Talar Anatomy and Subtalar Joint Alignment on Weightbearing CT: Correlation with Radiographic Flatfoot Parameters

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Disclosures

- The authors have no conflicts to disclose.
Background

- Underlying bony deformity may be related to development of adult acquired flatfoot deformity (AAFD)
- Multiplanar weightbearing computed tomography (MP-WB) can be used to measure 2 angles that evaluate the subtalar joint:
  1. Inftal-hor: angle between the inferior facet of the talus and horizontal
  2. Inftal-suptal: angle between the inferior and superior facets of the talus (Probasco et al., 2015)

- Inftal-hor and inftal-suptal angles measured on MP-WB images differ significantly between AAFD patients and controls (Probasco et al., 2015)
  - This work suggests that subtalar joint orientation may be a predisposing factor to development of AAFD

Haleem et al., 2014
Background

- What we don’t know:
  - Does subtalar joint orientation correlate with other components of AAFD?

- **Aim of this study**: correlate inftal-hor and inftal-suptal with standard radiographic measures of AAFD

- **Hypothesis**: inftal-hor and inftal-suptal would correlate strongly with commonly used radiographic measures of AAFD
1. On sagittal cuts, locate posterior facet
2. On coronals, scroll to cut at 50% of the A to P length of the posterior facet (red line)

**Inftal-hor:** angle between inferior facet of talus and horizontal; *measures* subtalar valgus

**Inftal-suptal:** angle between inferior and superior facets; *measures* innate talar valgus
Methods

- 45 patients with stage II AAFD scheduled for reconstructive surgery
- 17 control patients (no AAFD; evaluated for unrelated pathology involving forefoot)
- Exclusion criteria: h/o previous foot or ankle surgery, hindfoot arthritis, tarsal coalitions, midfoot arthritis, neurological conditions of the involved extremity
- All patients seen by one of two fellowship-trained orthopaedic foot and ankle surgeons
- Basic demographic data collected (age, sex, BMI)
- Study protocol approved by the institutional review board at HSS

- Radiographic angles measured: talar-first metatarsal angle and talocalcaneal angle on AP and lateral views, talonavicular coverage angle on AP views, calcaneal pitch and medial column height on lateral views, and hindfoot alignment (only in patients with AAFD)
- All patients also underwent pre-operative MP-WB imaging for inftal-hor and inftal-suptal angle measurements
- Differences between AAFD and control patients were assessed with chi-squared and Fisher’s exact tests for categorical variables and independent samples t-tests and Mann-Whitney U tests for continuous variables
- To assess whether correlation between each MP-WB measurement and each radiographic measurement was significant, a factorial generalized linear model (GLM) was constructed
Results

- Flatfoot group older than the control group ($p = 0.049$)
- No difference between groups in terms of sex or BMI

- Patients with AAFD differed significantly from the controls in all radiographic and MPWB angles ($p \leq 0.001$ for each)
- Inftal-hor and inftal-suptal correlated with radiographic measures of flatfoot to the same degree in patients with and without AAFD

- After accounting for differences between flatfoot and control patients:
  - Inftal-hor did not significantly correlate with any of the radiographic angles
  - Inftal-suptal significantly correlated with AP coverage angle ($p = 0.003$), AP talar-first metatarsal angle ($p = 0.003$), calcaneal pitch ($p = 0.014$), Meary’s angle ($p < 0.001$), medial column height ($p = 0.007$), and hindfoot alignment angle ($p = 0.004$)
  - Meary’s angle alone explained 48% of the variation in inftal-suptal angles
Radiographic differences between AAFD and control patients. Increasing inftal-hor and inftal-suptal angles reflect increasing degrees of valgus. *p < 0.05.

<table>
<thead>
<tr>
<th>Radiographic measurements</th>
<th>Flatfoot group (n=45)</th>
<th>Control group (n=17)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AP coverage angle</strong></td>
<td>34.8 ± 12.6</td>
<td>13.2 ± 7.4</td>
<td>&lt;0.001*</td>
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<tr>
<td><strong>AP talocalcaneal angle</strong></td>
<td>24.3 ± 7.0</td>
<td>15.6 ± 6.8</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td><strong>AP talar-first metatarsal angle</strong></td>
<td>20.5 ± 10.6</td>
<td>4.7 ± 7.3</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td><strong>Calcaneal pitch</strong></td>
<td>3.2 ± 5.1</td>
<td>8.2 ± 4.0</td>
<td>0.001*</td>
</tr>
<tr>
<td><strong>Meary’s angle</strong></td>
<td>-18.7 ± 9.7</td>
<td>2.2 ± 7.5</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td><strong>Lateral talocalcaneal angle</strong></td>
<td>38.5 ± 6.2</td>
<td>30.3 ± 3.1</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td><strong>Medial column height, mm</strong></td>
<td>11.4 ± 6.2</td>
<td>22.0 ± 5.4</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td><strong>Hindfoot alignment angle</strong></td>
<td>16.4 ± 6.2</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**MP-WB measurements**

| Inftal-hor angle                                  | 15.9 ± 5.7            | 5.7 ± 6.7            | <0.001* |
| Inftal-suptal angle                               | 21.2 ± 6.7            | 10.7 ± 6.4           | <0.001* |
Graphs demonstrating relationships between inftal-suptal angle and significantly associated radiographic measurements are shown.

Note that higher inftal-suptal values indicate increasing valgus; higher AP coverage angles and higher AP talar-first metatarsal angles reflect increasing forefoot abduction; and more negative Meary’s angles, decreased calcaneal pitch, and lower medial column height are indices of arch collapse.

The relationship with Meary’s angle is particularly strong.
73% of patients with stage II AAFD had infral-suptal angles >17°, compared to only 12% of control patients, suggesting this number as a useful threshold for clinicians.

Increased talar valgus is evident in the flatfoot patient.

The suptal-inftal angle is shown in a control patient (top, A) and in an AAFD patient (bottom, B).
Conclusions

- Patients with stage II AAFD had more innate valgus in their talar anatomy (as measured by inftal-suptal angle) as well as more valgus alignment of their subtalar joints (as measured by inftal-hor angle) than did control patients.

- It is possible that patients with greater innate talar valgus may be more likely to have progression of AAFD, although this has yet to be demonstrated.

- Inftal-suptal angle may be useful in operative planning: patients with excessive talar valgus may require more calcaneal medialization for adequate correction.

- With further research, MP-WB may become a valuable tool in helping to guide the decision-making surrounding operative reconstruction of AAFD.