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Research Article

Re-routing the Posterior Tibial Tendon and Transfer to Dorsal-Lateral Foot: Treatment for Post-Spinal Surgery Patients with Adult Acquired Cavo-Varus Foot with Out of Phase Tendon Transfer (Modified Putti Procedure)

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Abstract

Background: CavoVarus-Drop Foot type deformity can preclude patients from functioning in or attempting bracing. This can be further complicated by patients hesitant to undergo further spinal surgery, those that had damage after spinal surgery and especially those that had damage prior to spinal surgery but were still left with a deformity and loss of function to the lower leg, looking for other options. Many CavoVarus-Drop Foot patients still have gait abnormalities, cannot function in a brace, and experience secondary ambulatory pain and loss of function even when bracing. We review the results of 8 patients having these criteria and electing for a Modified Putti procedure and lower extremity reconstruction.

Materials and Methods: Eight patients with a symptomatic adult-acquired cavovarus foot type present prior to or after (iatrogenically-induced or due to neglect) spinal surgery were surgically corrected.

Results: The mean VAS score was 8.3 preoperatively and 1.3 postoperatively. There were no recurrences, 7 of the 8 (87.5%) patients related the surgery as a success, with 1 of 8 (12.5%) patients stating they would elect for arthrodesis if given the chance again. All patients (100%) had either soft tissue, osseous or a combination of procedures performed with the Posterior Tibial Tendon transfer. The mean time to weight-bearing was 5.1 weeks. One patient experienced complication in the form of chronic edema.

Conclusion: The adult-acquired cavovarus foot type, of etiology secondary to spinal issues, surgically managed with posterior tibial tendon transfer and various concomitant procedures provided symptomatic relief, corrective accommodation for bracing or return to shoe gear, and high patient satisfaction.

Level of Clinical Evidence: 4.

Keywords: *Drop Foot Surgery; Cavovarus; Tendon Transfer; Posterior Tibial Transfer; Acquired Footdrop; Putti*

Introduction

Having over a century and a half of documented use, tendon transfers have become staples in lower extremity reconstructive surgery. The Posterior Tibial Tendon (PTT) transfer (aka Putti procedure) is a versatile technique that is typically utilized in conjunction with multiple procedures for reconstructions relative to cavovarus deformities of the foot [1-13]. The PTT transfer described by Putti as routing the tendon anteriorly through the interosseous membrane [1] was originally tasked to allow for dorsiflexory restoration in patients suffering from drop foot secondary to paralytic causes [1]. Nearly two decades later, this tendon transfer was further performed and popularized [2]. Now utilized for a variety of foot and ankle deformities [1-10] the PTT transfer is a highly-regarded procedure in the lower-extremity reconstructive surgeon's armament.

As aforementioned, the transfer discussed in this paper was initially used to treat drop foot secondary to neurologic etiology [1,3-6,16]. This procedure can be commonly seen on patients with deformity owed to cavovarus foot type, regardless of etiology [7-10] various neuromuscular and neurologic issues including, but not limited to, Charcot-Marie-Tooth (CMT), cerebral palsy, myelodysplasia, Friedrich's ataxia, leprosy, and severe trauma [3,5,7,8,10,14,15]. Various authors have reported on neurological deformity pertaining to complications arising with surgery dealing with the L5 level of the spine, even when these symptoms are present prior to surgery or the onset was undelineated [16,17]. This could be due in part to insult to the Common peroneal nerve which innervates the anterior and lateral compartments of the leg, including the peroneal muscles, which allow for eversion. Without eversion, the antagonistic inversion muscles will undoubtedly pull the foot into an adducted, inverted position. This undelineated cavovarus deformity is addressable via the Putti procedure, albeit the availability of literature showing patient outcomes, etc. is all but available [3,4].

Today we will discuss our findings of a retrospective case series of 8 patients with adult-acquired cavovarus deformity post-spinal surgery, subsequently having undergone lower extremity reconstruction with the Putti technique and concomitant procedures.

Patients and Methods

After IRB approval, a retrospective chart review was performed between 2010 and 2018. The charts of 8 patients who had documented adult-acquired cavovarus foot deformity after previous lumbar spinal surgery and subsequently undergone PTT transfer were reviewed. The study included 4 males and 4 females. The average follow-up was 25 months.

Surgical technique

The patients were placed on the operating room table in the supine position. Following general anesthesia, a well-padded pneumatic thigh tourniquet was applied to the operative extremity. The foot was then scrubbed, prepped and draped in the usual aseptic manner. The posterior muscle group was lengthened prior to the PTT transfer.

Attention was then directed to the medial aspect of the foot where a linear incision was made at the level of the navicular tuberosity (Figure 1). Dissection was carried down through the subcutaneous tissue with care to avoid all neurovascular structures. The PTT was then identified and detached from its insertion site (Figure 2). It is important to harvest the entire distal portion of the tendon for maximum length by performing meticulous dissection as well as having your assistant supinate the foot in order to gain access to the distal most portion of the tendon. Once the distal portion of the tendon was harvested an additional incision was made at the medial aspect of the tibia, three fingerbreadths above the medial malleolus. The PTT was then easily identified under the fascial plane and routed from its distal insertion (Figure 3). A Rochester-Pean hemostat was then used to gain additional length of the PTT by strategically rolling the PTT in the hemostat and applying a gentle sustained force on the tendon in order to stretch the tendon at the myotendinous junction (Figure 4).

Figure 1

Figure 2

Figure 3

Figure 4

Next, a periosteal elevator was used to create a pilot hole for the tendon by carefully guiding the elevator along the posterior aspect of the tibia and through the interosseous membrane. This was done in order to safely reroute the tendon behind the tibia without damage to the neurovascular bundle. A new incision was then created at this site (anterior to the syndesmosis and above the ankle) and a hemostat was transferred back across the interosseous membrane from lateral to medial (Figure 5). This hemostat was then used to pull the PTT from the medial to lateral aspect of the leg (Figure 6).

Figure 5

Figure 6

The tendon is now located on the lateral aspect of the leg and through the interosseous membrane. An additional incision was made to the dorso-lateral aspect of the foot just above the level of the cuboid. The periosteal elevator was then used to create a tunnel under the extensor retinaculum from the proximal incision to the distal incision so a new hemostat could be passed from the distal aspect in order to retrieve the PTT (Figure 7 and 8). The tendon was then passed under the retinaculum with the hemostat in order to prevent bowstringing of the tendon. Anchor fixation was then utilized to attach the tendon to the $4^{th}/5^{th}$ metatarsal bases (or the distal cuboid) (Figure 9). Additional absorbable suture was used to reinforce the tendon to the surrounding soft tissue and tendon.

Figure 7

Figure 8

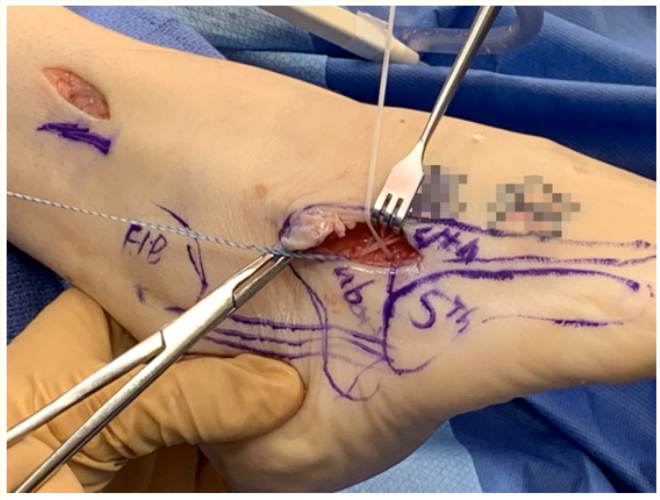

Figure 9

A well-padded posterior splint was applied and the patient was to be non-weight bearing for 4 - 6 weeks, later if osseous work was also performed. After initial splint application, mandatory cast application at or above 90 degrees was then routinely performed until cessation of the non-weight bearing (NWB) period.

Results

The mean age of the patients was 55.9 (range 39 - 67) years. Four patients were male and 4 were female. All 8 patients (100%) had attempted and failed AFO/Bracing before deciding to proceed with surgical intervention. Six of 8 patients (75%) had other osseous surgeries in conjunction with the PTT transfer. Four of 8 patients (50%) underwent a Dwyer calcaneal osteotomy. One patient (12.5%) required a talonavicular joint fusion. One patient (12.5%) underwent an additional midfoot fusion. One patient (12.5%) required a hallux interphalangeal joint fusion. All 8 patients (100%) also underwent additional soft tissue procedures to address various issues. Seven of 8 patients (87.5%) required a posterior capsule release, all 8 patients (100%) required a posterior muscle group lengthening and 1 patient (12.5%) required an extensor hallucis longus transfer. Additionally, 5 of 8 (52.5%) patients had procedures performed for hammertoe correction. One of 8 patients (12.5%) underwent additional surgery prior to 12 months, electing for tibiotalocalcaneal fusion. No patients (0%) in the group were noted to have recurrence of the deformity and 1 of 8 patients (12.5%) experienced a complication in the form of chronic edema.

Non-weight bearing was carried out to an average of 5.1 weeks, with 4 of the 8 patients (50%) having documented non-compliance in regards to NWB during their postoperative course. One of 8 patients (12.5%) transitioned into an AFO, 3 of 8 patients (37.5%) transitioned into a high-top boot, and 4 of 8 patients (50%) transitioned into normal shoe gear/high top shoe.

Mean VAS score was rated as 8.25 and 1.25 pre- and post-operatively, respectively. Seven of 8 patients (87.5%) described the surgery as a success and would undergo it again if given the choice, with 1 of 8 patients (12.5%) stating if they had to do it again they would elect for arthrodesis over tendon transfer.

Discussion

No studies have published results regarding primary use of the Putti procedure to directly address adult-acquired cavovarus foot deformity after spinal surgery, regardless of the initial insult. This study evaluated the outcomes of this procedure pertaining to the etiologic cause with a retrospective chart review. Overall results from this study showed not only great improvement in the VAS score of 8.3 to 1.3, but also recorded 87.5% of patients stating they would opt to undertake the surgery again if given the choice. All patients had additional procedures, being either soft tissue or osseous in nature, to address other necessary deformities to ensure optimal outcome. One-half (50.0%) of the patients had documented non-compliance in regards to their course of NWB. This could be why the single patient who experienced complications sustained them, though this is speculative. Although the authors do not condone patient non-compliance, an argument for lack of complications in the majority of the patient population (7 of 8 patients (87.5%)) could be due to the imperative notion that these patients be allowed to bear weight as soon as possible. This does not mean immediate weightbearing by any means, but rather the shortest course of NWB possible while still allowing for proper healing so soft tissue contractures do not cause recurrence. Along with the quickest return to weightbearing is the need for proper cast application, at or above 90 degrees. The authors believe these two factors alone allow for a high degree of success. It is important to state that this period of NWB can be increased when osseous procedures are involved. A Physical Therapy course of 8 - 12 weeks will also be necessary for nearly all patients to get the maximum function from this out of phase tendon transfer and optimal return of gait and function.

The surgical technique we performed involved detaching and re-routing the PTT through the interosseous membrane and deep to the extensor retinaculum prior to insertion onto the dorsal cuboid. While it has been shown that circumtibial routing has significantly improved gliding resistance, the transmembranous route allows for stronger dorsiflexory action exerted on the foot [18]. Patients in the literature treated with this transfer for drop foot secondary to leprosy have also achieved significantly greater dorsiflexion with the technique we elected for [18,19]. Various studies have also observed that circumtibial transfer produced a supinatory action on the forefoot, while routing the tendon through the membrane decreases the instances of inversionary deformity and recurrence [18,20]. Length of the PTT and the ability to harvest enough to allow for proper insertion to the cuboid has been an immanent difficulty when executing this procedure [2,21]. With our use of an anchor versus a biotenodesis screw, we were allowed a greater degree of error per se, because by employing an anchor, less tendon had to be harvested to achieve proper insertion, as shown in studies looking at FHL transfers [22].

Inherent weaknesses can be found within the study. The first being its retrospective nature. Although not ideal, it does allow for further insight into the subject. Next, the patient population of 8 this study encompassed is less than desired and could be argued that it would be hard to draw conclusions from.

The Evaluation of any valgus deformity which would be worsened to an unacceptable degree by harvesting the PTT should be evaluated and compensated for. The Evaluation of additional stability such as a subtalar fusion, calcaneal osteotomy, cuboid osteotomy and especially for a posterior ankle/stj capsule and gastroc or tendoachilles lengthening should be planned in conjunction. Many times, in long standing deformity, hammertoes have developed due to extensor substitution; these should be addressed at the same setting.

Conclusion

The authors believe that the Putti transfer, used with other procedures when necessitated, is a viable surgical alternative that can be successfully utilized in patients who have developed cavovarus foot deformity to create a plantigrade foot amenable to shoes and bracing. This procedure has value over a fusion in maintaining the motion of the ankle, and much less time non-weight bearing as with ankle fusions. We have presented this as a viable option to address cavovarus and drop foot due to spinal disease resulting in L4/L5 distribution weakness. Our results will be followed by a larger in progress study with different causation to the drop foot and cavovarus deformity.

We believe this is a valuable study to tie the foot and ankle surgeon to the spine specialist for best possible outcomes, especially when the patient has known pre-existing nerve injury and weakness prior to spinal surgery.

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