Hallux Valgus With Increased Distal Metatarsal Articular Angle

Abstract

Hallux valgus is a common deformity of the forefoot with a multifactorial etiology. It is important to have an understanding of foot anatomy and the intrinsic and extrinsic factors that can lead to the development of the condition when deciding on nonsurgical or surgical treatment.

Keywords: distal metatarsal angle, hallux valgus, metatarsophalangeal joint, proximal phalangeal articular angle

Definition of the Problem

Patient Presentation

Patients who present with a hallux valgus deformity most commonly report pain over a prominent medial eminence, a widened forefoot, and incompatibility with shoe wear; often a history of bunion deformities is noted in other members of the family. However, the underlying radiographic findings may differentiate a hallux valgus deformity that is characterized by a congruent metatarsophalangeal (MTP) joint articulation; this less common type of hallux valgus frequently requires a unique approach to treatment.

To understand the notion of the distal metatarsal angle (DMAA) and its association with hallux valgus, it is important to understand the basic anatomy of the first MTP joint. This MTP joint is stabilized circumferentially by a capsular ligamentous complex on the dorsal, medial, and lateral aspects. On the plantar surface, the medial and lateral sesamoids, enclosed within the tendons of the flexor hallucis brevis, give stability and strength to the plantar capsule. The intrinsic and extrinsic muscles that encircle the MTP joint provide for dorsiflexion and plantar flexion of the toe and stabilize the joint in a mediolateral plane. The first and second metatarsals diverge at their distal extent, normally at an angle of 9° or less; this constitutes the 1-2 intermetatarsal angle. The alignment of the hallux and the first metatarsal at their articulation is measured by the hallux valgus angle; the alignment of the distal and proximal phalanges is quantitated by the hallux interphalangeal angle (Figure 1).

The proximal phalanx of the hallux articulates with the distal articular surface of the first metatarsal. Both surfaces are covered by a cartilage surface, which is concave on the phalangeal surface and convex on the metatarsal surface. Although it initially might be assumed that these articular surfaces are positioned perpendicular to the longitudinal axis of the proximal phalanx and first metatarsal shaft, that is rarely the case. Frequently there is a slight valgus inclination at the MTP joint, which typifies the normal appearance of the foot as it fits in a toe box that is slightly pointed. Under normal circumstances the great toe is not perfectly straight, and thus, by definition, a hallux valgus angle of less than 15° is considered normal.

When the concept of joint congruity is discussed in relationship to the hallux MTP joint, it is the alignment of the articular surfaces that must be examined. In the case of a normal first ray, with no hallux valgus deformity, the base of the proximal phalanx is aligned concentrically with the first metatarsal head articular surface. This alignment is basically a congruent articulation that may remain congruent for the person's lifetime. However, with the passage of time, a dynam-
In a dynamic hallux valgus deformity, the base of the proximal phalanx subluxates in a lateral direction as it virtually slides off of the articular surface of the first metatarsal head. This subluxation rarely occurs in a rapid or dramatic fashion but typically develops slowly over a period of years. It begins with mild deviation and, in some cases, progresses to a substantial deformity characterized by a marked increase in the hallux valgus angle and the 1-2 intermetatarsal angle. This condition, characterized as a subluxated hallux valgus deformity, is by far the most common situation seen in adults. This joint relationship can also be described as incongruent or nonconcentric because the articular surfaces have migrated from their original congruent or aligned position to their incongruent or misaligned position. The deformity is described as dynamic because it progresses with time; the hallux can actually deviate more, although improvement or reduction in the deformity rarely if ever occurs.

In contradistinction to the subluxated or incongruent hallux valgus deformity, a congruent hallux valgus deformity may be observed (Figure 2). These deformities are decidedly less common, occurring in probably 5% of those with hallux valgus, although they have been noted to occur with increased frequency in adolescent hallux valgus deformities and in men with hallux valgus. What typifies a congruent hallux valgus deformity is the concentric relationship of the corresponding articular surfaces. The deformity is static and rarely progresses because the hallux valgus is a result of the angular relationship of the articular surfaces to the long axis of the phalanx and first metatarsal and not of subluxation at the MTP joint. Thus, in younger patients with hallux valgus, a congruent deformity is more often the underlying cause of the hallux valgus. Although this deformity rarely progresses, the patient’s age at presentation depends on when symptoms develop.

All hallux valgus deformities are quantitated by measuring the hallux valgus angle, the hallux interphalangeal angle, and the 1-2 intermetatarsal angle; however, the analysis of a congruent deformity requires estimation of the angulation of the respective articular surfaces. The major deformity typically occurs at the distal articular surface of the first metatarsal. The DMAA defines the relationship of the articular surface of the distal metatarsal to the longitudinal axis of the first metatarsal (Figure 3, A). A DMAA of less than 6° is considered normal. The proximal phalangeal articular angle (PPAA) defines the relationship of the articular surface of the proximal aspect of the proximal phalanx to the longitudinal axis of the proximal phalanx. A PPAA of less than 10° is considered normal (Figure 3, B). Whereas it is relatively easy to obtain...
Angular measurements while evaluating a hallux valgus deformity, estimating the medial and lateral extent of the metatarsal articular surface can be difficult, especially in the younger patient. The reliability of this analysis depends on the experience of the physician, and the angular measurements sometimes may be accurately estimated only at the time of surgical correction. Nonetheless, in many circumstances careful inspection of the radiographs of all hallux valgus deformities will uncover an increased DMAA that may otherwise have not been noticed.

**Physical Examination**

The history and physical examination of a patient with a hallux valgus deformity should include an in-depth family history and a history of shoe wear, injury, and any factors that may influence the onset of progression of a hallux valgus deformity. A positive family history is associated with a higher incidence of a congruent deformity. Typically, constricting shoe wear is not a factor in the progression of deformity; however, it may lead to discomfort and eventual medical evaluation. A history of early onset of a bunion and the development of a bunion deformity in a man typically is associated with an increased risk of a congruent hallux valgus deformity.

The physical examination should include evaluation of the patient in both standing and sitting positions. Frequently, the deformity is accentuated with the patient standing. Attention should be directed to the posture of the forefoot and hindfoot and to ankle motion. Pes planus, pes cavus, metatarsus adductus, and a contracted Achilles tendon are no more common in patients with hallux valgus than in the general population; nonetheless, patients should be evaluated for these problems because they may require other treatment. Assessment of the mobility of the metatarsocuneiform joint is also part of the evaluation process because, in a small percentage of patients with a congruent hallux valgus deformity, metatarsocuneiform hypermobility must be addressed as well.

The forefoot is examined for any lateral forefoot or lesser toe deformities and for callosities; the neurovascular status of the foot is examined as well. Attention is then directed to the first ray, which is inspected for alignment and motion. The magnitude of valgus of both the distal and proximal phalanx is quantitated, and pronation of the hallux is noted. Passive dorsiflexion and plantar flexion are noted. Then the great toe is deviated into a corrected alignment with the metatarsal articular surface, and range of motion is again evaluated. This provocative test is performed to determine if passive range of motion is decreased when the articular surfaces are realigned. In the presence of a congruent articulation, motion is often decreased. In the presence of a subluxated articulation, motion often does not diminish.

Weight-bearing AP and lateral radiographs are obtained to evaluate the hallux valgus deformity. Axes of the first and second metatarsals, the proximal and distal phalanges of the hallux, and the DMAA are drawn to analyze the deformity.

**Differential Diagnosis**

- Mild, moderate, or severely subluxed deformity
- Metatarsocuneiform hypermobility
- Degenerative arthritis of the MTP joint

**Additional Work-Up**

Rarely are hematologic or chemistry studies needed before bunion surgery unless there is an underlying medical problem. On occasion, further evaluation of the hallux valgus deformity to assess the MTP articulation necessitates CT or MRI. Adding air or contrast media may assist in defining the extent and shape of the articular cartilage.

**The Solutions**

**Treatment Options and Rationale**

For mild congruent hallux valgus deformities, the DMAA is not greatly increased. By definition, a mild deformity is characterized by a hallux valgus angle less than or equal to 20°. Thus, a distal metatarsal osteotomy usually will suffice for correcting the DMAA and the angular deformity of the first ray. Choices to be considered are the chevron osteotomy, a distal closing wedge osteotomy (Reverdin), Mitchell osteotomy, and scarf osteotomy. There are numerous other variations; however, these techniques are probably the most commonly used. A major consideration, however, is that all these osteotomies do not change the MTP articulation but rather achieve correction by a periarticular osteotomy. A distal soft-tissue realignment in the presence of a congruent deformity will create an incongruent articulation that may be at risk for joint stiffness, degenerative arthritis, or recurrence. Sometimes recurrence may be dramatic and rapid, within weeks or months after surgery (Figure 4). It is beyond the scope of this article to provide a step-by-step description of the

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Figure 3. Representative examples of DMAA and PPAA. A, Congruent hallux valgus deformity with a hallux valgus angle of 31° and DMAA of 27°. Almost all of the hallux valgus is caused by the DMAA. B, Hallux valgus interphalangeus with angulation at the proximal phalanx. (Reproduced with permission from Mann R, Coughlin M: Adult hallux valgus, in Coughlin M, Mann R, eds: Surgery of the Foot and Ankle, ed 7. St. Louis, MO, Mosby, 1999, pp 150-269.)

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For moderate congruent hallux valgus deformities, the magnitude of the DMAA may vary from greater than 20° to less than or equal to 40°, and much if not all of the hallux valgus deformity can be attributed to this angulation. A scarf osteotomy (Figure 5) or a biplanar chevron osteotomy (Figure 6) often will be adequate to correct the lower moderate deformities, but these osteotomies are underpowered for greater deformities. A closing wedge distal metaphyseal osteotomy can achieve greater correction in these instances. As the 1-2 intermetatarsal angle increases, a proximal osteotomy may be necessary; options include but are not exclusive to an opening wedge cuneiform osteotomy or a proximal first metatarsal osteotomy (opening wedge, closing wedge, crescentic). Often, an element of hallux valgus interphalangeus is present with moderate and severe deformities, and a closing wedge phalangeal osteotomy (Akin) may be considered as well.

In severe congruent hallux valgus deformities, the hallux valgus angle is greater than 40°, and much if not all of the deformity is a result of the increased DMAA. Surgical options remain similar to those for high moderate deformities. On occasion, there may be an element of further subluxation superimposed on a sloped distal metatarsal articular surface. In this situation, a capsulorrhaphy may also be a component of the surgical repair.

**Author’s Preferred Treatment and Rationale**

The armamentarium of a foot and ankle surgeon should include several procedures with which to correct the underlying pathology associated with a congruent hallux valgus deformity. For hallux valgus interphalangeus, a closing wedge phalangeal osteotomy is frequently a component of any of these other first ray realignment procedures. This closing wedge osteotomy may be in the proximal or distal metaphysis, depending on the location of the major phalangeal misalignment.

For a mild and low moderate deformity with a DMAA of 25° or less, a chevron osteotomy or a biplanar osteotomy is a reliable means of correcting the DMAA. Double and triple first ray osteotomies are preferable for correcting upper moderate and severe deformities and are used depending on the amount of correction needed.
necessary (Figure 7). A closing wedge distal metaphyseal osteotomy can be performed to correct a large amount of the increased DMAA. A proximal crescentic osteotomy can be performed to obtain a large correction of the increased 1-2 intermetatarsal angle. A phalangeal osteotomy can be performed to correct an increased interphalangeal deformity. Usually internal fixation is achieved with buried Kirschner wires that are removed 6 weeks after surgery.

Ambulation is allowed in a postoperative shoe, walking boot, or below-knee cast, depending on the stability of the osteotomies, security of internal fixation, and reliability of the patient. Care must also be taken during any surgical exposure, certainly in the first ray when multiple osteotomies are performed, to minimize excess surgical dissection to prevent devascularization of bone. A lateral MTP joint release is not performed in association with a closing wedge distal metatarsal osteotomy; when multiple osteotomies are performed in the first ray, care is taken to leave an extensive soft-tissue bridge on the intervening tissue to minimize the chance of vascular compromise that will affect ultimate bone healing.

Management of Complications

Complications after surgical correction of a hallux valgus deformity are numerous and include wound healing problems, osseous delayed unions and nonunions, nerve injuries, and a host of other expected and unexpected problems. The main complications particular to a congruent MTP joint with hallux valgus are undercorrection, recurrence, osteonecrosis, and malunion.

Undercorrection can occur when an underpowered procedure is used for correction. For example, a chevron osteotomy is not very likely to achieve total correction of a severe deformity. Analysis of the reasons for undercorrection will enable the physician to plan the salvage procedure, which may be a revision with periarticular osteotomies, or an MTP fusion may be a final solution. Recurrence is more often associated with failure to recognize the underlying congruent joint and may develop if the magnitude of the articular slope is underestimated. In this situation, a revision with periarticular osteotomies again may be the route of salvage. Osteonecrosis can occur after a procedure in which the vascular supply to the metatarsal head or the base of the proximal phalanx has been disrupted. It also can occur following attempts to salvage a failed correction, and a patient should be advised about the risks of salvage surgery. Usually the salvage following osteonecrosis is an MTP fusion. Malunion is probably one of the most significant risks when multiple first ray osteotomies are performed. Kirschner wire fixation usually is adequate, but external immobilization may be necessary if the osteotomy has questionable stability or patient reliability is in doubt. A malunion may actually result in an acceptable outcome; however, if overcorrection or undercorrection results in an unacceptable outcome, a correctional osteotomy may be considered. It is usually wise to wait several months before proceeding with correctional osteotomies to decrease the chance of osteonecrosis, delayed union, or wound healing problems.
Bibliography


