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# Study of Outcomes of Ponseti Technique Using Pirani Scoring System in Children with Idiopathic Cub-Foot

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**ABSTRACT**

Club-foot is one of the most common congenital deformities affecting 1 infant in every 1000 births. There is nearly universal agreement that the initial treatment of the club foot should be non-operative regardless of the severity of the deformity. Present study was aimed to study outcomes of Ponseti technique using Pirani scoring system in children with idiopathic clubfoot. Present study was single-center, prospective, observational study, conducted in pediatric patients, under two years of age, newly diagnosed with idiopathic club foot of any grade, underwent Ponseti technique and Tendoachilles tenotomy. In present study, 28 patients with 36 affected feet were followed up throughout the study period. Male to female ratio was 1.8:1.0. Mean of total number of casts applied for 36 foot to completing the study was 7.97. The average number of total casts requirement increased according to age. The average number of total casts requirement increased according to Pirani severity scores. Tenotomy was done to 83.33% (30) feet and cast correction was done for 16.67% (6) feet (table 21, chart 10). The equinus of 0-6 month and 6-12 month age groups were corrected by both tenotomy and casting and not in the higher age group. Pirani severity score ranging 3.5-4.5 was the most common score among foot counting 24. Both the methods of equinus correction are almost equal in low scores but correction by cast decreases as the score increases. Ponseti method of clubfoot treatment gave excellent results, with low cost and with minimum surgical intervention (percutaneous tenotomy),that too if needed.

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**Key Words**
Ponseti method, clubfoot treatment, percutaneous tenotomy, cast

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## INTRODUCTION

Talipes Equinovarus is the commonest deformity of the foot. Clubfoot is one of the most common congenital deformities affecting 1 infant in every 1000 births. Worldwide approximately 1,00,000 new cases of clubfoot occur every year which if un-corrected leaves infant to face a life of disability[1]. Clubfoot is a birth defect where one or both feet are rotated inward and downward. The affected foot and leg may be smaller than the other. In about half of those affected, both feet are involved[2]. There is nearly universal agreement that the initial treatment of the club foot should be non-operative regardless of the severity of the deformity. If there is no improvement, then most of the surgeons prefer postero-medial release (PMR) of the soft tissue. The primary disadvantages of PMR are high complication and recurrence (13-50%) rate and the difficulty of treating recurrences[3].

Over the past two decades, more and more success has been achieved in correcting CTEV without the need for surgery by Ponseti casting technique, which has become a gold standard worldwide[4]. Present study was aimed to study outcomes of Ponseti technique using Pirani scoring system in children with idiopathic clubfoot.

## MATERIAL AND METHODS

Present study was single-center, prospective, observational study, conducted in department of orthopedic surgery, at Government Medical College, Miraj, Maharashtra, India. Study duration was of 2 years (January 2020 to December 2021). Study approval was obtained from institutional ethical committee.

**Inclusion criteria:**

- All pediatric patients, under two years of age, newly diagnosed with idiopathic club foot of any grade, underwent Ponseti technique and/or Tendoachilles tenotomy, parents willing to participate in present study

**Exclusion criteria:**

- Pediatric patients more than 2 years of age.
- Syndromic patient having CTEV
- Patients having resistant CTEV,
- Patients having neglected CTEV
- Patients of CTEV treated by other treatment modalities
- Patients having vertical talus
- Parents not willing to give written informed consent

Study was explained to parents in local language and written consent was taken for participation and study. The cases were confirmed to be idiopathic clubfoot and below the age of two years by ruling out any other congenital anomalies, like spinal abnormalities, Arthrogryposis multiplex congenita or history of exposure to radiation or any teratogenic drug intake during pregnancy. Parents were made to understand that they will be given 6-10 casts at weekly interval, tenotomy if indicated and they will have to use foot abduction brace till 3-4 years of age and then regular follow up till maturity. Patients were also made known about other methods of treatment.

Routine Blood investigations like complete blood test and renal function tests were done before tenotomy. Scoring of the foot was done prior to the first casting and then henceforth on every visit before applying cast and changes were documented.

**Manipulation and application of cast:**

- **First-cast correction of cavus:** To correct the pronated forefoot, thus aligning it with already supinated hind foot(fig 1)
- **Cast application:** After about 1 to 2 minutes of gentle manipulation, cotton soft rolls of 3 inches width were wrapped distally from toe to proximally towards the thigh, while the assistant held the head of first metatarsal. (Fig 2,3)
- **Moulding of casts:** It was done in accordance to the manipulation. Moulding was done over both malleoli, over the talar head, the medial arch and finally the heel
- **Extending the cast:** Cast was extended proximally upto the thigh keeping knee at 900 of flexion, with more plaster applied over anterior aspect of knee and less over popliteal fossa. (Fig 4)
- Cast Removal
- **Second to last cast to correct adduction and varus:** Manipulation was initiated within an hour of first or prior cast removal. The casting protocol is same as given earlier
- **Manipulation for correction of adductus:** (Fig 5, 6, 7)
- **Cast application:** Cast was applied (Fig 8,9,10,11) similarly distally from toe to proximally the knee and then extended to the thigh. Cast was moulded simultaneously as the manipulation was done, with exactly similar pressure points with fingers continuously moving to prevent the pressure sores.
- **Correction of equinus:** After a mean of 6.41 casts that were applied, sufficient abduction of 400-500 was attained. If at this stage if 00-50 degrees of dorsiflexion was also possible and tendo achilles was stretchable, then it was preferred to apply 2-3 more casts to attain a final dorsiflexion of 150-200 (Fig12, 13). Cast application for plantar flexion correction is done by holding back of heel just superior to the insertion of tendo-achilles and pulling it inferiorly and gently forcing the whole of

the sole dorsally simultaneously with whole of the palm of another hand (Fig 14). Tenotomy was done if, tendoachilles was not flexible and mobile, even after about 5-9 casts, provided, 00-50 of dorsiflexion was attained with an abduction of 400-500

- **Percutaneous tendoachilles tenotomy:** Ponseti recommends it to be done under local anaesthesia. Local anaesthesia was given by anaesthetist. Tendo achilles was felt and seen (bluishinlight skin). Scalpel blade 11 or #15 was used for incision from medial side of tendon. The point of insertion of blade is 1.5 cm above the attachment of tendo achilles on calcaneum tuberosity. A "POP or SNAP" sensation is felt after a successful tenotomy, which gives an extra 150 to 200 of dorsiflexion. Wound is dressed, without putting stiches most of the time. Single dose of intravenous antibiotic given prior to the procedure and started with oral analgesic syrup and antibiotic for 3 days. (Fig 15)
- **Last cast application:** It was applied after attaining 150-200 of dorsiflexion and 400-500 of abduction and decent varus correction. This cast was applied maintaining the foot in 400-500 of abduction and 150-200 of dorsiflexion for 21 days (Fig16). After removal of cast, the outcome is, a pain-free, flexible with good mobility and cosmetically acceptable foot (Fig 17)
- **Bracing:** After the removal of last cast, the abduction brace was applied. In this study, we used Denis Browne splint maintaining the heel at shoulder width apart with foot in abduction of 400-500 and dorsiflexion of 150-200. Knees are usually kept free (Fig 18). Brace was advised to be applied throughout whole day and night for next 3months. Then brace is applied only at night and for 2-4 hours in the midday till the age of 4 years. Regular follow up were done after application of Denis Browne splint which was on the 14th day, after about 3 months and after every 4 months till the age of 4 years, to check for relapse and wear and tear of the splint. At the age of 4 years, splint is to be removed, and patients are counseled to come every 6 months till maturity.

Data was collected and compiled using Microsoft Excel, analyzed using SPSS 23.0 version. Frequency, percentage, means and standard deviations (SD) was calculated for the continuous variables, while ratios and proportions were calculated for the categorical variables. Statistical analysis was done using descriptive statistics.

## RESULTS

In present study, 28 patients with 36 affected feet were followed up throughout the study period. The mean age at presentation was 5.2 month (156 days),

Fig. 1: Showing cavus deformity.

Fig. 2: Showing plaster of paris and cotton soft rolls.

Fig. 3: Steps of case application.

Fig. 4: First cast showing cavus and pronated forefoot correction.

Fig. 5: Adductus Deformity.

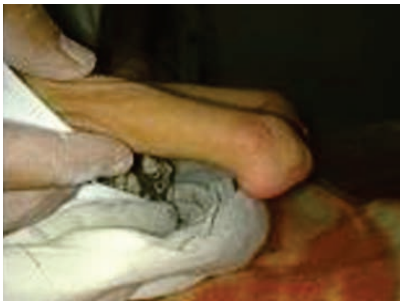

Fig. 6: Varus Deformity.

Fig. 7: Correcting adductus.

Fig. 8: Second case.

Fig. 9: Third cast.

Fig. 10: Fourth cast.

Fig. 11: Fifth cast.

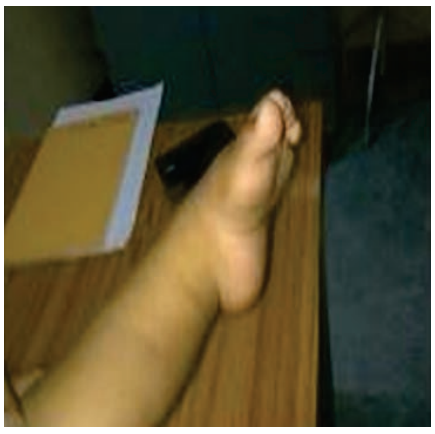

Fig. 12: Equinus Deformity.

Fig. 13: Abducted foot in 5 degree of dorsiflexion.

Fig. 14: Manipulation to correct the equinus by cast application.

Fig. 15: Percutaneous Tenotomy done. Entry of blade close to tendo achillis. 20 degrees of dorsiflexion achieved.

Fig. 16: Last cast.

Fig. 17: After treatment (after last cast).

Fig. 18: Denis Browne splint.

Fig. 19: Pressure sore over lateral aspect of talus.

Fig. 20: Eczema.

Fig. 21: Bruise over thigh.

Fig. 22: Loose and Broken cast.

Fig. 23: Blanching.

Table 1: General characteristics

| | No. of patients | Percentage |
|---|---|---|
| Age groups (in months) | | |
| 0-6 | 18 | 64.29 |
| 6-12 | 8 | 28.57 |
| 12-18 | 2 | 07.14 |
| 18-24 | 0 | 00.00 |
| Mean age (mean ± SD) | 5.06 ± 4.14 | |
| Gender | | |
| Male | 18 | 64.28 |
| Female | 10 | 35.72 |
| Side of involvement | | |
| Unilateral | | |
| Right | 12 | 42.86 |
| Left | 8 | 28.57 |
| Bilateral | 8 | 28.57 |

Table 2: Number of total casts in tenotomised foot

| Age | Average cast |
|---|---|
| 0-6 months | 7.36 |
| 6-12 months | 8.16 |
| 12-18 months | 10 |
| 18-24 months | --- |

Table 3: Number of total casts in non-tenotomised foot

| Pirani severity score | Average cast |
|---|---|
| = 1.5 | 7.54 |
| 2.0-3.0 | 8.21 |
| 3.5-4.5 | 10.8 |
| 5.0-6.0 | --- |

Table 4: Correlation between no. of casts and PSS before eq. Correction

| PSS | Average no. of cast |
|---|---|
| =1.5 | --- |
| 2.0-3.0 | 5.27 |
| 3.5-4.5 | 6.33 |
| 5.0-6.0 | 7.41 |

Table 5- Number of total casts in non-tenotomised foot

| Age in month | Average no. Of cast |
|---|---|
| =3 | 5.69 |
| >3-6 | 6.57 |
| >6-9 | 7 |
| >9-12 | 8 |
| >12-15 | 9 |

Table 6: Method of equinus correction in foot

| | No. of patients | Percentage |
|---|---|---|
| Tenotomy | 30 | 83.33% |
| Cast | 6 | 16.67% |

Table 7: Comparison of correction of equinus in the same age-group

| | By tenotomy | By cast |
|---|---|---|
| >0-6months | 21 | 4 |
| >6-12months | 7 | 2 |
| >12-18months | 2 | 0 |
| >18-24months | 0 | 0 |

Table 8: Pirani severity score

| PSS | No. of foot |
|---|---|
| =1.5 | 0 |
| 2.0-3.0 | 4 |
| 3.5-4.5 | 24 |
| 5.0-6.0 | 8 |

Table 9: Correlation between Pirani severity score and method of equinus correction

| Pirani severity score | Eq. correction method | |
|---|---|---|
| | Tenotomy | Cast |
| =1.5 | 0 | 0 |
| 2.0-3.0 | 2 (50 %) | 2 (50 %) |
| 3.5-4.5 | 20 (83.33 %) | 4 (16.67 %) |
| 5.0-6.0 | 8 (100 %) | 0 |

with range of 0.41-19 months (12-57 days) The most common age at presentation was between 0-6 months (64.29 %). There were total 18 male (64.28 %) and 10 female (35.72 %) patients. The male to female ratio was 1.8:1.0. There were 8 (28.57%) of bilateral and 20 (71.43%) unilateral cases. Among the unilateral cases there were 12 (42.86%) right and 8 (28.57%) left cases. Mean of total number of casts applied for 36 foot to completing the study was 7.97. The average number of total casts requirement increased according to age. The average number of total casts requirement increased according to Pirani severity scores.

Average number of casts applied before equinus correction was 6.41. No. of applications of cast is more for higher scores. According to flexibility of tendo

Table 10- Details of Pirani score-paired samples

| | | Mean±standard deviation | | Standard error of mean | | Range |
|---|---|---|---|---|---|---|
| Pair I | Before treatment | 4.147±0.713 | | 0.122 | | 2.5 |
| | After last cast | 0.147±0.231 | | 0.040 | | 0.5 |
| Pair II | Before treatment | 4.147±0.713 | | 0.122 | | 2.5 |
| | At follow up | 0.088±0.193 | | 0.033 | | 0.5 |
| Pair III | After last cast | 0.147±0.231 | | 0.040 | | 0.5 |
| | At follow up | 0.088±0.193 | | 0.033 | | 0.5 |
| Mean Pirani score | 99% Confidence interval of differences | T-value | | Degree of freedom | Significance (2-tailed) | |
| Pair I | 4.000 | 3.787 | 4.213 | 31.120 | 33 | <0.0005 |
| Pair II | 4.059 | | | 32.042 | 33 | <0.0005 |
| Pair III | 0.059 | | | 01.143 | 33 | 0.261 |

Table 11: Complications

| Complications | No. of patients | Percentage |
|---|---|---|
| Pressure sores | 6 | 21.42 |
| Slippage of cast | 6 | 21.42 |
| Bruise over thigh | 5 | 17.85 |
| Cast breakage | 3 | 10.71 |
| Overcrowding of toes | 2 | 07.14 |
| Flat heel pad | 2 | 07.14 |
| Blanching of toes | 2 | 07.14 |
| Skin blisters | 2 | 07.14 |
| Eczema | 1 | 03.57 |

achilles, plantar flexion was corrected by application of cast or by tenotomy. The mean age at presentation of patient was 5 months and the mean of number of casts was 6.41. The mean of number of casts applied to the age group =3 month was 5.69 and the same for >12-15 month group was increased to 9. Plantar flexion was corrected by cast or tendo-achilles tenotomy. Out of 36 feet, tenotomy was done to 83.33% (30) feet and cast correction was done for 16.67% (6) feet (table21, chart10). The equinus of 0-6 month and 6-12 month age groups were corrected by both tenotomy and casting and not in the higher age group. Pirani severity score ranging 3.5-4.5 was the most common score among foot counting 24.

Both the methods of equinus correction are almost equal in low scores but correction by cast decreases as the score increases. The mean initial Pirani score of the patients with 36 feet before starting treatment was 4.147. The mean Pirani score measured after full correction, that is after last cast is 0.147 and during follow-up at 6 month was 0.088. The difference in the Pirani scores for Pair I (before treatment and after last cast) was 4.000. Similarly, for Pair II (before treatment and at follow-up at 6 month) was 4.059. Both of these pairs, considering mean standard deviations and Degree of freedom, have a significance (2 tailed p<0.0005 and this is considered to be highly significant). For the third pair, the p-value was not found to be significant.

The complications of pressure sores, skin blisters were all managed by not applying cast for 1 week or less. Bruise and eczema were managed conservatively with lotions only. For the complication of cast-breakage, were enforced and re-applied the cast. For overcrowding of toes, we did cast trimming and found it to be of satisfactory help. We found that the most common cast related complication was a pressure sore usually of grade 1 and cast slippage.

## DISCUSSIONS

The Ponseti casting technique of clubfoot management has been shown to be effective, producing better results and fewer complications than traditional surgical methods. It includes serial corrective manipulation, a specific technique of the serial application of plaster cast supported by limited operative intervention. The method has been reported to have success rate approaching 90-96 % in short, mid and long-term results[4].

In this study, the most common age group for presentation was 0-6 months (64.29 %). The ratio of male to female was 1.8:1. This resembles the male to female ratio that was found in David A. Spiegel *et al*.,[5] But, the ratio in different studies varies[2,6]. In this study, patients with unilateral right-side clubfoot (42.86%) were commoner, more than the bilaterally (28.57%) affected patients. In general, other studies illustrates bilateral patients to be commoner than ours, as in Agrawal *et al*.[7]with 40%, Ankur *et al*.[2] with 37.66%. The total number of casts given were at an average of 7.97 in this study. Average number of casts applied before plantar flexion correction was 6.41. The number of cast application rose as the Pirani severity score of foot rises. The minimum number of casts in our study to correct adduction and varus was 5 and the maximum required was about[9]. Age and Pirani severity score for the patient who needed just 5 casts were in the range of 0.5-8 months of age and 3-4.5 score respectively. Similarly for 9 cast are 14 months of age and 4.5 score respectively. Thus, we can say that the number of casts depends on dual factors that is the age of presentation and mean Pirani severity score at presentation.

Similar conclusion was also put forth by Agrawal *et al*.[7] The number of cast rises by the rise of Pirani severity score. Thus, the number of casts applied ranged from 5-9 in our study and the same can be said for Ankur Gupta *et al*.[2] study, whose range was from 3-10 and in study of Ponseti *et al*.[7] where it is 5-10. Our average number of cast application w2as 7.97, comparatively more than that of Rebecca Kampa

*et al*.[8] and Ankur *et al*.[2] study. We utilized 2 methods for attaining equinus correction, namely by POP cast application and by Percutaneous Tendo-achilles tenotomy. We discovered, that earlier the age at presentation, less will be the requirement of number of cast application, provided Pirani score is not on the higher side initially.

There was no visible difference in proportion of tenotomy and cast application separately amongst male and female, for equinus correction. We can see, out of 30 tenotomised foot, 20 (66.66%) were male and 10 (33.33%) were female. Among cast applied patients, 4 (66.66%) were male and 2 (33.33%) were female for correction of equinus. The tenotomy required by Ankur *et al*.[2] was of the order of 95%. Pirani *et al*.[7] had a 90% tenotomy rate and Dobbs *et al*.[8] did it at a rate of 91%. So, our rate of requirement of tenotomy is around 83.33%.

For the correction of plantar flexion, maximum cast application was done in 0-6 months and 6-12 month age group. Almost all of the feet in our study were in the range of 3.5-4.5, according to Pirani severity score. We discovered that the frequency of tenotomy rises as the Pirani severity score of foot rises. 80.55% (29 feet) at follow up had no residual deformity and fully corrected. The Pirani score for the residual deformity was primarily the adductus deformity with maximum of 0.5 in Pirani severity score. The score of 0.5 in 6 foot is statistically insignificant. Ankur *et al*.[2] successful correction with no residual deformity in 6 month's worth of follow up. Successful early correction in Ashish *et al*.[3] study was around 95%. Recent study of Segev *et al*.[3] with 94% shows excellent results. Ponseti *et al*.[7] had a rate of 71% good results.

The final outcome after the last cast was seen to be statistically highly significant. The significance of treatment from presentation to last cast, and presentation to follow up, the p-value of significance was calculated and found to be <0.0005. Thus, there was a substantial decrease in the Pirani severity score, showing high efficiency of Ponseti method of correction of clubfoot. The transformation in mean Pirani severity score after management and at follow up was found to be insignificant according to p-value. Clinically, the feet were pain-free, flexible, mobile and cosmetically satisfactory.

In this study, we discovered that the baby was uncooperative during cast application, and tend to move their limbs. Tenotomy was done under local anaesthesia. We preferred to give oral antibiotics and analgesic syrups after tenotomy. There was no infection that was found in any patient over the surgical site. Ponseti casting technique is especially important in developing countries, where operative facilities are not available in the remote areas. The physicians and personnel trained in this technique can manage them effectively with the cast treatment only[4].

## CONCLUSION

The number of casts applied in Ponseti method, rose with the rise in age at presentation and higher Pirani severity score at presentation. Ponseti method of clubfoot treatment gave excellent results, with low cost and with minimum surgical intervention (percutaneous tenotomy) that too if needed. Ponseti technique gives a pain-free, flexible, mobile and cosmetically acceptable foot.

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