RIGID/FLEXIBLE CAVUS FOOT DEFORMITIES

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Introduction

The cavus foot deformity must be approached in a carefully planned and analytical manner. This evaluation begins well prior to and extends through the operative procedure. Certain decisions can be made prior to surgery. Others must be made during the operative procedures. Some decisions may be delayed until a second operative procedure based on the outcome of the first. Such planning is essential to the operative approach to this complex deformity. The decision making process and the surgical procedures employed constitute a systematic approach to the cavus foot.

The content of this text reviews the overall evaluation process necessary to assess a cavus foot deformity. The lecture will complement this text by presenting surgical approaches to the common forefoot complaints of two cavus foot types. The two cavus foot types to be covered include: 1) the flexible cavus foot that presents primarily with plantar tylomata and hammertoe complaints and 2) the rigid cavus foot that presents with discrete lesions plantar to the first and fifth metatarsals. The cavus foot is a complex deformity. It is not the intention of the lecture to present the approaches to cavus foot surgery in its entirety. We only wish to review the surgical approach to two very common symptom complexes of cavus foot.

Posterior Cavus

Foremost in the evaluation process is the need to identify the presence or absence of neuromuscular disease. The prognosis of any surgical reconstruction is based not only on the procedures themselves but on the possible changing neuromuscular status of a particular patient. Joint stabilization or arthrodesis may be indicated even in a milder form of cavus deformity in the presence of progressive neuromuscular disease. The surgical procedure selection may be influenced significantly if progressive disease is diagnosed. Screening tests by the podiatric surgeon are mandatory in all cavus foot patients. The neurologist's role can be significant in the diagnostic process. This step is the first major diagnostic differential in the evaluation process.

Once the diagnosis of idiopathic pes cavus is established the level of deformity within the foot must be identified. The rearfoot is approached first. The identification of posterior cavus is made by specific clinical and radiographic studies. Primarily two planes of deformity may be present; sagittal plane dorsiflexion of the rearfoot on the forefoot and frontal plane inversion on rearfoot varus. The frontal plane rearfoot varus component is evaluated separately from the sagittal plane. One or both may be present.

An uncompensated or partially compensated rearfoot varus component will not permit the calcaneus to be everted to a position perpendicular to the weight-bearing surface. This finding can be noted in examination of subtalar range of motion in a nonweightbearing posture. Tibial varum has no influence in the nonweightbearing examination. In stance such patients likewise show inability to evert the calcaneus to a valgus position. Tibial varum will influence the weightbearing examination. Also, it is important to perform the weight-bearing examination with the foot positioned to eliminate forefoot influence. This can be accomplished by having the patient stand with the forefoot off the edge of a step. If the varus component disappears and eversion is possible then rearfoot varus can be adequately compensated. If eversion is still not possible and a varus attitude persists, uncompensated or partially compensated rearfoot varus deformity is present.

Identification of the varus component of posterior cavus is based primarily on clinical evaluation. Specialized radiographic techniques have been described to evaluate this component.

Sagittal plane deformity is demonstrated primarily on radiographic evaluation. It presents as an increased calcaneal inclination angle. Forefoot influence must be eliminated to accurately assess the flexibility of the rearfoot deformity. Radiographs may be taken with the forefoot off the weight-bearing surface. If the calcaneal inclination angle reduces to normal levels, fixed deformity is not present. The subtalar joint is carefully observed for signs of pronatory motion. Partial reduction may also be noted. The degree of reduction will influence the choice of procedures planned to correct the rearfoot.

A high degree of fixed posterior cavus in the frontal and sagittal planes may require wedge resection of the subtalar joint with triple arthrodesis. A triple arthrodesis permits stable repositioning of the rearfoot in any plane.

Painful subtalar arthrosis can also be eliminated. It is important to note the presence of joint pain in clinical examination. Relief of pain with local anesthesia infections into the joint may aid in diagnosis and in establishing a prognosis. The quality as well as quantity of subtalar motion should be assessed.

The frontal plane component of posterior cavus or rearfoot varus can be addressed extra articularly by a Dwyer calcaneal osteotomy as part of the surgical plan. The size of the osteotomy is dependent only upon the amount of rear foot varus present. Compensatory varus position of the calcaneus or subtalar supination should be treated by forefoot or metatarsal osteotomy. If both are present the amount of influence of each deformity must be carefully assessed and individually approached. Overcorrecting either will not correct the other and can make symptoms worse.

The fixed sagittal plane component of posterior cavus may be addressed by the sliding calcaneal osteotomy of Samilson or by the two plane Dwyer osteotomy. This component is rarely associated with patient complaints. The frontal plane component of varus may be associated with lateral ankle instability. The sagittal plane component is generally associated with some degree of rigid anterior cavus. Some significant reduction of the calcaneal inclination angle can be expected with reduction of the fixed anterior cavus component. The reduction of fixed sagittal plane posterior cavus is most important clinically in the reduction of pseudoequinus. This is accomplished by raising the forefoot and thus plantarflexing the rearfoot at the ankle. If the posterior aspect of the calcaneus is raised, as in biplane osteotomies, the pseudoequinus can be worsened. Such calcaneal osteotomies are rarely indicated as isolated structural approaches to the cavus foot deformity.

Ankle Equinus

The ankle equinus component of cavus foot is difficult to assess. It is a rare occurrence. Osseous ankle equinus is evaluated by stress dorsiflexion and plantarflexion radiographs. The excursion of talar motion within the ankle mortise is evaluated. Anterior tibial or dorsal talar lipping may limit ankle motion. Gastrocnemius equinus is differentiated from triceps equinus by comparing ankle dorsiflexion with the knee extended and flexed. In the cavus foot this examination needs to be repeated following surgical reduction of pedal deformities. The persistence of a limitation of dorsiflexion is an indication that gastrocnemius or triceps equinus is actually present as distinguished from pseudoequinus. If limitation of ankle dorsiflexion persists only with the knee extended a tongue in groove type lengthening of the gastrocnemius aponeurosis as described by Baker and popularized by McGlamry is performed. If a limitation of ankle dorsiflexion persists with the knee both extended and flexed a White Z-plasty side lengthening of the tendo Achillis is appropriate.

It is important to recognize the rarity of this component. Inappropriate gastrocnemius or triceps surgery may produce the severe complication of a talipes calcaneus with an appropulsive gait. The loss of adequate triceps pull on the calcaneus may actually result in an increased calcaneal inclination angle.

Anterior Cavus

Anterior cavus is diagnosed if upon elimination of the forefoot influence in a cavus foot the rearfoot assumes a more normal position with a normal calcaneal pitch. Clinical and radiographic testing procedures have been discussed. The decision process must now include the differentiation between a plantarflexed first ray and a plantarflexion attitude of two or more metatarsals. This examination is carried out utilizing a modification of the Paulus technique. Clinical and radiographic examinations carried out by placing wedging under the anterior lateral forefoot. This examination is only possible in isolated anterior cavus deformity. The uncompensated or partially compensated rearfoot varus component will not permit adequate reduction due to the limitation of subtalar motion. If the rearfoot assumes a neutral position with lateral wedging under the forefoot, a plantarflexed first ray is present. This distinction is also diagnosed by careful palpation during the biomechanical examination.

If a flexible posterior cavus is present and lateral forefoot wedging does little to reduce the cavus deformity, sagittal plane plantarflexion of more than just the first metatarsal is present. The flexibility or rigidity of the above two types of anterior cavus helps determine the surgical procedure selection.

The rigidity or flexibility of the plantar flexed first ray is determined by clinical and radiographic evaluation, weightbearing, and nonweightbearing. Comparison weightbearing and nonweightbearing lateral foot radiographs show less change in first ray position the more rigid the deformity. The presence of plantar callosities in the region of the tibial sesamoid supports the finding of a rigid condition.

The presence of a rigid hallux malleus or hallux hammertoe makes preoperative assessment of the first ray mobility difficult. Intraoperative assessment following interphalangeal joint fusion of the hallux and metatarsophalangeal joint release is vital. Once the hallux deformity is released the presumed rigid deformity of the first

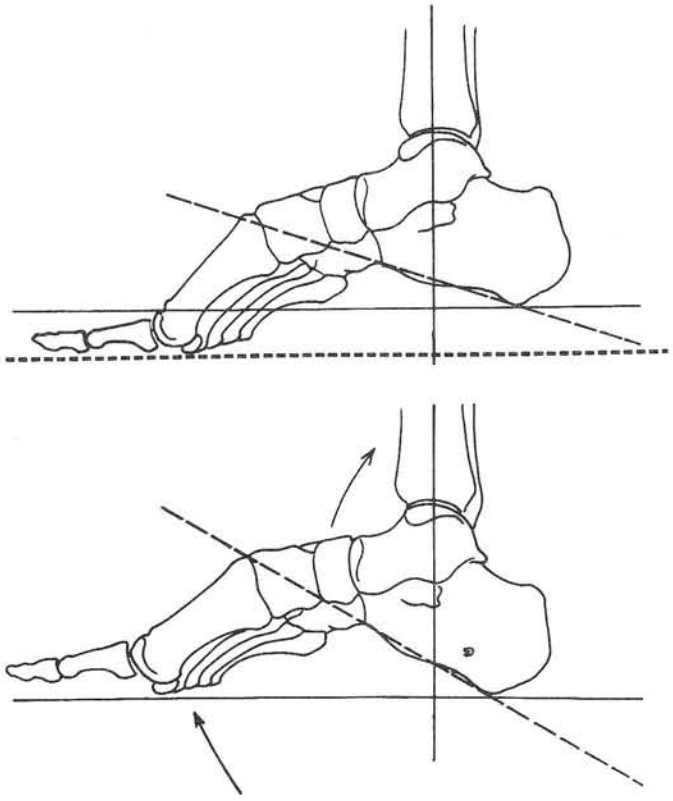

Fig. 1. To place both forefoot and heel on same weight-bearing source in structurally rigid anterior cavus, entire foot must be rolled back onto ankle mortice. Calcaneal inclination is increased. A portion of talar ankle excursion must be utilized to simply allow forefoot and rearfoot to purchase floor together.

metatarsal may in fact be flexible and the first metatarsal may assume a more functional attitude. Flexible deformity may be treated by surgically controlling hallux function alone.

Hallux deformity may occur in the presence of a weak tibialis anterior muscle or loss of intrinsic muscle function to the hallux. A Jones tendosuspension may be employed in the presence of muscle imbalance that creates hallux malleus. The rerouting of the long extensor of the hallux through the distal first metatarsal helps reduce flexible plantarflexed first ray deformities. Such procedures must be combined with appropriate arthrodesis of the hallux interphalangeal joint. Ankle dorsiflexory power is also maintained. An adequate dorsal range of motion of the first ray must be present for this procedure to be effective. Fixed first ray plantarflexion is not corrected by this procedure alone.

If the first ray position is rigidly plantarflexed, a dorsiflexory osteotomy of the first metatarsal is indicated. In the presence of muscle imbalances that cannot be reestablished about the first ray, a McElvenny-Caldwell type dorsiflexory arthrodesis of the first metatarsocuneiform joint will help stabilize the ray. Fixed plantarflexion deformity is also corrected. Arthrodesis of the interphalangeal joint of the hallux can be used in conjunction with these procedures to correct malleus deformity.

The rigidity or flexibility of anterior cavus of all five metatarsals is difficult but important to determine. If upon comparing the weightbearing with nonweightbearing lateral foot radiographs significant reduction in the cavus deformity is noted, some degree of flexibility is present. The flexibility of the deformity is difficult to assess in the presence of rigid hammertoe deformities. Rigid posterior cavus can and should be ruled our preoperatively. However, the degree of flexibility of the sagittal plane anterior cavus can only be accurately assessed following the release of contracted metatarsophalangeal joints and hammertoe deformities. The reverse buckling influence of the digits must be addressed and in so doing may release the forefoot to assume an acceptable functional alignment. If hammertoe deformities are not present and the posterior cavus component is reducible a definitive diagnosis of anterior cavus is made.

Rigid posterior cavus to any significant degree is generally accompanied by a degree of rigidity in the anterior cavus component. Structural correction of rigid anterior cavus can be approached by several methods. Our experience has been discouraging with midtarsal osteotomies. The Cole midtarsal wedge osteotomy results in a shortened and broader foot. The Japas displacing V osteotomy crosses a multitude of lesser tarsal joints and can be slow and difficult to heal. Sagittal plane deformity can be corrected with such procedures. However, the degree of frontal plane correction possible for varus or valgus forefoot deformities is severely limited especially with the Japas procedure. Some degree of frontal plane correction may be accomplished with the Cole type procedure.

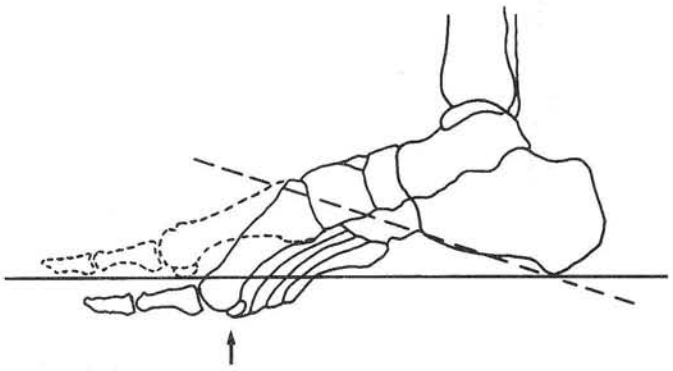

Fig. 2. In a flexible anterior cavus foot type compensation for deformity occurs with pedal joints. No ankle excursion is lost or pseudoequinus produced.

Most fixed anterior cavus deformities have triplane components to the deformity. In severe cavus foot triple arthrodesis provides more latitude for functional stability and triplane correction. If extrarticular correction is desired in less severe deformities without tarsal joint pain and without severely rigid and malaligned posterior cavus, multiple metatarsal dorsiflexory osteotomies or wedged Lisfranc's joint fusion is performed. The fixed posterior cavus, if present, must be addressed surgically.

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