

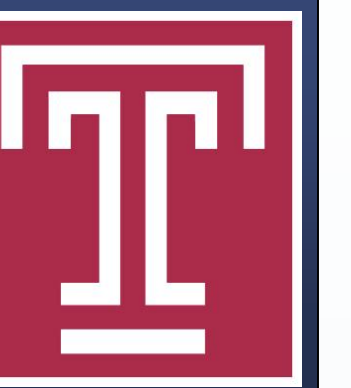
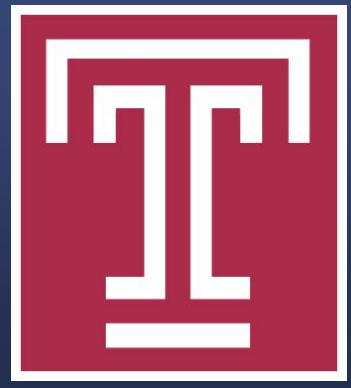
Towards an Objective Definition of First Ray “Hypermobility”

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Statement of Purpose and Literature Review

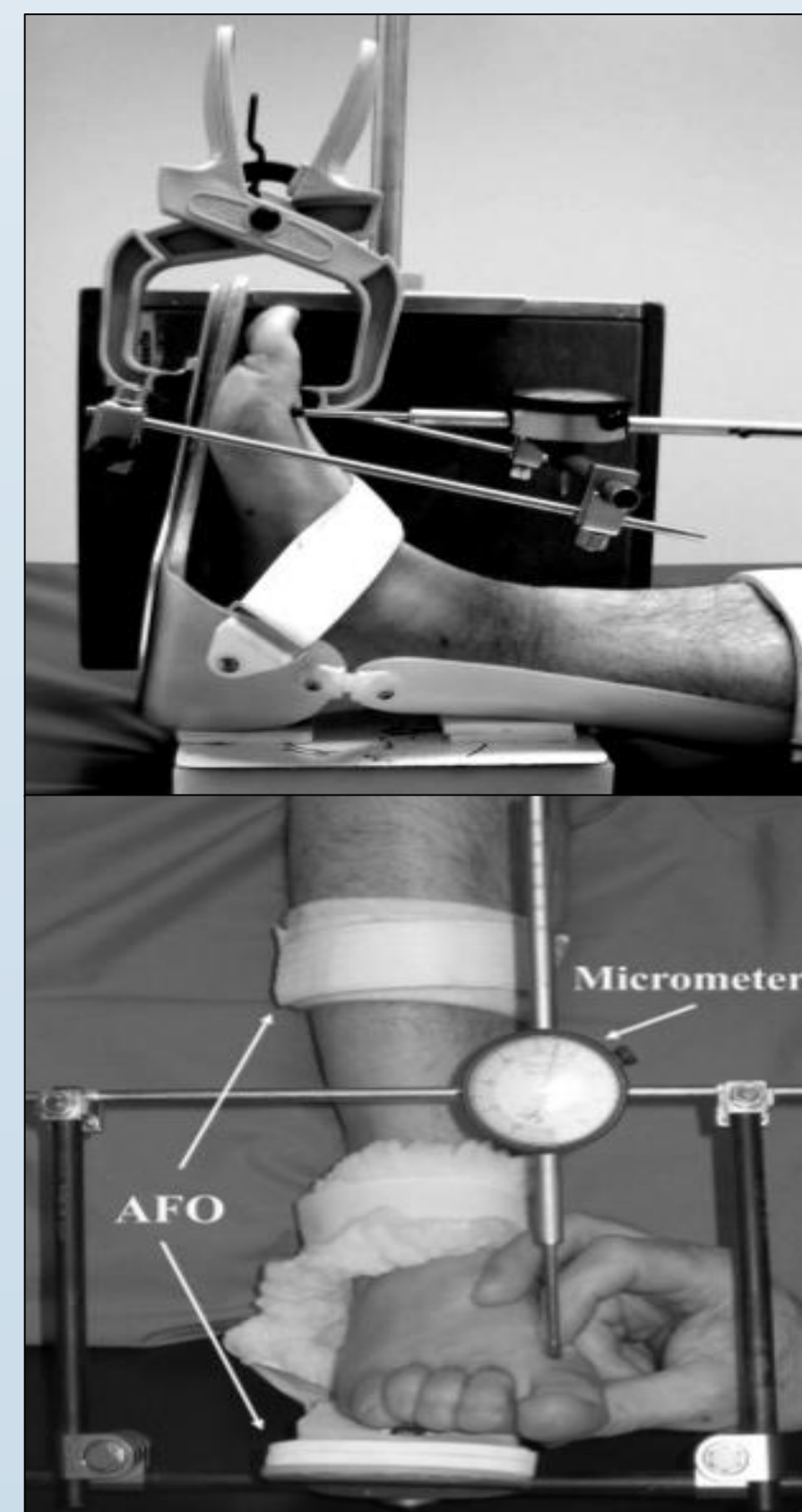
First ray hypermobility is a commonly accepted abnormal physical examination finding observed during the evaluation and treatment of the hallux abductovalgus deformity. Further, this variable has been strongly associated with surgical decision making and serves as a widely accepted indication for performance of the first metatarsal-medial cuneiform arthrodesis procedure [3]. Despite this, however, there is little objective normative data of the measurement of this parameter [1-5].

Therefore the objective of this investigation was to collect a quantitative measurement of first metatarsal sagittal plane range of motion from a large population in an attempt to begin to define a “normal” vs. “abnormal” definition.

Methodology

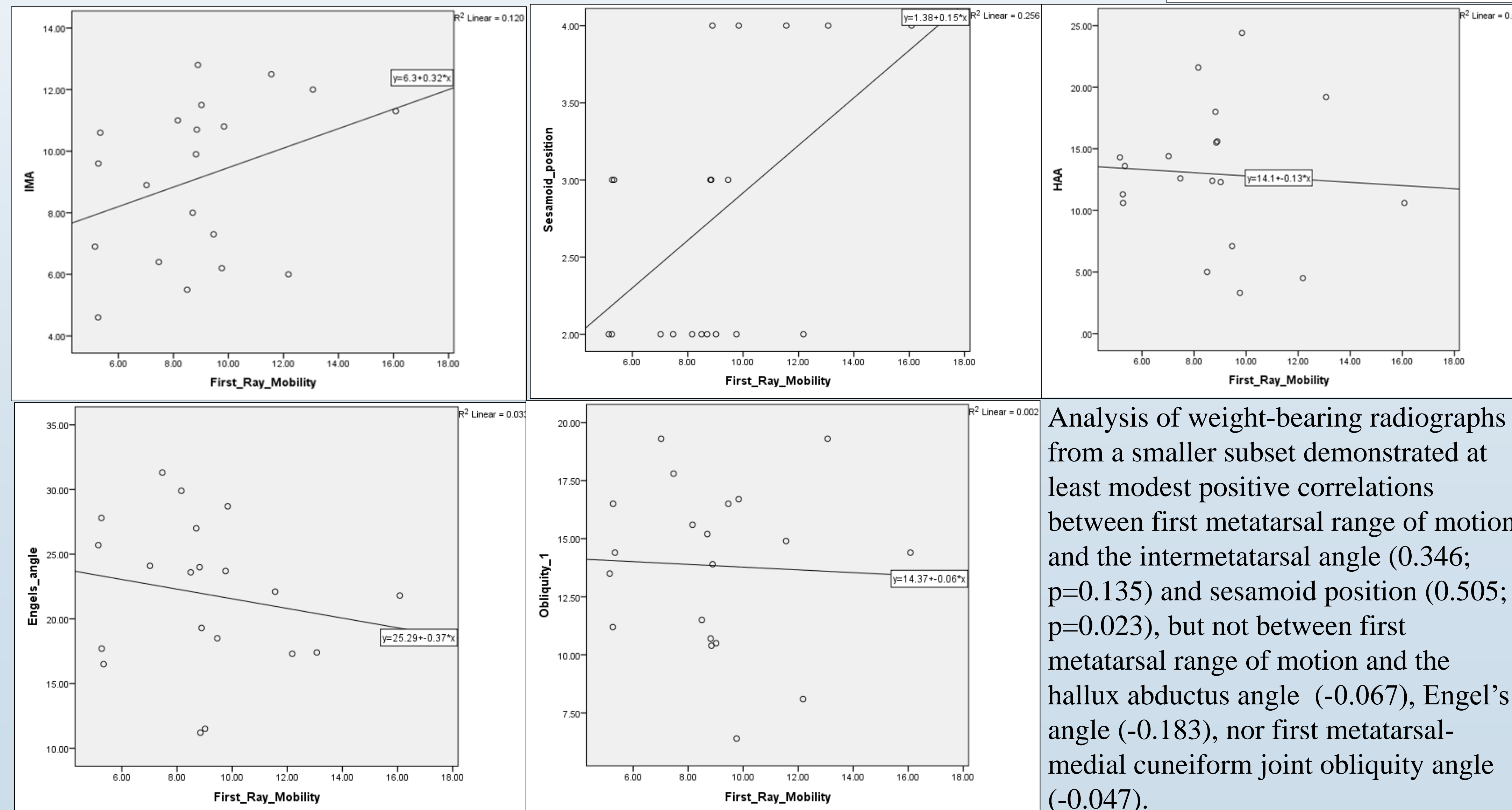
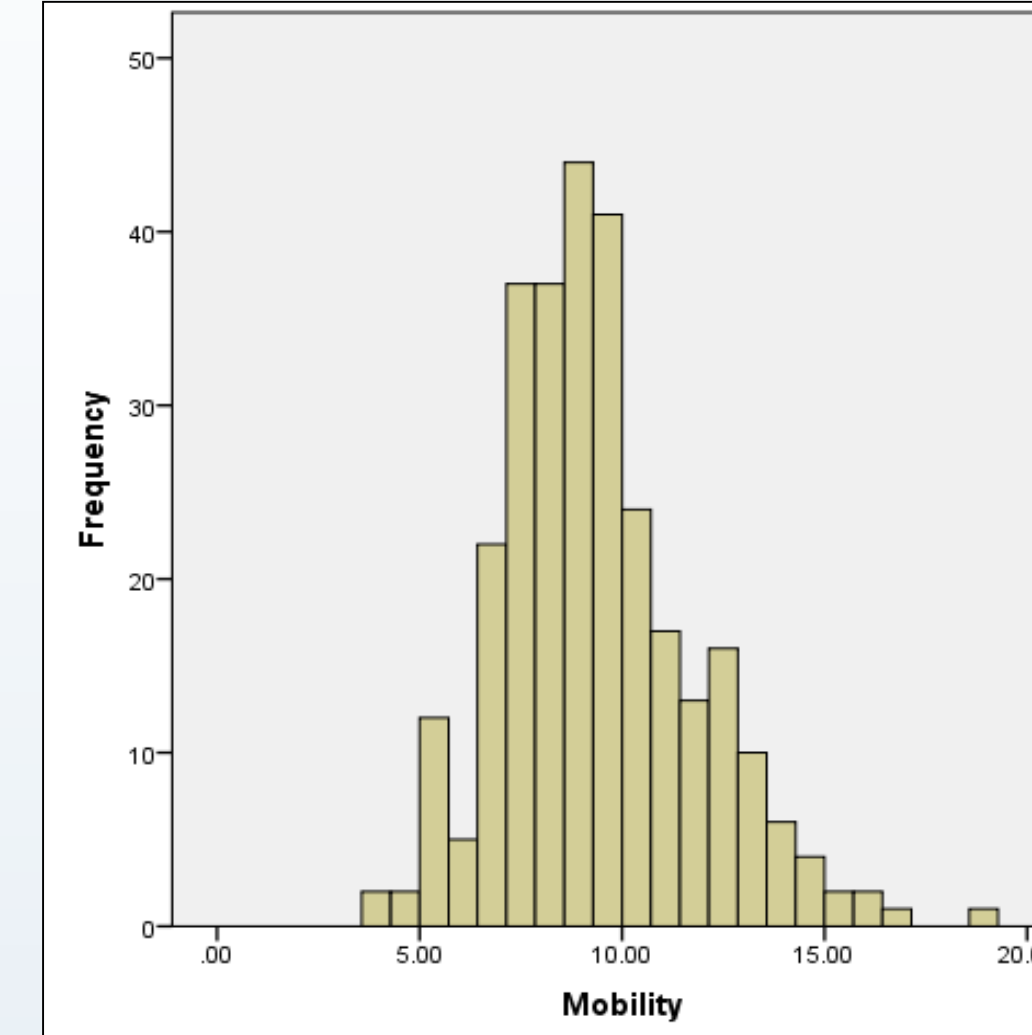
First metatarsal sagittal plane range of motion was measured in 318 feet from subjects without a history of foot and surgery. This was performed by means of the validated Klaue device utilizing the protocol outlined by Coughlin et al [1; Figures]. Descriptive statistics were performed on the data set.

Those subjects who additionally underwent weight-bearing AP foot radiographs were evaluated for measurement of the first metatarsal intermetatarsal angle (IMA), hallux abductus angle (HAA), tibial sesamoid position, Engel's angle, and the obliquity of the first metatarsal-medial cuneiform joint.



Results

The mean cumulative first metatarsal sagittal plane range of motion as measured with the Klaue device was 9.34 ± 2.42 mm (3.97-18.76). Although the mean dorsal excursion (6.16 ± 1.9 mm [2.02-13.5]) was nearly twice plantar excursion (3.18 ± 1.22 mm [0.3-8.25]), plantar excursion interestingly demonstrated wider variability. The data set was found to demonstrate many characteristics of a normally distributed population based on the histogram distribution (Figure; right), skewness (0.651), kurtosis (0.761) and Q-Q plot. Only 2.4% of measured feet demonstrated dorsal excursion greater than 10mm.



Analysis of weight-bearing radiographs from a smaller subset demonstrated at least modest positive correlations between first metatarsal range of motion and the intermetatarsal angle (0.346; $p=0.135$) and sesamoid position (0.505; $p=0.023$), but not between first metatarsal range of motion and the hallux abductus angle (-0.067), Engel's angle (-0.183), nor first metatarsal-medial cuneiform joint obliquity angle (-0.047).

Discussion

We believe these results are a first step towards an objective definition of first ray hypermobility:

-At the very least, **results indicate that first ray sagittal plane range of motion should be considered as a continuous variable as opposed to categorical variable.** In other words, patients don't absolutely have hypermobility or not have it, but rather there are varying degrees of joint mobility and stability. We did not observe a clear numeric threshold to help define this difference. Only 2.4% of measured feet demonstrated a dorsal excursion >10mm, while on the other hand, nearly 50% had a total sagittal plane range of motion >10mm. Perhaps interestingly, the Shibuya et al meta-analysis which found +3.62mm sagittal range of motion in HAV vs. non-HAV feet would equate to 1.5 standard deviations in our data set [2].

-Second, the dynamic range of motion of the first metatarsal was not clearly associated with static radiographic measures of its position. Modest positive correlations were observed between range of motion and the IMA and sesamoid position, but not with respect to the hallux abductus angle or the obliquity of the first metatarsal-medial cuneiform joint. **This underscores that the relationship between structure and function of the first ray remains an important avenue for future investigation.**

References

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- [5] Coughlin MJ, Jones CP. Hallux valgus and first ray mobility. A prospective study. *J Bone Joint Surg Am.* 2007 Sep; 89(9): 1887-98.