Original Article

Treatment of persistent forefoot adduction during ponseti method in treatment of idiopathic talipes equinovarus by minimal soft release

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ABSTRACT

Introduction: Abductor hallucis tenotomy sometimes necessary in treatment of clubfoot.**Material and methods:** Thirty children (45 feet) of one day old up to six months presented with idiopathic clubfoot. Patients were treated using the technique of Ponseti combined by abductor hallucis tenotomy after serial casting.**Results:** At a mean follow up period of 16.7 months, 43/45 feet were good (95%), 2/45 feet were bad (5%). The mean Pirani score at the final follow up was 1.05.**Conclusion:** Abductor hallucis tenotomy shortens the duration of casts, decrease the cost and risk of leg atrophy.

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1. Introduction

Clubfoot or talipes equinovarus is the most common congenital orthopaedic anomaly, with an incidence of approximately 1.24 per 1000 live birth. Clubfoot is less common in Orientals (0.6 per 1000), and higher in Hawaiians (6.8 per 1000). There is also a higher incidence in East Africans.¹ About 50% of cases are bilateral, and 70% of clubfoot occurs in boys.²

Many studies attribute the congenital clubfoot to: abnormal leg muscle development,³ connective tissue genetic defect,⁴ defective cartilaginous anlage of the anterior part of the talus,⁵ intra-uterine compression,⁶ dislocation of the talonavicular joint,⁷ defect in peroneal muscle innervation,⁸ myofibrosis,⁹ abnormal tendon insertions,¹⁰ arrest of development,¹¹ tight deltoid ligament.¹²

The goal in management of congenital clubfoot is to obtain a functional, pain-free, normal looking, plantigrade foot that has good mobility and does not require modified shoes.^{1,13}

Most orthopaedic surgeons agree that the initial treatment of congenital club foot should be nonoperative, beginning in the first days of life few authors described their technique of casting precisely. Kite,¹⁴ Shaw,¹⁵ Vessely,¹⁶ Ikeda et al,¹⁷ Bensahel et al.¹⁸ Ignacio Ponseti, described a protocol consisted of weekly

manipulations and long leg casting. This calls for forefoot abduction with counter-pressure on the neck of the talus. If residual equinus was observed after 4–8 weeks of casting and the foot had been abducted 60°, Achilles tenotomy was then performed and the foot was maximally dorsiflexed. After the last cast, all children were treated with orthotic talipes splints.^{19,20} The technique of ponseti was successful in 85%–90% of cases, in contrary to the other conservative methods, where the success rates are ranging from 11% to 58%.¹

Bhaskar A, Patni P were classified the relapse patterns after ponseti into 5 types: Grade IA: decrease in ankle dorsiflexion from 15 degrees to neutral, Grade IB: dynamic forefoot adduction or supination, Grade IIA - rigid equinus, Grade IIB – rigid adduction of forefoot/midfoot complex and Grade III: combination of two or more deformities: Fixed equinus, varus and forefoot adduction.²¹

1.1. Aim of the work

The aim of this work was to evaluate the results of treatment of persistent forefoot adduction during ponseti method in treatment of idiopathic talipes equinovarus by minimal soft release.

2. Material and methods

Thirty children of one day old up to six months presented with forty five idiopathic congenital talipes equinovarus were included in this work. 15 patients (30 clubfeet) (67%) were bilaterally

Abbreviations: AHT, abductor hallucis tenotomy; TAT, tendoachillis tenotomy.

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affected. The right side was affected in 8 patients (8 clubfeet) (18%), the left side was affected in 7 (15%) patients. There were 20 (67%) boys and 10 (33%) girls. All patients had no any associated anomalies.

Each clubfoot was rated according to the Pirani system.²² Six different components of the clubfoot were registered. These are divided into the hindfoot components: posterior crease, empty heel, and rigid equinus, and the midfoot components: medial crease, curvature of the lateral border of the foot, and the position of the head of the talus. A total score from 0 to 6 points, with 6 representing the most severe deformity. Each foot was rated before treatment, during, after the last cast removal and at the end of follow up (Table 1).

All patients were treated using the technique described by Ponseti.^{19,20} Feet were gently manipulated before cast application and then placed in above knee plaster casts with the knee flexed 90°. The casts were changed weekly. The number of casts were ranged from 4 to 6 weeks according to the clinical evaluation at each cast and the need of additional tenotomies.

Abductor hallucis tenotomise (AHT) were performed for persistent forefoot adduction after serial weekly casting in 40

(89%) feet. They were performed for feet with moderate or severe midfoot score (0.5 or 1). It was done in the operating room under general anaesthesia. The foot, leg, and knee, were prepared and draped. An assistant held the foot in abduction, a small 1 cm incision on the medial side of the base of the big toe was done, the tendinous part of the muscle is dissected, identified and cut (Fig. 1). After the tenotomy was performed, skin closure was done then covered with a small sterile gauze and a sterilized soft roll.

Tendoachillis tenotomise (TAT) were performed for 35 (77%) feet, all of them preceded by abductor hallucis tenotomies. It was done when the ankle dorsiflexion was less than 15° after abductor hallucis tenotomy. It was done in the operating room under general anaesthesia. The foot, leg, and knee, were prepared and draped. An assistant held the leg with the foot in dorsiflexion. Skin incision was done (about 1 cm) through the medial edge of the tendoachilles about 1 cm above its insertion, the tendoachilles was dissected, identified and completely cut (Fig. 2). The angle of dorsiflexion of the ankle suddenly increased and the equinus deformity was corrected. Skin closure was done then covered with a small sterile gauze and a sterilized soft roll. After tenotomies, the cast was applied with the foot abducted 60–70 degrees and the

Table 1

Pirani score before treatment, after the last cast, after tenotomy and the end of follow up.

Foot no.	First visit	The last cast	±Tenotomy		±Post-tenotomy	End follow-up
			AHT	TAT		
1	5.5	1.5	yes	no	.0	.5
2	6.0	2.0	yes	yes	.0	1.0
3	6.0	2.0	yes	yes	.5	.0
4	6.0	2.5	yes	yes	.5	1.0
5	6.0	2.0	yes	yes	.0	1.5
6	6.0	2.5	yes	yes	.5	1.5
7	5.0	1.0	no	no	1.0	.5
7	5.5	1.0	no	no	1.0	.5
9	5.0	1.5	yes	no	.5	.5
10	5.0	2.5	yes	yes	.5	.5
11	5.0	0.5	no	no	.5	1.5
12	5.0	0.5	no	no	.5	1.5
13	6.0	2.5	yes	yes	.5	1.5
14	6.0	2.5	yes	yes	.5	1.0
15	6.0	2.0	yes	no	.5	1.5
16	6.0	2.5	yes	yes	.5	1.5
17	6.0	1.0	no	no	1.0	1.5
18	6.0	1.5	yes	no	.0	1.5
19	6.0	2.0	yes	yes	.0	1.5
20	6.0	2.5	yes	yes	.5	1.5
21	6.0	2.0	yes	yes	.5	1.0
22	6.0	2.0	yes	yes	.5	1.0
23	5.0	2.0	yes	yes	.5	.5
24	6.0	2.5	yes	yes	.5	1.0
25	6.0	2.5	yes	yes	.5	1.5
26	6.0	2.5	yes	yes	.5	1.0
27	5.0	2.5	yes	yes	.5	1.0
28	6.0	2.0	yes	yes	.5	1.5
29	6.0	2.0	yes	yes	.0	1.5
30	6.0	2.0	yes	yes	.0	1.0
31	4.0	2.0	yes	yes	.0	1.0
32	6.0	1.5	yes	yes	.5	3.0
33	6.0	1.5	yes	yes	1.5	1.5
34	6.0	1.5	yes	no	0.5	2.0
35	5.0	2.0	yes	yes	.0	.5
36	6.0	2.5	yes	yes	.5	1.5
37	5.0	2.0	yes	yes	.0	.5
38	4.5	2.0	yes	yes	.0	.0
39	4.5	2.5	yes	yes	.0	.0
40	5.0	2.0	yes	yes	.0	.0
41	6.0	2.0	yes	yes	.5	1.5
42	4.5	1.5	yes	yes	.5	0.5
43	6.0	2.0	yes	yes	1.0	1.0
44	5.0	1.5	yes	Yes	0.0	0.0
45	4.0	1.5	yes	yes	0.0	0.0
Mean	5.21	2.13	yes = 40	yes = 30	0.25	1.05
SD	0.56	0.57	no = 5	no = 10	0.41	0.64

Fig. 1. **a**, Abductor hallucis tenotomy after removal of the last manipulation cast. **b**, 8 months follow up.

Fig. 2. **a**, Tendoachillis tenotomy. **b**, Equines correction after tenotomy.

ankle dorsiflexed to 15°. This cast was left in place for 4 weeks after complete correction. After 4 weeks, the cast was removed, and the foot was examined clinically.

Dennis-Brown splint was applied immediately after the last cast was removed. The affected foot is fixed in 70° external rotation then gradually decreased with follow up. The parents were told that the splint should be worn (22–24 h)/day, for the first 3 months after the tenotomy cast was removed. After that, the child wore the splint for 12 h at night for 2–4 years.

All patient were followed up for a period ranged from 12 to 24 months, with a mean of 16.7 months (after removal of the last cast). Supervision follow up was done regularly every month for at least 6 months.

The results were recorded, and evaluated clinically. A clinical assessment was performed to evaluate the hindfoot and forefoot. The results were graded as good, bad, and failed, according to the assessment criteria by Pirani et al.²² **Good results** were considered when Pirani score was ≤ 1.5 , **Bad results**; 1.5 to < 5 , **Failed results**; 5 to 6.

2.1. Method of statistical analysis

Statistical analysis was done using the statistical program for social sciences (SPSS)-version 20. t-test was used to analyze the relations between the obtained results and the different variables. 5% level of significance was chosen.

3. Results

The mean Pirani score at 1st visit was 5.21 points and became 2.1 points after the last manipulation cast (pre-tenotomy), 1.05 points at the final follow up. There was significant improvement of Pirani score from 1st visit and through the stages of treatment up to the final follow up. There was statistically significant relation between the mean Pirani score at 1st visit and that at the final follow up ($P = 0.002$). At the end of follow up; The results of all feet were as follows: 43/45 feet were good (95%), 2/45 feet were bad (5%) (Table 2) (Figs. 3 and 4), the Pirani scores of the two bad feet immediately after tenotomy were 0.5 and at the final follow up of both (20,22 months) were 2.5 and 3. These two bad results were attributed to poor parents compliance regarding regular follow up and proper bracing.

The mean age at presentation for good results was 2.15 weeks ($SD = 1.06$), the mean age for bad results was 3.5 weeks ($SD = 0.71$). The difference in the mean of the age was statistically significant

Table 2
The overall final results.

Result	No (of clubfeet)	%
Good	43	95%
Bad	2	5%
Total	45	100.0

Fig. 3. Male boy with congenital TEV, had 4 weeks casting, AHT + TAT followed by 1 month above knee plaster cast. After 8 months follow up, the results was good, Pirani score was 0.5.

Fig. 4. Male boy with congenital TEV, had 4 weeks casting, TAT followed by 1 month above knee plaster cast. After 24 months follow up, the results was good, Pirani score was 0.0.

($P = 0.000$). The younger the age of the patient at beginning of treatment, the better was the results (Table 3).

It was found that; both sex and the side affected had no statistical significance effect on the final end result ($P = 0.610$, $P = 0.435$). The relationship between bilaterality or unilaterality in relation to final result was statistically insignificant ($P = 0.132$). The number of casts had no statistically significant effect on the final results ($P = 0.252$). There was no significant difference of the final results between those that did and did not have a tenotomy. There were 2 feet had superficial cast ulcer during serial casting, they were treated by betadine dressing under the cast.

4. Discussion

Most orthopaedic surgeons agree that the treatment should begin as early as possible, and the initial treatment of idiopathic congenital clubfoot should be serial gentle manipulation to stretch the contractures, with serial casting, splinting, or strapping to maintain the correction obtained by stretching.^{23–25} Operative treatment should be considered only after manipulation and plaster cast have failed to obtain correction in a specified period of time, this period should not preferably be more than three months.²⁶

Table 3
Relationship between age (weeks) and final results.

	Final result	No. of feet	Mean	SD	P
Age (Weeks)	Good	43	2.15	1.06	0.000*
	Bad	2	3.55	0.71	
	Total	45	3.40	2.37	

The method of serial manipulations and casting which was developed and mastered by Ignacio Ponseti, at the University of Iowa in 1950 is applied to infants with congenital clubfoot deformity in an effort to achieve a plantigrade, functional foot without resorting to surgery.^{1,27} The long – term outcome of this technique has been reported to result in satisfactory functional results in 85%–90% of feet when appropriately applied.^{28,29}

The other non-surgical treatment regimens of manipulation and casting have had less success and have been associated with such complications as increased cavus deformity, false correction with mid-tarsal breach and rocker – bottom deformity, flattening of the talar dome, pressure sores from casts, and even fractures secondary to excessive force during manipulations.^{30,31}

The success rate in this study was 95%, 5% had bad results due to poor parents compliance with regular follow up and splinting. This agree with the results of others using the same technique. Michael, and Matthew, reported on 34 infants (57 clubfeet) treated by Ponseti technique; 54 of 57 (95%) clubfeet were successfully corrected, only 2 patients (5%) (3 clubfeet) required surgery, there was a lack of compliance with Dennis-Browne splint.³² Herzenberg and associates reported their results in the first 27 patients that they treated with the Ponseti technique, and found 97% success, with only one failure (3%).³³ Lehman and associates reported a 92% success rate in their initial series of 50 feet at short-term follow-up.³⁴ Segev and associates reported a dramatic increase in the success of manipulative treatment using the Ponseti technique at their institution. A success rate of 94% compared with only 43% in the group treated with a modification of the Kite technique was achieved.³⁵ In this study, the number of casts were ranged from 4 to 6 times changed weekly, after tenotomy the feet were placed in a cast for one month, the small number of casts before tenotomy

were due to abductor hallucis tenotomy that allowed adequate forefoot abduction. This abduction allowed the foot to be safely dorsiflexed without crushing the talus between the calcaneus and tibia. Ponseti and Smoley,³⁶ reported 5–12 weeks' duration of casts (average, 9.5 weeks). In another study by Laaveg and Ponseti,²⁸ the average duration was 8.6 weeks.

Scher and associates had prepared their study which was to determine how to predict the need for tenotomy at the initiation of the Ponseti treatment. Fifty clubfeet (35 patients) were prospectively rated according to Pirani scoring systems. Tenotomies were performed in 36 of 50 feet (72%). Those that underwent tenotomy required significantly more casts. Of 27 feet with initial Pirani scores about 5.0, 85.2% required a tenotomy and 14.8% did not following removal of the last cast. There was no significant difference between those that did and did not have a tenotomy. At the end of casting, feet were equally well corrected whether or not they needed a tenotomy.³⁷ In this study, 40 feet (89%) had AHT and 35 feet (77%) had TAT after the last manipulation cast, 5 feet among those of AHT did not required TAT where ankle dorsiflexion was more than 15°. At the final follow up (average; 16.7 months), There was no statistically significant difference between those that did and did not have a tenotomy. There were not leg muscle atrophy or discrepancy in the leg/foot size or length, this was attributed to the procedure of AHT that shortened the duration of the casts required to correct the forefoot adduction

In this study, there were 2 relapses; forefoot adduction (1 clubfeet, 2.2%), forefoot adduction and equines (1 clubfeet, 2.2%), this was due to lack of regular follow up and non-compliance of the brace and also partly due to application of the brace incorrectly at home when parents removed them for bathing. Both were treated by soft tissue release. Strict instructions for the brace application, motivation by dedicated personnel, and more frequent follow-up have led to increased compliance of the brace for the patients and early detection of any relapse, if any. Morcuende and associates,³⁸ reported a 6% relapse rate in compliant patients and 80% in non-compliant patients. The underlying cause for the relapse in the compliant group was underlying muscle imbalance of the foot and ligament stiffness. Cavus and forefoot adduction were encountered initially due to non-compliance of the brace but later on with regular follow-up and strict brace compliance, these relapses were less often.

There were 2 feet had superficial cast ulcer during serial casting, they were treated by betadine dressing under the cast. Morcuende and associates³⁹ were encountered by one patient had skin breakdown secondary to cast problems, it was treated by postponing the cast for few days and local antibiotic.

5. Conclusion

Treatment of clubfoot with the Ponseti method is successful when performed immediately after birth. The younger the age of the patient at beginning of treatment, the better were the results. Regular follow up and cooperative parents are very important to prevent recurrence. AHT shortens the duration of casts required to correct forefoot adduction, decrease the cost and the risk of leg and foot muscle atrophy.

Conflicts of interest

The author has none to declare.

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