Chapter 6 - The Great Toe

The great toe provides stability for the medial aspect of the foot through the windlass mechanism of the plantar aponeurosis (Fig. 6-1). The plantar aponeurosis arises from the tubercle of the calcaneus and passes forward to insert into the bases of the proximal phalanges.

During gait as the body passes over the foot, the big toe, being in the neutral position, dorsiflexes as the heel rises off the floor. It then plantar flexes prior to toe-off (Figs. 6-2 and 6-3).

HALLUX VALGUS

As stated in Chapter 2, the "normal" foot must be pain-free and have normal muscle balance, an absence of contracture, a central heel, straight and mobile toes, and three sites of weight bearing while standing and during the stance phase of walking.

Hallux valgus is a static subluxation of the first metatarsophalangeal joint (fig. 6-3).

There are three components of the bunion complex: (1) the large toe angulates laterally toward the second toe, (2) the medial portion of the first metatarsal head enlarges, and (3) the bursa over the medial aspect of the metatarsophalangeal joint becomes inflamed and thick walled (Fig. 6-3).

This condition is most frequently found in older women who have a broadened forefoot with a flattened transverse arch in a pronated foot.

The big toe frequently displaces the second toe. Although most frequently first noted in elderly women, this condition will have been present in the patient since early life. However, the condition only becomes symptomatic when the inflamed tissues become painful.

Hallux valgus occurs almost exclusively in people who wear inappropriate shoes, although it does sometimes develop in people who wear modest, proper footwear.

Because surgical intervention in abnormalities may interfere with the windlass mechanism, this change in the mechanism must be understood.

The metatarsophalangeal joint of the first toe differs from the other toes in that it has a sesamoid mechanism. The head of the first metatarsal has a cartilage-covered ovoid head that articulates with a smaller, concave, elliptically shaped base of the proximal phalanx (Fig. 6-4)

Fan-shaped ligamentous bands join the collateral ligaments of the metatarsophalangeal joint. The ligament runs distally and in a plantar direction to attach to the proximal phalanx, and the fan moves in a plantar direction to attach to the sesamoids and the plantar pads.

On the plantar surface of the metatarsal head are two parallel grooves.

The sesamoid bones contained within the flexor hallucis brevis tendons are convex and "ride" within these grooves. The sesamoids are attached to the base of the phalanx and not to the metatarsal head.

This means that the sesamoids move in whatever direction the great toe moves (Fig. 6-5).

The first metatarsal head has no muscle inserting on it and is thus supported by a capsular sling.
In a hallux valgus, when the metatarsal moves laterally and the proximal phalanx medially, the extensor hallucis longus and the flexor hallucis longus deviate their force laterally, accentuating the deforming forces.

The sesamoid bones also migrate and the fibular sesamoid becomes uncovered, allowing the abductor hallucis muscle to slide under the metatarsal head, causing pronation of the great toe.

The only structure that affords medial stability of the metatarsophalangeal joint is the medial ligamentous complex, which fails when the etiologic forces are imposed.

Any osteotomy that shortens the metatarsal more than 7 to 10 mm results in decreased weight bearing and thus transfers the weight laterally.

The metatarsophalangeal joint of the first toe differs from the other toes in that it has a sesamoid mechanism (fig. 6-4).

The sesamoids move in whatever direction the great toe moves (fig. 6-5).

**ETIOLOGIC CONCEPTS**

In ordinary orthopedic practice, hallux valgus is seen more frequently in adults. Yet with careful questioning, many, if not most, patients recall deformity occurring in early life.

Many concepts have been proposed regarding the etiology of hallux valgus (fig. 6-6).

Congenital factors may predispose to deformity in later life.

The first metatarsal may be shorter than normal and may be in varus as a residue of congenital metatarsus primus varus (fig. 4-18).

Whether the lateral deviation of the proximal phalanx occurs first rather than secondary to primary metatarsus varus remains unproved. This remains a bone of contention since permanent correction of the condition (hallux valgus) cannot be expected unless the "primary" condition has been corrected.

The intermetatarsal angle increases with age and thus, along with other forces, can increase the incidence of hallux valgus.

Subluxation of the first metatarsophalangeal joint occurs frequently before the epiphysis is closed, implying a "young" incidence of hallux valgus.

The varus of the first metatarsal may be brought about by the obliquity of the first cuneiform bone, which changes the angle of the first metatarsal joint (Fig. 6-6A).

The head of the first metatarsal may be more convex than normal and may permit the first proximal phalanx to shift laterally (Fig. 6-6B).

Primary or secondary muscular imbalance will pull the first phalanx laterally and over- come an inefflectual abductor hallucis (Fig. 6-6C).
Repeated trauma from wearing improper shoes, uncorrected pronation, added weight, and debilitated intrinsic muscles allow the big toe to deviate progressively in a lateral direction.

The long tendons, both flexor and extensor, of the big toe (see Fig. 6-5) shift laterally along with their enclosed sesamoid bones and exert traction, causing further valgus (Fig. 6-6B).

The adductor hallucis tendon is a relatively fixed structure, which inserts into the base of the proximal phalanx and thus simultaneously anchors the sesamoids so they cannot drift medially with the metatarsal head.

As valgus of the hallux occurs, the base of the proximal phalanx pushes the metatarsal head medially. This attenuates the medial capsule. The abductor hallucis, which inserts on the medial aspect of the proximal phalanx, moves medially.

The cartilage of the metatarsal head gradually smooths out and no longer becomes resistant to this migration (Fig. 6-7).

Whether there is rotation of the metatarsal shaft, which has been postulated, undergoes longitudinal rotation, placing the relationship of the metatarsophalangeal joint at an oblique position to the floor.

This places the joint at a mechanical disadvantage regarding the force applied to the joint in everyday activities. Many surgeons feel that failure of surgical procedures is brought about by a failure to correct this rotation.

**BUNIONS**

Many patients present to physicians for hallux valgus because of the presence of a "bunion," which is cosmetically unacceptable, causes pain, and prevents acquiring affordable, acceptable footwear.

A bony outgrowth of the metatarsophalangeal is not noted early in hallux valgus.

What appears as a prominence is a displacement of the proximal phalanx in a lateral direction. As the condition progresses, the phalanx deviates further in a lateral direction, and the sagittal groove on the head of the medial metatarsal head deepens as the medial eminence proliferates. The sagittal groove (see Fig. 6-6) migrates laterally as do the flexor tendon and its sesamoid, both of which thicken. Both gradually become attenuated as they are mechanically inefficient.

The overlying bursa on the medial aspect of the joint becomes inflamed, gradually thickens, and ultimately calcifies (fig. 6-8).

As the ligament of the medial sesamoid thickens, so does the medial collateral ligament, which gradually becomes attenuated because there is external friction.

**MUSCULAR ACTION IN HALLUX VALGUS**

The muscular dynamics of the formation of the hallux valgus can be understood by evaluating their function.
The long and short extensor tendons pass dorsally, and the long and short flexors pass on the plantar surface. The conjoined tendons of the abductor and adductor hallucis pass medially and laterally, respectively.

The joint capsule is covered only by the hood ligaments, which hold the extensor hallucis longus tendon in place.

As valgus motion develops, the medial hood capsule and the ligaments elongate, allowing the extensor hallucis longus tendon to migrate and contract. It now no longer merely extends the hallux but also adducts it.

As shown in Fig. 6-7, the adductor hallucis also becomes a deforming factor.

In 15% to 20% of patients with hallux valgus, a dislocation of the second toe occurs. The second toe has two dorsal and two plantar interossei (see Fig. 1-29).

Their tendons extend either dorsolaterally or dorsomedially, depending on the alignment of the phalanges. With the metatarsophalangeal joint in direct alignment, they act either as adductor or as abductor. As the metatarsophalangeal joint extends the base of the proximal phalanx, it is pulled dorsally by these muscles.

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If the foot is kept in a constant, toe-extended position, such as wearing a high heel does, the plantar capsule becomes overstretched (fig. 6-9).

With valgus of the hallux, the big toe veering laterally moves under the second toe and gradually dislocates it (Fig. 6-9).

**EXAMINATION**

Evaluation of the patient with hallux valgus (frequently the complaint is of a painful "bunion") is to ascertain the main complaint. It may merely be that the broad forefoot makes wearing normal shoes impossible.

Or there may be pain on movement of the big toe, rubbing of the second toe, which has been dorsally displaced by the valgus of the hallux, or a painful swelling of the medial aspect of the first metatarsophalangeal joint.

Examination of the standing, barefoot patient accentuates the weight bearing foot and its deformities (fig. 6-10).

In the seated position, the foot is actively moved at all joints, and the movement of the first metatarsophalangeal joint and distal phalangeal joints can be observed.

Limitation, crepitation, and even production of pain become apparent. Passive range of motion of each joint is then performed.

Degree of mobility is noted as being limited or hypermobile.
Callus formations are also noted.

**RADIOLOGIC STUDIES**
Radiologic studies are performed in a weight-bearing position and include anterior-posterior, lateral, and oblique views. The following must be analyzed:

- The angle of the valgus of the hallux
- The intermetatarsal angle
- The degree of the hallux interphalangeus
- The size of the medial eminence
- Evidence of degenerative changes in the first metatarsophalangeal joint
- Obliquity of the first metatarsocuneiform joint
- The presence of a lateral facet at the base of the first metatarsal shaft
- Determination of the congruity of the metatarsophalangeal joint

The following angles must be measured (Fig. 6-11). The hallux valgus angle is formed by a line that passes through the proximal phalanx, forming an angle with a line drawn through the first metatarsal. The angle (HV in Fig. 6-11) is essentially the angle of deviation from direct alignment of the hallux with the metatarsal.

Up to 10° is considered normal, with an angle of 15° considered abnormal. Metatarsal bone to the second and depicts the degree of metatarsus varus.

The intermetatarsal angle (IM) measures the relationship of the first metatarsal bone to the second and depicts the degree of metatarsus varus.

There may be malalignment of the metatarsophalangeal joint, which is usually not associated with arthrosis. When present, degenerative changes must be ascertained. This is done clinically by finding painful limitation and/or crepitation and is confirmed radiologically.

The size of an enlarged medial eminence ("bunion") must be determined and ascertained clinically as being the concern. A large HV angle may also implicate instability of the joint, which must be determined clinically, not radiologically.

An enlarged lateral facet at the base of the first metatarsal may block realignment of the first metatarsal and mandate an osteotomy if clinically significant. The congruity of the metatarsocuneiform joint must also be ascertained as to being a factor in the production of symptomatic hallux valgus.

Absence of lateral subluxation speaks against incongruity in spite of there being a hallux valgus. Lateral subluxation indicates incongruity, which further indicates that correction can be accomplished by "sliding" the proximal phalanx into an anatomic alignment.

It is apparent from the above that the decision as to the type and extent of hallux valgus and its correction demands determining the proper pathoanatomic basis for the condition.

Patient expectations from any corrective procedure must also be clarified because none will create a "new foot" or necessarily a pain-free one that permits wearing any type of shoe. Mere anatomic realignment is not an assurance.
Even a mild deformity may result in some stiffness, joint pain, joint limitation, and even some nerve entrapment.

Shoe wear must be carefully addressed because wearing narrow-toe-box shoes and high heels will undoubtedly never be acceptable.

Even successful surgical anatomic correction will not allow wearing inappropriate shoes, even if they are socially desirable

**TREATMENT**

Treatment must be individualized according to the age of the patient, the degree of deformity, the severity and duration of the symptoms, and the definite relationship of the symptoms to the hallux valgus.

Many persons with severe deformity are pain-free and not disabled. Cosmetic concern especially deserves guarded diagnosis and treatment.

A person who develops hallux valgus before the age of 20 and who has a family history should be treated conservatively and prophylactically.

Proper shoe wear that corrects or modifies the pes planus and foot pronation must be addressed. A broad-forefoot shoe must be stressed. A stabilizing splint should be worn at night (Fig. 6-12). The shoe should have a flat heel, and a pouch may be punched out or cut out over the bunion and bursa.

In the elderly, molded shoes that prevent pressure on the bunion and bursa are effective. Correction of the pronation, as tolerated, must be instituted as well as correction of the flattened longitudinal arch. Exercises have their advocates but are of a questionable value.

A stabilizing splint should be worn at night (fig. 6-12).

Osteotomy of the proximal phalanx, combined with excision of the medial exostosis, is a standard procedure (fig. 6-13).

Distal soft-tissue procedures that release the contracted tissue are also common.

With a hypermobile first metatarsocuneiform joint, an arthrodesis has its advocates.

A recent tricorrectional bunionectomy has been proposed that appears physiologically sound.

With or without surgical intervention, the individual with the hallux valgus foot will need modification (fig. 6-14).

**ELECTROMYOGRAPHIC ANALYSIS STUDIES**

These studies provide valuable information which should be considered before beginning any surgical intervention.
Six superficial skin electrodes are placed over the muscle bellies of the right and left tibialis anterior, peroneus longus, and medial gastrocnemius. The precise location is determined by having the patient perform a 5-second isometric contraction.

During gait and employing pressure mapping, the EMG is synchronized and recorded with the pressure mapping. The peroneus longus muscle controls the first metatarsal against the ground reaction forces.

One of the major causes of bunion deformity is an elevation of the first metatarsal, which is called hypermobility of the first ray. This allegedly contributes to formation of the bunion and limiting the motion of the hallux.

Generally, the peroneus longus and the extensor propulsion forces are dysfunctional when hallux valgus deformity develops in the pronated foot. Now, besides examining the patient with hallux valgus in the seated position, ambulatory testing is possible.

Mapping and concomitant EMG studies now record the exact mechanics of the patient's gait, which cannot be accurately evaluated by the human eye.

**HALLUX RIGIDUS**

Hallux rigidus is the second most common painful problem of the big toe.

The metatarsophalangeal joint of the hallux dorsiflexes and plantar flexes repeatedly during gait.

Thus, when this joint loses its flexibility, gait is impaired. Pain occurs when there are secondary degenerative changes of the cartilage, causing degenerative arthrosis. As the foot passes over from the mid-stance phase, it dorsiflexes and the big toe extends.

Since there is push-off of the foot, the big toe plantar flexes. The tendons of the flexor muscles contain the sesamoid bones, which further contribute to the mechanism and thus the pathology when the cartilage undergoes degeneration. Degenerative changes undergo various stages from merely softening of the cartilage with some synovitis to significant degeneration with partial fusion. This discussed in Chapter 5.

Pain is noted at every step.

The patient excessively supinates the weight-bearing foot in an attempt to place the weight to the outer border of the foot and avoid motion at the first ray, the inner border. During gait, the weight "rolls off" the fifth metatarsal head.

Fatigue occurs as the gait is significantly impaired and the foot gradually acquires calluses on the parts bearing weight (fifth metatarsal head), and the joints of the fifth metatarsal and proximal phalanx may undergo early degeneration.

**DIAGNOSIS**

The diagnosis is made by the patient indicating “when” during gait the pain occurs and “where” the pain is felt.
The examination of the first metatarsophalangeal joint (see Figs. 5-26 and 5-27) reveals crepitation, limited painful range of motion, and deformity of the joint.

The sesamoid bones can also be palpated (see Fig. 5-25) and cause pain as well as being painful on forceful extension of the hallux.

Radiologic studies reveal the extent of articular damage.

**TREATMENT**
Prevention of motion of the first metatarsal proximal phalanx during gait is indicated (fig. 6-15).

This is accomplished by the use of a steel shank in the shoe (see Fig. 5-52) or the use of a rocker sole (see Fig. 5-53) (Fig. 6-15). A pad insert placed under the shaft of the first metatarsal raises the bone and decreases the degree of flexion of the metatarsophalangeal joint.

In early degenerative changes, conservative measures usually suffice.

Interarticular injection of an analgesic agent with or without steroids gives temporary relief.

Oral anti-inflammatory medications afford some relief.

Surgical intervention is elective.

Once the joint is fused, articular changes occur at more proximal joints of the first metatarsal, and callus formation occurs at the pressure sites upon the first toe.

**HAMMER TOES**
A hammer toe is a fixed-flexion deformity of the interphalangeal joints (fig. 6-16) (between the metatarsal and proximal phalanx and the proximal and middle phalanges). The distal phalanx also usually flexes but is not fixed and may point straight ahead.

Calluses form on the dorsum of the flexed interphalangeal joints (Fig. 6-16). The proximal phalanx will often sublux from the capsule being over-stretched, and the capsules and tendons on the flexed (plantar surfaces) side will contract.

If the flexion deformity is mainly or exclusively in the distal joint, the condition is termed a *mallet toe*. 