Comparison of Changes in Radiographic Measurements of the Foot Based Upon Percentage of True Weightbearing

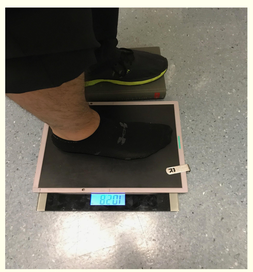
Frank L. Narcisi, DPM, Jonathan L. Hook, DPM, MHA, T. Craig Wirt, DPM, PhD, Ridhi Mehta, DPM
Mercy Hospital and Medical Center Chicago, Illinois 60616

BACKGROUND

Weightbearing radiographs are routine diagnostic exams used to evaluate pathology and anatomy of the foot and ankle. Often, patients are instructed to place 50% of their weight on the limb being imaged to most closely reproduce normal load. Studies have shown a high variability of the actual percentage of weight patients place on the imaged limb. The purpose of this study was to evaluate the effect various weightbearing statuses had on different radiographic measurements used to diagnose pathology and plan for surgery.

METHODS

Six volunteers (12 feet) were enrolled in the study. Dorsal-plantar x-rays were taken of the foot with three weightbearing statuses: 25%, 50%, and 100% body weight. Body weight was obtained with a scale and percentages were calculated. The scale was placed under the cassette and weightbearing was adjusted to the desired percentage. Radiographs were obtained and uploaded to the PACS system. The following angles were measured: 1st intermetatarsal (IM) angle, 1st-5th IM angle, hallux abductus (HA) angle, metatarsus adductus angle (MAA), and Kite's angle. We defined our 1st IM angle as the bisection of the shaft of the 1st metatarsal compared to the bisection of the 2nd metatarsal shaft. The 1st-5th IM angle was the comparison of the bisection of the 1st and 5th metatarsal shafts. The HA angle was comparison of the bisection of the 1st metatarsal shaft and the bisection of the shaft of the proximal phalanx of the hallux. MAA was defined as the bisection of the shaft of the 2nd metatarsal compared to the longitudinal axis of the lesser tarsus. The boundaries of the axis of the lesser tarus have been described in literature as: medially, the distal 1st metatarsal-cuneiform joint to the Talo-navicular joint; and laterally, the 5th metatarsal-cuboid articulation to the calcaneal-cuboid articulation[1]. After acquiring all radiographic measurements from our 12 feet across the three weightbearing statuses, a paired *t*-test was used to analyze the data.



(Clinical images showing the standing AP X-ray (left), and our set up (right) with a scale under the cassette to calculate percentage of weightbearing at the time of imaging.)

RESULTS

Statistically significant differences ($p \leq 0.05$) were found between weightbearing statuses of: 25% and 50% with respect to MAA; 25% and 100% regarding both HA angle and Kite's angle; and 50% and 100% with respect to 1st IM angle, HA angle, and Kite's angle. MAA was the only measurement found to be inversely related to WB status. P values are shown in the char abovet, with statistically significant values in bold.

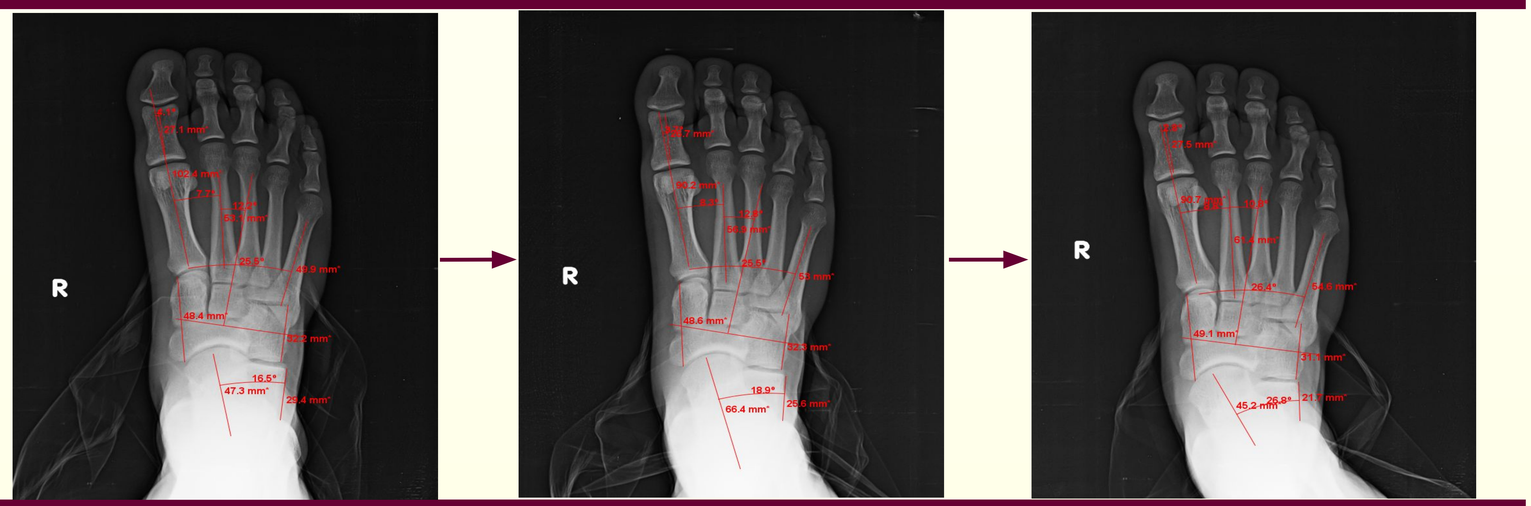
DISCUSSION

Radiographic measurements are routinely utilized to evaluate deformity in the foot and ankle. These values can help surgeons in surgical planning. In our study, measurements that were positively correlated with increased weightbearing included 1st IM, HA, and Kite's angle. MAA decreased significantly with increased weightbearing. Our results suggest that certain radiographic measurements may change significantly based upon percentage of weightbearing status. Further studies are needed to determine the clinical significance of these changes and whether or not they would alter preoperative planning. Future research in this area could include radiographic measurements taken from lateral views as well as examinations of more proximal joints such as the ankle.

Measurement P value	25% to 50%	25% to 100%	50% to 100%
1st Intermetatarsal angle	0.57	0.34	**0.004**
Hallux Abductus angle	0.86	**0.05**	**0.03**
1st-5th Metatarsal angle	0.50	0.06	0.09
Metatarsus Adductus angle	**0.03 (decreased)**	0.43	0.58
Kite's angle	0.08	**0.0002**	**0.00003**

Subject	1st IM 25% Weight	1st IM 50% Weight	1st IM 100% Weight
FN L	12.2˚	12˚	12.2˚
CW L	8.7˚	6.7˚	7.8˚
RM L	11.5˚	9.6˚	10.3˚
JW L	12.5˚	11.7˚	12˚
CM L	11.2˚	9.9˚	11˚
JH L	9.2˚	9.2˚	9.2˚
FN R	8.9˚	10.8˚	11.8˚
CW R	8˚	7.2˚	8.5˚
RM R	10˚	11.1˚	10.8˚
JW R	9.4˚	10.6˚	10.8˚
CM R	7.7˚	8.3˚	8.8˚
JH R	7.8˚	7.5˚	7.8˚

25% 50% 100%



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