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Original Research

Surgical Management of Stage 2 Adult and Pediatric Acquired Flatfoot Without Tendon Transfer or Arthrodesis: A Retrospective Study

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ABSTRACT

Posterior tibial tendon dysfunction (PTTD) is a common pathology of the foot and ankle. Numerous techniques are available to reconstruct the flatfoot. Fusions and tendon transfers are popular methods; however, a wide range of complications have been associated with these procedures. The objective of the present study was to demonstrate the outcomes of reconstructive surgery for flatfoot correction without tendon transfer or arthrodesis. We performed a retrospective study of 43 patients and 56 feet who had undergone flatfoot reconstructive surgery from November 2011 to June 2016, with a mean follow-up period of 60 weeks (range 12 to 60 months). Each patient demonstrated a stage 2 flatfoot deformity classified using the Johnson and Strom classification. Depending on the patient's deformity, the procedures consisted of different variations of gastrocnemius recession, medial displacement calcaneal osteotomy, Evans osteotomy, and Cotton osteotomy. Six different preoperative and postoperative angles were radiographically measured on each foot studied. In all cases, the differences in the preoperative versus postoperative measurements were statistically significant ($p < .003$). We believe the foot and ankle surgeon can correct flatfoot deformity with the use of extraarticular procedures and create a plantigrade functional foot without fusion or tendon transfer.

Posterior tibial tendon dysfunction (PTTD) is a progressive pathology that can become very debilitating. It is caused by elongation and degeneration of the posterior tibial tendon, which results in hindfoot valgus, collapse of the longitudinal arch, and abduction of the forefoot. Johnson and Strom (1) originally categorized PTTD into 3 stages and correlated the treatment options. Conservative treatment such as immobilization, shoe modifications, nonsteroidal antiinflammatory drug therapy, and physical therapy is recommended for stage 1 PTTD and is consistent with tenosynovitis of the posterior tibial tendon. If conservative therapy is not successful, Johnson and Strom (1) 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; in contrast, stage 3 will be rigid. A stage 4 deformity was later added by Myerson (2), consistent with stage 2 or 3 PTTD with ankle valgus. Johnson and Strom (1) recommended transferring the flexor digitorum longus (FDL) tendon to augment the diseased posterior tibial tendon for a stage 2 deformity and recommended triple arthrodesis for stage 3. A pantalar arthrodesis was recommended by Myerson (2) for the stage 4 PTTD.

Many surgeons have focused on repairing the stage 2 flatfoot with calcaneal osteotomies, tendon transfers, and isolated fusions. Historically, the FDL tendon was the tendon of choice for transfer. Foot and ankle surgeons have also used the flexor hallucis longus (FHL) tendon and the peroneal tendons for transfer (3). The problem with tendon transfers is that they do not correct the structural deformity. Even when combined with osteotomies, the major correction and realignment of the foot is created by the osteotomies, not the tendon transfers. Tendon transfers can also create biomechanical imbalances, which can lead to other complications (3,4). Also, additional incisions are needed to transfer the tendon.

Arthrodesis can be a viable procedure to realign the structure of the foot and ankle; however, it sacrifices motion. Often, the medial column is fused in the presence of hypermobility, midfoot sag, and

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forefoot varus. Arthrodesis should be reserved for end-stage deformity. The Cotton osteotomy can correct moderate deformities of the medial column without the need to sacrifice the joints.

An advantage of extraarticular osteotomies is that they can be used to correct both the adult and pediatric flatfoot, and they preserve the joints and growth plates while creating a powerful correction (5–11).

The purpose of the present retrospective study was to determine whether the sole use of extraarticular osteotomies (medial displacement calcaneal osteotomy [MDCO], Evans osteotomy, and Cotton osteotomy) with gastrocnemius recession can eliminate the need for transferring tendons and fusion of joints. We evaluated the radiographs preoperatively and postoperatively.

We performed a retrospective outcome study evaluating the surgical management of PTTD without the need for tendon transfer and fusion. We believe our findings can help guide foot and ankle surgeons in determining the right procedures for PTTD.

Patients and Methods

The present study retrospectively examined 56 feet and 43 patients who had undergone flatfoot reconstructive surgery in the Beaumont Healthcare System from November 2011 to June 2016. The medical records from both podiatry specialties clinic in Canton, Michigan and the podiatry private practice in Taylor, Michigan, were reviewed. Preoperative and postoperative radiographs were taken (Figs. 1 and 2) for all patients, and the radiographic angles were measured. The postoperative radiographic measurements were measured on the final postoperative radiographs after healing had occurred. The measured angles included the calcaneal inclination, Meary's line, and the anteroposterior talocalcaneal, calcaneal-cuboid, talonavicular, and talar declination. Demographic information extracted from the patient medical records included the stage of the flatfoot deformity, age, sex, and procedure performed (Table 1). One primary surgeon (L.M.F) performed the procedures for all 56 feet and 43 patients. The preoperative and postoperative evaluations were performed by the primary surgeon (L.M.F). The preoperative and postoperative radiographic measurements and demographic information extraction were performed by 2 of us (A.W., L.M.F).

The primary goal of the present study was to examine the structural correction obtained by our procedure selection by measuring the appropriate preoperative and postoperative measurements on radiographs. The outcome of the study was determined by the amount of correction obtained between the preoperative and postoperative radiographs. The Beaumont Health System institutional review board approved the present study.

We used the Johnson and Strom system to classify the stage of the flatfoot deformity. Stage 2 deformities were included in the present study. Both pediatric and adult patients were included in the present study. The International Classification of Diseases (ICD) codes were used to select the patients. Those with a diagnosis code of 734 (ICD, 9th revision) or M21.40 (ICD, 10th revision), which indicated acquired pes planus, and code 736.72 (ICD, 9th revision) or M21.6X9 (ICD, 10th revision), which indicated equinus deformity, were selected. Excluded from the study were those patients who had undergone Charcot reconstruction, coalition resection, or had a neurologic etiology.

Conservative therapy had failed in all our patients. Conservative therapy had consisted of a combination of icing, nonsteroidal antiinflammatory drug use, a change in shoe gear, custom orthoses, ankle foot orthosis bracing, controlled ankle motion walker immobilization, and physical therapy. Our physical assessment included the use of the Silverskoid test to examine for an underlying equinus deformity, double and single heel raise test, and Hubscher maneuver to evaluate flexibility of the pes planus deformity. All our patients exhibited pain and weakness to the posterior tibial tendon, collapse of the medial column, pain in the sinus tarsi, an abducted forefoot, and a valgus attitude of the heel. Gastrocnemius recession was performed on each patient and, if needed, MDCO, Evans osteotomy, and Cotton osteotomy were performed.

The radiographic preoperative and postoperative angle measurements were compared by calculating the *t* tests for dependent variables. Throughout the present study, a 2-tailed p value ≤ .05 was considered statistically significant. After the initial data entry using Microsoft Excel (Microsoft, Redmond, WA), Minitab Statistical Software (Minitab, State College, PA) was used to perform the statistical analyses.

Surgical Procedure

All the patients were brought to the operating room and placed on the operating table in the supine position. After induction of either general or spinal anesthesia, hemostasis was achieved using a pneumatic thigh tourniquet. First, gastrocnemius recession was performed. Attention was first directed to performing a longitudinal posterior incision slightly medial to the midline to the area of the Achilles tendon. The incisions measured ~3 cm in length and began 10 cm proximal to the insertion of the Achilles tendon. The incision site was deepened to the subcutaneum, with care taken to identify and retract all vital neurovascular and tendinous structures. All bleeding vessels were cauterized as deemed necessary by the surgeon. The gastrocnemius aponeurosis was isolated, and a transverse tenotomy was performed with dorsiflexion of the ankle to allow for correction of the equinus deformity. The wound was then copiously irrigated and closed with 3-0 Vicryl suture (Ethicon, Somerville, NJ) and nylon suture.

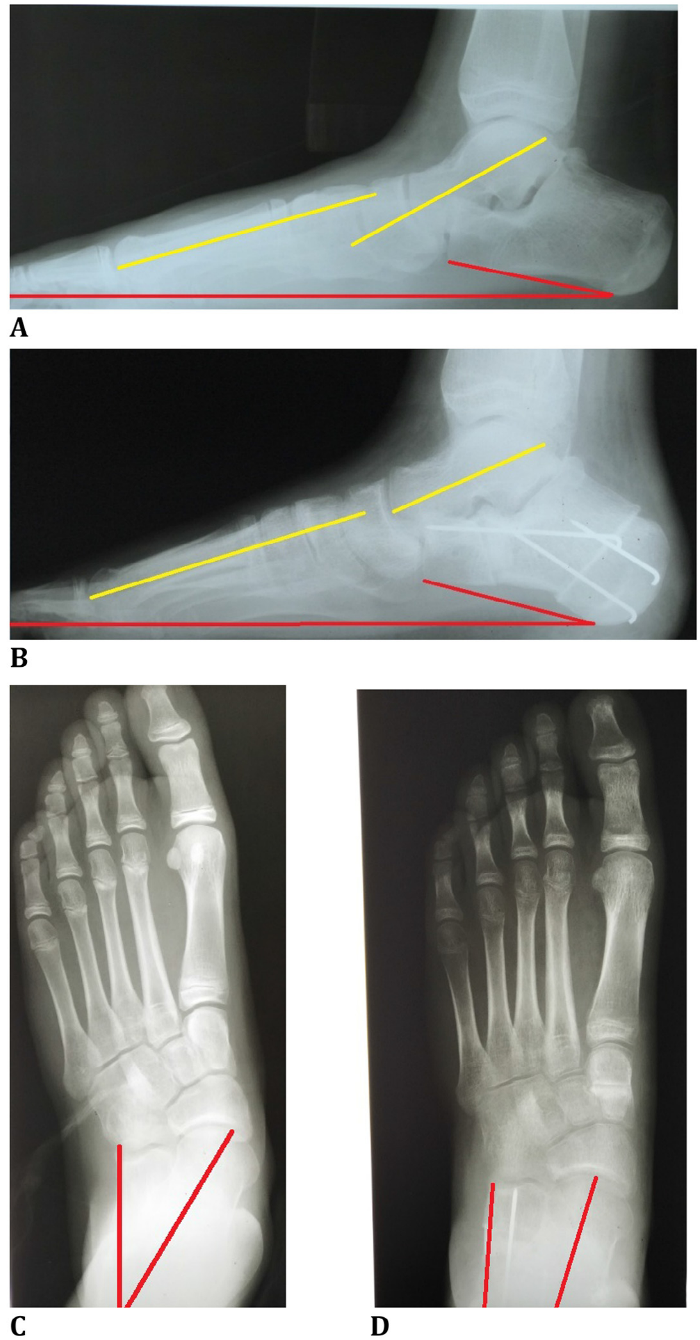

Fig. 1. *(A)* Pediatric preoperative sagittal view. *(B)* Pediatric postoperative sagittal view with Kirschner wire fixation. *(C)* Pediatric preoperative anteroposterior view. *(D)* Pediatric postoperative anteroposterior view.

Next, MDCO was performed. A lazy-L curvilinear incision was made at the posterolateral aspect of the calcaneal wall. This was performed distal to the lateral malleolus and parallel with the peroneal tendons. The sural nerve was identified and retracted. The periosteum overlying the lateral wall of the calcaneus was elevated, following the course of the incision site. An osteotomy was then performed between the posterior aspect of the calcaneus and the posterior facet of the subtalar joint with use of a sagittal saw. The medial cortex was left intact to avoid neurovascular compromise of the