RELIABILITY AND VALIDITY OF RADIOGRAPHIC MEASUREMENTS IN HINDFOOT VARUS AND VALGUS

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DISCLOSURES

- The authors have no disclosures.
PURPOSE OF THE STUDY

- To examine the clinical relevance of foot radiographic measurements
  - Reliability
    - Intra- and interobserver
  - Validity
    - Discriminant validity
    - Convergent validity
MATERIALS AND METHODS

- Approved by IRB
- 72 patients with hindfoot deformities
  - 36 hindfoot varus
  - 36 hindfoot valgus
- Inclusion
  - Wt bearing X ray, pedobarograph
- Exclusion
  - Previous surgery, severe equinus
FOOT X-RAY MEASUREMENTS

- Evaluating hindfoot deformity (varus vs valgus)
  - Calcaneal pitch angle (Lat)
  - Talocalcaneal angle (Lat)
  - Tibiocalcaneal angle (TibioCalc)
  - Talo-1st metatarsal angle (Lat)
  - Metatarsal stacking angle (MT stacking)
  - Medial-lateral column ratio (ML column ratio)
  - Naviculocuboid overlap (Lat)
  - Talonavicular coverage angle (AP)
  - Talo-1st metatarsal angle (AP)

(Davids et al. JPO 2005)
NAVICULOCUBOID OVERLAP (B/A)

Hindfoot varus

Hindfoot valgus
TALONAVICULAR COVERAGE ANGLE (AP)
TALO-1ST METATARSAL ANGLE (AP)

Hindfoot varus

Hindfoot valgus
VALGUS/VARUS INDEX

Valgus/varus index

\[
\frac{(MMF+MFF)-(LMF+LFF)}{(MMF+MFF+LFF+LMF)}
\]

(Riad et al. 2007)
RELIABILITY

- 3 orthopaedic surgeons measured radiographic indices twice with a three week interval
- Intra- and interobserver reliability
STATISTICAL ANALYSIS

- Sample size
  - ICC target 0.8 for three raters & 95% CI 0.2

- Discriminant validity
  - Cohen’s d & effect-size r

- Convergent validity
  - Correlation between radiographic measurements and pedobarographic index
### Summary of the patients

<table>
<thead>
<tr>
<th></th>
<th>Hindfoot valgus group</th>
<th>Hindfoot varus group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (SD)</strong></td>
<td>15.5 (4.2)</td>
<td>30.2 (18.0)</td>
</tr>
<tr>
<td><strong>Sex (M:F)</strong></td>
<td>21 : 15</td>
<td>20 : 16</td>
</tr>
<tr>
<td><strong>Diagnosis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>(No. of cases)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idiopathic planovalgus</td>
<td>(27)</td>
<td>Cerebral palsy (12)</td>
</tr>
<tr>
<td>Cerebral palsy (9)</td>
<td></td>
<td>Residual poliomyelitis (10)</td>
</tr>
<tr>
<td>HMSN (3)</td>
<td></td>
<td>Guillian-Barre syndrome (1)</td>
</tr>
<tr>
<td>Peroneal nerve injury (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congenital clubfoot (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CVA (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unknown cause (4)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HMSN, hereditary motor sensory neuropathy; CVA, cerebrovascular accident.
Intraobserver reliability of radiographic measurements

<table>
<thead>
<tr>
<th></th>
<th>CP</th>
<th>LatTC</th>
<th>Tibio Calc</th>
<th>Lat talo-1MT</th>
<th>MT stacking</th>
<th>NC overlap</th>
<th>ML column</th>
<th>AP TN coverage</th>
<th>AP talo-1MT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1\textsuperscript{st} rater</td>
<td>0.944</td>
<td>0.813</td>
<td>0.908</td>
<td>0.902</td>
<td>0.739</td>
<td>0.972</td>
<td>0.760</td>
<td>0.949</td>
<td>0.957</td>
</tr>
<tr>
<td>2\textsuperscript{nd} rater</td>
<td>0.963</td>
<td>0.814</td>
<td>0.915</td>
<td>0.750</td>
<td>0.873</td>
<td>0.956</td>
<td>0.828</td>
<td>0.857</td>
<td>0.860</td>
</tr>
<tr>
<td>3\textsuperscript{rd} rater</td>
<td>0.861</td>
<td>0.815</td>
<td>0.825</td>
<td>0.800</td>
<td>0.794</td>
<td>0.993</td>
<td>0.637</td>
<td>0.928</td>
<td>0.827</td>
</tr>
</tbody>
</table>
### Interobserver reliability of radiographic measurements

<table>
<thead>
<tr>
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<th>ML Column</th>
<th>AP TN coverage</th>
<th>AP talo-1MT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1st session</strong></td>
<td>0.957</td>
<td>0.826</td>
<td>0.783</td>
<td>0.850</td>
<td>0.767</td>
<td>0.950</td>
<td>0.564</td>
<td>0.877</td>
<td>0.882</td>
</tr>
<tr>
<td><strong>2nd session</strong></td>
<td>0.851</td>
<td>0.738</td>
<td>0.602</td>
<td>0.809</td>
<td>0.762</td>
<td>0.855</td>
<td>0.463</td>
<td>0.927</td>
<td>0.822</td>
</tr>
<tr>
<td><strong>overall</strong></td>
<td>0.908</td>
<td>0.784</td>
<td>0.731</td>
<td>0.826</td>
<td>0.783</td>
<td>0.908</td>
<td>0.561</td>
<td>0.906</td>
<td>0.889</td>
</tr>
</tbody>
</table>
## Discriminatory validity of radiographic measurements

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<th>AP talo-1MT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cohen’s d</strong></td>
<td>1.00</td>
<td>0.24</td>
<td>0.77</td>
<td>1.89</td>
<td>0.42</td>
<td>4.47</td>
<td>0.18</td>
<td>3.06</td>
<td>3.22</td>
</tr>
<tr>
<td><strong>Effect-size r</strong></td>
<td>0.45</td>
<td>0.12</td>
<td>0.36</td>
<td>0.69</td>
<td>0.20</td>
<td>0.91</td>
<td>0.09</td>
<td>0.84</td>
<td>0.85</td>
</tr>
</tbody>
</table>
## Convergent validity of radiographic measurements

<table>
<thead>
<tr>
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<th>AP TN coverage</th>
<th>AP talo-1MT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>r</strong></td>
<td>-0.146</td>
<td>0.110</td>
<td>0.138</td>
<td>0.386*</td>
<td>-0.337*</td>
<td><strong>0.639</strong></td>
<td>-0.023</td>
<td><strong>0.613</strong></td>
<td><strong>0.628</strong></td>
</tr>
<tr>
<td><strong>p</strong></td>
<td>0.240</td>
<td>0.374</td>
<td>0.266</td>
<td>0.001</td>
<td>0.005</td>
<td>&lt;0.001</td>
<td>0.855</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

* P < 0.05
## Clinical relevance of each radiographic measurements

<table>
<thead>
<tr>
<th>Measure</th>
<th>Reliability (ICC)</th>
<th>Discriminant validity (effect-size r)</th>
<th>Convergent validity (correlation r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcaneal pitch (Lat)</td>
<td>*****</td>
<td>***</td>
<td>-</td>
</tr>
<tr>
<td>Talocalcaneal (Lat)</td>
<td>****</td>
<td>*</td>
<td>-</td>
</tr>
<tr>
<td>Tibiocalcaneal (Lat)</td>
<td>****</td>
<td>**</td>
<td>-</td>
</tr>
<tr>
<td>Talo-1&lt;sup&gt;st&lt;/sup&gt; metatarsal (Lat)</td>
<td>****</td>
<td>****</td>
<td>**</td>
</tr>
<tr>
<td>MT stacking (Lat)</td>
<td>****</td>
<td>*</td>
<td>**</td>
</tr>
<tr>
<td>Naviculocuboid overlap (Lat)</td>
<td>*****</td>
<td>*****</td>
<td>****</td>
</tr>
<tr>
<td>ML column ratio (Lat)</td>
<td>***</td>
<td>*</td>
<td>-</td>
</tr>
<tr>
<td>Talonavicular coverage (AP)</td>
<td>*****</td>
<td>*****</td>
<td>****</td>
</tr>
<tr>
<td>Talo-1&lt;sup&gt;st&lt;/sup&gt; metatarsal (AP)</td>
<td>*****</td>
<td>*****</td>
<td>****</td>
</tr>
</tbody>
</table>

*, 0.0-0.2; **, 0.2-0.4; ***, 0.4-0.6; ****, 0.6-0.8; ***** 0.8-1.0; -, not significant.
CONCLUSIONS

- NC overlap, anteroposterior talonavicular coverage angle, and anteroposterior talo-1\textsuperscript{st} metatarsal angle were found to be clinically relevant methods in evaluating hindfoot varus and valgus deformities.
REFERENCES


THANK YOU!