

Assessment and Management of Untreated Congenital Talipes Equinovarus Using the Ponseti Method: A Comprehensive Review

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ABSTRACT

Background: Congenital talipes equinovarus (CTEV), or clubfoot, is a common congenital foot deformity. This study aimed to assess the clinical outcomes of the Ponseti method in untreated idiopathic clubfoot among children older than one year of age, as its effectiveness in walking-age children without prior treatment remains uncertain.

Methods: This prospective hospital-based study was carried out in the Department of Orthopaedics, Assam Medical College and Hospital, Dibrugarh throughout one year. 44 children (67 feet) with untreated idiopathic clubfoot attended our hospital and were treated by a modified Ponseti treatment protocol comprising serial manipulation, casting Achilles tenotomy, and bracing. To measure the severity of the deformity, the Pirani scoring system was used before and after the treatment.

Results: The mean age of patients at presentation was 2.9 years, with the majority (61.36%) of patients belonging to the 2-4 years age group. Males accounted for 59.09% of cases, and bilateral involvement was present in 52.27%. The average number of casts required for correction was 8.19. All feet underwent Achilles tenotomy. The mean Pirani score improved significantly from 4.88±0.74 before treatment to 0.87±0.26 after treatment. At the last follow-up, 95% of feet had a Pirani score of 0 to 1. Minor complications were skin redness, swelling, and dynamic supination without major complications.

Conclusion: The Ponseti method is a safe and effective treatment for children with clubfoot who are already walking and have never been treated before. It is a minimally invasive method with a low complication rate which can dramatically reduce the extent of the surgical procedure needed for the correction.

Key-words: Congenital talipes equinovarus, clubfoot, Ponseti method, Pirani score, walking-age clubfoot, Achilles tenotomy, Serial casting

INTRODUCTION

Congenital talipes equinovarus (CTEV), or clubfoot, is a musculoskeletal deformity affecting children that is present at birth and is one of the most common worldwide. Its incidence is about 1 in 1,000 live births. It is a complicated deformity of the foot in three spatial

varus adductus, and cavus. These abnormalities cause the foot and ankle to be misaligned which leads to loss of functions if no treatment is given. Proper evaluation of clubfoot is vital for assessing the initial severity of the deformity, keeping track of treatment progress, assessing treatment outcomes, and spotting relapses during follow-up^[1,2].

One cannot fully understand clubfoot without knowing its anatomical and biomechanical basis first, as these will be the two fundamental points of its evaluation and treatment. The adduction would be the moving of a tarsal bone to the median plane of the body, while abduction would be just the opposite, the movement away from the median plane. In the same way, flexion

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would be the movement in the direction of the sole of the foot, and extension would be the movement on the other side. Inversion and eversion are movements of the plantar surface respectively toward and away from the median plane. The combined movements of adduction, flexion, and inversion are called supination, while abduction, extension, and eversion make up pronation. The abnormal positional relationships of the foot in clubfoot deformity give rise to the typical appearance and stiffness of the affected foot ^[2].

Management of clubfoot has undergone a significant transformation over the past few decades. Earlier, treatment methods were mostly limited to conservative measures like manipulation, strapping, and serial casting or to drastic surgical corrections. Unfortunately, surgical treatments were usually accompanied by stiff joints, painful experiences, and long-term reduced functional abilities. Dr. Ignacio Ponseti came up with a non-surgical treatment method in the 1960s that was based on a good anatomical and biomechanical knowledge of the foot. Since then, the Ponseti method has become the worldwide standard for clubfoot treatment due to its very high success rate, the least amount of invasiveness, and cost-effectiveness ^[3,4].

The Ponseti technique involves the careful and gentle manipulation of the foot followed by a series of plaster casts to progressively straighten the foot. Usually, the correction is achieved in four to six weeks, with the child needing only about five casts on an average. To solve the remaining equinus deformity, percutaneous tendo-Achilles tenotomy is done, and afterward, foot abduction braces are used to keep the foot in the corrected position and prevent the foot from going back to the deformity. Correctly done and use of proper bracing protocols, the method has been reported to have a success rate of nearly 98% by various studies ^[3,4].

Starting treatment as soon as possible is one of the major determinants of treatment outcome. Due to soft tissues being quite modifiable at the early age of infancy, the Ponseti method yields the best results when it is initiated in the neonatal period. For attaining and retaining the results following the treatment, the ongoing, hands-on participation of parents and sticking to the use of the brace as per the protocol are critical elements ^[4]. Good functional outcome following the Ponseti method of treatment carried out during the first year continues to be the norm. This method is now

overwhelmingly the one most chosen for treating idiopathic clubfoot ^[8].

In numerous low- and middle-income countries, significant proportion of children present after walking age without having been treated which is quite common. Conventionally, such cases have been labeled as "neglected clubfoot," but this term should not be attributed to the families of affected individuals having limitation to healthcare. Because of this, "walking-age clubfoot" has been proposed to be a more neutral and fitting term ^[5,6]. Generally, untreated clubfoot is clubfoot which has not been subjected to any treatment before the walking age, mainly one year of age ^[7].

Children who are older in age and have untreated clubfoot frequently undergo physical, psychological, and social challenges, substantially. They may suffer pain resulting from abnormal weight-bearing, skin breaking down, joints being stressed, muscles becoming weak, social stigma, less opportunities for education, and even limitations when it comes to work prospects. Though, even with these challenges, more and more research indicates that the Ponseti method can be utilized as the main treatment method for children of walking age and cases of neglect even providing a good correction and at the same time avoiding extensive surgical procedures ^[7]. Considering the value of proper assessment and the popularity of the Ponseti technique, this review intends to be a detailed account of congenital talipes equinovarus covering its anatomy and biomechanics, ways for its evaluation, basics of Ponseti method, results of treatment, and up-to-date researches about its application for cases of early-presenting and children of walking age.

MATERIALS AND METHODS

Study Design and Setting- We conducted a hospital-based prospective study in the Department of Orthopaedics, Assam Medical College and Hospital Dibrugarh over a period of one year. The main objective of the study was to assess how effective the Ponseti method was in treating children with idiopathic clubfoot who had not been treated and were presenting for the first time after the walking age.

Study Population and Sample Size- The study population included children visiting the Orthopaedics Outpatient Department of Assam Medical College who met the

preset inclusion and exclusion criteria. Sample size determination was done by $(n = z^2pq/d^2)$ formula after assuming an 87% improvement rate with the Ponseti method, 95% confidence interval, and 10% margin of error. Lastly, the sample size was adjusted to 44 participants.

Clinical Assessment- All patients underwent detailed history taking and clinical examination. Documented were the congenital anomalies associated, as well as the treatment history of the cases. A clubfoot severity measurement was done using the Pirani scoring system which is based on the clinical evaluation of the contractures of the hindfoot and midfoot through six parameters and can be scored from 0 to 6. Evaluation was done before starting the treatment and also during the follow-up visits at regular intervals.

Treatment Protocol- All patients underwent treatment with a modified Ponseti method involving weekly manipulations and serial casting above the knee. Casting was done until proper correction and foot abduction of 3040 were obtained. Residual equinus deformity was fixed by Achilles tenotomy. Open tenotomy was performed in children of larger weight another tenotomy was done if first dorsal flexion was not enough. Percutaneous plantar fasciotomy was done in cases of persistent cavus deformity. After correction, a foot abduction brace was given and used as per the standard Ponseti protocol. Open tenotomy was performed in bigger children.

Follow-Up- After tenotomy, patients were monitored at 3, 6, and 9 months. The Pirani score was used as one of the measures for assessing clinical outcomes with degree of correction achieved, maintenance of correction, and occurrence of relapse.

Statistical Analysis- Data were entered into Microsoft Excel and analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean \pm standard deviation (SD), while categorical variables were presented as frequencies and percentages. The paired t-test was used to compare pre- and post-treatment Pirani scores. Pearson's correlation coefficient was used to assess the relationship between the initial Pirani score and the number of casts required,

as well as between the initial and final Pirani scores. A p-value of <0.05 was considered statistically significant.

Ethical Considerations- The study was started only after permission was obtained from the Institutional Ethics Committee (Human), Assam Medical College and Hospital. The study complied with the ethical codes that regulate research with human participants in clinical studies. Parents or guardians of all children who were enrolled signed the informed consent form.

RESULTS

We studied a total of 44 children with 67 feet affected by untreated idiopathic clubfoot. The average age when the children first came to us was 2.9 years. Many patients (61.36%) were aged between 2 and 4 years at the time of presentation. The male gender accounted for 59.09% of the study sample, with the ratio of males to females being about 1.4:1. Nearly half of the cases, 47.73%, were single-foot cases, whereas both feet were affected in 52.27% of the patients. The majority of patients were first-born children (54.54%). Positive family history of clubfoot was observed in six patients (13.64%), while only two children (4.55%) were born from consanguineous marriages (Table 1).

Table 1: Demographic and Clinical Profile of Study Participants (n = 44)

Variable	Number (%)
Age Group	
1–2 years	14 (31.81)
>2–4 years	27 (61.36)
>4–10 years	2 (4.54)
>10 years	1 (2.27)
Gender	
Male	26 (59.09)
Female	18 (40.91)
Laterality	
Left unilateral	12 (27.27)
Right unilateral	9 (20.45)
Bilateral	23 (52.27)
Family History Positive	6 (13.64)
Consanguineous Marriage	2 (4.55)
First-Born Child	24 (54.54)

All feet were managed by the modified Ponseti method. Surgical intervention through percutaneous Achilles tenotomy was performed on all 67 feet to get the complete correction. On average, it took 8.19 casts to achieve the correction. The Pirani scores after treatment

showed a significant drop, suggesting that the deformity was largely corrected. At the last follow-up, 95.52% of the feet had a Pirani score in the range of 0 to 1 (Table 2).

Table 2: Treatment Characteristics and Pirani Score Assessment (67 Feet)

Variable	Value
Total feet treated	67
Mean number of casts	8.19
Feet requiring tenotomy	67 (100%)
Mean pre-treatment Pirani score	4.88 ± 0.74
Mean post-treatment Pirani score	0.87 ± 0.26
Pre-treatment Pirani Score	
	Number of Feet (%)
3–5	43 (64.18)
>5–6	24 (35.82)
Post-treatment Pirani Score	
0–1	64 (95.52)
>1–2	3 (4.48)

Correlation analysis revealed a strong positive correlation between the initial Pirani score and the number of casts needed for correction. In the same way,

more severe cases before treatment resulted in higher post-treatment Pirani scores (Table 3).

Table 3: Treatment Outcome and Complications

Parameter	Observation
Correlation between initial Pirani score and casts required	Strong positive correlation
Correlation between initial and final Pirani score	Strong positive correlation
Skin redness/toe swelling during casting	7 patients
Dynamic supination	5 feet
Infection after tenotomy	None
Skin necrosis	None
Neurovascular complications	None
Excessive bleeding	None

Correlation between the initial Pirani score and the number of casts required for correction. Higher initial Pirani scores were associated with a greater number of casts needed before achieving correction (Fig. 1).

A marked reduction in the Pirani score was observed after completion of treatment, indicating significant clinical improvement following the Ponseti method (Fig. 2).

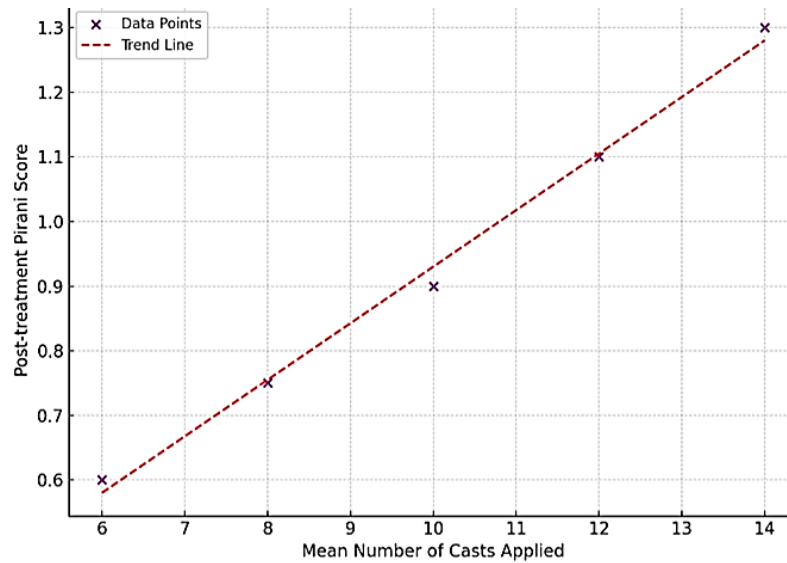


Fig. 1: Scatter Plot Showing Correlation Between Initial Pirani Score and Number of Casts Required.

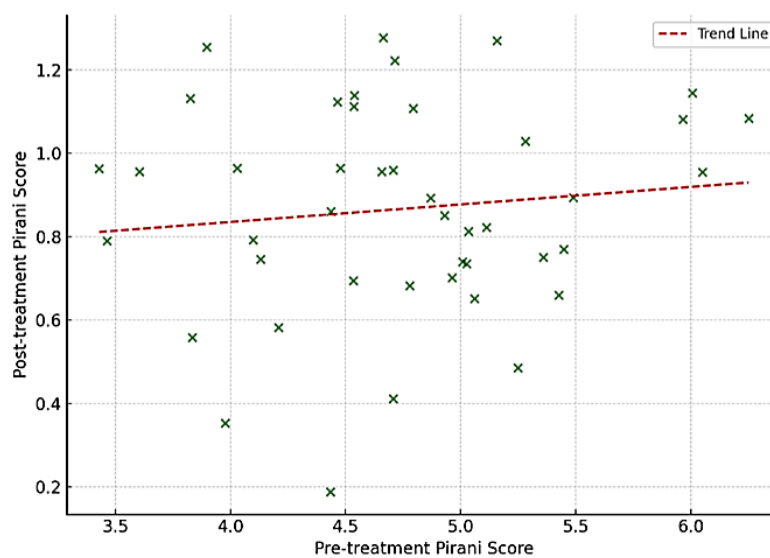


Fig. 2: Scatter Plot Showing Correlation between Initial and Final Pirani Scores.

A few minor side effects during treatment were fleeting skin redness, erythema, and swelling of toes in seven patients. Dynamic supination was noted in five feet but those did not require surgery. No serious problems like infection, skin death, nerve-blood vessel damage, or heavy bleeding occurred after the cutting of the tendon. In general, the modified Ponseti method managed to deliver good results with hardly any complications in children of walking-age who had untreated idiopathic clubfoot.

DISCUSSION

This paper mainly aimed at evaluating the effectiveness of the Ponseti method in idiopathic clubfoot cases that have not been treated earlier and in children who come to the clinic after the age of 1 year.

Around 61.36% of the patients aged between 2 and 4 years, with an average of 2.9 years, were brought to the clinic. Other studies have also found mean age of presentation around 3.4-3.9 years, which suggests that late presentation is still a norm in the developing world [9].

In our study, males were 59.09% of the patients reflecting the male predominance of the deformity. This is consistent with the earlier studies which have shown that the incidence of clubfoot is higher among males. About half of our patients, 52.27% had bilateral clubfoot which aligns with earlier studies that have shown bilateral affection in about 50-56% of patients [10,11].

The average number of casts needed to achieve correction was 8.19, which lies within the range reported in the literature for walking-age children treated with the

Ponseti method^[9,12]. Positive family history was found in 13.64% of patients, which corroborates the genetic role hypothesis for clubfoot etiology^[13]. Children affected were predominantly first-borns (54.54%), this aspect being in line with other studies that have pointed out the higher prevalence among first pregnancies^[14]. Consanguineous marriage was detected in only 4.55% of cases whereas in certain earlier studies it was reported a possible association between consanguinity and clubfoot occurrence^[15].

Every foot had to undergo Achilles tenotomy to attain full correction, which strongly suggests the indispensability of this surgical step in the Ponseti method. Second tenotomy had to be carried out in seven feet that still showed equinus deformity still none of the patients were subjected to major soft tissue release procedures.

On average, the Pirani score was improved significantly from 4.88 ± 0.74 pre-treatment to 0.87 ± 0.26 post-treatment. In addition, 95% of the feet obtained a Pirani score at the end between 0 and 1, indicating the high level of correction. These results are in line with already published research and validate the use of the Ponseti method for clubfoot correction in older children who have not been treated before^[9].

Complications were few and mostly limited to mild skin reddening, swelling, and dynamic supination. There were no major complications like infection, skin necrosis, neurovascular injury, or heavy bleeding. In general, the outcomes of this study support the Ponseti method as a reliable, powerful, and minimally invasive means of treating untreated idiopathic clubfoot in children of walking age and lead to the healing of almost all deformities. Besides, the rate of complications is quite low.

CONCLUSIONS

Ponseti method was found to be safe, effective treatment option in untreated idiopathic congenital talipes equinovarus in walking-age children. Significant improvement in the Pirani scores was observed, on average, scores dropped from 4.88 ± 0.74 before treatment to 0.87 ± 0.26 after treatment. Satisfactory foot correction with serial casting and percutaneous Achilles tenotomy was the norm for most cases, whereas there were no major complications reported. The results show that the Ponseti method has the ability to fix clubfoot

even if the children with deformity come for treatment after one year of age. Using the method, the amount of surgery could be reduced. Although, it is always best to start early for getting the best results first, and even if the child comes late, it should not be a reason to not begin with Ponseti method.

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