Surgical Management of Posterior Tibial Tendon Dysfunction without Tendon Transfer and Arthrodesis: A Retrospective Study

Beaumont

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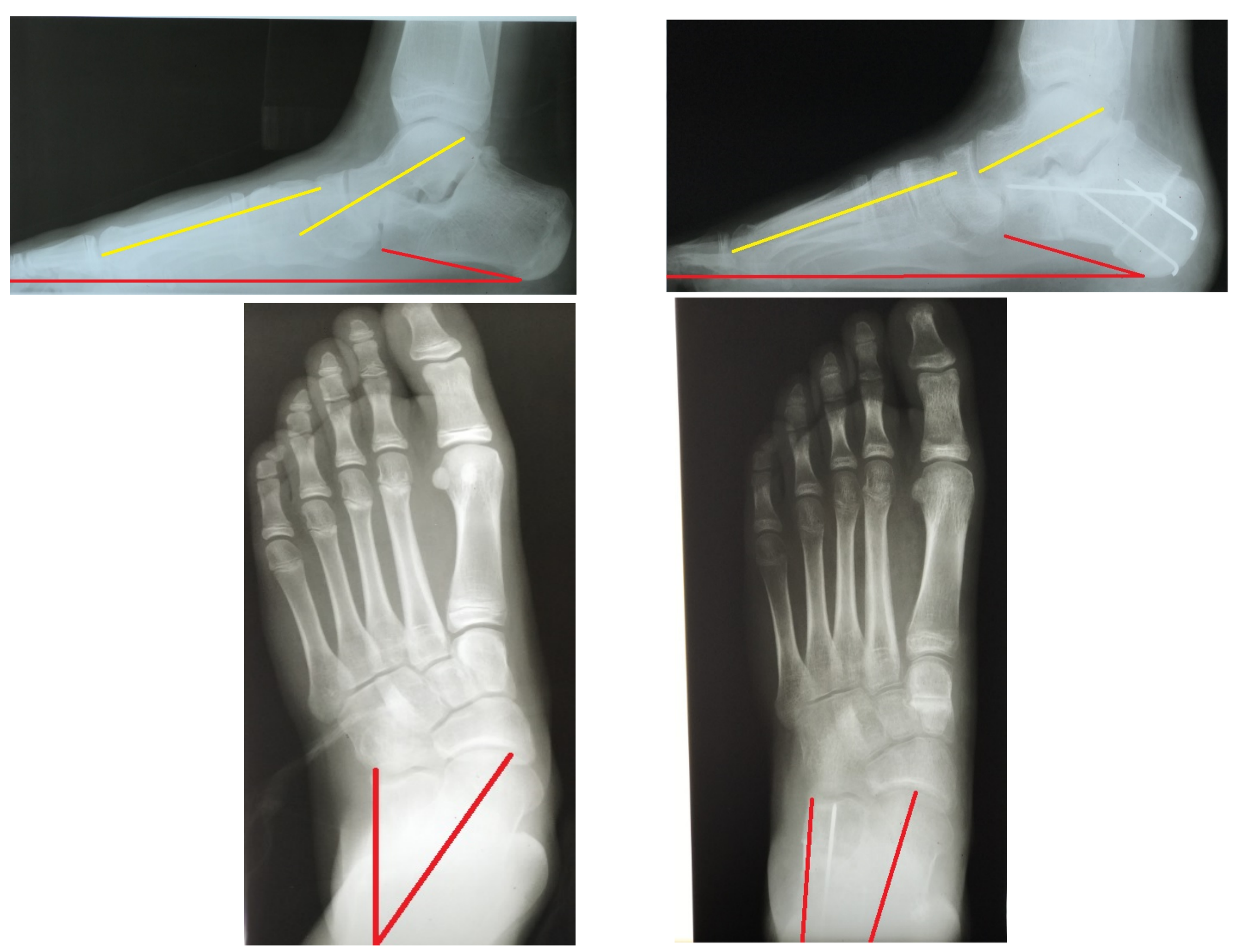
STATEMENT OF PURPOSE

The purpose of this retrospective study is to determine if the sole use of extra-articular osteotomies such as: Medial displacement calcaneal osteotomy (MDCO), Evans osteotomy, and Cotton osteotomy) with a gastrocnemius recession can eliminate the need for transferring tendons and fusion of joints in the surgical management of posterior tibial tendon dysfunction (PTTD). We will evaluate radiographs pre-operatively and post-operatively. This is a retrospective outcome study evaluating surgical management of posterior tibial tendon dysfunction without the need for tendon transfer and fusion. We believe this study can help guide foot and ankle surgeons determine the right procedures for posterior tibial tendon dysfunction.

METHODOLOGY AND HYPOTHESIS

The present study retrospectively examined 56 feet and 43 patients who underwent flatfoot reconstructive surgery in the Beaumont Healthcare System from November of 2011 to June of 2016 with mean follow-up of 60 weeks (12 months-60 months). Pre-operative and post-operative radiographs were taken (Figures 1 & 2) on all patients and radiographic angles were measured. Post-operative radiographic measurements were measured on the final post-operative radiographs after healing occurred. Angles measured include: Calcaneal inclination, Meary's line, AP talocalcaneal, calcaneal-cuboid, talo-navicular, and talar-declination. Demographic information extracted from patient charts included the stage of the flatfoot deformity, age, gender, and procedure performed. There was one primary surgeon (L.M.F) for all 56 feet and 43 patients. Pre-operative and post-operative evaluations was performed by the primary surgeon (L.M.F). Pre-operative and post-operative radiographic measurements and demographic information extraction was performed by the first and second authors (A.W., L.M.F). We used the Johnson and Strom (1) system to classify the staging of the flatfoot deformity. Stage 2 deformities were included in this study. Both pediatric and adult patients were included. All patients failed conservative treatment and demonstrated clinical and radiographic flatfoot changes. A gastrocnemius recession was performed on each patient and if needed, some combination of a MDCO, Evans osteotomy, and Cotton osteotomy was performed. Those excluded from the study were patients who underwent charcot reconstruction, coalition resection, and had neurological etiologies. The primary goal of this study was to examine the structural correction obtained by our procedure selection by measuring the appropriate pre-operative and post-operative measurements on radiographs. The outcome of the study was based on the amount of correction obtained between pre-operative and post-operative radiographs. The Beaumont Health System Institutional Review Board approved the present study. Radiographic pre-operative and post-operative angle measurements were compared by calculating t-tests for dependent variables. Throughout this study, a two-tail p-value ≤ 0.05 was considered statistically significant. Our hypothesis states that the sole use of extra-articular osteotomies with a gastrocnemius recession will correct the stage 2 flatfoot deformity without having to perform an arthrodesis or tendon transfer.

Figure 1. Pediatric pre-operative and post-operative x-rays.



PROCEDURE

First, a gastrocnemius recession was performed on all patients followed by a MDCO . This was performed distal to the lateral malleolus, parallel with the peroneal tendons. An osteotomy was performed between the posterior aspect of the calcaneus and the posterior facet of the subtalar joint with use of a sagittal saw. Medial translation was then performed until proper hindfoot alignment was obtained. The osteotomy was then fixated with either two 6.5 partially threaded cannulated screws or K-wire fixation for pediatric patients. If continued abduction of the foot with simulated weightbearing was noted with subluxation of the talonavicular joint, an Evans procedure was performed. The Evans osteotomy was performed 1.5 cm proximal to the calcaneocuboid joint. The osteotomy site was opened with the use of a distractor and an Evans allogenic bone graft was inserted from lateral to medial utilizing a tamp. Lastly if either a forefoot varus, hypermobility of the medial column, or an elevatus of the first metatarsal was noted, a Cotton osteotomy was performed. A dorsal osteotomy was performed with use of a sagittal saw at the first cuneiform. A Cotton allogenic bone graft was inserted from dorsal to plantar utilizing a tamp. Post-operatively, the patients were kept non-weightbearing in a well-padded below-knee fiberglass cast for 4-6 weeks. This was followed by a transitional partial-weightbearing in a CAM walker after evidence of radiographic union was confirmed.

LITERATURE REVIEW

Johnson and Strom (1) originally categorized PTTD into 3 stages and correlated treatment options. Conservative treatment such as immobilization, shoe modifications, NSAID therapy and physical therapy is recommended for a stage 1 PTTD and is consistent with tenosynovitis of the posterior tibial tendon . If conservative therapy is not successful, Johnson and Strom recommended tendon debridement. Stage 2 and 3 consist of further degeneration of the tendon with structural changes to the foot. A stage 2 deformity is characterized by a supple hindfoot valgus whereas a stage 3 is rigid in nature. A stage 4 deformity was later added by Myerson (2), this is consistent with a stage 2 or 3 PTTD with ankle valgus. Johnson and Strom recommended transferring the flexor digitorum longus (FDL) tendon to augment the diseased posterior tibial tendon for a stage 2 deformity and recommend a triple arthrodesis for stage 3 (1). A pantalar arthrodesis was recommended by Myerson for the stage 4 PTTD (2).

The purpose of this study was to demonstrate that PTTD can be surgically managed without tendon transfer or fusion. DiDomenico and colleagues demonstrated flatfoot correction in 34 patients with the use of a double calcaneal osteotomy and medial column fusion without the need for a flexor digitorum longus tendon (FDL) transfer. All 34 patients exhibited good correction without sacrificing the FDL tendon over an average follow-up period of 14 months (3).

A tendon transfer does not address the structural deformity of the painful flatfoot. Graham and colleagues concluded a 51% reduction in strain on the posterior tibial tendon with realignment of the hindfoot (4).

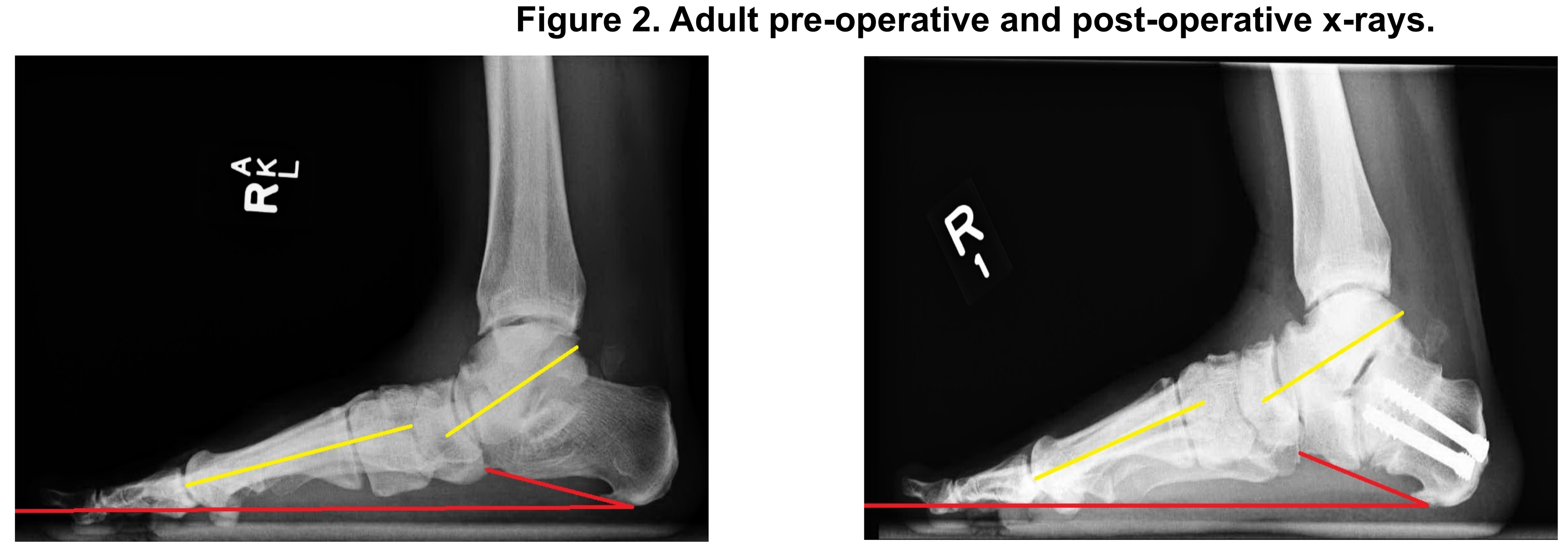
The foot and ankle surgeon must also recognize that transferring of tendons can create weaknesses in other areas of the foot. In a cadaveric study, Spratley and colleagues found that that both an FHL and FDL transfer reduced flexion strength in the hallux and lesser digits (5).

The flexor hallucis longus tendon is also used in tendon augmentation for flatfoot correction. Because of its anatomical placement in the foot and ankle, the surgeon does risk vital neurovascular structures with harvesting of this tendon. Mulier and colleagues performed a cadaveric study on 24 cavadavaric limbs in which they harvested the FHL using a 2- incision technique. They found 2 complete transections of the medial plantar nerve, 1 partial transection of the medial plantar nerve, 1 partial transection of the lateral plantar nerve, stretching of 3 medial plantar nerves, and stretching of 1 lateral plantar nerve (6).

Hansen described joints in the foot and ankle as essential and non-essential. Those joints which preserve other joints and do not redistribute biomechanical load are considered non-essential. These joints can be fused with little worry of creating degeneration to the adjacent joints. Joints which would limit patient functionality and create adjacent stress load on surrounding joints are considered essential. The ankle joint, subtalar joint, talo-navicular joint, and lesser metatarsophalangeal joints are all considered essential joints in the foot and ankle. These joints should not be sacrificed (7).

Catanzariti and colleagues performed a prospective study on 9 flatfeet, the objective of the study was to demonstrate a successful outcome with use of a double calcaneal osteotomy with posterior muscle lengthening without need for fusion. AP and lateral talar-first metatarsal angle, talocalcaneal angle, calcaneal inclination angle, talar-declination angle, and cuneiform-to-ground height were measured pre-operatively and post-operatively. All postoperative measurements were statistically significant demonstrating that the extra-articular procedures performed by these surgeons were successful in reconstructing the flatfoot while maintaining hindfoot mobility. Other ancillary procedures performed included 4 repairs of the posterior tibial tendon, 4 FDL transfers, 2 cotton osteotomies, 1 distal and proximal first metatarsal osteotomy (8)

Figure 2. Adult pre-operative and post-operative x-rays.



RESULTS

Table 1. Radiographic preoperative and postoperative measurements N= 56 feet, 43 patients (Total ,Adults, & Pediatrics)

Radiographic Angle	Pre-operative, Mean (Minimum, Maximum)	Post-Operative, Mean (Minimum, Maximum)	Change, Mean (Minimum, Maximum)	P Value
Calcaneal Inclination	13.06 (5.00, 45.0)	21.94 (5.00, 35.0)	8.91 (0.00, -10.0)	<0.001
Adults	12.10 (5.00, 20.0)	21.43 (5.00, 35.0)	9.32 (0.00, -15.00)	<0.001
Pediatrics	14.84 (5.00, 45.0)	22.95 (15.0, 30.0)	8.11 (10.0, -15.0)	<0.001
Mearys	13.48 (1.00, 35.0)	5.10 (0.00, 31.0)	-8.38 (-1.00, -4.00)	<0.001
Adults	12.57 (1.00, 35.0)	4.92 (0.00, 31.0)	7.65 (-1.00, 4.00)	<0.001
Pediatrics	15.26 (2.00, 32.0)	5.47 (0.00, 20.0)	-9.79 (-2.00, -12.0)	<0.001
AP Talocalcaneal	22.84 (5.00, 45.0)	11.32 (0.00, 32.0)	-11.53 (-5.00, -13.0)	<0.001
Adults	21.76 (9.00, 45.0)	11.84 (0.00, 32.00)	- 9.92 (-9.00, -13.0)	<0.001
Pediatrics	24.95 (5.00, 43.0)	10.32 (3.00 26.0)	-14.63 (-2.00, -17.0)	<0.001
Calcaneocuboid	22.25 (5.00, 40.0)	8.63 (0.00, 40.0)	-13.63 (-5.00, 0.00)	<0.001
Adults	22.30 (10.0, 60.0)	9.27 (0.00, 29.0)	-13.03 (-10.0, 31.0)	<0.001
Pediatrics	22.16 (5.00, 40.0)	7.37 (0.00, 40.0)	-14.79 (-5.00, 0.00)	<0.001
Talonavicular	32.63 (10.0, 60.0)	14.82 (0.00, 40.0)	-17.80 (-10.0, 20.0)	<0.001
Adults	31.73 (10.0, 60.0)	16.16 (0.00, 34.0)	-15.57 (-10.0, 26.0)	<0.001
Pediatrics	34.37 (17.0, 56.0)	12.21 (2.00, 40.0)	-22.16 (-15.0, 16.0)	<0.001
Talar Declination	31.2 (12.0, 56.0)	23.43 (2.00, 50.0)	-7.77(-10.00, -6.00)	<0.001
Adults	30.97 (12.0, 56.0)	24.00 (2.00, 50.0)	-6.97 (-10.0, -6.00)	0.003
Pediatrics	31.6 (20.0,45.0)	22.32 (15.0, 35.0)	-9.28 (-5.00, -10.0)	<0.001

Table 2. Adult vs Pediatric breakdown

Patient Total	43
Adults	32 (74.4%)
Pediatrics	11 (25.5%)
Number of Feet	56
Adults	37 (66%)
Pediatrics	19 (33.9%)
Side	Right: 30 (53.5%), Left: 26 (46.4%)
Adults	Right: 20 (54%), Left: 17 (45.9%)
Pediatrics	Right: 10 (52.6%), Left: 9 (47.3%)
Gender	Males: 22 (51.1%) Females: 21 (48.8%)
Adults	Males: 14 (43.7%) Females: 18 (56.2%)
Pediatrics	Males: 8 (72.7%) Females: 3 (27.2%)
Age Average	36
Adults	47
Pediatrics	13

Table 3. Procedure distribution Adult vs Pediatrics

Procedure Performed	Distribution
Gastroc, MDCO, Evans, Cotton	Total: 26 Adults: 12 (46.1%) Pediatrics: 14 (53.8%)
Gastroc, MDCO, Evans	Total: 19 Adults: 14 (73.6%) Pediatrics: 5 (26.3%)
Gastroc, MDCO, Cotton	Total: 6 Adults: 6 (100%) Pediatrics: 0 (0%)
Gastroc, Evans, Cotton	Total: 1 Adults: 1 (100%) Pediatrics: 0 (0%)
Gastroc, MDCO	Total: 4 Adults: 4 (100%) Pediatrics: 0 (0%)

DISCUSSION & ANALYSIS

In our study, all differences between pre-operative versus post-operative measurements were statistically significant (P<0.003) . All 43 patients did very well without having to sacrifice joints or tendons. There was 1 post-operative complication noted (1.78%). The patient experienced a painful screw displaced screw noted to the posterior calcaneus, this was reported 1 year after flatfoot reconstruction. The hardware was removed and the pain was resolved.

All 56 flatfoot deformities in our study were corrected with similar results to DiDomenico and Catanzariti (3,8). However, in the study performed by DiDomenico, a medial collumn fusion was performed in patients demonstrating hypermobility, midfoot sag, and arthritis (3). In our experience, the Cotton osteotomy addresses deformity noted to the medial column. It has powerful correction with the advantage of sparing joints. Taylor and Sammarco (9) mention that they use the Cotton osteotomy to correct rigid forefoot varus rather than a medial column fusion. Hirose and Johnson demonstrated excellent correction with the use of the Cotton osteotomy with 16 feet. They found statistically significant changes in the lateral talo-first metatarsal angle, calcaneal, pitch, and medial cuneiform-to-floor distance. The most significant correction was found in the lateral talo-first metatarsal angle averaging 14 degrees of correction. The authors concluded several advantages of the Cotton over fusion such as a more predictable union, preservation of motion, and ease of correction (10). This has been the case in our experience as well, the Cotton osteotomy is a powerful procedure in which the surgeon can obtain excellent forefoot correction while maintaining the supple nature of the foot.

The radiographic angles that were measured in our study are common angles that are used in a flatfoot workup. In our experience, the MDCO is a powerful procedure that corrects the calcaneal pitch and talocalcaneal angle. In some instances, we see resolution of talo-navicular subluxation which is measured using the talo-navicular angle, talar-declination angle, and Meary's line. In the classic study performed by Koutsogiannis, 19 patients and 34 feet were operated on using MDCO. The study demonstrated a decrease in talo-navicular subluxation and an elevation in the anterior calcaneus (11). The Evan's osteotomy offers multi-planar correction; however, it is well known for correcting forefoot abduction and talo-navicular subluxation which are measured by the talo-navicular and calcaneal-cuboid angle (12). Talo-first metatarsal angle or Meary's line is useful in terms of evaluating the medial column, moreover, in evaluating midfoot sag, first metatarsal elevatus, and forefoot varus. In 1936, Cotton described the opening wedge osteotomy at the first cuneiform in correcting elevatus of the first metatarsal (13). We have noticed adequate correction of Meary's line with the Cotton osteotomy as an adjunctive procedure to the MDCO and Evans osteotomy.

To conclude, all subjects in this study did very well with our procedure selection. We were able to reconstruct the flatfoot into a more plantargrade functional foot without having to unnecessarily fuse joints or transfer tendons. Tendon transfers and fusions result in the surgeon having to create extra incisions as well as large ones which run the risk of increased edema, wound dehiscence, and infection. With adjacent joint degeneration from fusion and weaknesses created in other aspects of the foot and ankle from tendon transfer, it is worthwhile to the surgeon to re-consider their operative plan when performing flatfoot surgery. It is in our experience that extra-articular osteotomies without transferring tendons or fusions can create a successful outcome for the painful flatfoot.

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