

# 8 Rearfoot Surgery

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## **Anterior Transfer of Tibialis Posterior Tendon for Treating Drop Foot: Technique of Enforcing Tendon Implantation to Improve Success Rate**

Wu CC, Tai CL

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*Introduction*—Foot drop is a gait abnormality where the forefoot weakness, irritation, or damage to the common fibular nerve, causes a loss of function of the anterior leg muscles. The foot is unable to lift the front part off the ground. Foot drop is not an uncommon disorder. The current surgical treatment for drop foot is to replace the dorsiflexion function of the tibialis anterior (TA) tendon by performing an anterior transfer of the tibialis posterior tendon (TP). Although there are a number of techniques, no one technique is proven to be better than another. This study provides a powerful technique for the treatment of foot drop. It was predicted that an anterior transfer of the TP tendon with bony attachment may increase the success rate of transfer and may be a better treatment option for foot drop.

*Methods*—Between 2001 to 2011, 37 consecutive adults with drop foot were treated with bone-to-bone TP tendon transfer. All patients were started with non-surgical treatment. Then, they requested surgical option after the long-term use of orthotic was intolerable. Four surgical indications were used for this technique: 1) complete loss of dorsiflexion of tibialis anterior tendon for more than one year, 2) intact bone and cartilage structures in ankle, 3) full motor function of the TP tendon, and 4) intolerable to non-surgical treatment.

The surgical procedure is as follows: 1) The TP tendon with a small bony attachment was obtained from the navicular; 2) The TP is transferred through a tunnel of interosseous membrane; 3) The navicular attachment was implanted in the tunnel of navicular or intermediate cuneiform; 4) The bony attachment is pulled through the tunnel and tightened, while the ankle is kept in mild dorsiflexion; 5) Cancellous bone graft procedures from the distal tibial metaphysis was packed into the tunnel opening to completely seal the tunnel; 6) The wound is closed with absorbable sutures and lastly, an ankle foot orthosis is applied.

*Results*—Thirty-one patients were followed for a mean of 2.8 years and all achieved satisfactory outcomes for the ankle. Six patients were lost to follow-up. All 31 patients achieved a normal gait after one year. At the one year mark, all 31 patients could perform ankle dorsiflexion actively beyond the neutral position. Eight patients required lengthening of the Achilles tendon along with the TP tendon anterior transfer. At the last follow-up all 31 patients achieved satisfactory outcomes (100%,  $p < 0.001$ ).

*Conclusion*—The proper treatment of drop foot involves carefully examining the pathology and etiology before treatment is initiated. This study used a side-to-side tendon suturing between the tibialis posterior tendon and tibialis anterior tendon. The technique used provides high success rate, it is simple and complications are minimal. All patients achieved active dorsiflexion ability of the ankle beyond 3° of dorsiflexion (mean, 5°; range, 3°-10°), and no limps were observed at the latest follow-up. Anterior transfer of the TP tendon to replace the dorsiflexion function of the tibialis anterior or tendon is only one of the common treatment methods, and unfavorable conditions must be excluded.—*D. Darji*

◆ It is important to remember that with a tendon transfer there will be at least a one grade decrease in muscle power. Your pre-operative examination becomes vitally important before the decision to transfer a tendon is made. An anterior transfer of the tibialis posterior tendon is an excellent adjunct in the reconstruction of a foot with drop foot deformity. This technique describes harvesting a bony attachment from the navicular along with the tendon and then implanting this tunnel in to the intermediate cuneiform. This is a secondary option to using anchors or interference screws.—*L. A. DiDomenico, D.P.M.; D. Butto, D.P.M.*

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**Rehabilitation Regimen After Surgical Treatment of Acute Achilles Tendon Rupture: A Systematic Review with Meta-Analysis**

Huang J, Wang C, Ma X, Wang X, Zhang C, Chen L  
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*Introduction*—Despite its size and strength, the Achilles tendon is often susceptible to rupture. Previous research suggests early surgical treatment may decrease the risk of rerupture. Newer research however, suggests nonsurgical intervention for patients at functional rehabilitation centers will attain the same decreased risk of rerupture, but will have the added benefit of no surgical complications. In the 1980s, Achilles rupture treatment often involved cast immobilization. Meta-analysis studies of the past have tried to compare the

best treatment course following rupture, however, they have been limited in the subjects and treatments analyzed. This study will look to provide an even greater comparison between early functional rehabilitation and cast immobilization based on current evidence-while also providing a subgroup analysis on various early functional regimens.

*Methods*—A systematic retrieval of previous studies were collected with the use of OVID, Medline, Embase, and the Cochrane Central Register of Controlled Trials. The quality of the studies was assessed by independent authors. Criteria for inclusion included adults older than 18, randomized controlled trials, patients with operative Achilles management within 7 days of rupture, a control group that is immobilized for at least 4 weeks following surgical intervention, and an experimental group with a functional rehabilitation program within 2 weeks of post-operative management. Nine studies were eligible for review. Data was extracted and subgroup analysis were performed on these studies.

*Results*—Analysis showed that patients with both early weightbearing and ankle motion exercises performed much better in comparison to patients with cast immobilization. The cohort with early weightbearing and ankle motion exercises show a subjective satisfaction rate of 93.6% (compared to 77.5% for the immobilization cohort), as well as similar rates of rerupture and complications. Patients with only early ankle motion exercises without weightbearing showed no significant difference in rerupture rate or complications compared to cast immobilization. However, only 2 out of 14 functional groups supported only early ankle motion exercises to be superior to cast immobilization.

*Conclusion*—Meta-analysis of data from 9 studies have supported early post-operative weightbearing with early ankle motion exercises to be an effective and superior treatment modality, in comparison to only early ankle motion exercises without weightbearing or cast immobilization. In addition, studies have shown early ankle motion exercise without weightbearing provides little to no advantages over cast immobilization.—*V. Desai*

◆ Much of the literature focuses on Achilles tendon ruptures and their methods of fixation versus treatment conservatively. It still holds true that surgical therapy provides a lower risk of rerupture than conservative treatment. Historically, patients were kept non-weightbearing for an extended period of time following surgical reconstruction. This meta-analysis found the rerupture rate was not significantly different with early functional rehabilitation versus prolong immobilization. Moreover, early rehabilitation lead to better subjective responses, a lower post-operative complication rate, and a more rapid recovery. Early weightbearing should be considered in patient post-surgical repair when deemed appropriate by the surgeon.—*L. A. DiDomenico, D.P.M., D. Butto, D.P.M.*

**Long-term Follow-up of Flexor Digitorum Longus Transfer and Calcaneal Osteotomy for Stage II Posterior Tibial Tendon Dysfunction**

Chadwick C, Whitehouse SL, Saxby TS

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*Introduction*—Acquired adult flat-foot deformity, is a progressive disorder of the posterior tibialis tendon that results in foot and ankle pain, and instability. The posterior tibial tendon serves to elevate the medial arch, invert the foot, and stabilize the ankle during ambulation. There are three stages of posterior tibialis tendon dysfunction as defined by Johnson and Strom, the second stage is characterized by marked weakness on single heel rise test, pain and swelling along the tendon, and a positive toe many toes sign. Typical treatment for stage II acquired adult flat-foot deformity is a flexor digitorum longus tendon transfer and a calcaneal osteotomy, and while the procedure reports excellent results at three to five years, there is little data to show longer term results. This study takes a closer look at the longevity of the procedure, and patient functional outcomes.

*Method*—A retrospective study was done on 48 patients with stage II posterior tibial tendon dysfunction who were treated with a flexor digitorum longus tendon transfer and calcaneal osteotomy. The patients were assessed using the American Orthopedic Foot and Ankle Society hindfoot/ankle score, a visual analogue score of 1-10, with 10 being the worst, and the short form 36 questionnaire.

*Results*—The study ended up with 31 patients available for participation. Failure was defined as recurrent pain or loss of function, and there were four patients who were classified as procedural failures. Mean functionality was overall significantly improved over preoperative function in 27 of the 31 patients, and all 27 of the patients were completely satisfied with the procedure and results. More than 85% of patients were pain free at the follow up.

*Discussion*—The flexor digitorum longus tendon transfer, with calcaneal osteotomy has shown to improve patient outcomes from acquired adult flat-foot deformity. The procedure demonstrates excellent postoperative pain relief and functionality in over 85% of the patients sampled at a mean of 15 years post procedure. The procedure demonstrates satisfactory treatment for stage II of posterior tibial tendon dysfunction.—*R. Cocks*

◆ This study demonstrated long term pain relief and improved function in >85% of patients who underwent a FDL tendon transfer and calcaneal osteotomy with a minimum of 11 years follow-up. These results demonstrate that the combination of the two procedures remains a viable option in correction of a stage II flat foot with posterior tibial tendon dysfunction and a valgus heel. The surgeon must carefully

assess the flat foot preoperatively before choosing procedures to correct the flatfoot. If there is fault in the medial column or a transverse plane deformity, this combination alone will not fully address the pathology.—L. A. DiDomenico, D.P.M., D. Butto, D.P.M.

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### **Ankle Joint Contact Loads and Displacement with Progressive Syndesmotiic Injury**

Hunt KJ, Goeb Y, Behn AW, Criswell B, Chou L  
*Foot Ankle Int.* 2015 Sep;36(9):1095-1103.

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*Introduction*—Despite a lower occurrence rate, ankle syndesmotiic injuries are more predictive of residual symptoms and long-term ankle dysfunction than other ankle injuries. The distal tibiofibular syndesmosis is comprised of 5 structures, which have a progressive pattern of failure with increasing force of external rotation (ER).

*Methods*—Eight below-knee cadaver specimens with intact tibiae and fibulae were used to analyze the effect of syndesmotiic injury on contact pressure and contact area during axial loading (AL) alone, and AL with ER. Skin around the ankle was removed, and several tendons were resected to provide visualization of the ankle joint and access for insertion of pressure sensors. An intramedullary rod was inserted through the tibial plateau into the shaft of the tibia and secured with transverse screws. The foot was fastened to a block with approximately 7 degrees of pronation of the forefoot. Axial and rotational forces were then applied to the leg by way of the intramedullary rod. After a period of preconditioning, the legs were loaded with 700 N (approx. average body weight) of axial compression followed by 20 N\*m of ER (approx. ER torsional forces during athletic activities). A total of 6 test conditions were used on each limb to examine the progressive nature of these injuries including: 1. intact state, and sequential sectioning of; 2. Anterior Inferior Tibiofibular Ligament; 3. Anterior Deltoid Ligament; 4. Interosseous/Transverse Ligaments; 5. Posterior Inferior Tibiofibular Ligament, and; 6. Whole Deltoid Ligament.

*Results*—When comparing AL+ER to AL alone, significant amount of ER of the fibula and talus relative to the tibia was recorded for each test condition relative to the intact condition. Anterior displacement of the fibula also increased with ER, but anterior-posterior talar motion was less than 1.5 mm for all conditions. There was a small amount of medial displacement of both fibula and talus, but no lateral movement. In AL the pressure on the joint was focused in the center, but with ER pressure shifted to two pressure points at the anteromedial and posterolateral margins of the joint with increased pressure and decreased contact area.

*Discussion*—Increases in contact pressure, and changes to points of articulation during ER with AL after a syndesmotic injury may lead to increased risk of osteochondral lesions, osteoarthritis, or long term dysfunction in the ankle. Restricting ER with AL during rehabilitation may reduce these risks and promote faster healing for these kinds of patients.—*S. Pickett*

◆ The distal tibiofibular syndesmosis is stabilized by 5 ligaments. Injuries to this complex most commonly result from an external rotation injury to the foot in relation to the tibia. It was found that there was a significant increase in tibiotalar contact pressures with increasing severity of injury to the ligaments. The syndesmosis is essential for protecting the ankle joint from injury. It is important for the physician to carefully examine the syndesmosis when evaluating patients who have sustained an external rotation injury, as this injury can be easily overlooked and detrimental long term if missed.—*L. A. DiDomenico, D.P.M., D. Butto, D.P.M.*

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**Mid- to Long-term Outcome of 96 Corrective Hindfoot Fusions in 84 Patients with Rigid Flatfoot Deformity**

Röhm J, Zwicky L, Horn Lang T, Salentiny Y, Hintermann B, Knupp M  
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*Introduction*—Triple arthrodesis is a common procedure used to treat rigid hindfoot deformity in patients with dysfunction of the posterior tibial tendon (PTT). The modified talonavicular and subtalar joint fusion through a medial incision has increased in popularity to treat the rigid flatfoot deformity. This study was designed to determine the clinical outcomes and rate of recurrence of talonavicular and subtalar fusion through a single medial incision through both clinical and radiographic progression.

*Methods*—Between June 2005 and July 2011, 96 consecutive modified triple arthrodeses were performed in 84 patients (mean age of 66) to treat symptomatic rigid flatfoot caused by posterior tibial tendon dysfunction. The average follow-up of each patient was 4.7 years. Both clinical and radiographic outcomes were used to determine the retrospective outcomes of individual patients. Pre- and post-operative radiological assessment, included a weight bearing anteroposterior view of the ankle joint and a lateral radiograph of the entire foot. Clinical assessment used the Ankle Hindfoot Score of the American Orthopedic Foot and Ankle Society and the Foot and Ankle Outcome Score.

*Results*—Radiological examination showed consistent correction in 86 (90.5%) feet at final follow-up. Loss of correction in the adjacent joints was seen in nine (9.5%) feet. Three patients had some valgus tilt in the ankle joint despite

good correction on the lateral view. AVN was present in three feet and proved to be the most serious outcome. Another three showed secondary loss of correction in the angle between the talus and the first metatarsal. Non-union was present in 11 (11.6%) feet. 5 feet were asymptomatic and 6 needed revision. Patient satisfaction was very good in 31% (24 feet); good in 35% (27 feet); moderate in 18% (14 feet); and bad in 16% (13 feet) of the cases. The mean AOFAS score at final follow-up was 67 points, the mean VAS for pain was 2.4, and the mean FAOS pain subscale was 72.66.

*Discussion*—The results of this study support the modified triple arthrodesis as a reliable tool for the correction of the rigid flatfoot due to posterior tibial tendon dysfunction. The modified procedure provides good clinical and radiographic outcome in mid- to long-term follow-up. A major issue with dysfunction of the PTT is that it may eventually affect all the peri-talar joints and those of the medial column of the foot, therefore patients may continue with progression of the deformity.—*M. Liette*

◆ The medial double arthrodesis (subtalar and talo-navicular joint) has become increasingly popular over the standard triple arthrodesis. This is a common procedure utilized in rigid flatfoot deformities. This study demonstrated reliable correction with good clinical outcome. As with the triple, the medial double is not without complications. Non-union is still the most frequent complication with both procedures. Attention to good joint preparation and stable fixation intra-operatively is key. The medial incision to approach the subtalar joint does exposed the deltoid ligaments of the ankle. One must be conscious of this as ankle valgus tilt post-operatively is a complication seen with the medial double approach.—*L. A. DiDomenico, D.P.M., D. Butto, D.P.M.*

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### **Injury to the Posterior Tibial Tendon After Open Reduction Internal Fixation of the Medial Malleolus**

DeMill SL, Bussewitz BW, Philbin TM  
*Foot Ankle Spec.* 2015 Oct;8(5):360-363.

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*Introduction*—Open reduction and internal fixation (ORIF) have been a proven method to help prevent deformity and post-traumatic arthritis of ankle fractures. The goal of this study was to determine if the starting point for medial malleolus screw placement is associated with posterior tibial tendon anatomically reduce the fracture fragments, the next method would be to do open reduction and internal fixation. ORIF offers significantly better outcomes than casting with immobilization. This present study is a follow-up to a

previous study that demonstrated that a screw placed in the posterior zone of the malleoli results in the PTT being at significant risk for injury.

*Methods*—Inclusion criteria for this retrospective review consisted of patients having ORIF of the medial malleolus for fracture and during follow-up developed pain at the area of the medial ankle. As a result, these patients required medial malleolar hardware removal and PTT repair. 5 males and 10 females were included in the study with an average age of 48.2 years at the time of hardware removal and PTT repair. Nine of the 15 patients' initial injury was a bimalleolar ankle fracture. Eight were nonsmokers and twelve were nondiabetic. The time between ORIF and hardware removal/PTT repair averaged 71 weeks. A template was used to evaluate the lateral radiographs and zones 1, 2, and 3 were established to analyze the position of the medial malleolus screws. Zone assignments were based on the location of only the screw head.

*Results*—15 patients with 27 total screws in the medial malleolus were examined. 15 screws were found in zone 1, 11 in zone 2, and 1 in zone 3. The location of the most posterior screw was also examined by assuming that damage to the PTT occurs because of the most posterior screw when multiple screws are present. Of the posteriorly placed screws in the 15 patients, three were found in zone 1, eleven were found in zone 2, and only one was found in zone 3. 12 of the 15 posterior screws (80%) were found in zones 2 and 3. Analysis of all PTTs of the 15 patients demonstrated some pathology near the medial malleolus including split tears, degeneration, or synovitis.

*Discussion*—The incidence of continued pain due to retained hardware after ORIF of ankle fractures has been documented. In the older population, microvascular and macrovascular complications were more commonly associated with the patients' comorbidities. 12 of the 27 total screws were in zones 2 and 3; therefore, potentially causing risk to the PTT. The screw placement in zones 2 and 3 increased the probability of PTT contact and damage. The limitations to this study are that this was a small retrospective case series, only symptomatic patients were included, and precise positions of the medial malleolus were difficult to achieve on lateral X-ray. Direct visualization of zone 2 and 3 screws may evidently be helpful in preventing injury to the posterior tibial tendon during insertion.

—S. Bateh

◆ Fixation of medial malleolar fractures is often done percutaneously with guide wires and screws. Due to the course of the posterior tibial tendon, there is risk for damage when fixating the fracture fragment. The medial malleolus is divided in to 3 zones- zone 1 in the anterior 1/3 of the medial malleolus, zone 2 central and zone 3 in the posterior 1/3. A majority of the screws that were found to cause injury to

the posterior tibial tendon were found in zones 2 and 3. The surgeon should be mindful of screw placement and consider the course of the posterior tibial tendon during fixation to avoid potential risk to the posterior tibial tendon. If screws need to be placed in zones 2 and 3 based on fracture pattern, one may consider direct visualization over percutaneous placement.—*L. A. DiDomenico, D.P.M., D. Butto, D.P.M.*

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**Irreducible Fracture-Dislocation of the Ankle Associated with Interposition of the Tibialis Posterior Tendon in the Syndesmosis: A Case Report**

Lacasse JS, Laflamme M, Penner MJ  
*J Foot Ankle Surg.* 2015 Sep-Oct;54(5):962-966.

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Uncommon, and the most important cause of disability after ankle fractures, is the failure to achieve anatomic reduction. This case exams a very rare cause of irreducible ankle fractures in a 17-year-old male, tibialis posterior interposition in the tibiofibular syndesmosis. The persistent symptoms were hallux interphalangeal joint contracture, and fibular and talar persistent anterior subluxation. After multiple surgeries for failure of reduction post-ankle fracture, magnetic resonance imaging was used to identify the tibialis posterior (TP) tendon had become interposed within the tibiofibular syndesmosis posterior medially near to and hooking under the posterior malleolus. The TP tendon remained extra synovial, leading to the inability of the talus to achieve sufficient posterior reduction and resulting in the patient's persistent anterior fibular and talar subluxations. Additionally, the displaced TP tendon was pulled tightly over the flexor hallucis longus (FHL) tendon, pulling and tethering it resulting in the interphalangeal hallux joint contracture noted clinically. After the cause was identified, the tibiofibular and tibiotalar joints were sufficiently reduced, and the patient was able to return to a normal activity.—*J. P. Carolin*

◆ The inability to close reduce an ankle fracture dislocation requires immediate surgery in order to achieve reduction to prevent compromise to the soft tissue. Often times, there is entrapment causing the inability to reduce the fracture. When a surgeon cannot fully reduce the fracture intra-operatively consideration should be given to tendon entrapment. If post-operatively the fracture re-dislocates, the overall fixation should be assessed. If deemed adequate, a MRI can be helpful to evaluate for tendon entrapment.—*L. A. DiDomenico, D.P.M. D. Butto, D.P.M.*

**QUESTIONS**

- 8-1. According to the article by Wu, et. al, a common cause of drop foot is:
- A. Sural nerve injury
  - B. Tibial nerve injury
  - C. Peroneal nerve injury
  - D. Plantar nerve injury
- 8-2. In the study by DeMill, et. al, a majority of the screws were found placed in zone:
- A. 1
  - B. 2
  - C. 3
  - D. No difference