The indications and biomechanical rationale for various hindfoot procedures in the treatment of posterior tibialis tendon dysfunction

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Posterior tibialis tendon dysfunction (PTTD) is traditionally divided into four categories, which would suggest that the treatment options and decision making are straightforward and consistent [1]. There are, however, several treatment options in every stage of the disease. The best option for a specific case is dependent upon the individual patient’s combination of deformities and associated adaptive changes. There are in fact subgroups in each classification stage and treatment should be individualized.

This article gives an overview of the hindfoot procedures that are available, the indications, rationale, the biomechanical impact, and potential problems with each of these procedures.

The algorithm that is suggested for treatment of stage II PTTD is shown in Fig. 1.

Achilles/gastrocnemius lengthening

Indications

In most cases of PTTD, the gastrosoleus complex will be shortened or functionally shortened.

An achilles or gastrocnemius lengthening should be an integral part of most, if not all, of the reconstructive procedures for PTTD.

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1083-7515/03/$ – see front matter © 2003 Elsevier Inc. All rights reserved.
doi:10.1016/S1083-7515(03)00038-X
Biomechanical rationale

Achilles tendon/gastrocnemius contracture is an integral part of PTTD. It is probably a contributing factor in many cases of PTTD and the complex continues to shorten in longstanding deformities. Most, if not all, of the patients who present with a grade 2 or higher deformity will need a gastrocnemius, or occasionally an Achilles, lengthening.

An inherently tight Achilles tendon might predispose the foot to degenerative changes by restricting hindfoot mobility, thereby transferring motion to the midfoot. With a tight Achilles tendon complex, dorsiflexion in the ankle is limited and additional motion occurs through the midtarsal joints. This results in a dorsal and lateral force and motion through the talonavicular (TN), naviculo-cuneiform (NC) and cuneiform-metatarsal (CMT) joints [2].

The increased midfoot motion places excessive stress and strain on the posterior tibialis tendon (PTT), spring ligament, inferior NC ligament, and NC capsular structures. With the progressive planovalgus collapse of the foot, the moment arm and force of the Achilles falls further laterally to the center of the joint. This results in an increased valgus force on the ankle/calcaneus.

Problems

Over lengthening - weakness in push-off
Sural nerve injury with a gastrocnemius slide
Calcaneal osteotomy and medial procedures

*Indications*

- Flexible/reducible hindfoot valgus deformity
- Normal calcaneal pitch
- Minimal forefoot varus
- In combination with a lateral column lengthening (LCL)

*Biomechanical rationale*

The obvious advantage of a medializing calcaneal osteotomy over a subtalar fusion is the fact that the triple joint complex mobility is not compromised. This, in turn, will help to protect the ankle and midfoot joints.

The biomechanical improvement of a medial translation of the calcaneus is believed to be a result of the restoration of the gastrosoleus insertion medial to the axis of the ankle joint. With the gastrosoleus complex medial to the midline, it functions as an inverter of the heel and a stabilizer of the midfoot. It also relieves some of the tension of the posterior tibial tendon repair or flexor digitorum longus (FDL) transfer. Medializing calcaneal osteotomy has no effect on the plantar fascia or windlass mechanism [3].

Medializing calcaneal osteotomy is not indicated as an isolated procedure. The PTT should be repaired or augmented and a gastrocnemius slide should be done if indicated.

*Problems*

- Incomplete correction
- Sural nerve injury

Lateral column lengthening (LCL) and medial stabilizing procedures

*Indications*

- Stage II PTTD as defined by Johnson and Strom [1]
- Pronation of the midfoot
- Abduction of the forefoot
- A flexible valgus deformity of the hindfoot
- Reduced or absent strength in inversion of the foot
- Minimal, if any, subtalar arthritis
- Passively correctible hind and forefoot deformities

*Biomechanical rationale*

The TN and subtalar joints are functionally coupled. A talonavicular fusion results in an 80% decrease in subtalar motion. A calcaneocuboid fusion causes a
less than 20% decrease in subtalar motion. In a mobile, reducible hindfoot valgus, a LCL could reduce the hindfoot deformity, restore the medial arch, and reduce the talonavicular subluxation [2].

On occasion, a medializing calcaneal osteotomy might further aid the hindfoot valgus correction if excessive LCL is required to bring the heel back to neutral. Medial column stabilization with a NC or CMT fusion corrects the forefoot supination that often results from a long-standing PTTD and planovalgus collapse.

A PTT augmentation and spring ligament repair are done in conjunction to repair the soft tissue structures around the TN joint.

Problems

Nonunion of the calcaneocuboid fusion is still the most common complication. It occurs in 10% to 20% of cases and usually requires a revision procedure.

Requires a prolonged period of non weight bearing (NWB) and immobility

Sinus tarsi pain which is probably due to lateral impingement

Improper rotation of the forefoot in varus and supination

Subtalar fusion

Indications

Rigid deformities
Subtalar degenerative joint disease (DJD)
As part of a double or triple arthrodesis
Isolated hindfoot valgus with a symptomatic subtalar joint
Failed joint-sparing treatment with recurrent valgus deformity
In combination with medial procedures where a lateral column lengthening is contraindicated or not preferred:

Obesity
Inability to be NWB for an extended period of time
Smoking
Elderly patient

Biomechanical rationale

Repositional arthrodesis has a role in pain relief and improvement of function. Pain that is associated with degenerative changes in the subtalar joint can be alleviated by fusion of the symptomatic subtalar joint. Pain that is associated with subfibular impingement of the peroneal tendons is addressed with reduction of the valgus hindfoot [4].

Persistant hindfoot eversion (valgus) after in situ arthrodesis yields poor results [2]. Reduction of the hindfoot valgus that is inherent in this deformity
is necessary to improve foot and ankle function. Reduction and stabilization of the talocalcaneal joint accomplishes several goals:

- Reduction of the subtalar joint reduces the length discrepancy between the medial and lateral columns, which reduces the peritalar subluxation [5].
- Restoration of the transverse tarsal joints improves midfoot stability during late stance (heel-rise through toe-off).
- Realignment of the subtalar joint can normalize weight-bearing forces at the ankle by correcting the mechanical axis.
- Medialization of the Achilles tendon insertion eliminates the valgus moment that is produced by the triceps surae when the hindfoot is in a valgus position.

A subtalar fusion allows for a satisfactory static and stable correction of the hindfoot valgus/unstable subtalar joint deformity. The patient’s ability to achieve a high level of function is least impaired after a subtalar arthrodesis. A subtalar fusion heals much more quickly and more reliably than a lateral column lengthening [6].

The position of the subtalar joint determines the flexibility of the transverse tarsal (talonavicular-calcaneocuboid) joint. The ideal position for a subtalar arthrodesis is approximately 5° of valgus to permit mobility of the transverse tarsal joint. A varus position of the subtalar fusion will lock the transverse tarsal joint, which forces the patient to walk on the lateral side of the foot [7].

A significant forefoot varus (in compensation for a hindfoot valgus) is a contraindication for an isolated subtalar fusion. If there is more than 10° to 12° of fixed forefoot varus, the foot cannot compensate for this deformity, which forces weight onto the lateral side of the foot.

An isolated subtalar arthrodesis is a better option than a triple arthrodesis in stage II PTTD, with less stress on the ankle joint.

A medializing calcaneal osteotomy can often be used instead of a subtalar fusion.

**Problems**

- Does not correct or address any forefoot deformities
- Lateral impingement – if too much valgus
- Lateral foot pain – if fusion in varus (lock transverse tarsal joints) or forefoot varus is more than 12°
- Nonunion (uncommon)

**Triple arthrodesis**

**Indications**

- Severe rigid deformities
- Advanced multi-joint degenerative changes
Intact ankle  
Revision for failed joint-sparing procedures

**Biomechanical rationale**

Unfortunately, a triple arthrodesis is sometimes the only option left to improve the function in a severely deformed foot. It will add significant stress across the ankle joint, which results in early deterioration of the joint. The severe malalignment before correction would, however, also have resulted in joint destruction.

Triple arthrodesis is technically demanding, but with meticulous attention to position, can produce a stable, plantigrade foot [8,9]. Each component of the deformity must be considered. The longitudinal arch (talo-1st metatarsal angle) is restored by reduction of the dorsolateral peritalar subluxation. Alignment of the forefoot (adduction and pronation) is also corrected by reduction of the talonavicular joint and supported by calcaneocuboid fusion. The hindfoot is corrected by reduction of the subtalar joint [10].

Ankle function is improved and preserved by anatomic alignment of the calcaneus beneath the ankle. Reduction of the subtalar joint restores the mechanical axis by reducing the valgus moment. The weight-bearing forces across the mortise are balanced and excessive tension on the deltoid ligament is relieved.

Pain that is associated with arthritis is improved by the healed arthrodesis of the involved joints. Subfibular impingement is relieved by realignment of the hindfoot. In many cases, correction of the alignment may allow the use of regular footgear and obviate the need for special appliances.

The complications of a triple arthrodesis reinforce the fact that the ankle, hind- and midfoot joints function in tandem. Removing the three hindfoot joints place increased stress on the ankle and midfoot joints. It is, therefore, advisable to consider a more limited arthrodesis when feasible.

The position of a triple arthrodesis is critical; after an arthrodesis has been achieved, the foot is in a fixed position and cannot conform to the ground. The ideal position of the fusion is hindfoot $- 5^\circ$ valgus, transverse tarsal joint in $0^\circ$ to $5^\circ$ abduction, and the forefoot in less than $5^\circ$ varus [5,7].

With all of its shortcomings, a triple arthrodesis is still a good option in the correct patient group [9].

**Complications**

Nonunion in 10% to 20% of cases. The talo-navicular is the most common site of nonunion.

Mal-position/malunion. After an arthrodesis has been achieved, the foot is in a fixed position and cannot conform to the ground.

Wound problems

Sural nerve impairments
Summary

Several procedures are available for the treatment of posterior tibialis tendon dysfunction. The procedure that is chosen for a specific patient should address the patient’s unique problem and make biomechanical sense. A fusion should be avoided, if possible; however, if a fusion is the appropriate solution, one should not hesitate to do it.

References