Preoperative First Metatarsal Pronation is a Risk Factor for Recurrence after Hallux Valgus Correction: A Semi-Weight-Bearing Computed Tomography Study

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INTRODUCTION: The impact of preoperative first metatarsal pronation on the surgical outcome of hallux valgus (HV) corrective surgery remains uncertain. This retrospective study aimed to utilize semi-weight-bearing computed tomography (sWBCT) to quantify the preoperative first metatarsal pronation angle (MTPA) and investigate its potential influence on postoperative prognosis.

METHODS: A total of 31 feet were included in the analysis. One year after surgery, feet exhibiting re-increased hallux valgus angle (HVA) compared to the immediate postoperative HVA were assigned to the non-maintained group, while feet maintaining the postoperative HVA were assigned to the maintained group. The preoperative MTPAs of the two groups were compared. The MTPA, measured as the angle between the metatarso-sesamoid facet and the floor in the coronal plane on sWBCT (Figure 1), was used to distinguish the two groups. The threshold angle was determined using receiver operating characteristic curve analysis, with the area under the curve indicating the threshold value. Based on this threshold angle, patients were categorized into high- and low-pronation groups. The relative risk of belonging to the non-maintained group in the high-pronation group compared to the low-pronation group was calculated. Furthermore, the relationship between the MTPA and the sesamoid position, as well as the distal metatarsal articular angle (DMAA) in plain radiographs, was assessed.

RESULTS: Thirteen feet (41.9%) were classified in the non-maintained group. The preoperative MTPA in this group was significantly greater than that in the maintained group (p=0.004) (Table 1). The determined threshold MTPA was 28.4 degrees (Figure 2). Among all participants, 11 feet were in the high-pronation group, while 20 feet were in the low-pronation group. The relative risk of belonging to the non-maintained group in the high-pronation group compared to the low-pronation group was 2.27 (p=0.005). The MTPA exhibited a moderate correlation with the sesamoid position (p=0.005), but no correlation with the DMAA (p=0.110).

DISCUSSION AND CONCLUSION: Our findings suggest that preoperative first metatarsal pronation, indicative of rotational deformity, may be associated with HV recurrence. In addition to previously reported risk factors such as large preoperative HVA and intermetatarsal angle, we propose that the degree of preoperative first metatarsal pronation also impacts postoperative prognosis. Given that HV is a three-plane deformity, a comprehensive understanding of deformity in the coronal and axial planes is necessary. Therefore, we recommend considering first metatarsal pronation beyond the determined threshold angle as a risk factor for poor prognosis after surgery. The utilization of sWBCT enables accurate measurement of first metatarsal pronation, facilitating the prediction of postoperative prognosis. Further investigations are warranted to validate our findings and establish standardized guidelines for evaluating and managing first metatarsal pronation in HV corrective surgery.

Figure 1. The first metatarsal pronation angle between the metatarso-sesamoid facet and the floor in the coronal plane on semi-weightbearing computed tomography scan.
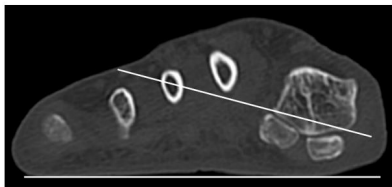

Figure 2. The threshold value of the first metatarsal pronation angle was determined by analyzing receiver operating characteristic curve.
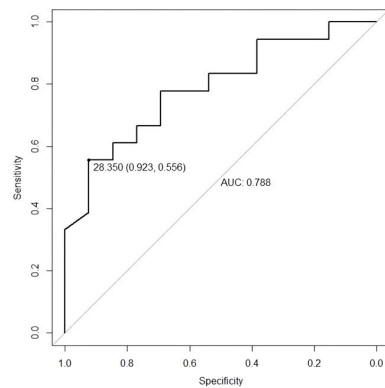
28.350 (0.923, 0.556)

AUC: 0.788

Table 1. Comparison of preoperative variables in a non-maintained group and a maintained group.

Variables	Non-maintained group (N=13)	Maintained group (N=18)	p-value
Plain radiographs data			
HVA (°)[a]	28.3 (5.98)	26.4 (6.10)	0.893
IMA (°)[a]	14.1 (2.58)	13.0 (2.09)	0.215
DMAA (°)[a]	21.6 (8.36)	22.9 (8.05)	0.679
Sesamoid position[b]	6 (2)	5 (1)	0.247
Semi-weightbearing CT data			
First metatarsal pronation angle (°)[a]	30.6 (10.5)	19.8 (7.23)	0.004
CT-DMAA (°)[a]	24.3 (10.6)	21.0 (6.49)	0.322

[a]Data are presented as the mean (standard deviation)
[b]Data are presented as the median (interquartile range)
HVA: hallux valgus angle; IMA: first-second intermetatarsal angle; DMAA: distal metatarsal articular angle