ORIGINAL RESEARCH

Posterior Tibial Tendon Excision and Postoperative Pain in Adult Flatfoot Reconstruction: A Preliminary Report

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ABSTRACT

Background: Posterior tibial tendon insufficiency plays a large role in the pathogenesis of adult acquired flatfoot deformity (AAFD) in select patients. Transfer of the flexor digitorum longus is indicated to compensate for the loss of posterior tibial tendon function; however the role of resection of the degenerated posterior tibial tendon remains unclear. The aim of this study was to determine the effect of posterior tibial tendon resection on pain relief following surgical treatment of stage II AAFD.

Methods: All patients who underwent surgical treatment for stage II AAFD and posterior tibial tendon insufficiency were retrospectively reviewed. Patients were divided into two groups based on whether the degenerated posterior tibial tendon was resected or left *in situ*. Twenty-seven patients with a mean follow-up of 13.3 months were included in the study. A visual analog scale (VAS) score for pain was recorded for each patient pre-operatively and at final follow-up. Concomitant surgical procedures and the incidence of postoperative medial arch pain were also reported. Preoperative deformity and postoperative deformity correction were assessed by measuring the anteroposterior talar-first metatarsal angle, the talonavicular (TN) coverage angle, the lateral talar-first metatarsal angle, and the calcaneal pitch onstandard weight bearing radiographs.

Results: Eleven patients underwent FDL transfer and resection of the posterior tibial tendon (PTT resection group), and 16 patients underwent FDL transfer without resection of the posterior tibial tendon (PTT *in situ* group). A greater percentage of patients in the PTT resection group underwent lateral column lengthening (100 *vs* 18.8%, p < 0.001), and a greater percentage of patients in the PTT *in situ* group had a medial displacement calcaneal osteotomy performed (93.8 *vs* 18.2%, p < 0.001). There was no difference in preoperative VAS pain scores between groups, and all patients demonstrated excellent pain relief postoperatively. No patient in either group reported medial arch pain postoperatively. Radiographic assessment revealed similar deformity preoperatively in both groups, and patients in the PTT resection group demonstrated a greater correction of the TN coverage angle (9.8 ± 4.6 *vs* 6.0 ± 4.1 degrees, p = 0.041).

Conclusion: Resection of the PTT did not significantly affect postoperative VAS scores at final follow-up. It did however, correlate with a slightly greater correction of the TN coverage angle. There were no instances of pain along the medial ankle or medial arch of the foot in either group postoperatively. Future prospective studies are needed to determine whether resection of the PTT is necessary at the time of surgery for stage II AAFD.

Keywords: Adult acquired flatfoot deformity, Posterior tibial tendon insufficiency, Talonavicular coverage, Postoperative pain, Tendinopathy.

INTRODUCTION

Adult-acquired flatfoot deformity (AAFD) is characterized by an abduction deformity of the midfoot, increased hindfoot valgus, and collapse of the medial longitudinal arch. The etiology of AAFD is multifactorial, however a vast majority of patients will present with insufficiency of the posterior tibial tendon, attenuation of the spring ligament complex, or a combination of both. Four stages of AAFD have been described which function to direct treatment.[1,2] Stage II AAFD is defined by abduction deformity at the talonavicular (TN) joint and increased hindfoot valgus that is passively correctable. Current surgical treatment for this stage of deformity includes tendon transfer to provide dynamic inversion to the foot, as well as bony procedures to reconstitute the medial arch, correct hindfoot valgus and correct midfoot abduction deformities.

The posterior tibial tendon (PTT) contracts eccentrically to stabilize the transverse tarsal joint and limit excessive subtalar eversion during stance phase, and contracts concentrically to adduct the transverse tarsal joint and invert the subtalar joint during early heel rise.[2,3] Patients with AAFD and PTT insufficiency are unable to perform a single heel rise, and report pain along the course of the posterior tibial tendon with activity. PTT insufficiency results from repetitive microtrauma that creates an inflammatory response within the tendon, which ultimately leads to tendon degeneration.[4,5] Degenerative changes within the PTT are most often found in a zone of hypovascularity that is located 4 cm proximal to the tendon's insertion on the navicular.[6-8] In addition, as the flatfoot deformity progresses, the PTT is placed in a more biomechanically disadvantageous position, thus increasing the forces at the PTT and accelerating the disease process.

The treatment of stage II AAFD is controversial. In cases of PTT insufficiency, flexor digitorum longus (FDL) transfer restores inversion and adduction strength across the transverse tarsal joint and subtalar joint. Although the FDL is not as strong a muscle as the intact PTT, it functions well to balance the forces of the peroneus brevis at the hindfoot.[9] FDL transfer is performed in combination with osteotomies to realign the hindfoot and midfoot, and restore normal foot biomechanics. These procedures include a medial displacement calcaneal osteotomy to correct hindfoot valgus, lateral column lengthening to correct abduction at the midfoot and improve the coverage of the talar head by

the navicular, and a dorsal opening wedge osteotomy of the medial cuneiform (Cotton) to plantarflex the first ray and correct supination in the forefoot.

Traditionally, FDL transfer for PTT insufficiency has been accompanied by resection of the diseased portion of the PTT. However, because of the many concomitant procedures at the time of surgery, it is difficult to know what role this has in relieving pain along the medial arch in the postoperative period. The purpose of this study is to determine, if excision of the PTT is necessary to relieve pain along the medial ankle and medial arch of the foot in patients who undergo reconstruction for stage II AAFD.

METHODS

All patients who underwent surgery for correction of stage II AAFD and posterior tibial tendon insufficiency by the two senior authors (JN and JD) between January of 2008 and December of 2011 were enrolled in this retrospective comparative study. The study was approved by the institutional review board at the investigators' institution. Twenty-seven consecutive patients were identified. Each patient was indicated for surgery after having failed a minimum of 6 months of nonoperative management including activity modification, nonsteroidal anti-inflammatories, bracing and orthotics. All patients underwent transfer of the FDL for posterior tibial tendon insufficiency with associated bony procedures to correct foot alignment as indicated by the senior authors. Patients who at the time of surgery were noted to have isolated spring ligament tears with an intact posterior tibial tendon did not undergo FDL transfer and were excluded from the study.

There were 13 male and 14 female patients. The mean age at the time of surgery was 53 (range, 22-73) years, and mean follow-up was 13.3 (range, 6.1-24.6) months. Patients were divided into two groups based on whether the diseased posterior tibial tendon was resected or left in place. A chart review was performed to identify associated procedures at the time of surgery. Preoperatively and at final follow-up

patients recorded a visual analog scale (VAS) score for pain. Moreover, the presence of postoperative medial arch pain was assessed for each patient. Standard weight bearing radiographs of the foot were obtained preoperatively and at final follow-up. The AP talo-first metatarsal angle, TN coverage angle, lateral talo-first metatarsal angle, and calcaneal pitch were assessed for each patient.[10,11] Preoperative radiographs were compared to postoperative radiographs at final follow-up to assess deformity correction for each patient.

The independent samples Student t-test was used for comparison between groups for continuous variables. The Pearson Chi-square test was used to compare the incidence of associated procedures at the time of surgery and the presence of medial arch pain postoperatively between groups. An alpha level of 0.05 was deemed statistically significant. All analyses were performed with SPSS software version 21.0 (IBM Corp, Armonk, NY).

RESULTS

Eleven patients underwent FDL transfer and resection of the posterior tibial tendon (PTT resection group), and 16 patients underwent FDL transfer without resection of the posterior tibial tendon (PTT *in situ* group). Patients' age at the time of surgery and time to follow-up was not different between the two groups (Table 1). When comparing associated procedures between the two groups, a significantly greater percentage of patients in the PTT resection group also underwent a concomitant lateral column lengthening procedure. Similarly, a significantly greater percentage of patients in the PTT *in situ* group had a medial displacement calcaneal osteotomy performed (Table 1). There was no difference in the incidence of concomitant spring ligament repair, Cotton osteotomy, or tendo-Achilles lengthening procedures between the two groups.

All patients had excellent pain relief postoperatively, and comparison of preoperative and postoperative VAS pain scores demonstrated no difference between groups

Table 1: Demographics and associated procedures by group			
	PTT resection (n = 11)	PTT in situ (n = 16)	p-value
Age (yr)	54.2 ± 5.6	53.1 ± 14.5	0.812
Follow-up (mo)	14.9 ± 5.6	12.1 ± 4.7	0.177
Associated procedures			
MCO*	2 (18.2%)	15 (93.8%)	<0.001
LCL+	11 (100%)	3 (18.8%)	<0.001
Spring ligament repair	2 (18.2%)	2 (12.5%)	0.683
Cotton	3 (27.3%)	2 (12.5%)	0.332
TAL++	5 (45.5%)	5 (31.3%)	0.453

*Medial displacement calcaneal osteotomy; +Lateral column lengthening osteotomy; ++Tendo-achilles lengthening procedures

Table 2: Pain scores and incidence of pain by group			
	PTT resection	*PTT in situ*	*p-value*
VAS pain scores			
Preoperative	5.4 ± 1.6	5.4 ± 1.7	0.956
Postoperative	0.3 ± 0.5	0.1 ± 0.3	0.163
Lateral foot pain	3 (27.3%)	1 (6.3%)	0.131
Medial arch pain	0 (0%)	0 (0%)	1.00

Table 3: Preoperative and change in radiographic measurements by group			
	PTT resection	*PTT in situ*	*p-value*
Preoperative			
AP talo-1st MT[+]	16.4 ± 4.1	18.1 ± 8.0	0.561
TN coverage[++]	29.5 ± 7.9	26.2 ± 8.0	0.325
Lat talo-1st MT[t]	21.8 ± 9.1	26.5 ± 6.8	0.152
Calc pitch[tt]	17.6 ± 6.2	16.5 ± 6.6	0.705
Deformity correction*			
Δ AP talo-1st MT	–8.2 ± 2.2	–6.3 ± 3.6	0.172
Δ TN coverage	–9.8 ± 4.6	–6.0 ± 4.1	0.041
Δ Lat talo-1st MT	–7.9 ± 4.7	–7.6 ± 5.0	0.887
Δ Calc pitch	5.9 ± 3.1	4.9 ± 4.8	0.557

[+]Anteroposterior talar-first metatarsal angle; [++]Talonavicular coverage angle; [t]Lateral talar-first metatarsal angle; [tt]Calcaneal pitch; *Difference between preoperative and most recent follow-up radiographic measurements in degrees. A negative value indicates a mean postoperative angle that is less than the mean preoperative angle, and a positive value indicates a mean postoperative angle that is greater than the mean preoperative angle

(Table 2). Three patients in the PTT resection group and one patient in the PTT *in situ* group reported lateral sided foot pain at most recent follow-up, and were patients who also underwent lateral column lengthening at the time of surgery. However, no patient in either group reported medial arch pain. Preoperatively, we noted no difference in any of the radiographic parameters of deformity between the two groups (Table 3). Patients in the PTT resection group had a greater correction of the TN coverage angle when compared to patients in the PTT *in situ* group (9.8 ± 4.6 *vs* 6.0 ± 4.1 degrees, p = 0.041). Correction of the AP talo-first metatarsal angle, lateral talo-first metatarsal angle, and calcaneal pitch was not different between groups.

DISCUSSION

AAFD is a complex deformity involving a combination of increased hindfoot valgus, midfoot abduction, and forefoot supination. For many patients, posterior tibial tendon insufficiency as a result of chronic degenerative tendinopathy plays a large role in the pathogenesis of the deformity. PTT tendinopathy was first reported by Fowler et al in 1955 who recognized at the time of surgery that the PTT sheath that was 'swollen and thickened, and the tendon greatly enlarged.[5,12] The concept of a tendon transfer for the treatment of PTT insufficiency was introduced by Goldner et al in 1974, who reported on nine patients who underwent transfer of the flexor hallucis longus to the periosteum of the plantar aspect of the navicular.[13] Mann

et al presented a variation of this technique, and reported their outcomes of FDL transfer for PTT insufficiency in 1985.[14] Since then, transfer of the FDL has been favored over the FHL because of its convenient location adjacent to the PTT as it courses posterior to the medial malleolus, and similar line of pull relative to the PTT. In addition, the PTT and FDL are in phase since both fire primarily during the mid-stance phase of gait.[15] However, FDL transfer is rarely performed in isolation since failure may be as high as 50% within the first year when not accompanied by additional procedures to correct the deformity.[16] Additional procedures include a medial displacement calcaneal osteotomy to correct hindfoot valgus, lateral column lengthening osteotomies to correct midfoot abduction, dorsal opening wedge osteotomy of the medial cuneiform to correct forefoot supination, and tendon-Achilles lengthening to correct equinus contracture.

Although FDL transfer for PTT insufficiency is well accepted, the role of resection of the degenerated PTT remains unclear. Immunohistochemistry has revealed that tendons with changes consistent with tendinopathy have a greater number of substance P-positive nerve fibers and a higher concentration of glutamate levels when compared to normal tendons.[17-19] Such changes within the diseased tendon are believed to contribute to the experience of pain associated with tendinopathy.[20-22] In addition, there is preliminary evidence to suggest that a humoral autoimmune response may contribute to the degenerative tendinopathy

seen in posterior tibial tendon insufficiency.[23] Based upon these findings, many have theorized that it is necessary to resect the diseased posterior tibial tendon at the time of reconstruction. However, there are others who advocate leaving the PTT *in situ*. Preserving the posterior tibial tendon at the time of surgery may allow the musculotendinous unit to work synergistically with the FDL transfer. In addition, the FDL may be transferred to the PTT tendon at its insertion onto the plantar navicular, thereby recreating the line of pull of the PTT, preserving its lever arm, and allowing the tendon transfer to act upon all distal insertions of the PTT in the midfoot and forefoot. The aim of this study was to determine the effect of PTT resection on postoperative pain in patients who underwent surgery for the treatment of stage II AAFD.

In our study, a greater percentage of patients in the PTT resection group underwent lateral column lengthening, and a greater percentage of patients in the PTT *in situ* group underwent medial displacement calcaneal osteotomy at the time of surgery. This reflects a philosophical difference between the two senior authors (JN and JD) and highlights the controversy in the treatment of stage II AAFD. Accordingly, we found that the PTT resection group had a greater correction of the TN coverage angle postoperatively, which we attribute to the lateral column lengthening procedure. All patients demonstrated excellent pain relief, and we did not find any difference in the change in VAS pain score postoperatively between groups. All patients who reported pain postoperatively underwent a lateral column lengthening procedure and described pain along the lateral border of the foot. None of these patients reported a VAS pain score greater than 1 out of 10. With lateral column lengthening, there is a risk of creating stiffness in the foot and limiting eversion. Clinically, lateral plantar foot pain has been reported in 8 to 45% of patients who have undergone lateral column lengthening.[24-26] Moreover, a study by Ellis et al demonstrated increased lateral plantar pressure measurements in patients with lateral foot pain after an Evans-type lateral column lengthening.[27] Most importantly, we did not find any patients in either group who reported pain along the medial aspect of the ankle or medial arch of the foot postoperatively.

There are several limitations to this study. This was a retrospective comparative study of a relatively small group of patients. Many patients required additional surgical procedures at the time of surgery, which may confound our results. In addition, a single surgeon (JN) performed all surgeries in the PTT resection group and another surgeon (JD) performed all surgeries in the PTT *in situ* group, thereby introducing an additional confounding variable.

In our study, pain relief was the same irrespective of whether the PTT was resected or left *in situ*. There was no incidence of pain along the medial ankle or medial arch of the foot postoperatively. This study will hopefully stimulate future prospective studies to determine whether resection of the degenerated PTT is necessary at the time of reconstruction for AAFD, and whether there are any benefits to leaving the PTT *in situ* at the time of surgery.

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