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ORIGINAL STUDY

Cobb procedure and Rose calcaneal osteotomy for the treatment of tibialis posterior tendon dysfunction

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Forty-three patients with stage 2 posterior tibialis tendon dysfunction underwent surgical reconstruction in the form of a Cobb procedure and Rose calcaneal osteotomy between 1997 and 2003, and were evaluated pre- and postoperatively.

The average age was 57 years, and the mean follow-up time was 51 months (range 10-83). The average AOFAS score preoperatively was 58 and improved to 85 postoperatively ($p < 0.0001$). Sixty-six per cent of patients achieved a single heel raise. Eighty-four per cent expressed a subjective satisfaction rate, whilst 16% reported no improvement. Seventy-eight per cent of the patients were able to use normal shoes and 65% no longer required the use of any orthotics. The minor complication rate was 16% with no major complications. All osteotomies united uneventfully. Two patients have subsequently developed subtalar osteoarthritis, and six calcaneal screws had to be removed for prominence and tenderness.

Our results compare very favourably with other less anatomical reconstructions, any donor site morbidity has been avoided and there have been very low complication rates.

Keywords :

INTRODUCTION

The tibialis posterior muscle is a very powerful unipennate structure with a limited tendon excursion of up to 2 cm (*14,18*). It functions across the ankle, subtalar, and midtarsal joints and principally acts in creating forefoot adduction and supination, with hindfoot varus and plantar flexion. Additionally, secondary to its anatomical position, it acts as a dynamic stabiliser of the medial longitudinal arch, particularly during mid-stance and initiates heel rise. It is also the primary antagonist of peroneus brevis, a potent foot everter. With chronic posterior tibialis tendon dysfunction (PTTD), the unopposed action of peroneus brevis and ground reaction forces gradually pushes the hindfoot into valgus and the forefoot into abduction, resulting in spring ligament failure and collapse of the medial longitudinal arch.

The aetiology of PTTD is multi-factorial (*16*). The typical presentation and clinical findings of PTTD patients include medial foot/arch pain initially, progressing to more lateral pain as the condition

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advances, with swelling, pes planus, "too many toes sign" (secondary to forefoot abduction), inability to initiate a single heel-rise, first metatarsal rise sign (*9*), and a progressive deformity. Magnetic resonance imaging (MRI) and ultrasonography (USS) may help with the evaluation of the soft tissues and tendons, in addition to weight-bearing radiographs in order to assess the calcaneal inclination angle, navicular coverage, forefoot angles and the presence and degree of arthritis (*17*).

Johnson and Strom stage 2 posterior tibialis tendon dysfunction is characterised by a flexible deformity, moderate pain, marked weakness with inability to initiate single heel-rise, and a positive "too many toes sign" (*11*).

Although they may be beneficial in stage 1 PTTD, there is paucity of data concerning soft tissue procedures and attempts at direct repair of the posterior tibial tendon (*3,12*). Therefore substitution procedures through the use of tendon transfers are the preferred surgical treatment methods for stage 2. A variety of bony procedures have been described along with tendon transfers in an attempt to improve deformity and reduce dynamic forces required on the tendon substitution.

The use of split tibialis anterior tendon transfer (combined with the Rose calcaneal osteotomy and reinforcement of the spring ligament) is a recognised procedure in the treatment of stage 2 tibialis posterior dysfunction (*2,8*), but there is paucity of data regarding its results.

MATERIALS AND METHODS

Forty three consecutive patients with stage 2 PTTD, and failed conservative management, underwent operative treatment in the form of a Cobb tendon procedure and Rose calcaneal osteotomy between 1997 and 2003, at a tertiary referral centre. Patients with fixed deformities markedly abducted unstable forefoot, degenerate subtalar joint, poor soft tissue quality and neuromuscular disorders had been considered ineligible for this type of reconstructive surgery.

The notes were retrospectively reviewed and patients were assessed by a detailed telephone interview or clinical review and completion of the American Orthopaedic Foot and Ankle Society hindfoot scores (AOFAS) at 10 months and again at latest follow-up. All patients had preoperative AOFAS scores available. Due to the widespread geographic location of the discharged patients it was not possible to recall some of them into a clinic. In these patients, the clinical objective data was extracted from the last assessment, and the subjective data was gathered via the telephone interview.

In all patients the Cobb procedure and Rose calcaneal osteotomy was performed by the two senior authors (JCA and DS). Two patients underwent simultaneous 1st tarso-metatarsal fusion surgery.

All 43 patients were available for follow-up, averaging 51.4 months (10 to 83 months). The average age of the patients at the time of surgery was 57 years (27 to 75 years), comprising 6 male and 37 female patients. The right side was affected in 13 patients, the left side in 30 patients. Nineteen patients (44%) described a history of trauma preceding symptoms, and one patient had psoriatic arthropathy.

Statistical analysis was carried out using paired t test to reveal differences in pre and post operative AOFAS scores, and unpaired t test to compare subgroups.

Surgical technique

The Rose calcaneal osteotomy (*20*) was performed first, using the extended lateral approach. A transverse osteotomy was fashioned, followed by excision of a medially based ½ width wedge of bone. This then allowed a combination of 50% medial displacement and varus angulation to realign the insertion of the Achilles tendon (fig 1). The osteotomy was stabilised with a large AO cancellous screw positioned axially.

Following the bony realignment procedure, the tibialis posterior tendon was exposed, using a medial 8-10 cm curvilinear incision extending from the posterior aspect

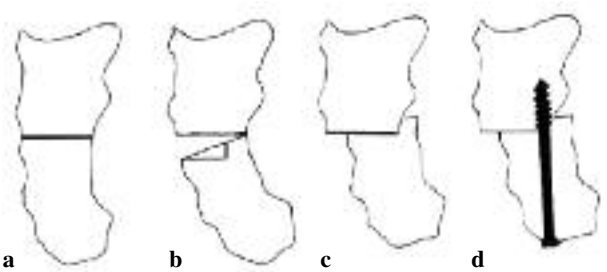

Fig. 1. — Schematic illustration of a Rose calcaneal osteotomy (a), resection of triangle of bone (b), medial displacement and varus angulation of the calcaneum (c) secured with screw fixation (d).

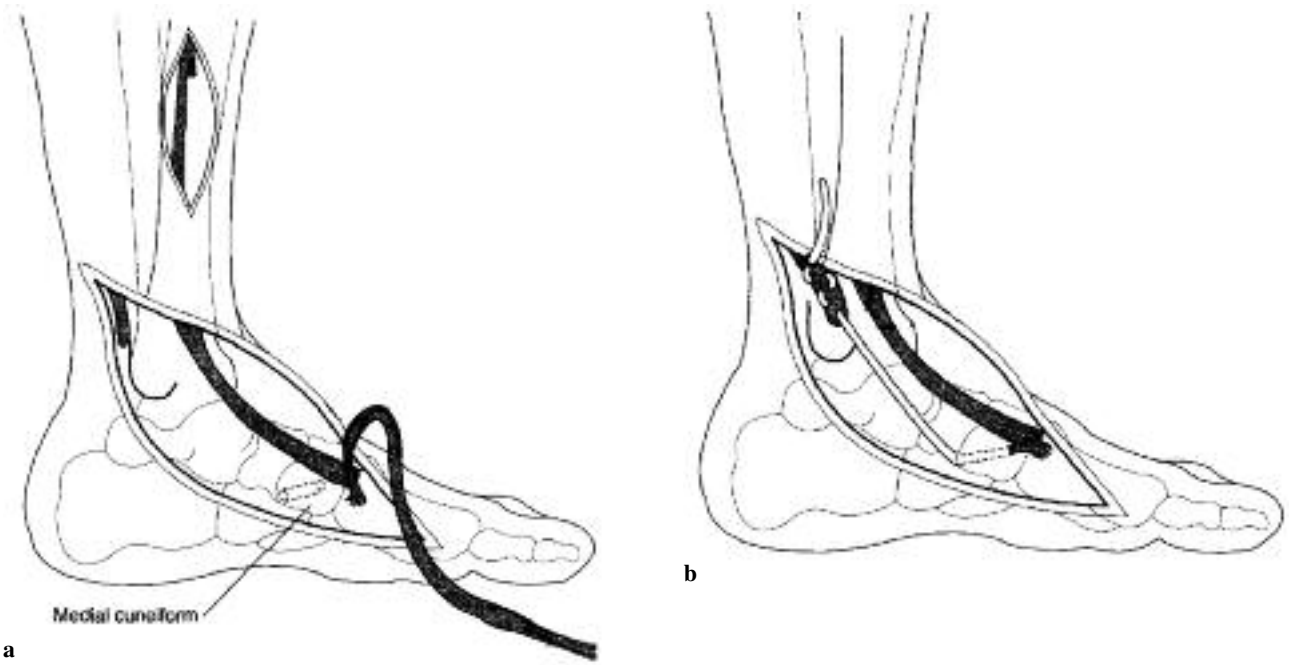

Fig. 2a/b. — Schematic illustration of the Cobb procedure showing harvesting of the split tibialis anterior tendon with placement of a bony tunnel in the medial cuneiform (a). The tendon graft, its distal end still attached, is then fed through the bony tunnel and attached to the end of the posterior tibialis tendon with a Pulvertaft weave (b), before it is "snapped" back into its groove behind the medial malleolus and under the talonavicular joint.

of the medial malleolus to just distal to the medial cuneiform (fig 2) *(2)*. The diseased segment of tendon was then excised. The Cobb tendon procedure utilises part of the tibialis anterior tendon harvested through a separate 3 cm pretibial incision at its musculotendinous origin. The distal end of the medial 1/2 to 3/5 of the split tibialis anterior tendon was drawn into the distal incision, along its original tract thus dissecting itself free, to its distal attachment into the medial cuneiform and base of the first metatarsal. A tunnel was drilled through the medial cuneiform, starting antero-medially and exiting plantar-laterally. With the foot in plantar flexion and inversion the harvested half tendon was then passed through the bony tunnel exiting on the plantar aspect. It was then attached to the proximal stump of the tibialis posterior tendon using a combination of Pulvertaft weave and No 1 vicryl. The tendon was then "snapped" back into its groove behind the medial malleolus and under the talonavicular joint ; the flexor retinaculum was repaired. The repair was thereby heavily tensioned. The transferred tendon also acts as a substitute for the attenuated spring ligament, via its direction of pull.

Postoperatively, the patients were immobilised using a below-knee non weight bearing plaster cast with the ankle plantigrade and hind foot inverted. The cast was changed at 2 weeks and 4 weeks, each time bringing the hind foot into more neutral. At 6 weeks a neutral weight bearing cast was applied for 2 weeks. Thereafter, physiotherapy was commenced to regain muscle strength and range of motion.

RESULTS

At the time of surgery, 56% had an abnormally stretched and thickened tibialis posterior tendon without evidence of any tear or splits, with 44% displaying complete tendon ruptures. Overall, the average preoperative AOFAS scores were 58 and improved postoperatively to 85 (average improvement = 27, statistically significant ($p < 0.0001$)). At latest follow-up, 84% of patients were subjectively "much better" or "better", with 16% claiming to be the "same" and no patients were "worse" following

Fig. 3a/b. — Photographs showing valgus deformity and "too many toe signs" of the right foot, and postoperative appearance of the previously corrected left foot (a) Frontal view (b) Rear view.

surgery. The average preoperative and postoperative scores for those with intact tendons were 59 and 82 respectively (average improvement = 23, statistically significant ($p < 0.0001$)), with a 76% subjective satisfaction rate ("much better" or "better"). The average preoperative and postoperative scores for those with ruptured tendons were 56 and 88 respectively (average improvement = 32, statistically significant ($p < 0.0001$)), with a 94% subjective satisfaction rate ("much better" or "better"). The difference in postoperative scores between the two subgroups is not statistically significant ($p = 0.168$).

The ability to initiate a single heel raise was achieved by 66% of patients. Overall 78% were able to use normal footwear, and 65% no longer required orthotics (fig 3).

Complications

We had 6 postoperative complications consisting of 2 partial nerve injuries (1 saphenous, 1 sural) and 4 cases of minor oozing from the lateral wounds which later resolved uneventfully. Two cases went on to develop subtalar joint osteoarthritis. All osteotomies went on to clinical and radiological union, although six cases subsequently required calcaneal screw removal for local irritation.

DISCUSSION

Numerous surgical procedures have been described for the management of stage 2 PTTD whic have failed non-operative treatment, with the ultimate goal being alleviation of symptoms, restoration of normal foot alignment, and limitation of loss of foot and ankle function. Historically, triple arthrodesis had been the treatment of choice for stage 2 and 3 PTTD in the presence of hindfoot deformity, as it reproduces a stable and realigned hindfoot. However, the resultant loss of hindfoot motion increases the stresses on adjacent joints, leading to degenerative changes with return of pain. Thus, in recent years, there has been a move toward joint sparing procedures for late stage 1 and 2 disease. As attempts at direct repair of the posterior tibial tendon have been unsatisfactory (*12*), substitution through the use of tendon transfers is an alternative solution. Tendon augmentation may be carried out in isolation or in combination with osseous procedures. Many combinations have been described including calcaneal osteotomy, medial column stabilisation or lateral column lengthening, all of which aim to decrease the strain on the tendon reconstruction.

Evans popularised the idea of lateral column lengthening in children with flexible flatfoot in 1961, and it subsequently became a popular osseous procedure to correct the forefoot abduction deformity in adult acquired flat foot (*4,5*). This procedure is associated with high complication rates with regard to wound infection and lateral pain (*15,19*). Medial column stabilisation can be achieved by talonavicular fusion in isolation or in combination with other procedures (*13*), but this sacrifices flexibility and again can lead to degenerative changes in adjacent joints.

The commonest combination of procedures is calcaneal slide osteotomy with tendon reconstruction. The bony correction that can be achieved is restricted by the narrow width of the calcaneum. In our study, we used an osseous calcaneal procedure which was described and performed by GK Rose (*20*). By combining angulation and translation, greater correction can be achieved together with reduction in complications associated with screw placement. We found it to be an excellent adjunct in the treatment of stage 2 PTTD when used in combination with a Cobb tendon reconstruction.

Flexor digitorum longus tendon transfer is the most commonly used tendon transfer in the treatment of PTTD. This is used as a complete musculotendinous unit replacement in place of tibialis posterior and has been shown to be efficacious in the short to intermediate term (*6,21,24*). There are, however, concerns regarding longevity in view of the poorer strength characteristics compared with that of tibialis posterior tendon. Additionally, it does not address the failed spring ligament and hence medial column stability. Other tendons, which may be used, are the flexor hallucis longus and tibialis anterior tendons (*8,22*). In 1990 Helal described the procedure used for tibialis posterior tendon rupture by Cobb for many years (*2,8*). The Cobb reconstruction relies on re-recruiting the tibialis posterior muscle either in isolation or in conjunction with an osseous procedure (*1,26*). By the nature of the tibialis anterior graft insertion and alignment, it also acts as a substitute for the spring ligament. Helal described good results in 6 patients at 1 to 4 years using isolated Cobb procedure, with one failed procedure (*8*). Janis *et al* similarly reported 11/17 patients with excellent or good resolution of pain and good return to full activity (*10*). The potential recovery of a previously defunctioned and atrophied muscle has been the subject of much scrutiny. Wacker *et al* alluded to the "irreversible fatty degeneration" seen in a study using MRI (*25*). Other research involving combined imaging and histological animal studies in rotator cuff musculotendinous units have shown this to be fatty displacement of myofibrils rather than actual degenerative replacement (*7*). A study evaluating pre and post late tibialis posterior tendon reconstruction for complete ruptures, utilising an interpositional tendon graft confirmed reversibility of the fatty "degeneration", and demonstrated good recovery potential, excellent functional results, with a significant increase in muscle strength (73% of normal side) and size (55% of normal side) (*23*). In diseased but intact tibialis posterior tendons, Wacker *et al* demonstrated lack of fatty "infiltration" and good retention of muscle volume (83% of normal side) (*25*). Previous studies have failed to quantify the proportion of intact versus ruptured tendons, but in our study we noted 56% had attenuated but intact tendons. Interestingly, the functional objective and subjective improvements were better with the ruptured group ; this difference was not statistically significant ($p = 0.167$).

Based on the results of our study, we propose that a combined Cobb procedure and Rose calcaneal osteotomy, is an effective and safe treatment option for PTTD. We believe that the re-recruitment of tibialis posterior tendon after altering the mechanics of the hind foot by a calcaneal osteotomy is an alternative long-term solution to the use of the flexor digitorum longus (with a longer muscle tendon unit excursion). However, long-term comparative studies of both procedures are needed.

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