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ORIGINAL ARTICLE**Tibialis Anterior Tendon Transfer in Management of Relapsed Clubfoot, a Clinical Trial****Khaled Edris Abdelrahman, Mohammed Abdelfattah Sebaei, Hossam Fathi Mahmoud and Kareem Hany Mohamed Al-Kelesh****Orthopedic Surgery Department, Faculty of Medicine, Zagazig University, Egypt****Corresponding Author:**

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E-mail :Kareem_hany2002@hotmail.com**Submit Date** 2020-10-24**Revise Date** 2020-12-09**Accept Date** 2021-01-03**ABSTRACT****Objectives:** To determine the efficacy of Tibialis Anterior Tendon Transfer in treatment of cases of Dynamic Foot Supination in Relapsed Clubfoot.**Methods:** Pediatric Unit of Orthopedic Surgery Department, Zagazig University Hospitals. All patients fulfilling the inclusion criteria included in the study in a time period of 6 months were 12 patients. A total of 12 patients (9 males and 3 females) with 1 bilateral, 7 right feet and 4 left feet. The 9 males were (1 bilateral, 5 right foot and 3 left foot). The 3 females were (2 right foot and 1 left foot)**Results:** We studied 12 cases 9 males and 3 females with mean age of 4.83 ± 0.71 to assess outcome of Tibialis Anterior Tendon Transfer in Management of Relapsed Clubfoot.**Conclusion:** Tibialis anterior tendon transfer has been the treatment of choice for cases of relapsed CTEV in the form of dynamic supination for years. It has a high success rate and very low post-operative complications and very low incidence of residual deformity if done correctly.**Key words:** Tibialis Anterior, Tendon Transfer, Clubfoot .**INTRODUCTION**

Idiopathic Congenital Talipes Equinovarus or “Clubfoot” is a congenital foot deformity in which the infant’s foot is turned inward in degrees up to facing sideways or even upward. It’s not a common congenital abnormality counting around one infant in every 1.000 infants. It’s not a painful condition during infancy. However, if not treated correctly early in life, the child will not be able to walk normally afterwards. ^[1] The Standard treatment for Clubfoot is The Ponseti Method, which is a series of weekly manipulations, casting and bracing of the foot. Percutaneous Achilles Tenotomy may be needed in some cases after 4 to 6 weeks to completely correct the deformity. ^[2]

Unfortunately, deformity relapse has been reported in approximately about 5-55% of the patients treated with the Ponseti Method. Common Causes of the relapse includes inadequate short-term use of Foot Abduction Orthosis, non-adherence to foot bracing recommendations, severe pathology, scarring and muscle imbalance. Relapses usually appear in the form of dynamic foot supination and heel varus malalignment. ^[3] The most common time of presentation of the relapse is between 2.5 to 5 years of age as this is the period of rapid growth of the foot. Dynamic foot supination is the

commonest form of clubfoot relapses counting around 68% of cases. The treatment of choice for dynamic foot supination is Tibialis Anterior Tendon Transfer. ^[4]

In these cases of Talipes Equinovarus Relapse, the affected foot looks normal in standing and static phase. Dynamic supination appears during swinging phase of walking. So, diagnosis of these cases is mainly by Clinical Examination. There have been several modifications to the procedure of transferring the tendon whether in its origin or insertion. The most recent and commonly used technique these days is transferring the insertion of tibialis anterior tendon from the medial cuneiform and 1st metatarsal bones to the lateral cuneiform bone. This procedure has proved great success in correcting the relapse without affecting the long-term functions of the foot.

^[5] Restoring the muscle balance of the foot is the main function of the newly transferred tendon as the tibialis anterior muscle in clubfoot is almost normal while the peroneal muscles are weak. Transferring the tibialis anterior tendon to the mid-dorsum of the foot restores balance and prevents dynamic supination produced by its original medial insertion. ^{[6][7]}

METHODS

Technical design

Place of Study: Pediatric Unit of Orthopedic Surgery Department, Zagazig University Hospitals

Sample Size: All patients fulfilling the inclusion criteria included in the study in a time period of 6 months were 12 patients. A total of 12 patients (9 males and 3 females) with 1 bilateral, 7 right feet and 4 left feet. The 9 males were (1 bilateral, 5 right foot and 3 left foot). The 3 females were (2 right foot and 1 left foot).

Inclusion Criteria: Age group (2-6) years old and Relapsed cases after initial correction by Ponseti Method by Dynamic Supination

Exclusion Criteria: Children below 2 years and above 6 years of age, Cases of clubfoot treated by other methods rather than Ponseti and Associated neuromuscular conditions or syndromes.

Preoperative Examination: Examination of feet before and after the operation is very important to evaluate the results and efficacy of the operation.

One of the grading systems we used is **Garceau and Palmer's criteria** preoperative and postoperative (Table1) (Fig.1) Their criteria were based on metatarsus adductus, heel varus and equinus. A normal looking foot was considered excellent (4 points). A mild deformity in one or two of the parameters above is considered a good result (3 points). A moderate deformity in all three parameters with equinus less than 10 degree is considered a fair result (2 points). Severe deformity in all three parameters is considered a poor result (1 point).^[8] Another grading system we used is to evaluate the **restoration of muscle balance by Thompson** and correction of dynamic supination. (Table2) (Fig.2) Good results demonstrated no further dynamic supination and smooth dorsiflexion. Fair results had improved muscle function but with mild residual dynamic supination. Poor results had no improvement of the deformity.^[8] Written informed consent was obtained from all participants, the study was approved by the research ethical committee of Faculty of Medicine, Zagazig University. The study was done according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Operative Technique: Preoperative Planning: Treatment with serial manipulations and casts is essential to correct forefoot adduction, supination, varus and hindfoot equinus deformities preoperatively. Obtain standing AP and Lateral X-rays to confirm the presence of lateral cuneiform as its usually present at 2.5 years. Ensure that forefoot adduction is corrected in AP x-ray and equinus and cavovarus^[8] are corrected in lateral x-ray. The foot must be corrected and flexible prior to surgery as

few degrees of rigid deformity will result in a failed operation. Achilles tenotomy or lengthening may be needed before surgery for residual rigid equinus. **The Start of The Operation:** Position the patient supine on a radiolucent table. Anesthesia team will induce general anesthesia. Place a tourniquet on the thigh. Clean the leg up to mid-thigh

Identify and Release the Tendon from Its Insertion: Palpate the Tibialis Anterior Tendon on the medial dorsum of the foot opposite the medial cuneiform and first metatarsal. Make a 2cm longitudinal incision opposite the insertion and slightly distal. Dissect sharply and carefully through skin and subcutaneous tissue till you reach the tendon sheath then incise it in line with the tendon fibers. Using a Graham Hook, dissect 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. Avoid any harm to the tendon, periosteum, cartilage or bone to prevent any future deformity.

Prepare the Tendon for Transfer: Use scissors to dissect the tendon and release it from the surrounding tissue up to its proximal part and inferior retinaculum. Prepare the tendon using a strong non-absorbable suture and Bunnell type stitch to secure the distal 2-3cm of the tendon.

Prepare the Lateral Cuneiform: Using fluoroscopy, identify the lateral cuneiform bone which is usually opposite the 3rd metatarsal. Make a 2cm incision over the lateral cuneiform and dissect through subcutaneous tissue. Retract the extensor digitorum brevis and longus muscles till you reach the bone. Make a drill hole in the center of the lateral cuneiform towards the center of palm of foot to ensure no harm to plantar nerves and vessels.

Transfer the Tendon: Using a blunt hemostat, create a subcutaneous path from lateral incision to the medial incision. Retrieve the prepared tendon and pull it through the tunnel and bring it out from the lateral incision. Make sure it's a clear path with no obstacles or kinking of the tendon. Thread the suture on a K-wire and pass it through the hole of lateral cuneiform 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.

Postoperative Care: Above knee cast is done and non-weight bearing for 6 weeks. Then cast, suture and button are removed, and patient is allowed to resume his normal life with no bracing or orthosis. Evaluate the foot for any residual deformity or complications

STATISTICAL ANALYSIS

Data were entered checked and analyzed using Epi-Info version 6 and SPP for Windows version 8

RESULT

We studied 12 cases 9 males and 3 females with mean age of 4.83 ± 0.71 to assess outcome of Tibialis Anterior Tendon Transfer in Management of Relapsed Clubfoot. Age was distributed as 4.83 ± 0.71 years with minimum 4 years and maximum 6 years, regard sex male was majority

with 75% and female 25%. (Fig.3) 58.3% were right and 33.3% were left and just one case was lateral 8.3%. (Fig.4) Score of feet according to Garceau and Palmer’s significantly improved from pre to post. (Table 1) (Fig.1) Majority were good 91.7% and only one case was fair 8.3%. 16.75 (2 cases) only had infection. 75% were very satisfied and 25% were satisfied. There was significant positive correlation between score and age.

Table1: Preoperative and postoperative rating and score of feet according to Garceau and Palmer’s criteria

		Pre		Post		P
		N	%	N	%	
Garceau and Palmers criteria	Poor	3	25.0	0	0.0	0.002*
	Fair	8	66.7	0	0.0	
	Good	1	8.3	5	41.7	
	Excellent	0	0.0	7	58.3	
	Total	12	100.0	12	100.0	

Table2: Restoration of muscle balance according to Thompson after operation

	N	%
Muscle balance		
Fair	1	8.3
Good	11	91.7
Total	12	100.0

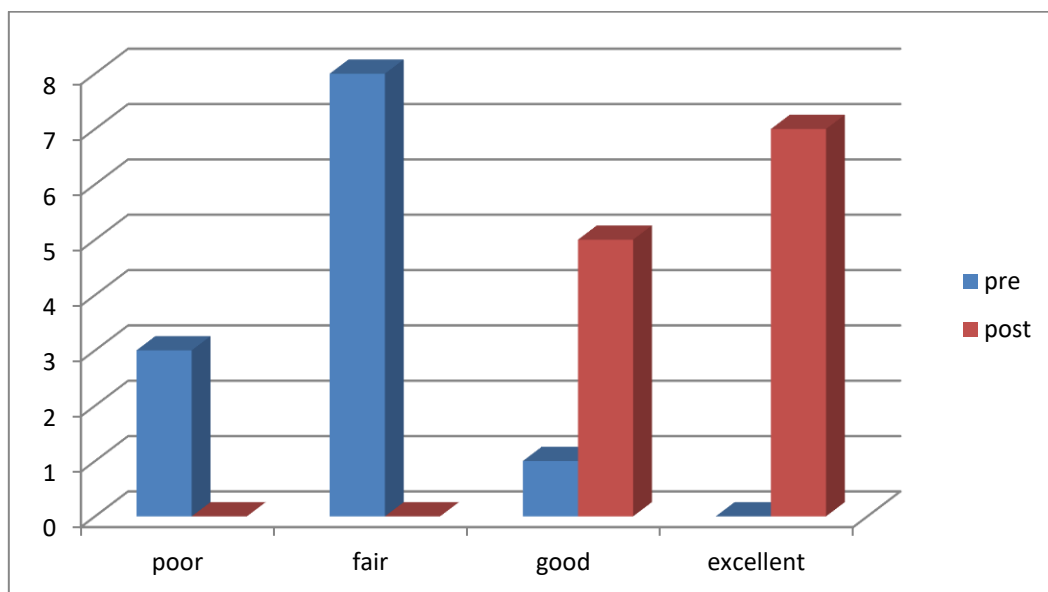


Fig. 1: Preoperative and postoperative rating and score of feet according to Garceau and Palmer’s criteria

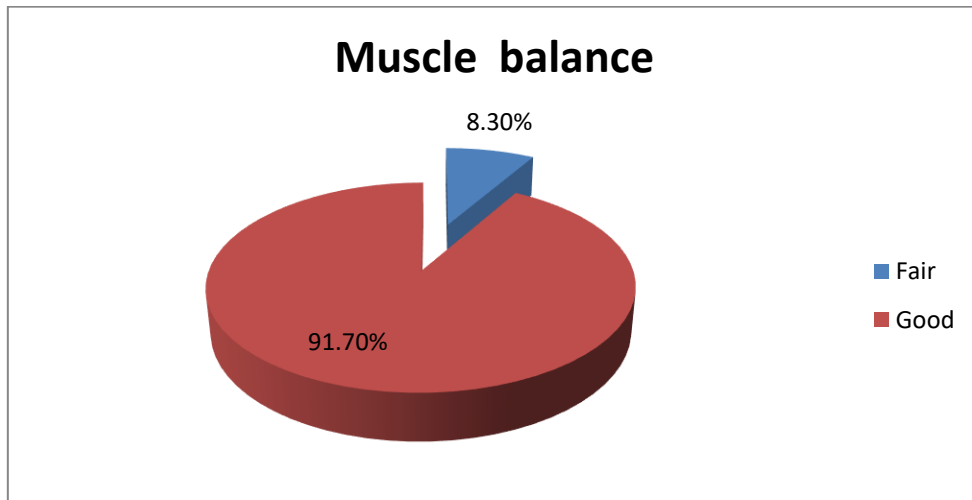


Fig. 2: Restoration of muscle balance according to Thompson after operation

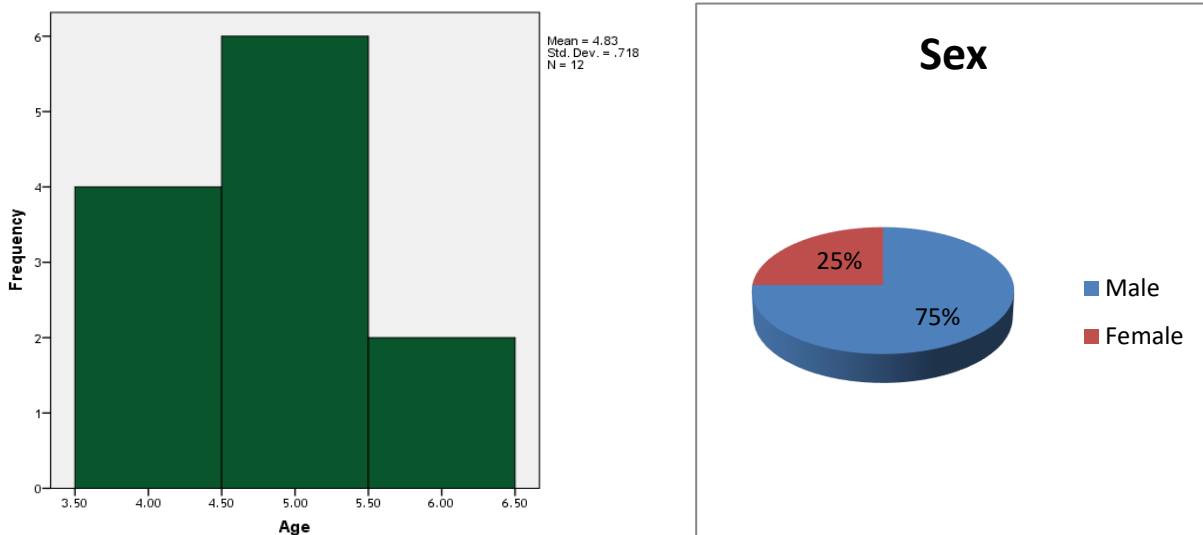


Fig. 3: age and sex distribution among studied group (12 cases)

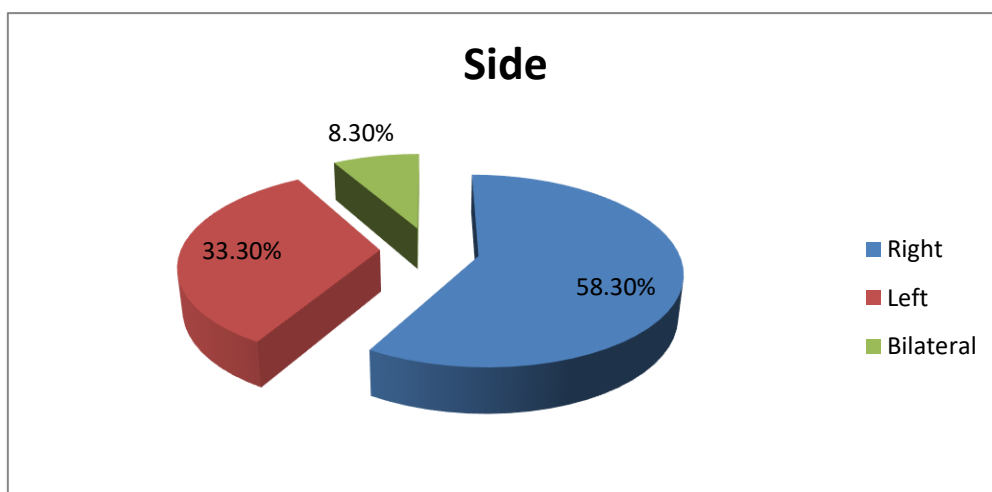


Fig. 4: side distribution among studied group

DISCUSSION

For years, The Ponseti technique has been the treatment of choice for cases of talipes equinovarus. It showed almost 90% success rate in cases which completed the whole course of treatment. As any other medical condition, recurrence of the disease may occur. Recurrence of talipes equinovarus comes in many forms as forefoot, midfoot, hindfoot, lateral border, medial border and dynamic supination.

Dynamic foot supination is a common form of clubfoot relapse. In these cases, 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. The treatment of choice for dynamic foot supination is tibialis anterior tendon transfer which is a very successful soft tissue procedure for the relapsed clubfoot.

In our study where the unilateral cases of clubfeet were the most ones representing 92% of our investigated patients. On the other hand, the bilateral cases were only one case out of the 12 patients. Regarding the gender, there were 75% males and 25% females. This finding is in general agreement with that of **Wijayasinghe et al** who investigated a total number of 354 patients and found the ratio of 2.7:1 regarding males and females respectively. However, **Wallander** found no gender differences detected regarding the incidence of clubfoot.^{[10][11]}

Family history of our cases indicated that their mothers were no smoking or alcoholic drinking. This might match with the findings of **Wijayasinghe et al** who found that only three out of 354 mothers were consuming alcohols. On the other hand, **Honein et al** and **Skelly et al** reported that there was an increasing risk of clubfoot with maternal smoking especially during pregnancy.^{[10][12][13]}

Medical history of our cases was examined very precisely as any patient who had any other medical condition was not concluded in our study as he may need any operation or other method of treatment rather than tibialis anterior transfer as reported by **Hosseinzadeh et al**.^[4]

Two types of transfer are reported. Full tendon transfer to the third cuneiform, or split tendon transfer to the cuboid. The initial **Garceau** technique was transfer of the whole tendon which was also adopted by **Ponseti**. However, **Hoffer** introduced the split transfer technique.^{[8][29]}

In our study, total tendon transfer was performed according to **Ponseti IV** and **Joshua B. Holt et al** with two incisions technique who approved that total transfer is more effective in 80% of cases of relapsed clubfoot dynamic supination better than split transfer.^{[16][17]}

Regarding the postoperative evaluation of feet in our study, Graceau and Palmer criteria preoperative were 3 poor feet, 8 fair feet and 1 good feet. Postoperatively the criteria became 5 good feet and 7 excellent feet. (Table 1) (Fig.1)

Regarding the postoperative complications of surgery, it was noticed that the tibialis anterior tendon transfer was in general with low incidence of complications. Only two out of twelve patients presented with skin infection and were treated by antibiotics and resolved completely.

The big problem of clubfoot management in the developing countries that might yields unpredictable results is the ignorance of parents **Kumar et al**.^[19] This could lead to late presentation of cases as well as loss of regular follow-up. Our 12 cases of relapsed clubfoot were operated at Zagazig University and instructed to come for regular follow-up. Such follow-up ranged from 3-6 months postoperatively for clinical assessment. **Ponseti** relied mainly in his assessment on the clinical examination. The radiological investigation was resorted only for the unusual cases or associated medical conditions.^[16] Postoperative follow-up of our patients with tibialis anterior transfer showed excellent foot dorsiflexion and muscle power balance between inversion and eversion as also stated by **Joshua Burns et al** with improved walking ability and no residual dynamic foot supination.^[20]

Anil Agarwal et al stated that the younger the patient the better the postoperative results and patients older than 6 years tibialis anterior transfer may not be sufficient alone and may need other procedures which is also what we found in our study that the younger the patient the faster he goes back to normal activity postoperative.^[21]

CONCLUSION

Tibialis anterior tendon transfer has been the treatment of choice for cases of relapsed CTEV in the form of dynamic supination for years. It has a high success rate and very low post-operative complications and very low incidence of residual deformity if done correctly. Recent studies showed that total tendon transfer is better than split transfer in cases of dynamic foot supination as patients benefit from the whole strength of the newly transferred muscle and not part of it and won't need any other procedure afterwards or recurrence. It's always preceded by serial castings and manipulations to allow the foot to accommodate the new post-operative changes and the new muscle power changes. It's very simple but yet very effective soft-tissue procedure to correct the muscle imbalance of the foot.

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