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Modified Putti Procedure for the Surgical Management of Patients with Adult Acquired Cavo-Varus Resulting from Peroneal Tendon Rupture

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ABSTRACT

Background: Peroneal pathology, including trauma, can result in Cavovarus-Drop Foot type deformity, precluding patients from functioning in or attempting bracing. Lateral ankle stabilization and other associated procedures sometimes are not enough to address the resultant deformity, thus many CavoVarus-Dropfoot patients still have gait abnormalities, function minimally in a brace and still have secondary ambulatory pain and loss of function even when braced. We review the results of 9 patients meeting this criteria and electing for a Modified Putti Procedure and lower extremity reconstruction.

Materials and Methods: The charts of 9 patients with adult-acquired CavoVarus deformity foot type after peroneal rupture were reviewed, all but 1 had failed previous AFO/bracing. These patients underwent surgical correction all consisting of the Modified Putti procedure, along with other ancillary procedures and the results and outcomes were collected. Additionally, surgical technique was documented.

Results: The mean VAS score improved from 9.1 to 2.4 pre- and post-operatively, respectively. The average time to weight bearing was 7.2 weeks. Four of 9 (44.44%) patients experienced some form of complication. Eight of 9 (88.88%) patients relayed the surgery was a success and would opt to undergo it again, given the choice.

Conclusion: The Modified Putti Procedure showed promising

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results, great patient satisfaction and marked improvement in pre-operative and post-operative pain rating. This technique, utilized after severe peroneal trauma and resultant deformity is present, is a considerable option to have in the foot and ankle surgeon's armament.

Keywords: Peroneal Rupture, Cavovarus; tendon transfer; Posterior Tibial Transfer; Acquired Cavovarus; Putti

Introduction

Peroneal rupture is a common pathology seen with lateral ankle injury, observed in up to one-third of acute injuries in some studies, with similar findings in the chronic setting.^[1-3] Although simultaneous rupture is rare, it is still a documented occurrence with either it or singular tendon rupture (more commonly, the brevis) having the capability of leading to severe cavovarus deformity.¹⁻³ In 2004, Redfern and Myerson^[3] published their algorithm on treatment of these tears; in it, a salvage option for concomitant tears did warrant tendon transfer and was performed utilizing the Flexor Digitorum Longus (FDL) tendon. Similarly, Stamatis et al.^[4] reviewed the literature on peroneal tendon salvage, first commenting on the sparse documentation of actual occurrence of this, then drawing similar conclusions to other authors with surgical procedures consisting of realignment osteotomies, FDL and Flexor Hallucis Longus (FHL) transfers when needed. Multiple authors cite [peroneal] trauma as one of the 4 causes of this lower extremity deformity.^[1-3,5,6] Surgical management and insight into the cavovarus foot type has been studied as well, with recommendations on how to treat this deformity being outlined, regardless of the etiology.^{5,6} Similarly to Redfern and Myerson's work on peroneal pathology, Maskill et al.^[7] reported on their algorithm for the subtle cavovarus foot, noting it is commonly developed from peroneal injury, reporting on various osteotomies and tendon transfers to address the resultant structural changes.

Whether the authors aimed to evaluate isolated peroneal tendon ruptures or resultant cavovarus deformity, tendon transfers could always be found in the discussion, especially as the severity progressed. Historically, Mayer^[7] developed the principles of tendon transfer, years later Watkins^[9] would describe tendon transfer regarding the Posterior Tibialis Tendon (PTT). Four incisions were utilized, described chronologically later in a study by Hsu and Hoffer,^[10] with the tendon then being directed through the interosseous membrane, ultimately attaching on the midfoot.

This paper aims to add to this collective data, in it reporting the outcomes and results of 9 patients electing to undergo the Modified Putti Procedure for treatment of adult-acquired cavovarus foot deformity after sustaining peroneal tendon ruptures. Additionally, we describe our surgical technique which was utilized on patients receiving this procedure along with discussion.

Patients and Methods

After IRB approval, a retrospective chart review was performed between 2013 and 2020. The charts of 9 patients with documented adult-acquired cavovarus foot deformity stemming from peroneal tendon rupture, surgically managed with the modified Putti procedure, were reviewed. The study included 3 males and 6 females. The follow-up was 12 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.



Figure 1



Figure 2

Attention was then directed to the medial aspect of the foot where a linear incision was made at the level of the navicular tuberosity. 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 (Fig. 1). 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. 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 (Fig.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 the above ankle) and a hemostat was transferred back across the interosseous membrane from lateral to medial (Fig. 3). This hemostat was then used to pull the PTT from the medial to lateral aspect of the leg (Fig.4).



Figure 5

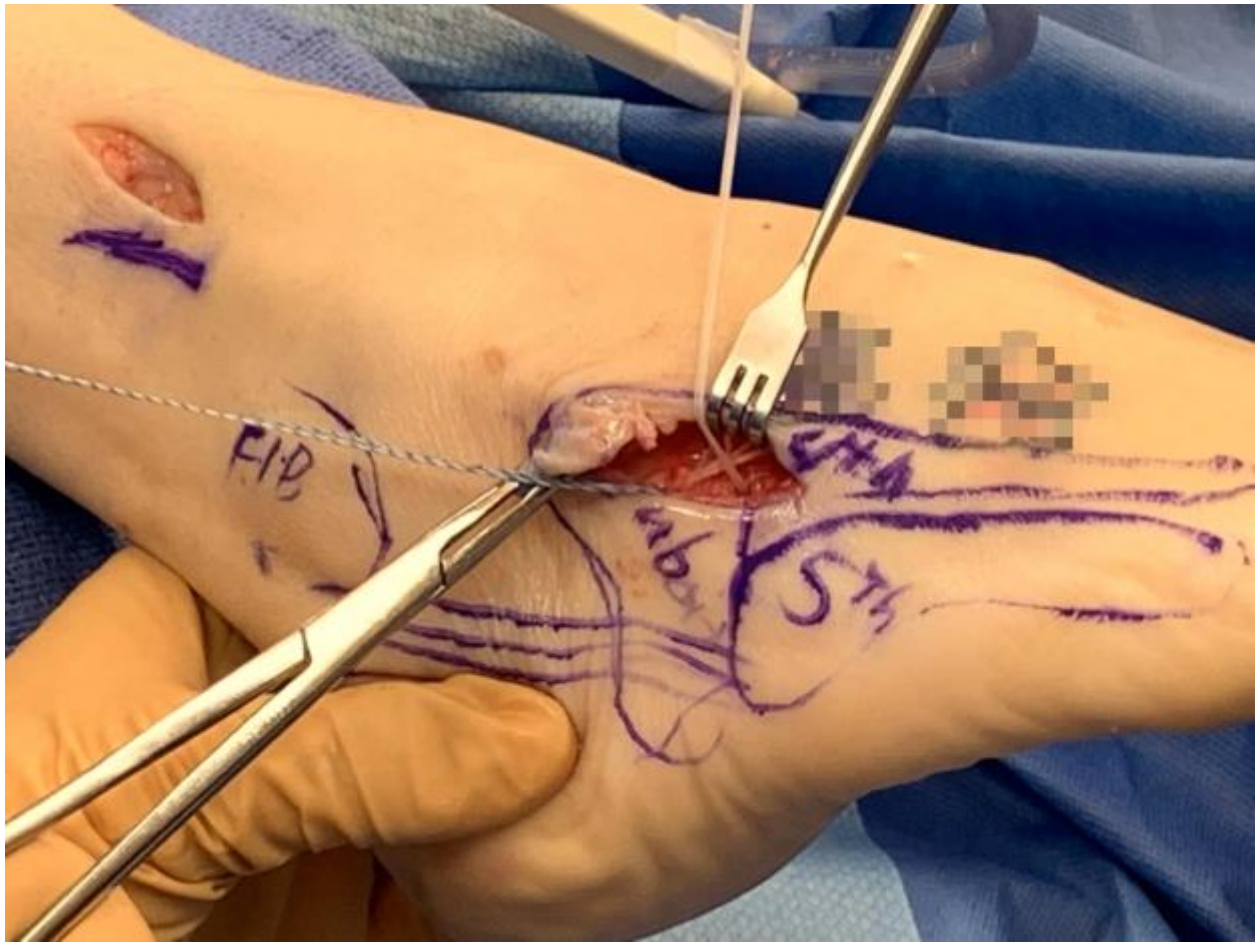


Figure 6

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 (Fig.5). 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 4th/5th metatarsal bases (or the distal cuboid) (Fig.6). Additional absorbable suture was used to reinforce the tendon to the surrounding soft tissue and tendon.

A well-padded posterior splint was then applied and the patient was to be non-weight bearing for

6 weeks. After initial splint application, mandatory cast application at or above 90 degrees was then routinely performed until cessation of the NWB period.

Results

The mean age of the patients was 49 (range 38-72) years. 3 (33.33%) patients were male and 6 (66.66%) were female. 8 of the 9 (88.88%) patients had attempted and failed previous AFO or bracing prior to elective surgery.

All patients had additional osseous procedures performed at the time of surgery. Eight (88.88%) patients had a Dwyer calcaneal osteotomy, 3 (33.33%) patients had a 1st Metatarsocuneiform joint arthrodesis, 2 (22.22%) patients had a Cotton osteotomy and 1 (11.11%) patient had a Cuboid osteotomy performed. Furthermore, 8 of the 9 (88.88%) patients had concomitant soft tissue procedures at the time of surgery. Eight of the 9

(88.88%) patients had a Tendo-Achilles lengthening performed and 7 of the 9 (77.77%) patients had a posterior tibiotalar capsular release at the time of initial surgery.

Non-weight bearing was carried out to an average of 7.2 weeks. There was documented patient non-compliance from 7 of 9 (77.77%) patients, leaving only 2 of the 9 (22.22%) patients which were compliant with their postoperative weight bearing course. After their respective courses of NWB were complete, 6 of 9 (66.66%) patients successfully transitioned into normal/hightop shoe gear. Two (22.22%) patients transitioned into a hightop boot and 1 (11.11%) patient successfully utilized an AFO.

Overall, 4 of the 9 (44.44%) patients experienced some form of complication. Only 1 of the 9 (11.11%) patients had a recurrent deformity. Two of the 9 (22.22%) experienced prolonged chronic edema and, lastly, 1 of 9 (11.11%) patients experienced complications in the form of nerve entrapment.

Mean VAS score, on average, improved from 9.1 to 2.4 pre- and post-operatively, respectively. Eight of 9 (88.88%) patients described the surgery as a success and would undergo it again if given the choice, with 1 (11.11%) patient unsure if they would consider the surgery a success. All patients (100%) stated that, if given the choice again, none would elect for an ankle arthrodesis over the procedure that was performed.

Discussion

Barring inability to undergo operation, patients unable to manage bracing will almost invariably require surgical correction to allow for proper conservative management. Our results, showing recurrence in only 1 of 9 patients, even with the majority of them having documented non-compliance in regards to NWB, reveals the success the Putti procedure can exert, when properly utilized. Furthermore, the base goal of these

procedures, which is to allow for return to AFO/bracing was achieved in all of the patients included in this study. It is imperative to reiterate that much of the success of this procedure is owed to the fact that patients were tried to be progressed to weightbearing as soon as possible, with serial casting at or above 90 degrees being just as important to the process: These aspects should not be overlooked or taken lightly. 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.

Our decision to employ the PTT over the FDL or FHL was multifactorial. Even though the PTT is an out-of-phase tendon, removing the multitude of insertion points the tendon has on the foot immediately contributes to alleviating one of the deforming forces. Next, the transfer to the lateral aspect of the foot, even with a drop in strength that tendon is allowed, is far superior than the non-functional ruptured peroneals. Additionally, the PTT can now add dorsiflexory power to the foot, coming from a lateralized vector. As prior authors in the literature have opted for tendon transfers consistent with the latter, [3,7] we believed the PTT to be superior when regarding our patient population, as seen in other studies as well. [6,7,12,13]

Our technique involved detaching and repositioning the PTT in a transmembranous manner, keeping the tendon deep to the extensor retinaculum and inserting it onto the dorsal cuboid. Some literature reveals that by routing tendons in a circumtibial manner, gliding resistance is significantly improved, but the transmembranous route allows for a stronger dorsiflexory action, this notion is also supported in reports of similar patients with deformity secondary to leprosy.⁹⁻¹² These studies, among others, also give

us insight that the circumtibial manner in which transfers can be performed may produce supination of the forefoot, but with transmembranous direction, inversionary instances are decreased, as is deformity recurrence.^[10-13] Even though one of Mayer's 5 main principles^[8] was to "Have the tendon course through tissue that is adapted to gliding of the tendon" and the circumtibial route is preferential in that regard,^[11] we believe that the dorsiflexory advantage gained from transmembranous routing to be more important in this instance. We opted for the cuboid as our insertion point, other authors agree that there is adequate length the PTT can allow for even this far lateral, this is supplemented with our decision to use anchor fixation versus biotenodesis screw, as less tendon was needed to be harvested.^[5,14,15] By fixating the PTT to the cuboid, more eversive forces can be exerted on the foot, this idea is compounded by the fact the PTT and its inversive actions on its many attachment point to the medial foot were nullified after harvest.^[5]

Inherent weaknesses, such as the retrospective nature and small patient population can be found within this paper. The need for prospective studies and larger patient cohorts can always be argued, this study is no different in this sense. Notwithstanding, the authors do believe this paper still allows for great insight into a more uncommon pathology, describing our management and surgical technique with observably good outcomes.

Conclusion

The Modified Putti Procedure allows for return to bracing/shoegear, which is the ultimate goal of adult-acquired cavovarus foot management while sparing the tibiotalar joint from fusion. While other options for the tendon to transfer have been proposed, we believe the PTT to have a variety of advantages and is used in our practice and is our recommendation for the

patient type present in this study. We acknowledge this procedure and these findings as viable options to deformity secondary to peroneal rupture leading to moderate to severe deformity. We plan to follow up on our results in a larger study with more encompassing causation to both dropfoot and cavovarus foot type.

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