Abstract Number: 10946

JOURNAL OF THE JFA Foot & Ankle

Influence of hallux valgus varus deformity on first metatarsal sagittal inclination assessment: A comparison between weight-bearing radiography and weight-bearing computed tomography

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Introduction: The sagittal inclination of the first metatarsal (1M) is a key parameter in the evaluation of foot deformities. However, 1M varus in hallux valgus (HV) may cause projection bias on weight-bearing radiographs (WBR). This study evaluated whether HV varus deformity alters the apparent sagittal inclination of the 1M on WBR. Measurements from lateral WBR were compared with weight-bearing computed tomography (WBCT) measurements aligned with the true longitudinal axis of the 1M. We hypothesized that if varus deviation produces relevant projection bias, sagittal inclination values would differ between WBR and WBCT. This difference would affect surgical planning for 1M realignment in isolated HV and in foot deformities such as progressive collapsing foot deformity (PCFD).

Methods: Eighty-four feet were analyzed, including 42 HV cases (IMA >15°) and 42 controls. A geometric triangle model was applied, considering that the lateral forefoot projection resembles a rectangular scalene triangle, in which perspective changes may affect side lengths and angles. The first metatarsal declination angle (FMDA) and first metatarsal length (L1M) were measured to evaluate the model and to determine whether 1M varus influences differences in sagittal alignment between WBR and WBCT.

Results: FMDA demonstrated no significant differences within or between groups, with a mean difference of 0.39° ($p = 0.98$). Conversely, L1M differed significantly between imaging modalities and between HV and controls, with a mean difference of 2.48 mm ($p < 0.05$). Agreement analysis revealed strong concordance between WBR and WBCT, indicating minimal systematic bias.

Conclusion: Although geometric changes affected L1M measurements, they did not influence sagittal inclination as assessed by FMDA. The strong agreement between WBR and WBCT supports FMDA as a reliable parameter for evaluating 1M sagittal alignment and planning realignment procedures. WBR-based FMDA assessment appears sufficient for surgical planning, reducing the need for WBCT.

Keywords: Hallux valgus; Radiography; Observer variation.

DOI: https://doi.org/10.30795/jfootankle.2026.v20.2071

This abstract was presented at the XXII Brazilian F&A Meeting 2026, held in São Paulo, Brazil, from April 18 to 21, 2026.