measurements.
- Showed that hallux rigidus patients were more likely to have an elevated first metatarsal compared to controls.

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Future Directions

• These measurements could be used in future work to examine
  • How an elevated first metatarsal relates to the etiology of hallux rigidus
  • How an elevated first metatarsal relates to the progression of the disease
  • How an elevated first metatarsal affects the results of operative treatment