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Original article

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Split Transfer of Tibialis Posterior for Dynamic Equinovarus Deformity in Children with Cerebral Palsy

Ravi Chandra Vattipalli DNB Ortho [1], Manoranjan Bandela MS Ortho [1]

Abstract

Children with cerebral palsy often have foot deformities, equinovarus being one of the most common deformities. Several procedures have been advocated, centered around rerouting the tibialis posterior tendon. Whole transfer of the tendon is associated with poor results. The current study aims to establish the efficacy of split tendon transfer of the posterior tibial tendon rerouted through the interosseous membrane and anchored to the lateral cuneiform. Surgical results were analyzed using an indigenously developed score, considering the cultural need for bare foot walking.

Keywords: Split tendon transfer of tibialis posterior, equinovarus deformity, cerebral palsy

Dr. Ravi Chandra Vattipalli

Dr. Manoranjan Bandela

Introduction

Children with cerebral palsy (CP) often have foot deformities, with equinovarus being one of the most common [1]. Equinovarus foot deformity is caused by the spasticity of the foot invertors—tibialis anterior (TA) and tibialis posterior (TP) muscles. Excessive muscle spasticity can lead to imbalance and painful callus formation at the lateral plantar surface and can largely impact patient's walking ability. Over activity of the posterior tibial tendon causes the equinovarus deformity, which is brought out or unmasked by the effort of walking [1], [2], [3], [4].

Several procedures, directed mostly at the posterior tibial tendon, have been advocated to correct this equinovarus posture [5-7,8,9-11,12-14]. Baker and Hill removed the tendon from its sheath and rerouted it anterior to the medial malleolus, with good results in twenty-seven feet. However, Bleck noted poor results with this operation, often because of late deformities of the calcaneus, because the transferred spastic posterior tibial muscle acted continuously as a strong dorsiflexor of the ankle. Bisla et al. reported no change in gait after this operation in most of the feet that they reviewed, and stated that none had complete correction of the varus deformity. Tenotomy of the posterior tibial tendon at its insertion has led to collapse of the talonavicular joint with significant valgus deformity, but lengthening of the tendon has been favored and has produced good results [7,10]. Full transfer of the posterior tibial tendon through the interosseous membrane has been popular [6,8,11,12-14] but an unacceptable number of poor results have been reported [6,7,11,12]

A possible treatment option for these patients is the split tendon transfer of the posterior tibial muscle (SPOTT). This technique involves longitudinal tendon splitting, detaching the tendon from its medial insertion, and transferring the lateral part of the split tendon to the outer part of the foot [16]. The purpose of the split tendon transfer is to change the muscle-tendon-bone complex and gain balance between foot invertors and evertors, while maintaining foot stability and flexibility [15]. The SPOTT procedure was first described in 1977 by Kaufer [16] and further developed by Green [17] and Kling [18]. This procedure produces a neutral hind

Address of Correspondence
Dr. Ravi Chandra Vattipalli,
Consultant Orthopedic Surgeon, Apollo Hospitals,
Visakhapatnam, Andhra Pradesh, India.
E-mail: vatravi@hotmail.com

[1]Department of Orthopaedics, Apollo Hospitals, Visakhapatnam, Andhra Pradesh, India.

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foot alignment while maintaining adequate plantar flexion. Transfer through the interosseous membrane, retains the advantage of anterior to posterior directed pull, while a split transfer avoids excessive valgus or persistent plantar flexion. Keeping these in mind, we employed the SPOTT procedure with rerouting through the interosseous membrane. We evaluated our results keeping in mind the demand of patients for barefoot walking. Barefoot walking requires good calf push off power as well as ankle dorsiflexion to avoid forefoot drag during the swing phase of gait. Children were evaluated at 4 and 6 months postoperatively to assess gait patterns and the need for walking aids needs.

Materials and Methods

Study Population

We conducted a retrospective study on children between 7 and 16 years of age with dynamic equinovarus secondary to GMFCS I – III spastic cerebral palsy. Feet with equinovarus deformity resulting from other conditions and ataxic or athetoid cerebral palsy were excluded. The study includes 36 feet in 27 children. 9 children had spastic diplegia requiring correction of equinovarus in both feet along with simultaneous medial hamstring recession for knee flexion deformity. 18 children had hemiplegic cerebral palsy. All children initially underwent physiotherapy and serial corrective cast followed by bracing. Surgery was reserved for those children where conservative means failed.

Surgical Technique

In the modified SPOTT procedure, the tibialis posterior tendon was exposed using an L-shaped incision starting 10 cm proximal to the medial malleolus, along the front edge of triceps surae muscle, curving around the ankle and ending at the level of navicular tuberosity. The TP tendon sheath was opened longitudinally to the tip of the medial malleolus where it was left intact with part of the deltoid ligament, approximately 1 cm from its insertion. The tendon was split longitudinally in two equal halves (anterior and posterior) from the origin of the muscle belly proximally to its insertion in the navicular distally. The posterior half was detached from the navicular insertion and a provisional suture was placed at the tendon tip (absorbable, synthetic suture size 1 or 2). It was delivered into the proximal aspect of the wound. The split posterior half of the tendon was brought into the anterior compartment. Through an incision overlying the site of anterior transposition, a tendon tunneler was passed distally to the lateral cuneiform and tendon delivered distally. A tunnel was fashioned in the lateral cuneiform and the tendon passed into the tunnel. Suture was anchored to a button in the sole of the foot with adequate soft padding. The tendon bone interface was also reinforced using absorbable synthetic sutures. All wounds were closed in anatomical layers. A below-knee walking cast was applied for six weeks after surgery. The cast and the button were removed subsequently and rehabilitation initiated.[19]

The decision to perform additional procedures such as split tendon transfer of the tibialis anterior (SPLATT); equinus correction (Achilles tendon (TA) elongation, Strayer's, Hoke) and other procedures was left to the discretion of the surgeon.

All children were assessed on their ability to push off, bare foot walking, ankle deformity and ease of clearing the toes during swing phase at 4 and 6 months after surgery. Absence of ability for bare foot walking, poor push off, persistent equinus deformity or varus were classified as Poor.

Children who were able to walk bare foot without need for a walking aid with good ground clearance and push off as well as absence of deformity were classified as Excellent.

Children with good push off and barefoot walking ability but either postoperative valgus or poor ground clearance (insufficient dorsiflexion power) but plantigrade foot were classified as Good.

Results

Three children had a poor result with persistent equinus deformity, poor ground clearance and persistent varus deformity. All these children had hemiplegic type of CP. One child had a dysfunctional transferred tendon and was reoperated. The two other children had a functioning transferred tendon with mild difficulty in walking. They were managed by bracing.

Six children with excellent result were able to perform barefoot walking without need for aids. Fifteen children

Table 1: shows the results according to type of cerebral palsy.

Patient	Gender	Topographical type	Result	Postop Tendoachilles push off	Bare foot walking	Postop Valgus or varus	Postop Toe Drag
1	M	CP Hemiplegia	Good	+	+	-	-
2	M	CP Diplegia	Good	+	+	-	-
3	M	CP Hemiplegia	Good	+	+	-	-
4	M	CP Hemiplegia	Good	+	+	-	-
5	M	CP Hemiplegia	Excellent	+	+	-	-
6	M	CP Diplegia	Good	+	+	-	-
7	M	CP Hemiplegia	Good	+	+	-	-
8	M	CP Hemiplegia	Good	+	+	-	-
9	F	CP Hemiplegia	Excellent	+	-	-	-
10	M	CP Hemiplegia	Poor	-	-	+	+
11	M	CP Hemiplegia	Good	+	+	-	-
12	M	CP Diplegia	Good	+	+	-	-
13	M	CP Hemiplegia	Poor	_	-	-	+
14	M	CP Diplegia	Good	+	+	-	+
15	M	CP Hemiplegia	Poor	_	-	+	+
16	M	CP Hemiplegia	Good	+	+	-	-
17	M	CP Hemiplegia	Excellent	+	+	-	-
18	M	CP Hemiplegia	Good	+	+	-	-
19	F	CP Hemiplegia	Good	+	+	-	-
20	M	CP Hemiplegia	Excellent	+	+	-	-
21	M	CP Hemiplegia	Good	+	+	-	-
22	M	CP Diplegia	Excellent	+	+	-	-
23	M	CP Hemiplegia	Excellent	+	+	-	-
24	M	CP Diplegia	Good	+	+	-	-

with good results a functional gait and able to walk barefoot which meant good ground clearance as well as good push off, but had mild dynamic varus probably due to improper tensioning of the transferred tendon.

Discussion

Spastic varus and equinovarus deformities are frequently seen in patients with spastic cerebral palsy. The etiology of the varus deformity of the hind part of the foot is usually a spastic posterior tibial muscle [6,7,8,10,11,12]. Hoffer et al. postulated that over activity of the anterior tibial muscle is to blame for the varus deformity of the hindfoot. They described the split anterior tibial-tendon transfer that yielded good correction of the hindfoot varus in their series. It has been our experience, however, that the anterior tibial muscle is weak in most children with a spastic hemiparesis and therefore it is not the offending muscle [20]. In addition, we believe that the varus deformity of the hindfoot is caused by overactivity of the posterior tibial muscle unopposed by weak peroneal muscles, whereas a varus or supination deformity of the midfoot is caused by overactivity of the anterior tibial muscle [6-12].

Transfer of the posterior tibial tendon to the dorsum of the foot through the interosseous membrane has been described [21]. Williams [24] described results in 42 patients and considered the technique to be reliable and successful. Results of other studies with long-term follow-up were poor. It was noticed that a reverse deformity often developed when this procedure was combined with an Achilles tendon lengthening [22,23]. Complete anterior transfer of the posterior tibial tendon combined with a heel-cord lengthening greatly weakens plantar flexion. The spastic posterior tibial tendon being converted into a dorsiflexor of the foot, a calcaneus deformity develops [22,23]. Transfer of the PT yielded unpredictable results in children less than 6 years of age and in children where the PT was continuously active in the stance and swing phases of gait [21]. These problems prompted us to favour the split tibialis posterior transfer over a whole tendon transfer.

Treating patients with equinovarus deformity due to CP can be challenging for the surgeon. Success of the SPOTT procedure largely depends on achieving adequate tension of the transferred tendon and obtaining the optimum foot position. Several authors have tried to modify the SPOTT procedure with alternative attachment sites or different routes for the transferred tendon [25, 26]. For patients with TP overactivity and dorsiflexor weakness, two additional approaches were developed where the split TP tendon was routed through the interosseous membrane. By attaching the split TP tendon to the lateral cuneiform on 23 feet, Saji et al [26] achieved excellent results in 61% of feet, good results in 35% of feet and only one poor result at 8.4 years of follow-up. Other authors have transferred the split TP tendon through the interosseous membrane to the distal peroneus brevis tendon [25]. Our procedure consisting of split tibialis posterior tendon transfer through the interosseous membrane yielded good to excellent results in 87.5% of cases while poor results were seen in 3 cases, all of them being children with hemiplegic CP with weak tibialis anterior muscle. The stronger calf muscles caused persistent equinus in the postoperative period.

Conclusion

The present study highlights the importance of bare foot walking as a criterion to assess surgical outcomes in the developing world. Good plantar flexion power to achieve push, adequate dorsiflexion during swing phase for ground clearance, muscle balance at the ankle and subtalar joints are necessary to have stable, comfortable barefoot ambulation. The technique of rerouting the split tibialis tendon transfer to the lateral cuneiform through the interosseous membrane have yielded good to excellent results in majority of children with equinovarus deformity secondary to spastic cerebral palsy. We acknowledge the limitations of our study such as a small sample size and absence of gait analysis. Further studies are necessary to evaluate the scoring system used by us.

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Declaration of patient consent : The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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