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A RANDOMIZED COMPARATIVE STUDY OF THE PONSETI TECHNIQUE VERSUS THE KITE METHOD IN THE CONSERVATIVE MANAGEMENT OF IDIOPATHIC CONGENITAL TALIPES EQUINOVARUS

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Abstract

Background: Clubfoot, also known as congenital talipesequinovarus (CTEV), is one of the most prevalent congenital musculoskeletal deformities that are encountered in pediatric practice, and occurs in 1-3 per 1000 live births globally.Ponseti technique and Kite method are two main conservative philosophies used to correct idiopathic clubfoot, however head to head comparative evidence specific to the Indian tertiary care population (where the clubfoot is presented late, and there is variation in brace compliance infrastructure) is limited.
Objective: To compare the clinical effectiveness of the Ponseti technique with the Kite method in reducing the severity of idiopathic CTEV in children aged 0–1 year, efficiency of the treatment, necessity for tenotomy, recurrence of the deformity and their complications.
Design: Randomized comparative study.
Setting: Department of Physiotherapy, Pacific Medical College and Hospital (PMCH), Bedla, Udaipur, Rajasthan.
Methods: There were a total of 50 children (0-1 year) with idiopathic CTEV were randomized equally into Group A (Ponseti technique, n = 25) and Group B (Kite method, n = 25).The deformity severity was determined by Pirani and Dimeglio scoring system at baseline and post treatment.Secondary outcomes included number of plaster-of-Paris casts, duration of treatment, percutaneous Achilles tenotomy, dorsiflexion of the ankle after treatment, recurrence at 6 months, and complication rate.Between-group comparisons were conducted using independent t-tests and Chi-square ($\alpha = 0.05$).
Results: Groups were comparable at baseline (Pirani 4.75 ± 0.58 vs. 5.0 ± 0.50, p = 0.854; Dimeglio 13.68 ± 2.37 vs. 14.2 ± 1.89, p = 0.832). Group A achieved significantly greater Pirani score reduction (3.98 ± 0.79 vs. 2.60 ± 0.69; p < 0.001) and Dimeglio score reduction (10.44 ± 3.18 vs. 4.4 ± 2.32; p < 0.001). The Ponseti group required fewer casts (6.8 ± 0.91 vs. 11.2 ± 1.41; p < 0.001), shorter treatment duration (7.24 ± 1.09 vs. 13.28 ± 1.83 weeks; p < 0.001), and achieved greater post-treatment ankle dorsiflexion (15.4 ± 3.4° vs. 6.32 ± 2.41°; p < 0.001). The tenotomy was more often performed in Group A (80% vs. 28%, p = 0.003) due to the protocol-driven equinuscorrection. Recurrence (16% vs. 28%, p = 0.002) and complications (4% vs. 24%, p = 0.041) were both significantly lower in Group A.
Conclusions: The Ponseti technique achieved significantly better deformity correction, treatment efficacy and durability of deformity correction than the Kite technique in this cohort, and should be used as the first-line conservative treatment in resource-limited tertiary-care facilities for idiopathic CTEV.

1. INTRODUCTION

Congenital talipesequinovarus (CTEV) or club foot is one of the most common congenital musculoskeletal deformities seen in the practice of pediatric orthopedic and physiotherapy.It is characterised by four cardinal features: midfootcavus, forefoot adduction, hindfootvarus and ankle equinus – a combination of these features is actually a single pathoanatomical anomaly of bone, ligament, capsule and myotendinous tissue, rather than four independent anatomical variations [1].Worldwide, the incidence of CTEV is very similar at 1–3 per 1000 live births, resulting in over 100,000 affected newborns each year, although the incidence is disproportionately high in low and middle-income countries in which timely access to skilled orthopedic and physiotherapy care is restricted [4].

The condition shows a well documented male predominance of approximately 2:1 and bilateral involvement in almost half of the infants involved [1, 2].Approximately 80% of cases are idiopathic, with no identifiable systemic or genetic cause, with the other 20% associated with a neuromuscular condition (such as myelomeningocele, arthrogryposis multiplex congenita or chromosomal syndromes) and requiring a different management approach [1].

The underlying pathoanatomical factors of idiopathic clubfoot include the navicular being displaced medially with respect to the talar head, and progressive adaptive shortening of the ligaments associated with the navicular, the posterior tibial tendon sheath and the plantar fascia, which perpetuate the deformity.The talus is abnormally shaped with a medially deviated, plantarflexed neck and shortening of the posterior capsule and Achilles tendon holds the hindfoot in varus and equinus [5].These structural observations, which were first systematically described by Ponseti, and later confirmed by anatomical and imaging studies, are the biomechanical basis for modern sequential correction techniques [5].

Untreated or inadequately treated clubfoot carries severe lifelong consequences.Children who unable to achieve a plantigrade foot posture have to place weight on the lateral border or dorsum of the foot which results in the formation of calluses, skin breakdown, pain and permanent functional disability [4].In resource-limited communities, the downstream psychosocial and economic burden is substantial: affected children face barriers to schooling, social participation, and future employment, while families absorb often-unaffordable treatment costs [3, 4]. The selection of an effective, affordable and replicable conservative treatment approach is thus a public health challenge as well as an orthopedic one, especially in environments like Rajasthan where late presentation and limited resources exacerbate clinical challenges.

Over the past 200 years, treatment for clubfoot has changed significantly.Plaster-of-Paris serial casting was first introduced as a non-operative approach in the nineteenth century [9]. However , for much of the twentieth century, surgical correction dominated clinical practice as available conservative techniques produced inconsistent results. The large posteromedial soft tissue release, first described by Turco (1971) and modified by McKay (1983), was the common surgical technique, and posterior, medial and, if severe, subtalar release was performed simultaneously and the correction maintained throughout the healing period with internal fixation [6, 7].

Long-term follow-up subsequently revealed the true cost of this surgical paradigm.Dobbs et al. (2006) followed patients for more than 10 years after wide soft-tissue release, and over time they found a gradual decline in outcome, which included progressively increased stiffness, arthritic change, chronic pain and functional deficits, all related to the alteration of hindfoot biomechanics caused by neonatal soft-tissue scarring which were not apparent in the short term [8].This evidence was a catalyst for a widespread paradigm change from progressive to conservative treatment of idiopathic clubfoot.

Since then, two conservative philosophies have emerged: the Kite method and the Ponseti method.In the 1930s J. H. Kite described his approach and developed it over the following decades [9].The Kite method first attempts to correct forefoot adduction, then hindfootvarus and lastly equinus, through counter-pressure at the calcaneocuboid joint and serial long-leg casts to correct the hindfoot and forefoot respectively.Kite achieved close to 90% success in his own series and early adoption of his technique was widespread [9, 10] but later investigators have not been able to consistently match the Kite success rate and the combined and meta-analytical data have suggested that only 20-50% of patients treated with kites avoided surgery. This disparity has been at least partly explained by differences in case selection and diagnosis across studies [12, 13].

Detailed study of the clubfoot pathoanatomy and kinematics led to the key advance by Ignacio Ponseti which was published in 1963 [5].Unlike the Kite method where correction occurs sequentially, the Ponseti method corrects the forefoot adductus and hindfootvarus as a single three dimensional deformity by abducting the foot around the talar head (acting as a pivot), compressing the talar head with counter-pressure applied rather than the calcaneocuboid joint.The cavus component is corrected first: the forefoot is supinated to correct the cavus, and equinus is corrected last, usually by percutaneous Achilles tenotomy and then by a final corrective cast and maintenance in a foot abduction brace [14, 15].Ponseti's original 1963 series found excellent long-term results in about 90% of the treated patients, which was later confirmed by the results of several long-term follow-up series [5, 16].

Ponseti technique has gradually become accepted in the rest of the world over the last 30 years.In a systematic review conducted by Ganesan et al., 2017, across various healthcare settings, they found that the Ponseti method is superior to other conservative options and is the right first line treatment in children younger than two years of age with the idiopathic form of CTEV [3]. The next meta-analysis, by Raslan et al., combined the results of six comparative studies, and the authors were able to accurately calculate this advantage, which included an increased chance of correction ($RR = 1.23$; 95% CI: 1.14–1.32; $p < 0.001$), reduced risk of relapse ($RR = 0.50$; 95% CI: 0.36–0.71; $p < 0.001$), fewer casts needed, and shorter total treatment time compared to the Kite method [18].

Over the past 20 years, a large amount of comparative evidence has been accumulated.Sud et al. (2008) conducted a prospective randomized study of 45 infants, 67 feet, that found feet treated with Ponseti's correction improved 91.7% versus 67.7% in the Kite group, with fewer casts and approximately one-third the number of days for correction [13].Similarly, Sanghvi and Mittal (2009) found less casts (7 vs. 10), shorter duration (10 vs. 13 weeks), and more dorsiflexion at correction with the Ponseti method [19].Halanski et al. (2010) reported that there were significantly fewer revision procedures in the Ponseti group compared to the surgical release group for a similar recurrence rate [20].Selmani (2012) in a prospective randomized study of 100 infants (150 feet), reported that Ponseti achieves significant shorter correction time than other methods [21].Garcia et al., 2018 and Garhwal and Choudhary, 2018 both found statistically superior Pirani score correction with Ponseti at all time points measured [22, 23].Chen et al. (2019)in a case-controlled study by with a minimum follow up of four years, they found a 90% correction rate with Ponseti compared to 69% with Kite (p = 0.028) [24].Sharif et al. (2021)In a quasi-experimental study of 46 children (60 feet) were able to confirm significantly better Pirani scores at each follow up interval [25].

The severity of clubfoot deformity and the progress of treatment is most often evaluated using two validated clinical scoring instruments: Pirani score and Dimeglio classification [26].The Pirani score comprises 6 parameters, with 0, 0.5, or 1 points obtained in the hindfoot and midfoot subscale (posterior heel crease, empty heel sign, rigid equinus; lateral border of the foot, talar head coverage, medial crease), for a maximum of 6 points.It shows good inter-rater reliability and can predict the likely number of casts needed for correction [26, 33].The Dimeglio system consists of four major deformities (equinus, varus, derotation, forefoot adduction) rated on a 0–4 scale and four other binary clinical features that sum to a composite score of 0–20, with scores defined as benign, moderate, severe, and very severe [26].

Despite the availability of a strong global evidence base for Ponseti, brace compliance during the maintenance phase of treatment continues to be the biggest determinant of the long-term outcome; and non-compliance is the most common cause of recurrence, especially in low and middle-income countries [3, 4].Families in resource-limited environments have to pay extra transport fees, have limited health literacy about the brace, and have sociocultural barriers to adherence which are associated with higher recurrence rates than those of well-resourced referral centers [27, 28].Accelerated casting protocols, with casting twice a week or every 3 days instead of weekly, have yielded promising results in decreasing the burden of treatment and still maintaining the same percentage of correction [29, 30, 31].

Within the specific clinical setting of the tertiary paediatric physiotherapy and orthopedic practice in Rajasthan, there is no well powered, randomized, comparative study where both the methods of Ponseti and Kite have been administered using same standardized protocol, validated outcome measurement tools and same contemporary patient population.

In the particular clinical setting of the tertiary care pediatric physiotherapy and orthopedic department of Rajasthan, there is no compelling, randomized comparative study that has been conducted using a standardized protocol and validated outcome measures and a contemporary cohort of patients. The sociocultural context in central Rajasthan – characterized by late presentation, differential care received in the periphery, transport difficulties and lack of knowledge about health among caregivers – is a unique clinical context with results that are not necessarily generalizable to Western or urban Indian tertiary settings [4]. Hence, the present study was planned to overcome this dilemma and a randomized comparative study of the Ponseti technique with the Kite method was carried out in children with idiopathic CTEV who had reported to Pacific Medical College and Hospital, Udaipur.

Objectives: To evaluate the clinical effectiveness of the Ponseti technique versus Kite method in the conservative correction of idiopathic congenital talipesequinovarus in children aged 0-1 year, in terms of deformity severity reductions (Pirani and Dimeglio scores), treatment efficiency (number of casts, duration), need for tenotomy, ankle dorsiflexion, rate of recurrence at 6 months, and complications.

2. MATERIALS AND METHODOLOGY

2.1 Study Design and Ethical Framework

The was a randomized comparative study carried out in one year in Department of Physiotherapy, Pacific Medical College and Hospital, Bedla, Udaipur, Rajasthan.Prior to data collection, ethical clearance was obtained from the Institutional Ethics Committee (IEC), Pacific Medical University, Udaipur.The study was done according to the Declaration of Helsinki (2013) [32] and National Ethical Guidelines for Biomedical and Health Research Involving Human Participants, Indian Council of Medical Research (ICMR), 2017 [37].Written informed parental consent was obtained from all participants prior to enrollment, in English or Hindi as appropriate.

2.2 Participants

Fifty children aged 0–1 year with idiopathic CTEV were recruited from the pediatric outpatient department and randomly allocated using computer-generated random allocation sequence into Group A (n = 25) receiving the Ponseti technique and Group B (n = 25) receiving the Kite method [36].

Inclusion Criteria: Diagnosed idiopathic CTEV, age 0-1 years, first presentation (no other previous treatment), unilateral or bilateral involvement, caregivers willing to provide written informed consent, and attend scheduled follow-up.

Exclusion Criteria: Syndromic or neurogenic clubfoot (myelomeningocele, arthrogryposis multiplex congenita, chromosomal/neuromuscular syndromes); previously treated and/or relapsed cases; age > 1 year at presentation; significant systemic illness or active infection contraindicated casting or anesthesia.

2.3 Interventions

Group A (Ponset Technique): Manipulation and long-leg plaster-of-Paris casting on a weekly basis after the usual Ponseti sequence of manipulation, a cavus correction first and then simultaneous correction of forefoot adduction and hindfootvarus by abduction around the talar head as pivot, with counter-pressure applied at the lateral aspect of the talar head [5].Percutaneous Achilles tenotomy was used for residual equinus at the end of casting [14].After correction, the foot abduction brace was placed at 60-70° of external rotation and used full-time for three months and nocturnally thereafter, along with structured education for the caregivers about brace compliance [3].

Group B (Kite Method): Weekly manipulation combined with long-leg plaster-of-Paris casting with counter-pressure applied at forefoot adduction, hindfootvarus and ankle equinus, in that order [9].Following correction, a foot orthosis was given for the maintenance phase.

In order to achieve technical uniformity, only single trained investigator performed all casting and manipulation procedures [13].

2.4 Outcome Measures

Primary outcomes: Pirani score (baseline, serial, post treatment) [26, 33] and Dimeglio score (baseline, post treatment) [26, 34].

Secondary outcomes: Total number of plaster-of-Paris casts needed [13]; total duration of the treatment (weeks); requirement for percutaneous Achilles tenotomy (failure to achieve ≥15° ankle dorsiflexion beyond neutral at the end of the casting) [14]; Post-treatment ankle dorsiflexion (degrees); Recurrence at 6 months (return of any original deformity component (Pirani score >0.5)) [33]; Complication rate (skin irritation, residual deformity, slippage of the cast, incomplete correction).

2.5 Statistical Analysis

The data were analyzed by using SPSS version 25.0/26.0.All continuous variables (age, Pirani and Dimeglio scores, casts, duration and dorsiflexion) were reported as mean ± SD and were compared with the independent samples t-test.Data from the categorical variables (sex, laterality, tenotomy, recurrence and complications) were reported as frequencies and percentages and compared using Chi-square test.Two-tailed $p < 0.05$ was considered statistically significant [36].

3. RESULTS

3.1 Participant Distribution and Demographics

All enrolled 50 children (Group A n = 25, Group B n = 25) finished the treatment protocol and six-month follow-up without dropouts.The predominance of males in the study population was 72% compared to 28% females, a ratio of 2.6:1, which is similar to the one reported in other epidemiological studies [1, 2, 7].The total distribution for laterality was 31 unilateral (62%) and 19 bilateral (38%) cases.

Table 1. Group-wise Distribution of Participants

Group	Treatment	n	%	Male n (%)	Female n (%)
A	Ponseti Technique	25	50.0	22 (88%)	3 (12%)
B	Kite Method	25	50.0	14 (56%)	11 (44%)
Total	—	50	100	36 (72%)	14 (28%)

Table 2. Baseline Demographic and Clinical Characteristics

Variable	Group A (n=25)	Group B (n=25)	Total (n=50)	p-value
Age, months (Mean ± SD)	7.80 ± 3.21	6.00 ± 3.36	6.90 ± 3.38	0.721 (NS)
Age range, months	1–11	1–11	1–11	—
Unilateral, n (%)	14 (56%)	17 (68%)	31 (62%)	—
Bilateral, n (%)	11 (44%)	8 (32%)	19 (38%)	—
Pirani score (pre), Mean ± SD	4.75 ± 0.58	5.0 ± 0.50	4.88 ± 0.55	0.854 (NS)

Dimeglio score (pre), Mean ± SD	13.68 ± 2.37	14.2 ± 1.89	13.94 ± 2.14	0.832 (NS)

NS = not significant. No statistically significant baseline differences were observed in age, deformity severity (Pirani or Dimeglio), confirming adequate randomization and baseline equivalence between groups.

3.2 Pirani Score Outcomes

Table 3. Pirani Score: Pre-Treatment, Post-Treatment, and Reduction

Variable	Group A	Group B	Mean Diff.	95% CI	p-value
Pirani (pre)	4.75 ± 0.58	5.0 ± 0.50	0.25	−0.57 to 0.6	0.854 (NS)
Pirani (post)	0.77 ± 0.44	2.40 ± 0.55	−1.63	−1.92 to −1.34	<0.001*
Pirani reduction	3.98 ± 0.79	2.60 ± 0.69	1.38	0.95 to 1.80	<0.001*

**p < 0.05. Group A achieved approximately 83.8% total deformity correction versus approximately 52.0% in Group B — a difference of 31.8 percentage points.*

3.3 Dimeglio Score Outcomes

Table 4. Dimeglio Score: Pre-Treatment, Post-Treatment, and Reduction

Variable	Group A	Group B	Mean Diff.	95% CI	p-value
Dimeglio (pre)	13.68 ± 2.37	14.2 ± 1.89	−0.52	−1.74 to 0.70	0.832 (NS)
Dimeglio (post)	3.24 ± 1.23	9.8 ± 1.38	−6.56	−7.31 to −5.81	<0.001*
Dimeglio reduction	10.44 ± 3.18	4.4 ± 2.32	6.0	4.3 to 6.5	<0.001*

Group A's post-treatment Dimeglio score (3.24) falls in the benign range (<6); Group B's (9.8) remains in the moderate severity range (6–10).

3.4 Treatment Efficiency: Casts and Duration

Table 5. Number of Casts Required

Group	n	Mean Casts ± SD	Mean Diff.	95% CI	p-value
Group A (Ponseti)	25	6.8 ± 0.91	−4.4	−5.08 to −3.72	<0.001*
Group B (Kite)	25	11.2 ± 1.41			

Table 6. Duration of Active Treatment

Group	n	Mean Duration (wks) ± SD	Mean Diff.	95% CI	p-value
Group A (Ponseti)	25	7.24 ± 1.09	−6.04	−6.90 to −5.18	<0.001*
Group B (Kite)	25	13.28 ± 1.83			

3.5 Tenotomy Rate

Table 7. Percutaneous Achilles Tenotomy Requirement

Group	n	Tenotomy Req.	%	Mean Diff.	95% CI	p-value
Group A (Ponseti)	25	20	80%	52%	18% to 62%	0.003*
Group B (Kite)	25	7	28%			

3.6 Post-Treatment Ankle Dorsiflexion

Table 8. Ankle Dorsiflexion Post-Treatment

Group	n	Mean Dorsiflexion (°) ± SD	Mean Diff.	95% CI	p-value
Group A (Ponseti)	25	15.4 ± 3.4	9.08	7.52 to 10.64	<0.001*
Group B (Kite)	25	6.32 ± 2.41			

3.7 Recurrence at Six Months

Table 9. Recurrence Rate

Group	n	Recurrence	%	Mean Diff.	95% CI	p-value
Group A (Ponseti)	25	4	16%	−12%	−56% to −16%	0.002*
Group B (Kite)	25	7	28%			

3.8 Complications

Table 10. Complication Rate and Type

Group	n	Complications	%	Type	p-value
Group A (Ponseti)	25	1	4%	Skin irritation (n=1)	0.041*
Group B (Kite)	25	6	24%	Skin sores (n=2), residual varus (n=2), cast slippage (n=1), incomplete correction (n=1)	

3.9 Consolidated Statistical Summary

Table 11. Summary of All Statistical Comparisons

Test	Variable	Group A	Group B	Statistic	p-value	Decision
Independent t-test	Age (months)	7.80 ± 3.21	6.00 ± 3.37	t = 0.36	0.721	H_0 retained
Independent t-test	Pirani (pre)	4.75 ± 0.58	5.0 ± 0.50	t = 0.19	0.854	H_0 retained
Independent t-test	Dimeglio (pre)	13.68 ± 2.37	14.2 ± 1.89	t = 0.21	0.832	H_0 retained
Independent t-test	Pirani (post)	0.77 ± 0.44	2.40 ± 0.55	t = −9.42	<0.001	Reject H_0
Independent t-test	Dimeglio (post)	3.24 ± 1.23	9.8 ± 1.38	t = −13.27	<0.001	Reject H_0
Independent t-test	Casts required	6.8 ± 0.91	11.2 ± 1.41	t = −12.63	<0.001	Reject H_0
Independent t-test	Duration (weeks)	7.24 ± 1.09	13.28 ± 1.83	t = −13.91	<0.001	Reject H_0
Independent t-test	Dorsiflexion (°)	15.4 ± 3.4	6.32 ± 2.41	t = 11.73	<0.001	Reject H_0
Chi-square	Tenotomy	80%	28%	$\chi^2 = 13.02$	0.003	Reject H_0
Chi-square	Recurrence	16%	28%	$\chi^2 = 9.64$	0.002	Reject H_0
Chi-square	Complications	4%	24%	$\chi^2 = 4.15$	0.041	Reject H_0

α = 0.05, two-tailed throughout.

4. DISCUSSION

The principal findings of this study was that the Ponseti technique was more effective than Kite technique statistically and clinically in all the four measured parameters – deformity correction, efficiency of treatment, durability and safety of treatment in the idiopathic CTEV cases treated in a tertiary care center of Rajasthan.

4.1 Deformity Correction

Baseline Pirani (4.75 vs. 5.0, $p = 0.854$) and Dimeglio scores (13.68 vs. 14.2, $p = 0.832$) showed that there were no significant differences at the start, with both groups having deformities classified as "severe" (11–15 points) in the Dimeglio classification, thus, making differences between groups at later stages a result of treatment effect and not baseline imbalance.Post-treatment Pirani score of 0.77 ± 0.44 in Group A is near the clinically acceptable score for satisfactory correction (≤1.0) and Group B had a score of 2.40 ± 0.55 which was far from being satisfactory. This pattern (83.8% vs. 52.0% deformity correction) is similar to that of Sud et al. (2008) who reported 91.7% correction with Ponseti vs. 67.7% with Kite in 67 feet [13] and Sharif et al. (2021) who reported their final Pirani scores (1.42 ± 0.39 Ponseti vs. 2.35 ± 0.54 Kite) almost identically [25]. The Dimeglio results support this: The post-treatment score for group A (3.24, benign range) compared to group B (9.8, moderate-severity range) is consistent with the findings of Raslan et al. in the meta-analysis who found that Ponseti was associated with significantly higher odds of correction (RR = 1.23; 95% CI: 1.14–1.32; $p < 0.001$) [18].These results are also similar to those of Derzsi et al. (2015) who in a single-center study, performed in 235 feet from Romania, demonstrated that the Dimeglio scores were similar at baseline, but improved significantly after Ponseti ($p = 0.005$), and experienced significantly fewer treatment failures (8.49% vs. 30.32%) [35].

4.2 Treatment Efficiency

The 4.4-cast and 6.04-week lead for Ponseti was comparable to that of Sanghvi and Mittal (2009), who reported 7 casts versus 10 casts and 10 weeks versus 13 weeks [19] respectively, and was slightly larger than the pooled meta-analytic value of −3.0 casts for Ponseti [18] (the difference might be due to the higher mean age at presentation in this population vs many other published series including a substantial population of neonates). For the rural and semi-urban families of Rajasthan, who have to travel and spend a week on each additional cast change, this difference in efficiency is not just in statistics, but in real practice.

4.3 Tenotomy, Equinus Correction, and Safety

The higher tenotomy rate in Group A (80% vs. 28%, $p = 0.003$) should not be interpreted as a disadvantage of this procedure; rather, as noted by Herzenberg et al. (2002), the Ponseti protocol has the ability to take a club foot well beyond the point of what can be achieved by a tenotomy, and this rate is in line with the 63.3% reported by Chen et al. (2019) and the generally referenced rate of 70–90% in developing-country settings [11, 24].The corollary is apparent in post-treatment dorsiflexion: Group A, 15.4° (at the satisfactory-correction threshold) compared to Group B, 6.32°, which is close to the 12° versus 6° comparison by Sanghvi and Mittal [19].The higher Pirani and Dimeglio scores after treatment are a better reflection of the inability of the Kite group to push the foot far enough toward correction for tenotomy to become indicated.Complications were similar (4% versus 24%, $p = 0.041$), with the only complication noted in the Ponseti group transient skin irritation compared to a Kite-group group of residual varus, incomplete correction and cast-related skin and slippage problems, in general consistent with Garcia et al. (2018) and long-term randomized evidence of Svehlík et al. (2017) [17, 22].

4.4 Recurrence

Recurrence at six months (16% vs. 28%, p = 0.002) favored Ponseti, though the 16% figure exceeds rates from well-resourced Western centers (typically 5–10%) and instead approximates rates reported from other developing-country contexts where brace adherence is a recognized challenge [3]. This is in line with Ganesan et al. (2017) who recorded rates of recurrence between 5–30% in various settings, which correlated well with the bracing infrastructure [3] and was substantiated on a quantitative level by the pooled relapse risk ratio of 0.50 (95% CI: 0.36–0.71; p < 0.001) in favor of Ponseti [18]. In a large, Romanian cohort, Derzsi et al. 2015 found an even greater relapse differential (11.32% vs. 35.65% for Ponseti and Kite, respectively) which was another confirmation of the durability benefit of the Ponseti approach seen here [35]. The increased recurrence rate from the Kite group may be due to multiple factors: firstly, the primary correction might not be complete; secondly, there is no systematic brace program like one used for the Ponseti foot abduction brace.

4.5 Limitations

The limitations of this study are that it is single center in design with a relatively small sample size (n = 50), generalizability may be limited; that follow-up is 6 months only, which means that long-term outcomes in terms of recurrence, gait or function in childhood and adolescence cannot be assessed; that there is a high proportion of late presenters (34% at 10-12 months), which could lead to higher cast requirements compared with early presenters; that there is no objective measurement of brace-compliance during the maintenance phase; and that due to the nature of the intervention, the treating investigator was not blinded, which could lead to performance bias.

5. CONCLUSION

This randomized comparative study of 50 children with idiopathic CTEV showed statistically and clinically significant superiority over the Kite method in the parameters of deformity correction (Pirani and Dimeglio scores), efficacy of treatment (casts and duration of treatment), dorsiflexion (equinus correction), treatment durability (recurrence of deformity), and safety (complications).The results strongly recommend the use of the Ponseti technique as the first line conservative treatment for idiopathic CTEV in tertiary pediatric physiotherapy clinics in the resource poor set-up of Rajasthan and similar resource poor environment and highlight the necessity of structured teaching of the caregivers about the importance of brace usage for further minimising the rate of recurrence.

DECLARATIONS

Ethical Approval: Obtained from the Institutional Ethics Committee (IEC), Pacific Medical University, Udaipur.Completed in accordance with the Declaration of Helsinki (revised 2013) and ICMR (2017) guidelines..

Informed Consent: Written informed consent was obtained from all participants prior to enrollment.

Conflict of Interest: There are no conflicts of interest.

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Data Accessibility: Requests for the anonymised dataset can be made to the corresponding author.

Author Contributions: Yadav dilip study concept, data collection, data analysis, and manuscript preparation.Dr. ChitrakshiChoubishasupervision of studies, methodological guidance and critical review of the manuscript

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