Effect of Metatarsophalangeal Joint Position on the Reliability of the Tangential Sesamoid View in Determining Sesamoid Position

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Effect of Metatarsophalangeal Joint Position on the Reliability of the Tangential Sesamoid View in Determining Sesamoid Position

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ABSTRACT

Background: **Lateral displacement of the sesamoids of the first toe relative to the metatarsal head is a common finding in hallux valgus deformity. Several methods have been described for quantifying the amount of subluxation from anteroposterior radiographs but a tangential sesamoid radiograph has been determined to be the best view to evaluate sesamoid displacement.** ***Method:*** **We evaluated the sesamoid position at different angles of the first metatarsophalangeal (MTP) joint to determine the effect of first MTP joint dorsiflexion on sesamoid position when tangential sesamoid view radiographs are made. Sesamoid positions of 22 feet with hallux valgus were graded from the short axis computed tomography (CT) images obtained with the MTP joint in 0, 35, and 70 degrees of dorsiflexion.** ***Results:*** **Approximation of the sesamoids to reduction was apparent as dorsiflexion of the first MTP joint increased.** ***Conclusion:*** **Different dorsiflexion degrees of the first MTP joint when tangential sesamoid radiographs are made modulate the position of the sesamoids and may lead to misclassification on grading.**

Key Words: Hallux Valgus; Reduction; Sesamoid; Tangential View

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INTRODUCTION

Lateral migration of the sesamoids relative to the first metatarsal head is a common finding in patients with hallux valgus deformities and has an important role in the development of the deformity.[15] Proper restoration of the metatarsosesamoid articulation is essential to prevent recurrence of the hallux valgus deformity.[3]

Several methods for quantifying the amount of metatarsosesamoid displacement from anteroposterior (AP) radiographs have been described,[5,13,14] but tangential sesamoid radiographs have been shown to be best for evaluating sesamoid position.[6,8] When obtaining a tangential sesamoid radiograph, some first metatarsophalangeal (MTP) joint dorsiflexion is required[4,9,15] to delineate the sesamoid-metatarsal sulci relationship. Dorsiflexion of the first MTP joint in a tangential sesamoid view may affect the congruence of the metatarsosesamoid complex.

The purpose of this study was to investigate the effect of various degrees of dorsiflexion of the first MTP joint on the sesamoid position as shown on tangential sesamoid view radiographs.

MATERIALS AND METHODS

Twenty-eight feet of 16 patients with hallux valgus angles of more than 30 degrees were included in the study. Short axis computed tomography (CT) images of the sesamoid were taken with the MTP joint at 0 (neutral), 35, and 70 degrees of dorsiflexion. A specially designed polyethylene orthosis was used for standardization of 35-degree and 70-degree dorsiflexion. The sesamoid position relative to the intersesamoid ridge was measured on the CT images.[15] First, a line was drawn between the lateral edge of the lateral sulcus, and the medial edge of the medial sulcus. From this line, a perpendicular line was drawn to the most prominent tip of the intersesamoid ridge. A four-stage grading

system was used according to the position of the medial sesamoid relative to the intersesamoid ridge (Figure 1):[15] grade 0, the medial sesamoid is entirely medial to the intersesamoid ridge; grade 1, less than half the width of the medial sesamoid is subluxated laterally; grade 2, more than half the width of the medial sesamoid is subluxated laterally; and grade 3, the medial sesamoid is entirely lateral to the intersesamoid ridge.

Feet with reduced sesamoids (grade 0) with the MTP joint in neutral and feet that could not be dorsiflexed to the desired position (both feet of one patient and one foot of four patients) were excluded from the study. The remaining 22 feet (15 patients) were examined using one-way ANOVA to compare the results of sesamoid position grading with the MTP at different dorsiflexion degrees. Informed consent was obtained from all patients.

RESULTS

The median sesamoid grade was 1 when the MTP joint was at neutral (0 degrees of dorsiflexion). The interquartile range was 1 to 3 and mean value was 1.27 (SD = 0.55).

When the first MTP joint was at 35 degrees of dorsiflexion, the median sesamoid grade also was 1. The interquartile range was 0 to 2 and the mean value was 0.90 (SD = 0.61).

When the MTP joint was at 70 degrees of dorsiflexion, the median sesamoid grade decreased to 0, the range was between 0 to 2, and the mean value decreased to 0.54 (SD = 0.67) (Table 1).

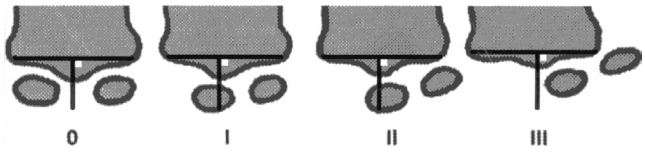

Fig. 1: Sesamoid grading according to the position of the medial sesamoid relative to the intersesamoid ridge

A significant decrease in the sesamoid grade (i.e. approximation to reduction) was apparent as dorsiflexion of the MTP joint increased (Figure 2). The differences between average measurements of sesamoid grades at neutral position and 35 degrees of dorsiflexion ($p < 0.01$) and average measurements at 35 degrees and 70 degrees ($p < 0.01$) were statistically significant. The difference was statistically more significant when the sesamoid grades at neutral and 70 degrees of dorsiflexion were compared ($p < 0.001$).

DISCUSSION

The sesamoids have an important role in the development of hallux deformity. Sesamoid subluxation usually is indicative of hallux valgus,[15] and a relationship is present between the amount of sesamoid subluxation and the severity of the hallux valgus deformity.[3,5] Reduction of the sesamoids to their proper position has been a criterion of successful hallux valgus correction from as early as 1923.[3,12]

Several investigators have described methods for quantifying the extent of metatarsosesamoid subluxation from AP radiographs,[5,13,14] but the tangential sesamoid radiograph has been determined to be the best view for evaluating the amount of sesamoid displacement.[1,6,15] The AP radiograph has been shown to be unreliable for evaluating sesamoid position,[9,10,15] but the tangential radiograph has not been thoroughly evaluated. The tangential sesamoid view is made with the first MTP joint in different degrees of dorsiflexion, usually over 40 degrees[9,15] and up to 75 degrees.[4]

Talbot and Saltzman[15] compared sesamoid position measurements made from AP radiographs and tangential sesamoid views[15] and concluded that the AP view was not valid for determining the grade of sesamoid position. In a similar study, Kuwano et al.[9] compared the sesamoid rotation angle (SRA) measured from the tangential sesamoid view and the position of the sesamoids from the AP radiograph.[9] They defined a

Table 1: Relation of the Sesamoid Grade with MTP Joint Position

Position of MTP Joint	Neutral	35-degrees Dorsiflexion	70-degrees Dorsiflexion
Maximum SG	1.0	0.0	0.0
Maximum SG	3.0	2.0	2.0
Median SG	1.0	1.0	0.0
Mean SG	1.27	0.90	0.54
Standard Deviation	0.55	0.61	0.67
95% CI	1.02–1.51	0.63–1.18	0.24–0.84

MTP = Metatarsophalangeal SG = Sesamoid Grade CI = Confidence Interval.

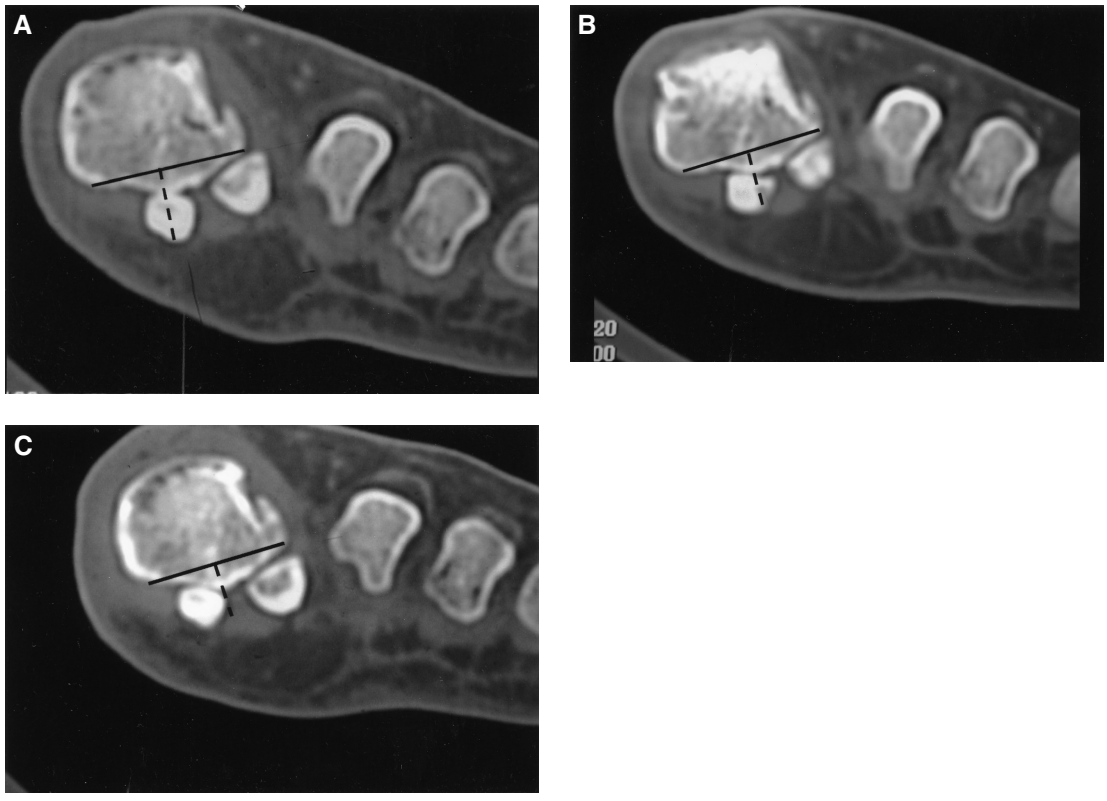

Fig. 2: Approximation of the sesamoids to reduction as dorsiflexion of the first MTP joint is increased. **A**, MTP joint in neutral position. **B**, MTP joint at 35 degrees of dorsiflexion. **C**, MTP joint at 70 degrees of dorsiflexion

discrepancy between the SRA and AP parameters when the tangential sesamoid view was taken with the MTP joint at 45 degrees of dorsiflexion. Different positions of the first MTP joint (neutral in AP radiographs but dorsiflexed in tangential radiographs) were proposed as the cause of this discrepancy but this hypothesis was not proven.

In the present study, short axial CT images made with the first MTP joint in different degrees of dorsiflexion were used to evaluate the sesamoid position. A difference in sesamoid positions on the CT images was noted when the MTP joint was at 0 (neutral), 35, and 70 degrees of dorsiflexion. The sesamoid subluxation grade decreased as dorsiflexion of the MTP joint increased. The anatomy of the metatarsophalangeal complex appears to be the main reason for this alteration of the sesamoid subluxation grade (Figure 2).

In the standing position, the sesamoids are located posterior to the metatarsal head and with the dorsiflexion of the hallux they are pulled distally.[4,7,11] Mobility of the sesamoid complex produces reduction of the sesamoids as dorsiflexion of the MTP joint increases. This occurs more easily with an atrophied intersesamoidal ridge, which is common in patients with hallux valgus.[4] Reduction of the sesamoids with increased dorsiflexion is in accord with the observations of Aper et al.[2] who found a relationship between MTP joint angle and the effective tendon moment arm of the flexor hallucis brevis (FHB). They noted an increase in the moment arm with increasing first MTP joint dorsiflexion, especially with 25 degrees or more of dorsiflexion. As dorsiflexion of the MTP joint is increased during positioning for the tangential view, the moment arm of the FHB is raised, which not only pulls the subluxated sesamoids distally and dorsally[11] but produces a ''bowstringing effect'' that brings them closer to reduction.

In the current study, the sesamoids approached reduction on the metatarsal head (decrease in sesamoid subluxation grade) as dorsiflexion of the first MTP joint increased. This finding is important because the tangential sesamoid view requires dorsiflexion of the first MTP joint,[4,9,15] and different degrees of MTP joint dorsiflexion may position the sesamoids inaccurately. For this reason, MTP dorsiflexion needs to be standardized in tangential sesamoid views. Kinematic study[2] of the first MTP joint have shown that from midstance to toe-off the mean range of motion is between 18 and 64 degrees.

Because the tangential sesamoid view is important in the evaluation of patients with hallux valgus to determine the amount of sesamoid displacement,

we included only patients with hallux valgus angles of more than 30 degrees to determine the effect of MTP joint dorsiflexion on sesamoid position. Future studies of the effect of MTP joint dorsiflexion on position of the sesamoids in normal feet may help to determine the normal tracking limits of the sesamoids and the likelihood of success of hallux valgus correction.

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