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Residual Dynamic Metatarsus Adductus Correction by Split Tibialis Anterior Transfer Following Ponseti Management of Idiopathic Clubfoot

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Abstract

Background: Idiopathic clubfoot is characterized by an alteration of the morphology of the foot that cannot physiologically move on the ground. Tibialis anterior tendon transfer was is an effective method in the management of dynamic supination as well as prevention of clubfoot relapse in children. The aim of the current study to confirm the best management of split tibialis anterior tendon transfer in the treatment of residual clubfoot. Patients and methods: A prospective study included 18 patients (22 feet) with residual dynamic supination deformity following previous ponseti management. Patients underwent split transfer of the anterior tibial tendon at Zagazig University hospitals. Clinical and radiographic assessment of outcomes is performed at the end of healing. Results: The present study included 18 cases (12 males and 6 females) with mean age of 3.43 years ± 0.71 to assess outcome of split tibialis anterior tendon transfer in management of residual clubfoot. Patient age ranged from 2.5 years to 5 years old at the time of the operation, 9 with right foot affection, 5 with left foot deformity while 4 patients (8 feet) were bilateral. The majority of cases were males (66.7%) and females were (33.3%).Right side was affected in 9 cases (50%), the left was affected in five .cases (27.8%) while four cases (22.2%) were bilateral. The mean radiological measurment improvement of AP talocalcaneal angle, AP talofirst metatarsal angle, Lattalocalcanael angle, Lattalo-first metatarsal angle, First-fifth metatarsal over lap, and the improvement of all angles were stastistically significant. The complication rate was 16.7% (3 cases) all had superfecial infection only. Conclusion: The anterior tibial tendon transfer is a practical method for achieving fully or split transfer due to both techniques have an excellent outcomes with low complication. It is simple and effective soft-tissue procedure to correct the muscle imbalance of the foot. The split tibialis tendon transfer are still better because of low risk of over correction which preserve some inversion function.

Keywords: Split Tibialis Anterior Transfer; Clubfoot; Ponseti Management

INTRODUCTION

Foot deformities interfere with the ability to walk and induce symptoms because of abnormal distribution of load under the plantar surface of the foot. Therefore, there is a need to assess the foot biomechanically, including the study of kinetics and kinematics **(1,2)**.The kinematics is greatly altered by the severe shortening of the medial and posterior tarsal ligaments and by the tightness of the tibialis posterior and gastrosoleus muscles. The fibrotic and contracted deltoid ligament holds

the calcaneus in inversion. The navicular is held medially displaced and inverted by the fibrosis of the tibionavicular, the plantar calcaneonavicular ligaments, and the pull of the tight tibialis posterior tendon **(3)**.

The main method of management in use today is the Ponseti technique. When done well, have excellent long term results and avoid major surgery in the majority of patients **(4)**. The success rate of Ponseti method depends on the degree of stiffness of the foot, the experience of the surgeon, and the eliability of the family. In most situations, the success rate can be expected to exceed 90%.Some cases may require an additional procedure, usually Achilles tenotomy alone or combined with tibialis anterior transfer **(5)**.

Overcorrection may be the result of overzealous primary surgery and is more likely to happen in children who have evidence of generalized ligamentous laxity. The hind foot is in valgus with a flattened medial arch. Management of this condition should follow the normal sequence with orthotics being first line and surgical options considered later as symptoms dictate **(6)**.

Dynamic forefoot adduction and supination can be observed after clubfoot treatment with orwithout soft tissue releases. Dynamic forefoot supination deformity results from residual medial displacement of the navicular on the head of the talus, which results in muscle imbalance **(7).**

In a comparison of the three different methods of anterior tibial tendon transfer for relapsed clubfoot on 46 feet, found that whole transfer had better absolute ankle dorsiflextion than split transfers. Hoffer and Ponseti had the same inversion, but more than Garceau transfer. For eversion, best values occurred with Ponseti transfer **(8).** Therefore, the current study to confirm the best management of split tibialis anterior tendon transfer in the treatment of residual clubfoot.

PATIENTS AND METHODS

A prospective study included eighteen 18 (22 feet) with residual dynamic supination deformity following previous ponseti management, underwent split transfer of the anterior tibial tendon at Zagazig University hospitals. A written consent was taken from each child`s parents.

Inclusion Criteria:

Patient with idiopathic clubfoot deformity ranged from 2.5 years to 5 years and previously treated by Ponseti technique show residual dynamic supination.

Exclusion Criteria

Patient with static bony defect and long lateral column, syndromic cases and patients with comorbidities, complex or atypical congenital talipes equinovarus were excluded.

Management protocol:

All the patients subjected to: obstetric and family history as well as previous line of treatment history. Clinicalexamination were done for exclusion of neurological disorders and other congenital anomalies. Radiological examination including plain X-ray anteroposterior and lateral views were done for the affected feet.

The foot is tested in all plans both passively and actively (if the child is old enough to co-operate) including ankle, subtalar and forefoot mobility, this help to differentiate rigid deformity from mobile one. The range is scored according to Dimeglio score System. Criteria of Garceau and Palmer were used in this study.

Operation technique:

Position the patient supine on a radiolucent table. Patient at the time of the operation with mean age was (3.42). 12 were male and 6 female. 9 with right foot affection, 5 with left foot deformity while 4 patients (8 feet) were bilateral. Anesthesia team will induce general anesthesia. A third generation Cephalosporin was administered before induction of anaesthesia. Place a tourniquet on the thigh. Clean the leg up to mid-thigh.

The technique was as the follow: palpate the Tibialis Anterior Tendon on the medial dorsum of the foot opposite the medial cuneiform and first metatarsal , a 2cm longitudinal incision opposite the insertion and slightly distal, then incise it in line with the tendon fibers. Using a Graham Hook, split the tendon and isolate it from the surrounding tissue then elevate the tendon up and using a scalpel, release it from its insertion from proximal to distal by sliding the scalpel parallel to the bone Using fluoroscopy, identify the cuboid bone which is usually opposite the fourth and fifth metatarsals and using a blunt hemostat, create a subcutaneous path from lateral incision to the medial incision.Thread the suture on a K-wire and pass it through the hole of cuboid and partially out of the palm of the foot. Pass a piece of non-sticking sponge and a button through the k-wire and pull the wire and tendon out of skin and through the button. Hold the foot in maximum abduction and moderate dorsiflexion then tension the suture and tie it over the button **(Figure 1)**.

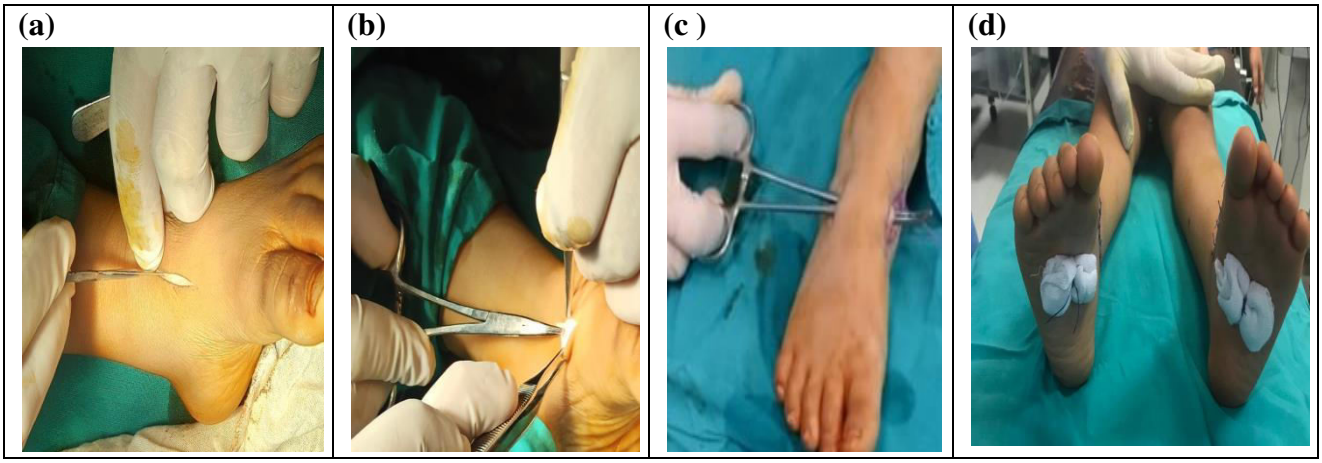

Figure (1): Operation technique showing: (a) The incision overlying the tibialis anterior tendon insertion, (b) release of the tibialis anterior tendon at its insertion, (c) blunt tunnel from lateral to medial,(d) The tendon fixation technique on the plantar aspect of the foot.

Postoperative care:

In patients under 5 years of age and those who may be noncompliant, a toe-to-groin cast flexed knee is maintained with the patient non-weight bearing forabout 6 weeks. At 6 weeks, the button and suture are removed and the patient is allowed to begin walking and placed in a short-leg walking cast foran additional 3 weeks to ensure healing and to avoid tendon rupture. Clinical and radiographic assessment of outcomes is performed at the end of healing. Plain radiographs (standing AP and lateral foot radiographs) are usually sufficient.

Statistical Analysis:

Data analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) software for analysis. According to the type of data qualitative represent as number and percentage, quantitative continues group represent by mean ± SD, the following tests were used to test differences for significance, difference and of paired qualitative variable by Sign. Differences between quantitative paired groups by paired t test, correlation by Pearson's correlation. P value was set at <0.05 for significant results &<0.001 for high significant result.

RESULTS

The present study included 18 cases (12 males and 6 females) with mean age of 3.43 years ± 0.71 to assess outcome of split tibialis anterior tendon transfer in management of residual clubfoot. Patient age ranged from 2.5 years to 5 years old at the time of the operation, 9 with right foot affection, 5 with left foot deformity while 4 patients (8 feet) were bilateral. The majority of cases were males (66.7%) and females were (33.3%).Right side was affected in 9 cases (50%), the left was affected in five .cases (27.8%) while four cases (22.2%) were bilateral **(Figure 2)**. The mean pre-operative and post-operative improvement according to demiglio scoring system, which is statistically significant (p value<0.001) **(Figure 3)**. The mean pre-operative and post-operative improvement according to Garceau scoring system, which is statistically significant (p value<0.001) **(Table 1)**. The mean radiological measurment improvement of AP talocalcaneal angle, AP talofirst metatarsal angle, Lattalocalcanael angle, Lattalo-first metatarsal angle, First-fifth metatarsal over lap, and the improvement of all angles were stastistically significant **(Table 2)**. The complication rate was 16.7% (3 cases) all had superfecial infection only **(Figure 4)**.

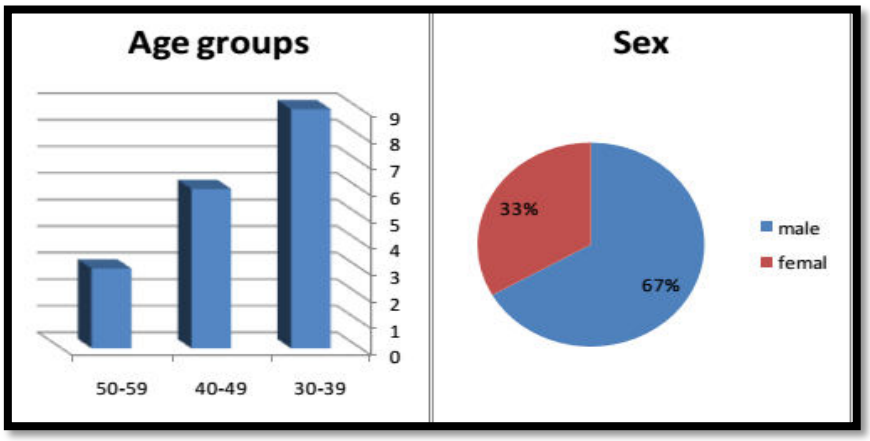

Figure (2): Age and sex distribution among the studied cases.

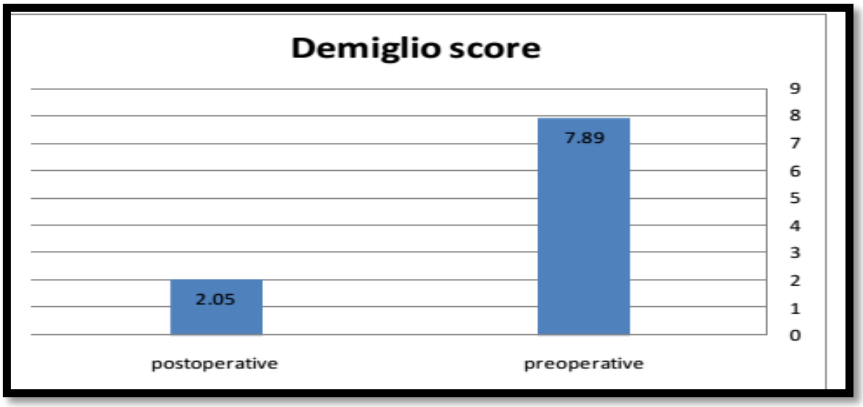

Figure (3): Preoperative and postoperative mean according to Demiglio score.

Table (1): Preoperative and postoperative mean according to Garceau score:

	Pre	Post	Wilcoxon signed test	P
Garceau score	**2.5±0.5 (2-3) 2.5**	**3.28±0.46 (3-4) 3**	**4.5**	**0.00****

Table (2): Radiological results among the studied patients:

X-ray measured angles	Base line Mean± SD	6 months Mean± SD	Correction angle	P value
AP talocalcaneal angle	20.2±5.3°	32.6±7.2°	12.4°	**0.000****
Lattalocalcaneal angle	24.1±4.6°	30.8±5.5°	6.7°	**0.000****
Lattalo-first metatarsal angle	8.1±2.1°	11.5±1.2°	3.4°	**0.000****
First-fifth metatarsal over lap (in grades)	2.8±0.9	1.6±1.4	0.6	**0.000****

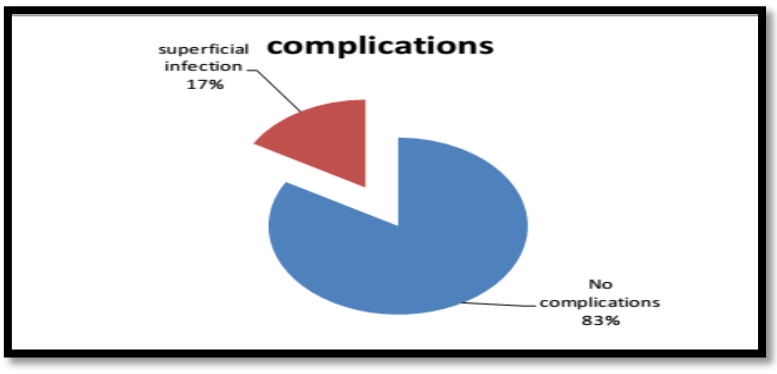

Figure (4): Pie chart showing complication

DISCUSSION:

Clubfoot represents one of the most common congenital orthopedicdeformities. It affects 1-2/1000 live births all over the world. Cases of rigid and severe deformity represent a challenging problem. This is because the conservative management is not effective; as well as the surgical options are little **(9)**. Dynamic foot supination is a common form of residual clubfoot. the deformity occurs as a result of a strong tibialis anterior muscle and weak antagonists, particularly the peroneal and tibialis posterior muscles **(10)**. The foot appears normal in standing without any deviation but when the child starts walking, the foot goes into inversion what's called dynamic supination **(11)**. Two types of transfer are reported and full tendon transfer to the third cuneiform, or split tendon transfer to the cuboid **(12)**.

Twenty-one clubfeet in eighteen patients were undergoing split TATT at the Orthopedic Department, ZUH during the period from March 2020 and February 2021. In our study the mean age was 41.05 ranged from 30to 59months. Out of the 18 patients, there were 12 males and 6 females. four cases(22.2%) were bilaterally affected. While 14 patients (77.8%) were one-sided affected. (5 left foot affected and 9 right foot affected). This study aimed to find the best management of split tibialis anterior tendon transfer in the treatment of residual clubfoot. This management is to correct the deformity early and fully, and maintain correction with growth until skeletal maturity; this should result in a flexible, pain-free plantigrade foot.

This results are agree with **Abdel-AAl (13)** revealed the mean age in his study was 37.5 months (range 37-59months) and all feet at the final follow up proves that tibialis anterior transfer effectively corrects residual metatarsus adductus deformity following Ponseti management for idiopathic congenital talipesequinovarus. Also, **Wijayasinghe et al., (14)** stated a total number of 354 patients and found a ratio of 2.7:1 regarding males and females respectively.

The current study showed significant improvement of heel varus by 12.4° as at that the preoperative mean AP talocalcaneal angle was 20.2°, while the mean postoperative changed to 32.6° at 6months postoperatively. A significant improvement in forefoot adduction as at the baseline, the AP talo-first metatarsal angle had a mean value of -10.2° and the mean angle changed to 1.3° at 6 months. It was known that when being negative value indicates forefoot adduction.

A study of **Kuo et al. (15)** revealed the outcome of full tendon (FT) transfer and the split tendon (ST) transfer, the AP talo–first metatarsal angle in both groups corrected an average of 20.9 degrees. The FT group corrected an average of 24.2 degrees, The ST group was corrected an average of 16.6 degrees, the lateral talo–first metatarsal angle was corrected an average of 4.7 degrees, the average improvement in the overlap ratio for 68 feet in both groups was 0.5 ± 1.3 grades. However, averages follow-up period of this study was 8.8 years which may explain the difference between the results.

In our study, the mean demiglio score preoperatively was 7.89±1.13 and it improved postoperatively reaching a mean 2.05±1.16 the p-value was < 0.001. The mean Garceau and palmer's criteria improved to3.28 from 2.5,the improvement was highly significant ($P<0.0001$). Also, all feet were improved according to the criteria of Garceau and Palmer was mentioned in a study of **Eid et al. (16)** stated a preoperative mean of score changed from 2.5 to 3.2 at the final follow-up. Also, **Abdel-AAl (13)** had Demiglio score in the split group was improved from 5.8 preoperatively to 1.3 post-operatively at the final follow-up.

In our study, no major complication as our results showed three cases (16.7%) had surgical site infection and were treated by antibiotics and resolved completely. **Abo El-Fadl (17)** documented there were no complications reported in our patientssuch as infection, loosening of the transferred tendonfrom the new insertion at the cuboid bone, or overcorrection. Also, **Eid et al. (16)** results showed there was no loss of correction. None of the operated feet had any relapse. There were no major complications observed during the period of follow-up.

CONCLUSION:

The anterior tibial tendon transfer is a practical method for achieving fully or split transfer due to both techniques has excellent outcomes with low complication. It is simple and effective soft-tissue procedure to correct the muscle imbalance of the foot. The split tibialis tendon transfer is still better because of low risk of over corrections which preserve some inversion function.

With increased understanding of the clubfoot deformity parameters, a superior results achieved by surgery with the Ponseti method of serial casting followed by bracing becoming the first-line management in the newly diagnosed clubfoot.

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