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Original Article

Study of Split Tibialis Anterior Tendon Transfer to Peroneus Brevis in Management of Equinovarus Deformity among Children with Cerebral Palsy

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Abstract

Background: About one third of kids with spastic hemiplegic cerebral palsy also have equinovarus. For equinovarus deformity, the ideal soft-tissue surgical treatment is a split transfer of the tibialis anterior tendon.

Objectives: To evaluate the radiological as well as clinical results of split transfer of tibialis anterior to peroneus brevis in management of equinovarus deformity among children with cerebral palsy.

Subjects and methods: This is interventional clinical trial study that was performed on 18 patients presented to orthopedic department at Zagazig University Hospitals with equinovarus foot deformity undergone split tibilais anterior transfer to peroneus brevis with fractional lengthening of tibilais posterior and gastrocnemius recession.

Results: The pain and difficulty of shoe-wearing were improved in all the patients (100.0%). There were 15 patients (83.3%) had an excellent outcome, and only 3 patients (16.7%) had a good outcome according to Kling's score. We found a highly statistically significant decrease (improve) in the GMFC score from (2.3±0.48) to become (1.3±0.47) (p-value<0.001) with a percent of improvement (50.4%) ranging from (43.1%-69.2%). There were 13 patients (72.2%) didn't have any complications, two cases (11.1%) had dry, flaky skin & itching after the cast and three cases (16.7%) had superficial wound infections which treated by parental antibiotics for 2 weeks.

Conclusion: The benefits of split tibialis anterior transfer to peroneus brevis in treating equinovarus foot deformity in cerebral palsy patients have been demonstrated by this research. The procedure is technically simple, with high rates of success and minimal complications.

Keywords: Split Tibialis Anterior Tendon Transfer, Peroneus Brevis, Equinovarus Deformity, cerebral palsy.

INTRODUCTION

Treatment for cerebral palsy often involves a multidisciplinary team of experts in the field. The team includes not only medical professionals (general practitioners, neurologists, physiatrists, orthopedists, and any other specialists required due to the presence of co-morbid conditions), but also therapists (physical, speech and occupational), mental health professionals, as well as social workers/case managers. The goal of any interventions should be to increase functionality and lessen the impact of disability. Realistic functional goals should be established by the patient, family, and team and evaluated regularly [1].About one third of kids with spastic hemiplegic cerebral palsy have equinovarus. Among these individuals, it is second only to equines as the most prevalent foot and ankle deformities. Muscle imbalance between the foot and ankle's invertors and evertors is thought to be responsible for the varus component. Tibial anterior and posterior muscles, in particular, are prioritised over peroneal muscles [2].The lateral half of the divided tibialis anterior tendon is transferred to a bone tunnel in the cuboid or the base of the fifth metatarsal, as described in the surgical procedure [3].Skin ulceration, plantar sensitivity, and tendon transfer failure are all possible complications of suturing a tendon to bone by the use of a plantar button or felt pad. Interference screws and suture anchors are two other options [2].Although the peroneus brevis is commonly employed as a receiver for tibialis posterior tendon transfers, split tibialis anterior transfers to the peroneus brevis are not as commonly reported [4].Since the peroneus brevis is very uniform in both thickness and length, allowing for dependable tendon to tendon healing, it was decided by Wong et al. that it would be an ideal recipient tendon, The lateral half of tibialis anterior was transferred to peroneus brevis, with gastrocnemius recession and fractional lengthening of tibialis posterior to reduce imbalance between the invertors and evertors [2].Gastrocnemius recession as well as fractional lengthening of the tibialis posterior with a split transfer of the tibialis anterior tendon are just two of the many soft tissue surgical treatments available to treat equinovarus deformity in cerebral palsy [5].That's why, this study aimed for evaluation of the clinical and radiological results of split transfer of tibialis anterior to peroneus brevis for equinovarus deformity in children with cerebral palsy at Zagazig university hospitals.

PATIENTS AND METHODS

This is a prospective study on eighteen patients presented with cerebral palsy and equinovarus deformity, were treated with split tibialis anterior transfer to peroneus brevis, with gastrocnemius recession and fractional lengthening of tibialis posterior at Zagazig University Hospitals, during the period from May 2022 to June 2023. The follow up period is 6 months after surgery.Children included were from both sexes aged from 4 to 10 years with ambulatory or potentially ambulatory children with cerebral palsy, or flexible varus foot deformity and were medically and surgically fit. Any cases with the following criteria were excluded; non-ambulatory patients with cerebral palsy, rigid varus foot deformity in cerebral palsy children.

The ethical committee at Zagazig University approved the study (IRB #10212/11-10-2022). Written informed consent was obtained from all participants. The study was done according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

METHODS

All cases were subjected to complete history was taken. The clinical examination included: general condition of patient, and gait examination: evaluation of gait pattern, observation of laterality of deformity.Lab evaluation included complete blood count, liver and kidney functions, coagulation profile (International normalized ratio, Prothrombin time as well as partial thromboplastin time) in addition to viral markers (HBs-Ag and HCV-Ab).

Radiological evaluation: X-ray (AP and lateral views) on ankle and foot to evaluate the deformity.

- The radiographic indices calculated were:

1- Tibiocalcaneal angle.
2- Lateral talocalcaneal angle.
3- Talo-1st -metatarsal angle

Surgical Approach

The patient was placed supine on a radiolucent table, and general anaesthesia and non-sterile tourniquet control were used during the procedure. An incision 2 inches long is made behind the midcalf and the gastrocnemius muscle is first resected. Separate the fascia covering the superficial posterior compartment to reveal the sural nerve and saphenous vein, then pull them back and cover them up. Locate the gastrocnemius tendon just above where it joins the Achilles tendon. Cut the fascia of the gastrocnemius in a transverse fashion just above where it joins the tendon, but don't cut the muscle itself.We tested the lengthening procedure, If this isn't done, the foot (rather than the ankle) will initiate dorsiflexion, leading to an insufficient correction of equinus. Incision is made over the medial boundary of the distal third of the leg to perform tibilais posterior fractional lenghthening. To locate and divide the tibilais anterior tendon, a 3–4 cm longitudinal incision was performed along the tendon's distal length. First, a medial, distal incision was made to remove the plantar half of the anterior tibial tendon, and then a 4-5 cm longitudinal incision was made over the front of the lower leg, lateral to the tibial crest, In order to remove the whip stitch from the distal stump of the split AT tendon, a tendon passer was inserted into the lower leg incision (deep to the extensor retinaculum). The peroneus brevis tendon was uncovered by cutting into the lateral side of the calcaneus. The tendon from the front tibia was divided and reattached to the dorsal side of the ankle, close to the peroneus brevis muscle. Except for the incision through which the tendon transfer will be performed, all other incisions were closed in the usual fashion. AWith the foot in eversion and the ankle in neutral dorsiflexion, the tendon transfer was performed using two or three nonabsorbable 3-0 sutures after all other wounds had been closed. After the last stitch was in place, the foot remained in that position until the above-the-knee cast was finished. If just soft-tissue work was done, the youngster could resume weight-bearing as tolerated right away. The patients legs have been put in a cast for 6 weeks and a brace for 6-8 hours a day for at least 6 months after surgery.

Statistical Analysis:

Data analyzed using SPSS version 23. Numbers and percentages utilized to describe qualitative facts. When comparing between various groups using categorical data, chi-square fisher exact tests when appropriate were employed. The results were significant with $p<0.05$.

RESULTS

The average age of the cases was 7 years (range 4-10 years), 15 patients were males, and 3 patients were females, more than half (66.7%) of the studied group were right-sided affected, (22.2%) were left-sided and (11.1%) were bilateral (Table 1).The pain and difficulty of shoe-wearing were improved in all the patients (100.0%), most of the studied group (83.3%) had an excellent outcome, and only (16.7%) had a good outcome (Table 2).There with a highly statistically significant decrease (improve) in the GMFC score from (2.3±0.48) to become (1.3±0.47) (p-value<0.001) with a percent of improvement (50.4%) ranging from (43.1%-69.2%). The grades of GMFC were highly statistically significantly decreased among the studied group after treatment than before where (100.0%) of grade 2 became grade 1 and (100.0%) of grade 3 became grade 2 (p-value=0.001*). (Table 3).Because the lateral tibiocalcaneal angles are positive, a decrease in these angles indicates a transition from varus to normal, Positivity in the lateral talocalcaneal angles indicates a deviation from varus to normal, and most varus feet have negative talo-1st metatarsal angles, which improve following surgical correction (Table 4).We found that 13 patients (72.2%) didn't have any complications, two cases (11.1%) had superficial wound infections which treated by parental antibiotics for 2 weeks and three cases (16.7%) had dry, flaky skin & itching after the cast which treated by washing and use the topical cream (Table 5).

Table (1). Descriptive data of demographic parameters in the different studied groups.

Demographic data	The studied group	
	No=(18)	**%**
Age (years) *Mean ± SD* *Median* *(Range)*	6.4±1.4 6.5 (4-10)	
Age (years)		
4-6 years	9	50.0%
6-8 years	8	44.4%
8-10 years	1	5.6%
Male	15	83.3%
Female	3	16.7%
Left	4	22.2%
Right	12	66.7%
Bilateral	2	11.1%

Table (2): Pain and difficulty of shoe wearing, post-operative Kling Score among the studied group.

Pain and difficulty of shoe wearing	**The studied group**	
	No=(18)	**%**
Improved	18	100.0%
The post-operative Kling Score	**The studied group**	
	No=(18)	**%**
Good	3	16.7%
Excellent	15	83.3%

Table (3): Comparing pre and post-operative GMFC among the studied group.

GMFC	***Preoperative*** *Mean ± SD* *Median* *(Range)*	***Postoperative*** *Mean ± SD* *Median* *(Range)*	***Paired t-test***	***p-value***
GMFC	2.3±0.48 2 (2-3)	1.3±0.47 1 (1-2)	25.9	**0.001****
Percent of improvement	50.4% (43.1%-69.2%)			
The grade of GMFC	***After treatment***		***M.N-test***	***p-value***
before treatment	**Grade 1** ***No=22(%)***	**Grade 2** ***No=14(%)***		
Grade 2 *(No=12)*	12 (100.0%)	0 (0.0%)	42.9	**0.001****
Grade 3*(No=6)*	0 (0.0%)	6 (100%)		

Table(4) :Lateral tibiocalcaneal, lateral talocalcaneal and talo-1st-metatasal angles of studied cases pre & postoperative

	Normal Range (+/- 2 sd)	Preoperative Mean (Range)	Postoperative Mean (Range)	Change preoperative to postoperative (95% confidence interval)	p-value
Lateral Tibiocalcaneal angle	69 (52.2 to 85.8)	90 (48 to 128)	67.7 (44 to 86)	22.3 (16.4 to 28)	< 0.001
	Normal Range (+/- 2 sd)	**Preoperative Mean (Range)**	**Postoperative Mean (Range)**	**Change preoperative to postoperative (95% confidence interval)**	**p-value**
Lateral Talocalcaneal angle	49 (35.2 to 62.8)	21.5 (2 to 39)	43 (8 to 72)	-21.5 (-24.5 to -18.6)	< 0.001
	Normal Range (+/- 2 sd)	**Preoperative Mean (Range)**	**Postoperative Mean (Range)**	**Change preoperative to postoperative (95% confidence interval)**	**p-value**
Talo-1st-metatarsal angle	10 (-4 to 24)	-22.9 (-54 to 28)	8.3 (-38 to 36)	-31.1 (-36 to - 26.3)	< 0.001

Table (5): Postoperative complications among the studied group.

Complications	The studied group	
	No=(18)	**%**
No	13	72.2%
Dry, flaky skin & itching after the cast	3	16.7%
Superficial wound infection	2	11.1%

A case of male patient 7 years old with left equinovarus foot, with pain and difficulty with shoe wearing, walks independently, but difficulty with uneven surfaces, minimal ability to jump (GMFCS level II), preoperative radiological evaluation: talo-first metatarsal angle = 27.3°, managed surgically with split tibilais anterior transfer to peroneus brevis, fractional lenghthening of tibilais posterior tendon and gastrocnemius recession, postoperative radiological evaluation talo-first metatarsal angle = 14.2° (Figure 1).

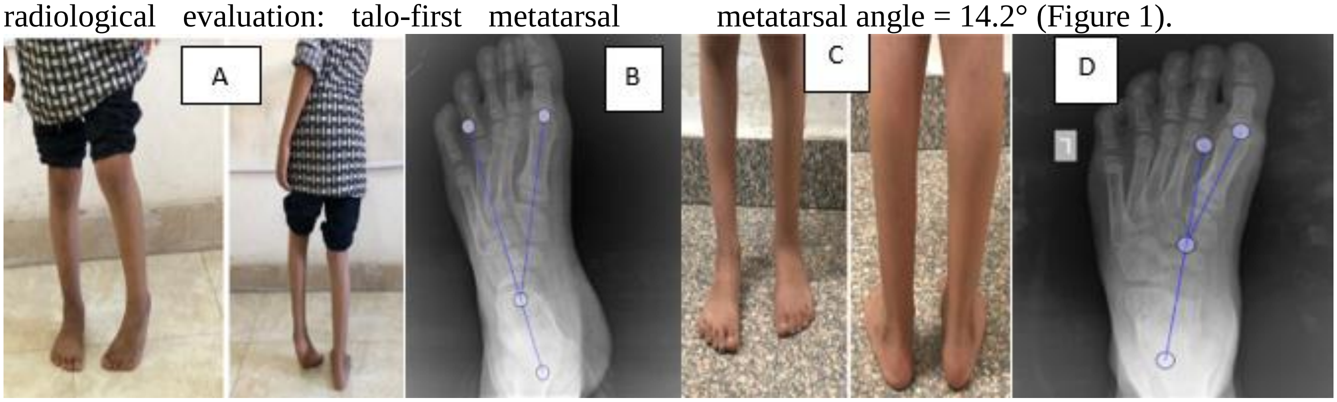

Figure 1: A case of male patient 7 years old with left equinovarus foot, (A) Pre-operative clinical photos, (B) Pre-operative X-ray; talo-first metatarsal angle, (C) Postoperative clinical Photos, (D) Post-operative X-ray: talo-first metatarsal angle

DISCUSSION

Traditional split tibial anterior tendon transfers to bone have been linked to skin callus and tissue necrosis in spastic patients due to button fixation. [1]. The goal of this research was to determine whether or not tibialis anterior tendon splits to the peroneus brevis were effective in correcting equinovarus feet in children with cerebral palsy to improve the pain, difficulty of shoe wearing and correct the foot morphology to provide better lifestyle activities.Wong et al. verified its usefulness in reducing painful symptoms and facilitating the use of orthotics and shoes. The shape of the foot, especially in infants and toddlers, is greatly enhanced [2].Patient independence, as measured by Vogt, increased both in terms of ambulation and the ability to do so without assistance and without the use of orthopaedic shoes or orthoses.[6].In our study, the pain and difficulty of shoe-wearing were improved in all the patients (100.0%) at 6 months post-operative. This comes in agreement with Vogt et al study, in which there were 132 cases of split tibilais anterior tendon transfer to the cuboid, and after surgery 4% of patients experienced tendon rupture or necrosis, 4% had wound problems, and 1.5% developed complex regional pain syndrome.[7].In a study of 47 patients, Holsakar et al. found that the insertion of screws or screws-like implants increases the risk of problems such implant breakage and pull-out when correcting spastic equinovarus.[8].Twenty-two patients with spastic equinovarus foot deformities were treated by Gasse et al. using a split tibialis anterior tendon transfer, with fixation of the split tendon to the base of the fifth metatarsal using bone anchors; They believed that this would be easier on the foot's sole than a bone tunnel or transplantar fixation. After a minimum of 2 years of follow-up, all patients expressed complete satisfaction, except one bone anchor detached at 6 months post-operative (1/22 = 4.5 percent).[9].

In our study which included 20 limbs in 18 patients, there were 13 patients (72.2%) didn’t have any complications, two cases (11.1%) had superficial wound infections and three cases (16.7%) had dry, flaky skin & itching after 6 months post-op.In the same line, in a study involving 31 children (average age, 8 years) with cerebral palsy and tibialis posterior tendon spasticity throughout the gait cycle, Kling et al. used a split tibialis posterior tendon transfer to the peroneus brevis. Thirty-four patients experienced either excellent or good outcomes (91.9 percent) [10]. In our study, on 20 equinovarus feet in 18 ambulatory children with CP (average age 6.4 years), There were 15 patients (83.3%) had an excellent outcome, and only 3 patients (16.7%) had a good outcome. The grades of GMFC were highly statistically significantly decreased among the studied group after treatment than before where (100.0%) of grade 2 became grade 1 and (100.0%) of grade 3 became grade 2. Also, excellent or good outcomes were reported for 85.0 percent of feet after Limpaphayom et al. performed a split tibialis anterior tendon transfer to the cuboid on equinovarus feet in 45 ambulatory children with CP (average age 8.1 years) They found an improvement in GMFCS levels for 34.0 percent of the children (75.6 percent). The results were poor for 10% of the children.[11].To correct varus foot abnormalities in infants with static encephalopathy, Lullo B. et al. advocated a split tibialis anterior tendon transfer to peroneus tertius or brevis. No serious wound problems were observed, and complications were uncommon. 77% of patients see improvement after surgery, while others experience late-onset valgus or recurring varus abnormalities that require additional surgery. An alternative surgical method for transferring the tibialis anterior tendon to the peroneus brevis muscle is presented in this study, which shows promise for reducing wound complications and achieving similar outcomes to the current gold standard [5].Wong et al. found significant variations between the mean preoperative radiological readings and the normal range. Postoperative means tend to normalize, albeit there is a tendency for minor overcorrection into valgus.[2].In our study, the postoperative radiological values there were tendency towards the normal values of the measured angles, confirmed the value of split tibialis anterior transfer to peroneus brevis in correcting the equinovarus foot deformity in children with cerebral palsy, as safe and effective method with little complications, and no major wound issues were seen. And successful correction of all patients undergoes our study in short term follow up of patients.For the treatment of equinovarus foot abnormalities in CP patients, Sarkaya et al. advocated a split tibialis anterior tendon to peroneal tendon [12]. Wong et al. found no cases of early revision surgery due to failure of split tibialis anterior tendon transfers to peroneus brevis [2]. In our study, no failures reported in the operated cases require early revision surgery.The average length of our follow-up was only 6 months, which may limit our capacity to correctly account for all long-term problems and measure changes in the functional outcomes over time as children grow. Another limitation is the small number of cases so further studies are needed for more confirmation of results of our study.

CONCLUSION

The benefits of split tibialis anterior transfer to peroneus brevis in treating equinovarus foot deformity in cerebral palsy patients have been demonstrated by this research. The procedure is technically simple, with high rates of success and minimal complications.

No potential conflict of interest was reported by the authors.

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