Quantitative Assessment of the Obliquity of the First Metatarsal-Medial Cuneiform Articulation.

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Statement of Purpose and Literature Review

The obliquity of the first metatarsal-medial cuneiform articulation has been described as an atavistic trait of human foot morphology, and is commonly proposed as a risk factor for the development of the hallux abductovalgus (HAV) deformity. Despite this however, there is a relative lack of objective analysis of this joint, and that which has been published is often with somewhat contradictory results with respect to its association with the HAV deformity [1-4].

First, it might be interesting to consider the actual definition and meaning of the term "atavistic" [5-8]. Although this certainly indicates a relation to ancestral function, and it has been fairly well established that larger primates who ambulate with a more erect, bipedal gait generally have less obliquity to this articulation, it might also be unfair to characterize this obliquity as a "deformity" given that it is a part of the natural history of the human species. It might also be inaccurate to assume that the human species is progressing toward a point where there is less or no obliquity whatsoever. In the absence of objective data demonstrating an association between proximal obliquity and HAV deformity, it is at least possible that this represents an incidental finding providing confirmation bias to surgeons viewing this joint as the apex of the HAV deformity.

A review of the peer-reviewed literature might actually provide some support to this supposition. Perhaps most notably, Hatch et al observed an inverse relationship between proximal obliquity and the hallux abductus angle when considered as a categorical variable [1]. In other words, less HAV deformity was noted with increased obliquity of the first metatarsal-medial cuneiform articulation in this study.

Therefore, the objective of this investigation was to 1) provide descriptive normative data on a large series of first metatarsal-medial cuneiform articulations, and 2) correlate these findings with other common radiographic parameters used to define the HAV deformity.

Methodology

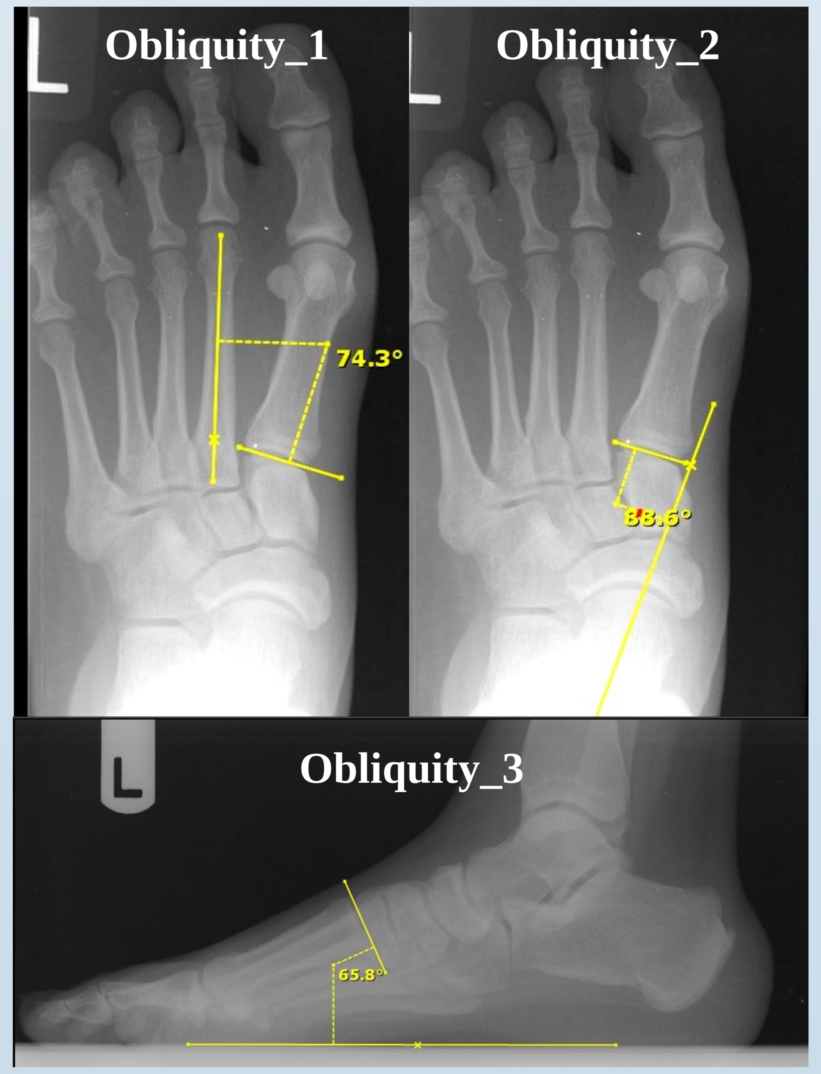
On a consecutive series of 136 weight-bearing foot radiographic projections from subjects without a history of foot/ankle surgery or fracture/dislocation, we measured the first intermetatarsal angle, hallux abductus angle, metatarsal sesamoid position, Engel's angle, and three measures of the 1st metatarsal-medial cuneiform joint obliquity:

-Obliquity_1: Between the obliquity and the long axis of the 2nd metatarsal shaft (Figure 1)

-Obliquity_2: Between the obliquity and the long axis of the talus (Figure 2), and

-Obliquity_3: Between the obliquity and the weight-bearing surface (Figure 3).

This investigation is unique in that radiographic measures were considered as a continuous variable to allow for calculation of a measure of correlation. Measurements were first graphically depicted against each other on frequency scatter plots and then analyzed by means of Pearson correlation coefficients.



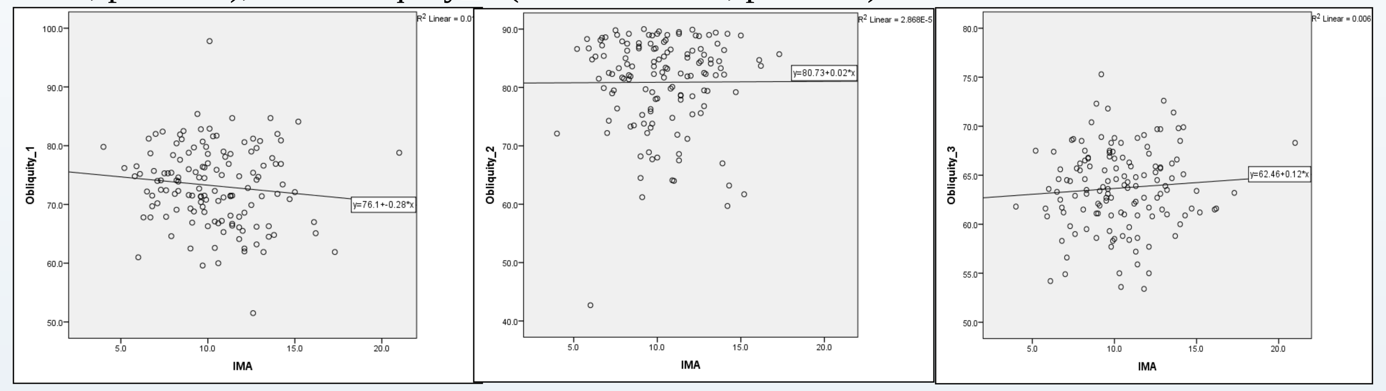
Figures 1-3: We defined the obliquity of the first metatarsal-medial cuneiform articulation in two planes and relative to both the forefoot and the rearfoot. We defined **Obliquity_1** as the angular relationship between the obliquity and the long axis of the second metatarsal on the DP projection. We defined **Obliquity_2** as the angular relationship between the obliquity and the long axis of the talus on the DP projection. And we defined **Obliquity_3** as the angular relationship between the obliquity and the weight-bearing surface on the lateral projection.

Results

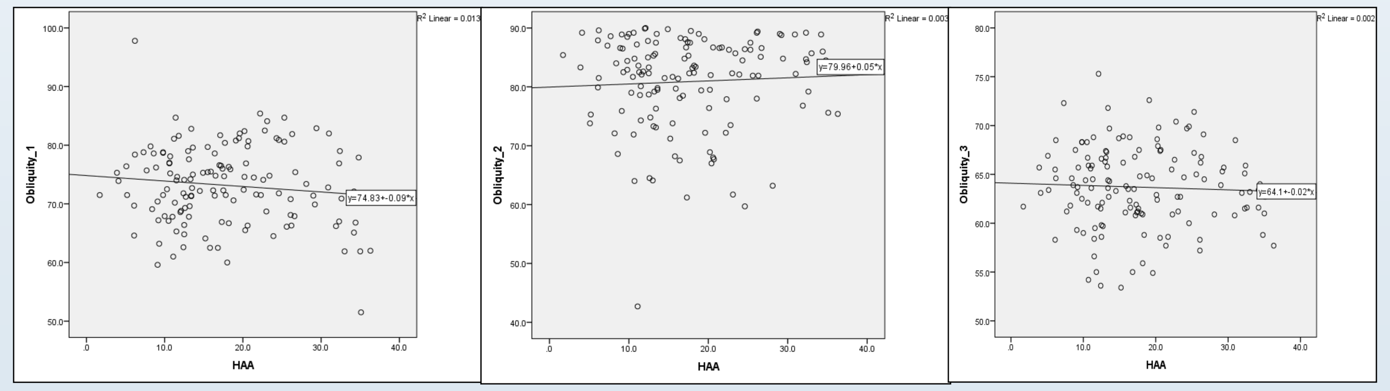
A selection of our results are displayed in the following graphs and tables.

Radiographic Parameter	Descriptive Statistics
First Intermetatarsal Angle	10.37 ± 2.70º (4.0-21.0)
Hallux Abductus Angle	17.67 ± 8.18º (1.7-36.3)
Metatarsal Sesamoid Position	3.63 ± 1.08 (2-7)
Engel's angle	22.1 ± 5.75º (9.0-39.5)
Obliquity_1	73.18 ± 6.73º (51.5-97.8)
Obliquity_2	80.89 ± 7.97º (42.7-90.0)
Obliquity_3	63.70 ± 4.16º (53.4-75.3)

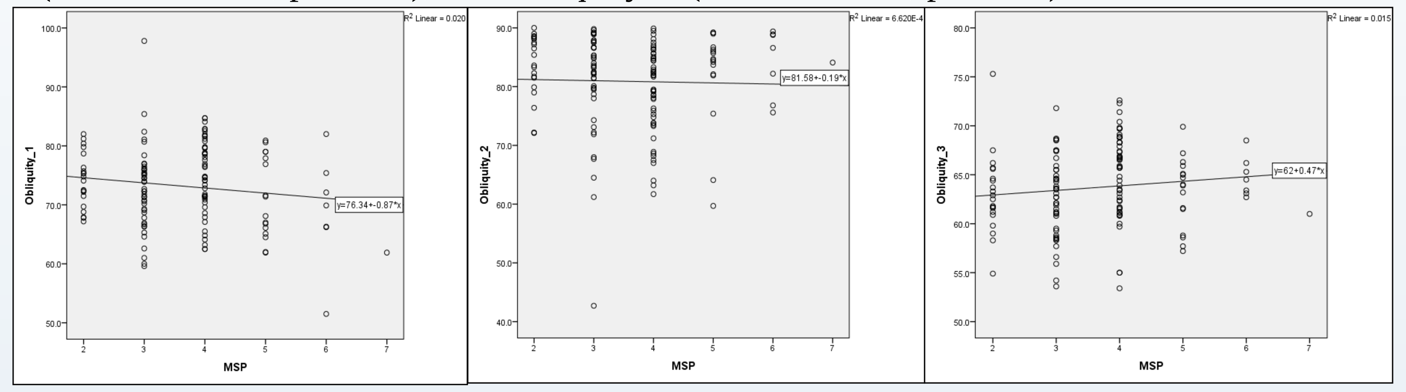
Figures 4-6: Correlation of the first intermetatarsal angle with measures of obliquity. No statistically significant nor clinically substantial correlations were observed between the first intermetatarsal angle and Obliquity_1 (Pearson -0.113; p=0.189), Obliquity_2 (Pearson 0.005; p=0.951), and Obliquity_3 (Pearson 0.077; p=0.370).



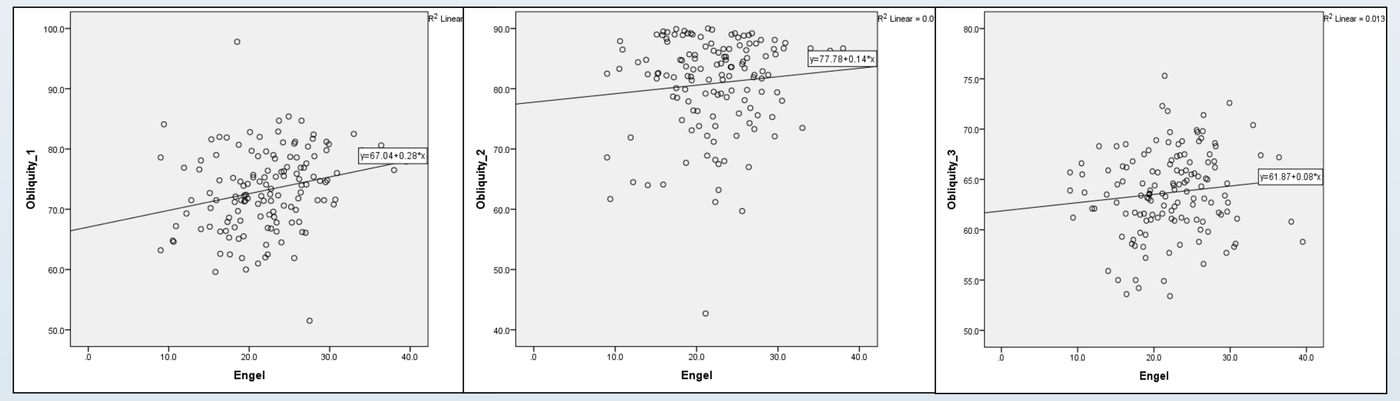
Figures 7-9: Correlation of the hallux abductus angle with measures of obliquity. No statistically significant nor clinically substantial correlations were observed between the hallux abductus angle and Obliquity_1 (Pearson -0.113; p=0.189), Obliquity_2 (Pearson 0.054; p=0.532), and Obliquity_3 (-0.045; p=0.605).



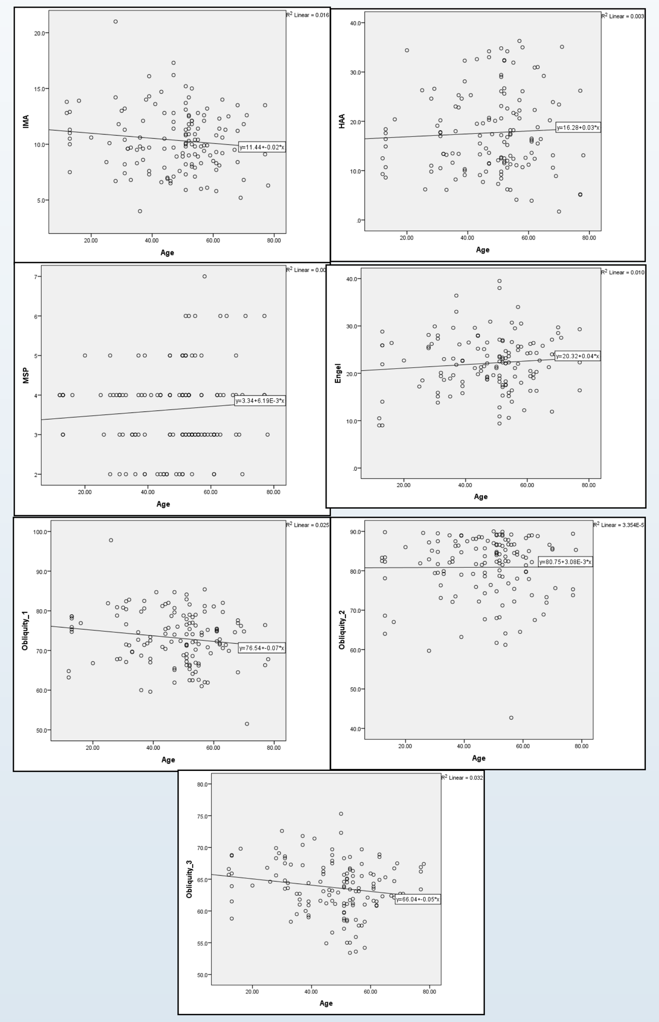
Figures 10-12: Correlation of the metatarsal sesamoid position with measures of obliquity. No statistically significant nor clinically substantial correlations were observed between the metatarsal sesamoid position and Obliquity_1 (Pearson -0.140; p=0.105), Obliquity_2 (Pearson -0.026; p=0.766), and Obliquity_3 (Pearson 0.121; p=0.161).



Figures 13-15: Correlation of Engel's angle with measures of obliquity. A "weak", but statistically significant positive relationship was observed between Engel's angle and Obliquity_1 (Pearson 0.237; p=0.005). No statistically significant nor clinically substantial correlations were observed Engel's angle and Obliquity_2 (Pearson 0.102; p=0.239) nor Obliquity_3 (Pearson 0.114; p=0.186).



Figures 16-22: We also measured correlation between each radiographic parameter and subject age, and did not observe any statistically significant nor clinically substantial correlations (Pearson's correlation coefficient range: -0.178 – 0.099).



Discussion

As with any scientific investigation, critical readers are encouraged to review the study design and specific results and reach their own independent conclusions, while the following represents our conclusions based on the specific results. As scientists, we also never consider data to be definitive, but do think that these results are worthy of some attention and future investigation.

-The results of this cross-sectional investigation analyzing radiographic parameters as continuous variables indicate that there is no statistically significant nor clinically substantial association between the obliquity of the first metatarsal-medial cuneiform articulation and the HAV deformity. This might be considered a surprising finding that does appear in line with conventional thinking of the first ray. These findings might indicate a more dynamic, as opposed to structural, etiology of HAV development.

In conclusion, we hope that the results of this investigation add to the body of knowledge and lead to future investigations into the progression, evaluation and treatment of the hallux abductovalgus deformity.

References

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