

ORIGINAL ARTICLE

Effectiveness of the Ponseti technique in treating children with different types of clubfoot: A cross-sectional study at Lady Reading Hospital.Alia Batool Zafar¹, Seema Gul², Nazish Faiz³, Zarmina Behram Durrani⁴, Marina Khan⁵, Shafiq Syed⁶

ABSTRACT... Objective: To evaluate the effectiveness of the Ponseti technique in relation to different types of clubfoot on the basis of Pirani scoring among patients at lady reading hospital (LRH) Peshawar. **Study Design:** Retrospective Cross Sectional study. **Setting:** Department of Clubfoot, Lady Reading Hospital Medical Teaching Institute, Peshawar. **Period:** Study conducted till November 2024; retrospective Data was obtained from December 2020 to December 2022. **Methods:** This was a retrospective cross-sectional study conducted on children with clubfoot deformity visiting Clubfoot department of Lady Reading Hospital Peshawar. On the basis of selection criteria, data of total 408 patients (mean age = 6.29 ± 6.04 months), comprising 271 males and 137 females were included in the study. Data related to study population was collected. Pirani score was used as an assessment tool to investigate the effectiveness of Ponseti method in treating clubfoot deformity. Data was analyzed using SPSS version 26.

Results: Total 614 clubfoot were treated in this study. In this sample, the ratio of males to females was approximately 2:1, indicating that males were affected about twice as common as female. By the end of treatment, 76.34% (n = 468) of cases achieved maximum correction with a Pirani score of ≤ 1 , including 48.77% who reached a score of 0.00. A marked shift was also observed in both the median and mode of Pirani scores from pre- to post-treatment, reflecting a significant improvement in clinical outcomes. The results of this study showed the Ponseti method is significant effective in treating clubfoot (p -value = 0.001 Wilcoxon Signed-Rank Test).

Conclusion: This study concludes that the Ponseti method is highly effective in the treatment of various types of clubfoot, including idiopathic, syndromic, and neurogenic forms. The significant improvement observed in Pirani scores from pre- to post-treatment demonstrates the method's ability to achieve substantial correction of the deformity.

Key words: Clubfoot, Ponseti Technique, Pirani Score.

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INTRODUCTION

Clubfoot is one of the oldest and most common pediatric deformities, characterized by abnormal alignment of the lower extremities. It ranks among the seven most frequently occurring musculoskeletal congenital defects and is often challenging to correct.¹ Globally, clubfoot is affecting 1 to 2 children per 1,000 live births; low income countries showing the highest prevalence rate (80%), eventually, it is estimated that every year 175,000 children are born with clubfoot worldwide.² The prevalence of clubfoot is higher in male infants than female.³ In majority cases of clubfoot (50%) involve both feet and in unilateral cases it is observed that the right foot is affected more.⁴ Contrary to its neighbor countries; Pakistan shows a higher incidence rate of 1.5 per 1000 live births that is 6000 to 7000 children are

affected by clubfoot deformity every year.⁵

Previous studies have reported that approximately 80% of cases have an idiopathic etiology while remaining 20% are associated with neuromuscular and chromosomal abnormalities, such as distal arthrogryposis and myelomeningocele.⁶ Several risk factors have been recognized, including family history, infections or drug usage during pregnancy, smoking during pregnancy, and oligohydramnios, all these factors elevate the risk of clubfoot occurrence.⁷ Environmental factors such as intrauterine growth restriction and gestational diabetes can contribute to the development and severity of clubfoot. If left untreated, barriers like financial constraints, lack of resources, isolation, and physical discomfort can result in lifelong disability.⁸

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Clubfoot can manifest in two forms one is known as idiopathic type which occurs in normal infants (80% of cases), or other in non-idiopathic type in babies with neuro-muscular diseases or various syndromes. Idiopathic clubfoot, also known as Congenital Talipes Equinovarus (CTEV), is the most common type of clubfoot and is not associated with any other medical conditions or syndromes.⁶ Non-idiopathic clubfoot refers to cases where the condition occurs as a result of secondary to underlying conditions, most commonly being spina bifida (neurogenic clubfoot) or arthrogryposis, constriction band syndrome and tibial hemimelia (syndromic clubfoot). These deformities are generally more resistant to treatment compared to idiopathic clubfoot.⁹ In the treatment of clubfoot, surgical interventions can lead to complications such as pain, stiffness, and foot weakness.¹⁰

Therefore many orthopedic surgeons favor non-operative approaches as the primary treatment that should be started soon after birth. Conservative approach corrects the deformity through gentle manipulation and casting, reducing the need for surgery.¹¹ Among conservative treatments; Ponseti's method is considered as the gold standard.¹² This technique was originated in late 1940 by Ignacio V. Ponseti to treat clubfoot. It consists of 3 phases of treatment: manipulation and casting, Tenotomy, and bracing. The first phase involves weekly manipulations followed by cast immobilizations. Typically, deformations were corrected within 4–5 weeks, except for equinus.¹³ The second phase consists of percutaneous Tenotomy of Achilles tendon for treating residual equinus; followed by cast immobilization. In third phase, foot abduction braces are applied until the child is 4 to 5 years old.¹¹ The Parental commitment is essential, as achieving satisfactory correction is often difficult, with frequent relapses following cast removal. Ongoing challenges include delayed presentation, poor follow-up, prolonged casting, brace non-compliance, and high relapse rates.¹⁴ Clubfoot can be categorized as mild, moderate or severe based on several scoring systems, with the Pirani system being the most commonly utilized. Developed by Shafiq Pirani, it comprises six categories three for the midfoot and three for the hindfoot, each graded as 0 (no deformity), 0.5 (moderate), or 1 (severe).

Each foot is assigned a total score ranges from 0 to 6, which is commonly used to assess treatment outcomes.¹⁵

Neglected clubfoot, also known as untreated clubfoot, poses significant challenges and complications for affected individuals. Children with neglected clubfoot often experience difficulties in their daily task activities, including mobility issues, abnormal gait patterns, limitations in participating in social activities, and challenges in performing daily living skills.¹⁶ This may lead to physical impairment which severely limits mobility and lifelong functional limitations, impacting various aspects of daily life for affected children.¹⁷ Moreover, the long-lasting disability can lead to emotional, economic, and social challenges, aggravating the burden faced by individuals with clubfoot.¹⁸ Timely intervention of neglected clubfoot is crucial to alleviate the adverse effects and prevent long-term complications.

The Ponseti method is widely regarded as the gold standard for treating idiopathic clubfoot due to its high success rate and minimally invasive nature. However, the effectiveness of this technique in managing non-idiopathic forms—such as syndromic and neurogenic clubfoot—remains a topic of ongoing debate. These cases are often more resistant to correction, require additional interventions like Achilles Tenotomy, and are associated with higher relapse rates compared to idiopathic clubfoot. Moreover, common barriers in low-income regions—such as delayed presentation, poor brace compliance, limited follow-up, and lack of trained personnel—can affect long-term outcomes. This study aims to assess treatment outcomes using retrospective data from the past two years (December 2020 to December 2022) to evaluate the efficacy of the Ponseti method across different clubfoot types.

METHODS

This cross-sectional study was conducted in the Clubfoot Department of Lady Reading Hospital, Peshawar. A total of 408 children with either unilateral or bilateral clubfoot were included using a census sampling technique. The inclusion criteria were: (1) children diagnosed with any type of clubfoot, and (2) those who had undergone the Ponseti technique

for clubfoot management. Children who had not completed the Ponseti treatment protocol were excluded from the study.

Approval was obtained from the Review Board of Khyber Medical University (DIR/KMU-AS&RB/EP?002204) and Clubfoot Department of Lady Reading Hospital, Peshawar (REF NO. 029/PT&R/LRH-MTI/24). The data, originally maintained in Excel format by the Clubfoot Department, was accessed with permission following ethical clearance. The dataset was based on information collected through the International Clubfoot Registry Visiting Form. After retrieval, the data was screened and refined according to the study's selection criteria.

The finalized dataset was then entered into Statistical Package for the Social Sciences (SPSS) version 26. Descriptive statistics like mean and standard deviation was used for continuous variable like age. For categorical variable like gender, number of casts applied during treatment time period, history of Tenotomy and events of relapse were presented using frequency tables and charts.

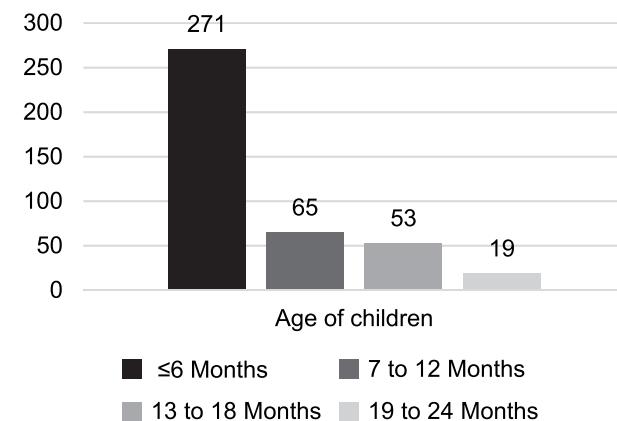
To investigate the impact of Ponseti technique in clubfoot management; Pirani score was used. Pirani score is an ordinal scale; used to assess the severity of clubfoot. Pre and post treatment scores were obtained by detailed evaluation of each clubfoot using Pirani score. The effectiveness of the Ponseti method was defined as (1) achieving a median and mode of Pirani score of ≤ 1 at final evaluation (2) at least 75% (n= 460 and above) of total clubfeet would be achieving Pirani score of ≤ 1 and (3) For pre- and post-treatment changes in Pirani scores using Wilcoxon Signed-Rank Test; significance level of $p < 0.05$ was considered statistically significant.

RESULTS

A total of 408 patients with 614 clubfeet were included in the study. The optimal age of study sample 6.29 ± 6.04 months, comprising 271 males and 137 females. (See Figure-1)

FIGURE-1

Showing optimal age of children receiving the first cast



Among clubfeet, 68.4% were idiopathic congenital talipes equinovarus (CTEV), 18.6% were syndromic, and 13.0% were neurogenic in origin. The percutaneous procedure "tenotomy" for Achilles tendon release was performed in 63.2% of patients. Half of the patients (50%) required fewer than 7 casts to achieve complete correction, while 32.35% needed 7 to 10 casts, and 17.64% required prolonged casting involving more than 10 casts. See Table-I

All patients in the sample underwent the Ponseti method and achieved maximum correction of clubfoot by the final evaluation. The severity of the deformity was assessed both before and after treatment using the Pirani scoring system. The distribution of clubfoot severity across different Pirani score categories, pre- and post-treatment, is presented in terms of frequency. See Table-II.

At the final evaluation; Patients were categorized into three groups based on the total Pirani score achieved; a total score of 0.00 was considered as 'complete correction', 0.5 to 1 as 'fair correction' and a score greater than 1 as 'poor correction'.¹⁹

In CTEV 75.5% clubfeet achieved 0.00, 22.30% achieved 0.5 to 1 and 2.11% achieved poor outcome. In Syndromic clubfoot; only 1.8% recovered completely, 41.44% achieved fair while 56.76% achieved poor correction. In neurogenic clubfoot; only 3.89% recovered completely, 36.36%

achieved fair while 59.74% achieved poor correction at final evaluation.

A marked shift was also observed in the mean, median and mode of Pirani scores from pre- to post-treatment in all types of clubfoot; thus reflecting a significant improvement in clinical outcomes. To further evaluate the pre- and post-treatment changes in Pirani scores across all the types of clubfoot, the Wilcoxon Signed-Rank Test was used. The null hypothesis, "The median difference between pre-treatment and post-treatment Pirani scores equals zero", was rejected, indicating that the Ponseti method significantly improves clubfoot deformity ($p = 0.001$) in any type of clubfoot deformity. See Table-III

DISCUSSION

In this study we determined that Ponseti method is effective in the treatment of various types of clubfoot, including idiopathic, syndromic, and neurogenic forms. The highest success rate was observed in

CTEV type (75.58%) showing complete correction of the clubfoot deformity at final evaluation.

The results of this study indicate that clubfoot deformity is more prevalent in male infants compared to females. The male-to-female ratio in our sample is 66.42% to 33.56%, suggesting that males are twice as likely as females to be born with a clubfoot deformity. Our findings are consistent with previously published literature. A comprehensive survey was conducted by Pavone et al; that included a total of 801,324 live births recorded between January 1991 and December 2004. Within this population, 827 cases of clubfoot deformity were identified. Of these, 560 were male infants, indicating a significantly higher prevalence in males. The resulting male-to-female sex ratio was calculated to be 2.1, suggesting that male newborns were more than twice as likely as females to be affected by the condition.²⁰ The study conducted by Pavone et al focused exclusively on infants with idiopathic clubfoot deformity.

TABLE-I
Characteristics of study population according to the type of clubfoot

Variable	Total	CTEV Clubfoot (n)	Syndromic Clubfoot(n)	Neurogenic Clubfoot(n)
No. of patients	408	279 (68.38%)	76(18.72%)	53(12.99%)
No. of clubfeet	614	427 (69.5%)	110 (17.9%)	77(12.5%)
Gender	Male (271)	182 (67.1%)	50(18.4%)	39(14.3%)
	Female(137)	97(70.8%)	26(18.9%)	14(10.2%)
Mean Age (month)		(5.901±5.97)	(5.89±5.47)	(8.81±6.65)
Laterality	Left (89)	62(69.6%)	14(15.7%)	13(14.6%)
	Right(113)	69(61.0%)	28(24.7%)	16(14.1%)
	Both(206)	148(71.8%)	34(16.5%)	24(11.6%)
Tenotomy	Yes(258)	137(53.1%)	72(27.9%)	49(18.9%)
	No(150)	142(94.6%)	4(2.6%)	4(2.6%)
Compliance	Yes(204)	193(94.6%)	5(2.4%)	6(2.9%)
	No(204)	86(42.1%)	71(34.8%)	47(23.0%)
Relapse	Yes(204)	86(42.1%)	71(34.8%)	47(23.0%)
	No(204)	193(94.6%)	5(2.4%)	6(2.9%)
Previous Treatment	Yes(202)	94(46.5%)	66(32.6%)	42(20.7%)
	No(206)	185(89.8%)	10(4.8%)	11(5.3%)
Total no. of casting required for treatment	< 7 (204)	198(97.0%)	6(2.9%)	0(0%)
	7 to 10 (132)	62(46.9%)	65(49.2%)	5(3.7%)
	> 10 (72)	19(26.3%)	5(6.9%)	48(66.6%)

TABLE-II

Distribution of pre- and post-treatment pirani scores among clubfoot patients

Pirani Score	CTEV Clubfoot		Syndromic Clubfoot		Neurogenic Clubfoot	
	Pre (n)	Post (n)	Pre (n)	Post (n)	Pre (n)	Post (n)
0.00		322(75.5%)		2(1.8%)		3(3.8%)
0.50	4(0.9%)	79(18.5%)		23(20.9%)		10(12.9%)
1.00		16(3.7%)		23(20.9%)		18(23.3%)
1.50		5(11.7%)		28(25.4%)		22(28.5%)
2.0		1(0.2%)		13(11.8%)		5(6.4%)
2.5				17(15.4%)	1(1.2%)	10(12.9%)
3.0				3(2.7%)		7(9.0%)
3.5						1(1.2%)
4.0	27(6.3%)					
4.5	43(10.7%)					
5.0	165(38.6%)		3(2.7%)	1(0.9%)	2(2.5%)	
5.5	64(14.9%)	2(0.4%)	6(5.4%)		5(6.4%)	
5.56	2(0.4%)					
6.0	122(28.5%)	2(0.4%)	101(91.8%)		69(89.6%)	1(1.2%)
Total	427		110		77	

TABLE-III

Showing change in Pre- and Post-treatment pirani scores among clubfoot patients

Statistical Tests	CTEV Clubfoot	Syndromic Clubfoot	Neurogenic Clubfoot
Pirani score at the final evaluation	Complete Correction	322 (75.5%)	2 (1.8%)
	Fair correction	95 (22.2%)	46 (41.8%)
	Poor Correction	10 (2.3%)	62 (56.3%)
Mean \pm SD	Pre	5.20 \pm 0.75	5.94 \pm 0.19
	post	0.20 \pm 0.62	1.45 \pm 0.82
Median	Pre	5.00	6
	post	0.00	1.5
Mode	Pre	5.00	6
	post	0.00	1.5
Percentile	25 th	Pre=5 post=0	Pre=6 post=1
	50 th	Pre=5 post=0	Pre=6 post=1.5
	75 th	Pre=6 post=0	Pre=6 post=2
Wilcoxon Signed-Rank Test		P= 0.001	P= 0.001
Cohen' d effect size		r = 0.87	r = 0.87

In contrast, our study included all types of clubfoot; we found that the male-to-female risk ratio of 2.1 was consistent across all types of clubfoot, not limited to the idiopathic form. The male to female ratio was observed across different types of

clubfoot as 39:14, 50:26 and 182:97 in Neurogenic, Syndromic and CTEV respectively.

The pattern of laterality related to clubfoot in our study sample was reported as 21.8% infants with

unilateral left foot deformity, 27.69% with unilateral right foot deformity, while majority of the sample, i.e. 50.4% presented with bilateral clubfoot deformity. A similar retrospective descriptive study was conducted in Sri Lanka, utilizing data from the national Sri Lankan Clubfoot Program database. The study included a total of 354 patients diagnosed with clubfoot deformity. Among these cases, 48% presented with bilateral involvement, indicating that both feet were affected. Unilateral cases accounted for the remaining 52%, with 20.91% involving only the left foot and 30.79% involving only the right foot.²¹ These findings highlight a slightly higher prevalence of right-sided unilateral clubfoot in this population.

In our study, we found that the average number of casts required for complete correction of clubfoot varied by type. For idiopathic cases, an average of less than 7 casts were needed; syndromic cases required approximately 10 casts; and neurogenic cases typically required more than 10 casts to achieve full correction. Our findings regarding the number of casts required for clubfoot correction are supported by several studies in the literature. Boehm and colleagues, in their study on clubfoot associated with arthrogryposis, reported an average of 6.7 casts to achieve full correction, highlighting the increased complexity of such cases.²² Similarly, Ponseti et al., pioneers of the Ponseti method, found an average of 7.6 casts per foot in their cohort, which aligns closely with our findings in idiopathic cases. In contrast, Morcuende et al reported that 90% of patients needed fewer than five casts, suggesting that early detection and initiation of treatment can significantly reduce the number of casts required for full correction.²³ These variations across studies underscore the importance of early intervention and the influence of underlying etiologies on treatment duration and response.

A percutaneous Tenotomy of the Achilles tendon is a critical component of the Ponseti method, particularly for correcting residual equinus deformity that often persists following the initial casting phase.²⁴ Numerous studies have emphasized the importance of routinely performing Tenotomy after serial casting, as it significantly reduces the risk of relapse and minimizes the need for more extensive

surgical interventions later.²⁵ Our study supports these findings, as we observed a high frequency of Tenotomy (63.23%), across all types of clubfoot; particularly in bilateral clubfoot cases, reflecting the necessity of this procedure in achieving complete correction.

In our study, we found a very strong association between bracing compliance and relapse in clubfoot cases. Patients who were non-compliant in using the prescribed braces following correction were significantly more likely to experience relapse (chi square p=0.001). Noncompliance with wearing the foot abduction orthosis has been identified as the leading cause of relapse.²⁶

In our study, based on the final Pirani scores, patients were categorized into three outcome groups to assess the effectiveness of treatment. A total score of 0.00 was classified as 'complete correction', scores ranging from 0.5 to 1.0 were labeled as 'fair correction', and scores greater than 1.0 were considered as 'poor correction'. This approach of assigning clinical meaning to the final Pirani scores has also been employed in previous studies, such as the one conducted by Jain et al., where Pirani score thresholds were similarly used to evaluate treatment outcomes and categorize levels of deformity correction.¹⁹ On the basis of this, 75.5% idiopathic clubfeet achieved complete correction and 22.30% achieved fair correction of the deformity. In Syndromic clubfoot; only 1.8% recovered completely and 41.44% achieved fair correction. In neurogenic clubfoot; only 3.89% recovered completely and 36.36% achieved fair correction. Across all the types we observed that total 81.23% complete correction was reported at the final evaluation. These findings align with a systematic review conducted by Lopez et al; that the Ponseti method is effective with a success rate of 90% in correcting clubfoot deformity.¹³ A marked shift was also observed in the mean, median and mode of Pirani scores from pre- to post-treatment in all types of clubfoot; thus reflecting a significant improvement in clinical outcomes. To further evaluate the pre- and post-treatment changes in Pirani scores across all the types of clubfoot, the Wilcoxon Signed-Rank Test was used. The null hypothesis, "The median difference between pre-

treatment and post-treatment Pirani scores equals zero", was rejected, indicating that the Ponseti method significantly improves clubfoot deformity ($p = 0.001$) in any type of clubfoot deformity. Effect size for improvement in clubfoot deformity was assessed; showing a large treatment effect size ($r=0.8$) in all types of clubfoot.

LIMITATION & RECOMMENDATION

This study is single-center design, which may limit the broader applicability of the findings. Additionally, being a retrospective study based on data from the previous years may impose potential selection bias. Despite these constraints, larger, multicenter, prospective studies are recommended for broader validation.

CONCLUSION

This study concludes that the Ponseti method is highly effective in the treatment of various types of clubfoot, including idiopathic, syndromic, and neurogenic forms. The significant improvement observed in Pirani scores from pre- to post-treatment demonstrates the method's ability to achieve substantial correction of the deformity

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION

1	Alia Batool Zafar: Conception of study.
2	Seema Gul: Study design.
3	Nazish Faiz: Methodology.
4	Zarmina Behram Durrani: Analysis.
5	Marina Khan: Interpretation of data.
6	Shafaq Syed: Drafting, revising manuscript.