

Hallux Valgus: Anatomy, Pathogenesis, Assessment, and Treatment

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Abstract

Background: The first ray plays a key role in maintaining the structure of the medial arch, and as the main load-bearing structure, it is subject to substantial forces during gait. Failure anywhere along the first ray, from the distal phalanx to the talo-navicular joint, can result in HV. It is therefore worth considering the first ray biomechanics as a common factor to many of the key theories. There are no tendon attachments on the metatarsal head, and maintenance of this inherently unstable axial array requires a congruent and stable MTPJ during push-off, a distal metatarsal articulation angle that encourages stability, balanced static and dynamic restraints, and a stable tarso-metatarsal joint(TMTJ). It is a complex condition, suggesting that several factors are responsible. The different factors can be divided into extrinsic and intrinsic risks: The first treatment option is non-operative care. Conservative treatment will not make the bunion go away, but it will hopefully decrease the signs and symptoms and help patient get rid of the pain and get him back to activities. It may be the treatment of choice in the elderly and those with neurological or vascular compromise. Adjustment to footwear can be utilized to eliminate friction over the medial eminence, e.g., providing a wider and deeper toe box. High-heeled shoes are prevented.

Objective: Anatomy of the First Metatarso-phalangeal Joint and Big Toe, Pathogenesis and Etiology, Assessment, and Treatment of hallux valgus.

Conclusion: There is no procedure that can successfully apply to all deformities. Most procedures for correction of HV do work if properly performed in the right indications. Selecting the proper procedure in the appropriate foot and appropriate patient is the key to the success of each individual procedure.

Keywords: Hallux valgus; first metatarsophalangeal joint; pathogenesis; radiographic assessment; conservative treatment; proximal metatarsal osteotomy.

Introduction

In the nineteenth century, HV was thought to be due to an enlargement of MTPJ of the big toe. It was so until Carl Hueter (1838-1882), a German-born surgeon, coined the term hallux abducto valgus (HAV) that the deformity was more correctly described as a lateral deviation of the big toe at MTPJ. (1)

The first ray plays a key role in maintaining the structure of the medial arch, and as the main load-bearing structure, it is subject to substantial forces during gait. Failure anywhere along the first ray, from the distal phalanx to the talo-navicular joint, can result in HV. It is therefore worth considering the first ray biomechanics as a common factor to many of the key theories. There are no tendon attachments on the metatarsal head, and maintenance of this inherently unstable axial array requires (1) a congruent and stable MTPJ during push-off, (2) a distal metatarsal articulation angle that encourages stability, (3) balanced static and dynamic restraints, and (4) a stable tarso-metatarsal joint(TMTJ). (2)

It is generally accepted that HV occurs in steps, frequently on a background of several predisposing factors. These steps do not necessarily occur in series but may occur in parallel. These steps are as follows: (1, 3)

The first treatment option is non-operative care. Conservative treatment will not make the bunion go away, but it will hopefully decrease the signs and symptoms and help patient get rid of the pain and get him back to activities.

It may be the treatment of choice in the elderly and those with neurological or vascular compromise. Adjustment to footwear can be utilized to eliminate friction over the medial eminence, e.g., providing a wider and deeper toe box. High-heeled shoes are prevented. (4)

The indication for surgery is pain which is not adequately controlled by non-operative means or difficulty of shoe wear not responding to orthoses. Surgical treatment of HV for cosmetic reasons alone is seldom indicated except in an adolescent with a significant progressive deformity. Even the mildest symptoms in an adolescent often worsen, especially when there is a family history of HV. (5)

Anatomy and Biomechanics of the First Metatarso-phalangeal Joint and Big Toe

The first metatarso-phalangeal joint and big toe (MTPJ) is surrounded by four groups of muscles with two sesamoids: (6)

On the plantar surface (Figures 1 and 2), the tendons of the medial and lateral heads of flexor hallucis brevis are inserted into their respective sesamoid platforms, themselves attached distally to the base of the proximal phalanx by the plantar plate. The flexor hallucis longus tendon lies plantar to the sesamoid complex and inserts into the base of the distal phalanx. (1)

Dorsally, the extensor hallucis longus and brevis tendons pass centrally to insert into the distal and proximal phalanges, respectively. The extensor hallucis longus is anchored by the hood ligaments, fibrous bands interdigitating with the collateral ligaments of MTPJ and plantar sesamoids to form the joint capsule. (1)

The tendons of abductor and adductor hallucis run on the plantar medial and plantar lateral aspects, respectively, to insert into the base of the proximal phalanx and adjacent sesamoids (Figure 2). The abductor hallucis abducts, plantar flexes, and inverts the great toe, while the adductor hallucis adducts, plantar flexes, and everts the toe, providing a balanced so-called plantar rotator cuff (Dynamic stabilizers around the first MTPJ). (1)

The peroneus longus muscle, coursing around the cuboid, normally inserts into the base of the first metatarsal (M1) and the medial cuneiform and stabilizes the first ray at toe off. The peroneus longus muscle in turn is dependent on the stability of the midtarsal joint because it uses the cuboid as its fulcrum. The triplane stability exerted on the first ray in normal biomechanics is one of plantarflexion, abduction, and a posterior pull. In normal gait, as the foot progresses from midstance into propulsion, the supinating subtalar joint also locks the midtarsal joint; this ensures a stable lateral column of the foot and provides the peroneus longus muscle with an efficient fulcrum at the cuboid to exert a plantar, lateral, and posterior pull on the first ray. Consequently, any pronatory influence that causes an unlocking of the midtarsal joint may result in metatarsus primus adductus over a period of time. (7)

Sesamoids

Sesamoids are fibrous, cartilaginous, or osseous structures that are almost always contained with a tendon. Although the precise functions of sesamoids are uncertain, it has been suggested that they (1) alter the pull of a tendon, (2) decrease friction at articular surfaces, and (3) decrease pressure within a tendon to allow circulation to the tendon. (8)

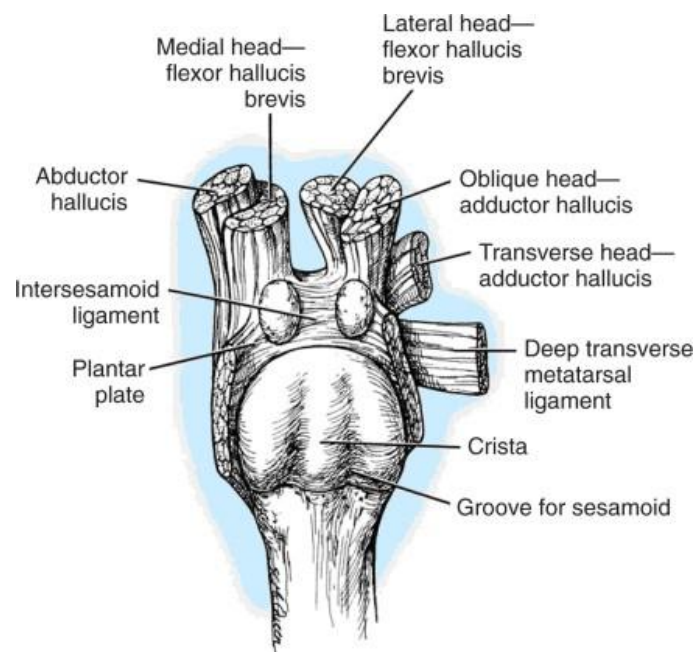


Figure 1: Plantar surface of M1 head. Entire sesamoid sling with attached intrinsic musculature has been rotated distally off metatarsal head to present structures around MTPJ. (5)

There are only two regular sesamoids in the foot, the medial (tibial) and lateral (fibular) hallucal sesamoid. Each sesamoid is oval, measuring approximately 10 mm in length and 8.5 mm in width, with the tibial sesamoid being larger and more elongated than the fibular sesamoid. These sesamoids are located in the tendon of the flexor hallucis brevis muscle proximal to MTPJ and articulate with the plantar surface of the first metatarsal head which has a ridge or crista which separates and articulates with the medial and lateral sesamoids (Figure 4). (6, 9).

The first metatarsal head is elevated on the sesamoids during stance, but the sesamoids move during hallux dorsiflexion, coming to lie anterior to the metatarsal head rather than inferior. The sesamoid sling thus facilitates the first metatarsal plantar flexion that is essential for hallux dorsiflexion. (10, 11)

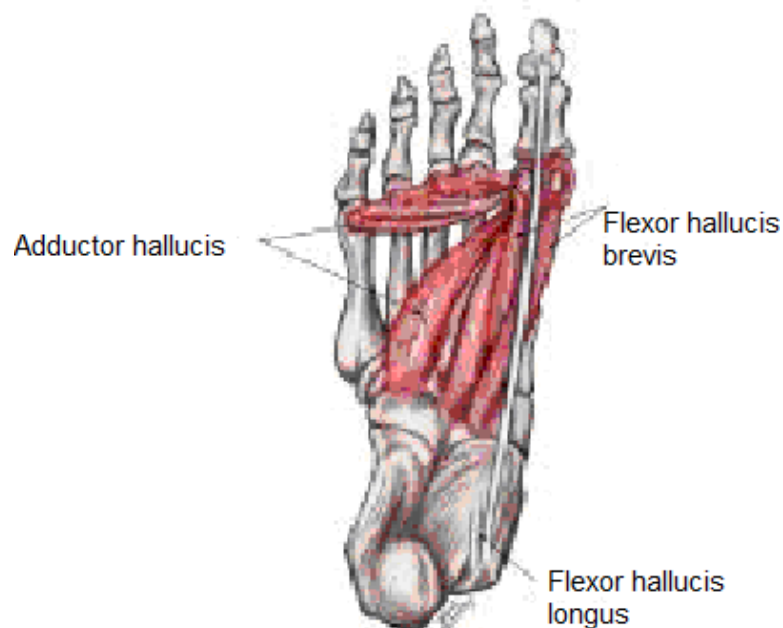


Figure 2: Plantar muscles about MTPJ. (12)

Pathogenesis of Hallux Valgus

Pathogenesis of hallux valgus

It is generally accepted that HV occurs in steps, frequently on a background of several predisposing factors. These steps do not necessarily occur in series but may occur in parallel. These steps are as follows: (1, 3)

As the only medial supporting structures of the first MTPJ are the medial sesamoid and medial collateral ligaments, their failure is the “early and essential lesion.” Sectioning them alone results in a valgus angulation of $>20^\circ$. These structures are mechanically abnormal in hallux valgus, with altered organization of the type-I and type-III collagen, leaving the first MTPJ vulnerable to continuous and cyclical distraction during gait. (1)

The metatarsal head can then drift medially, slipping off the sesamoid apparatus. An oblique or an unstable TMTJ may encourage this movement (Figure 3). (1)

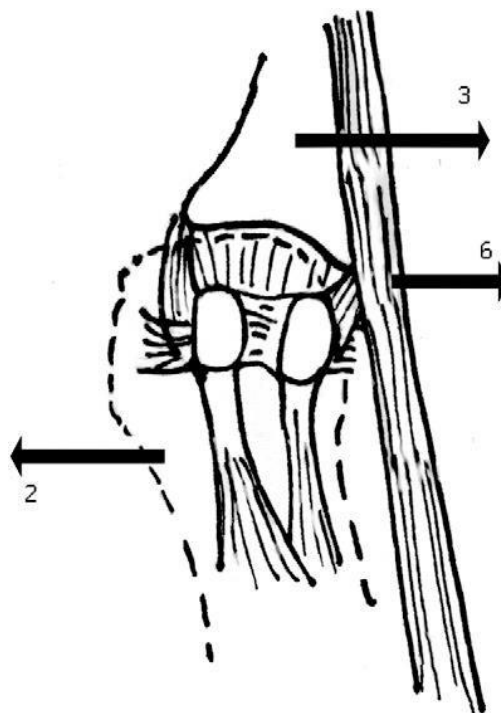


Figure 3: Illustration of the metatarsal head of the hallux in the antero-posterior plane, showing the medial shift of the metatarsal head (step 2 in the development of HV), with the valgus displacement of the proximal phalanx due to its attachment to the sesamoids, the deep transverse ligament (via the plantar plate), and the adductor hallucis tendon (step 3). The extensor hallucis longus bowstrings laterally (step 6). (1)

The proximal phalanx moves into a valgus position as it is tethered at its base to the sesamoids, the deep transverse ligament (via the plantar plate), and the adductor hallucis tendon (Figure 3). (1)

The metatarsal head sits on the medial sesamoid and can erode the cartilage and the crista. The lateral sesamoid can appear to sit in the intermetatarsal space although it does not actually move. The adductor hallucis, arising from the shafts of all the lesser metatarsals, tethers the sesamoid platform and proximal phalanx against the medially deviating first metatarsal. Thus there is progressive erosion of the crista by the medial sesamoid. Eventually, the metatarsal head is completely displaced from the sesamoid platform and the crista becomes completely eroded (Figure 4). (1)

The bursa overlying the medial eminence can thicken because of the pressure effect of footwear on a prominent medial eminence. It is important to note that the sagittal sulcus which develops as a groove between the medial eminence and the medial edge of the distal metatarsal articular surface becomes increasingly lateral as the deformity progresses and is not therefore a good marker at operation for bunionectomy. As the MTPJ deviates

laterally, uncovering medially the distal metatarsal articular surface, it then subluxes with loss of joint congruity. (1)

The extensor and flexor hallucis longus tendons appear to bowstring laterally, increasing the valgus displacement and occasionally acting as dorsiflexors of the proximal phalanx (Figure 3). (3)

As the metatarsal head drops off the sesamoid apparatus, it pronates because of the muscle forces acting across it (Figure 4). (3)

Normally, the abductor hallucis strongly resists valgus of the proximal phalanx, but it becomes dysfunctional as its medial and plantar attachment rotates inferiorly. The adductor hallucis is attached on the plantar surface laterally so it tends to pull the phalanx into pronation as well as tethering its base (Figure 4). When these moment arms are altered, the imbalance plays an important role in deformity progression. Suggestions of a primary muscle imbalance based on histological and electromyography studies probably reflect changes secondary to the deformity. There is no evidence of shortening or over activity of the adductor tendon, although botulinum toxin injection into the muscle has successfully treated hallux valgus. (1, 3)

The metatarsal head elevation with medial motion can transfer plantar pressure laterally. The relatively mobile fifth metatarsal may also splay. In the final stages the whole forefoot fails with excessive loads transferred onto the lesser metatarsal heads. This causes transfer metatarsalgia with risk of stress fracture in addition to pain from the bunion. (1)

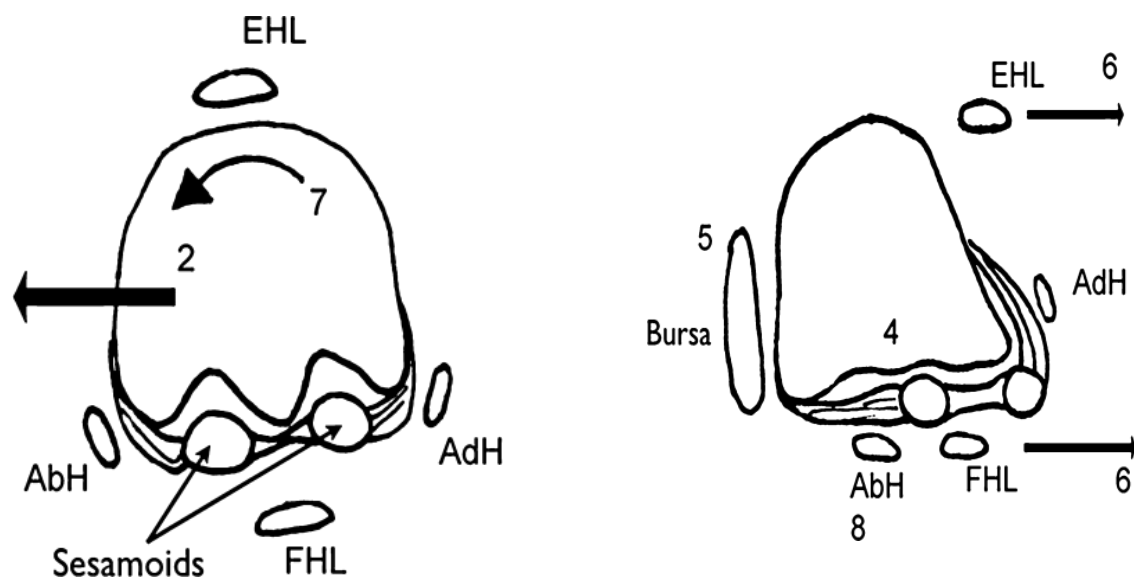


Figure 4: A- Illustration showing the medial shift of the metatarsal head in the axial plane (step 2 in HV) and the pronation of the metatarsal head that results from the muscle forces acting on it (step 7). The figure also illustrates the position of the sesamoids, abductor hallucis (AbH), adductor hallucis (AdH), flexor hallucis longus (FHL), and extensor hallucis longus (EHL). B- Illustration of HV in the axial plane. The metatarsal is pronated and shifted medially, resulting in the lateral shift of the abductor hallucis (AbH), adductor hallucis (AdH), flexor hallucis longus (FHL), and extensor hallucis longus (EHL) (steps 6 and 8 in HV). The bursa overlying the medial eminence thickens because of the pressure effect of footwear on a prominent medial eminence (step 5). Because of the pressure of the medial sesamoid on the crista, the cartilage is eroded and the crista flattened (step 4). (1)

Etiology of Hallux Valgus

It is a complex condition, suggesting that several factors are responsible. The different factors can be divided into extrinsic and intrinsic risks (Table 1): (1)

Table 1: Potential Intrinsic and Extrinsic Factor

Extrinsic	Intrinsic
High-heeled narrow shoes Excessive weight-bearing	Genetics Ligamentous laxity Metatarsus primus varus Pes planus Functional hallux limitus Sexual dimorphism Age Metatarsal morphology First-ray hypermobility Tight Achilles tendon

Extrinsic Factors

Footwear

Even prior to the understanding of HV pathology, the use of footwear has been implicated as an etiology. There is a low prevalence of HV in unshod populations, and the prevalence increases with changes in shoe fashion. However, the association is not complete, and footwear is not at all important in juvenile hallux valgus (JHV). (13)

High heels are commonly blamed for HV, and there is a direct association between increased first metatarsal loading and a valgus moment. This forefoot loading is exacerbated by the forefoot sliding forward into the toe-box, pronating as it does so. However, this forefoot loading is probably more important in deformity progression than initiation. The prevalence of HV in women who wear shoes with a narrow toe-box or a high-heel is certainly not 100%. So even in women, footwear is probably more important in progression than causation. It is intuitive to presume that this risk is greater in those with a wider foot. (14)

Excessive Loading

HV develops slowly, suggesting a process of repetitive trauma; however, despite a perception that occupation or excessive walking and weight bearing is important, there is no proven link. The only exception is a weak association with ballet dancing. Mann and Coughlin reviewed the literature on cumulative industrial trauma and dismissed any occupational link. (15)

Intrinsic Factors

Age

A biomechanical study in elderly patients showed that changes in posture, plantar pressure and joint kinematics are associated with a greater risk of hallux valgus. Although the peak onset is from thirty to sixty years of age, it is more likely that the initial changes occur during adolescence or even earlier for JHV. (13, 16)

Genetic Factors

A genetic predisposition had long been suspected. The best evidence showed that 90% of 350 white patients had at least one affected relative, with the most common pattern of inheritance being autosomal dominant with incomplete penetrance. The role of genetics in JHV is much more established, with maternal transmission found in 94% (twenty-nine) of thirty-one patients with a family history. (13) There is weak evidence of a racial difference. The prevalence of hallux valgus in whites has been reported to be two times greater than that in black Africans. (1)

Sexual Dimorphism

The true sex ratio is unknown, although the male-to-female ratio of 1:15 among those who have corrective surgery is well established. The higher prevalence among women may be due to footwear fashion resulting in earlier and more frequent presentation. Even less is known of the prevalence between the sexes with regard to JHV. (1)

There are fundamental differences in osseous anatomy; the metatarsal head articular surface in female patients is more rounded and smaller, providing a less stable joint. Women also tend to have a more adducted first metatarsal, which in turn may be due to differences in the tarso-metatarsal articulation. Other differences include metatarsal dimension and distal and proximal articulation shape and angle. (17) Ligamentous laxity and first ray hypermobility are more common in women, although several major series on the outcomes of hallux valgus surgery have failed to provide male to- female ratios. No link has been made with pregnancy. (1)

Biomechanical instability

The most common but most difficult to understand etiology is biomechanical instability with its origin in the rearfoot. Contributing factors, if present, include equinus, pes planovalgus, rigid or flexible forefoot varus, dorsiflexed first ray and hypermobility. Most often, excessive pronation at the midtarsal and subtalar joints compensates for these factors throughout the gait cycle. (7)

First ray hypermobility

Lapidus 1930 proposed an association between increased first ray mobility and the development of HV. He suggested that pathologic increased first ray sagittal motion at the first MTCJ led to coronal plane instability and the development of the HV deformity. He advocated arthrodesis of the first MTCJ as a component in his surgical treatment of HV for correction of the deformity and stabilization of the first ray. (18)

Coughlin et al. concluded that while flexibility in the first MTCJ is necessary for the development of HV deformity, but for a different reason than that envisioned by Lapidus and others. The theories developed at that time relied on a paucity of means by which to quantify mobility. Re-establishment of normal first ray alignment resolves increased first ray mobility; and suggested that the increased mobility was a result rather than a cause of the deformity. (18, 19)

Clinical Evaluation of HV Deformity

A record should be made of the onset of the symptoms, progression of the symptoms, and any aggravating factors as well as elements that provide relief of the local symptoms. Information should be acquired as well about the frequency of recreational activities such as running, jumping, 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. It was 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. (20, 4)

Podiatric evaluation of HV

The usual presentation of symptoms of a patient with HV is pain over the medial or dorso-medial aspect of the first metatarsal head. Pain over the medial eminence is due to irritation of the dorsal or plantar cutaneous nerve of the great toe, an inflamed or thickened bursa, or skin irritation or breakdown; occasionally is the bone truly hypertrophied. (4) Occasionally, pain can present on the plantar aspect of MTPJ region as a result of degenerative changes at the sesamoid- metatarsal articulation. (20)

Numbness may also be encountered along the medial side of the hallux secondary to pressure over the sensory nerve in the area producing symptomatic paresthesia. (20)

Plantar callosities under the lateral metatarsal heads indicate transfer metatarsalgia secondary to reduced loading on the first metatarsal head due to first ray instability and dorsiflexion. (21)

Evaluation of HV deformity should be carried out with the patient weight-bearing as well as non-weight-bearing. Usually the deformity is accentuated when the patient is standing. Equally important to this examination is an evaluation of the associated deformities (i.e., hammer toes, digital subluxation, and hyperkeratotic lesions) present on weight bearing. Lateral deviation of the great toe may be a result of luxation within MTPJ or involve the structure of the hallux itself. Hallux abduction may be caused by positional or structural changes within MTPJ. It is important to clinically differentiate the level and etiology of this lateral deviation so that the appropriate procedures are selected. (20)

Splaying of the forefoot is more evident during weight bearing and reflects the true functional position of the foot. Pronation of the first ray is more obvious when standing and is often associated with a callus on the plantar-medial aspect of the hallux distally. There is a strong association between pronation of the first metatarsal and both widening of IMA and first metatarsal dorsiflexion. (21)

Flexibility of forefoot splaying is assessed by applying a laterally directed force on the medial aspect of the first metatarsal as the hallux is brought to neutral with the other hand (Figure 5). If there is insufficient mobility through the MTCJ, then a proximal osteotomy can be added. (20)

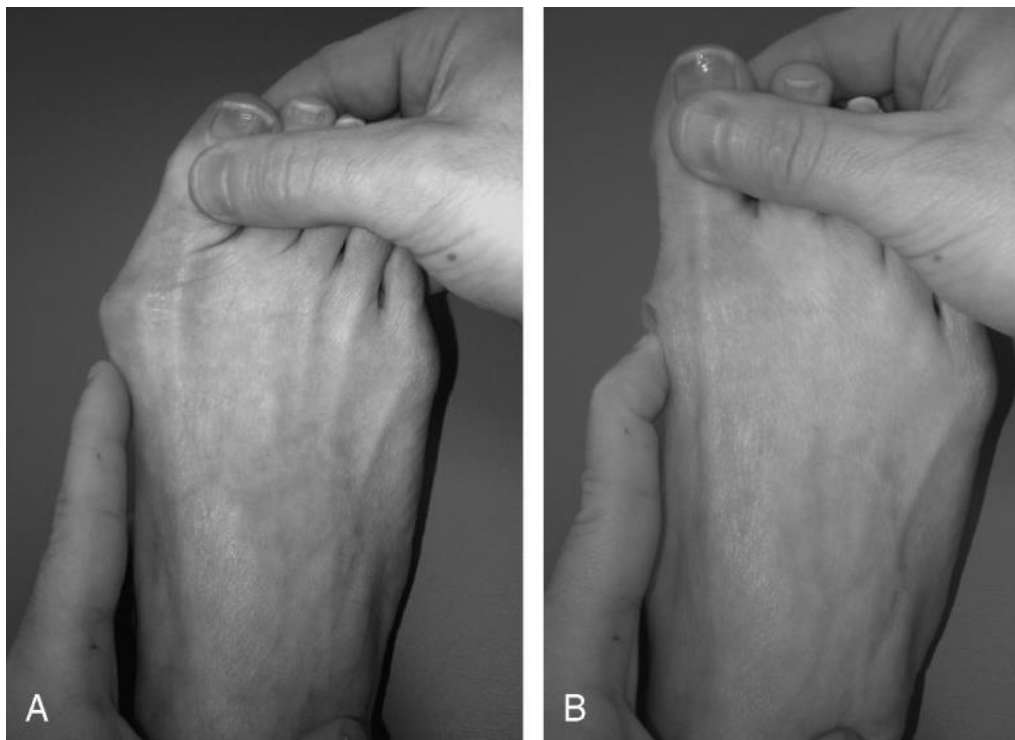


Figure 5: A and B, Assessment of first metatarsal axial plane flexibility. (20)

Podiatric Vascular Examination

The evaluation of the patient's vascular status is always relevant and must be performed before initiating any type of treatment. One of the most important skills of the examiner is the ability to determine the state of pulsations in the peripheral arteries of the foot and leg. Also, color, temperature, and sensation of the foot and lower leg are evaluated and compared one foot to the other. Capillary filling is assessed. A finding of a time longer than 3-5 seconds could indicate vascular disease. (20)

Radiographic Evaluation of HV Deformity

It should always be performed with weight-bearing dorso-plantar (DP) and lateral views of the foot (Figure 6 A&B). Additional views include the oblique view of the foot and the sesamoid view, which are non-weight-bearing (Figure 6 C& D). On the DP view, the hallux valgus angle, interphalangeal angle, proximal and distal articular set angles, and the first intermetatarsal angle can be evaluated together with the nature of the first MTPJ

and TMTJ. The lateral view is used to evaluate the first metatarsal elevation and dorsal spurring. The oblique view is best for evaluation of dorso-medial bony proliferation and spurring at the metatarsal head. The sesamoid view is superior to the DP view in the evaluation of lateral sesamoid subluxation and the sesamoid-metatarsal articulation. (22)

These measurements help the surgeons in all aspects of management including:

Classifying the deformity.

Follow the progression of deformity.

Operative decision-making.

Assess the results of surgical treatment. (1)

It has been demonstrated that inter- and intra-observer reliability is poor, especially with DMAA. The errors can be reduced to some extent by using standardized X-ray technique and having well defined guidelines placing reference points to draw the axis for the first metatarsal, second metatarsal, proximal phalanx and distal phalanx of the big toe.(1, 23)

Hallux Valgus Angle (HVA):

HVA is the angle measured between the bisection of the longitudinal axis of the first metatarsal and the proximal phalanx of the hallux (Figure 7). It is the principle determinant of severity of hallux valgus deformity and normally measures less than 15°. (1)

First Intermetatarsal Angle (IMA):

IMA is measured between the line bisecting the longitudinal axis of the first metatarsal and the line bisecting the longitudinal axis of the second metatarsal (Figure 7). It is normally $<9^\circ$. When the angle is increased, the term metatarsus primus adductus or metatarsus primus varus is often used. (22) Also, by comparing the longitudinal bisection of the first metatarsal with the longitudinal bisection of the medial cuneiform, if the angle formed between this intersection is greater than 25° , a metatarsus primus varus deformity is said to exist within the first ray. (20)



Figure 7: DP radiograph; First intermetatarsal angle 16° and hallux valgus angle 39°. (24)

Computer-assisted radiographic measurements for HV

Recent technologic advances now allow the radiographs to be digitized, stored electronically and retrieved with a computer. Computer software available creates opportunities for more reliable, quick and easy angular measurements, potentially reducing errors with manual measurement such as use of marker pens, difficulty in drawing lines and corrections, and errors in measuring angles with protractor. The reliability of computer-assisted method could be further enhanced by using specially designed software that involves placing reference points on relevant bones in the foot and measuring the angles. (1) The measurement error is reduced irrespective of experience and skill level with the computer-assisted method. (25)

T.N. Joseph & K.J. Mroczek graded HV deformity according to HVA, 1-2 IMA and subluxation of lateral sesamoid. (4)

Table 2: Severity classification of HV deformity. (4)

Degree	HVA	IMA	LS position
Mild	<20°	<11°	<50% subluxation
Moderate	20-40°	<16°	<75% subluxation
Severe	>40°	>16°	>75% subluxation

Conservative Treatment

The first treatment option is non-operative care. Conservative treatment will not make the bunion go away, but it will hopefully decrease the signs and symptoms and help patient get rid of the pain and get him back to activities. It may be the treatment of choice in the elderly and those with neurological or vascular compromise. Adjustment to footwear can be utilized to eliminate friction over the medial eminence, e.g., providing a wider and deeper toe box. High-heeled shoes are prevented. (4)

Stretching the contracted soft tissue around MTPJ with the use of orthoses (night splints), and improving muscle strength by foot exercises or resolving abnormal function by manual and manipulative therapy (Figure 8). Orthoses are considered to be most effective in the early stages of HV. (26, 27) The condition of pes planus may be helped by an orthosis (foot arches). Achilles contracture may require stretching or even lengthening. (4)



Figure 8: A. 1st MTPJ mobilization. B. Night splint. (27)

Surgical Treatment

The indication for surgery is pain which is not adequately controlled by non-operative means or difficulty of shoe wear not responding to orthoses. Surgical treatment of HV for cosmetic reasons alone is seldom indicated except

in an adolescent with a significant progressive deformity. Even the mildest symptoms in an adolescent often worsen, especially when there is a family history of HV. (5)

Goals and expectation:

A thorough understanding of patient goals and the mechanical influences contributing to HV deformity are necessary factors in determining the correct procedure in each individual. In general, anatomic alignment of IMA and HVA, congruency of the joint, anatomic alignment of the sesamoids, first ray length, and function of the windlass mechanism are necessary endpoints if the goal is to create or maintain normal first ray function. (28) The outcomes from HV surgery are not always ideal and extensive pre-operative counselling is required. Only 60% of patients can expect to wear unlimited shoes following surgery. If transfer lesions are present before operation, it may be necessary to wear cushioned shoes or even insoles following operation. (29)

There is no procedure that can successfully apply to all deformities. Most procedures for correction of HV do work if properly performed in the right indications. Selecting the proper procedure in the appropriate foot and appropriate patient is the key to the success of each individual procedure. (28) Coull & Stephens had redeveloped a treatment algorithm for HV depending on the principles outlined by Mann to include the key clinical and radiological features that must be assessed in each case (Figure 9). (21)

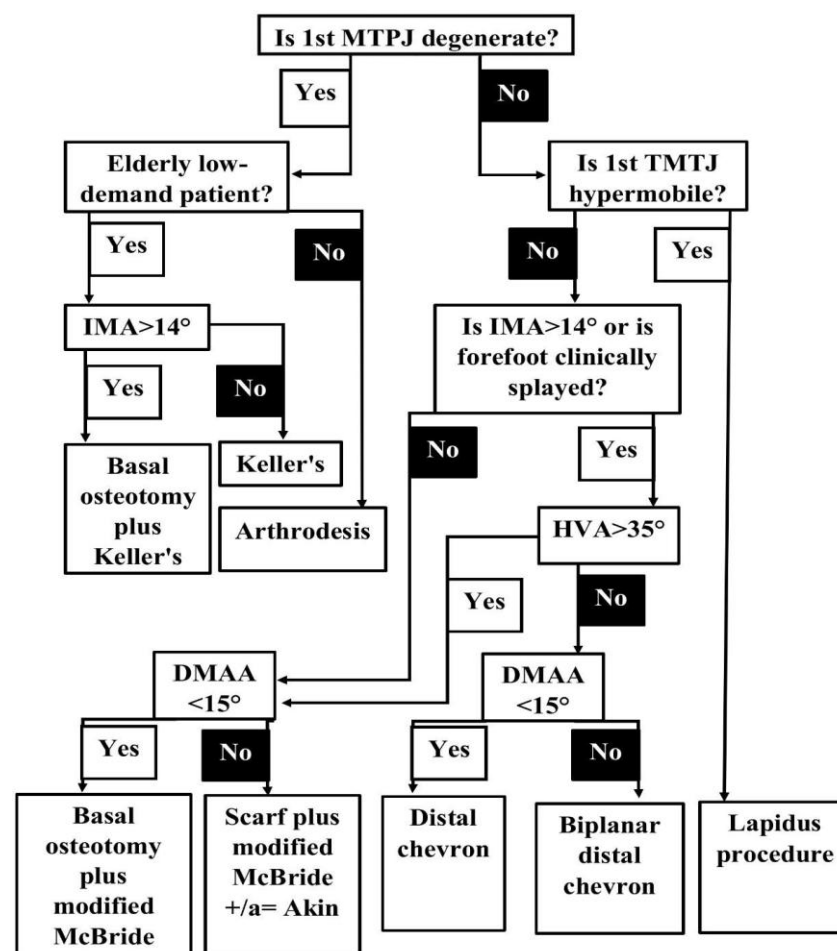


Figure 9: Treatment algorithm for hallux valgus surgery. (21)

Surgical options include:

- MTPJ soft-tissue reconstruction.
- Osteotomy (of the proximal phalanx of the great toe, of the first metatarsal bone or of the cuneiform).
- Arthrodesis (of the first MTPJ or of MTCJ).

Arthroplasty (exisional or implant).

Minimal invasive surgery.

Osteotomy sparing techniques:

Syndesmosis procedures. Mini tight-rope fixation.

Proximal Metatarsal Osteotomies

The two important features are joint subluxation and the metatarsus varus. A distal osteotomy will not achieve satisfactory correction of either. A basal osteotomy is required to achieve adequate reduction of the IMA combined with a lateral release to correct the joint subluxation. (21)

The IMA is not the sole determinant of the site of osteotomy. When the IMA is 120-140 and the choice is between basal or distal procedure, the decision is based on the clinical assessment. Patients with HV associated with pes planus, splay foot or a very flexible first ray usually need a basal osteotomy, even if the IMA is less than 140. (21)

The proximal (basal) osteotomies (Opening wedge, closing wedge, crescentic and basal chevron osteotomies) have all been described. It is usually combined with a distal soft-tissue procedure. It has high corrective power due to its proximal location providing a long lever arm. However, if DMAA is increased pre-operatively, it will worsen this problem. This is overcome by adding a distal osteotomy to rotate the metatarsal head medially (a double osteotomy), and in some cases also an Akin osteotomy to correct hallux valgus interphalangeus (triple osteotomy). (5)

Closing wedge osteotomy always is combined with a lateral soft tissue release. The osteotomy is performed with a micro-sagittal saw blade from the lateral side, 10 mm distal to MTCJ. By preserving the medial cortex, a biplanar wedge with approximately 3-5 mm bases, laterally and plantarly, is removed and the osteotomy is closed (Figure 10). Screw fixations are the most popular, but multiple Kirschner wire fixations were presented. Clinical studies confirmed the inherent instability and the high incidence of dorsal elevation and subsequent metatarsalgia.(30)

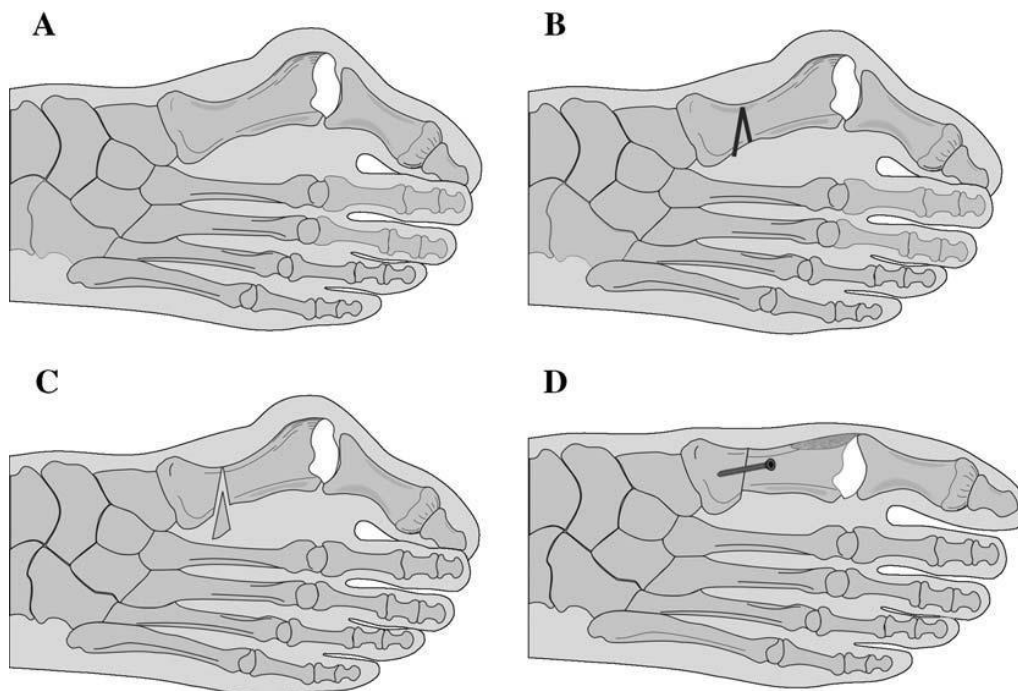


Figure 10: (A-D) Closing wedge osteotomy. (30)

Basal chevron osteotomy combined with a modified McBride's lateral release and medial plication. The basal chevron osteotomy alone allows correction of the IMA but does not permit plantar flexion or supination of the first ray. For this reason, A 60° chevron cut is made apex distally distal to the first TMTJ and at 90° to the axis of

the first metatarsal. As the distal fragment is displaced laterally, the distal fragment is plantar flexed and supinated so that the dorsal limb opens. The gap is then filled with a wedge of bone from the excised exostosis. Interestingly, this osteotomy is stable in this position due to distraction of the soft tissue. High levels of patient satisfaction are achieved with this procedure with objective increased first-ray loading, i.e. increased first-ray function. (Figure 11) (21)

The proximal crescentic osteotomy is one of the most popular proximal osteotomies. It is always combined with a lateral soft tissue release. Using an oscillating saw with curved blade, the osteotomy is cut halfway between the planes perpendicular to the metatarsal shaft and perpendicular to the ground, 1.5-2 cm distal to TMTJ. After manual displacement of the fragments, the obtained correction is checked and the osteotomy is fixed with 4.0-mm cancellous screw (Figure 12). Crossed Kirschner wires are used only when screw placement is unstable or impossible. (27)

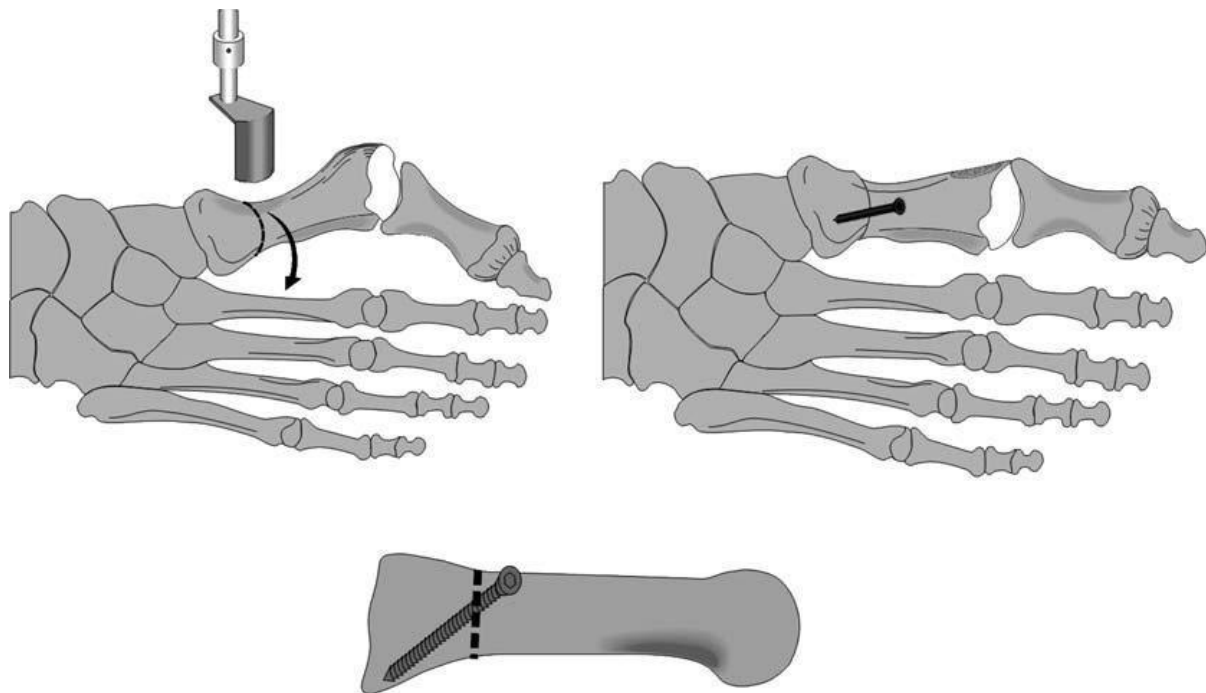


Figure 12: The proximal crescentic metatarsal osteotomy. (30)

The opening base wedge (OBW) osteotomy for correction of HV was introduced by Trethowan in 1923. His technique described a hinged osteotomy with interposition of a wedge-shaped graft. He did not recommend fixation. The osteotomy is vulnerable to hinge fracture and subsequent elevation of the capital arm, as well as delayed union or nonunion. To effectively open the medial base of the wedge on the first metatarsal, the lateral hinge has to be made sufficiently thin; if the hinge is too thick, it will likely fracture as the wedge is opened. (31)

Using of the plate system to offload the ground reactive forces, caused by weight bearing, on the intact hinge allows the bone to incorporate into the gap, with diminished risk of fracture or disruption during the postoperative course. Recent literature has supported the use of a low-profile plate and screw system (Arthrex, USA) designed specifically for a basilar opening wedge procedure (Figure 13). The technique is technical but reproducible. Of critical importance is maintaining a lateral cortical hinge without fracture as well as avoidance of TMTJ violation with the osteotomy and the screws. (32)



Figure 13: Arthrex OBW plate. It has many desirable features; a low profile design, a solid wedge that is offset from the wall of the plate. The wedge allows seating of the plate into a reproducible location and holds the osteotomy at a predictable gap distance. (31)

Incorporating the locking-plate technology with a wedged plate can strengthen the construct, allowing better results, particularly with early weight-bearing goals or into patients or surgeries that are “at risk.” The Darco Base Opening Wedge (BOW) Plate is analogous to the Arthrex plate with locking capabilities (Figures 14 and 15). (31)



Figure 14: Intraoperative picture of the Darco Base Opening Wedge (BOW) plate. (31)

Use of bone graft to backfill the opening wedge site can be performed with the OBW. The medial eminence from the distal bunionectomy can be used, and a cancellous allograft or a demineralized bone matrix has also been documented. (31)

Conclusion

There is no procedure that can successfully apply to all deformities. Most procedures for correction of HV do work if properly performed in the right indications. Selecting the proper procedure in the appropriate foot and appropriate patient is the key to the success of each individual procedure. (28) Coull & Stephens had redeveloped a treatment algorithm for HV depending on the principles outlined by Mann to include the key clinical and radiological features that must be assessed in each case (Figure 32). (21)

The indication for surgery is pain which is not adequately controlled by non-operative means or difficulty of shoe wear not responding to orthoses. Surgical treatment of HV for cosmetic reasons alone is seldom indicated except in an adolescent with a significant progressive deformity. Even the mildest symptoms in an adolescent often worsen, especially when there is a family history of HV. (5)

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