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Original Article

Outcomes of clubfoot conservative treatment using the Ponseti technique in an academic hospital in Saudi Arabia

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ABSTRACT

Objectives: Congenital talipes equinovarus (CTEV), commonly known as clubfoot, affects 1–4/1000 births, predominantly males. Without intervention, children face mobility limitations and deformities. Conservative treatment, particularly the Ponseti technique, which boasts a success rate exceeding 90%, is favored despite potential complications.

Methods: This study aimed to assess the efficacy of the Ponseti technique through a retrospective analysis of idiopathic CTEV cases. Data on pre- and post-treatment Pirani scores were analyzed across variables including age, sex, number of casts, Achilles tenotomy, surgical intervention, and complications. Participants were categorized based on treatment outcomes to identify contributing factors.

Results: Among 42 participants (69 feet), 62% were male, presenting at an average age of 9 weeks and receiving an average of 5.26 casts per patient. Pre-treatment Pirani scores averaged 4.52, significantly decreasing to 0.88 post-treatment. Feet managed without surgery demonstrated greater improvement in Pirani scores (mean change 3.888) compared to those requiring surgery (mean change 2.364), a statistically significant difference ($P < 0.001$). Acceptable outcomes were observed in 84.06% of feet. Percutaneous Achilles tenotomy was performed in 84% of cases. Surgical intervention was necessary in 15.94% of feet. Casting complications occurred in 14.49% of feet.

Conclusion: This study confirms the Ponseti technique's effectiveness in managing idiopathic CTEV, emphasizing early detection and initiation of conservative treatment. The early findings establish the Ponseti technique as the preferred initial approach for CTEV management.

Keywords: Casts, Clubfoot, Congenital talipes equinovarus, Conservative treatment, Saudi Arabia

INTRODUCTION

Congenital clubfoot, or congenital talipes equinovarus (CTEV), is a prevalent complex congenital malformation among pediatric patients.[1] Clubfoot occurs with a prevalence of 1–4 cases/1000 births, with males constituting two-thirds of the overall cases.[1] While idiopathic cases

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predominate, secondary clubfeet can also occur as a result of pre-existing neuromuscular disorders such as spina bifida and cerebral palsy. Similarly, congenital disorders such as amniotic band syndrome and arthrogryposis have been linked to secondary clubfeet.[2] CTEV development is influenced by environmental, chromosomal, and genetic factors, although the exact cause remains unknown.[3] Dislocation of the talus bone, abnormalities in the calf and peroneus muscles, contractions of soft tissues on the medial aspect of the foot, and subluxation of the talocalcaneonavicular joint are all potential causes of clubfoot structural deformity.[4] Atrophic calf muscles, cavus and forefoot adduction, hindfoot varus, and ankle equinus are the defining characteristics of CTEV.[5] Children will endure daily hardships in terms of mobility, gait pattern, and persistent foot deformity without foot treatment.[6]

Clubfoot initiation occurs in the initial trimester; however, it is feasible to identify it at an early stage through prenatal ultrasound examinations.[7]

CTEV is proposed to be treated surgically and conservatively.[8] However, surgical intervention has limitations as a primary management strategy due to the occurrence of post-surgical complications.[9] The majority of orthopedic surgeons today prefer conservative over surgical treatment.[10] Preventing pain and restoring foot function without impeding mobility is the principal objective of conservative treatment.[8] The Ponseti technique, which has over a 90% success rate, is regarded as the gold standard of initial conservative management for CTEV.[8] Despite encouraging results from clinical trials, it is not without possible complications and the likelihood of recurrence or relapse ranges from 11% to 40%.[11] This is mostly due to a lack of compliance with using the brace.[12] Even though casting and manipulation are the most effective management methods, studies have identified complications that must be considered.[8] The objective of the present study was to assess the efficacy of the Ponseti technique and to evaluate its early outcomes in the context of conservative clubfoot management at the authors' institute.

MATERIALS AND METHODS

After receiving approval from the Institutional Review Board, a retrospective study was conducted at King Saud University Medical City. The patients' demographic, clinical, and radiological information was gathered from their medical records.

The study included all patients with idiopathic CTEV who started their treatment using the Ponseti technique between January 2016 and January 2020. Patients with secondary clubfoot, incomplete data, or missed during follow-up were excluded from the study.

All patients in the study were treated according to the authors' institute protocol for idiopathic CTEV which is based on the Ponseti technique. The protocol involves initiating the process as soon as feasible after birth by employing a series of weekly gentle manipulations followed by serial casting for 4–6 weeks or until a full correction is achieved. If the equinus persists before the final cast, percutaneous Achilles tendon tenotomy should be performed to rectify the deformity. After correction, a full-time Dennis Brown splint should be worn for at least 12 weeks with 70° external rotation for the affected foot and 40° for the non-affected foot. This will be followed using a nighttime Dennis Brown splint until the age of 4 years. An ankle-foot orthosis and special boots are used afterward to avoid recurrence in some cases. Surgical correction was considered for those with residual deformity or recurrent cases. All patients underwent a follow-up period of at least 4 years after starting the treatment regimen. After applying the Dennis Brown splint, patients were reviewed every 6 weeks. When the use of the splint is reduced to at nighttime, the patients undergo regular reviews every 3 months for 1–2 years, followed by semiannual reviews. The follow-up protocol was modified as necessary, particularly in the presence of residual deformity or if recurrence has occurred.

Data collection was conducted retrospectively, and pre- and post-treatment Pirani scores were registered. The changes in Pirani scores were then compared across multiple variables, including age at presentation, sex, number of casts, tenotomy, presence of surgical intervention, and occurrence of serial casting complications, to identify factors contributing to the significant changes in the Pirani scores.

The study subjects were then categorized into two groups based on their outcomes: Acceptable and non-acceptable. Non-acceptable outcomes were referred to those feet that have residual deformity, recurrence of any component of the original deformity, stiffness that affects gait or walking, persistent pain, or surgical intervention. The two groups were then compared with all variables including changes in Pirani scores to assess factors affecting the final outcome.

The data were analyzed using the Statistical Package for the Social Sciences 24.0 (IBM Inc., Chicago, IL) statistical software. Descriptive statistics were reported, such as means with standard deviations (SDs) for continuous variables and frequencies with percentages for categorical variables. Comparative analyses were conducted using the Student's *t*-test for independent samples for continuous variables, while the Chi-square test was employed to compare categorical variables.

RESULTS

Among the 42 eligible participants (69 feet) in this study, the majority were male (62%), with a mean age of presentation at

approximately 9 weeks (SD = 11.80) and an average of 5.26 casts per patient (SD = 1.28). Casting-related complications were observed in 14.49% of affected feet (n = 10). Percutaneous Achilles tenotomy was performed on 84% of the deformed feet (n = 58). Various surgical correction methods were implemented in 15.94% of the deformed feet (n = 11) due to failure of correction with the Ponseti technique, with some feet requiring more than one surgical procedure. Specifically, wedge osteotomy, open elongation of tendo Achilles (ETA), and tendon transfer were performed concurrently in 7.25% (n = 5) of feet, and posteromedial release, including ETA in 8.70% (n = 6) of feet. Furthermore, the pre-treatment Pirani scores averaged 4.52 (SD = 0.96), compared to the post-treatment scores, averaging 0.88 (SD = 1.21) [Table 1].

Several sets of variables were assessed concerning the change in the Pirani score. Notably, feet that did not undergo surgical correction exhibited a greater change in the Pirani score compared to those after a surgical correction, with mean scores of 3.888 and 2.364, respectively. The difference was statistically significant (P < 0.001). In addition, earlier presentations were associated with a higher change in mean scores, but the association was insignificant. Other assessed variables, including the number of casts, sex distribution, tenotomy, and complications of serial casting, had an insignificant association with the change in Pirani scores [Table 2].

Regarding the final outcome of the present study, 84.06% of the feet were deemed acceptable. The acceptable group showed a significant change in the Pirani score (3.88, SD = 0.81) compared to the non-acceptable group (2.36, SD = 0.71). On the other hand, the relationship between the outcome and other variables was insignificant [Table 3].

Table 1: Demographics.

	Mean or frequency	% or SD
Age at presentation (week)	9.34	11.80
Number of casts	5.26	1.28
Sex		
Male	27	64.29%
Female	15	35.71%
Percutaneous Achilles tenotomy	58	84.06%
Correction		
Full	58	84.06%
Residual	11	15.94%
Complications of serial casting	10	14.49%
Pre-treatment Pirani score	4.52	0.96
Post-treatment Pirani score	0.88	1.21
Change in Pirani score	3.64	0.97
Underwent surgical correction	11	15.94%
Wedge osteotomy, ETA, and tendon transfer	5	7.25%
Posteromedial release	6	8.70%

ETA: Elongation of tendo Achilles, SD: Standard deviation

DISCUSSION

This study reveals that most patients with idiopathic CTEV presented within the first 3 months of life, which is expected for this easily detectable deformity. However, this figure is lower than that of other similar studies.[13,14] This finding suggests an effective screening and referral system coupled with heightened parental awareness.

The higher incidence of male affection that was observed in the present study (male-to-female ratio, 1.8:1) is comparable

Table 2: Change in pre- and post-treatment Pirani scores (No. of feet=69).

Category	Mean score change	*P*-value
Age at presentation (weeks)		
>10	3.188	0.156
≤10	3.705	
Number of casts		
>5	3.609	0.779
≤5	3.676	
Sex		
Male	3.685	0.632
Female	3.565	
Percutaneous Achilles tenotomy		
Done	3.638	0.891
Not done	3.682	
Surgery		
Done	2.364	<0.001
Not done	3.888	
Complications of serial casting		
Occurred	3.7	0.847
Not Occurred	3.64	

Table 3: Association between the variables and the final outcome (No. of feet=69).

	Acceptable *n*=58	Non-acceptable *n*=11	*P*-value
Age at presentation (weeks)	8.57 (11.23)	13.39 (14.32)	0.216
No. of casts	5.31 (1.25)	5.00 (1.48)	0.465
Sex			
Male	38 (65.52%)	8 (72.73%)	0.642
Female	20 (34.48%)	3 (27.27%)	
Change in Pirani score	3.88 (0.81)	2.36 (0.71)	<0.001
Percutaneous Achilles tenotomy	50 (72.46%)	8 (72.73%)	0.263
Complications of serial casting	9 (13.04%)	1 (9.09%)	0.579

Results presented as mean or n (%).

to most previous similar studies that show a higher prevalence of idiopathic clubfoot in males (male-to-female ratio, 2.5:1–1.4:1). This observation has no definite explanation, despite some suggested but not confirmed theories.[14-18]

The average number of casts required for full correction in the present study was 5, which is consistent with multiple studies suggesting that the mean number of casts required in idiopathic CTEV ranges from around 4 to 7.[19-22]

The mean initial Pirani score in idiopathic CTEV in various studies ranges from 3.3 to 5.5,[19,20,23] which is consistent with the mean initial Pirani score reported in the present study. However, the final mean Pirani score recorded in the present study was slightly higher than in other studies. Jain *et al*. reported a mean Pirani score of 0.16 for the right foot post-treatment and 0.3 for the left foot post-treatment, and they reported that the difference was statistically significant.[24] In addition, Faizan *et al*. in their study, reported a mean post-correction total Pirani score of 0.55, and they indicated a significant improvement in the deformity after treatment.[25] Nevertheless, the difference between pre- and post-treatment Pirani scores for the present study is comparable to most of the previous studies.

Percutaneous Achilles tenotomy was needed before applying the final cast to 84% of the affected feet. The need for percutaneous tenotomy in the present study is slightly lower but comparable to previous studies.[26,27] Incomplete tenotomy was the cause of repeating the procedure. This situation was considered a resolvable treatment error rather than a failure of the technique.

This study demonstrates that using the Ponseti technique for conservative treatment of idiopathic CTEV is superior to any surgical correction. The patients who were treated using the Ponseti method had significantly greater improvement in Pirani scores compared to those who underwent any surgical procedure. Many previous studies support this finding.[28,29] Although most reports showed that non-operative Ponseti treatment of idiopathic CTEV can maintain the correction of the deformity in most cases. A systematic review reported a relapse rate as high as 47% after using the Ponseti technique.[30] We do not have a similarly high percentage among our cases, possibly due to the short follow-up period in our study. However, we believe that patients treated with the Ponseti technique should be observed carefully for possible recurrence.

Limitations

This study has certain limitations. First, it is retrospective, and the relatively small number of patients included is a limitation. Another limitation is the lack of measurement of patient and parent compliance with the treatment, particularly regarding brace usage, as well as the parent's educational level. It is well documented that these two factors affect the outcome of idiopathic CTEV, which is treated by the Ponseti technique.[31,32]

CONCLUSION

This study contributes additional evidence to the growing body of literature supporting the efficacy of the Ponseti technique in managing idiopathic CTEV. By confirming the existing knowledge on treatment outcomes and associated factors, our findings reinforce the importance of early detection of CTEV and the value of conservative treatment over surgical correction. Considering possible recurrence, post-treatment observation is highly recommended.

AUTHORS' CONTRIBUTIONS

KB contributed to conceptualization and validation. MZ contributed to investigation, validation, and manuscript writing. AKA contributed to data collection, data analysis, statistical analysis, and manuscript writing. SMB was involved in conceptualization and study design. FAA, KMA, and TMA were involved in data collection, manuscript preparation, and manuscript editing. All authors have critically reviewed and approved the final draft and are responsible for the manuscript's content and similarity index.

ETHICAL APPROVAL

The study was approved by the Institutional Review Board at the College of Medicine, King Saud University (Ref. No. E-22-7224) on November 01, 2022.

DECLARATION OF PARTICIPANT CONSENT

The authors certify that they have obtained all appropriate participant consent forms. In the form, the participants have given their consent for their images and other clinical information to be reported in the journal. The participants understand that their names and initials will not be published, and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY FOR MANUSCRIPT PREPARATION

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

CONFLICTS OF INTEREST

There are no conflicting relationships or activities.

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