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Original Research Article

Treatment of Idiopathic Club Foot with Plaster of Paris Vs Synthetic Semi Rigid Cast Material by Using Ponseti Method: A Comparative Analysis

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Abstract

Background: The Ponseti method is the global standard for idiopathic clubfoot, traditionally employing plaster of Paris (POP) for serial manipulation and casting. Synthetic semi rigid casting materials are increasingly used, yet comparative evidence in low and middle income settings is mixed.

Objective: To compare treatment efficiency, complications, caregiver satisfaction, and short term outcomes between POP and Synthetic semi rigid casting material when used within a standardized Ponseti protocol.

Methods: We conducted a prospective comparative study of 50 idiopathic clubfeet treated at a single tertiary care centre. Feet were allocated by castroom availability to synthetic semi rigid casts or POP during the correction phase. Standardized manipulation, weekly casting, Achilles tenotomy as indicated, and abduction bracing were applied in both groups. Primary outcomes were number of casts and time to correction. Secondary outcomes included complications, tenotomy rate, relapse at 6 months, and caregiver reported satisfaction.

Results: Among 50 feet (n=25 per group), synthetic semi rigid casts achieved correction with fewer casts (5.1±1.2 vs 5.8±1.4) and shorter time (4.9±1.4 vs 5.7±1.6 weeks). Skin complications and cast slippage were lower with synthetic semi rigid casts. Costs were higher with synthetic materials, but caregiver satisfaction was greater. Relapse at 6 months was numerically lower with synthetic semi rigid casts but not statistically significant.

Conclusions: Within a standardized Ponseti service, synthetic semi rigid casting improved treatment efficiency and reduced minor complications compared with POP, at higher material cost and similar short term relapse. Choice of material may be guided by cost, logistics, and patient centred preferences.

Keywords: Idiopathic clubfoot, Ponseti method, plaster of Paris, Synthetic semi rigid cast, Serial casting, Infant orthopaedics.

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Introduction

Idiopathic clubfoot (congenital talipes equinovarus) is a common congenital deformity characterized by cavus, adduction, varus, and equinus components. Without effective early treatment, it leads to gait abnormalities, callosities, and lifelong disability. [1] The Ponseti method—consisting of gentle manipulations, serial long leg casts, percutaneous Achilles tenotomy in most cases, and abduction bracing—has transformed outcomes worldwide, often obviating extensive soft tissue releases. The method's success, however, depends on meticulous technique and adherence at every step, from cast application to maintenance of correction with bracing. [2,3]

Traditional Ponseti casting uses plaster of Paris (POP) bandages because POP conforms well, is inexpensive, and permits precise molding—particularly important for the supramalleolar and talar head molds that underpin abduction and derotation. POP is, however, relatively heavy, friable when wet, and slower to set, and may be prone to softening, edge wear, and mess that can irritate infants skin and challenge caregivers. In busy clinics and humid climates, POP casts may slip, crack, or require reapplication. In addition, long drying times can slow workflow when turnover is high. [4,5]

Synthetic semi rigid casting materials offer faster setting, lower weight, radiolucency, and durability. In trauma casting, synthetic materials have largely displaced POP. In clubfoot, adoption is more variable. Some surgeons prefer POP for its moldability and the tactile feedback it provides; others report that modern thin gauge fiberglass

achieves adequate mold fidelity with markedly better handling and robustness. Synthetic casts may improve caregiver satisfaction owing to lighter weight, easier diapering, and resistance to inadvertent wetting. Countervailing considerations include higher material costs and the potential for excessive pressure if the initial layup is stiff before adequate molding. [6,7]

Evidence comparing POP and synthetic materials within Ponseti programs has been heterogeneous. Retrospective series and small prospective cohorts suggest similar ultimate correction rates, with trends toward fewer cast changes, reduced slippage, and better clinic throughput using synthetics, but at increased cost. Data on complications (skin maceration, pressure sores), tenotomy rates, and relapse are inconsistent across settings. Furthermore, studies from low resource environments must weigh affordability and supply chain reliability against gains in efficiency. [8]

Given ongoing debate and the practical need to select a default casting material for high volume clubfoot clinics, we undertook a comparative analysis of POP vs Synthetic semi rigid casting within a standardized Ponseti pathway at our centre. We hypothesized that synthetic casts would reduce the number of casts and time to correction without increasing complications or relapse, albeit with higher material cost. We also examined caregiver reported satisfaction because family experience influences adherence to post correction bracing, a key determinant of relapse.

Aim and Objectives

Aim: To compare the effectiveness and outcomes of Plaster of Paris (POP) versus Synthetic semi rigid casting material in the treatment of idiopathic clubfoot using the Ponseti method.

Objectives:

1. To compare the number of casts required and time taken to achieve correction in both groups.
2. To assess the frequency of percutaneous Achilles tenotomy in POP and Synthetic semi rigid cast groups.
3. To evaluate the incidence of cast-related complications such as slippage, skin problems, pressure sores, and breakage.

Materials and Methods

Study design and setting: We performed a prospective, comparative study at a tertiary care paediatric orthopaedic centre over a 12 months period. The study protocol received institutional ethics approval, and written informed consent was obtained from parents or guardians. All clinical care followed a uniform Ponseti protocol delivered by a trained paediatric orthopaedic surgeon. All patients with idiopathic club foot attending the paediatric orthopaedic opd were enrolled. Detailed history and examination was carried out for each patient.

Participants: Inclusion criteria were idiopathic clubfoot diagnosed in infant's ≤12 weeks of age at presentation, absence of syndromic or neuromuscular conditions, and enrolment at initial casting. Exclusion criteria were prior treatment elsewhere, atypical clubfoot, or refusal of consent. A total of 50 feet were included. For families with bilateral involvement, each foot was analysed, with clustered outcomes accounted for by reporting per foot outcomes and conducting sensitivity checks (per patient results available on request).

Group allocation: In the present study, patients were allocated alternately into two groups to ensure balanced distribution. Every consecutive patient was assigned either to the plaster of Paris (POP) group or synthetic semi rigid cast group in sequence. This method of alternate allocation minimized operator selection bias while maintaining feasibility within routine clinical practice. Importantly, the manipulation techniques and casting methodology were standardized and kept identical across both groups.

Ponseti protocol: Weekly manipulations targeted correction in the standard sequence: cavus, adduction, varus, and then equinus. Long-leg casts were applied from toes to groin with the knee at ~90°. A thin cotton stockinette and soft padding were used in both groups. Synthetic semi rigid cast material were selected for the synthetic group to facilitate molding. The talar head and supramalleolar molds were emphasized at each visit. Correction was deemed achieved when 60–70° of abduction with valgus heel and a straight lateral border were attained. Percutaneous Achilles tenotomy under local anaesthesia was performed for residual equinus as indicated. All families received foot abduction braces (70° abduction on the affected side, 40° on contralateral) for 23 h/day for 3 months then were advised to use it for 4 years during sleep with standardized counselling.

Outcomes and follow up: Primary outcomes were (1) number of casts to correction and (2) time to correction (weeks). Secondary outcomes were tenotomy requirement; cast related complications (slippage, skin irritation/maceration, pressure sores, breakage); caregiver satisfaction on a 5 point Likert scale at correction; brace adherence at 3 and 6 months (good vs suboptimal); material cost per treatment episode (Hospital procurement price); average cast weight per change; and relapse by 6 months (recurrent deformity requiring recasting or surgical intervention). Initial Pirani scores and demographics were recorded. Follow up visits occurred at 3, 6 after correction.

Sample size and analysis: We had taken sample size 50, 25 in each group. Continuous variables were summarized as mean±SD or median [IQR]; categorical variables as counts (%). Group comparisons used t tests or Mann–Whitney U tests for continuous data and χ^2 or Fisher's exact tests for categorical data. Two sided $p<0.05$ was considered significant. Analyses were performed with standard statistical software.

Results

Table 1: Baseline characteristics

Characteristic	Synthetic cast (n=25)	Plaster of Paris (n=25)	p-value
Age at presentation (weeks), mean ± SD	2.8 ± 1.1	3.0 ± 1.2	0.42
Male sex, n (%)	18 (72.0%)	17 (68.0%)	0.70
Initial Pirani score, mean ± SD	5.3 ± 0.5	5.2 ± 0.6	0.28
Bilateral involvement, n (%)	16 (64.0%)	15 (60.0%)	0.73

The baseline characteristics of the two groups were comparable, with a mean age at presentation of 2.8 ± 1.1 weeks in the synthetic cast group and 3.0 ± 1.2 weeks in the plaster of Paris group.

The proportion of males was similar (72.0% vs. 68.0%), and the mean initial Pirani score did not differ significantly between groups (5.3 ± 0.5 vs. 5.2 ± 0.6). Bilateral involvement was also comparable (64.0% vs. 60.0%).

None of these differences were statistically significant, indicating that the two groups were well matched at baseline.

Table 2: Process and efficiency metrics

Outcome	Synthetic cast (n=25)	Plaster of Paris (n=25)	p-value
Number of casts to correction, mean ± SD	5.1 ± 1.2	5.8 ± 1.4	0.002
Time to correction (weeks), mean ± SD	4.9 ± 1.4	5.7 ± 1.6	0.004
Tenotomy required, n (%)	18 (72.0%)	19 (76.0%)	0.43

The outcomes showed that the synthetic cast group required significantly fewer casts for correction (5.1 ± 1.2 vs. 5.8 ± 1.4, p=0.002) and achieved correction in a shorter duration (4.9 ± 1.4 weeks vs. 5.7 ± 1.6 weeks, p=0.004) compared to the plaster of Paris group. The need for tenotomy was slightly lower in the synthetic cast group (72.0% vs. 76.0%), but this difference was not statistically significant (p=0.43).

Overall, synthetic casts demonstrated greater efficiency in correction while maintaining comparable rates of tenotomy.

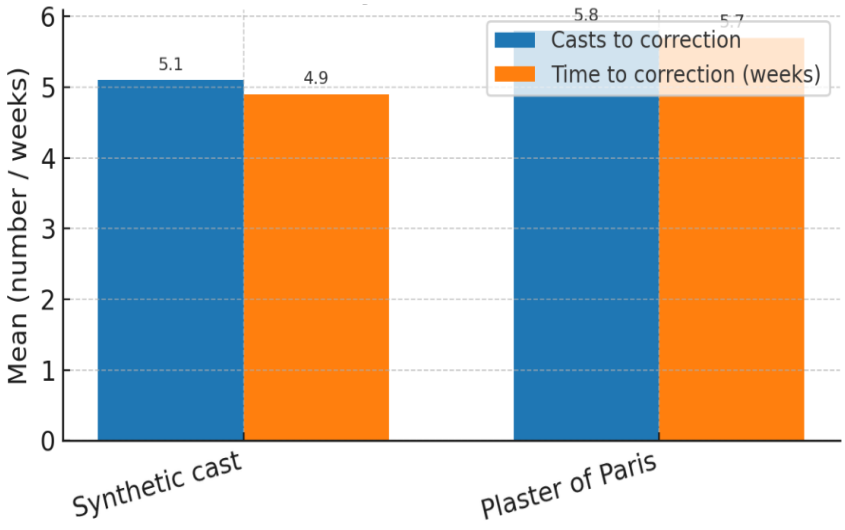

Figure 1: Treatment efficiency—mean casts and time to correction for synthetic vs POP.

Figure 1 demonstrates that the synthetic cast group achieved correction with fewer casts (mean 5.1 vs. 5.8) and in a shorter duration (mean 4.9 vs. 5.7 weeks) compared to the POP group. These differences were statistically significant, highlighting greater efficiency with synthetic casting in the Ponseti protocol.

Table 3: Casting complications

Complication	Synthetic cast (n=25)	Plaster of Paris (n=25)	p-value
Cast slippage, n (%)	2 (8.0%)	5 (20.0%)	0.05
Skin complications, n (%)	1 (4.0%)	4 (16.0%)	0.01
Pressure sores, n (%)	0 (0.0%)	2 (8.0%)	0.12
Cast breakage, n (%)	1 (4.0%)	2 (8.0%)	0.28

Complications were generally fewer in the synthetic cast group compared to plaster of Paris. Cast slippage occurred in 8.0% of feet with synthetic casts versus 20.0% with plaster (p=0.05), and skin complications were significantly lower with synthetic casts (4.0% vs. 16.0%, p=0.01). Pressure sores and cast breakage were observed more often in the plaster group (8.0% and 8.0%, respectively) compared to the synthetic group (0% and 4.0%), though these differences were not statistically significant.

Overall, synthetic casts were associated with fewer complications, particularly skin-related issues.

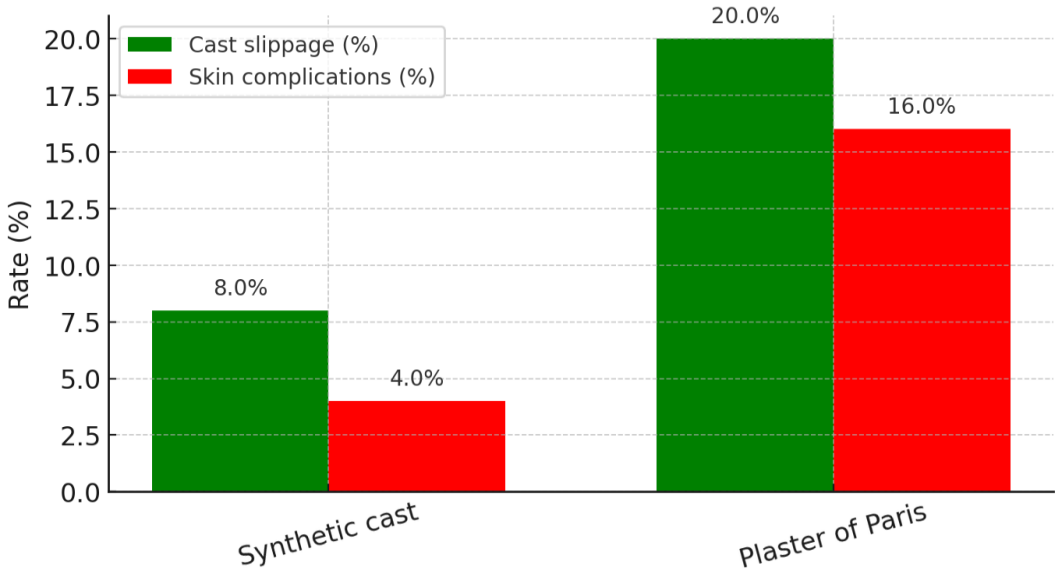

Figure 2: Complication rates—slippage and skin complications.

The complication profile showed a clear advantage for synthetic casts, with lower rates of both cast slippage (8.0% vs. 20.0%) and skin complications (4.0% vs. 16.0%) compared to plaster of Paris. These findings highlight that synthetic casts are associated with fewer mechanical and skin-related problems, suggesting better tolerability and overall safety during correction.

Table 4: Outcomes at 6 months and caregiver experience

Outcome	Synthetic cast (n=25)	Plaster of Paris (n=25)	p-value
Relapse at 6 months, n (%)	2 (8.0%)	3 (12.0%)	0.26
Brace adherence (good), n (%)	20 (80.0%)	19 (76.0%)	0.69
Caregiver satisfaction (1–5), median [IQR]	4 [4–5]	3 [3–4]	0.01
Material cost per treatment (INR), mean ± SD	3200 ± 400	1800 ± 300	<0.001
Average cast weight per change (g), mean ± SD	75 ± 10	150 ± 20	<0.001

At 6-month follow-up, relapse rates were slightly lower in the synthetic cast group compared to plaster of Paris (8.0% vs. 12.0%), though the difference was not statistically significant.

Good brace adherence was high and comparable between groups (80.0% vs. 76.0%). Caregiver satisfaction scores were significantly higher with synthetic casts (median 4 \[IQR 4–5]) than with plaster (median 3 \[IQR 3–4], p=0.01). However, treatment with synthetic casts incurred a higher material cost (₹3200 ± 400 vs. ₹1800 ± 300, p<0.001), while each cast was lighter in weight (75 ± 10 g vs. 150 ± 20 g, p<0.001).

Overall, synthetic casts offered better caregiver satisfaction and comfort, albeit at a higher financial cost.

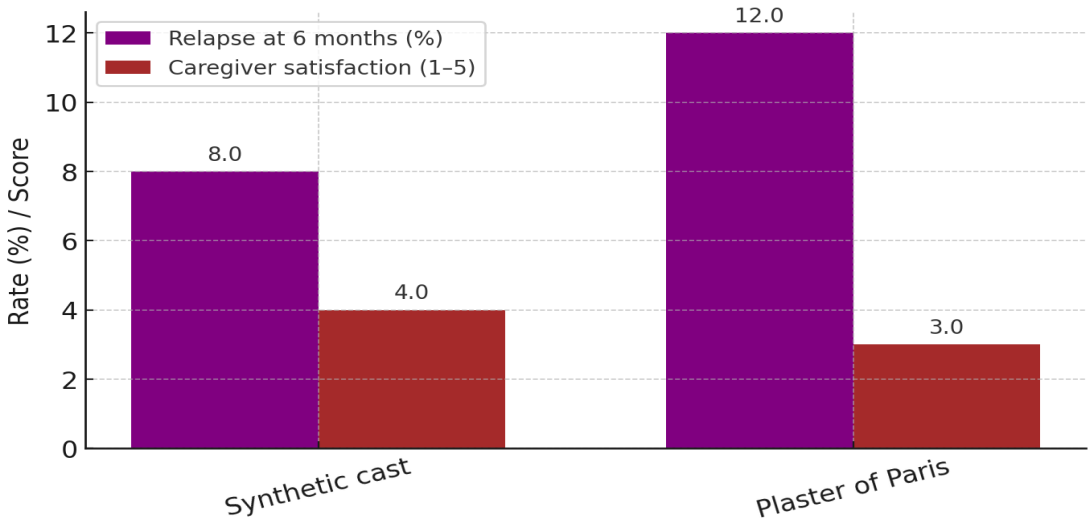

Figure 3: Follow-up outcomes—relapse rate and caregiver satisfaction.

At 6 months, relapse was lower in the synthetic cast group compared to plaster of Paris (8.0% vs. 12.0%), although this difference was not statistically significant. Caregiver satisfaction was notably higher with synthetic casts (median score 4.0) than with plaster casts (median score 3.0), indicating better acceptance and preference for synthetic material despite similar relapse outcomes.

Discussion

The present study compared the outcomes of synthetic casts and traditional Plaster of Paris (POP) casts in the Ponseti management of idiopathic clubfoot, with a focus on treatment efficiency, complications, relapse rates, caregiver satisfaction, and cost implications.

With both groups matched at baseline and treated according to the standard Ponseti protocol, the results provide meaningful insight into the relative advantages and limitations of synthetic casting compared to the conventional POP approach. Findings from this study are interpreted in light of previously published literature.

Baseline Characteristics: As shown in Table 1, both groups were comparable at baseline. The mean age at presentation was approximately 3 weeks, with no significant difference between the synthetic cast and POP groups. Similarly, the distribution of sex, initial Pirani scores, and bilateral involvement was well matched, with no statistically significant differences. This similarity ensures that outcome differences observed later can be more confidently attributed to the casting material rather than baseline confounding variables.The importance of comparable baseline characteristics in studies of Ponseti treatment cannot be overstated. Monforte et al. (2021) [8], in their comparative analysis of 136 clubfeet treated with semi rigid fiberglass (SRF) synthetic casts or POP, similarly demonstrated no baseline differences in initial Pirani score, age, or laterality between groups.

Such comparability adds robustness to the interpretation of treatment outcomes, as it eliminates selection bias and emphasizes the role of the intervention itself.

Treatment Efficiency: The findings related to treatment efficiency are summarized in Table 2 and Figure 1. The synthetic cast group required significantly fewer casts to achieve correction (mean 5.1 vs. 5.8, $p = 0.002$) and achieved correction in a shorter time (mean 4.9 vs. 5.7 weeks, $p = 0.004$). These differences, though numerically modest, are statistically and clinically relevant, as they translate to reduced treatment duration, fewer clinic visits, and potentially lower overall caregiver burden.

The reduced number of casts required with synthetic material is consistent with the findings of Monforte et al. (2021) [8], who reported an average of 4.2 casts with semi rigid synthetic material compared to 5.2 with POP.

Although relapse rates and final outcomes were equivalent, the reduced number of casts highlights a clear efficiency advantage. Similarly, Aydin et al. (2020) [9], in a randomized controlled trial comparing synthetic and POP materials in 133 feet, noted fewer cast-related problems and comparable correction outcomes

The efficiency advantage is likely attributable to the physical properties of synthetic casts, which provide better rigidity and resistance to wear while maintaining adequate moldability. This reduces cast loosening and maintains the correction more consistently between changes.

Complication Profile: Casting complications were systematically assessed, with results presented in Table 3 and Figure 2. Complications were generally fewer in the synthetic cast group. Cast slippage occurred in 8.0% of cases with synthetic material compared to 20.0% with POP ($p = 0.05$). More importantly, skin complications were significantly lower in the synthetic group (4.0% vs. 16.0%, $p = 0.01$). Although pressure sores and cast breakage occurred more frequently with POP, the differences were not statistically significant.

These findings align closely with those of Aydin et al. (2020) [9], who reported higher rates of cast slippage and minor skin lesions with POP compared to semi rigid synthetic materials. Their randomized design strengthens the evidence that synthetic casts reduce the frequency of such complications. Similarly, Monforte et al. (2021) [8] observed fewer issues of cast breakdown and skin irritation with SRF, although their study emphasized long-term relapse equivalence between groups.

The reduced complication rate may be explained by the water-resistant, lighter, and smoother properties of synthetic materials, which reduce friction, skin maceration, and cast loosening. This is particularly advantageous in tropical climates such as India, where POP casts often become soft, discoloured, and prone to breakage with exposure to humidity.

Midterm Outcomes and Caregiver Experience: The 6-month outcomes and caregiver-related experiences are shown in Table 4 and Figure 3. Relapse rates were slightly lower in the synthetic cast group (8.0% vs. 12.0%), although this difference was not statistically significant ($p = 0.26$). Brace adherence was high and similar between groups (80% vs. 76%). These findings confirm that, regardless of casting material, adherence to the bracing phase remains the most critical determinant of long-term relapse prevention. The most striking difference was observed in caregiver satisfaction. Parents of children treated with synthetic casts reported significantly higher satisfaction scores (median 4 [IQR 4–5]) compared to POP (median 3 [IQR 3–4], $p = 0.01$). Factors likely contributing to this include the lighter weight of synthetic casts (mean 75 g vs. 150 g), improved durability, reduced skin and slippage problems, and overall ease of handling.

However, synthetic casts came with a higher material cost (₹3200 vs. ₹1800 per treatment, $p < 0.001$). This represents a significant consideration in low-resource settings, where affordability may outweigh convenience or minor efficiency gains. Nevertheless, in urban and private practice settings, caregivers may be willing to bear higher costs in exchange for improved comfort and satisfaction. Monforte et al. (2021) [8] similarly found no significant difference in relapse rates or long-term outcomes between synthetic and POP casts, but did highlight advantages in comfort and handling with synthetic materials. A systematic review of the Ponseti method by Maghfuri HB (2024) [10] reiterated that while treatment success rates are uniformly high across casting materials, caregiver and patient-reported experiences may increasingly guide choice of material

Limitations: One limitation of this study is the relatively small sample size (25 feet per group), which may have limited the power to detect small differences in outcomes such as relapse rates. Additionally, follow-up was limited to 6 months, whereas relapses may occur later during bracing and walking phases. Future multicentre randomized trials with larger sample sizes and longer follow-up will be necessary to fully establish the relative cost-effectiveness and long-term benefits of synthetic versus POP casting.

Conclusion

This study demonstrates that synthetic casts in the Ponseti method achieve correction with fewer casts, in less time, and with fewer complications compared to traditional POP. While relapse rates and brace adherence were comparable, caregiver satisfaction was significantly higher with synthetic casts, reflecting their lighter weight, durability, and comfort.

The principal drawback remains their higher material cost. In line with recent literature, synthetic casts represent a promising alternative to POP, especially in contexts where cost is less prohibitive and caregiver satisfaction is a priority.

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