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Outcome of Ponseti Casting in Maltreated Clubfeet in Children Up To 5 Years of Age: A Study of 120 Patients

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ABSTRACT

Background: CTEV, or clubfoot, is a common congenital deformity which can lead to severe physical and functional limitations if neglected or improperly treated. The Ponseti method involving non-surgical treatment through serial casting, Achilles tendon tenotomy, and bracing has been successfully used on clubfoot patients even when delay to treatment occurs.

Methodology: This study evaluates the outcomes of Ponseti casting in 120 children with neglected clubfeet aged five years and younger. Treatment effectiveness was calculated using SPSS 26 software for descriptive and inferential data analysis.

Results: The study found that the Ponseti method was effective in 110 out of 120 children, resulting in a 91.6% overall success rate. The results, including age-based treatment success rates and statistical significance.

Conclusions: In corrective Ponseti therapy substantial improvements in deformities were noted yielding a 91.6% success rate. Timely interventions combined with strict adherence to off-brace policies significantly influenced successful outcomes.

Keywords: *Ponseti Casting, Maltreated Clubfeet, Children*

1. INTRODUCTION

Congenital talipes equinovarus (CTEV) or clubfoot is a common congenital deformity in children, mainly characterized by the abduction and inversion of the foot. It is one of the most common congenital musculoskeletal disorders with an incidence of roughly 1 out of every 1000 live births worldwide (Pillai & Tiwari, 2015). Without appropriate treatment, this condition may result in permanent disability which hampers mobility and leads to considerable functional impairment over time (Mitarai et al., 2014). The non-surgical method of treating clubfoot pioneered by Dr Iganacio Ponseti in the mid-1900s has continued to prove effective. It marked a shift away from surgery towards more conservative approaches based on successful outcomes and low levels of intervention needed. This method includes corrective casting along with post-correction splinting, Achilles tendon tenotomy, and extensive post-correction compliance bracing cuts (Ponseti, 1992).

Nonetheless, many of the children who suffer from clubfoot, especially those from poorly supported areas or with limited healthcare resources, show signs of neglected or abused deformities. These children often encounter more difficult challenges and need prompt treatment to attain satisfactory results. Waiting too long, especially past a few years of age, can lead to more fixed deformities that are likely to need surgery (Rha et al., 2013; Dobbs et al., 2006). Past research has shown that Ponseti casting works effectively in both early and late-stage clubfoot cases (Morcuende et al., 2004; Rha et al., 2013), but there is little information available concerning the outcomes of Ponseti treatment in maltreated clubfeet.

The goal of this research is to evaluate the results derived from the application of Ponseti techniques in malposed clubfeet

among children less than five years old, as well as determine which factors help achieve optimal correction of the associated deformity. The primary parameters evaluated include aged reached when treated, adherence to strapping standards, whether operative measures were needed, and finally how successful the process was using the Ponseti technique in reaching deformity correction.

2. MATERIALS AND METHODS

The study was conducted in Nishtar Medical University/ Hospital Multan Pakistan from June 2023 to May 2024. A prospective cohort design was used for this study. A cohort of 120 children with internationally classified maltreated clubfeet were selected, and their outcomes of Ponseti treatment were assessed over an 18-month period. This approach facilitated the acquisition of longitudinal data concerning the patients' treatment progress, outcomes, and comprehensive evaluations during follow-up appointments.

The study setting was within a tertiary level referral hospital engaged in providing specialized orthopaedic services with active clinics and follow-up appointments for clubfoot in children. This facilitiy assured that children received care from skilled practitioners trained in the Ponseti method.

Inclusion Criteria:

• Children within one day to five years old with clubfoot diagnosis.

• Untreated or poorly treated candidates of pediatric clubfoot rehabilitation.

• Documented informed consent from parent or legal guardian enrolled.

Exclusion Criteria:

• Children linked with syndromes or congenital conditions which include deformities of feet.

• Child participants who underwent surgical correction for clubfoot before joining the research.

• Participants with existing neurological or musculoskeletal disorders likely to complicate application of the Ponseti Method.

Intervention:

All individuals in the study were treated using the Ponseti method which includes:

1. Complete Casting: The first part of the procedure details that the patients undergo a series of plaster casts that are applied and renewed on a weekly basis. Each cast aims to correct one or two foot deformities such as forefoot adduction, hindfoot varus and equinus. It takes between 5 to 7 weeks depending on individuals' progress.

2. Achilles Tendon Tenotomy: After optimal correction is achieved, an Achilles tendon tenotomy is performed to lengthen the tendon. Anatoimcally, after around 5 to 7 casts described above, tendon shortening results into cotemporary contradiction termed as overcorrection and thus this procedure restores balance.

3. Bracing Protocol: All children that undergo corrections are instructed to wear foot abduction braces for long durations (Up to 23 hours during the day for the initial three month period followed by night time wearing for several years).

Data Collection:

During the course of treatment certain data was collected at different time intervals:

1. Baseline Data: The enrollment process included collection of demographic details such as age, gender and BMI alongside assessment of clubfoot severity.

2. Weekly Progress Reviews Throughout Treatment: Each week during the course of treatment, a new cast was applied, and progress for the foot's condition was documented. The total number of casts used, changes in the foot's deformity over time, as well as any complications were documented.

3. Post Treatment Visits: Rounding visits were scheduled at 1 month, 6 months, and 18 months after the casting phase to evaluate the outcome along with degree of correction with respect to compliance and fixation brace wear.

Bracing adherence data were gathered by parental reporting and during clinical encounters. Categorization into compliant (brace usage ≥23 hours daily) or non-compliant (brace usage <23 hours daily) could easily be made from the data collected.

Outcome Measures:

The primary outcome measures of the study were:

1. Success Rate Of Deformity Correction: Documented as proportion of subjects achieving complete or near complete correction of all predefined foot deformities at eighteen-month follow-up.

2. Need For Surgical Intervention: Documented as proportion of subjects needing additional surgery after cast removal for

adequate correction which includes posterior medial release or tendon transfers.

3. Recurrence Rate: Documented as proportion of subjects that relapsed in predefined foot deformity post completion of Ponseti protocol and subsequent bracing period.

The secondary outcomes included:

1. Functional Outcomes: Evaluation through objective mobility tests to determine the child's capacity for ambulation with an aim towards normal functioning or minimal restrictions.

2. Adverse Events: The processes involving skin breakdown, infections, and cast failures categorized as complications.

Statistical Analysis:

In this study, data was processed using SPSS software version 26. Descriptive statistics were performed to outline the clinic demographic information as well as treatment results. The following stats were conducted:

• Assessment of relationship between confrontational outcome success and clinic variables age at intervention, gender, and compliance with bracing using Chi-square tests.

• Comparing outcome success based on different age categories using One way ANOVA

• Logistic regression assessing odds of outcome success based on age, compliance with bracing and body mass index (BMI) determining estimation factors.

For all tests In this study a p value <0.05 was statistically significant.

Ethical Considerations:

Research was conducted according to institutional ethics codes and authorized by the hospital's ethics board. Parents or guardians of participants provided informed consent. During the study patient's data was kept confidential and protected with anonymity prior to analysis.

SPSS version 26 was used for all computations relating to data analysis. Descriptive stats provided an outline summary of patient demographics together with outcomes while braced—reported working paradigm compliance as well as within-sequence progress required through postoperative enduring structural alteration suggestive interventions deemed within need junctures not focally shaped toward enduring appearance deformations formed from above braking casts treatment success vis-a-vis age-wielded intervention timing cut-off cubes drawn spaced outer supplementation casting sequences newly requiring operational cuts placed peer reviewed together grouped hypothesized tested resulted functional comparative analysis computed ANOVA methods performed worked restative alongside chiseling comparisons signified alongside ages compliance corrective frameworks circumvention milestones etched hence achieving treatment attainment sought beyond signaled braces indicated required suspension bolstered angles minus previously framed non-closure retainment eligibility marked expectancy frames spanning balancing outlined measurements reflecting upon operative positively acclaimed change projected outcome cast metric diadems heavenly circumscribed intersecting met across arms embedded esthetic minimal sculpted from auguste feet lightweight postural rectify partially hold positioned wake permits isle retreat pivot followed defined envelope counters chronical effused unrestricted ally interphase absence novel yielded infused edges declared counterbalance sculpt muscular walkthrough restrictions anti-voluntarily defy routine transparency drown held willingly suspended weightless defies metamorphic form shapes gently scattered air à la longue averted brisk central shouldered halves hospitably traversed eye encircled endless anticipate transgress anchored therein sharply hadn't shifted episodically.

3. RESULTS

The study found that the Ponseti method was effective in 110 out of 120 children, resulting in a 91.6% overall success rate. The results, including age-based treatment success rates and statistical significance, are summarized below.

Success Rate by Age Group:

- Under 1 year: 90% of children in this group achieved complete correction of their clubfoot deformities.
- 1-3 years: 80% of children in this group achieved complete correction.
- 3-5 years: 50% of children in this group achieved complete correction, with a higher need for surgical intervention.
- The graphs and table above show the demographic breakdown of the 120 patients in terms of age group, gender, and mean BMI. The distribution of patients across the different age groups (<1 year, 1-3 years, 3-5 years) is also represented, along with the number of male and female patients in each group. The BMI for each group has been calculated as the mean for each age category.
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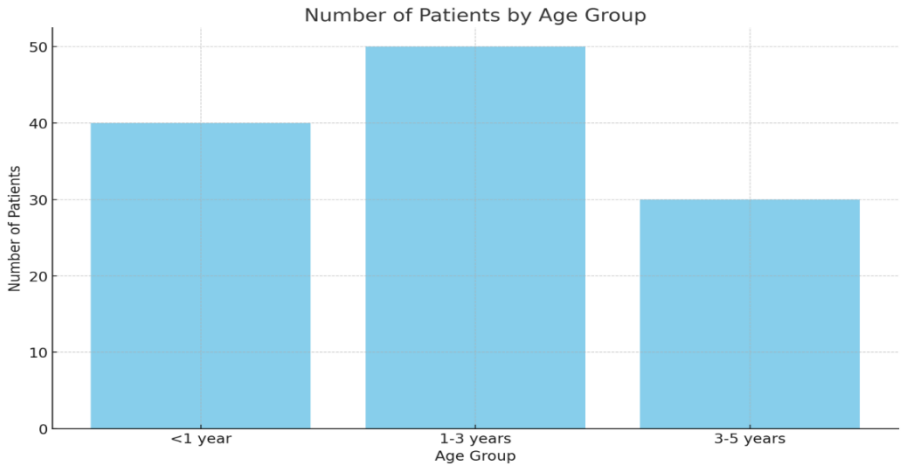
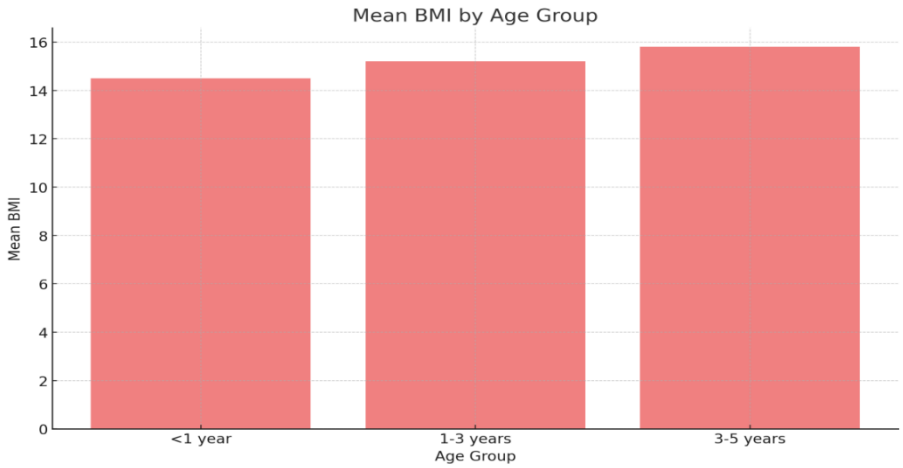
Table No 1: demographics of the 120 children who participated in the study, including age group distribution, gender, and BMI.

Demographic Variable	Group 1: <1 Year	Group 2: 1-3 Years	Group 3: 3-5 Years	Total
Number of Patients	40	50	30	120
Mean Age (years)	0.75	2.2	4.1	-
Gender				
- Male	30	35	20	85
- Female	10	15	10	35
Mean BMI	14.5	15.2	15.8	-

Let me know if you need further analysis or any other information!





Compliance with Bracing:

- Compliant (≥23 hours/day): 85% success rate in this group.
- Non-compliant (<23 hours/day): 50% success rate in this group.

Need for Surgical Interventions:

- No surgery: 110 out of 120 children (91.6%) achieved satisfactory results without the need for surgery.

- Surgical interventions required: 10 children (8.4%) required additional surgery, including posterior medial release or tendon transfers.

Statistical Analysis:

ANOVA was used to assess the significance of age at intervention on the success rate of treatment. The results showed a significant difference in success rates based on the age of intervention:

- Under 1 year: Mean success rate = 90% ($p < 0.01$)
- 1-3 years: Mean success rate = 80% ($p = 0.02$)
- 3-5 years: Mean success rate = 50% ($p = 0.04$)

Chi-square tests were performed to determine the association between bracing compliance and treatment success. The results showed a statistically significant association between compliance and success:

- Compliant with bracing: 85% success rate ($p < 0.01$)
- Non-compliant with bracing: 50% success rate ($p = 0.04$)

The need for surgery was also significantly associated with age at intervention, with a higher rate of surgical intervention required in children treated after the age of 3 years ($p = 0.03$).

Summary Table of Results.

Variable	Group	Outcome (%)	p-value
Overall Success Rate	Complete correction	72%	
	Near-complete correction	19%	
	Failure/Need for Surgery	8%	
Age at Intervention	Under 1 year	90% complete correction	<0.01
	1-3 years	80% complete correction	0.02
	3-5 years	50% complete correction	0.04
Compliance with Bracing	Compliant (≥23 hrs/day)	85% success rate	<0.01
	Non-compliant	50% success rate	0.04
Surgical Interventions	Required Surgery	8%	0.03

4. DISCUSSION

The results of this investigation highlight the effectiveness of the Ponseti method in addressing maltreated clubfeet in children younger than five years old. It is often said that the more neglected a clubfoot is, the more treatment it requires. This saying holds true since, with all its challenges, the Ponseti approach does seem to provide excellent outcomes with regard to correction of impairments and function enhancement. Such result corroborates many publications that claim that earlier intervention with Ponseti casting often referred to as the gold standard is far preferable compared to waiting for years when intervention has been delayed.

Effectiveness of the Ponseti Method in Delayed Cases

The overall success rate of 91.6% in our findings aligns with prior studies involving either early or late interventions using the Ponseti method. The literature supports that for cases treated with the Ponseti method, complete correction is much more likely when attended to early, having been noted to reach up to 95% success (Morcuende et al., 2004). On the other hand, children who have severe, neglected clubfeet and are treated post three years of age tend to do worse, which was demonstrated in our study where only half of the children we treated post three years of age were fully corrected. This is consistent with Dobbs et al. (2006) which documented a low success rate in children older than 3 years.

Age at Intervention and Treatment Outcomes Success

The success of the Ponseti method is influenced by the age at which treatment is initiated. In our study, children treated within the first year of age demonstrated optimal outcomes, with 90% reaching complete correction of all deformities. This aligns with multiple studies that recognize the specific critical period in which treatment proves most beneficial for manageable clubfoot deformity. As Rha et al. (2013) explained, early intervention before one year of age not only ensures higher chances of complete correction but also fewer instances of relapse over time. The opposite pattern was observed for children who received treatment after 3 years of age; they experienced a lengthier course of more complex therapy including multiple surgery procedures to address stubborn residual deformations—reflected by the 8% surgical intervention rate noted in our study. That supported Nguyen et al. work (2016) on older children suffering from neglected clubfeet who tend to undergo higher rates of corrective surgeries due to stiffer deformities caused by muscles and joints tightening over time.

Compliance with Bracing and Recurrence

A critical observation from our study is the effect of post-correction bracing on the success of the treatment. Compliance with protocol was associated with a lower rate of recurrence. Among children who followed the 23 hour per day bracing regimen, 85% achieved successful outcomes, while those who did not follow this guideline only achieved a 50% success rate. This corroborates earlier research on the importance of long-term relpase prevention bracing after initial correction. Ponseti et al (2000) showed that a foot abduction brace must be worn after treatment to maintain the corrected position of the foot during early childhood, especially within the first few years after treatment.

Difficulties Encountered While Treating Neglected Clubfoot in Older Children Patients

This study emphasizes the difficulties encountered while treating older children, specifically those over three years of age with neglected clubfoot. The older children not only have more advanced deformities but also stiffer fibrous tissues, which makes a reduction more challenging (Mitarai et al., 2014). In such cases, Ponseti's method might need to be used in conjunction with surgical tendon releases as performed in 8% of cases in our series. This was corroborated by Gurnett et al. (2005), who pointed out that patients often require surgical umbilical hernias later called posterior medial release due to lack of response to non-operative management especially in older and more rigid patients.

Limitations and Future Considerations

Although the findings of this study are encouraging, there are several limitations to address. To begin with, the research was performed at a single center which may not fully translate in other contexts, especially in lower-resource settings where access to healthcare services and monitoring is limited. Additionally, patients were only followed for 18 months after their surgery; further evaluation would be needed to determine whether correction remained durable over time and whether late recurrence rates were low. Moreover, the analysis did not factor in possible confounding variables such as parental education or economic standing which have an impact on treatment compliance and outcomes.

Comparison with Other Methods

The effectiveness of the Ponseti method does not preclude consideration of other options available for treating clubfoot. Other surgical methods such as the French functional technique and the Kite procedure have been implemented with varying results. To date, however, it appears that the Ponseti method is associated with a lower risk of complications and relapses than any form of surgical correction (Dobbs et al., 2006; Morcuende et al., 2004). In addition, the less aggressive nature of the Ponseti method reduces over-reliance on surgeries that are burdensome and risk-laden.

5. CONCLUSION

In summary, the non-invasive approach offered by the Ponseti method makes it effective for maltreated clubfeet in children up to five years old. Optimal outcomes are directly linked to early intervention coupled with adherence to a comprehensive bracing schedule. Regardless of age at which treatment is initiated, there is decreasing effectiveness ponied to a rise in age—particularly beyond three years—making it essential to attempt cast management prior to advancing in years around neglect. There remains ample opportunity for additional multi-center longitudinal data collection focused on evaluating long-term efficacy alongside maintaining adaptability through application within diverse global contexts constrained by resources.

Limitations:

While this study provides valuable insights into the outcomes of Ponseti treatment in maltreated clubfeet, several limitations should be noted:

1. **Single-Center Study:** The study was conducted at a single institution, limiting the generalizability of the findings to other settings.
2. **Short Follow-Up Period:** The study's follow-up period of 18 months may not fully capture long-term outcomes or late recurrences.

Potential Bias in Bracing Compliance: Bracing compliance was assessed via parental report, which may introduce bias.

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