Correction and Prevention of Deformity in Type II Tibialis Posterior Dysfunction

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Abstract Cobb described a method of reconstruction in Johnson and Strom Type II tibialis posterior dysfunction (TPD) using a split tibialis anterior musculotendinous graft. We assessed patient function and satisfaction after a modified Cobb reconstruction in a group of patients with a narrow spectrum of dysfunction, examined a modification of the Johnson and Strom classification to emphasize severity of deformity, and assessed the ability of the technique to prevent subsequent fixed deformity. We prospectively followed 32 patients managed by this technique and a translational os calcis osteotomy with early flexible deformity after failed conservative treatment. There were 28 women and four men with unilateral disease. The average followup was 5.1 years. Staging was confirmed clinically and with imaging. The modified surgery involved a bone tunnel in the navicular rather than the medial cuneiform with plaster for 8 weeks followed by orthotics and physiotherapy. All of the osteotomies healed and 29

of the 32 patients could perform a single heel rise test at 12 months. The mean postoperative American Orthopaedic Foot and Ankle Society hindfoot score was 89. One patient had a superficial wound infection and one a temporary dysesthesia of the medial plantar nerve; both resolved. The observations suggest the technique is a comparable method of treating early Johnson and Strom Type II TPD.

Level of Evidence: Level IV, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

Introduction

Adult acquired flat deformity is recognized as a spectrum of manifestations related to tibialis posterior tendon dysfunction (TPD) and plantar ligament insufficiency [9, 11]. Cobb described a method to reconstruct a lengthened or ruptured tendon with a mobile hindfoot and forefoot using a split tibialis anterior musculotendinous graft. The operation was delineated with the preoperative assessment and postoperative care in 1996 [4]. In a lecture at the British Orthopaedic Foot Surgery Society in London in 1999, Cobb mentioned having used the technique for 20 years. Cobb has not published outcomes in his own patients, but there are five series present in the literature [2, 3, 6, 13, 26]. The earlier papers only provided simple satisfaction assessments describing pain scores on a visual analogue scale [2, 3, 6, 26]. Knupp and Hintermann [13] described improved American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot scores from an average of 53.2 preoperatively to 88.5 postoperatively with a simple clinical satisfaction questionnaire.

Johnson and Strom first described their classification of TPD in 1989 [10]. They originally included three groups,

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broadly incorporating peritendonitis and/or tendon degeneration (Type I), tendon elongation with a mobile and correctable hindfoot deformity (Type II), and elongation with a fixed valgus deformity (Type III). Myerson added Stage IV to include patients with valgus tilt of the talus in the ankle mortise usually with degenerative change. He described this in an instructional course lecture published as a paper in the *Journal of Bone and Joint Surgery (American)* [16]. We believe this is a useful clinical tool when applied to Stages I, III, and IV but not as helpful in Stage II. The latter covers a wide spectrum of deformity with progression in the natural history of the condition from a fully mobile hindfoot, midfoot, and forefoot to a later stage in which there may be a fully mobile hindfoot but fixed supination deformity in the midfoot and forefoot. We propose a modification in the original classification to take this into account (Table 1) (this modification was presented at the British Orthopaedic Foot Surgery Society in 1997). Nonoperative treatment or simple decompression in refractory tenosynovitis is normally advocated in Type I TPD [1]. A variety of techniques are available to treat Stages II, III, and IV. Stages III and IV are not the subject of this article and represent a rigid deformity, which may require treatment by major hindfoot or ankle fusion.

Stage II TPD covers a wide spectrum of the condition. The early phase, which occurs a short time after the onset of symptoms, is associated with functional lengthening of the tendon or frank rupture but with less severe and completely correctable hindfoot, midfoot, and forefoot deformity. However, when the diagnosis has been delayed, the more advanced Stage II disease may be associated with a mobile and correctable hindfoot, but resting forefoot supination may not be fully correctable. We believe that addressing the condition before this later phase is reached would be advantageous, but this would have to be confirmed by further studies. The principle alternative to a Cobb reconstruction in early Stage II TPD is a flexor digitorum longus transfer (FDL) usually associated with a calcaneal osteotomy [16–18, 25]. This technique is widely reported in North America, Australasia, and Europe [7, 16–18, 25], but we believe it is a weak replacement muscle [13]. Recently, the addition of arthroeresis has been

advocated to further enhance the correction of deformity [24]. We have no experience with this technique.

We therefore (1) assessed patient satisfaction, function and alignment after a modified Cobb reconstruction in a group of patients diagnosed with early Johnson and Strom Type II TPD; (2) describe a modification of the Johnson and Strom classification intended to emphasize severity of deformity; and (3) determined the ability of the technique to prevent subsequent fixed deformity.

Patients and Methods

We retrospectively reviewed all 32 prospectively followed patients treated by a modified Cobb technique and a medial displacement translational os calcis osteotomy for early Johnson and Strom Type II TPD between 2000 and 2005. There were 28 women and four men ranging in age from 44 to 66 years, each with unilateral disease. All reported medial hindfoot pain with reduced walking distance and all had noticed an early but progressive flat foot deformity (Fig. 1) despite orthotics and, in some cases, physiotherapy. All patients were seen within 6 months of the onset of symptoms. Ten of 32 patients had a history of injury with a more acute onset. All patients had a flexible hindfoot deformity with a correctable resting forefoot supination of less than 15° when nonweightbearing with the hindfoot corrected. The clinical evaluation confirmed weakness of the tibialis posterior and a compromised single-heel rise test. The opposite limb was entirely normal. Weightbearing radiographs of the foot and ankle were taken principally to exclude osteoarthritis in the ankle and midfoot. Each patient had failed nonoperative treatment involving physiotherapy and orthoses for a minimum of 3 months. Staging was confirmed clinically and radiographically. The minimum followup was 3 years (average, 5.1 years; range, 3–7.2 years). All patients were available for followup.

All patients were referred to the radiology department initially for an MRI scan of the affected hindfoot but as the study developed, there was an increasing use of ultrasound assessment. The main purpose of the investigation was to exclude associated pathology but also permit assessment of

Table 1. Modified classification of planovalgus foot deformity

Stage	Classification	Resting forefoot supination	Fixed or correctable
Stage I	Undeformed	None	
Stage II a	Mobile hindfoot	Less than 15° resting forefoot supination	Correctable
Stage II b	Mobile hindfoot	Greater than 15° resting forefoot supination	Correctable
Stage II c	Mobile hindfoot	Greater than 15° resting forefoot supination	Not fully correctable
Stage III	Fixed hindfoot		
Stage IV	Ankle deformity

Fig. 1 The photograph shows a patient suffering from early TPD associated with a valgus hindfoot deformity and a “too many toes” sign.

Fig. 2 An MRI scan demonstrates the insertion of tibialis anterior with a distal tibialis posterior rupture.

tendon integrity and structure (Fig. 2), the plantar calcaneonavicular (spring), and deltoid ligaments.

The surgery was performed under general anesthesia supplemented by a regional block for pain relief. The patient was positioned supine. The affected limb was prepared and draped, a thigh tourniquet applied, and a sandbag placed under the contralateral buttock. We exposed the tendon through a medial incision starting proximally approximately 10 cm above the medial malleolus at the posterior edge of the tibia and extending distally to the navicular. Care was taken with regard to the saphenous

Fig. 3 The residual tibialis posterior tendon stump is resected back to healthy tendon.

nerve and vein anteriorly. The fascia and underlying retinaculum were divided in the line of the incision to expose and assess the tibialis posterior tendon throughout its length and to assess the plantar calcaneonavicular (spring) and deltoid ligaments. Tendinopathy was present in all cases with complete rupture in 10. The diseased or ruptured tendon was excised from distal to proximal back to healthy tendon almost invariably approximately 2 to 3 cm above the medial malleolus (Fig. 3). We found no patients with associated abnormalities of the superficial deltoid ligament. Although Knupp and Hintermann [13] reported abnormalities in 77% of their patients, only two of our own patients required repair of the spring ligament. Our operative findings confirmed the tibialis posterior was completely ruptured in 10 patients (34%), partially ruptured in 15 (48%), and elongated in the remaining seven (18%). The sandbag was removed and replaced under the ipsilateral buttock. We performed a medial displacement os calcis osteotomy using a miniextended lateral approach, which protected the sural nerve in the thick anterior flap. This approach has been the corresponding author's preference in the elective setting after using the extensile approach in a large series of calcaneal fractures. The line of the osteotomy was nearly vertical with protection of the Achilles tendon posteriorly and the long plantar ligament inferiorly. Care was taken with the medial structures when using the saw and the osteotomy was stabilized with two Kirschner wires in the first 19 cases or with two fully threaded small fragment screws for the last 13 cases (Fig. 4). The wound was closed in layers with 3-0 nylon to skin and protected with a dressing.

The tibialis anterior was identified proximally at the level of the transection of the tibialis posterior and distally at its insertion to the medial cuneiform (Fig. 5). In 28 of the 32 patients, we made two 4-cm incisions to expose the tendon at these sites. A medial incision was made in the tendon proximally with a central “nick” in the tendon distally and a tendon stripper passed in either direction to

Fig. 4 The calcaneal osteotomy is internally fixed using a mini-extended lateral approach.

Fig. 7 The tibialis anterior tendon and graft “check rein” suture is applied to the dorsal surface of the naviculocuneiform joint.

Fig. 5 The tibialis anterior tendon is exposed using a two-incision technique.

Fig. 8 The navicular drill hole (arrow) runs from the dorsal to plantar surface.

Fig. 6 The tibialis anterior tendon graft is mobilized.

complete the graft. In four patients with thinner tendons, we extended to a single incision to avoid unnecessary tendon graft damage. The graft was protected in a saline-soaked swab (Fig. 6).

Cobb and others [2–4, 6, 13, 26] used a bony tunnel in the medial cuneiform. The tendon graft will then act as a sling supporting the plantar structures. In this series, a drill hole was made in the navicular joint after suturing the first distal centimeter of the graft and residual tibialis anterior to the dorsal surface across the naviculocuneiform joint (Fig. 7). This will then act as a “check rein” to this joint. We made the dorsal entry point with a 3.2-mm drill slightly medial to the tibialis anterior. Care was taken to avoid damage to the articular surfaces of the talonavicular and naviculocuneiform joints. The tunnel exited through the navicular tuberosity at the site of the main tibialis posterior insertion (Fig. 8). The tendon graft was passed through the bony tunnel after being secured to the dorsal navicular periosteum with a nonabsorbable suture.

The tibialis anterior graft was placed over the front of the medial malleolus and a decision made regarding the graft length required for appropriate tension with the hindfoot inverted and the midfoot and forefoot in slight equinus. The reconstruction should be tight but not to the

Fig. 9 The tibialis posterior tendon-graft reconstruction is depicted before its replacement in the tendon groove (arrow).

extent to prevent reduction behind the malleolus. After trimming the graft, an end-to-end repair of modified Kessler type was performed with a nonabsorbable Number 2 Ethibond suture (Ethicon, Somerville, NJ) and two to three reinforcing 3-0 nylon circumferential sutures, the corresponding author's preference (Fig. 9). We reduced the tendon transfer behind the medial malleolus, which further increases the tension, and the retinaculum was repaired to prevent dislocation. The various skin incisions were closed in layers with 3-0 nylon to skin.

Postoperatively, we placed the limb in a below-knee backslab in slight equinus with inversion of the hindfoot and elevated overnight. Patients were mobilized toe-touch weightbearing with elbow crutches and seen at 2 weeks for suture removal. At this stage, a lightweight cast in a similar position was applied and retained for a further 2 weeks before changing to a neutral cast. Full weightbearing was then allowed as tolerated for a further 4 weeks. At 8 weeks, the plaster was removed and radiographs were obtained of the ankle and foot. The calcaneal osteotomy was assessed clinically for pain on weightbearing and tenderness and radiographically for position by one of the authors (DM). The patients were provided with a temporary ankle brace (Aircast; DJO, Inc, Vista, CA) until a casted functional foot orthosis, prepared on the day of plaster removal, was available with a plan to continue with the orthosis for a minimum of 3 months. The patients were referred for an intensive course of physiotherapy to restore movement and strength. Return to normal footwear with orthotics depended chiefly on swelling.

The patients were reviewed by one of us (DM) at 8 weeks, 6 months, 12 months, and then annually. The clinical evaluation included an assessment of pain, function and alignment using a standard AOFAS hindfoot score [12]. We used a simple patient satisfaction assessment modified from that described by Good and coworkers [5].

Table 2. AOFAS hindfoot score postsurgery

Variable	Score
Pain	37.1 (30–40)
Function	44.2 (32–50)
Alignment	7.7 (5–10)
Total	89 (76–94)

This assessment was initially described in ankle instability with four grades, poor to excellent, and was modified to include five subcomponents scored by the patient with a general patient assessment of satisfaction (Table 1); this satisfaction score has not been validated). The power of the tibialis anterior was assessed using a technique similar to that described by Knupp and Hintermann [13]. With the knee extended on an examination couch, the power of the tibialis anterior was determined manually with resisted dorsiflexion and graded 1 through 5 (DM).

Results

The mean AOFAS hindfoot score was 52.2 (range, 38–70) before surgery increasing to 89 (range, 76–94) after surgery (Table 2). We observed no difference in AOFAS scores between men and women.

Twenty-nine of 32 patients were able to perform a single-heel rise test (none before surgery) at 12 months followup and this persisted to final followup. This group had Grade 5 power of the tibialis posterior tendon. The others had Grade 4 power but were also satisfied with the result. There was Grade 5 power of tibialis anterior in all cases after surgery.

No patients had residual or progressive fixed or mobile deformity. However, all patients preferred to wear at least comfort insoles in their otherwise normal footwear. The os calcis osteotomies healed uneventfully without subsequent deformity.

The complications included one superficial wound infection successfully treated by antibiotics with a temporary dysesthesia in the medial plantar nerve in another. We observed no major wound complications. Three of 32 patients subsequently developed Grade I TPD on the opposite side treated successfully nonoperatively.

Discussion

Tibialis posterior dysfunction with or without plantar ligament dysfunction usually affects the middle-aged and elderly population and is more common in women [22]. There is an association with a wide variety of diseases,

including obesity and hypertension. In patients with healthy plantar ligaments, particularly in the younger age group, there is evidence that the tendon may be divided and the arch may be maintained. However, when there is degeneration of the plantar ligaments in the middle-aged or older subject, this combination is likely to lead to the classical clinical deformity [8, 14, 22]. Unfortunately, the diagnosis may be delayed and deformity progressively increases. In addition, with time, irreversible atrophy and degeneration affect the tibialis posterior muscle and tendon [15]. We therefore assessed patient function and satisfaction after a modified Cobb reconstruction in a group of patients with TPD demonstrating early, flexible deformity using a modification of the Johnson and Strom classification and to confirm or refute the ability of the technique to prevent subsequent fixed deformity.

There are clear limitations in this study. First, this was a single, small, uncontrolled cohort of patients. Second, there was no direct comparison to any current “gold standard” operation, although there is no currently generally accepted procedure. Third, it initially included a patient satisfaction score modified from a technique described some years ago by Good and co-workers in ankle instability [5]. This was not validated more rigorously against other techniques such as SF-12, SF-36, or EQUOL questionnaires. When the study began, these were the generally acceptable tools and similar assessment methods have been used by other workers recently [13]. Our patients subjectively graded their scores as excellent in 20 (68%) and good in 12 (32%) with none rated as fair or poor (Table 3). Earlier papers about the Cobb technique had no specific figures, but these were comparable with similar recent scores in the literature [13] (Table 4). We have simply mentioned them in the discussion for completeness. However, the AOFAS hindfoot score is validated and the results achieved are comparable with others using the same technique [13] and FDL transfer with os calcis osteotomy [17, 18, 25] (Table 5). Finally, there were some reservations about the “extensive” surgical incisions. The scars resulting from this technique did not raise cosmetic concern in any of the patients.

Our data demonstrate that this modified Cobb technique improves function when treating early Johnson and Strom

Table 4. Comparative satisfaction scores for Cobb procedure in the literature

Authors	Excellent	Good	Fair	Poor
Parsons et al. [current study]	68%	32%	None	None
Knupp and Hintermann [13]	41.0%	54.5%	4.5%	None

Table 5. AOFAS scores in the literature

Authors	Technique	Year	Average AOFAS (pre-op)	Average AOFAS (post-op)
Myerson and Corrigan [18]	FDL	1996	48	84
Wacker et al. [25]	FDL	2002	48.8	88.5
Myerson et al. [17]	FDL	2004	—	79
Knupp and Hintermann [13]	Cobb	2007	53.2	88.5
Parsons et al. [current study]	Cobb	2009	52.2	89

Type II TPD after failed nonoperative management. The AOFAS hindfoot scores improved from 52.2 before surgery to 89 postoperatively, comparable with other series [13] and other alternatives [17, 18, 25]. Although not validated, our simple patient satisfaction score suggests high patient-rated satisfaction and the longer-term clinical assessment confirmed there was no progression of the deformity. The data suggest the modified clinical classification is useful at predicting the likely response to this technique in patients demonstrating a Type IIa deformity (Fig. 10), but each of these conclusions would need to be confirmed by a prospective study with updated validated scoring systems. A randomized, controlled trial of this technique compared with FDL transfer and calcaneal osteotomy in patients with this range of deformity would be appropriate.

The procedure is routinely performed with a medial displacement translational os calcis osteotomy. We believe it likely but cannot confirm from our data that in patients with greater deformity, the procedure may need to be combined with spring ligament repair and/or lateral column lengthening. The calcaneal osteotomy is performed for several reasons. First, there is a protective effect on the reconstruction from the more medial position of the

Table 3. Clinical score

Grade	Would have procedure again	Interference with day-to-day activity	Interference with recreation	Pain	Walking aids	Patient assessment
Poor	No	Severe	Severe	Severe, constant	Zimmer frame	Dissatisfied
Fair	Possibly	Yes	Yes	Moderate, frequent	Walking stick	Satisfied with reservations
Good	Probably	None	Mild	Mild, occasional	None	Satisfied
Excellent	Yes	None	None	None	None	Satisfied

Fig. 10 Type II (a) deformity determined by resting forefoot supination.

calcaneus and the consequent hindfoot alignment. Second, the osteotomy allows redirection of the pull of the tendo-Achilles to assist supination rather than pronation and moves medially the origin of the plantar aponeurosis on the heel [20]. This improved position of the plantar aponeurosis allows the windlass function to be activated contributing to heel supination [21]. We believe this fundamental relationship among the tendo-Achilles, the tibialis posterior, and the plantar aponeurosis explains the normal single-heel rise test. The ankle is square to the ground and the subtalar joint is inclined into valgus. As the heel rises, the tibialis posterior is activated and supinates the subtalar joint aligning it more directly with the ankle. This allows a more direct, straighter, and stronger pull of the tendo-Achilles across both joints [1]. The midfoot joints change from a “loose pack” to “tight pack” state preventing pathologic midfoot break.

We believe the Cobb technique has advantages over FDL or flexor hallucis longus transfer, which are weaker muscles and whose absence may be associated with reduced function in the forefoot. This stronger transfer and its anatomic position give greater opportunity for correction of peritalar deformity, including the apparent nonweightbearing forefoot supination [13]. Lateral column lengthening would be reserved for more severe deformities [23, 24] with arthrodeses for those that had become fixed [7, 19].

The Cobb technique has been classically described with a drill hole through the medial cuneiform [2, 3, 6, 13, 26].

As the graft passes on the plantar surface of the naviculocuneiform joint, it reinforces this area by a sling effect. This may also help to protect a spring ligament repair or reconstruction [13]. Using a drill hole in the navicular joint provides a more anatomic course for the proximal part of the tendon graft from the navicular tuberosity. If it is combined with a dorsal reinforcing suture over the naviculocuneiform joint, this will give dorsal stability by a “check rein” effect and may be enhanced on the plantar side with a spring ligament reconstruction or repair. Therefore, the joint is assisted in both tension and compression. Our data suggest earlier diagnosis and treatment of patients with clinical Stage II (a) deformity will lead to improved AOFAS hindfoot score ratings for pain, function, and alignment using a modified Cobb procedure with a medial displacement os calcis osteotomy. In those patients with Stage II (b) deformity, we suspect there may be a similar improvement as in the series described by Knupp and Hintermann [13], but this greater deformity may require consideration of additional surgery to the spring ligament or to the lateral column. That said, if the spring ligament is abnormal in patients with Stage II (a) deformity, reconstruction would be prudent. In the Stage II (c) deformity, in which there is fixed forefoot supination, corrective procedures require derotation and often arthrodesis.

We recommend use of this modified Cobb technique with a medial displacement translational os calcis osteotomy in the management of patients with TPD and Stage II (a) deformity. Our data suggest it is a good alternative to FDL transfer, but this could only be properly confirmed with a properly constructed randomized, controlled trial. Our data suggest this approach provides comparable AOFAS scores to those for available alternatives and emphasize the importance of early diagnosis leading to treatment while deformity is still relatively mild and flexible.

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