CHAPTER 12

RADIOGRAPHIC EVALUATION OF THE HALLUCAL SESAMOIDS

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LITERATURE REVIEW

David, et al completed an anatomical and functional review of the sesamoid apparatus in their paper "Anatomical Study of the Sesamoid Bones of the First Metatarsal." They extensively evaluated the anatomy of the sesamoid complex. One significant anatomic finding was the orientation of the two facets. The sesamoidal articular facets have differing slants, notably the medial being directed more plantar and the lateral positioned more upward and outward. However as the heel elevates and the foot goes into propulsion the sesamoids orient parallel to the supporting surface. The function of the sesamoid articulation is to act as a guide and a propellant in foot function. The sesamoids act to guide by directing and orienting the foot's position in preparation for heel contact, and they act as a propellant by removing the foot from the ground at the end stage of weight bearing. Finally, sesamoids through the adductor muscle complex were found to distribute and coordinate the forces placed on all of the metatarsals during gait.

Recent literature has quelled the debate as to whether or not the sesamoids move from their original position to a pathological position in a patient with hallux abducto valgus deformity. Saragas and Becker studied 118 pedal radiographs finding no difference in the sesamoid position relative to the second metatarsal in the hallux abducto valgus and control groups. Mann and Coughlin state that as the hallux moves into valgus and the metatarsal into varus, the sesamoid apparatus retains its relationship with the second metatarsal. Alvarez, et al extensively researched the pathomechanics of the sesamoid complex in the development of hallux valgus deformity and concluded that the sesamoids do not dislocate. Finally, Shereff, et al stated in their research of normal and hallux valgus deformity subjects that there was no significant difference in the displacement of the medial or lateral sesamoid.

Traditionally sesamoid position has been measured almost exclusively on the AP projection radiograph. Some questions have been raised to the validity of this AP projection measurement. Talbot and Saltzman studied the position of the sesamoids on an AP projection radiograph and compared it with the position of the sesamoids on an axial sesamoid projection radiograph. They determined that the standard method for measuring sesamoid position on the AP projection is not valid, and that the axial sesamoid projection must be evaluated to obtain accurate sesamoid position.

SESAMOID POSITION EVALUATION

Traditional methods of measuring sesamoid position include two main methods. One method more recognized in the podiatric community uses seven positions. The tibial sesamoid position (TSP) as described by Hardy and Clapham is determined relative to the first metatarsal longitudinal bisection. The bisection is felt to represent the plantar cristae of the metatarsal head. Seven standard positions exist. TSP 1 is when the sesamoid is entirely medial to the bisection line without touching it. As the tibial sesamoid progresses lateral to this position, it is assigned a higher position number. When the lateral border of the sesamoid just touches the bisection line, it is referred to as TSP 2. TSP 3 occurs when up to one half of the tibial sesamoid extends lateral to the bisection. TSP 4 is found when the bisection line equally bisects the sesamoid. TSP 5 exists when greater than one-half of the sesamoid extends lateral to the bisection. TSP 6 is when the medial border of the sesamoid touches the bisection line. Finally, TSP 7 occurs when the sesamoid is entirely lateral to the bisection, without touching (Figure 1).

The research committee of American Orthopaedic Foot and Ankle Society developed another grading scale, using a four-position assessment. Simplified from the approach of Hardy and Clapham, there is no loss of clinical relevance and measurements should have less variability. This method also relates the position of the tibial sesamoid to the longitudinal axis of the first metatarsal. A sesamoid, which has no lateral displacement

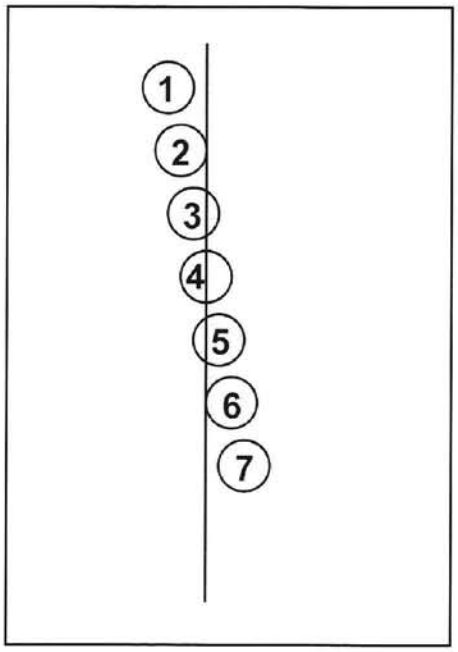

Figure 1. Tibial sesamoid position as described by Hardy and Clapham

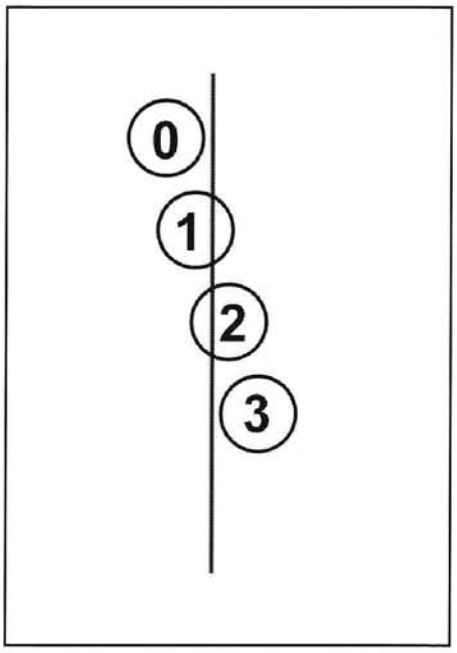

Figure 2. Description of the tibial sesamoid position as recommended by the American Orthopaedic Foot Society

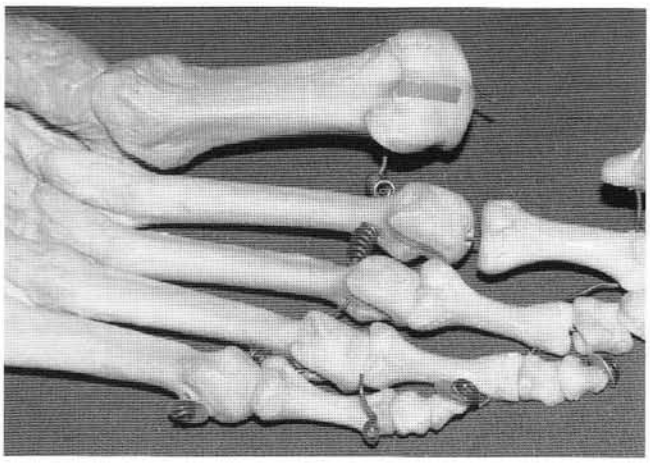

Figure 3. A lead marker is place on the cristae of the first metatarsal head

relative to the bisection line, is deemed as Grade 0. Grade 1 occurs when there is an overlap of less than 50% of the sesamoid to the bisection. Grade 2 is when the overlap of the sesamoid becomes greater than 50% of the bisection. Finally, when the sesamoid is completely displaced laterally beyond the reference line, it is called Grade 3 (Figure 2).

Kuwano et al in 2002 presents a new radiographic analysis of sesamoid position, which evaluates the rotational position of the sesamoids. They describe a new measurement called the sesamoid rotation angle (SRA). They designed a specific tangential positioning device to take the axial sesamoid position in which the metatarsophalangeal joint is placed in 45° of dorsiflexion. The SRA is measured as the angle between the tangential line of the most inferior aspect of the medial-lateral sesamoids and the lead marker line (Figure 3). The SRA was then compared in this article to both the seven position and four grade scales. Their conclusions found that the scale of position on the AP view is not valid in some cases, whereas the SRA was more useful in assessing the rotational position of the sesamoids in cases of hallux valgus.

MATERIALS AND METHODS

Several measurements were made on standard AP and axial sesamoid views of radiographs in patients with hallux abducto valgus. The following measurements were made on the AP radiographs: First Intermetatarsal Angle (IM), Hallux Abductus Angle (HA), Tibial Sesamoid Positions (TSP both orthopedic and podiatric scales), and the distance between the first and second metatarsal heads (1st-2nd MTD). The following measurements were made on the axial radiographs: IM, TSP, Tibial Sesamoid Position in relationship to the cristae utilizing the podiatric scale, 1st-2nd MTD, Sesamoid Rotation Angle (SRA), and Relationship of the Medial Eminence to the Ground (METG).

DISCUSSION

The tibial sesamoid position is measured based on its relationship to the bisection of the 1st metatarsal. This longitudinal marker is believed to equally divide the metatarsal into medial and lateral halves, corresponding with the cristae, which serves as the anatomical bisection of the metatarsal head. David, et al have demonstrated the asymmetry of the metatarsal head and sesamoid articulations. Viewing the foot on an AP x-ray it is difficult to clearly visualize the lateral flare of the metatarsal head, which is often obscured by the underlying density of the fibular sesamoid. The cristae, therefore, is located to the lateral side of the standard metatarsal bisection (Figures 3, 4).

This study has shown that the tibial sesamoid position in relation to the cristae as seen on the axial projection does not always correlate with the AP x-ray (Figures 5, 6). AP x-rays were also taken with the foot on an axial positioner, since axial x-rays are taken with the heel elevated and the toe dorsiflexed approximately 30∞, to see if this would change the sesamoid orientation. The change in sesamoid position was negligible but a small change in the intermetatarsal angle was noted

The position of the sesamoids on the axial view was also studied in relation to its frontal plane rotation. In some instances the sesamoid rotation increased to 35∞ but in other instances it remained parallel to the supporting surface. The larger the intermetatarsal angle the greater the sesamoid rotation in most cases. It does not

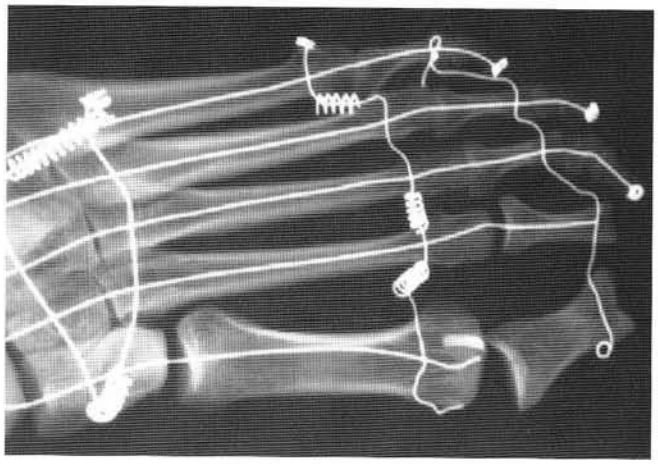

Figure 4. An AP radiograph of the foot in figure one demonstrating the apparent lateral position of the cristae relative to the first metatarsal bisection

Figure 5. AP radiograph with the sesamoid apparently lying directly over the cristae.

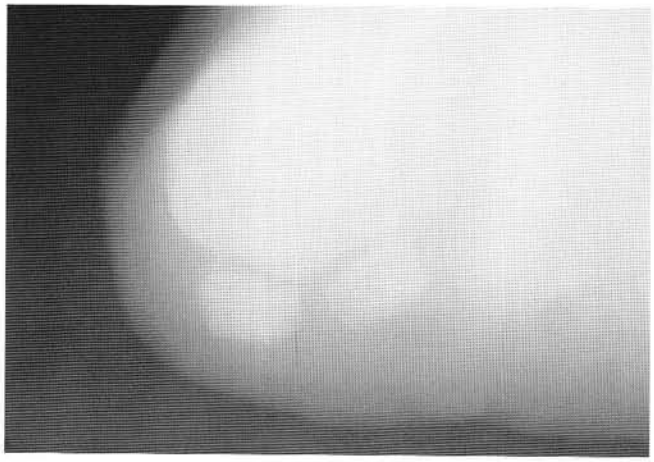

Figure 6. Axial projection of Figure 3, revealing the sesamoids in their normal anatomic positon.

Figure 7. Radiograph shows valgus rotation of the sesamoids. Note the medial cortical wall of the first metatarsal is not rotated.

appear the rotation of the sesamoids corresponds to rotation of the metatarsal head. The medial cortex of the metatarsal head to the supporting surface was measured as well and in nearly all instances in all degrees of hallux valgus this relation remained perpendicular. Very little frontal plane motion of the metatarsal was noted. It appears from analyzing the x-rays that as the metatarsal head moves medially, the fibular sesamoid moves dorsally (Figure 7). On axial x-rays the fibular sesamoid did not move any closer to the second metatarsal, confirming previous studies which have demonstrated the metatarsal head moves medial in hallux valgus deformity while the sesamoids remain stationary in the transverse plane.

BIBLIOGRAPHY

Alvarez R, et al. The Simple Bunion: Anatomy at the Metatarsophalangeal Joint of the Great Toe. *Foot Ankle Intl* 1984;4:229-40.

David R, et al. Anatomical Study of the Sesamoid Bones of the First Metatarsal. *J Am Podiatry Med Assoc* 1989;79:536-44.

Hardy, R., and Clapham, J. Observations on Hallux Valgus. *J Bone Joint Surg Br* 1951;33:376-91.

Jahss M. The Sesamoids of the Hallux. *Clin Orthop Rel Res* 1981;157:88-97.

Judge MS, et al. The Effect of Hallux Abducto Valgus Surgery on the Sesamoid Apparatus Position. *JAPMA* 1999;89:551-9.

Kuwano T, et al. New Radiographic Analysis of Sesamoid Rotation in Hallux Valgus: Comparison with Conventional Evaluation Methods. *Foot Ankle Intl* 2002;23:811-7.

Mann R, Coughlin M. Hallux Valgus – Etiology, Anatomy, Treatment and Surgical Considerations. *Clin Orthop Rel Res* 1981;157:31-41.

Saragas N, Becker P. Comparative Radiographic Analysis of Parameters in Feet With and Without Hallux Valgus. *Foot Ankle Intl* 1995;16:139-43.

Shereff M, et al.: Kinematics of the First Metatarsophalangeal Joint. *J Bone Joint Surg Am* 1986;68:92-397.

Smith RW, Reynolds JC, Stewart MJ. Hallux Valgus Assessment: Report of Research Committee of American Orthopaedic Foot and Ankle Society. *Foot Ankle Intl* 1994;5: 92-103.

Talbot K, Saltzman, C. Assessing Sesamoid Subluxation: How Good is the AP Radiograph? *Foot and Ankle Intl* 1998;19:547-54.