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Management of congenital talipes equinovarus by Ponseti technique and percutaneous needle tenotomy

Mohammed Mukkaram[1]*, Daniya Awais[2], Ali Razvi[1]

[1]Department of Orthopaedics, Shadan Institute of Medical Sciences, Hyderabad, Telangana, India
[2]Department of Orthopaedics, Shadan and Allied, Ayan Institute of Medical Sciences, Hyderabad, Telangana, India

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***Correspondence:**
Dr. Mohammed Mukkaram,
E-mail: dr.mukkaram@gmail.com

ABSTRACT

Background: This study evaluates the Ponseti technique combined with percutaneous needle tenotomy for treating congenital talipes equinovarus (CTEV), or clubfoot, assessing efficacy, complications, and outcomes. Conducted at a tertiary medical center in Hyderabad from 2021 to 2024, it included patients of all ages presenting with CTEV.
Methods: This is a prospective and retrospective study. The Ponseti method, a conservative approach involving serial casting and gentle foot manipulation, was applied, with percutaneous needle tenotomy used for achilles tendon lengthening when necessary. Compared to traditional surgical methods, this minimally invasive approach is associated with fewer complications and improved correction rates. Patients were assessed using Pirani scores, with data on cast numbers, tenotomy needs, and relapses.
Results: The study demonstrated significant efficacy, particularly when treatment began early, reducing the number of casts required. Needle tenotomy, preferable over blade tenotomy, was particularly effective in India and among patients from lower socioeconomic backgrounds, proved more effective than blade tenotomy. The approach was associated with fewer complications and better correction rates.
Conclusions: The Ponseti technique is an effective, accessible, and economical option with minimal complications. Early diagnosis and intervention were found essential for optimal outcomes. Further research is suggested to refine treatment protocols for older children and severe deformities.

Keywords: Congenital talipes equinovarus, CTEV, Ponseti technique, Percutaneous needle tenotomy, Clubfoot

INTRODUCTION

Congenital talipes equinovarus (CTEV), commonly known as clubfoot, is a complex congenital deformity of the foot, characterized by four primary components: cavus, adduction, varus, and equinus. Affecting about 1 in 1000 live births, CTEV can involve one or both feet, with bilateral cases comprising approximately 50% of all instances. The deformity is more prevalent in males, occurring at a ratio of approximately 2:1 compared to females.

The treatment of CTEV has evolved from aggressive surgical interventions to more conservative, less invasive approaches. The Ponseti technique, introduced by Dr. Ignacio Ponseti in the mid-20th century, has become the gold standard for the management of CTEV worldwide.[1] This technique, which includes serial manipulations and casting, followed by percutaneous Achilles tenotomy when necessary, aims to correct deformity while preserving the function and flexibility of the foot. This research paper evaluates the effectiveness of the Ponseti technique combined with percutaneous needle tenotomy in treating CTEV, based on a study conducted at our tertiary medical institute, Hyderabad, between May 2021 and March 2024.[1] Most of the previous studies were done either on non-Indian population or relatively high socio-

economic class. Our study was done on Indian population and also people of low socio-economic strata.

Historically, the management of CTEV has seen significant advancements. Early references to the deformity date back to ancient texts like the "Yajurveda," which recommended massage as a treatment. However, it was not until the works of Hippocrates in 460-377 B.C. that clubfoot was given a more clinical description, attributing the condition to malposition in the uterus.

The 19th and early 20th centuries saw the rise of surgical interventions, including the subcutaneous tenotomy of the Achilles tendon and various forms of osteotomies and soft tissue releases. While these methods provided some correction, they often resulted in stiffness, scarring, and long-term pain, leading to a search for more effective and less invasive treatment options. Dr. Ignacio Ponseti's method revolutionized the treatment of CTEV by focusing on gentle, systematic manipulation and casting, which allowed for the gradual correction of the deformity with minimal surgical intervention.[1] Ponseti's technique emphasizes the importance of addressing each component of the deformity in a specific sequence: correcting cavus first, followed by adduction, varus, and finally equinus (principle of coupling kinematics is used).[1] The inclusion of percutaneous Achilles tenotomy as part of the Ponseti method significantly improves outcomes, particularly in cases where equinus persists after casting.[1] In our study, needle was used instead of blade in almost all cases which further made the procedure minimally invasive and more economical.

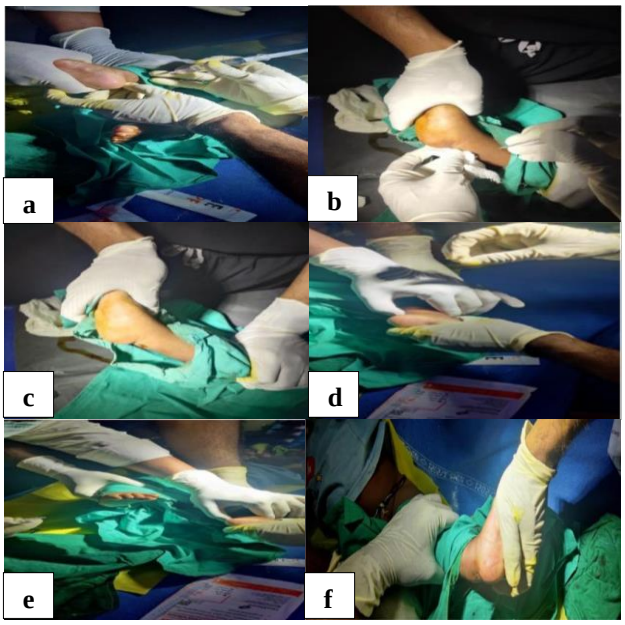

Figure 1 (a-f): Correction of CTEV with Ponseti technique with needle tenotomy.

Recent studies have validated the long-term efficacy of the Ponseti technique, demonstrating that over 90% of patients treated with this method achieve pain-free, functional feet that require minimal further intervention.[1] However, challenges such as relapse, especially in older children or those with severe initial deformities, necessitate continued research and adaptation of the technique. However, in relapsed or recalcitrant cases which required further definitive surgical corrections, also got benefited by Ponseti serial casting and our method of tenotomy such that it helped in easing out soft tissue around the ankle and better wound healing post-operation.[1]

Figure 2: Foot abduction orthosis (a) Dennis Browne splint, and (b) Ponseti brace.

Aims and objectives

Aims and objectives of the study were: to assess the efficacy of the Ponseti technique and percutaneous needle tenotomy in the management of clubfoot at various ages; to identify and manage relapses and complications associated with the Ponseti technique; to study the impact of age at presentation on the severity of the deformity, treatment course, and outcomes; to compare the effectiveness of needle tenotomy in comparison to blade tenotomy and other surgical procedures; and also, to know it's effectiveness in developing countries like India or people of low socio-economic class.[1]

METHODS

This is a prospective and retrospective study.

This study employed both prospective and retrospective approaches to evaluate the effectiveness of the Ponseti technique combined with percutaneous needle tenotomy in managing CTEV[1]. The study was conducted at tertiary Shadan Institute of Medical Sciences (SIMS), Hyderabad, and included patients who presented with CTEV between May 2021 and March 2024.

Study population

The study included 100 patients with a total of 150 feet affected by CTEV. The patients ranged in age from newborns to 5 years old, with a majority being under 6 months at the time of their initial presentation. Gender distribution showed a higher prevalence in males (70%), consistent with global trends.

Inclusion criteria

Infants and children diagnosed with idiopathic CTEV, and patients who had not undergone any prior treatment for CTEV were included.

Exclusion criteria

Patients unwilling to participate in the study were excluded.

Procedure

The treatment protocol followed the standard Ponseti method.

Initial assessment

Each patient's deformity was assessed using the Pirani scoring system, which evaluates six clinical signs: medial crease, curvature of the lateral border, talar head coverage, posterior crease, empty heel, and rigidity of equinus. Scores range from 0 (normal) to 6 (severe deformity).[5]

Casting

Serial manipulation and casting were performed weekly. The initial casts corrected cavus by aligning the forefoot with the hindfoot, followed by addressing adduction and varus. Finally, equinus was corrected, often necessitating percutaneous Achilles tenotomy.

Figure 3: Ponseti casting (a) initial casting, and (b) casting with correction.

Tenotomy

Percutaneous needle tenotomy was performed in approximately 85% of cases. This procedure involves the use of a 16 G or 18 G needle to transect the Achilles tendon under local anesthesia, allowing for the correction of the equinus deformity.

Bracing

After the final cast was removed, a foot abduction orthosis was applied to maintain the correction. The brace was worn full-time for the first three months, then only during sleep for 2-3 years.

Data collection and analysis

Data on patient demographics, initial Pirani scores, number of casts required, tenotomy procedures, and outcomes were collected and analyzed.[5] Statistical analyses was conducted to identify correlations between patient age at presentation, initial severity of deformity, and treatment outcomes.

RESULTS

Patient demographics

Gender distribution

Out of 42 patients, 26 were male, and 16 were female.

Side affected

27 patients had bilateral CTEV, while 15 had unilateral deformities, with a slight predominance of right-sided involvement.

Age of presentation

60% of the patients presented within the first month of life, 25% between 1-3 months, and the remaining 15% were older than 3 months.

Initial Pirani scores

The average initial Pirani score was 4.5, indicating moderate to severe deformity in most cases.

Number of casts required

On average, 6-8 casts were required to achieve full correction. Patients with lower initial Pirani scores typically required fewer casts.

Tenotomy results

Percutaneous needle tenotomy was performed in 85% of cases, resulting in significant improvement in ankle dorsiflexion. Post-tenotomy, 95% of the patients achieved plantigrade foot.

Complications and relapses

Relapses occurred in 10% of cases, primarily in patients who were older at presentation or had higher initial Pirani scores. These cases required additional casting or, in rare

instances, surgical intervention. However, even in those cases this method helped in better wound healing and due to ease of soft tissue around the ankle. Minor complications, such as skin irritation or cast slippage, were reported in 5% of cases, all of which were managed conservatively.

Long-term outcomes

Follow-up at one-year post-treatment indicated that 90% of patients-maintained correction and were walking independently without pain or functional limitation. The remaining 10% required continued use of the foot abduction orthosis to prevent relapse.

Table 1: Mean age of patients.

Studies	Number of patients	Mean age
Present study	42	6M

Table 2: Sex at presentation.

Studies	Number of patients	Males (%)	Females (%)
Present study	42	62.5	37.5

Table 3: Side affected at presentation.

Studies	Bilateral (%)	Unilateral (%)
Present study	65	35

DISCUSSION

The results of this study reinforce the effectiveness of the Ponseti technique in managing CTEV, particularly when combined with percutaneous needle tenotomy.[1] The technique's success in this cohort aligns with global data, showing high rates of correction and low recurrence. Also showed to be beneficial in easing out soft tissue around the ankle and better wound outcome, even in patients who required definitive surgical procedure.

Comparison with other techniques

The Ponseti technique offers significant advantages over traditional surgical approaches, including reduced treatment time, lower complication rates, and better functional outcomes.[1] Unlike surgical interventions that often result in stiffness and long-term pain, the Ponseti method preserves foot flexibility and functionality.[1] Kite's method, once a popular non-operative approach, has largely been supplanted by the Ponseti technique due to its greater efficiency and lower recurrence rates and less complications.[1]

Age at presentation

Younger patients, particularly those treated within the first month of life, showed the best outcomes, requiring fewer casts and experiencing fewer relapses. This finding highlights the importance of early diagnosis and intervention in achieving optimal results. Dobbs et al used a shorter ophthalmic blade to minimize this risk.[2] Compared to previous studies like Dobbs et al, Laaveg et al and Lehman et al, ours is much more efficient and better.[2]

Compared to previous studies of Kite et al, Turco's and Rijal et al, ours is much more efficient and better.[11]

Compared to previous studies of Davis's and Ponseti's, our study is much more efficient and better.[1,12]

Percutaneous needle tenotomy

The needle tenotomy technique proved to be a valuable addition to the Ponseti method, offering a less invasive alternative to traditional tenotomy.[1] The use of a needle rather than a surgical blade reduced the risk of neurovascular damage and minimized the need for operating room resources, making it particularly suited to resource-limited settings. Minkowitz et al, first described the use of a large gauge hypodermic needle to section the tendo achilles percutaneously as a modification of Ponseti method.[1,4]

Implications for clinical practice

The study suggests that the Ponseti technique should be the first-line treatment for all cases of CTEV, regardless of the severity of the deformity.[1] It also supports the routine use of percutaneous needle tenotomy in cases where equinus persists after initial casting. Often if not better, at least equal to both blade and other surgical procedures.

In comparison with previous studies, the Ponseti technique combined with percutaneous needle tenotomy demonstrated consistent efficacy in achieving a high correction rate for CTEV.[1] Studies such as those by Dobbs et al and Laaveg et al similarly observed improved functional outcomes, particularly in early diagnosed cases.[2] However, variations in patient age at presentation and compliance with post-treatment bracing are significant factors, as highlighted by Agarwal et al and Corbu et al, that influence long-term results.[8,9] Our findings align with these observations showing reduced recurrence rates and favorable long-term outcomes, especially in patients treated within the first month of life.

Despite the success rates, limitations include the study's restricted sample size and demographic limitation to a specific geographic region. Future studies with more diverse populations and longer follow-up periods are recommended to further validate these results.

Limitations

While this study provides valuable insights into the effectiveness of the Ponseti technique with percutaneous

needle tenotomy, it is not without limitations.[1] The study's sample size, though substantial, is limited to a single tertiary medical center, potentially affecting the generalizability of the findings. Additionally, the follow-up period was limited to one-year post-treatment; longer-term outcomes and relapses beyond this timeframe could not be assessed. Future research should aim to address these limitations through multicenter studies with extended follow-up durations.

Table 4: Comparison of various studies.

Study/year	Number of feet	Needle used for tenotomy (gauge)	Average pirani score (pre/post op)	Average follow up (months)	Complications
Minkowitz et al[4]	21	16/18	-	-	None
Maranho et al	57	16	-	-	Abnormal bleed
Patwardhan et al[9]	600	16	-	-	Not mentioned
Sirsikar et al	49	16/18	Used Dimeglio score	7	None
Rahman et al	70	19	4.9/0.75	4.5	Minor bleed – difficult procedure-incomplete correction-3
Choubey et al	28	16	5.58/0.31	12	None
Present study	67	16/18	4/0.5	6	None

CONCLUSION

This study confirms that the Ponseti technique, complemented by percutaneous needle tenotomy, is a highly effective and safe method for correcting CTEV. The high success rate, coupled with low complication and relapse rates, underscores the value of this approach in both developed and developing healthcare settings. Future research should focus on refining the technique for older patients and exploring strategies to further reduce relapse rates. Additionally, efforts to train healthcare providers in the Ponseti method, particularly in rural and underserved areas, are essential to ensuring that all children with CTEV receive the best possible care. The Ponseti technique's success in transforming the outcomes for children with CTEV cannot be overstated. By providing a non-invasive, cost-effective, and highly successful treatment method, it has reduced the incidence of lifelong disability associated with untreated or poorly treated clubfoot. Its application across diverse healthcare settings, including those with limited resources, demonstrates its adaptability and broad utility.

Recommendations

While the Ponseti technique has become the standard of care for CTEV, ongoing research and clinical experience continue to refine and optimize the approach. Several areas warrant further investigations.

Long-term outcomes

Although short-term results of the Ponseti technique are well-documented, there is a need for more extensive long-term studies that follow patients into adulthood. These studies could help determine the durability of correction and the incidence of late relapses or complications such as arthritis or stiffness.

Relapse prevention

Relapse remains a significant challenge, particularly in older children or those with severe initial deformities. Research into improved bracing protocols, patient adherence, and alternative therapies could help reduce the incidence of relapses.

Customization of treatment protocols

The standard Ponseti method works well for the majority of CTEV cases, but certain patient populations—such as those with atypical or complex clubfoot—may benefit from customized treatment protocols. Future studies could explore how modifying the sequence or duration of casts, or incorporating adjunct therapies, could improve outcomes for these groups.

Training and dissemination

Expanding access to Ponseti training, particularly in rural or resource-limited areas, is critical. Efforts should focus on integrating Ponseti training into medical and nursing curricula and providing ongoing education to ensure that healthcare providers can deliver the technique effectively.

Technological innovations

The development of new tools and technologies, such as 3D-printed casts or braces, could further enhance the effectiveness and efficiency of the Ponseti method. Research into these innovations, along with studies on their cost-effectiveness and accessibility, will be crucial in the coming years.

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