



## A Study on the Effectiveness of Accelerated Ponseti Technique in the Management of CTEV

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### Abstract

**Introduction:** The study aimed to estimate the effectiveness of Accelerated Ponseti technique (twice weekly casting ) in the management of idiopathic congenital equinovarus in children aged less than two years thereby reducing the duration of treatment compared to Standard Ponseti method ( once weekly casting ).

**Materials And Methods:** We analyzed 26 patients (38 feet) treated with twice weekly casting at 3 or 4 days interval. All the cases were assessed using Pirani scoring system and Functional Ponseti score. Patients were followed up for a duration of 15 months.

**Results:** 3 out of initial 29 cases (10.3 %) were lost to follow-up and excluded from analysis. The mean age was 17.2±9.7 days. There were 9 female and 17 male patients. 12 patients had bilateral and 14 had unilateral deformity.. Average number of casts required excluding tenotomy cast was 5.4±1. Average duration from starting of manipulation till tenotomy or correction of equinus was 2.7±0.5 weeks. Initial Pirani score was 5.3±0.5 which reduced to mean score of 0.7±0.4 post treatment before tenotomy. Final Pirani score was 0.2±0.3. 33(86.84%) of feet required tendoachilles tenotomy. There were three relapses (7.89%) in 2 patients and got corrected by repeat Accelerated Ponseti technique. There was excellent and good outcome in 92.11% of feet. 94.89% cases were very satisfied or satisfied. None of the feet required tendon transfer or any other surgical procedure.

**Conclusion:** In developing countries the adoption of ‘accelerated casts’ can reduce the duration of treatment and help to improve compliance, leading to better outcomes.

**Keywords:** Accelerated Ponseti, CTEV, Functional Ponseti score, Pirani score.

### Introduction

Congenital talipes equinovarus (CTEV), also known as clubfoot, is characterised by excessively inward turned foot (equinovarus) and a high medial longitudinal arch(cavus). Its incidence is approximately one in every thousand live births. Untreated cases result in long-term disability, deformity and pain<sup>[1]</sup>. The goal of clubfoot management is to produce and maintain a functional, painless, plantigrade, mobile, callosity free, normal shoe able foot. Ponseti method of serial manipulation

and casting has claimed a success rate of about 95%. The standard Ponseti technique uses weekly plaster cast change. Many authors emphasized that shortening the cast interval can reduce the duration of treatment while being equally effective. This biweekly casting regime is referred to as Accelerated Ponseti technique. There are only a few studies on effectiveness of this technique in the Indian population. This study was undertaken to estimate the effectiveness and benefit of Accelerated Ponseti technique in the management of CTEV.

## Materials and Methods

This prospective observational study was conducted in Department of Orthopedics in R G Kar Medical College after taking ethical clearance and informed consent from child's parents. Manipulation and plaster were done by single person in this study on Tuesday and Friday of every week.

### Inclusion criteria:

1. CTEV diagnosed on clinical grounds since birth.
2. Age: since birth up to 2 years of age.
3. Unilateral or bilateral presentations

### Exclusion criteria:

1. CTEV due to causes other than idiopathic like neuromuscular disease, arthrogryposis.
2. Patients failing to follow-up for 15 months duration.

We had selected the sample size {number of feet} to be 42.

### Sample Size Calculation: $[(Z_{1-\alpha/2})^2 XSD^2]/D^2$

D is precision, for practical feasibility and administrative purpose the precision is taken 0.2 to calculate the sample size. Standard deviation of average value of Pirani score is 0.58<sup>[2]</sup>. Taking the

confidence interval 95% [  $(Z_{1-\alpha/2})$  value is 1.96 then  $(Z_{1-\alpha/2})^2$  approximates 4 thus sample size comes to be 38. Taking non response rate/loss to follow-up 10% the actual sample size comes to be 42. Simple random sampling was done.

### Study technique:

Clinical assessments included: the incidence of residual and relapsed deformities, passive range of movement (measured by goniometer), appearance, calf atrophy, foot size and complications. Functional assessments included: gait, functional limitation, shoe wear, pain and patient satisfaction i.e. patient's parents' satisfaction. The Ponseti scoring system<sup>[3]</sup> for functional results was used, with 100 points indicating a normal foot. This includes a maximum score of 30 points for amount of pain; of 20 points each for level of activity and patient satisfaction; and of 10 points each for motion of the ankle and foot, position of the heel during stance, and gait. For Satisfaction and Function category, data had been recorded from the patients' parents considering the patient as a minor. (Table 1) The results were graded as Excellent (90-100 points), Good (80-89 points), Fair (70-79 points) and Poor (less than 70 points)<sup>[3]</sup>. Poor and fair results were considered failures and needed further management for residual or recurrent deformity.

## Tables

**Table 1. Distribution of patients according to age group**

Age group(days)	No of patients	percentage
1-10	9	34.62%
11-20	6	23.08%
21-30	10	38.46%
31-40	1	3.85%
<b>Grand Total</b>	<b>26</b>	<b>100.00%</b>

**Table 2. Distribution of no. of casts required excluding post tenotomy cast**

No of casts	No of feet	percentage
4-5	25	65.79%
6-7	13	34.21%

**Grand Total                      38                      100.00%**

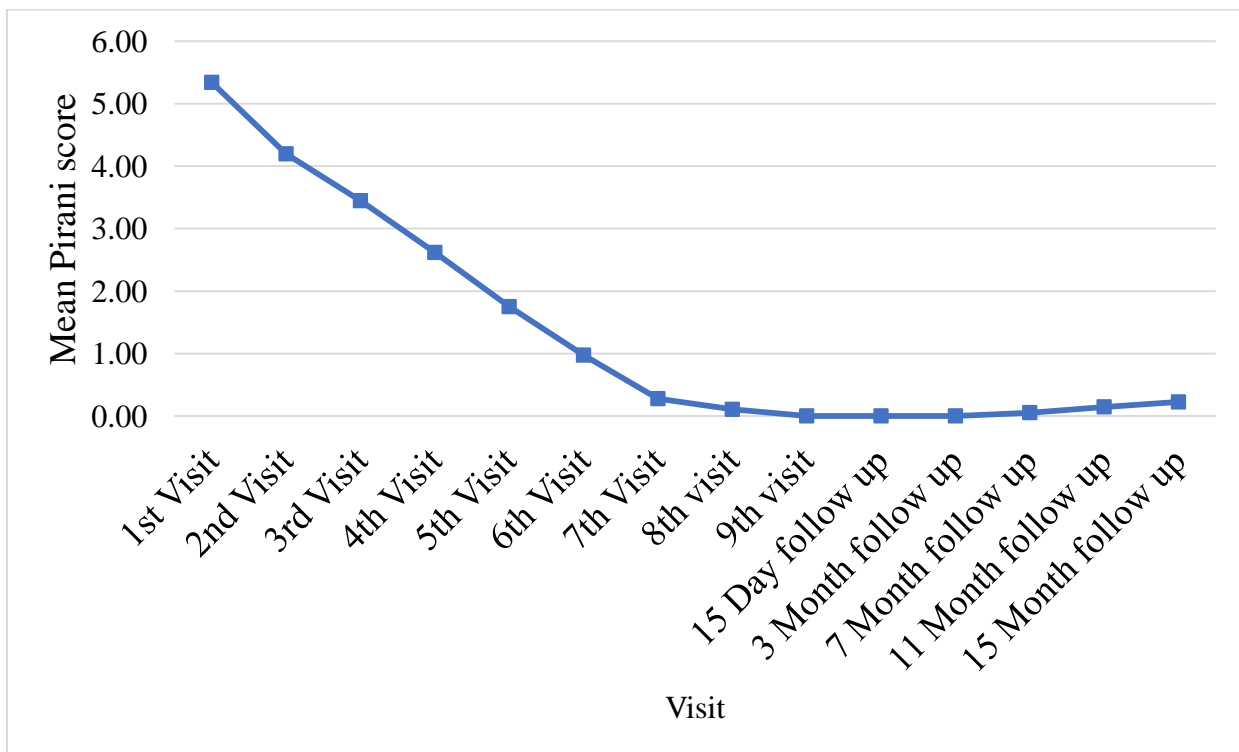
**Table 3. Distribution of feet according to duration taken from start of casting up to tenotomy or equinus correction without tenotomy in days**

<b>Duration from start of manipulation till tenotomy or correction of equinus without tenotomy (Days)</b>	<b>No of feet</b>	<b>percentage</b>
15-19	25	65.79%
20-25	13	34.21%
<b>Grand Total</b>	<b>38</b>	<b>100.00%</b>

**Table 4. Distribution of outcome according to functional Ponseti score among treated feet at final follow up**

<b>Outcome</b>	<b>No. of feet</b>	<b>Percentage</b>
<b>Excellent</b>	31	81.58%
<b>Good</b>	4	10.53%
<b>Fair</b>	2	5.26%
<b>Poor</b>	1	2.63%
<b>Grand Total</b>	<b>38</b>	<b>100.00%</b>

**Figure 1: Line chart showing trend of average Pirani score in the study population at follow up**



## Results

Initially we had selected sample size (number of feet) to be 84 in 58 cases but 6 cases (10.3%) were lost in follow-up. So we analyzed 52 patients (76 feet). The mean age of 52 patients was  $17.2 \pm 9.7$  days. (range 2-36 days). There were 18 female and 34 male patients. 24 patients had bilateral and 28 had unilateral (left=12, right=16) cases. Average number of casts required excluding tenotomy cast was  $5.4 \pm 1$  (Range 4 to 7). Average duration from start of manipulation till tenotomy or correction of equinus without tenotomy was  $2.7 \pm 0.5$  weeks (2-3.5) i.e.  $19.4 \pm 3.3$  days (15-25). Initial Pirani score was  $5.3 \pm 0.5$  (4-6) which reduced to mean score of  $0.7 \pm 0.4$ . (0.5 to 1.5) post treatment before tenotomy. Final Pirani score at last Follow-up was  $0.2 \pm 0.3$  (0-1). Number of casts was positively correlated with initial Pirani score. 66(86.84%) of feet required tendoachilles tenotomy. There were six relapses (7.89%) in 4 patients; two feet at 7 month and 4 feet at 11 months and those got corrected by repeat Accelerated Ponseti technique requiring 4 more casts. There was excellent and good outcome in 92.11% of feet as assessed with Functional Ponseti Score at 15 months. 94.89% cases were very satisfied or satisfied at last follow up. None of the feet required tendon transfer or any other surgical procedure.

## Discussion

Idiopathic clubfoot has been recognized as a difficult deformity to treat. [4] The Ponseti method has attained wide popularity in the last two decades and is currently accepted as the optimal treatment for congenital clubfoot deformity. [5,6] The Ponseti method requires serial corrective casts with long-term brace compliance for maintaining correction. [7] Pirani et al [8] found that abnormal shapes of the chondro-osseous structures are corrected by Ponseti method due to changes in mechanical loading of fast growing tissues.

The mean age of 52 patients was  $17.2 \pm 9.7$  days. In the study by Mageshwaran et al [9], mean age at presentation was 28.4 days in Standard group, and 28.1 days in Accelerated group. Our hospital is a tertiary care institute and most babies with same institutional deliveries were referred to us so that we can start treatment as early as possible.

In our study there were 18 female and 34 male patients. The ratio of M:F= 1.8:1. Sahu B et al [10] in 2015 had male to female ratio of 2.53 : 1. Turco et al [11] and Kite et al [12] also reported preponderance of male cases. The slight less male proportion might be due to hospital bias, and small number of cases.

Twenty four patients in our study had bilateral deformity and 28 patients had unilateral deformity (left=12, right=16). A study conducted by Sahu B et al [10], 27 patients (50.94%) had bilateral foot involvement and 26 patients (49.06%) had unilateral involvement (15 right sided and 11 left sided). Less proportion of bilateral cases might have been due to smaller sample size.

At initial visit, most of the feet had a score of 5-6. Most of the feet got corrected with 4-5 casts. In a multicentre study done by Bor et al [13] in 117 clubfeet treated by Standard Ponseti technique with 5 years follow up, the average number of casts was 6.3. Their initial mean Pirani score was  $4.8 \pm 1.3$ . Harnett et al in 2011 found that the initial median Pirani score was 5.5 in the Accelerated group and 5.0 in the Standard group. The scores decreased by an average 4.5 in the Accelerated group and 4.0 in the control group. There was no significant difference in the final Pirani score between the two groups. [14] Median number of casts in both Accelerated and Standard Ponseti technique were 5. In a study by Sahu B et al [10] in 2015, average initial Pirani score was 5.03 and 5.3 in Standard Ponseti group and Accelerated Ponseti group, respectively. The average final Pirani score was 0.2 and 0.25 in Standard Ponseti group and Accelerated Ponseti group, respectively. The average number of casts required for correction was 6.2 in Standard Ponseti group and 7.4. in Accelerated group, the difference was not statistically significant. In a comparative study done by Elgohary et al [15] in 2015, average initial Pirani score in Standard Ponseti technique was  $5.2 \pm 0.6$  and in Accelerated Ponseti group  $5.13 \pm 0.6$ . Average number of casts in Standard Ponseti group ( $4.8 \pm 0.8$ ) was not significantly different from Accelerated Ponseti. ( $5.2 \pm 0.7$ ). The minimum number of casts required was 4 and maximum 7 in both the groups. In a study by Barik S et al [16] in 2019, the average number of casts in standard and accelerated group was  $5.23 \pm 0.59$  and  $4.72 \pm 0.61$  ( $p < 0.01$ ). Mean Pirani score before tenotomy was  $1.71 \pm 0.66$  in the Standard Ponseti group compared to  $1.12 \pm 0.47$  in the Accelerated

Ponseti group. Pirani score showed a faster reduction in the accelerated group. In another study on Accelerated Ponseti technique by Ahmad MN et al<sup>[17]</sup> in 2019, average Pirani score before casting was 4.69 (3.5-6). Average Pirani score post-treatment was 0.48. The average number of casts applied was 5.14 (4-7) by Accelerated Ponseti technique. A one-way repeated measures ANOVA showed significant difference up to 9th visit ( $F(13,481) = 566.73, p < .001$ ). Most of the feet maintained correction at 15 months follow up. The average Pirani score at 15 months follow up was  $0.2 \pm 0.3$ . In the study by Harnett et al<sup>[14]</sup> average Pirani score at the end of treatment was 0.5 for both Accelerated and Standard Ponseti groups. In the study by Sahu et al<sup>[10]</sup> average final Pirani Score was 0.2 and 0.25 in Standard Ponseti group and Accelerated Ponseti group respectively. In a study by Elgohary et al<sup>[15]</sup> final Pirani score range from 0 to 1 in both standard and accelerated Ponseti groups with mean values of  $0.49 \pm 0.42$  and  $0.52 \pm 0.38$  respectively. ( $P=0.89$ ). The excellent reduction in score achieved in our study might be due to earlier age of starting the procedure which was less than most of the other studies.

In our study most of the feet had deformity corrected by 2-3 weeks. (15-19 days). Mean duration for casting before tenotomy or correction of equinus without tenotomy was  $2.7 \pm 0.5$  weeks, ( $19.4 \pm 3.3$  days). A study by Xu RJ et al<sup>[18]</sup> in 2011 noted all aspects of the deformity with the exception of the equinus were corrected in 2.94 weeks in the modified group and in 5.05 weeks in the regular group ( $P=0.0001$ ). Elgohary et al in 2015 found that the mean duration from start of correction till tenotomy or correction of equinus was  $4.77 \pm 0.96$  weeks (range 21-42 days) for Standard Ponseti group, and  $2.59 \pm 0.43$  weeks (range 11-22 days) for Accelerated Ponseti group.<sup>[15]</sup> In 2015, Sahu B et al noted the average duration of casting was 8.2 weeks for Standard Ponseti group, and the average duration of casting was 3.4 weeks for Accelerated Ponseti group.<sup>[10]</sup> A study by Ibraheem GH et al<sup>[19]</sup> in 2017 noted that the study showed a significantly shorter treatment period in the accelerated protocol (5.57 weeks) compared with the standard protocol (7.43 weeks); with no significant increase in the number of casts needed for treatment. In a study by Ahmad MN et al<sup>[17]</sup> in 2019, average time required for correction from onset of Ponseti cast till correction of equinus is

2.21 weeks (11–20 days) by Accelerated Ponseti technique. In a study by Barik S et al<sup>[16]</sup> in 2019, the average number of weeks required for correction of feet was  $7.77 \pm 1.10$  and  $4.84 \pm 1.29$  ( $p < 0.01$ ) respectively, for standard and accelerated groups.

Percutaneous tenotomy was done to correct equinus deformity in 66(86.84%) of feet out of 76 feet. In a study conducted by Morcuende et al in 2005, 92 out of 108 feet(85.19%) in modified group and 90 out of 111(81.08%) feet in regular group required percutaneous tenotomy.<sup>[20]</sup> A study by Xu RJ et al<sup>[18]</sup> in 2011 showed that percutaneous tendoachilles tenotomy was performed in 87.5% (35 of 40) of those in the modified group and 87.5% (28 of 32) of those in the regular group ( $P=0.47$ ). In a prospective analysis conducted by Sahu B et al<sup>[10]</sup> from January 2014 to December 2015 noted that about 31 out of 40 (77.5%) feet required tendoachilles tenotomy for equinus correction in standard group, whereas 33 (82.5%) out of 40 feet required tenotomy in accelerated group. In a comparative study by Sharma P et al<sup>[21]</sup> tenotomy rate was 77% and 74% in Standard and Accelerated Ponseti group respectively. Ahmad MN et al<sup>[17]</sup> in 2019 found that out of 57 feet, tenotomy was done to 53 feet (92.98%) by Accelerated Ponseti technique.

In the present study, no other surgical procedures other than tendoachilles tenotomy like tibialis anterior tendon transfer or posteromedial soft tissue release was required for any patient. In the study by Elgohary et al<sup>[15]</sup> additional surgical procedure was required in 9% of feet in both Standard and Accelerated Ponseti group. In a study by Sahu et al<sup>[10]</sup> only one patient (4%) in accelerated group required posteromedial soft tissue release and none in Standard group. A retrospective study published in 2009 by Bor et al<sup>[13]</sup> over 88 patients undergoing Standard Ponseti correction required additional surgical procedures over twenty-four (32%) babies other than tenotomy, including 21% who underwent tibialis anterior tendon transfer. In a multicenter study of 162 clubfeet followed for 2–5 years by Saetersdal et al<sup>[22]</sup> in 2002-2003 by undergoing Standard Ponseti correction noted that 3.7% had been operated on with more extensive surgery than tenotomy of the tendoachilles tendon. 1.9% were operated on with postero-medial release, 2 with posterior release, and 1 with transfer of the tibialis anterior tendon. In the study by Harnett et al<sup>[14]</sup> one

patient (5%) from Accelerated group, two (10%) from Standard Ponseti group required tibialis anterior transfer to achieve correction. Our study findings support the justification to start the correction procedure at an early age.

94.89% of our patients were very satisfied or satisfied at last follow up. Four feet with relapse were neither satisfied nor unsatisfied. 97.4% had no limitation of daily activities. 92.11% feet had no or occasional mild pain. 70 feet had no heel varus or had some valgus while standing. 92.11% feet had achieved almost normal range of motion. 86.8% patients had normal gait. None of the patients had limp. We had excellent and good outcome in 92.11% of feet, fair outcome in 4(5.26%) feet and poor outcome in 2(2.63%) foot. Long term results in 104 clubfeet by Laaveg and Ponseti<sup>[23]</sup> showed satisfactory results in 88.5% feet. 90% of patients were satisfied with the appearance and function of clubfoot following treatment with Standard Ponseti technique. The amount of motion in the joints of foot and ankle correlated with the degree of patient's satisfaction and the functional rating. In the study by Pavone et al<sup>[24]</sup> functional Ponseti scores were good/excellent in 96.3% patients (95.6% feet) following treated by Standard Ponseti technique. They found near normal passive range of motion in 98.78% of patients (98.25% feet). The parents of 98.78% patients accepted the appearance of the foot as normal. In a study by Bor et al<sup>[13]</sup> final dorsiflexion was adequate (5 degree or greater) in 89% feet and 89.2% achieved good to excellent outcome after Standard Ponseti technique. So Accelerated Ponseti technique has outcome comparable to Standard technique while decreasing the duration of treatment significantly.

We found significantly positive moderate correlation between number of casts and initial Pirani score. (Pearson coefficient=0.6,  $p < 0.001$ )

We had three relapses (7.89%). All three feet had no residual deformity after completion of casting and were prescribed Denis Browne splint. However at 7 month follow up recurrence of adductus and cavus deformity was seen in 1 foot and recurrence of equinus was seen in 2 feet at 11 months. After talking with the parents, we found that they were using Denis Browne splint infrequently. At 15 months follow up there was some residual deformity in those three relapsed feet. Elgohary et al<sup>[15]</sup> in their study had

relapse rate of 14.7 % in the Standard Ponseti group and 15.6 % in the Accelerated Ponseti group. Harnett et al<sup>[14]</sup> in their study found no relapse at 6 months follow up in both the groups. Sahu B et al<sup>[10]</sup> reported relapse in 9 out of 40 feet in Standard group (22.5%) and 13 out of 40 feet in Accelerated Ponseti group (32.5%) at follow up. In a study by Jayasomeswar et al<sup>[25]</sup> 6.78% of the patients (2 children) reported relapses after initial successful treatment. Relapses were treated with a second series of sequential manipulation and casting. Their findings agreed with our results. Dobbs et al<sup>[26]</sup> detected relapse in 31% feet and found noncompliance with orthotic use to be most strongly associated with increased risk of recurrence. (odds ratio =183). Parental education level was also a significant risk factor. Parental education level and economic condition was low in our relapse cases. The less relapse rate compared to other studies might be explained by earlier age of starting correction and better brace wearing compliance.

## Conclusion

The results of this study support accelerated frequency of cast changes in Ponseti technique. In developing countries where travelling to clinics necessitates time away from home, work, and family, the adoption of 'accelerated casts' can reduce the duration of treatment and help to improve compliance, leading to better outcomes.

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