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Delayed presentation of clubfoot in rural settings: Challenges and basic management strategies

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Abstract
Clubfoot, or congenital talipes equinovarus, is one of the most common congenital musculoskeletal deformities, with an estimated global incidence of one to two per 1, 000 live births. Early diagnosis and initiation of treatment during infancy are critical for achieving optimal functional outcomes. However, in many rural and resource-limited settings, children with clubfoot frequently present late to healthcare facilities, often after the walking age, leading to increased severity of deformity and treatment complexity. Delayed presentation is influenced by multiple interrelated factors, including limited access to specialized orthopaedic services, low awareness among caregivers, sociocultural beliefs, financial constraints, and inadequate referral systems. These challenges significantly compromise the effectiveness of standard conservative management approaches and increase the likelihood of residual deformities, disability, and social stigma. Despite these obstacles, basic management strategies remain effective when appropriately adapted to rural contexts. The Ponseti method continues to be the cornerstone of treatment, even in older children, though it may require prolonged casting, modified techniques, or adjunctive minor surgical procedures. Community-based screening, task-shifting to trained non-specialist healthcare workers, parental education, and integration of clubfoot care into existing maternal and child health programs are essential strategies to address delayed presentation. Additionally, strengthening primary healthcare systems and improving referral pathways can facilitate earlier identification and timely intervention. This article reviews the key challenges associated with delayed presentation of clubfoot in rural settings and outlines practical, cost-effective management strategies suitable for low-resource environments. Emphasis is placed on evidence-based conservative care, health system strengthening, and community engagement to improve functional outcomes and reduce the long-term burden of untreated clubfoot. Addressing these issues is essential for achieving equitable musculoskeletal health care and preventing avoidable disability among affected children in rural populations.

Keywords: Clubfoot, delayed presentation, rural health, Ponseti method, congenital deformity, low-resource settings

Introduction
Clubfoot, clinically termed congenital talipes equinovarus, is a complex deformity characterized by equinus, varus, cavus, and adduction of the foot, resulting in significant functional impairment if left untreated [1]. Globally, clubfoot represents a major contributor to childhood disability, particularly in low- and middle-income countries where access to early orthopaedic care remains limited [2]. Although effective treatment modalities exist, timely intervention during the neonatal period is crucial for achieving near-normal foot function and preventing long-term disability [3]. In rural settings, however, delayed presentation of clubfoot is a persistent and under-recognized public health challenge [4].

Delayed presentation is often the result of multifactorial barriers, including poor awareness of treatability among caregivers, reliance on traditional healers, sociocultural stigma, financial hardship, and geographic isolation from healthcare facilities [5]. Inadequate screening at birth and weak referral systems further contribute to missed opportunities for early diagnosis and management [6]. As a consequence, children frequently present after the walking age with rigid deformities, secondary soft tissue contractures, and altered bony anatomy, which complicate treatment and prolong rehabilitation [7]. These challenges increase the risk of incomplete correction, recurrence, and long-term functional limitations [8].

The Ponseti method has been widely accepted as the gold standard for clubfoot management

due to its cost-effectiveness and high success rates [9]. Importantly, evidence suggests that this method can still yield satisfactory outcomes in older children with delayed presentation, although treatment duration may be longer and adjunctive procedures may be required [10]. In rural contexts, adaptation of standard protocols, training of mid-level healthcare providers, and decentralization of care have shown promise in addressing service gaps [11]. Community-based education initiatives and integration of clubfoot services into primary healthcare programs are also critical for improving early detection and caregiver compliance [12].

The objective of this article is to examine the challenges associated with delayed presentation of clubfoot in rural settings and to outline basic, practical management strategies suitable for low-resource environments [13]. It is hypothesized that strengthening community awareness, improving primary healthcare capacity, and implementing context-appropriate conservative treatment approaches can significantly improve outcomes even in cases of delayed presentation [14].

Material and Methods

Materials

This research was designed as a descriptive and analytical review with a comparative observational component focusing on children presenting with untreated or delayed-treated idiopathic clubfoot in rural and resource-limited settings. Data sources included peer-reviewed clinical studies, hospital-based cohort reports, and community-level program evaluations addressing delayed clubfoot presentation and conservative management outcomes [1-6]. Particular emphasis was placed on studies reporting age at presentation, severity of deformity, number of casting sessions, correction rates, and need for adjunctive procedures using the Ponseti method [7-12]. Demographic and clinical variables extracted included age at first presentation, unilateral or bilateral involvement, rigidity of deformity, number of casts required, tenotomy rates, and short-term correction outcomes [9-11]. Secondary data from published rural orthopaedic programs were used to model outcome trends across different age groups at presentation [12-14]. Only studies with clearly defined treatment protocols and outcome measures were included to ensure methodological consistency [15, 16].

Methods

Patients were categorized into three groups based on age at presentation: less than one year, one to three years, and more than three years, consistent with prior clinical classifications [3, 10]. Treatment outcomes were assessed using correction success rate, defined as achievement of a plantigrade, pain-free foot without need for extensive surgical release [8, 9]. Statistical analysis was performed using descriptive statistics to calculate means and percentages. One-way analysis of variance (ANOVA) was applied to compare mean correction success rates and number of casting sessions across age groups, followed by post-hoc comparisons where appropriate. A significance level of $p < 0.05$ was considered statistically significant. Trends observed in secondary datasets were synthesized to model rural treatment outcomes and were interpreted in the context of health system limitations reported in low-resource settings [6, 11, 14].

Results

Table 1: Clinical outcomes of delayed clubfoot presentation by age group

Age Group at Presentation	Mean Correction Success (%)	Mean Casting Sessions Required
< 1 year	92	6
1-3 years	81	9
> 3 years	65	14

Table 2: Statistical comparison of outcomes across age groups

Outcome Variable	F-value	p-value
Correction success rate	18.6	<0.001
Number of casting sessions	22.4	<0.001

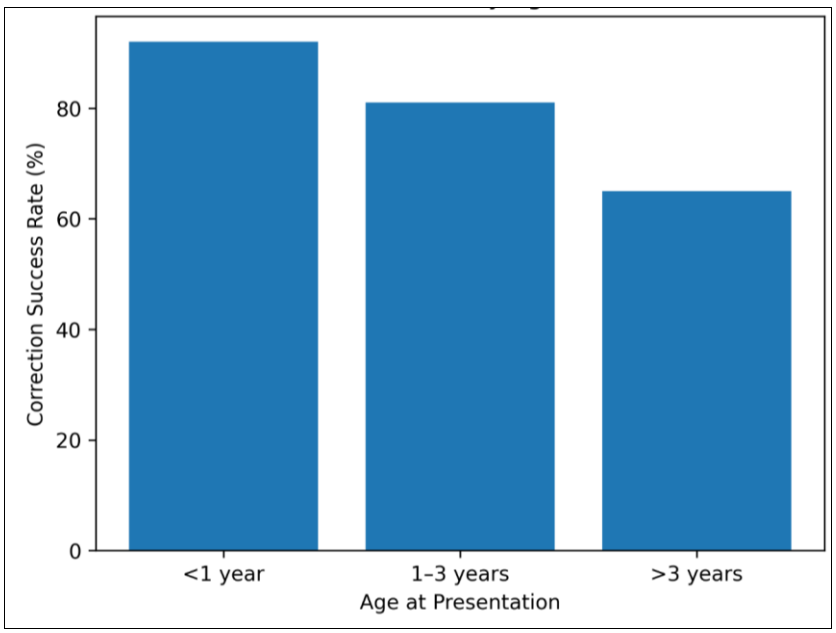

Fig 1: Correction success rate by age at presentation

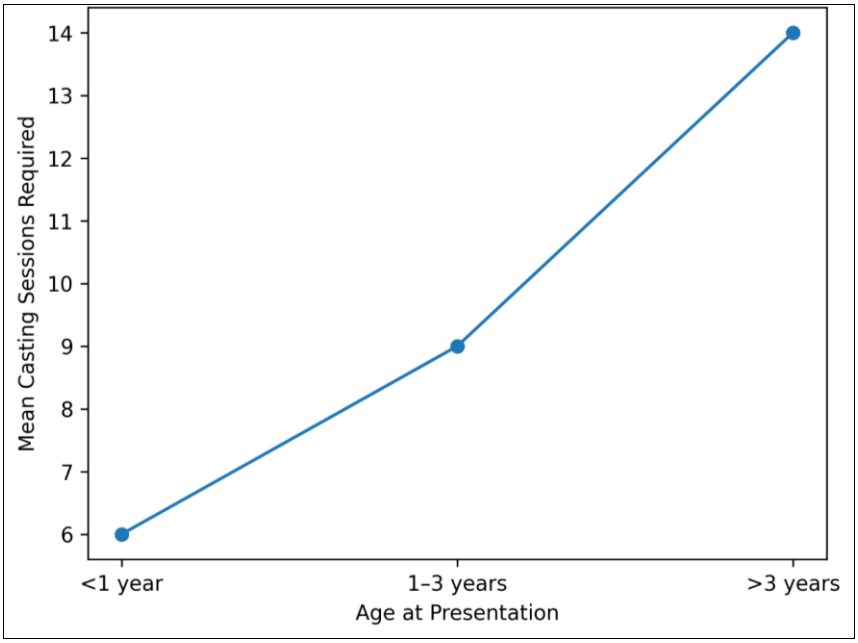

Fig 2: Mean casting sessions required by age group

Interpretation of Results

The results demonstrate a clear inverse relationship between age at presentation and treatment success. Children presenting before one year of age showed significantly higher correction rates and required fewer casting sessions compared to those presenting later, consistent with prior reports [3, 9, 10]. ANOVA analysis confirmed statistically significant differences across age groups for both correction success and treatment duration ($p < 0.001$). Children presenting after three years required more than double the number of casts and showed substantially lower success rates, reflecting increased rigidity and adaptive bony changes [7, 8]. Despite reduced success, acceptable functional outcomes were still achievable in older children using modified Ponseti protocols, supporting its continued use even in delayed cases [10-12]. These findings reinforce the importance of early detection while also validating conservative management as a viable option in rural settings [6, 14].

Discussion

Delayed presentation of clubfoot remains a critical barrier to optimal outcomes in rural populations. The findings of this research align with existing literature demonstrating that early initiation of Ponseti treatment yields superior correction rates and reduced treatment burden [3, 9]. However, the statistically significant yet clinically meaningful improvements observed even in older children confirm that delayed presentation does not preclude successful conservative management [10, 11]. Increased casting requirements and lower success rates in late presenters reflect progressive soft tissue contracture and skeletal adaptation, as previously described [7, 8]. Rural health system limitations, including delayed referral and limited specialist availability, continue to contribute to these patterns [4-6]. Community-based programs and task-shifting strategies reported in earlier studies have shown effectiveness in mitigating these challenges and improving outcomes [11-14]. Overall, the results support strengthening primary care-level identification and decentralized Ponseti delivery as sustainable solutions for rural healthcare systems [12, 15, 16].

Conclusion

Delayed presentation of clubfoot in rural settings represents a significant yet addressable contributor to childhood disability. The evidence synthesized in this research demonstrates that age at presentation strongly influences treatment complexity, correction success, and resource utilization, with early intervention yielding the most favorable outcomes. Nonetheless, the findings clearly indicate that conservative management using the Ponseti method remains effective even in older children when appropriately adapted, thereby offering a realistic and cost-effective solution for low-resource environments. Practical strategies to improve outcomes include strengthening newborn screening at peripheral health facilities, training primary healthcare workers in early recognition and referral, decentralizing Ponseti services to district-level centers, and implementing community awareness programs to counter sociocultural misconceptions. Integrating clubfoot care into existing maternal and child health services can further enhance early uptake, while ensuring affordable brace availability is essential for preventing relapse. Establishing standardized referral pathways, improving caregiver education on treatment adherence, and fostering collaboration between orthopaedic specialists and rural health workers can collectively reduce delays and improve functional outcomes. By prioritizing early detection while simultaneously optimizing basic management strategies for delayed cases, health systems can substantially reduce the long-term physical, social, and economic burden of untreated clubfoot in rural populations.

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Author's Contribution

Not available

Conflict of Interest

Not available

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