Hallux valgus (HV) is a valgus angulation of the first metatarsophalangeal (MTP) joint of the great toe. Hallux valgus is distinct from a bunion, which is an exostosis on the dorsomedial aspect of the first metatarsal (MT) head. The word bunion is derived from the Greek, *bunio,* and means turnip; better known is the meaning of the Latin derived *hallux valgus,* that roughly translates to “large toe with an outward angulation,” but more informally as a “crooked big toe.” Hallux valgus is also frequently painful and may both limit physical activities and create a psychological distress for patients, depending on the severity of the deformity. The condition of HV includes not only the outward lateral deviation of the great toe (distal segment of the first metatarsal) but a medial deviation of the first MT. Commonly, there is progressive subluxation of the first MTP joint. Occasionally, there is a static deformity due to valgus angulation of the distal articular surface of the first MT or proximal phalangeal articular surface.

Constricting footwear is a major extrinsic cause of HV. Couglin and Thompson noted the high prevalence of HV in American females in the fourth, fifth, and sixth decades of life and its probable association with footwear type. The prevalence of HV in Japanese females also increased dramatically after the introduction of high-fashion footwear following WWII.

Intrinsic factors also play a role in HV; those suggested include: pronation of the hind foot, pes planus, an increased angle between the first and second MT (metatarsus primus varus), association between the HV angle and the first to second intermetatarsal angle, contracture of the Achilles tendon, generalized joint laxity, and hypermobility of the first MT-cuneiform joint. Heredity also can be a factor in HV. Hardy and Clapham showed that 63% of patients with HV had a parent with HV. Coughlin reported a 94% incidence of bunions in mothers of children with HV. Finally, neuromuscular disorders, including cerebral palsy and stroke, can play a role.

Anatomy*

The MTP first ray is unique. It possesses a sesamoid mechanism and a set of intrinsic musculature that provide stability and strength. As described by Coughlin, The muscles and tendons can be separated into four groups that surround the first MTP. Dorsally, the extensor hallucis longus (EHL) inserts onto the distal phalanges and the extensor hallucis brevis (EHB) onto the proximal phalanges. The EHL is secured by the hood ligaments, fashioning the capsule of the MTP joint. The flexor hallucis longus (FHL) and flexor hallucis brevis (FHB) are present on the plantar aspect of the foot. The tendons of the medial and lateral heads of the FHB insert onto the medial and lateral sesamoids, respectively. The sesamoid bones are fastened to the base of the proximal phalanx via the plantar plate. The FHL, which inserts onto the base of the distal phalanx, is plantar to the sesamoid complex, and encased within its own tendon sheath.

The abductor (AbH) and adductor (AdH) hallucis tendons are located plantar medial and plantar lateral, respectively; they insert into base of the proximal phalanx and the sesa-

*The reader is referred to the comprehensive article “Hallux Valgus” by Michael J. Coughlin, from which parts of the anatomical description were used: Instr Course Lect. 1997;46:357-91 or J Bone Joint Surg Am. 1996;78(6):932-66.
moids. The plantar half of the MTP joint capsule is reinforced by the tendons of the AbH and AdH. The dorsal half is thin and without tendinous constraints. As HV increases, the AdH becomes a deforming force and tethers the sesamoids and proximal phalanx as the first MT deviates medially. The tendon exerts a rotational force, because it inserts on the plantar aspect of the proximal phalanx. The plantar cuff (AbH, FHB, and AdH) rotates laterally; the EHL then displaces into the first interspace and becomes an adduction force. This results in lateral subluxation of the sesamoids. The crista, or intersesamoid ridge, articulates with the medial and lateral sesamoids. As displacement occurs, this ridge is smoothed out until it offers no resistance to displacement.

**History and Physical Examination**

The occupational history of the patient is very important and one should inquire whether their job requires them to be on their feet all day, working at heights, or wearing stylish shoes with a narrow toe box. If a patient has an occupation that requires standing, financial difficulties could result. Information should be acquired as well about the frequency of recreational activities such as running, jumping, racquet sports, gymnastics, and basketball. Athletes should be counseled that they might not be able to return to their previous level of play.

With respect to shoe wear, relief of pain is the major objective. Improved appearance and ability to wear smaller or narrower shoes frequently are goals of the patient but may not be verbalized. Mann and associates found that 41% of patients were unable to wear their choice of shoe following HV repair. Postoperative expectations should be addressed preoperatively, whether a patient desires cosmesis or pain relief.

The physical examination must be thorough. The medial eminence (bunion) is often the most visible feature on physical examination. Pain over the medial eminence is often the primary symptom, due to irritation of the dorsal or plantar cutaneous nerve of the great toe, an inflamed or thickened bursa, or skin irritation or breakdown; only occasionally is the bone truly hypertrophied.

Physical examination should be performed with the patient both sitting and standing. During weightbearing, the deformity is generally accentuated. The examiner should evaluate the patient for assessment of pes planus and contracture of the Achilles tendon. The longitudinal arch and great toe, with its relation to the lesser toes, are also examined. Careful measurement is made regarding the magnitude of the HV, the pronation of the great toe, gait abnormalities, motor weakness, or abnormal alignment of the lower extremity. Passive and active range of motion (ROM) of the MTP joint should be performed. Pain and crepitus can indicate degenerative joint disease (DJD). The physician should attempt to manually correct the hallux valgus deformity, moving the great toe in dorsiflexion and plantar flexion. This maneuver will demonstrate the approximate amount of surgical correction that can be performed while maintaining a satisfactory range of motion. To evaluate for metatarsocuneiform (MTC) hypermobility, the examiner must hold the second MT head in one hand and the first MT in the other. The first MT head subsequently is deviated dorsomedially and then plantar laterally. Greater than 9 mm of deviation represents hypermobility. Significant instability is observed in about 5% of patients with HV. This condition is often associated with moderate to severe flatfoot deformity. Next, the lesser toes are inspected. The lesser toes can cause significant pain, even though their deformity is secondary to HV. Conditions such as hammertoe of the second toe, metatarsalgia of the lesser MTP joints, plantar surface keratoses, and callosities can be present. Doppler studies should be obtained if there is any question of adequate circulation.

**Radiological Assessment**

Radiographic examination should include weightbearing anterior-posterior (AP), lateral, and axial (sesamoid) radiographs, routinely. Radiographic measurements are made using standing radiographs. The HV angle is the intersection of the longitudinal axes of the proximal phalanx and the first MT. A normal HV angle is considered to be less than 15°. The 1-2 intermetatarsal angle is the intersection of the longitudinal axes of the first and second metatarsals. Less than 9° is considered normal. Subluxation of the lateral sesamoid, as measured on the AP radiograph, can be used for classification.

Broadly, mild HV is defined as an HV angle of less than 20° and a 1-2 intermetatarsal (IM) angle less than 11°, with less than 50% subluxation of the lateral sesamoid. Moderate HV is a HV angle of 20° to 40° and a 1-2 IM angle that is less than 16°, with 50% to 75% subluxation of the lateral sesamoid. Severe HV is defined as a HV angle greater than 40°, a 1-2 IM angle that is greater than 16°, and more than 75% subluxation of the lateral sesamoid.

The radiographic morphology of the distal articular surface of the first MT can vary. A rounded contour is the most common and more prone to subluxation. A flattened or chevron-shaped contour is more stable. Congruity, or correspondence in character, is ascribed to the normal relationship between the MT and phalangeal surfaces. The relation is considered “congruous” when the joint surfaces are parallel, and there is no lateral subluxation; the surfaces are “aligned.” The relation is described as noncongruous when the joint surfaces are not aligned, there is subluxation of MTP joint, and the joint surfaces are no longer parallel. Lateral subluxation of the proximal phalanx occurs on the MT head. A congruous joint is less likely to have a progression of HV. A noncongruous joint is more likely to subluxate further with time.

The distal metatarsal articular angle (DMAA) describes the relationship between the distal articular surface and the long axis of the first MT. A normal angle is less than 10°. The DMAA is also known as MT articular orientation or...
proximal articular set angle (PASA). The proximal articular surface of the proximal phalanx forms an angle with the longitudinal axis of the proximal phalanx, the proximal phalangeal articular angle (PPAA). This angle is also called the phalangeal articular orientation or the distal articular set angle (DASA).

Hallux valgus interphalangeus is the angle between the lines bisecting the proximal and distal phalanges of the metatarsal. A normal angle is less than 10°. With progressive MTP subluxation, a groove (sagittal sulcus) develops at the medial border of the MT articular surface. The magnitude of the HV deformity determines the presence and location of the angle. While it delineates the border of the articular surface, it is an unreliable landmark for the planning of a medial exostectomy. In severe deformities, the hallux valgus interphalangeus angle may be located in the center of the MT head. Its use as a guide may lead to excessive bone resection.

The shape and orientation of the MTC is variable and influences the magnitude of medial inclination of the first MT. Normally, the first MTC is inclined medially. Occasionally, there is increased medial obliquity that may result in instability of the MTC joint. The first MTC may appear flat, curved, or oblique and may vary with the plane of the radiograph.

Treatment

Nonoperative

The first treatment option is nonoperative care. Adjustment to footwear can be utilized to eliminate friction over the medial eminence, e.g., providing a wider and deeper toe box. The condition of pes planus may be helped by an orthosis. If the pes planus condition is severe, this can lead to a recurrence of HV. Achilles contracture may require stretching or even lengthening.

Operative

Only after nonoperative treatment fails should surgery be considered. Surgical options include proximal phalangeal osteotomy, MTP soft tissue reconstruction, distal or proximal MT osteotomy, MTC arthrodesis, MTP arthrodesis, or excisional arthroplasty.

The Akin procedure is a medial eminence resection, medial capsular reefing, and a medial closing-wedge phalangeal osteotomy. An increased 1-2 intermetatarsal angle is not corrected by this technique. Indications for the procedure include HV interphalangeal, mild HV without MT primus varus, and a mild HV with an enlarged medial eminence. In a congruous MTP joint with HV, an Akin procedure can be combined with an MT osteotomy for extra-articular realignment. Goldberg and colleagues,8 in 351 patients, showed a 53% satisfaction rate; however, there also was a 21% recurrence rate. Broad indications were applied: HV angle less than 40° and no osteoarthritic (OA) changes. Frey and colleagues6 demonstrated, in 45 feet, 89% good to excellent results. Most surgeries were performed for second toe symptoms. The outcome of the series included one nonunion and one recurrence. Plattner and Van Manen,10 in 22 patients, had an average correction of the HV angle of 13°. At 4.5 years, there was a 6° correction, with a 61.5% satisfaction rate reported. The investigators suggested that a major indication for the Akin procedure is HV interphalangeal and that the procedure is not indicated for HV with subluxation of the MTP joint.

Distal Soft Tissue Realignment

The Silver procedure is a medial capsulorrhaphy, medial exostectomy, lateral capsular release, and adductor release. The McBride modification describes the removal of the lateral sesamoid and transfer of the adductor to the lateral aspect of the MT head. This procedure was modified further to exclude sesamoid excision due to the high rate of hallux varus. Indications include a noncongruous HV deformity of less than 30° and a 1-2 intermetatarsal angle of less than 15°. The foot must have mobility of the first MTC joint so that the 1-2 intermetatarsal angle can decrease.

Kitaoka and colleagues,11 performed a simple bunionectomy and medial capsulorrhaphy, with or without lateral capsulotomy, in 49 feet. They found 67% good to excellent results, with a 29% reoperation at five years. The procedure was most successful for patients who presented with and had treatment for a painful medial eminence. Mann and Pfeffinger,12 in 72 feet, found a 92% satisfaction rate. The HV angle improved from 32° to 16° and the IM angle from 14° to 9°. There was no postoperative progression of the HV deformity at an average of 4 years; 64% wore unrestricted footwear. The investigators found the procedure was not appropriate for a severe deformity. Six patients had hallux varus (average 7.5°). They recommended the procedure for a HV angle of less than 30° and an intermetatarsal angle less than 15°.

The Chevron osteotomy is a medial eminence resection, distal MT osteotomy, and medial capsulorrhaphy. Indications include a HV angle less than 30°, a 1-2 IM angle less than 13°, subluxation of the MTP joint, and a congruous MTP joint if the DMAA is less than 15°. Chevron osteotomy does not correct pronation and only partially corrects the sesamoids. A phalangeal osteotomy can be added to improve alignment. A lateral soft-tissue release is discouraged, as it may result in devascularization of the MT head. Results by Hattrup and Johnson,13 in 225 feet, showed complete satisfaction in 79.1%, satisfaction but with reservations in 12.9%, and dissatisfaction in 8%. The average correction of the HV angle was 12° to 13° and the IM angle was 4° to 5°. Meier and Kenzora14 examined 72 feet. They found a 74% satisfaction if the IM angle was more than 12° and a 94% satisfaction rate if the IM angle was 12° or less. Stienstra and colleagues,15 in 38 feet, found that the HV angle corrected an average of 18° and the IM angle 11°; 95% had no activity limitations. The most frequent complications associ-
ated with the Chevron osteotomy are recurrence (especially with large corrections), loss of correction due to slippage at the osteotomy, transfer metatarsalgia, and osteonecrosis. Osteonecrosis can be increased after performing an adductor tenotomy.

Mitchell and Wilson, among several others, described a distal MT osteotomy in a biplanar or oblique fashion, respectively. Indications include a HV angle of less than 35°, an IM angle of less than 15°, subluxation of the MTP joint, and a congruous MTP joint if the DMAA is less than 15°. The average correction of the HV angle is 10° to 25° and the IM angle 5° to 10°. Excessive shortening with transfer metatarsalgia and callus formation occurs in 20% to 40%. Under correction, recurrence, and osteonecrosis (increased with adductor release) can occur.

A proximal MT osteotomy with distal soft tissue reconstruction can be performed in several ways. These include an opening-wedge, closing-wedge, oblique (a.k.a. Luddoff), Chevron, crescentic, or Scarf (Z-shaped). Indications include moderate to severe HV with a HV angle of 35° or greater and an IM angle 13° or greater, with subluxation of the MTP joint. Average correction of the HV angle is 24°. The IM angle corrects 8° to 11° with a crescentic, 3° to 6° with a closing-wedge, and 7° with an opening-wedge osteotomy. A crescentic osteotomy causes minimal shortening. Complications include recurrence, under correction, and overcorrection, failure of fixation, shortening, metatarsalgia, and delayed union or malunion. Mann and workers examined 109 feet and found a 93% satisfaction rate. The HV angle corrected from 31° to 9° and the IM angle from 14° to 6°. However, they discovered hallux varus in 13 feet. Thordarson and Leventen examined the results of 33 feet in 23 patients. They found an HV angle correction from 37.5° to 13.8° and an IM angle correction of 14.9° to 4.7°. Hallux varus occurred in four feet. They concluded that the use of screws or screws and K-wires increased stability with less shortening.

The modified Lapidus procedure is an arthrodesis of the first MTC joint with distal soft tissue realignment of the MTP joint. Indications include a moderate to severe HV with a HV angle 30°+ and an IM angle 16°+, with MTP subluxation and MTC hypermobility or generalized ligamentous laxity. The procedure is also indicated in recurrent deformity in adolescents or young adults. Average correction of the HV angle is 18° and the IM angle is 6° to 8°. There is, however, a lengthy convalescence (cast until radiographic healing is observed). Complications include nonunion (10% to 12%), malunion (up to 20%), plantar keratosis if excessive plantar flexion, lateral metatarsalgia if excess dorsiflexion, under correction, and overcorrection with occurrence of hallux varus. Mauldin and colleagues, in 51 feet, found 90% patient satisfaction. The procedure incorporated the use of inlay bone block. The results included a 25.5% achievement of bony union at 27.6 months and 8 occurrences of hallux varus. Myerson and workers examined 67 feet and found 77% attained complete relief and 15% partial relief. They found a correction of the HV angle of 34.5° to 14° and that of the IM angle of 14.3° to 5.8°. There were seven nonunions (one symptomatic), three dorsal bunion (one repeat surgery), one hallux varus, and three neuromas of the deep peroneal nerve.

Arthrodesis of the first MTP joint is considered a salvage procedure for severe HV, recurrent HV, rheumatoid arthritis, previous infection, posttraumatic OA, or HV associated with a neuromuscular disorder. The osteotomy can be performed as a flat osteotomy or cup-shaped, using specially made reamers. Fixation can be with compression screws, Steinmann pins, Kirschner wires, staples, or compression plates. Acceptable alignment is 15° to 20° valgus, 20° to 30° dorsiflexion, and neutral rotation. Overall successful fusion with dorsal plating is 92% to 100%. Alignment and fixation are critical for success. Too little valgus angle causes increased interphalangeal OA. Excess plantar flexion causes increased pressure beneath the tip of the toe. Excess dorsiflexion causes plantar keratoses beneath the sesamoids. Coughlin and Abdo used a Vitallium plate in 58 feet due to its low profile. Virtually all (98%) cases fused with 93% good or excellent results. Plate removal was required in four feet. Nonunion and delayed union occurred in one foot each.

Excisional arthroplasty (a.k.a. Keller) is a medial eminence resection, partial proximal phalangectomy, and medial capsular plication. Indications include moderate HV with a HV angle less than 30° and limited ambulatory expectations in older, sedentary patients with OA of the MTP joint. The surgery is considered a salvage procedure. Results show the HV angle reduced 50% with no significant change in IM angle. Functional results deteriorate with time. Transfer metatarsalgia can occur since the first toe is unable to bear weight. Also, a cock-up deformity, stiffness of the IP joint, shortening, impaired control and function, and decreased flexor strength are known complications of this procedure.

Other surgical treatments include multiple osteotomies (double or triple osteotomies). Nine percent of adults with HV have congruous MTP joints, potentiating the need for such a procedure. The indication for a multiple osteotomy procedure is a large DMAA (greater than 15°) with a congruous MTP joint. Complications include loss of fixation, loss of correction, malunion, osteonecrosis, intraarticular extension of the osteotomy, and degenerative OA of the IP or MTP joint. Coughlin and Carlson treated 21 feet. The patients’ average age was 26 years. They found a correction of the HV angle to 23° and the IM angle to 9°. One hallux varus and one malunion occurred (both required surgery).

Summary
The surgeon must determine the pathologic elements that need correction. Close observation for an increased HV angle, increased IM angle, pronation of the first toe, increased DMAA, enlarged medial eminence, and subluxation of the sesamoids must be performed. While there are a large
number of procedures available for the management of HV, no one method sufficiently corrects all HV deformities. The upper limits of deformity correction for each procedure vary with the surgeon and their familiarity with each procedure. Ultimately, the surgeon must attempt to maintain a flexible first MTP joint and preserve the normal weightbearing pattern of the forefoot. Patient education also can be assistive in avoiding aggravating activities and making better choices in shoe wear. Tracings of the weightbearing foot and the shoe can be used to demonstrate to patients the size differences between the natural size and shape of the foot and that of the shoe, both pre- and postoperatively.

References