CHAPTER 36

THE FIRST METATARSOCUNEIFORM JOINT: Analysis and Clinical Application

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"Divergence of the first metatarsal from the second is one of the most significant relationships in the deformity of hallux abductovalgus." Patrick Landers, D.P.M. *Comprehensive Textbook of Foot Surgery*, 1992

"The orientation of the metatarsocuneiform (MC) joint may be the most important factor in the development of an increased intermetatarsal angle." Coughlin and Mann *AAOS Instruction Course Lectures*, 1987

The first metatarsocuneiform joint is an important contributor to the development of advanced hallux abductovalgus deformity. However, the literature is full of controversy as to how to systematically analyze the joint and clinically apply the information for treatment. The consensus is that for adults with this overall deformity, the hallux valgus portion about the first metatarsophalangeal joint is the primary deforming force, and the diastasis between the first and second metatarsals develops as a consequence of it. However, for juvenile hallux valgus, it is agreed that the angular divergence of the first metatarsal is the primary deformity. It may precede or occur simultaneously with the development of the more distal hallux valgus.

Truslow (1825) identified obliquity of the base of the first metatarsal relative to the lesser tarsus as the primary deformity in juvenile hallux valgus, and termed it "metatarsus primus varus." His work was supported by Halebian, Jones, and Ellis. It was not until 1960 that Simmonds and Menelaus suggested the term "metatarsus primus adductus" to more accurately identify the deformity of the first metatarsal diastasis. In addition, Ewald (1912), Bernsten (1930), and Haines and McDougall (1954) were able to clearly demonstrate the relationship between the obliquity of the first metatarsocuneiform joint and the development of hallux abductovalgus deformity.

It has been accepted that both the cuneiform and metatarsal base take part in the oblique alteration of alignment, with neither one really predominating. It was also felt that the base of the first metatarsal can adapt itself to changing conditions of pressure, particularly in juvenile hallux valgus development.

Hardy and Clapham (1952) felt that the "deformity of hallux valgus precedes widening of the first intermetatarsal angle." They thought that this was more likely to be the cause and not the result of the metatarsus primus varus, again looking at adults.

In addition to the applications for hallux valgus, analysis of the first metatarsocuneiform joint can have applications to the treatment of many other types of deformities, including: collapsing pes valgo planus, cavus foot deformity, metatarsal boss formation, metatarsus primus elevatus, metatarsus adductus, and degenerative joint disease.

The purpose of this paper is to attempt to achieve some measure of systematic analysis of the first metatarsocuneiform joint, and apply such information to the successful treatment of various foot deformities.

ANATOMY

The distal surface of the medial cuneiform is kidney-shaped with an indentation on the lateral margin. About 50% of the time, the upper and lower facets will be partially united, and 6% of the time there will be completely separated upper and lower facets. Interestingly, approximately 14% of the time there will be a crescentic facet with a concavity facing laterally. With the anterior surface elongated vertically, it is oriented somewhat inferiorly with the plantar border more proximal than the dorsal border, and inclined medially and posteriorly to various degrees. The surface is only minimally convex transversely, and is flat in the vertical direction (Fig. 1).

The articulating base of the first metatarsal is also reniform in shape with the hilum on the lateral side. It has a slight transverse concavity, but is again flat in the direction of the long axis. It too may be separated into partially united upper and lower segments.

The dorsal medial surface and the plantar surface of these two bones have attachments for multiple, strong ligaments. It is worthy to note that there is no ligament between the bases of the first and second metatarsals, which may assist in allowing divergence in the face of deforming forces.

Figure 1. Anatomy of the first metatarsocuneiform joint showing the articular surface of the base of the first metatarsal and the distal surface of the first cuneiform bone.

Figure 2. Axis of motion of the first ray. This is an axis that allows tri-plane motion which includes dorsiflexion/eversion and plantarflexion/inversion.

Anomalies at this site include an articular facet that may occur at the lateral aspect of the base of the first metatarsal butting up against the second metatarsal. On extremely rare occasions, this facet may be congenitally fused between these metatarsals.

It should also be noted that the lateral margin of the cuneiform is approximately one millimeter longer in length than the medial margin. Also, the inferior lateral angle of the base of the first metatarsal is usually prolonged posteriorly, thus producing a lip or a ridge. This will restrict motion by locking the joint at the end range of dorsiflexion and will rotate the plantar aspect of the first cuneiform medially into inversion.

FUNCTION

Hicks was able to determine that the first ray axis of motion runs obliquely through the medial mid-tarsus from distal-lateral to proximal-medial (Fig. 2). As a result, the motion of the first ray which includes the hallux, first metatarsal, medial cuneiform, and naviculocuneiform joint, functions by way of dorsiflexion/inversion and plantarflexion/eversion for a total range of motion of approximately 22 degrees. The first metatarsocuneiform joint by itself, due to this relatively flat articulating surfaces, has a lower total range of motion of approximately 15 degrees in dorsiflexion and plantarflexion, and about half that for medial and lateral movement. Thus, the first metatarsocuneiform joint and the first cuneonavicular joints move in concert about a common axis of motion, as defined by Hicks and confirmed by Ebisui.

RADIOGRAPHIC ANALYSIS

It is important that x-rays be taken in a standard fashion, preferably weight bearing in angle and base of gait, to maintain consistency. Studies have shown that by changing the angle of the central ray, there is a significant resulting alteration in the metatarsal cuneiform angle no matter what method is used to measure it.

Unfortunately, there is no consensus on exactly what is the first metatarsocuneiform angle. In fact, several different types of angles have been used to analyze the first metatarsocuneiform articulation (Fig. 3A-3E).

The first metatarsocuneiform joint as seen on the AP radiograph should be analyzed for the shape of the joint, the slope, a lateral facet abutting the second metatarsal, and any signs of hypermobility such as a diastasis between the first and second cuneiform bones. The shape may be straight or transverse, rounded, or sloped in an oblique fashion medially and posteriorly as seen in the transverse plane (Fig. 4A-4E). Straus determined that the orientation of the first metatarsocuneiform joint was in marked varus during embryologic development. The joint was angulated approximately 32 degrees in an 8-week-old fetus compared to 6.2 degrees in the average adult. Lapidus thought this represented a form of "atavism" and called it the atavistic cuneiform (Fig. 5).

In the lateral view, observation must be made for first metatarsal declination, the presence of a first metatarsocuneiform or naviculocuneiform fault, plantar gapping (Fig. 6), or evidence of degenerative changes such as dorsal osteophyte formation. Degenerative changes are seen more readily in the lateral view than the AP view.

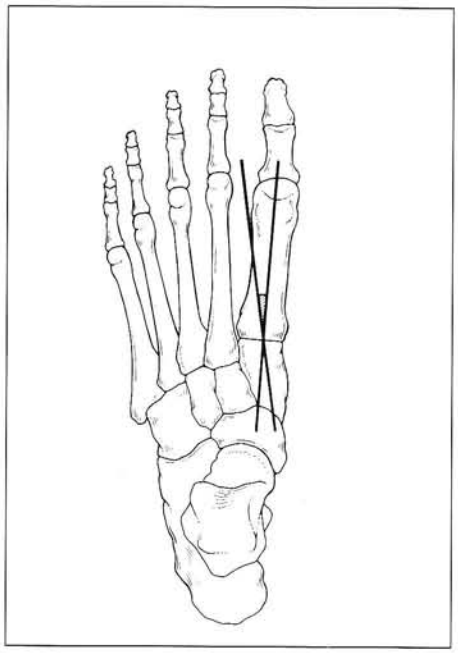

Figure 3A. Angles about the first metatarsocuneiform joint. Kalen and Breecher. (The Metatarsus Varus Angle). The angle formed by the bisection of the first metatarsal and the bisection of the first cuneiform. Also called "the first metatarsocuneiform joint angle" by Whitney.

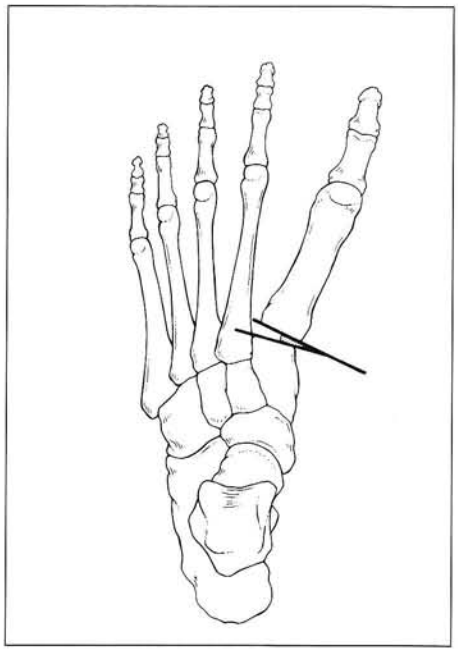

Figure 3B. Goldner and Gaines. (First Metatarsal-First Cuneiform Angle). The angle between the lines paralleling the base of the first metatrsal and the distal first cuneiform. These seem to indicate more overlap of the dorsal and plantar articular margins than actual angulation.

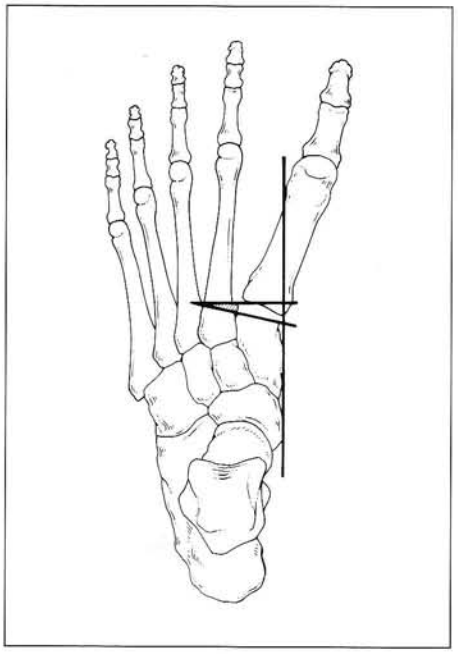

Figure 3C. Brage, Holmes, Sangeorzan. (The First Metatarsocuneiform Angle). The angle formed by the line along the distal surface of the cuneiform versus the right angle to the line paralleling the medial surface of the first cuneiform.

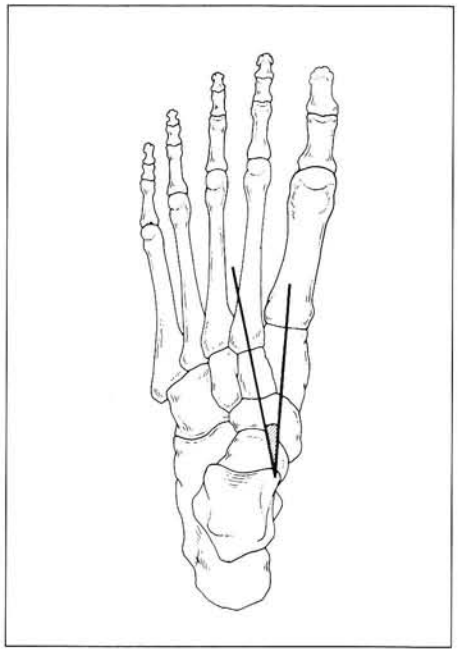

Figure 3D. McNerney and Johnston. (Cuneiform Divergence Angle). The angle between the bisections of the first and second cuneiform bones.

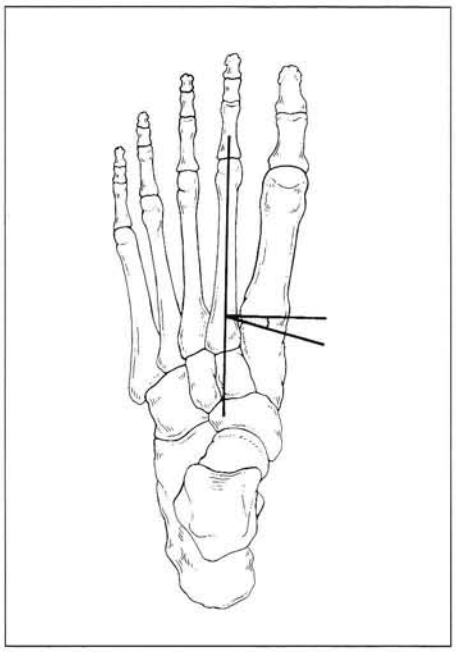

Figure 3E. McCrea and Lichty. (First Metatarsocuneiform Angle). The angle formed by the right angle line to the bisection of the second metatarsal and the line parallel to the articular surface of the joint.

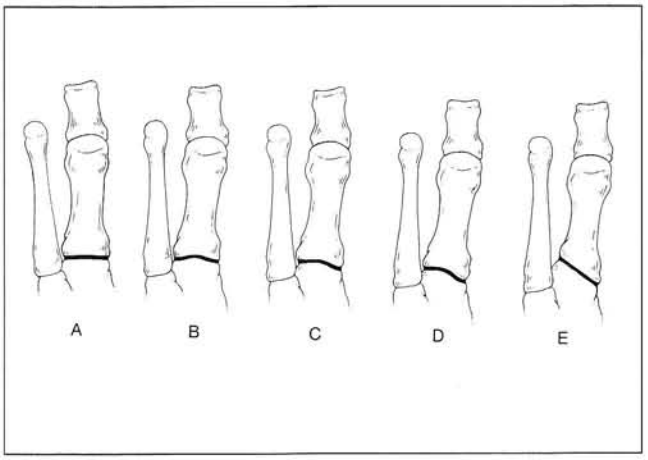

Figure 4A. Various shapes and orientations of the first metatarsocuneiform joint. A. Inherently stable horizontal articulation. B. Oblique articulation. C. Curved articulation. D. Facet at the base of the first metatarsal abutting the second metatarsal base. E. Reverse slope of the first metatarsocuneiform joint articulation.

Figure 4B. Oblique articulation may be nonflexible and require osteotomy or arthrodesis to correct.

Figure 4C. Curved articulation with instability that may encourage first and second metatarsal diastasis.

Figure 4D. Facet at the base of the first metatarsal abutting the second metatarsal base may limit the ability to reduce the intermetatarsal angle.

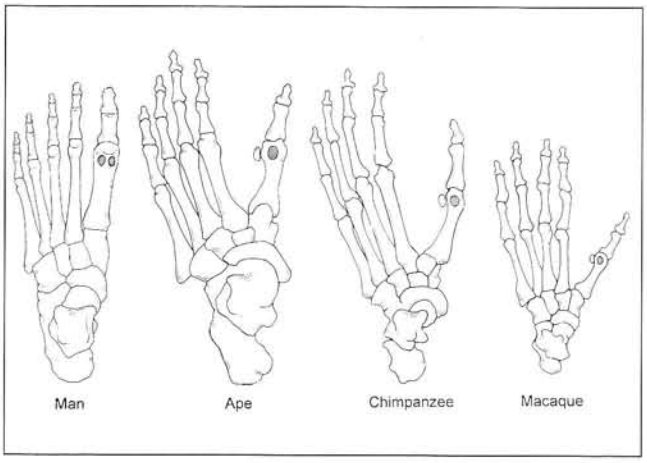

Figure 5. Comparison of first metatarsocuneiform joint to primates termed "atavistic."

Figure 4E. Reverse slope of the first metatarsocuneiform joint articulation. In this case, due to the congenital fusion of the bases of the first and second metatarsals.

Figure 6. Observe plantar gapping at the first metatarsocuneiform joint. This may indicate hypermobility.

CLINICAL EVALUATION

The architecture of the first metatarsocuneiform joint can only be analyzed radiographically. Clinical examination is limited to evaluation of the mobility of the first metatarsocuneiform joint, and the presence or absence of pronation.

Hohman, Lapidus, DeVries, and Inman all agreed that instability of the medial column as caused by pronation, and demonstrated by hypermobility, predisposed the foot to the development of hallux abducto valgus. Hardy and Clapham (1951) in their study of 89 patients with hallux valgus, made the interesting observation that the more limitation of motion that occurred at the first metatarsocuneiform joint, the higher the intermetatarsal angle, (24.7 degrees in the feet with less mobility versus 21.7 degrees in the mobile feet.)

There is no standardized method of determining or defining hypermobility at either the first metatarsocuneiform joint or the first ray. The subtalar and midtarsal joints must be stabilized or neutralized when determining the amount of mobility present along the first ray.

SURGICAL APPLICATION

Each subtle manifestation of the first metatarsocuneiform articulation can be applied to various clinical applications when analyzed by a critical eye. If the articular surface is rounded in the presence of a metatarsus primus adductus, then soft tissue correction can be expected to achieve satisfactory reduction of the intermetatarsal angle, as long as the deformity is flexibly reducible. However, if there is a lateral facet at the base of the first metatarsal abutting against the second metatarsal, the chance of the reduction persisting is low. Similarly, a straight joint surface will exhibit very little transverse plane motion and, therefore, little reduction can be expected in the metatarsus primus adductus angle, following simple soft tissue correction. Attention must then be made to the possibility of a metatarsal base osteotomy or arthrodesis of the joint. Conversely, a horizontal setting would tend to resist increase in the intermetatarsal angle, while an oblique orientation of the first metatarsocuneiform joint would tend to allow an increase in the intermetatarsal angle. Therefore, the hallux valgus cannot be reduced without attention to the base of the first metatarsal itself.

If the obliquity of the first metatarsocuneiform joint is pronounced, then a metatarsal base osteotomy is necessary to reduce the metatarsus primus adductus, and correct the hallux valgus on a more permanent basis. Goldner and Gaines proposed that if the angle between the first cuneiform and first metatarsal is 0 - 25 degrees, then realignment can be done by the base osteotomy, or even soft tissue realignment. However, if the angle is greater than 25 degrees, then more aggressive realignment procedures must be undertaken such as cuneiform osteotomy or arthrodesis of the joint.

When there is marked sagittal plane hypermobility of the first metatarsocuneiform joint in the face of a hallux abducto valgus deformity, arthrodesis becomes the procedure of choice in order to stabilize the first ray and thereby correctly realign the medial column. Care must be taken to achieve a biplane correction to both adduct the first metatarsal and plantarflex it at the same time. Indicators of hyper-mobility at the first metatarsocuneiform joint include diastasis between the first and second cuneiform bones, or plantar gapping of the first metatarsocuneiform joint on the lateral x-ray view.

When applying these principles to a flexible flatfoot, arthrodesis for medial column stabilization is indicated when there is a fault at the first metatarsocuneiform joint. When the fault is at the naviculocuneiform articulation, it is primarily because there is more range of motion available at that joint. Consideration must be given to fusing both of the joints in the face of medial column hypermobility when stabilization is desired as part of the flatfoot correction. Cavus foot requires a different orientation for the arthrodesis of the first metatarsocuneiform joint, and may also include the medial naviculocuneiform joint.

Finally, as an alternative to arthrodesing the first metatarsal cuneiform joint, or using the first metatarsal base osteotomy to close the intermetatarsal angle, patients who have limited capacity for single-limb weight bearing, can be considered for an osteoarthrotomy procedure. This involves resecting the distal articular surface of the first cuneiform bone, allowing the first metatarsal to "float" and reduce the intermetatarsal angle. This can only be done in a foot that is maximally and relatively rigidly pronated, so that there are no midfoot stress points to compromise the osteoarthrotomy.

CONCLUSION

There is no doubt that much remains to be know about the exact contribution of the first metatarsocuneiform joint to the development of medial column deformities. For example, determining exactly which side of the joint is more contributory to the development of deformities such as sloping or medial angulation remains a mystery. The tendency is to attribute it more to the base of the first metatarsal due to the proximity of the growth center. Exact methods to more specifically define the range of motion, hypermobility, three dimensional orientation of the joint, as well as contribution of the ligaments remain ripe topics for further research. It is unfortunate that the first metatarsocuneiform joint is so critically a part of medial column deformities, especially hallux abducto valgus, and yet its exact mechanism of contribution is still relatively unknown.

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