SPLIT TIBIALIS POSTERIOR TRANSFER FOR EQUINOVARUS DEFORMITY IN CEREBRAL PALSY

LONG-TERM RESULTS OF A NEW SURGICAL PROCEDURE

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We report the results of a new surgical procedure for spastic equinovarus deformity due to cerebral palsy. This is the transfer of the anterior half of the split tibialis posterior to the dorsum of the foot through the interosseous membrane. We performed the operation on 23 feet in 18 children.

All patients were assessed before operation and at follow-up at a mean of 8.4 years postoperatively. Using the criteria of Kling et al (1985), excellent results were obtained in 14 feet, good results in eight, and a poor result in only one.

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Spastic equinovarus deformity is often seen in patients with cerebral palsy. Overactivity of the tibialis posterior is thought to be the cause (Ruda and Frost 1971; Turner and Cooper 1972; Bleck 1987) and several surgical procedures have been described which use the tendon to correct the deformity. Simple release of tibialis posterior from its insertion was described by Duncan (1960), while others favoured lengthening (Banks and Panagakos 1967; Hoffer 1976). Baker and Hill (1964) rerouted the tendon anterior to the medial malleolus with good results, but Bisla, Louis and Albano (1976) did not find this method effective. Rerouting through the interosseous

membrane to the dorsolateral aspect of the foot has been widely used (Gritzka, Staheli and Duncan 1972; Turner and Cooper 1972; Bisla et al 1976; Root, Miller and Kirz 1987). Most of these surgical procedures, however, have produced inconsistent results (Watkins et al 1954; Duncan 1960; Baker and Hill 1964; Banks and Panagakos 1967; Gritzka et al 1972; Schneider and Balon 1977; van der Werf and Tonino 1984; Root et al 1987).

The technique of splitting the tendon and implanting half of it into the peroneus brevis, behind the lateral malleolus, was reported by Kaufer (1977) and later used by Green, Griffin and Shiavi (1983) and by Kling, Kaufer and Hensinger (1985).

We believe that splitting the tendon and transferring half of it through the interosseous membrane to the lateral cuneiform is a new procedure. We report our use of this method in 23 equinovarus feet.

PATIENTS AND METHODS

From 1977 to 1988, 20 patients with spastic cerebral palsy, with 25 equinovarus feet, underwent split tibialis posterior tendon transfers at the Duchess of Kent Children's Hospital. Of these, 18 (23 feet) were reviewed. There were eight boys and ten girls and their average age at operation was 8.2 years $\pm$ 2.2 (4 to 12.6) and at final follow-up 16.4 years $\pm$ 3.7 (8 to 21.5). The mean follow-up time was 8.4 years $\pm$ 3.4 (4 to 14.5); eight patients (11 feet) were 18 years or older at follow-up.

There were ten hemiplegics, seven spastic diplegics and one quadriplegic. Five patients had bilateral surgery. None of them had dyskinesia, athetosis or rigidity. Preoperatively, they could all walk, 13 independently and five with aids.

Eight patients had tightness of the hamstrings (11 legs), two had dislocated hips and one had a cavus deformity of the same foot. None of the patients had had any previous surgical procedure on the foot.

The selection criteria for surgery were an equinovarus gait, hindfoot varus and forefoot adduction with or without fixed equinus deformity, age four years or more, and failure of an orthosis to control the foot.

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Operative procedures. A medial incision is made along the tibialis posterior tendon, from 5 cm proximal to the medial malleolus to the navicular. The tendon is exposed, preserving the flexor retinaculum, and split longitudinally up to the musculotendinous junction (Fig. 1a). The anterior half of the tendon is released from its navicular insertion (Fig. 1b). Through a separate 2 cm anterior incision a window is made in the interosseous membrane just proximal to the inferior tibiofibular syndesmosis and the detached half of the tendon is passed through this hole. A third incision, 2 cm long, is made over the dorsum of the lateral cuneiform. The tendon is passed subcutaneously to this incision and through a drill hole in the lateral cuneiform (Fig. 1c). The tendon suture is tied under tension over a button on the sole of the foot and the junction of the tendon with the drill hole edge is reinforced by a few sutures to the periosteum. Postoperatively, a well-padded below-knee plaster cast is applied with the heel in slight valgus and the foot plantigrade. Weight-bearing is started in plaster three weeks after the operation. The cast and the tendon suture are removed six weeks postoperatively. The patient then wears a short-leg caliper with a posterior stop for six months to one year.

Assessment. A clinician and a physiotherapist performed the assessment which included analysis and video recording of the gait and clinical photographs. EMG studies were also performed in eight patients. Standing anteroposterior and lateral radiographs of the foot and ankle were taken.

The results were graded according to Kling et al (1985):

Excellent. The foot was plantigrade with no fixed or postural deformities. Normal shoes could be worn. There were no callosities and the patient was pleased with the result.

Good. There was less than 5° of varus, valgus or equinus deformity. Normal shoes could be worn. There were no

callosities and the patient was satisfied with the procedure.

Poor. There was recurrent equinovarus deformity or a reverse deformity of more than 5°.

RESULTS

Correction of equinus deformity. The 13 feet with fixed equinus deformities of more than 10° (Fig. 2a) all had subcutaneous release of tendo Achillis at the time of the tendon transfer. At follow-up all were plantigrade (Figs 2b and 2c), except one which had a 5° persistent equinus deformity.

The ten feet with dynamic equinus deformity in which no tendon lengthening had been performed were all plantigrade at follow-up.

Correction of hindfoot varus. All 23 feet had preoperative varus deformity of the hindfoot. One foot had a fixed varus of 20° which was corrected by a calcaneal osteotomy at the time of the tendon transfer. At follow-up 14 feet had no residual hindfoot deformity (Fig. 2c). Seven had persistent hindfoot varus of 5° or less and one had a 5° valgus deformity. In one foot, a valgus heel developed four years after operation and the deformity continued to increase until a second procedure for tenotomy of the transferred tendon was undertaken.

Correction of forefoot varus. Preoperatively, all 23 had varus of the forefoot (Fig. 3). At follow-up 19 feet had full correction, three had persistent varus of 5° and one (the case in which the transferred tendon eventually required tenotomy) had more than 10° of valgus.

Muscle grading before and after surgery

Dorsiflexors. Muscle grading was assessed by the MRC grading scale. Preoperatively, two feet had zero grading. Of the remaining 21, eight were grade III, seven grade IV, and two grade V. Four feet (two patients) could not be graded accurately due to lack of co-operation. All but two of the feet with muscle power of less than grade V

Fig. 2a

Fig. 2b

Fig. 2c

Figure 2a - Feet of a nine-year-old boy showing preoperative equinovarus deformity and forefoot adduction. Figure 2b - The same boy nine years after split tibialis posterior transfer and subcutaneous lengthening of the tendo Achillis showing full correction of the forefoot deformity. Figure 2c - The same boy showing full correction of the hindfoot varus.

preoperatively showed postoperative improvement of at least one grade. The overall improvement in muscle grading was significant (Student's *t*-test, $p < 0.001$).

Invertors. Preoperatively, the muscle power was grade V in nine, grade IV in eight, grade III in one and grade II in one. Two patients (four feet) could not be graded due to lack of co-operation. At follow-up, there was an average loss of one grade of muscle power (range 0 to 5).

Overall grading. At a mean follow-up time of 8.4 years there were 14 feet with excellent results, eight with good results and one with a poor result. The failure was in the patient who developed a reverse deformity. At follow-up 13.5 years after operation he had a plantigrade foot with pes planus and hindfoot and forefoot valgus of about 20° .

Of the eight feet with good results, seven had mild hindfoot varus (5° or less); one also had 5° of equinus. The remaining patient had 5° of valgus of the hindfoot. Seven of these feet had a flat-foot gait and one patient walked with a mild equinovarus gait.

DISCUSSION

Duncan's (1960) operation of tenotomy of the tibialis posterior tendon at its insertion often led to collapse of the talonavicular joint (Green et al 1983; Bleck 1987; Root et al 1987). Lengthening of the tibialis posterior was advocated by Banks and Panagakos (1967), Hoffer (1976) and Bleck (1987) but at long-term follow-up others have reported a high incidence of recurrence (Ruda and Frost 1971; Root et al 1987).

Rerouting of the tibialis posterior tendon anterior to the medial malleolus (Baker and Hill 1964) was a satisfactory procedure in the hands of its originators, but Bisla et al (1976) did not achieve adequate correction of deformity in their patients. Transfer of the whole tibialis posterior tendon to the dorsum of the foot through the interosseous membrane produced satisfactory results at three years or less (Watkins et al 1954; Gritzka et al 1972; Williams 1976; van der Werf and Tonino 1984), but in the longer term (five to six years) the results were generally poor, mainly due to development of the reverse deformity (Turner and Cooper 1972; Schneider and Balon 1977).

The split tendon transfer to the peroneus brevis, passing posterior to the tibia (Kaufer 1977), was reported to give good results at five-year follow-up and this was later supported by Kling et al (1985) who had satisfactory results in 34 of 37 feet. Their study, however, included patients with spasticity after head injuries and encephalitis. Green et al (1983) reported 100% excellent or good results with the same procedure but only at a minimum follow-up period of two years; their patients with good results (four feet) were still using night braces to prevent recurrence of deformity. In most studies the continued need for a brace is considered to indicate a poor result (Root et al 1987).

All but one of our patients had excellent or good

Fig. 3

Standing radiographs of the feet of an 11-year-old girl with spastic diplegia and bilateral forefoot adduction (above). Seven years after tendon transfer there is good correction of the deformity (below).

results at a mean follow-up of 8.4 years. The one patient with a poor result relapsed into overcorrection four years after operation, demonstrating that a long follow-up is necessary after these procedures.

In nine feet the tibialis anterior was strong preoperatively (grade IV or V) although this muscle was not able to dorsiflex the ankle. After the tendon transfer, the position of the foot improved and the tibialis anterior muscle was able to function effectively. Thus the operation helps to restore active dorsiflexion in spastic equinovarus deformity.

Normally, the tibialis posterior is active during the stance phase (Bleck 1987). In spastic equinovarus deformity, it is active during the swing phase as well (Waters et al 1982; Bleck 1987). Even if the transferred part of the muscle acts only during the stance phase, its tenodesis effect continues to counteract the equinus and varus forces.

We believe that although Kaufer's method may be

suitable for varus deformity of the hindfoot, our technique is indicated in spastic equinovarus deformities. The split tendon is converted from an equinovarus-producing muscle to a 'balanced yoke' which spans the medial and lateral aspects of the foot, as well as the axis of dorsal and plantar flexion of the ankle.

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