The Use of Weight-Bearing CT Scan in the Evaluation of Hindfoot Alignment

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The Foot and Ankle Association Inc.

Coordinating the global delivery of orthopedic foot and ankle care to underprivileged patients and communities
Disclosures

• NO CONFLICT TO DISCLOSE
• Jonathan Kaplan MD
• Tony Tracey BS MS
• Matthew Welck FRCS (orth)
• Shu-Yuan Li MD PhD
• Adriana Avila MD
• Mark Myerson MD

• Our disclosures are in the Final AOFAS Mobile App
Radiographic Hindfoot Alignment

- Hindfoot Moment Arm (HMA)
- Hindfoot Alignment Angle (HAA)

**Strengths**
- Reproducible, Quick

**Weaknesses**:
- Rotation dependent,
- 2-dimensional
- lacks foot ‘contribution’
CT Scan: Torque Ankle Levar Arm System (TALAS)

- Calculates hindfoot alignment based on contribution of the foot

- Tripod ‘Contact Points’
  - Talar Dome
  - Calcaneus
  - 1\textsuperscript{st} MTH
  - 5\textsuperscript{th} MTH

- PedCat (Curvebeam, Warrington, USA) 3-D weight bearing CT scans
Ground Reactive Force Calcaneal Offset (GRFCO)
<table>
<thead>
<tr>
<th></th>
<th>X</th>
<th>Y</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Met1</td>
<td>525.0</td>
<td>139.0</td>
<td>487.4</td>
</tr>
<tr>
<td>Met5</td>
<td>343.0</td>
<td>279.0</td>
<td>487.4</td>
</tr>
<tr>
<td>Calcaneus</td>
<td>512.0</td>
<td>727.0</td>
<td>500.0</td>
</tr>
<tr>
<td>Talus</td>
<td>542.0</td>
<td>636.7</td>
<td>282.0</td>
</tr>
</tbody>
</table>

**Foot:** RIGHT

**F.A.O. [%]:** 8.23

**C.O. [mm]:** 19.04

**H.A. [°]:** 32.55

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Varus

Valgus

GRFCO
Study Design

• Purpose: Compare XR HMA, XR HAA, CT GRFCO
• Retrospective Review 2014-2016
• n = 104 feet
  • 52 Males : 52 Females
  • 68 valgus : 36 Varus
• Three investigators
  • Two sets of measurements per investigator
  • Measurements taken ≥2 weeks apart
• Statistics:
  • Means, Standard Deviations, ANOVA,
  • Correlations
  • Reliability ICC
## Hindfoot Moment Arm

<table>
<thead>
<tr>
<th>Investigator - Measurement</th>
<th>Mean (mm)</th>
<th>Standard Deviation</th>
<th>Intraobserver Reliability (ICC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigator 1 – Measurement #1</td>
<td>17.2</td>
<td>12.9</td>
<td>.449</td>
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<tr>
<td>Investigator 1 – Measurement #2</td>
<td>20.0</td>
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<tr>
<td>Investigator 2 – Measurement #1</td>
<td>15.8</td>
<td>12.7</td>
<td>.921</td>
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<td>12.0</td>
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<tr>
<td>Investigator 3 – Measurement #1</td>
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<td>.908</td>
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### Hindfoot Alignment Angle

<table>
<thead>
<tr>
<th>Investigator - Measurement</th>
<th>Mean (degrees)</th>
<th>Standard Deviation</th>
<th>Intraobserver Reliability (ICC)</th>
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</thead>
<tbody>
<tr>
<td>Investigator 1 – Measurement #1</td>
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<td>9.0</td>
<td>.896</td>
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<tr>
<td>Investigator 1 – Measurement #2</td>
<td>12.3</td>
<td>8.7</td>
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<tr>
<td>Investigator 2 – Measurement #1</td>
<td>13.3</td>
<td>8.9</td>
<td>.954</td>
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<tr>
<td>Investigator 2 – Measurement #2</td>
<td>13.5</td>
<td>9.0</td>
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<td>8.9</td>
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## Ground Reactive Force Calcaneal Offset

<table>
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<tr>
<th>Investigator - Measurement</th>
<th>Mean (degrees)</th>
<th>Standard Deviation</th>
<th>Intraobserver Reliability (ICC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigator 1 – Measurement #1</td>
<td>7.85</td>
<td>6.1</td>
<td>.955</td>
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<tr>
<td>Investigator 1 – Measurement #2</td>
<td>7.87</td>
<td>5.7</td>
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<td>Investigator 2 – Measurement #1</td>
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<tr>
<td>Investigator 2 – Measurement #2</td>
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<tr>
<td>Investigator 3 – Measurement #1</td>
<td>7.99</td>
<td>6.34</td>
<td>.962</td>
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<tr>
<td>Investigator 3 – Measurement #2</td>
<td>8.10</td>
<td>6.23</td>
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</tbody>
</table>
Conclusions

- Radiograph Hindfoot Moment Arm
  - Good to Excellent Intra-observer Reliability (ICC .449-.921)
  - No significant difference between investigators (Interobserver)

- Radiograph Hindfoot Alignment Angle
  - Excellent Intra-observer Reliability (ICC .896-.954)
  - No significant difference between investigators (Interobserver)

- CT GRFCO
  - Best Intra-observer Reliability (ICC .955-.962)
References


• Baverel L, Brilhault J, Odri G, Boissard M, Lintz F. Influence of lower limb rotation on hindfoot alignment using a conventional two-dimensional radiographic technique [published online March 30, 2016]. Foot Ankle Surg.


• Richter M, Seidl B, Zech S, Hahn S. PedCAT for 3D-imaging in standing position allows for more accurate bone position (angle) measurement than radiographs or CT. Foot Ankle Surg. 2014;20(3):201-207

• Saltzman CL, el-Khoury GY. The hindfoot alignment view. Foot Ankle Int. 1995 Sep;16(9):572-6