

Residual Deformity and Recurrence Following Ponseti Treatment and Posteromedial Release in Clubfoot

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Received: 01-05-2026 / Revised: 15-06-2026 / Accepted: 21-07-2026

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Conflict of interest: Nil

Abstract

Background: Residual deformity and recurrence remain important concerns following treatment of idiopathic clubfoot. This study compared residual deformity, recurrence, and functional outcomes following Ponseti treatment and posteromedial release.

Methods: This comparative observational study included 100 patients with idiopathic clubfoot, comprising 50 treated using the Ponseti method and 50 by posteromedial release. Patients were evaluated for residual and recurrent deformity, ankle range of motion, pain, gait, footwear difficulty, functional outcome, satisfaction, and requirement for additional intervention.

Results: Residual deformity was significantly less frequent in the Ponseti group than in the posteromedial release group (16.0% vs 36.0%; $p=0.023$). Recurrence occurred in 18.0% and 38.0%, respectively ($p=0.025$). Mean ankle dorsiflexion was significantly greater following Ponseti treatment (15.8° vs 8.6° ; $p<0.001$). Pain, abnormal gait, footwear difficulty, and ankle stiffness were significantly more frequent following posteromedial release. Excellent or good functional outcomes were achieved in 90.0% of the Ponseti group compared with 74.0% of the posteromedial release group ($p=0.037$). Additional surgical procedures were required in 12.0% and 30.0%, respectively ($p=0.027$).

Conclusion: Ponseti treatment was associated with lower residual deformity and recurrence, greater ankle mobility, and better functional outcomes than posteromedial release. Long-term surveillance remains important because recurrence may occur following either treatment.

Keywords: Clubfoot; Ponseti Method; Posteromedial Release; Residual Deformity; Recurrence; Relapse; Functional Outcome.

DOI: 10.25258/ijcpr.18.8.95

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Introduction

Congenital idiopathic clubfoot is a complex musculoskeletal deformity characterized by cavus, forefoot adduction, hindfoot varus, and equinus. The principal objective of treatment is to obtain a painless, plantigrade, flexible, and functional foot while minimizing residual deformity and recurrence. Long-term studies have demonstrated that appropriately treated clubfeet can maintain satisfactory function into adulthood. [1]

The Ponseti method, consisting of serial manipulation and casting, percutaneous Achilles tenotomy when required, followed by maintenance with a foot-abduction brace, has become the preferred initial treatment for idiopathic clubfoot. Its widespread adoption has substantially reduced the requirement for extensive corrective surgery.

[2] However, recurrence may still occur, particularly in patients with severe initial deformity or poor compliance with the prescribed bracing protocol. [3] Before widespread adoption of the Ponseti method, extensive soft-tissue procedures, including posteromedial release (PMR), were commonly performed for resistant clubfoot. Although surgical release can achieve initial correction, long-term follow-up has demonstrated problems such as stiffness, pain, weakness, residual deformity, and degenerative changes in some patients. [4,5] Comparative studies have generally demonstrated better foot and ankle mobility and functional outcomes following Ponseti treatment than after extensive surgical release. [6]

Nevertheless, residual and recurrent deformities remain clinically important following both treatment approaches. Long-term assessment after posteromedial release has demonstrated that some patients develop recurrent equinus, varus, adduction, stiffness, or functional limitation requiring further intervention.⁷ Therefore, evaluation of residual deformity and recurrence is important when comparing the durability of clubfoot correction achieved by different treatment strategies.

The present study was undertaken to compare residual deformity and recurrence following Ponseti treatment and posteromedial release in patients with idiopathic clubfoot, with particular emphasis on maintenance of correction, ankle range of motion, functional outcome, residual deformity patterns, recurrence, and requirement for additional treatment.

Materials and Methods

Study Design and Participants: This comparative observational study included 100 patients with idiopathic clubfoot who had undergone primary treatment and subsequently presented for clinical follow-up. Patients were divided into two groups according to the initial treatment received:

Group P (Ponseti group): 50 patients treated using the Ponseti method.

Group S (Posteromedial release group): 50 patients treated by surgical posteromedial release.

Patients were evaluated after completion of primary treatment and followed to assess residual deformity, recurrence, functional status, and requirement for additional intervention.

Inclusion Criteria: Patients with congenital idiopathic clubfoot who had completed primary correction using either the Ponseti method or posteromedial release and had adequate clinical follow-up were included. Both unilateral and bilateral clubfeet were eligible.

Exclusion Criteria: Patients with syndromic or neurological clubfoot, arthrogryposis, spina bifida, congenital limb deficiency, secondary clubfoot, incomplete treatment records, or inadequate follow-up were excluded.

Clinical Assessment: A detailed history was obtained regarding age, sex, laterality, age at initiation of treatment, severity of initial deformity, treatment received, duration of treatment, compliance with bracing, and any additional procedures.

Clinical examination included assessment of:

- Hindfoot varus
- Forefoot adduction

- Equinus
- Cavus
- Ankle dorsiflexion and plantar flexion
- Foot and ankle flexibility
- Dynamic supination
- Gait pattern
- Pain during activity
- Footwear difficulty
- Callosities and other pressure-related abnormalities

Severity of residual deformity was assessed using the Pirani and/or Dimeglio scoring system.

Ponseti Treatment: Patients in Group P had been treated using standard Ponseti principles. Gentle manipulation and serial above-knee casting were performed at regular intervals to sequentially correct cavus, adduction, and varus.

Percutaneous Achilles tenotomy was performed when adequate correction of equinus could not be obtained with casting alone. Following correction, patients were prescribed a foot-abduction brace according to the standard Ponseti maintenance protocol.

Brace compliance was documented and classified as satisfactory or unsatisfactory based on the prescribed duration and reported adherence.

Posteromedial Release: Patients in Group S had undergone posteromedial soft-tissue release for correction of clubfoot. The procedure included release or lengthening of contracted posteromedial structures as required to obtain correction of equinus, varus, and adduction.

Following surgery, the corrected foot was immobilized in an appropriate cast, followed by orthotic support and physiotherapy according to the treating surgeon's protocol.

Definition of Residual Deformity: A residual deformity was defined as persistence of one or more components of clubfoot after completion of the initial corrective treatment without a documented period of complete correction.

Residual abnormalities evaluated included:

- Residual equinus
- Hindfoot varus
- Forefoot adduction
- Cavus
- Dynamic supination
- Restricted ankle movement

Definition of Recurrence: Recurrence or relapse was defined as the reappearance of one or more components of the clubfoot deformity after an initially satisfactory clinical correction had been achieved.

Recurrence was categorized according to the predominant deformity as equinus, varus, adduction, cavus, dynamic supination, or a combination of these deformities.

Functional Outcome Assessment: Functional outcome was evaluated according to pain, walking ability, gait, ankle range of motion, footwear requirement, participation in routine activities, and patient/parent satisfaction.

The International Clubfoot Study Group (ICFSG) scoring system was used where complete clinical and radiological information was available. Final outcomes were categorized as excellent, good, fair, or poor according to the selected standardized assessment system.

Radiological Assessment: Weight-bearing anteroposterior and lateral radiographs were obtained when clinically indicated. Radiological parameters included the AP and lateral talocalcaneal angles and talo-first metatarsal angle. Additional abnormalities such as flattening of the talar dome and degenerative changes were documented.

Follow-up Outcomes

The primary outcomes were:

- Residual deformity rate
- Recurrence rate

Secondary outcomes included:

- Ankle dorsiflexion and plantar flexion
- Foot and ankle flexibility
- Pain
- Gait abnormality

- Functional outcome
- Requirement for repeat casting
- Repeat Achilles tenotomy or lengthening
- Tibialis anterior tendon transfer
- Additional corrective surgery

The relationship between brace compliance and recurrence within the Ponseti group was also evaluated.

Statistical Analysis: Data were analyzed using SPSS version 25.0. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. Continuous variables between the Ponseti and posteromedial release groups were compared using the independent Student's t-test or an appropriate non-parametric test. Categorical variables, including residual deformity and recurrence rates, were compared using the Chi-square test or Fisher's exact test. Multivariable logistic regression was used where appropriate to identify factors associated with recurrence, including initial severity, age at treatment, treatment method, and brace compliance. A p-value <0.05 was considered statistically significant.

Results

A total of 100 patients with idiopathic clubfoot were included in the study, with 50 patients each in the Ponseti (Group P) and posteromedial release (Group S) groups. The two groups were comparable with respect to demographic characteristics and laterality. Residual deformity and recurrence were observed in both groups but were more frequent following posteromedial release.

Table 1: Baseline Characteristics of the Study Groups

Variable	Ponseti Group (n=50)	Posteromedial Release Group (n=50)	p-value
Mean age at final evaluation (years)	9.8 $\pm$ 2.7	10.2 $\pm$ 2.9	0.477
Male, n (%)	36 (72.0)	34 (68.0)	0.663
Female, n (%)	14 (28.0)	16 (32.0)	
Unilateral clubfoot	32 (64.0)	30 (60.0)	0.680
Bilateral clubfoot	18 (36.0)	20 (40.0)	
Mean age at initiation of treatment (months)	2.1 $\pm$ 1.3	2.4 $\pm$ 1.5	0.289
Mean initial Pirani score	5.2 $\pm$ 0.6	5.3 $\pm$ 0.5	0.367
Mean duration of follow-up (years)	7.8 $\pm$ 2.3	8.1 $\pm$ 2.5	0.533

The groups were comparable in terms of age, sex, laterality, age at initiation of treatment, initial deformity severity, and duration of follow-up ($p>0.05$), allowing meaningful comparison of subsequent outcomes.

Table 2: Residual Deformity and Recurrence Following Treatment

Outcome	Ponseti Group (n=50)	Posteromedial Release Group (n=50)	p-value
Any residual deformity	8 (16.0%)	18 (36.0%)	0.023
Residual equinus	4 (8.0%)	11 (22.0%)	0.050
Hindfoot varus	3 (6.0%)	9 (18.0%)	0.065
Forefoot adduction	5 (10.0%)	12 (24.0%)	0.062
Residual cavus	2 (4.0%)	7 (14.0%)	0.160
Dynamic supination	6 (12.0%)	8 (16.0%)	0.564
Recurrence/relapse	9 (18.0%)	19 (38.0%)	0.025
Multiple recurrent components	3 (6.0%)	10 (20.0%)	0.037

Residual deformity was significantly less frequent following Ponseti treatment (16.0%) than after posteromedial release (36.0%; $p=0.023$). Recurrence was also significantly lower in the Ponseti group (18.0% vs 38.0%; $p=0.025$). Equinus

and forefoot adduction were among the most frequent residual abnormalities, while complex recurrence involving multiple deformity components was significantly more frequent after posteromedial release.

Table 3: Functional and Clinical Outcomes at Final Follow-up

Outcome	Ponseti Group (n=50)	Posteromedial Release Group (n=50)	p-value
Ankle dorsiflexion (degrees)	15.8 ± 5.4	8.6 ± 4.8	<0.001
Plantar flexion (degrees)	38.7 ± 7.2	30.2 ± 7.5	<0.001
Pain during activity	4 (8.0%)	13 (26.0%)	0.016
Abnormal gait	6 (12.0%)	15 (30.0%)	0.027
Footwear difficulty	3 (6.0%)	12 (24.0%)	0.012
Stiffness/restricted ankle movement	5 (10.0%)	21 (42.0%)	<0.001
Plantigrade foot maintained	46 (92.0%)	39 (78.0%)	0.050
Patient/parent satisfied	47 (94.0%)	40 (80.0%)	0.037
Excellent/good functional outcome	45 (90.0%)	37 (74.0%)	0.037

Patients treated using the Ponseti method demonstrated significantly greater ankle dorsiflexion and plantar flexion at final follow-up. Pain, gait abnormalities, footwear difficulty, and ankle stiffness were significantly more frequent following posteromedial release. Excellent or good functional outcomes were achieved in 90.0% of the Ponseti group compared with 74.0% of the posteromedial release group ($p=0.037$).

Table 4: Additional Treatment for Residual or Recurrent Deformity

Additional Intervention	Ponseti Group (n=50)	Posteromedial Release Group (n=50)	p-value
Repeat manipulation/casting	8 (16.0%)	5 (10.0%)	0.372
Repeat Achilles tenotomy/lengthening	4 (8.0%)	8 (16.0%)	0.218
Tibialis anterior tendon transfer	5 (10.0%)	6 (12.0%)	0.749
Repeat extensive soft-tissue release	0	6 (12.0%)	0.027
Osteotomy/other corrective surgery	1 (2.0%)	7 (14.0%)	0.059
Any additional surgical procedure	6 (12.0%)	15 (30.0%)	0.027

Repeat casting was the most frequently used treatment for recurrence in the Ponseti group. More extensive corrective procedures were required more commonly after posteromedial release. Overall, an additional surgical procedure was required in 12.0% of Ponseti-treated patients compared with 30.0% of surgically treated patients ($p=0.027$).

Discussion

The present study compared residual deformity and recurrence following Ponseti treatment and posteromedial release (PMR) in 100 patients with idiopathic clubfoot. Residual deformity was significantly lower in the Ponseti group than in the PMR group (16.0% vs 36.0%), while recurrence occurred in 18.0% and 38.0%, respectively. Ponseti-treated patients also demonstrated greater ankle mobility, less pain and stiffness, and better overall functional outcomes. Church et al. [8] compared Ponseti and surgically treated clubfeet and demonstrated superior functional characteristics following Ponseti treatment, particularly in measures of strength, motion, and physical performance. These observations correspond with the present finding that excellent

or good functional outcomes were achieved in 90.0% of Ponseti-treated patients compared with 74.0% following PMR. The lower residual deformity and better mobility observed following Ponseti treatment are also consistent with the meta-analysis by Lykissas et al. [9], which demonstrated advantages of the Ponseti method over surgical soft-tissue release. Preservation of joint mobility is an important benefit of minimally invasive correction because extensive surgical release may result in scar formation and progressive stiffness. Recurrence remains an important concern even after successful Ponseti correction. Radler et al. [10] reported favorable midterm outcomes with the Ponseti method but emphasized the continuing possibility of relapse during growth. In the present study, recurrence occurred in 18.0% of the Ponseti group. Brace adherence, initial deformity severity, and continued follow-up are therefore important components of successful treatment.

Long-term differences between conservative and surgical approaches may become more evident as patients grow. Smith et al. [11] reported better long-term physical function in patients treated by the Ponseti method compared with comprehensive

surgical release. In the present study, ankle dorsiflexion and plantar flexion were significantly greater following Ponseti treatment, while stiffness was substantially more frequent after PMR (42.0% vs 10.0%).

Radiological abnormalities may also reflect persistent or recurrent structural deformity. Shabtai et al. [12] demonstrated that radiographic parameters following Ponseti treatment may provide information regarding subsequent surgical requirements and functional outcomes. Clinical and radiological follow-up may therefore be useful in patients showing recurrent equinus, varus, or adduction.

Relapse may present differently according to the patient's age and stage of growth. Mahan et al. [13] described age-related patterns of clubfoot relapse and emphasized that treatment should be individualized according to the recurrent deformity. In our study, repeat casting was commonly sufficient for recurrent deformity following Ponseti treatment, whereas patients previously treated with PMR more frequently required additional surgical intervention.

Despite its tendency to relapse, the Ponseti method can provide durable correction and high long-term satisfaction. Zions et al. [14] demonstrated favorable long-term patient satisfaction following Ponseti treatment despite the inherent tendency of clubfoot to recur. Similarly, patient or parent satisfaction in the present study was significantly higher in the Ponseti group (94.0%) than in the PMR group (80.0%).

Corbu et al. [15] directly compared long-term outcomes following posteromedial release and Ponseti treatment and found more favorable results with the Ponseti approach, particularly regarding mobility and functional parameters. The present findings support these observations and suggest that although both methods can achieve correction, Ponseti treatment is associated with less residual deformity, lower recurrence, better ankle mobility, and reduced need for further corrective surgery.

Conclusion

The Ponseti method demonstrated more favorable outcomes than posteromedial release in patients with idiopathic clubfoot. Residual deformity and recurrence were significantly less frequent following Ponseti treatment, while ankle mobility, gait, footwear tolerance, patient satisfaction, and overall functional outcomes were better. Patients treated with posteromedial release demonstrated greater stiffness and a higher requirement for additional corrective surgery. These findings support the Ponseti method as the preferred primary treatment for idiopathic clubfoot, with

continued follow-up and brace compliance being important for minimizing recurrence.

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