50 Posterior tibial tendon insufficiency

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50.1 Introduction

Posterior tibial tendon insufficiency (PTTI) was initially described as a degenerative condition of the tendon, but it is also associated with progressive collapse of the foot. Both aspects are important, with deformity in the foot becoming most problematic in the later stages.\(^1,2\)

50.2 Anatomy

The posterior tibial tendon acts to invert the hindfoot and midfoot through insertions on the navicular, as well as the sustentaculum tali of the calcaneus and bones of the midfoot. The spring ligament complex is the static soft tissue support of the talonavicular joint, resisting excessive abduction and plantar sag at that joint.\(^3\) Ligaments at the level of the navicular cuneiform and tarsal metatarsal joints prevent sag at those joints.

50.3 Biomechanics

Failure of the arch can occur at multiple levels, the most important of which is the triple joint complex (talonavicular, subtalar, and calcaneal cuboid joints). Failure of the ligaments supporting these joints results in hindfoot valgus, midfoot abduction, and plantar sag in the midfoot and hindfoot. The naviculocuneiform and tarsometatarsal joints can also be involved, resulting in dorsiflexion of those joints.

50.4 Clinical Presentation
PTTI presents in its earlier stages with pain and tenderness over the posterior tibial tendon, most commonly distal and inferior to the ankle. With failure of the ligaments, deformity occurs at the involved joints. With progression of deformity, particularly at the triple joint complex, the deformity itself becomes painful, with pain in the lateral hindfoot. Patients who present later in the course of the condition can, therefore, present with lateral pain and no medial pain well after complete failure of the tendon. Ligament failure can occur at the same time as tendon failure, after, and, least commonly, before.

50.5 Pathogenesis

The etiology of this condition has not been fully elucidated. Failure of the tendon has been linked to areas of decreased vascularity in the tendon and probable physical overload of the tendon. Posterior tibial tendon insufficiency commonly occurs in people whom already have a flatfoot and, therefore, are at increased risk of stress to the soft tissue structures on the medial side of the foot over time. The pain in the tendon often resolves after the tendon fails, resulting in a period of minimal pain or just weakness in the arch. Later on, with the occurrence of enough deformity, pain recurs but now occurs laterally from impingement at the level of the subtalar joint and distal tip of the fibula. Remember that ligament failure can occur at the same time, after, or, less commonly, before failure of the tendon. Patients can develop deformity at the level of the ankle, which results in the latest stage of posterior tibial insufficiency.

50.6 Classification (Staging)

- **Stage I** - No deformity from the condition is present, but there is pain over the tendon with synovitis and/or degeneration or partial tear of the tendon. A flatfoot is often present, which is the flatfoot the patient has had during his/her adult life (commonly will be symmetric to the contralateral side).
- **Stage II** - Collapse has occurred to the arch of the foot secondary to the failure of the ligaments. The deformity is flexible with the foot being able to be brought into inversion through the triple joint complex. Deformity most commonly occurs at the triple joint complex, but can occur at the other joints. Deformity to the triple joint complex produces hindfoot valgus, abduction, and sag to varying degrees creating a pronation deformity.
  - **Stage IIA** has been described with mild abduction to the midfoot, less than 40% uncoverage of the talar head on a standing AP X-ray of the foot.
  - **Stage IIB** has more than 40% uncoverage.
  - A third subclassification has been proposed to indicate the presence of forefoot varus, II\textsubscript{Ac} and II\textsubscript{Bc}.
- **Stage III** - The deformity is fixed so that passive inversion of the foot at the triple joint complex beyond neutral is not possible even with the patient under anesthesia.
- **Stage IV** - The deltoid ligament has clinically failed, producing a lateral talar tilt of the talus within the ankle mortise; deformity has, therefore, progressed to involve the ankle joint as well.

50.7 Physical Examination
If failure of the tendon is occurring, the tendon is tender most commonly between the medial malleolus and the navicular insertion. Standing alignment of the foot and ankle is checked by assessing hindfoot valgus from the standing posterior view of the foot and midfoot abduction and sag from a standing AP view (Figures 1a-b). The height of the medial longitudinal arch is also noted.

![Figure 1a. A front view showing collapse of the left midfoot. The red arrow is showing the midfoot pronation.](image1)

![Figure 1b. A hindfoot view showing left heel valgus.](image2)

It is important to confirm good passive motion of the triple joint complex in the supine position. With the hindfoot and ankle held in neutral position, also check for excessive supination deformity of the forefoot resulting in elevation of the first ray. Contracture of the gastrocsoleus complex should be assessed by placing the foot in neutral position with the deformity passively corrected and dorsiflexing the ankle and hindfoot with the knee straight. Gastroc contracture is confirmed if the ankle cannot be dorsiflexed. A contracture of the soleus is present as well if ankle dorsiflexion is not possible with the knee bent. It also should be remembered that standing hindfoot valgus could come from the ankle as well as from deformity in the triple joint complex. A standing AP X-ray of the ankle should therefore be checked.

### 50.8 Imaging
Standing lateral X-ray of the foot should be assessed for the amount of deformity at the different joints. A standing AP of the foot should be assessed at the talonavicular joint, looking for the amount of uncoverage of the talar head (Figures 2a-b). A hindfoot or tibial-calcaneal alignment view can be useful in assessing the magnitude of calcaneal valgus and in planning the medial displacement required at the site of the calcaneal osteotomy. Standing AP of the ankle should be done on patients with hindfoot valgus to rule out stage IV deformity (2c). An MRI scan is not necessary for the diagnosis, which can be made by clinical and X-ray examination. With proper technique, failure of the spring ligament can be assessed with an MRI.

Figure 2a. Stage Ila deformity

Figure 2b. Stage Ilb
50.9 Conservative Treatment

If the patient presents with a painful tendon, a boot with an internal orthotic to support the medial longitudinal arch is used to take stress off the tendon and relieve pain. Once tenderness of the tendon has mostly resolved, different supports for the foot can be used, depending on the amount of deformity.

- In patients with minimal deformity, an orthotic with a medial longitudinal arch support can be used.
- Those with more deformity can use a hinged ankle brace with an incorporated orthotic to support the medial longitudinal arch.
- For those with fixed and/or the most severe deformity, a custom leather gauntlet-type brace can support the midfoot, hindfoot, and ankle. This type of brace limits motion in the foot and the ankle, however.

Braces can be helpful in minimizing symptoms and perhaps slowing the progression of deformity. This does not mean the brace will prevent the progression of deformity.

50.10 Operative Treatment

With the failure of conservative treatment, surgery is indicated to obtain proper alignment, restore function, and treat the pain. It is important to stop progression of the deformity yet maintain good flexibility and function in the foot.

- **Stage I** - Debridement of the tendon with possible tendon repair or flexor tendon transfer is used to restore painless inversion of the foot. Debridement with tenosynovectomy with possible tendon repair or flexor tendon transfer (most commonly using the flexor digitorum longus) is considered. Some surgeons would include a medial slide calcaneal osteotomy for the heel valgus if a flatfoot is present.
Stage IIA - With failure of the tendon and deformity from PTTI, a flexor tendon transfer and a calcaneal osteotomy, most commonly of the medial slide type, are used. If the 1st ray is grossly elevated but stable, the medial cuneiform open wedge osteotomy (Cotton osteotomy) is considered. If very unstable, a 1st metatarsal-tarsal fusion is considered. Correction of the navicular cuneiform joint is not commonly done, as fusion of this joint can be difficult to achieve and often is not necessary for a good clinical result.

Stage IIB - Flexor tendon transfer and a combination of a medial slide calcaneal osteotomy, lateral column lengthening of the calcaneus, and/or spring ligament repair/reconstruction are used to correct deformity. The treatment at this stage is most controversial, with some physicians performing lateral column lengthening and others not, instead resorting to fusions or performing less correction of alignment. Lateral column lengthening does have the risk of lateral discomfort/overload. For the lesser deformities in the hindfoot (Stage IIA or early Stage IIB), some surgeons are using an arthroereisis screw as part of their treatment, possibly combining it with a medial heel slide. Fusions such as a subtalar arthrodesis significantly limit motion but can provide an acceptable result for more sedentary individuals. Whatever the treatment, the surgeon should seek to obtain good alignment and retain as much function as possible.

Stage III - Arthrodesis is performed involving the triple joint complex, most commonly a triple arthrodesis. Correction of alignment should be achieved without overcorrection. The talonavicular joint should be fused in neutral position without excessive abduction, but also without supination (varus of the midfoot and forefoot). The metatarsal heads should be even to the floor with the heel in neutral position. If the excessive heel valgus remains after fixation for triple arthrodesis, a medial heel slide is added at the same time to give good alignment and avoid excessive stress on the deltoid and progression to stage IV.

Stage IV - Little clinical follow-up of Stage IV patients is available. Flexible deformities in the foot, if present, should be corrected as described in Stage II. Correction of fixed deformity is performed as described in Stage III. Consideration for reconstruction of the deltoid ligament with tendon graft can be done and may give correction to alignment at the ankle. Correction of alignment in the foot is critical. If symptomatic ankle arthritis is present, fusion of the ankle or an ankle replacement is necessary to relieve pain. Inadequate function of the deltoid ligament after insertion of the ankle replacement can result in failure of the replacement.

In all stages, assessment of an Achilles contracture is important (described in Physical Exam). If contracted, an Achilles lengthening or gastrocnemius recession should be considered. Furthermore, instability or hypermobility of the 1st ray should also be assessed. If present, a 1st metatarsal tarsal fusion or medial cuneiform osteotomy (Cotton) should be considered.

50.11 Controversy
The treatment of Stage IIB deformity is most controversial, with some clinicians performing a lateral column lengthening for this stage and others using different procedures. The precise amount of abduction requiring a lateral column lengthening has not been established in a controlled study. Alternatives to and different types of lateral column procedures are being explored, as are more precise guidelines for judging the amount of lengthening required. More precise guidelines for when a metatarsal-tarsal fusion and medial-cuneiform open wedge osteotomy are also needed.

Comparative studies to establish the necessity of each procedure when multiple procedures are performed are difficult as there are multiple variables, including the amount of deformity, the locations of the deformity, and multiple procedures performed in each foot. It is important to correct, but not over correct, the deformity. Achieving a well-aligned foot, without excessive stiffness, is a fundamental goal.

50.12 References