CHAPTER 43

Surgical Classification of the Cavus Foot Deformity

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Historically, surgical repair of the cavus foot deformity has been based on many different complicated and confusing classification systems. Each individual expert with an interest in the cavus foot deformity has attempted to make sense of the deformity from his own experience.

There is no single universal system for classifying all cavus deformities. Literally, each individual cavus deformity has unique components and combinations of deformity. There are, however, certain generalities or broad groupings that can include most of the cavus deformities. The author will describe such a classification and correlate specific surgical procedures to each category (Table 1).

Table 1

SURGICAL CLASSIFICATION OF CAVUS DEFORMITIES

I.	Mild	FLEXIBLE FOREFOOT / DIGITAL-METATARSOPHALANGEAL JOINT (anterior, global, flexible)
II.	Moderate	FUNCTIONAL / BIOMECHANICAL Plantarflexed First Metatarsal / Calcaneal Varus (anterior local-posterior)
III.	Severe	ADVANCED STRUCTURAL / FUNCTIONAL NEUROMUSCULAR DISORDERS (global rigid, unstable)

MILD FLEXIBLE FOREFOOT/DIGITAL MPJ

The first or simplest category to define is a cavus foot type where the deformity is primarily restricted to the metatarsal, metatarsophalangeal, and digital segments of the foot (Fig. 1). A common description for this type of deformity would include the flexible forefoot equinus, where the foot, in a resting attitude, demonstrates significant plantarflexion of the metatarsals and an associated extension contracture of the metatarsophalangeal joints. This flexible deformity will commonly reduce with stance or weight bearing. It is not uncommon to see this flexible forefoot equinus foot type reduced to a pes valgus foot-type with associated hammertoe deformities upon weight bearing. The most common complaint for this type of condition is metatarsalgia associated with the hypermobility and plantar prominence of the metatarsal heads.

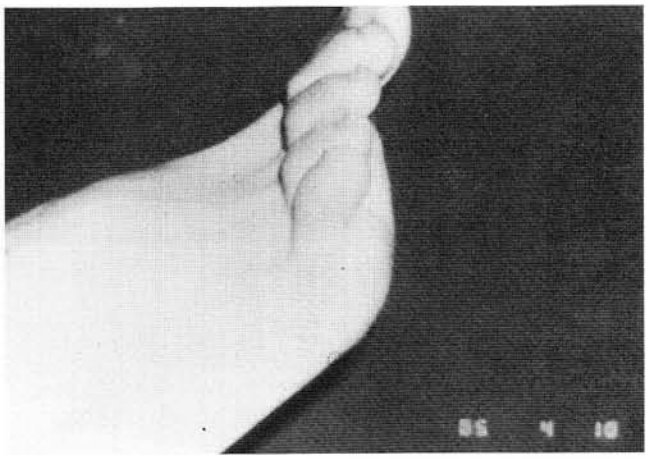

Figure 1. Forefoot equinus deformity with extensor contraction of the hallux and lesser digits.

As the patient ages and various levels of the deformity become more fixed in their degree of contracture, severe dorsal luxation of the metatarsophalangeal joint can occur, and may become resistant to reduction with weight bearing. This fixed extension contracture at the metatarsophalangeal joint is usually countered by severe contracture at the interphalangeal joint level, and rigid, dorsally luxated hammertoe deformities result.

Overpowering on the dorsal or extensor side of the metatarsophalangeal joint will result in contracture of the extensor tendon apparatus, as well as the extensor hood apparatus and other dorsal tissues about the metatarsophalangeal joint.

Common Surgical Procedures

The group of surgical procedures commonly employed in correction of the flexible forefoot cavus deformities are focused around digital and metatarsophalangeal joint pathology (Fig. 2A, 2B). The specific procedures include:

1. Digital arthrodesis (hallux and lesser toe)
2. Metatarsophalangeal joint release (extensor hood release, extensor digitorum tendon lengthening)
3. Extensor tendon transfer techniques (Hibbs suspension, Jones suspension)
4. Biomechanical control

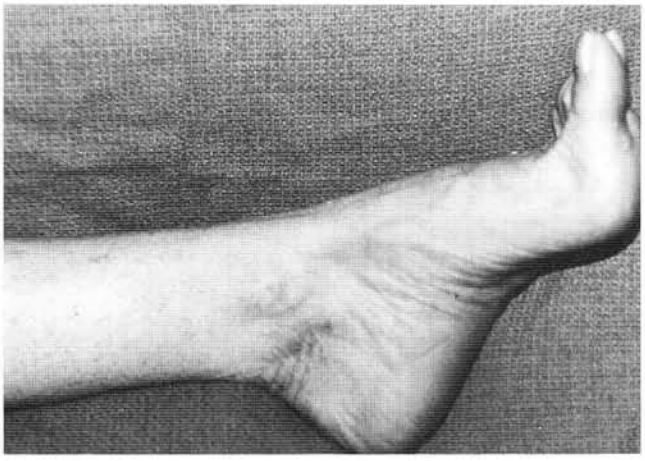

Figure 2A: Preoperative view of a typical forefoot equinus deformity.

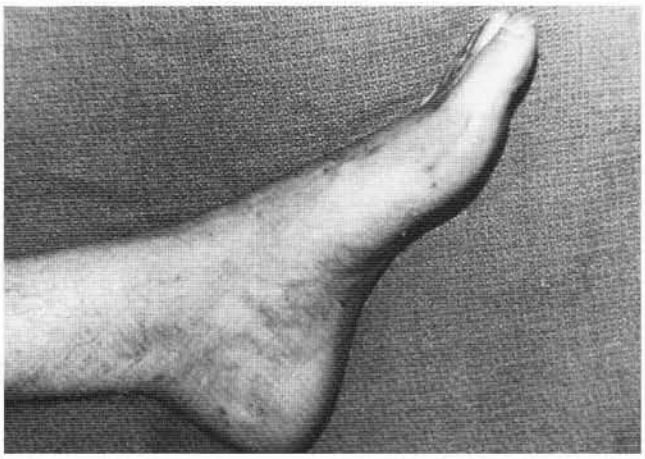

Figure 2B: Postoperative view of a forefoot equinus deformity following hallux and lesser digit interphalangeal arthrodesis, extensor hood release, and appropriate extensor tendon lengthening.

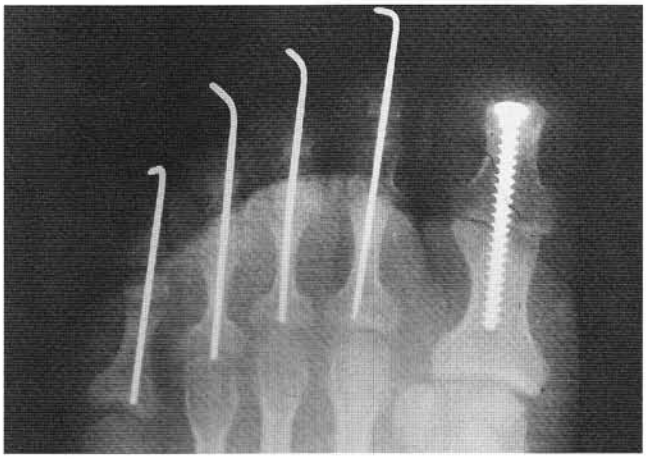

Figure 3. Dorsoplantar radiograph demonstrating hallux interphalangeal joint fusion and proximal interphalangeal joint fusions on digits 2, 3, 4 and arthroplasty with pinning of the 5th digit.

Digital Arthrodesis.

The primary rationale for digital arthrodesis in the flexible forefoot cavus deformity is elimination of the retrograde buckling force at the level of the metatarsophalangeal joint (Fig. 3). Digital arthrodesing procedures will correct the digital deformity, however, the primary mechanical influence that is created on the foot is a reduction in the plantigrade pressure on the metatarsal head. This will have a positive effect at reducing the forefoot equinus, as well as allowing the extensor tendon to be converted to a more effective dorsiflexor of the forefoot.

MPJ Release with Extensor Hood Release.

Long-standing forefoot equinus, although flexible, will result in progressive contracture of soft tissues on the dorsal side of the metatarsophalangeal joint. It is essential that these contractures be released in order to accomplish an effective reduction of the metatarsophalangeal joint, and eliminate the retrograde digital pressure on the metatarsal head. A fundamental technique employed before release of dorsal metatarsophalangeal joint contracture includes the extensor hood release. The expansion fibers of the extensor hood leave the extensor tendon and progress medially and laterally to encase the metatarsal head and phalangeal base of the metatarsophalangeal joint. Contracture of this expansion will prevent reduction of the proximal phalanx to a plantigrade attitude or alignment. The technique of extensor hood release entails a longitudinal incision along the medial and lateral aspect of the extensor tendon in order to

release the extensor hood apparatus. The extensor tendon is then mobilized and can be elevated from the metatarsophalangeal joint capsule. Following this release, a complete dorsal capsulotomy can be performed. A sequential release of the metatarsophalangeal joint may also include release of collateral ligament structures, as well as the flexor apparatus.

Extensor Tendon Transfers: Jones Tendon Suspension

The Jones tendon suspension has been traditionally employed for equinus deformities of the first metatarsal with an associated cock-up deformity of the hallux. The purpose of the procedure is to eliminate the pull of the extensor hallucis longus on the hallux, and transfer its power into the first metatarsal in an attempt to dorsiflex the first ray. Equinus deformity of the first metatarsal and associated hallux malleus have a variety of different etiologies. The specific cause of the deformity must first be identified, and procedures should be selected to correct the specific imbalance. The Jones suspension, in general, has been unsuccessful. Detachment of the extensor hallucis longus tendon from the hallux, in most instances, leaves a flail hallux which drags the ground during gait and makes the application of socks and shoes difficult for the patient. Arthrodesis of the interphalangeal joint of the hallux is routine if the Jones suspension is employed.

In addition, transfer of the EDL tendon into the neck of the first metatarsal has not proven to be an effective means for correction of the plantarflexed first metatarsal deformity.

In most instances, the combination deformity of flexible plantarflexed first metatarsal and hallux malleus (cocked hallux) can be successfully corrected with a straight-forward arthrodesis of the interphalangeal joint of the hallux, and appropriate hood release and metatarsophalangeal joint capsulotomy. If a more rigid deformity of the first metatarsal exists, then a dorsiflexory osteotomy is the procedure of choice.

Extensor Tendon Transfers: Hibbs Tendon Suspension

The Hibbs tendon suspension was a popular forefoot procedure in the mid 1970s. The specific goals of the procedure are similar to the Jones, which is to remove the deforming force of the EDL tendons on the digits, and transfer the tendons into the metatarsal region to act as a more effective dorsiflexor of the forefoot. This procedure has fallen out of favor, as it tended to create more problems than it corrected. Flail lesser digits, along with flexion contractures of the distal interphalangeal joint, were common. No significant increase in dorsiflexion of the flexible forefoot equinus was appreciated.

The traditional PIPJ arthrodesis, along with appropriate muscle-tendon balancing on the extensor side of the joint, has been proven to be more effective than the Hibbs tendon suspension.

MODERATE FUNCTIONAL/ BIOMECHANICAL PLANTARFLEXED FIRST METATARSAL/CALCANEAL VARUS CAVUS FOOT DEFORMITY

The next level of cavus deformity should be called podiatry's cavus foot. This deformity is very functional in etiology and demonstrates classic pathologic biomechanics. The typical deformity consists of a rigidly plantarflexed first metatarsal and associated varus angulation of the heel (Figs. 4A, 4B). The resultant supinatory function of the foot produces the classic cavus deformity with or without associated digital deformities.

Figure 4A. Forefoot valgus created by rigid plantarflexed first metatarsal.

Figure 4B. Calcaneal varus associated with the biomechanical cavus foot deformity.

The specific etiology of this common cavus disorder can include a variety of early neurologic disorders. The surgeon must take care to evaluate the patient thoroughly and differentiate the idiopathic condition or disorder from those with neuromuscular disease.

Common Surgical Procedures

The group of surgical procedures commonly employed in correction of the moderate category of cavus foot deformity include:

1. Dorsiflexory Wedge Osteotomy, First Metatarsal
2. Dwyer Calcaneal Osteotomy
3. Functional Tendon Transfer Techniques
   A. STATT (Split Tibialis Anterior Tendon Transfer)
   B. Peroneal Stop (Anastomosis)

Dorsiflexory Wedge Osteotomy (DFWO) of the First Metatarsal.

Surgical correction of a rigidly plantarflexed first metatarsal is a relatively common procedure. The standard technique employed by members of the Podiatry Institute includes an oblique osteotomy with the apex or hinge at the plantar/proximal aspect of the first metatarsal (Fig. 5). The osteotomy is obliqued distally and fixated with one or two screws from dorsal to plantar.

A technical pearl for fixation would include the use of cortical screws. The partially threaded cancellous screw has a tendency to glide along the internal cortex of the metatarsal and complicate the fixation process.

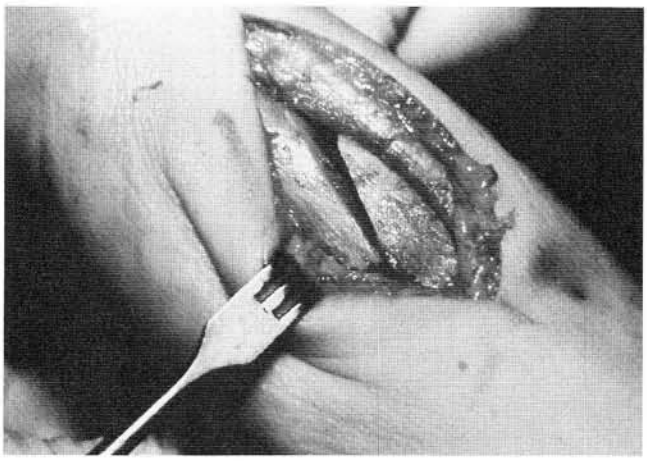

Figure 5. Oblique dorsiflexory wedge osteotomy of the first metatarsal.

Dwyer Calcaneal Osteotomy

Correction of a rigid or fixed heel varus is routinely accomplished with a Dwyer calcaneal osteotomy. The technique is usually performed through a curved lateral incision, with the calcaneal osteotomy in the mid or central portion of the posterior body or tuber of the calcaneus. Care must be taken to avoid violation of the subtalar joint or achilles insertion. Fixation is routinely performed with two lateral staples (Fig. 6). The Coleman block test may be helpful to identify the need for the Dwyer, or to rule-out those patients where there is adequate eversion range of motion within the subtalar joint.

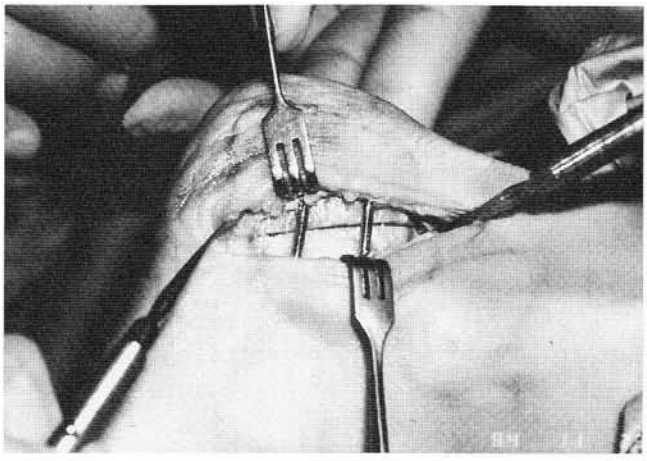

Figure 6. Closure and fixation of a Dwyer calcaneal osteotomy.

STATT (Split Tibialis Anterior Tendon Transfer)

Use of the split tibialis anterior tendon transfer is an attempt to modify the foot attitude during the swing phase of gait. In many of the biomechanical cavus deformities, the foot is observed in the swing phase with a significantly adducted attitude. The STATT will effectively distribute dorsiflexion through a yoke system or technique, and apply equal dorsiflexory power to the medial and lateral aspects of the foot. This will swing the foot forward in a more even attitude and prepare it for plantigrade foot contact. Elimination of excessive adductus of the foot and/or varus at heel contact will reduce muscle compensation, which has promoted plantarflexion of the first metatarsal and heel varus.

Peroneal Stop (anastomosis)

This simple technique can decrease hyperactivity of the peroneus longus tendon. An overactive peroneus longus can create a rigidly functioning plantarflexed first metatarsal. The peroneal stop technique is performed through a lateral incision just proximal to the fibular malleolus. The foot is placed into a perpendicular attitude. The peroneus longus tendon is pulled distally to relax tension on its muscle length, and the peroneus brevis is pulled proximally to support the foot in a slightly everted attitude. The tendons are then sutured together, and create an equal balance of peroneal activity.

SEVERE ADVANCED STRUCTURAL/FUNCTIONAL NEUROMUSCULAR DISORDERS

The most complex and debilitating cavus deformities are grouped into this category (Fig. 7). These are severe cavus deformities of rearfoot and whole foot involvement, and are usually associated with significant neuromuscular disease or imbalance. Common disorders include Charcot-Marie-Tooth Disease, post-polio, and post-cerebrovascular accident.

Common Surgical Procedures

Triple arthrodesis is the mainstay for repair of these severe deformities. This surgical procedure allows for realignment of severe deformity, and creation of a stable plantigrade foot (Figs. 8A, 8B).

The Cole osteotomy can also be grouped in this category, where the focus of the cavus deformity is more midfoot in origin, and in cases where the rearfoot alignment is satisfactory and can be preserved.

Major tendon transfers are also commonly employed in these more severe deformities, and common procedures include the tibialis posterior tendon and peroneus longus tendon transfers.

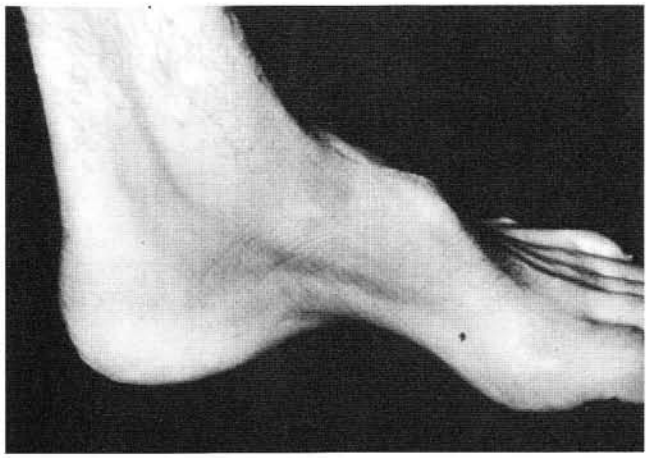

Figure 7. Severe neurologic cavus foot deformity.

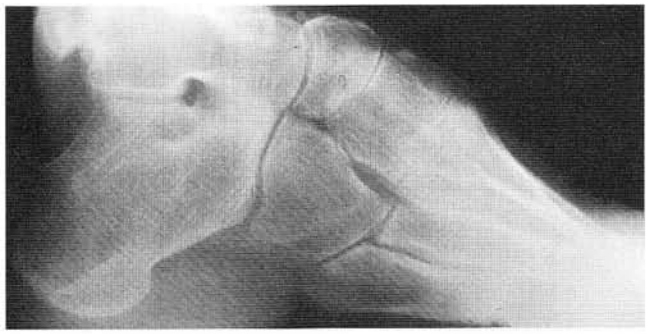

Figure 8A. Lateral radiograph of severe neurologic cavus foot deformity, preoperative view.

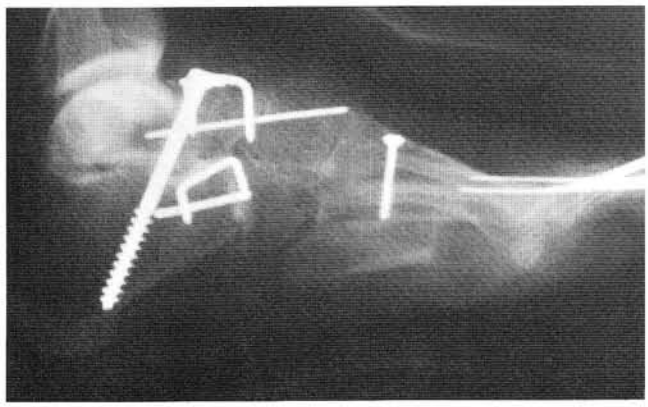

Figure 8B. Postoperative view of same foot including triple arthrodesis, dorsiflexory wedge osteotomy of the first metatarsal and digital fusions. Other procedures included muscle tendon transfer such as the tibialis posterior tendon transfer.