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Surgical Considerations: Repair of Long Segment Defect Posterior Tibial Tendon Using Fresh Frozen Tibial Tendon Allograft

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ABSTRACT

Tibialis posterior (TP) tendon ruptures are common after ankle injuries, degenerative processes, or biomechanical instability. The TP tendon decelerates the subtalar joint pronation and internal rotation of the leg during the contact phase. It also plantarflexes and inverts the foot on the leg during the static phase of gait. When this function is lost, the medial longitudinal arch collapses, increasing the length of time of rearfoot pronation, eventually rupturing the TP tendon. Conservative treatment includes immobilization, strapping, antiinflammatories, custom-fabricated orthotics, and physical therapy. If the TP tendon rupture is severe, conservative treatment will provide little relief and surgery is indicated. This case study presents 53-year-old female who presented with left TP tendon rupture with a defect of 6 cm after sustaining an ankle injury that was surgically repaired using a TP tendon fresh frozen allograft and flexor digitorum longus tenodesis. After a 16-month follow-up, the patient was healed without complications and returned to preinjury activity. We believe that surgically repairing a TP tendon rupture with a TP tendon allograft and flexor digitorum longus tenodesis can be 1 of the treatment options for patients with extensive disruption of the TP tendon.

The tibialis posterior (TP) tendon muscle originates on the tibia, interosseous membrane, and fibula. The TP runs distally in the posterior compartment between the flexor digitorum longus and the flexor hallucis longus until it reaches the medial malleolus. At the medial malleolus, there is an almost 90° change of direction as the TP turns underneath (1). The TP inserts into the navicular tuberosity; all tarsal bones with exception of the talus; and the second, third, and fourth metatarsals. Branches of the posterior tibial (PT) artery supply the tendon distally, resulting in a watershed area of poor intrinsic blood supply between the navicular and distal medial malleolus approximately 2 to 6 cm proximal to navicular insertion. This watershed area is the most common area of TP injury.

The TP functions as a pulley to dynamically stabilize the medial longitudinal arch, plantarflex the ankle, and supinate the foot through the subtalar joint. A loss of PT tendon function creates a mechanical overpull from the peroneus brevis tendon, forcing the hindfoot into the valgus position. Spring ligament and deltoid ligament attenuation results in talus plantarflexing and adducting, unlocking the midtarsal joint and causing more instability (2).

Weakness and dysfunction of the TP presents with pain along the tendon, swelling near the medial malleolus, and partial or complete loss of medial arch height (3). Further activity with these symptoms results in partial or complete rupture of the PT. Acute rupture of PT tendon can occur; however, it is uncommon in an emergent setting without an ankle fracture (3). Degeneration and lengthening will result in remarkable loss of function and strength.

Conservative treatment for a partial or complete rupture of the PT tendon includes weight loss, physical therapy, bracing, orthotics, custom-molded ankle orthotics, and activity modifications (2). Surgical repair of a partial or completely ruptured PT tendon includes PT tendon debridement and synovectomy, flexor digitorum longus transfer, use of PT tendon allograft, or use of tendon autograft from the Achilles tendon.

In this case, we present a complete rupture of the PT tendon approximately 6 cm in length in a 53-year-old female and the treatment plan after 16-month follow-up proved successful in allowing her to return to preinjury function.

Case Study

A 53-year-old female presented to the podiatry office in September 2015 with pain in her left foot. Her medical history consisted of hypercholesterolemia; her surgical history consisted of lumbar fusion. The patient denied a history of smoking, alcohol, or substance use. The patient reported that she had arch pain for 6 months after an initial

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injury of inversion ankle sprain. The patient had pain and instability of her left foot, causing pain on ambulation. Before her presentation, she had seen a podiatrist after the injury occurred and had 2 cortisone shots in the medial ankle, which temporarily relieved the pain. The patient also presented with a magnetic resonance imaging report stating that the TP tendon rupture from medial malleolus to the navicular with the distal tendon remnant appreciated (Fig. 1). Initial physical examination noted collapsing pes valgo planus deformity of the left foot with complete loss of medial longitudinal arch and an everted heel (Fig. 2). The patient was unable to rise on her toes with her left foot. A palpable defect was noted from the tibial malleolus to the navicular, signifying a TP rupture. The gap in the tendon was approximately 4 cm. Gait examination revealed an antalgic gait. Radiographs were taken and revealed degenerative osteoarthritis at the first metatarsophalangeal joint, with no acute fracture of dislocation and severe pronation of the left foot with excessive plantar flexion of the talus (Fig. 3). Initially, the patient was placed in a strap of the foot and ankle with a prescription for physical therapy to reduce pain and inflammation. At her follow-up visit, however, the patient had no resolution of pain and was agreeable to surgical intervention.

The patient was medically cleared for application of a TP tendon allograft with flexor digitorum longus tendon transfer. Intraoperatively, there was a loss of the TP tendon; an incision was made along the course of the TP tendon and an area approximately 4 cm proximal to the medial malleolus to an area of the navicular tuberosity (Fig. 4). The distal tendon was identified at the level of the navicular, and the proximal tendon identified an area approximately 2 cm proximal to the medial malleolus. There was an approximate 6-cm tendon length loss (Fig. 5). A PT tendon fresh frozen allograft was used to bridge the tendon gap (Fig. 6). It was believed that because of the functional demands of the tendon, this would be the best course to bridge this gap. The donor PT tendon was normal without defect; a segment of the allograft was chosen and sharply incised at a level of 6 cm. A Bunnell-type technique both distally and proximally was used on the allograft tendon, as well as distally and proximally on the autogenous tendon in the area of rupture. The arms of the Bunnell anastomosis were separately tied, and

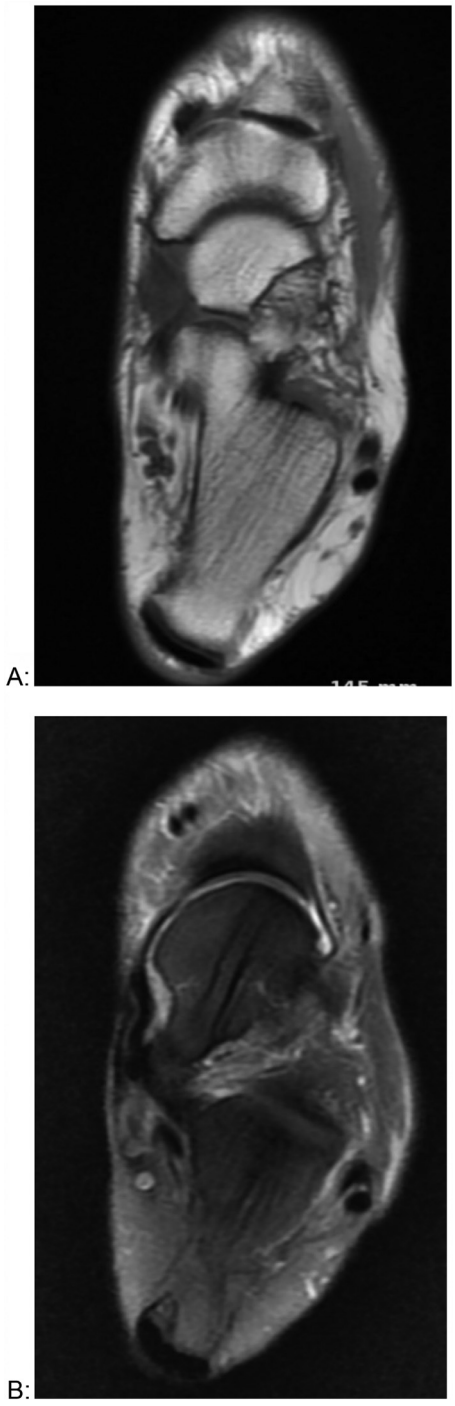

Fig. 1. Magnetic resonance images of the left foot. Axial T1 (*A*) and axial fat-suppressed (*B*) images showing absence of the posterior tibial tendon from the level of the distal tibia to the medial tubercle of the navicular, compatible with a complete tear.

Fig. 2. Initial clinical presentation noting collapsing pes valgo planus deformity of the left foot (*A*) with complete loss of the medial longitudinal arch and an everted heel (*B*).

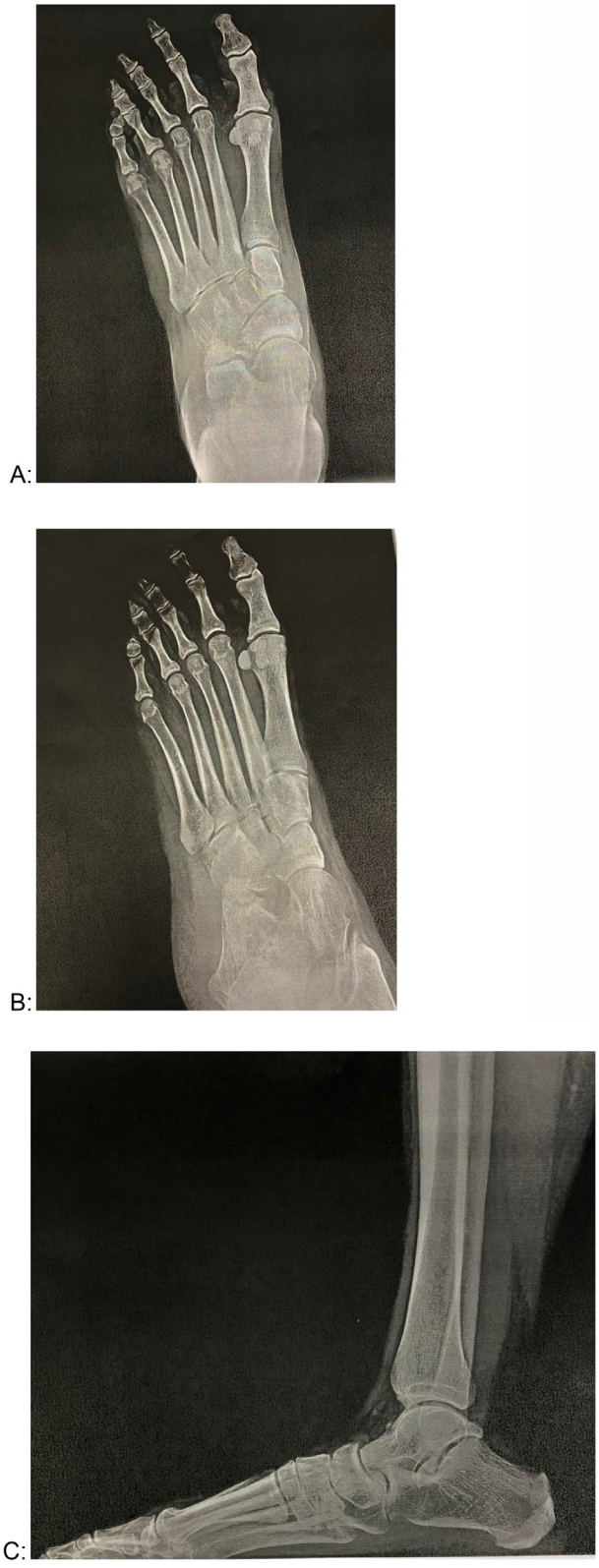

Fig. 3. Radiographic images of the left foot. Dorsoplantar (*A*), medial oblique, (*B*) and lateral (*C*) views revealing degenerative osteoarthritis at the first metatarsophalangeal joint. No acute fracture or dislocation was identified. There is severe pronation of the foot.

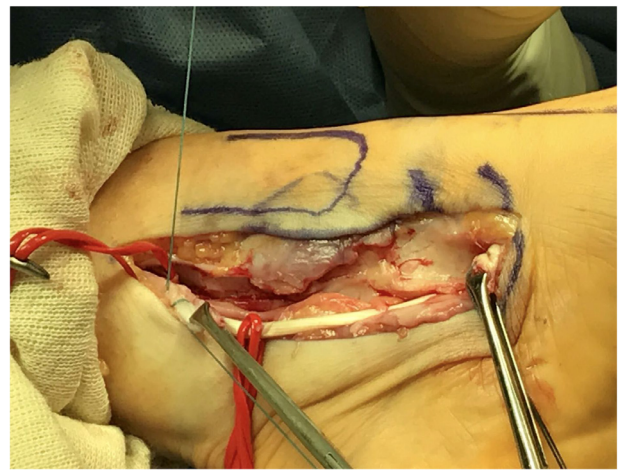

Fig. 4. Intraoperative image noting loss of the tibialis posterior tendon along the incision made along the course of the tibialis posterior tendon and area approximately 4 cm proximal to the medial malleolus to an area of the navicular tuberosity.

Fig. 5. Intraoperative image noting approximately 6 cm length of tendon loss.

there was good apposition of the tendon both distally and proximally. Appropriate tension was placed on the TP tendon (Fig. 7). The flexor digitorum longus tendon was anastomosed to the TP tendon (Fig. 8). It was believed that this tendon apposition would help in revascularizing the allograft. The patient was placed in a short leg synthetic cast, and the foot and ankle were maintained in a neutral position.

Two weeks postoperatively, the patient presented with improving foot and ankle pain, no calf pain, and no signs of infection. On physical examination, she had one fifth muscle strength of the TP tendon. The short leg cast with the foot and ankle in neutral position was continued until postoperative week 5. At postoperative week 5, the patient admitted no pain and was given a controlled ankle movement walker and prescription for physical therapy to perform passive and active exercises twice per week. At week 7 postoperatively, the muscle strength of TP tendon was four fifths, with good gliding motion of the tendon. The patient was instructed to continue physical therapy and begin weightbearing with crutches. At week 9, the patient was allowed to

Fig. 6. A posterior tibial tendon fresh frozen allograft was used to bridge the tendon gap.

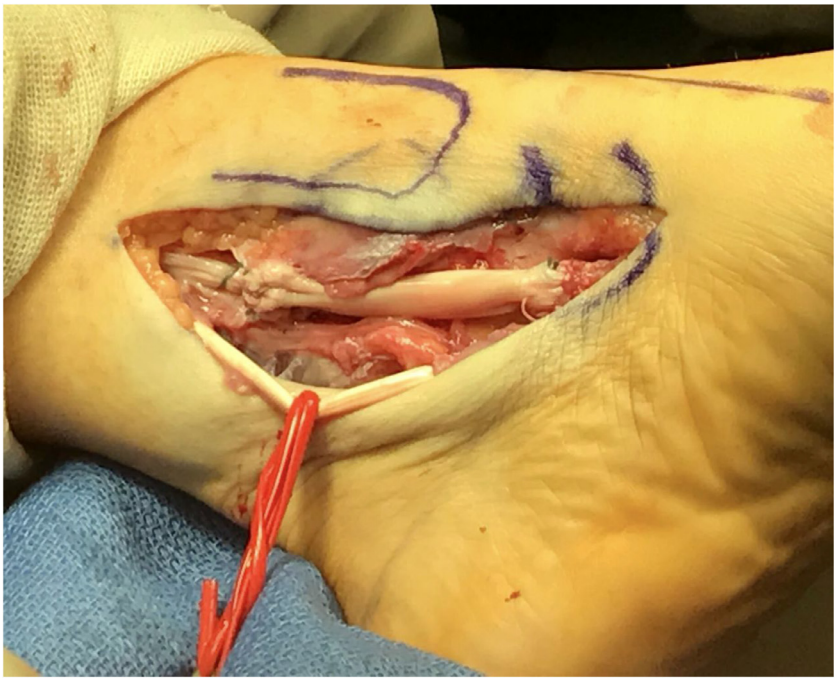

Fig. 7. Intraoperative image showing that a Bunnell-type technique both distally and proximally was used on the allograft tendon as well as distally and proximally on the autogenous tendon in the area of rupture.

begin full weightbearing and continue physical therapy. At week 13, she was able to return to work and wear dress shoes with custom-fabricated orthotics. Clinical pictures were taken to show the increase in arch height from her preoperative presentation, and a video was taken to illustrate normal range of motion without pain with adequate function of the PT tendon (Fig. 9). Radiographs were taken, revealing degenerative osteoarthritis at the first metatarsophalangeal joint with no acute fracture of dislocation and resolved hindfoot alignment without plantarflexion of the talus (Fig. 10). An ultrasound was taken using a linear probe to examine the TP tendon; it showed that the TP tendon and flexor digitorum longus exhibited good gliding function without crepitation and normal echoes from their musculotendinous origins to their insertions. Range of motion was noted to be normal and gliding without crepitation (Fig. 11). At the 16-month follow-up visit, the patient returned to preinjury activities and began to jump rope without pain or complications.

Discussion

For a patient who sustains an acute injury to the TP tendon, early recognition is important to prevent deformity and need for surgery; however, when injuries are severe, as in this case, and the TP tendon retracts a significant amount, there are very few conservative options to use. Patients may complain of pain and swelling around the medial

Fig. 8. Intraoperative image showing the flexor digitorum longus tendon anastomosed to the tibialis posterior tendon.

Fig. 9. (*A*, *B*) Postoperative week 13 clinical presentation noting normal medial arch height of the left foot with a less everted heel. (*C*) Normal range of motion with adequate inversion and plantarflexion of the posterior tibial tendon.

malleolus with tenderness along the course of the tendon. There is usually difficulty in performing a single heel raise, or, if there is a collapse of the medial longitudinal arch, "too many toes" can be seen (4).

In the early stages of TP tendon injury, radiographs are usually normal when taken non-weightbearing (5); however, when taken weightbearing, the medial longitudinal arch is usually decreased in height. An ultrasound can be used to give a quick diagnosis, but a magnetic resonance image is more useful in advanced stages (6).

The standard of care for early surgical intervention to pedal tendon ruptures is usually performed by simple end-to-end suturing for small defects. For example, Miyazaki et al (7) report that for ruptures to the tibialis anterior muscle, they surgically repair by end-to-end suturing or Z-lengthening with side-to-side anastomosis. If extensive damage is done to the tendon, however, repair techniques include flaps, autografts, allografts, and fresh frozen allografts for larger defects. Studies have shown that dry allografts have smaller tensile strength before transplantation and diminish after transplantation compared with freeze-dried tendon allografts (8); therefore, freeze-dried allograft tendon is an optimal replacement for dry allograft tendon.

Allografts show smaller tensile strength and tangent modulus before transplantation; however, their inferiority in material properties diminish over time after transplantation. Freeze-dried tendon allografts sterilized by gamma irradiation could be a suitable replacement for fresh frozen grafts if care is taken to protect the grafts in the early stages following implantation.

Allograft reconstruction is a new idea compared with simple tenodesis or radical flatfoot reconstructive procedures. Surgeons fear the possibility of graft failure, especially in the case presented, in which the graft needed suture security and vascularity at the distal and proximal segments of the TP tendon. Pellegrini et al (9) examined the effectiveness of allograft reconstruction and tenodesis for peroneal brevis tears. Their study showed that tenodesis was ineffective for restoration of peroneus brevis function and that allograft reconstruction restored distal tension under physiologic loads (9). This concept can be used for TP allograft reconstruction.

TP allograft tendons have been used in ligament reconstruction of the knee (10). Palmer et al (10) compared allograft tendons for ligament

Fig. 10. Postoperative radiographic images of the left foot. Dorsoplantar (*A*), medial oblique (*B*), and lateral (*C*) views revealing degenerative osteoarthritis at the first metatarsophalangeal joint. No acute fracture or dislocation was identified. There is resolved hind foot pronation.

reconstruction of the knee and found that TP tendons exhibited sufficient biomechanical strength and stiffness. TP tendon allograft healing takes approximately 4 weeks in a healthy patient.

In conclusion, there are limited case reports published in the literature that demonstrate the use of an allograft tendon for TP tendon ruptures.

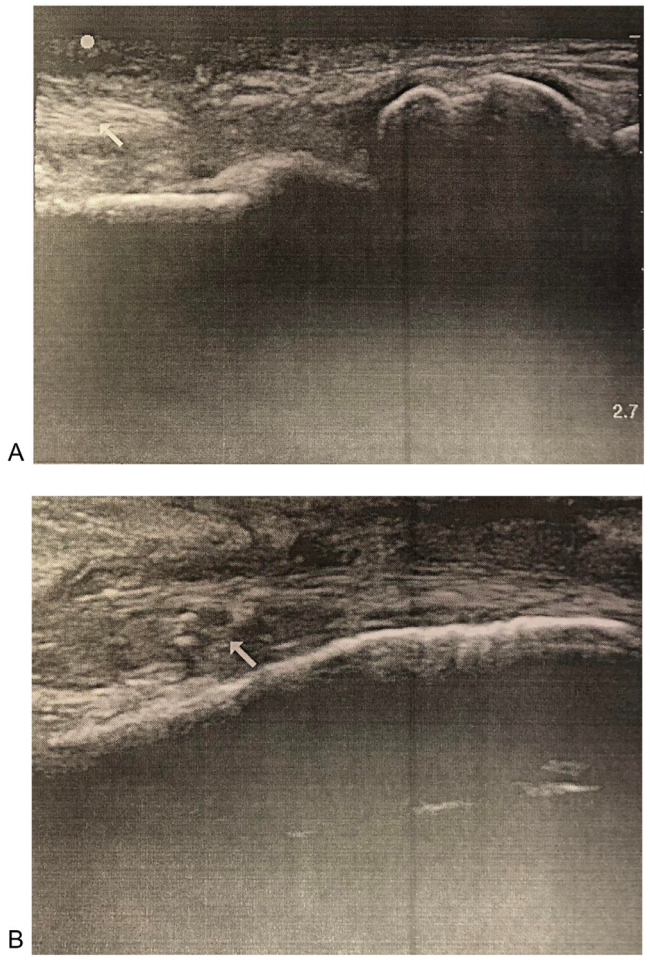

Fig. 11. Ultrasound images of the left foot and ankle. Subcutaneous tissue shows normal echoes, and there is no evidence of a foreign body. The posterior tibial tendon and flexor digitorum longus exhibit good gliding function without crepitation and exhibit normal echoes. Edema is noted within the tendon sheath. Range of motion was noted to be normal and gliding without crepitation. (*A*) Posterior tibial tendon at the navicular with the graft site intact. (*B*) Incorporation of the tendon-graft junction.

This case study is designed to assist in diagnosis and treatment for severe TP ruptures that are unable to be resolved with conservative treatment. The present patient had a frank rupture of the left TP tendon of approximately 6 cm. Because of the severity of the TP tendon retraction, the use of an allograft tendon was indicated. Anastomosis of the flexor digitorum longus was performed to help revascularize the allograft. Using an identical allograft tendon of similar size allows for more appropriate reconstruction, tendon assimilation, and return to physiologic function. In this case, a fresh frozen donor tissue was preferred because it was similar to the tissue lost that must be repaired. The patient showed satisfactory recovery of TP tendon function after the use of allograft tendon insertion. With the help of physical therapy, at 16 months postoperatively, the patient healed unremarkably with full recovery of daily function.

Supplementary Materials

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1053/j.jfas.2018.12.029.

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