Current Concepts Review: Hallux Valgus Part 1: Pathomechanics, Clinical Assessment, and Nonoperative Management

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INTRODUCTION

Theories on the pathology and appropriate treatment of hallux valgus have been extensively described in the orthopaedic literature. The wealth of information on the operative management of hallux valgus has been molded into frequently taught treatment algorithms and principles. Although these algorithms and principles aim to provide consistency in treating symptomatic hallux valgus, the wide variety of approaches to treating hallux valgus suggests that they are far from commonly accepted. The purpose of this current concept review is to provide a balanced representation of current thinking on the pathomechanics, assessment, and treatment of hallux valgus. This review will include two parts to accommodate the breadth of this topic. The first part includes the background, etiology, pathomechanics, typical clinical presentation, and nonoperative treatment of hallux valgus, and the second part focuses on operative treatment and potential complications in the management of hallux valgus.

This review will remind the reader that hallux valgus deformity is complex and that our understanding of this condition remains incomplete. Operative management of hallux valgus remains challenging. It is probably incorrect to state that the operative management of hallux valgus deformity is evolving; at this time it is safer to say that it remains dynamic. Despite the appeal of establishing universally accepted treatment algorithms, this review suggests that the surgeon treating hallux valgus deformity should individualize management to the particular patient.

HISTORY AND ETIOLOGY

Bunion, a term evolving from the Latin word *bunion*, meaning turnip, poorly defines the condition. To our knowledge, the first published reference to *hallux valgus* was by Carl Hueter in 1870.[33] Hallux valgus is commonly thought to develop because of shoes that are not accommodative. Some support this conclusion,[39,43] but insufficient evidence exists to confirm unaccommodative shoes as an etiological factor in the development of hallux valgus. Conversely, the observation that many individuals do not develop hallux valgus despite nonphysiologic shoe wear for many years implies that some individuals may have an incompletely defined predisposition to hallux valgus. Other studies have reported that hallux valgus develops in some unshod individuals, implying a congenital predisposition.[2,16,19,30,35,47,74] Hallux valgus in juveniles, adolescents, and men whose feet have not been subjected to shoes with narrow toe boxes supports a congenital predisposition. An association between hallux valgus and female gender also has been

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Table 1: Level of evidence and grades of recommendation

Level of Evidence
— Level I: high quality prospective randomized clinical trial
— Level II: prospective comparative study
— Level III: retrospective case control study
— Level IV: case series
— Level V: expert opinion

Grades of Recommendation (given to various treatment options based on Level of Evidence supporting that treatment)
— **Grade A** treatment options are supported by strong evidence (consistent with Level I or II studies)
— **Grade B** treatment options are supported by fair evidence (consistent with Level III or IV studies)
— **Grade C** treatment options are supported by either conflicting or poor quality evidence (Level IV studies)
— **Grade I** when insufficient evidence exists to make a recommendation

suggested,[31,75] as has a familial predisposition to develop hallux valgus.[9,26,30,36] The exact etiology leading to the development of a hallux valgus deformity remains unclear and may be multifactorial. However, because a bunion deformity tends to develop over time, it seems reasonable to conclude that repetitive forces applied to the first metatarsophalangeal joint leads to hallux valgus.

PATHOMECHANICS

Anatomic Considerations

Patients without hallux valgus maintain physiologic alignment of the hallux metatarsophalangeal (MTP) joint with: (1) congruent and symmetric alignment of the articular surfaces of the first proximal phalanx and the first metatarsal head during the repetitive joint loading associated with gait, (2) physiologic relationship of the distal first metatarsal articular surface and the first metatarsal shaft axis, (3) stable balance of soft tissues about the first metatarsophalangeal joint, and (4) stable first tarsometatarsal joint. Because there is no musculotendinous attachment to the metatarsal head, any divergence from these physiologic factors predisposes a patient to hallux valgus.

Repetitively forcing the hallux into a valgus position, particularly with weightbearing and ambulation is believed to eventually result in a valgus deformity at the first MTP joint. The summation of ground reactive forces and dynamic muscular forces eventually leads to attenuation of the medial joint capsule and contractures of the lateral joint capsule and adductor tendons, with a resultant medial deviation of the first metatarsal head ("bunion deformity").

Ground reactive forces may play a role in the gradual development of a hallux valgus deformity. The forefoot is subject to ground reactive forces equal to more than body weight with each step. When these forces are channeled through the plantar pulp of the hallux, the first MTP joint moves through a physiologic range of motion. However, if these forces are channeled through the plantar medial aspect of the hallux, then the structures restraining the medial aspect of the first MTP joint tend to become attenuated over time. In this model anything that leads the hallux to accept weightbearing asymmetrically on the medial aspect of the hallux can predispose to hallux valgus. Restrictive shoes and hypermobility of the first ray are examples of factors that may produce this situation.

Dynamic muscular forces across the first MTP joint also may contribute to the development of the hallux valgus deformity. If the pull of the medial dynamic structures, particularly the abductor hallucis, is redirected plantarward, the force opposing the adductor hallucis is negated. The extensor hallucis longus (EHL) and flexor hallucis longus (FHL) gradually create a more lateral force across the joint, the plantar aponeurosis (windlass mechanism) is directed more laterally, and the flexor hallucis brevis forces also shift slightly more laterally. With these eccentric forces, the crista under the first metatarsal head fails to maintain proper tracking of the sesamoids. The resulting muscular forces across the first MTP joint function to deviate the hallux laterally.

Several factors have been implicated in the development of hallux valgus. These include: (1) pes planus, (2) hypermobility of the first tarsometatarsal joint, (3) the relationship and characteristics of the first metatarsal head and proximal phalanx, and (4) the condition of the medial capsule.

Pes Planus and Hallux Valgus

Pes planus may lead to hallux valgus because of increased forefoot abduction that creates a nonphysiologic load on the plantarmedial aspect of the great toe during heel rise. The association between pes planus and hallux valgus is controversial. Although some authors suggest that patients with pes planus have a greater tendency to develop hallux valgus than patients with maintained arches,[1,15,22,32,38,57,62,65] others do not support this association.[5,9,40,49] The combination of conflicting reports and consistently Level III to V evidence provides insufficient evidence (Grade I) to prove or disprove an association between pes planus and hallux valgus.

Hypermobility of the First Tarsometatarsal Joint

Mobility of the first tarsometatarsal (TMT) joint is observed in the sagittal and transverse planes.[21] The prevalence of medial column hypermobility continues to be controversial in patients with hallux valgus. It is theorized that hypermobility could lead to the development of hallux valgus in two ways. First, more than physiologic dorsal subluxation of the first metatarsal could result in pes planus alignment, increased forefoot abduction, and a nonphysiologic load on the plantarmedial aspect of the great toe during heel rise. Second, more than physiologic medial subluxation of the first metatarsal could increase the 1–2 intermetatarsal angle, promoting metatarsus primus varus. Some foot and ankle surgeons maintain that hypermobility of the first TMT joint or lack of stability of the foot's medial column contributes to the development of hallux valgus[3,42,53,60,66] and resultant pain,[34] a theory popularized by Morton.[19,28,50–52] Lapidus supported this theory and suggested operative correction with a first TMT joint arthrodesis.[44–46] While a convincing argument in theory, no evidence exists to support such a correlation and, in fact, other investigators have demonstrated that hypermobility of the first TMT joint is not directly associated with hallux valgus.[13,14,24,27,28,55] Insufficient evidence (Level III to V) exists to support or disprove the contribution of first TMT joint hypermobility to the development of hallux valgus (Grade I).

Characteristics of the First Metatarsal Head

Shape

A "squared" or flattened configuration of the MTP joint may resist valgus forces and limit development of hallux valgus; in contrast, a rounded, concentric shape of the MTP joint may predispose to hallux valgus if a valgus stress is consistently maintained on the hallux. To our knowledge, the contribution of metatarsal head configuration with development of hallux valgus remains an observation; no evidence supports the association of metatarsal head configuration to hallux valgus.

Distal Metatarsal Articular Angle (DMAA)

Hallux valgus may exist with a congruent, symmetric relationship between the first proximal phalanx and the first metatarsal head, suggesting a congenital predisposition in some patients with an increased DMAA.[8,10,11] Richardson et al.[56] noted that the DMAA ranged from 6.3 to 18 degrees in patients with hallux valgus; as the angle increases, so does the propensity for hallux valgus. Coughlin[9] added that the DMAA tends to be larger in patients with juvenile hallux valgus younger than 10 years of age when compared to those over the age of 10. Although Richardson et al.[56] suggested that the DMAA can be determined reliably radiographically, others have reported poor interobserver reliability.[6,12,72]

Medial Capsular Integrity

Recently, Uchiyama et al.[71] demonstrated in a cadaver model that feet with hallux valgus have a different organization of collagen fibrils than that observed in normal feet. These findings may be in response to abnormal stress repetitively applied to this part of the joint capsule. Alternatively, abnormal mechanical properties of the medial capsule, such as in patients with conditions like rheumatoid arthritis may increase the propensity to develop hallux valgus.

CLINICAL PRESENTATION

History

Not all patients with hallux valgus are symptomatic. Besides an obvious cosmetic deformity, patients with symptomatic hallux valgus generally complain of pain exacerbated by shoes, particularly those with a narrow toe box. Frequently reported complaints include pain over the medial eminence and pain with first MTP joint motion. Pain also may be reported at the second MTP joint, under the second metatarsal head, and occasionally with impingement of the first toe on the second. In addition to identifying pain related to hallux valgus, the physician should determine limitations in shoes and activity level resulting from the deformity.

Physical Examination

The severity of the hallux valgus deformity and the presence of pes planus are assessed with the patient weightbearing. To illustrate the appropriateness of shoes, the physician may wish to contrast an outline of the patient's foot with nonphysiologic shoes. Medial eminence tenderness, first MTP joint range of motion, and first TMT joint hypermobility can be evaluated with the patient seated.[27] Limited first MTP joint range of motion with or without crepitance should alert the physician to the possibility of degenerative changes in the first MTP joint.

Physiologically normal values of first TMT joint mobility have not been defined, and first ray hypermobility remains a controversial finding and a diagnostic challenge, despite methods suggested to objectively quantitate first TMT joint motion.[73] Even though a validated Klaue device exists to measure first ray mobility,[25,37] it is not particularly practical in the clinical setting. Moreover, first TMT joint hypermobility may not occur only in the sagittal plane but also in the transverse plane.[21] Clinical evaluation may not be adequately specific to isolate the first TMT joint and may assess only medial column mobility. Physical examination also should include evaluation of the second MTP joint for the presence of synovitis, metatarsal head overload, and second toe deformity, all of which often are associated with hallux valgus.

Imaging Studies

Proper evaluation of a hallux valgus deformity requires weightbearing anteroposterior and lateral radiographs of the entire foot. From these radiographs, the angular relationships that identify the presence and determine magnitude of the deformities of the bones and the joints associated with hallux valgus are measured. Other conditions, such as instability, arthrosis, and malalignment of joints elsewhere in the foot or the manifestations of vascular, neurogenic, or systemic disorders that affect the function of the foot also may be appreciated. Oblique views of the foot may facilitate the recognition of these associated problems; however, they are not used to measure any of conventional parameters of pedal alignment and often are unnecessary. Weightbearing sesamoid views may help in preoperative planning for hallux valgus correction. The sesamoid bones may appear laterally displaced on weightbearing anteroposterior views in congruent hallux valgus when actually they rest in their respective facets on the axial sesamoid view.

Radiographic Measurements Pertinent to Hallux Valgus

Several parameters measured on anteroposterior radiographs aide in the basic characterization of a hallux valgus deformity. The hallux valgus angle (HVA), defined as the angle formed by the intersection of longitudinal axes of the diaphyses of the first metatarsal and the proximal phalanx, quantifies the malalignment of the first MTP joint. Several authors have suggested that the upper limit of normal for this measurement is 15 degrees.[30,48,58,64] The intermetatarsal angle (IMA) represents the angle formed between the diaphyses of the first and second metatarsals. This measurement quantifies the extent of metatarsus primus varus. The upper limit of normal for the IMA is 9 degrees.[30,48,58,64] The interphalangeal angle, which is the angle between the metaphysis and diaphysis of the proximal phalanx determines the amount of hallux valgus interphalangeus (HVI). The physiologic upper limit of normal for this parameter is 10 degrees.[12,48,58] The distal metatarsal articular angle (DMAA) assesses the angular relationship between the articular surface of the head and diaphysis of the first metatarsal. The upper limit of normal DMAA is 10 degrees.[12,28,56] The literature suggests that while preoperative intraobserver and interobserver reliability for the HVA and IMA is excellent (less than 5 degrees, 95% confidence interval),[12,58,61,63] assessment of the DMAA remains a diagnostic challenge, with poor intraobserver and interobserver reliability.[6,10,12,56,72]

Radiographic Measurements Purported to Suggest Hypermobility

Second metatarsal diaphyseal hypertrophy, a medially-oriented first TMT joint, and first TMT joint obliquity have been suggested to indirectly determine hypermobility of the first ray. Diaphyseal hypertrophy of the second metatarsal, particularly the medial cortex has been suggested as a sign of hypermobility of the first ray.[3,29,53,54,60] No investigation has demonstrated a correlation between radiographic changes in the second metatarsal and hypermobility;[20,28,55] however, one study demonstrated a marginal correlation between the IMA and dorsal mobility of the TMT joint in patients with hallux valgus.[23] A medially-oriented obliquity of the first TMT joint has been proposed as a sign of hypermobility, but Brage et al.[4] demonstrated that changing the inclination of the radiographic beam relative to the floor created wide variations in the measurement of the first TMT joint obliquity. Based on these findings, Brage et al.[4] concluded that first TMT joint obliquity was not a reliable indication for first TMT arthrodesis in the management of hallux valgus. A more recent investigation found significant dorsal translation and dorsiflexion of this joint in a series of patients with moderate to severe hallux valgus compared to normal controls.[41] The appearance of plantar gapping at the TMT joint has been attributed to radiographic projection and discounted as an indication of hypermobility.[33,71] At this time, no investigation has correlated these presumed radiographic abnormalites of the TMT joint with clinical hypermobility.

Correlating Physical and Radiographic Findings

Thordarson et al.[68] evaluated 285 women with an average age of 49 years who were scheduled for corrective surgery for hallux valgus. Validated AAOS foot-specific outcomes data collection questionnaires were used. Preoperative radiographic data (HVA and IMA) were stratified into degree of deformity. The data were stratified into age groups consistent with those reported for the SF-36, and the results were compared to the SF-36 for the general population. The global foot and ankle score and the shoe comfort score were compared with the general population, and the severity of the preoperative deformity was correlated with the baseline scores. Bodily pain scores were uniformly worse for hallux valgus patients than for the general population, with significantly lower global foot and ankle and shoe comfort scores, a finding that suggests that the bodily pain score from the SF-36 represents a sensitive measure of the difficulties experienced by patients who have corrective hallux valgus surgery. The preoperative radiographically-determined severity of deformity failed to correlate with any scores measured.

Degree of Severity

Radiographic measurements of the HVA and IMA define the degree of severity in hallux valgus deformity, and surgeons commonly use these measurements to select particular procedures for the operative management of hallux valgus. In the literature, hallux valgus has been defined with some variability as *mild, moderate*, and *severe* In various articles, while the HVA is relatively consistent (*mild,* less than 30 degrees; *moderate,* 30 to 40 degrees; and *severe,* more than 40 degrees), the IMA varies (*mild*, less than 10 to 15 degrees; *moderate*, 10 to 15 degrees; and *severe,* more than 15 to 20 degrees).[7,17,18,59,67,68,70] To our knowledge, these measurements are arbitrarily assigned, and currently no evidence exists to support absolute radiographic measurements to define the degree of severity of hallux valgus deformity.

NONOPERATIVE TREATMENT

Nonoperative management of hallux valgus can improve a patient's symptoms and avoids the complications that may be associated with hallux valgus surgery. To ensure appropriate nonoperative treatment of hallux valgus, the patient's specific complaints must be identified. Pain may not be a major component of the patient's symptoms. Cosmetic concerns and difficulty with shoes often are common complaints. Because of the recovery time and the potential for complications associated with operative correction of hallux valgus, it is not indicated.

Symptoms of pain are best treated with shoe and activity modifications. Accomodative shoes with a wide toe box are often helpful. Padding over the medial eminence or adjustments to the shoe to create more space medially can be helpful. However, nonoperative management cannot reverse hallux valgus deformity, and successful surgery may improve functional outcome. A randomized controlled trial of 209 consecutive patients with symptomatic hallux valgus treated in four Finnish general community hospitals demonstrated that while orthoses provided short-term symptomatic relief, operative management of hallux valgus led to superior functional outcome and patient satisfaction compared to orthotic management at a minimum followup of 12 months.[69] Operative correction also led to better functional outcome and patient satisfaction than observation ("watchful waiting"), suggesting that the natural history of symptomatic hallux valgus deformity, is not one of improvement (Level I evidence). Although this prospective, randomized study demonstrated the benefits of operative correction of hallux valgus when compared to nonoperative treatment, this isolated study is insufficient evidence to support a definitive treatment recommendation that corrective surgery should be favored over nonoperative management for hallux valgus deformity (Grade I).

Summary points

1. The exact pathomechanics underlying the development of a hallux valgus deformity are still unclear; however, they are invariably related to repetitive loading of the hallux that leads to attenuation of the medial capsular structures.
2. The first metatarsal head has no musculotendinous attachments
3. Clinical and radiographic assessment of hallux valgus deformity must be made with the patient weightbearing.
4. Intraobserver and interobserver reliability is satisfactory for measuring the hallux valgus and intermetatarsal angles; however, it is poor for measuring the distal metatarsal articular angle.
5. Many bunion deformities are asymptomatic and do not warrant operative correction
6. Nonoperative management of hallux valgus can improve a patient's symptoms and avoids potential operative complications; however, nonoperative treatment cannot reverse hallux valgus deformity, and successful surgery may improve functional outcome.

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