CHAPTER 2

TIBIALIS POSTERIOR DYSFUNCTION: A Critical Look At Surgical Options

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Tibialis posterior dysfunction (TPD) is a clinical presentation of an adult flatfoot, where the longitudinal medial arch is flattened, the rearfoot is in valgus, the forefoot is abducted, and the "too many toes" sign is present. The dysfunction of the posterior tibialis has a major effect on the function and shape of the foot. The end result of TPD is a devastating foot deformity with eventual arthrosis of multiple joints.

Tibialis posterior dysfunction continues to be a challenging entity to manage successfully. When recognized in its early stages, conservative treatments have the best chances for success. Unfortunately, in the more advanced stages conservative treatment is likely to fail. The conservative management of this presentation may include supportive therapy (functional bracing), immobilization, physical therapy, injections followed by protective weight bearing, and orthotic control. The purpose of this article is to discuss some surgical concepts in patients in which conservative treatment was unsuccessful.

ANATOMY & FUNCTION

The multiple insertions of the tibialis posterior tendon explain the importance of the tibialis posterior function. It inserts into the navicular tuberosity, medial and intermediate cuneiforms, and the bases of the central metatarsals. Johnson[1] described the tibialis posterior as having a short dynamic excursion, which means that it creates minimal visible motion on the foot. However due to its multiple insertions, it is a primary stabilizer of the foot during the stance phase of the gait, locking the midtarsal joint and preventing abnormal pronation.

ETIOLOGY

There are many causes and contributing factors that lead to TPD. Mueller[2] described and classified four etiologies of TPD: direct trauma, pathologic rupture, idiopathic rupture, and functional rupture. Mahan[3] felt that in most cases of TPD, the posterior tibialis tendon is intact, however it has lost its function (functional rupture) secondary to the healing of the tendon in a lengthened position. Since the posterior tibialis tendon has a short excursion, the lengthened posterior tibialis tendon will dramatically affect stabilization of the foot. Additionally, Mahan discussed the presence of an os tibiale externum to cause a mechanical disadvantage on the insertion of the posterior tibialis. In his experience, he found this accessory bone to be present in 60% of his TPD patients. Banks and McGlamry[4] discussed abnormal biomechanics (i.e. collapsing pes plano valgus) as the most common cause of TPD. The compensation or the response of the foot to this collapse is determined by the planal dominance of the foot.

PLANAL DOMINANCE

The concept of "Planal Dominance" was introduced by Green and Adele[5] in 1984. The deformity and compensation of the foot in TPD and flexible flatfoot deformity follows this important concept. The planal dominance of the subtalar and midtarsal joints are determined by the position of their axis. Root et al.[6] introduced the average subtalar joint axis to be located 42° from the transverse plane, 46° from the frontal plane and 16° from the sagittal plane. The oblique midtarsal joint axis is located 52° from the transverse plane and 57° from the sagittal plane. The longitudinal midtarsal axis is located 15° from the transverse plane and 9° from the sagittal plane.

When one evaluates the subtalar joint, the amount of frontal and transverse plane motion is carefully observed. In a patient with a "high" subtalar joint axis (one moving closer to the frontal plane), the motion will occur more in the transverse plane. In contrast, a "low" subtalar joint axis (one moving closer to the transverse plane) will result in more motion in the frontal plane.

Figure 1A. Example of transverse plane dominant flatfoot with mild calcaneal eversion.

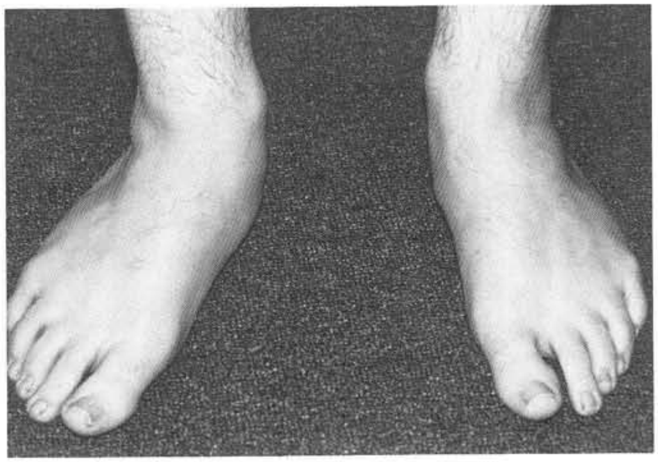


Figure 1B. Transverse plane dominant flatfoot. Most of the compensation exists in abduction of the midfoot and forefoot.

Since the subtalar joint axis is tri-planar, there is never pure motion in only one plane, yet many times one plane will be dominant upon examination. The sagittal plane components are also present and will present with equinus and medial column faulting. The authors believe the primary plane of compensation should be considered in selecting procedures with more predictable success (Figs. 1A, 1B).

CLASSIFICATION

Johnson and Strom[7] described the "too many toes" sign, and positive "single-leg heel rise" test to be diagnostic signs. Recently, Hintermann and Gachter[8] reported that the "first metatarsal rise sign" is a simple and sensitive sign to detect TPD. They found that the "first metatarsal rise sign" is more reliable in detecting TPD than either MRI, radiographs, the "too many toes" sign and the "single-leg heel rise" test.

Johnson and Strom describe three stages of TPD which deal with signs, symptoms, radiographic findings, and treatments for each stage. In Stage I, the signs and symptoms are minimal to mild where the "too-many-toes" sign is negative. Their recommendations for Stage I starts with three months of conservative care, then synovectomy and tendon debridement if this treatment fails. In Stage II, the signs and symptoms are moderate with a flexible to semi-flexible deformity. The "single heel rise" test and "too-many-toes" signs are positive. Tendon transfers are recommended surgical approaches in this stage. In Stage III, the signs and symptoms are severe with rigid foot deformities and arthrosis. Johnson and Strom recommend joint fusions as the procedures of choice.

TREATMENT

As mentioned previously, Johnson and Strom recommend aggressive conservative treatment in the first three months of Stage I TPD. The early peritendinitis is treated with anti-inflammatory medications, shoe modification, steroid injections, inverted orthotics, and cast immobilization. When tenosynovitis continues to persist after adequate conservative treatment, they recommend surgical intervention. This will include synovectomy and tendon debridement. In Stage 2, they recommend a flexor digitorum longus transfer to the posterior tibialis tendon. In Stage 3, a subtalar arthrodesis is used to correct the deformity.

It is well-understood that Stage 3 requires some type of arthrodesis to address the arthrosis and long-term deformity. However, the surgical treatments are the most controversial at Stage 2. Jahss,[9] and Banks and McGlamry[1] recommend triple arthrodesis to stabilize and address deformity in multiple planes. They feel the soft tissue procedures do not adequately address the underlying collapsing pes plano valgus. Myerson and Corrigan[10] also feel an isolated flexor digitorum tendon transfer does not correct the deformity. Instead, they added a calcaneal osteotomy with the flexor digitorum tendon transfer. They reported a 94% success rate of (30/32) patients having pain relief and improvement in the arch position.

Frankel et al.[11] feel soft tissue procedure alone are doomed for failure and the arthrodesis is premature for non-arthritic joints. They recommend a double calcaneal osteotomy (Koutsgiannis and Evans osteotomy) to address the Stage II deformity.

Hansen considers the ankle, subtalar, talonavicular, and metatarsophalangeal joints as "essential joints" to maintain normal function of the foot. He considers the calcaneocuboid joint as a "non-essential" joint thereby minimizing the loss of mobility in the remaining essential joints. The calcaneocuboid joint distraction arthrodesis primarily addresses the transverse plane dominant deformity. This arthrodesis relocates the abducted forefoot at the midtarsal joint and stabilizes the subtalar joint. Caldarella[12] feels the calcaneocuboid joint distraction arthrodesis preserves the subtalar and talonavicular joints and their mobility, thereby allowing better shock absorption through the rearfoot.

Carter and Ruch[13] discussed talonavicular arthrodesis to treat TPD. They feel the talonavicular joint arthrodesis improves and maintains foot position while blocking up to 80% of subtalar joint motion. Fogel et al.[14] reported a 9.5 year follow-up study with gait analysis in 11 patients. They found that talonavicular arthrodesis significantly reduced the subtalar motion. Although three patients had radiographic changes in adjacent joints, none of them exhibited any clinical signs of arthrosis in these joints. Harper and Tisdel[15] found one new adjacent joint arthrosis in twenty-seven cases. Furthermore, O'Malley et al.,[16] and Astiom et al.[17] reported that talonavicular arthrodesis addresses the deformity in all three planes. The isolated subtalar arthrodesis fails to correct the forefoot abduction, and isolated calcaneocuboid arthrodesis provided less correction in the flatfoot deformity.

DISCUSSION

A valuable part of the examination is to attempt a "Subtalar Joint Neutral" position radiograph (Figs. 2A, 2B, 3A, 3B). This will allow one to evaluate the ability of the foot to become manually reduced to a neutral position. Often, the patient will be able to place their own foot in what they feel is neutral position simply by the fact it feels better to them. It is important the anterior tibialis tendon is not contracting, as this will introduce an inaccurate amount of "supinatus" into the picture. Neutral position can be assessed by evaluating the sinus tarsi on the lateral view, the alignment of the cyma line on both the dorsoplantar and lateral radiographs, as well as the first metatarsal-talar relationship. A residual supinatus in the foot usually will not reduce completely, and will present as a metatarsus primus elevatus on the lateral radiograph (Figs. 4A, 4B). This will provide helpful information on how the joints align in relationship to one another, and assist in proper procedural selection. If the entire foot can re-align with the patient in "neutral" position, then soft tissue and/or osseous procedures in the rearfoot should adequately control foot position and function. Radiographic findings should, however, be carefully correlated with the clinical examination in both weight bearing and non-weight bearing attitudes.

The variety of procedures range from soft tissue procedures to osseous procedures. Soft tissue procedures include synovectomy and debridement, FDL transfer, Kidner procedure, and modifications of the Young's tenosuspension. As an isolated procedure, these have limited indications. Often they are performed in conjunction with other structural procedures for more predictable success. Another important soft tissue procedure is a posterior heel cord lengthening to treat an equinus.

Extra-articular procedures are also extremely important in attempts to structurally control the foot when joint fusion is neither desirable nor indicated. The proper selection of procedures should take into consideration the planal dominance of the deformity. For transverse plane deformities, an Evans calcaneal osteotomy may be a good choice. A subtalar joint arthroereisis or Koutsgiannis medial displacement osteotomy may work well with primary frontal plane deformities. Sagittal plane correction may involve opening wedge osteotomies of the medial column, to reduce residual varus or supinatus deformity.

Can an Evans osteotomy be performed in a patient with a dominant frontal plane deformity? Can a subtalar joint arthroereisis be performed in a patient with a dominant transverse deformity? There are reports that state these procedures are interchangeable, as pronation and collapse occurs as a triplanar motion. Correction of one plane will usually result in mild to moderate correction of the other planes. However, selection of procedures

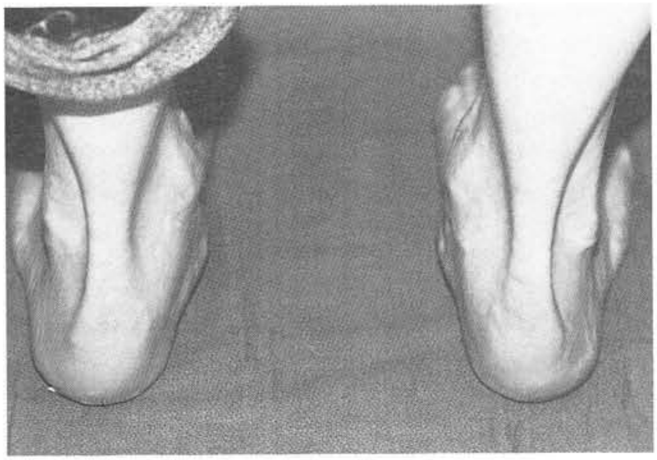


Figure 2A. Clinical example of patient shown in resting calcaneal stance position.

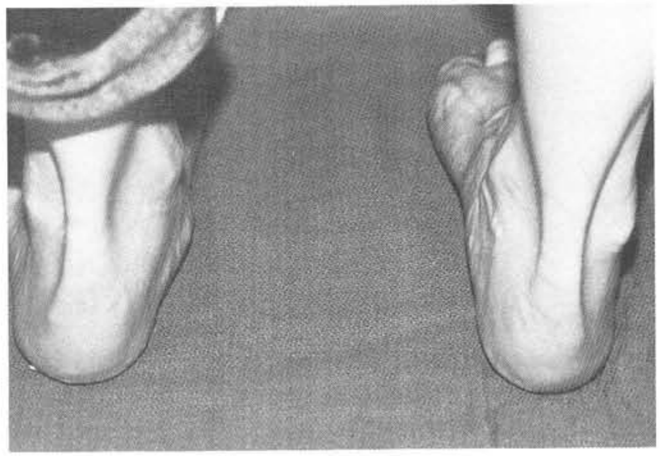


Figure 2B. Example of patient in neutral calcaneal stance position. Note the appearance of the arch without a supinatus in the medial column. The 1st metatarsal is still on the ground.

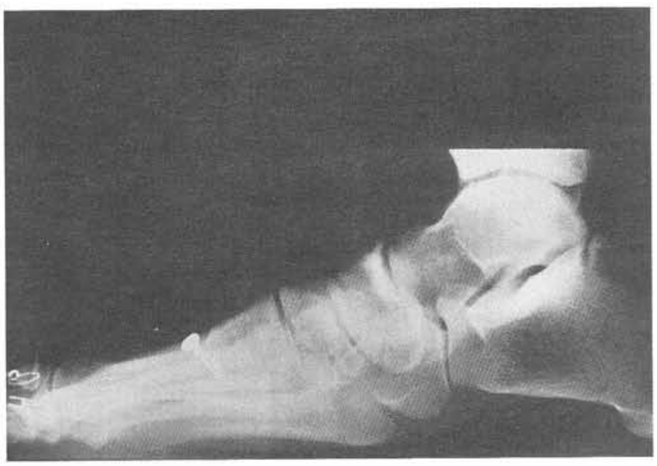


Figure 3A. Radiographic example of resting calcaneal stance position in the same patient.

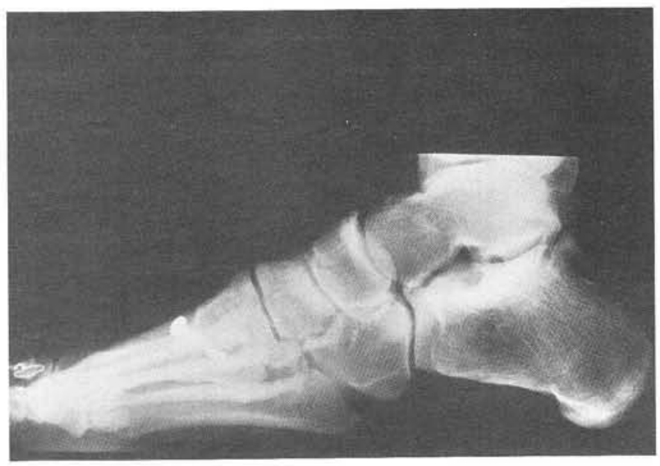


Figure 3B. Example of neutral calcaneal stance position. Note the alignment of the cyma line and sinus tarsi in the lateral view. The first metatarsal is also in better alignment.

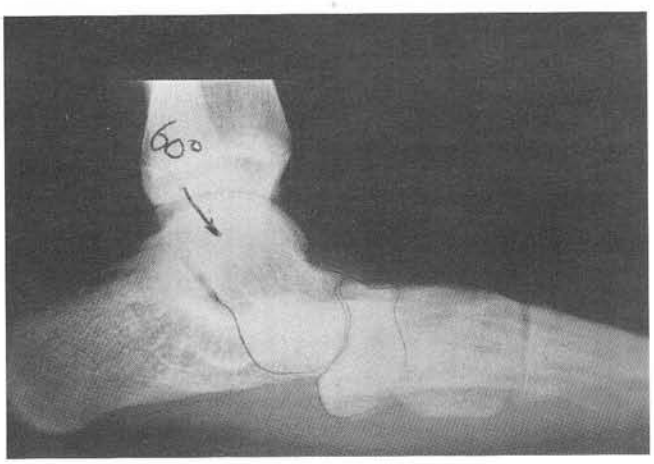


Figure 4A. Dramatic example of severe flatfoot in resting calcaneal stance position.

Figure 4B. Example of severe flatfoot in neutral calcaneal stance position. Note the supinatus maintained after alignment of the rearfoot. This illustrates adaptive soft tissue/osseous changes within the medial column.

which most directly address the dominant plane of compensation can most likely result in correction.

Joint arthrodesis is still the most predictable approach when joint arthrosis is present, or ultimate stability is required and/or desired for control. Triple arthrodesis has always been the gold standard for providing stability to the foot in end-stage arthrosis and/or collapse. Current trends are looking at the utilization of isolated joint fusions which provide similar stability to the traditional triple arthrodesis when joint arthrosis is absent. These include subtalar joint fusion, talonavicular fusion, and distraction calcaneocuboid arthrodesis. Isolated fusions are potentially easier to perform and provide less morbidity in recovery for the patient. An isolated subtalar fusion is acceptable when there is minimal to no midtarsal joint malposition. The distraction calcaneocuboid fusion accomplishes generally the same correction as the Evans osteotomy, yet the incorporation of an autogenous graft will delay the healing time compared to both talonavicular and subtalar joint healing. It is well-accepted that isolated talonavicular fusion will minimize subtalar joint motion more dramatically than the distraction calcaneocuboid fusion. The ball-and-socket shape of the talonavicular joint allows more motion when left intact, as opposed to the saddle-shaped orientation of the CC joint (Figs. 5A-5H).

Planal dominance in cases of rearfoot arthrodesis is not as important as described for extra-articular procedures. If the rearfoot has the ability to reduce into a clinical and radiographic "neutral position" before surgery, the authors believe any of the three isolated joint fusions will provide functional stability to the foot and ankle. Each of these three procedures have their own advantages and disadvantages. The personal experience and philosophy of the surgeon will also influence the preference and desire for certain procedures.

Figure 5A. AP radiograph of Stage I/II PT Dysfunction.

Figure 5B. Lateral radiograph of Stage I/II PT Dysfunction

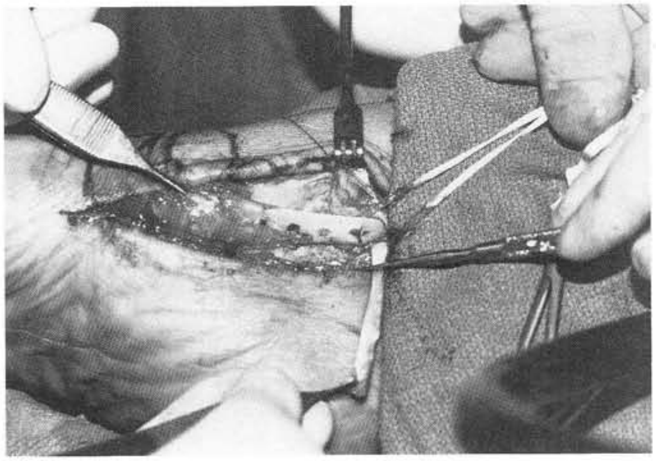


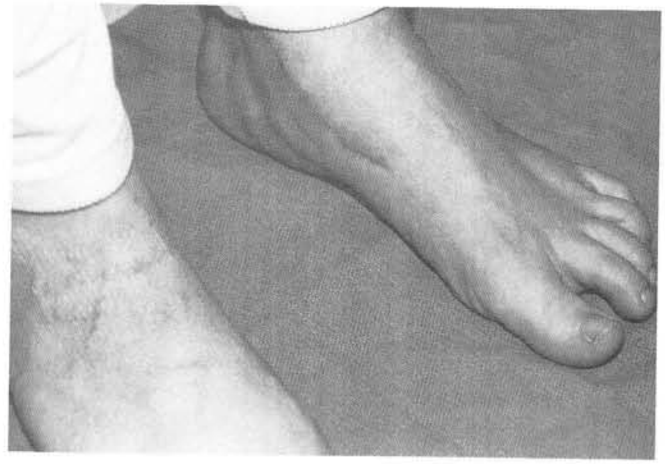
Figure 5C. FDL transfer with advancement of the PT tendon.

Figure 5D. Postoperative AP radiograph illustrating minimal change in foot position from preoperative radiographs.

Figure 5E. Postoperative lateral radiograph.

Figure 5F. Subtalar joint neutral radiograph with good alignment of the rearfoot and forefoot.

igure 5G. Patient with TN fusion to capture a "neutral to mildly pronated" functional position.



FFigure 5H. Note restoration of the arch in the early follow-up period.

SUMMARY

Tibialis posterior dysfunction is a progressive deformity that results in severe flatfoot with marked rearfoot valgus and forefoot abduction. As with most deformities, the podiatric surgeon has a large armamentarium of procedures to select from. An understanding of "planal dominance" coupled with the ability to manipulate a patient back into "neutral position" in the preoperative evaluation should assist the surgeon in procedural selection. Aggressive treatment is recommended at any stage, however poor results from soft tissue procedures have prompted surgeons to consider osseous procedures more critically. Adjunctive release of the heel cord should be considered in most cases. Finally, the foot position after the arthrodesis or osteotomy is paramount for long-term satisfaction while minimizing the stress to adjacent joints. When proper procedures are selected for the individual's specific foot-type, the successful management of most deformities is more predictable.

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