Evaluation of Ponseti method in neglected clubfoot

Abhinav Sinha, Anil Mehtani, Alok Sud, Vipul Vijay, Nishikant Kumar, Jatin Prakash

ABSTRACT

Background: Gentle passive manipulation and casting by the Ponseti method have become the preferred method of treatment of clubfoot presenting at an early age. However, very few studies are available in literature on the use of Ponseti method in older children. We conducted this study to find the efficacy of Ponseti method in treating neglected clubfoot, which is a major disabler of children in developing countries.

Materials and Methods: 41 clubfeet in 30 patients, presenting after the walking age were evaluated to determine whether the Ponseti method is effective in treating neglected clubfoot. This is a prospective study. Pirani and Dimeglio scoring were done for all the feet before each casting to monitor the correction of deformity. Quantitative variables were expressed as mean ± standard deviation and compared between preoperative and postoperative followup using the paired t-test. Also, the relation between the Pirani and Dimeglio score, and age at presentation with the number of casts required was evaluated using Pearson’s correlation coefficient. No improvement in Dimeglio or Ponseti score after 3 successive cast was regarded as failure of conservative management in our study.

Results: The mean age at presentation was 3.02 years (range 1.1 - 10.3 years). The mean followup was 2.6 years (range 2–3.9 years). The mean number of casts applied to achieve final correction were 12.8 casts (range 8 - 18 casts). The mean time of immobilization in cast was 3.6 months. The mean Dimeglio score before treatment was 15.9 and after treatment were 2.07. The mean Pirani score was 5.41 before treatment and 0.12 after treatment. All feet (100%) achieved painless plantigrade feet without any extensive soft tissue surgery. 7 feet (17%) recurred in our average followup of 2.6 years.

Conclusions: Painless, supple, plantigrade, and cosmetically acceptable feet were achieved in neglected clubfeet without any extensive surgery. A fair trial of conservative Ponseti method should be tried before resorting to extensive soft tissue procedure.

Key words: Clubfoot, neglected clubfeet, Ponseti, plaster correction, Pirani scoring, Dimeglio scoring

MeSH terms: Clubfoot, plaster of paris, neglected diseases, prospective studies, foot deformities

INTRODUCTION

Congenital talipes equinovarus is recognized as the “down and in” foot, often resembling a club-like appearance. It is the most important cause of physical disability among all congenital musculoskeletal defects occurring in an otherwise normal child.¹ For many years, the Kite’s method was used for the correction of clubfoot, but it took enormous amount of time for correction and produced excellent results only in the hands of Kite.² In recent years, the Ponseti method has become the gold standard for correction of clubfoot.¹² However, most of the studies on Ponseti method are done in younger children, before the walking age. Neglected clubfoot is the primary problem in developing nations, where social stigma, lack of education, poverty and lack of proper health services hinder the early presentation and treatment of a child with clubfoot. The deformity becomes worse by walking as the weight bearing takes place on the side or dorsum of the foot, causing further contracture of the medial soft tissues and plastic deformation of bones.³ Most of the literature on treatment of neglected clubfoot focuses on soft tissue release surgery, osteotomy or fixators. The problem in
developing country is the large number of patients and scarcity of skilled surgeons and OT time. Further, the good short term results have shown to deteriorate over longer followup resulting in rigid painful feet. The scars are cosmetically unacceptable. Lastly, any relapse after surgical treatment was very difficult to manage. This calls for a simpler method that can be easily applied to larger population with better results.

Inspired by the success of Ponseti method in idiopathic clubfeet, the method was tried in neglected feet as well in past, but in small series. We here present one of the largest prospective studies published till date. We wanted to evaluate the effect of Ponseti method of casting on neglected feet, to assess its failure and recurrence rate. We also wanted to evaluate if there is any improvement in radiological parameters following serial casting by Ponseti method. Further, we wanted to find if any correlation exists between total number of casts and initial Pirani and Dimeglio scores, and age of initial presentation of the patients.

Materials and Methods

41 feet of 30 patients with mean age of 3.02 years (range 1–10.3 years) were included in this prospective study children with virgin idiopathic clubfoot, with no previous treatment, in the age group of more than 1 year at the time of presentation were included in the study. There were 24 male and 6 female patients. Nineteen patients had unilateral deformity, whereas 11 had bilateral deformity.

A thorough clinical examination was done to exclude all cases of secondary clubfoot. Consent was taken prior to enrolment in the study after explaining the mode of treatment. Quantification of various components of clubfoot deformity was done using the Dimeglio score and Pirani score prior to application of every cast and at each followup.

Anteroposterior (AP) and lateral standing radiographs of the feet were taken prior to treatment, immediately after correction and at the time of the latest followup. Child was placed on a specially designed step stool to take standing lateral X rays, with the lateral border of foot touching the cassette and rays perpendicular to the foot [Figure 1]. On the AP view, the talo-calcaneal and the talar-first metatarsal angles were recorded. On the lateral view, the talo-calcaneal angle was measured. The Beaton-Pearson index (sum of the talo-calcaneal angle in the AP and lateral views) was used for overall radiological assessment. Patients underwent weekly above knee cast application in the day care clinic. The casts followed standard Ponseti protocol. Initially, cast was applied in supination for the correction of cavus. Subsequent casts were applied in serial abduction under the head of the talus. Percutaneous tenotomy of the tendo-Achilles was done once the forefoot deformity was corrected with a fully reducible talar head which was assessed using Pirani scoring (lateral head talar sign in Pirani scoring was 0). Tenotomy was performed either under general or local anesthesia. The technique was always percutaneous and in no case we had to resort to open lengthening [Figure 2a and b]. Tenotomy of the tendo-Achilles was done in all patients, even up to the age of 10.3 years. A repeat tenotomy of tendo-Achilles was done in children where adequate dorsiflexion, i.e., at least ten degree of dorsiflexion was not achieved by the first tenotomy. Posttenotomy cast was removed at 3 weeks in patients aged <3 years and 4 weeks in patients aged more than 3 years. Despite our initial apprehensions regarding tenotomy in older children, there were no complications regarding healing of the tendo-Achilles. The strength of plantar flexion was normal. Plantar flexion was checked at 3 months and 6 months using clinical and radiological studies. Clinically the strength was considered adequate when child could stand on toes unassisted and radiologically we used ultrasound to assess adequacy of the tendon. In no case was tendo-Achilles found inadequate with most children found to stand on toes in 3–4 months unassisted. No strict protocol is present in the available literature regarding the splinting in children of older age group. Compliance to bracing is much less in the children of older age groups. Steenbeek foot abduction brace was given to all the patients posttenotomy. It was applied for 23 h a day for the first 3 months in all the patients and advised for sleep time use up to the age of 4 years or 1 year in children older than 4 years.

During our study, we assessed the age at the time of presentation, severity of deformity by the Pirani and Dimeglio score at each visit, the number of casts required for the correction, amount of ankle dorsiflexion after tenotomy, need for any other surgery, change in the Pirani and Dimeglio score, and residual deformities.

The quantitative variables were expressed as mean ± standard deviation and compared between preoperative and postoperative followup using the paired t-test. Also, the relation between the Pirani and Dimeglio score and age at presentation with the number of casts required was evaluated using Pearson’s correlation coefficient. Statistical analysis was performed using SPSS version 15.0 software (IBM software, United States) and a P < 0.05 was considered statistically significant.

Results

The mean followup was 2.6 years (range 2–3.9 years). No patient was lost to followup.
The mean number of casts applied, to achieve final correction, were 12.8 casts (range 8-18 casts). The mean time of immobilization in cast was 3.6 months. The average dorsiflexion achieved was 12.26° (range 3–20°) at the end of treatment. The final dorsiflexion achieved showed a downward trend with age. The average dorsiflexion achieved in age group 1–3 years was 15.48°, between 3 and 5 years was 8.54° and >5 years was 7° [Figure 3].

The older children had lesser dorsiflexion, yet the children and parents were satisfied with the final results as they were able to wear normal footwear and carry on most of the functions. In seven cases, where the dorsiflexion was less than ten degree after the tenotomy of tendo-Achilles, we did a repeat tenotomy, after 1 month, to further improve the dorsiflexion. The mean Pirani and Dimeglio score before treatment was 5.41 and 15.9 respectively.
The mean Dimeglio score after treatment was 2.07. The mean Pirani score after treatment was 0.12. The change in both the scores was statistically significant ($P < 0.01$). Figures 4 and 5 show the clinical photographs of 2 cases in our series.

Cavus was seen as one of the most severe deformities and in 5 children cavus remained even after complete correction of other deformities. A percutaneous plantar fasciotomy was needed in these 5 feet for the correction of residual cavus. This was done at the time of percutaneous tenotomy of tendo-Achilles. None of the patients required any other soft tissue release procedures.

Three patients developed casting related complications of erythema and superficial sore, which were managed by generous padding in the subsequent casts. One patient with bilateral clubfeet developed flat top talus probably as a result of more number of casts ($n = 18$) and the dorsiflexion achieved was less, ($3^\circ$) even after tenotomy.

We calculated the correlation between the number of casts required for correction versus the initial age, Pirani scores, and Dimeglio scores. There was a significant positive correlation between age and number of casts required ($r = 0.528, P < 0.001$). This has also been shown in the scatter diagram where an increasing trend is seen in the number of casts required for maximal correction with increasing age [Figure 6]. Also, age was negatively correlated with initial Pirani score ($r = -0.510, P = 0.001$) and positively correlated with initial Dimeglio score ($r = 0.439, P = 0.004$). Figure 7 shows a scatter diagram showing a relationship between Pirani score and age of patient. On the other hand, number of casts required had no significant correlation with initial Pirani score ($r = -0.234, P = 0.141$) while it was positively correlated with initial Dimeglio score ($r = 0.413, P = 0.007$).

The range of AP talo-calcaneal angle, precorrection, was from $0^\circ$ to $14^\circ$, with a mean of $5.04^\circ$. The postcorrection AP talo-calcaneal angles ranged from $15^\circ$ to $35^\circ$, with a mean of $26.14^\circ$. The range of lateral talo-calcaneal angle, pre correction, was from $0^\circ$ to $16^\circ$, with a mean of $5.29^\circ$.  

Figure 4: Clinical photograph of 5-year-old child showing (a) neglected bilateral clubfeet at presentation (b) neglected bilateral clubfeet after 8 casts in tenotomy

Figure 5: Clinical photograph of 4-year-old child showing (a) neglected unilateral clubfoot before treatment (b) neglected unilateral clubfoot after 7 casts and tenotomy

Figure 6: Scatter diagram where an increasing trend is seen in the number of casts required for maximal correction with increasing age
The range of postcorrection lateral talo-calcaneal angle was 15–40° with a mean of 25.24°. Figures 8 and 9 show AP and lateral X-rays of our clinical case at pre- and post-treatment time. The mean Beatson-Pearson index before treatment was 10.34°. After correction our mean Beatson-Pearson index was 51.39°.

Figure 7: Scatter diagram, where the initial Pirani scores show a decreasing trend with increasing age, despite the stubborn foot deformity

Figure 8: Anteroposterior X-ray of foot before treatment showing (a) parallel talo-calcaneal relation (b) radiological improvement with talo-calcaneal angle nearing 30° in both planes

Figure 9: Lateral X-ray of foot before treatment showing (a) parallel talo-calcaneal relation (b) radiological improvement with talo-calcaneal angle nearing 30° in both planes
7 patients developed recurrence of the deformity. All these cases were severe to begin with. Pirani score over 5 and Dimeglio score over 15 in all of them. Another common feature in all relapse cases was non-adherence to bracing protocol. The time to wear brace in these cases was less than 8 hours a day. Mean age group of relapsed patient was 2.8 years. It was mainly a recurrence of equinus in 3 feet whereas adduction cavus and equinus in four. These were treated by repeat Ponseti casting and tenotomy in 4 feet and 3 patients required a tibialis anterior tendon transfer.

**Discussion**

The children with neglected clubfoot deformity are unable to mix with their peers because of stigmatization, and as a result very few go to school. Most of the literature on treatment of neglected clubfoot has focused on extensive soft tissue release surgery, osteotomies, and various types of fixators or arthrodesis. Long term studies of surgical procedures have shown poor results with complications like painful feet, arthritis, stiffness of ankle and subtalar joint, and residual deformity. The few studies, evaluating the use of Ponseti method in children with neglected clubfeet have shown promising results.

Lourenço and Morcuende treated 17 patients (24 feet) with neglected clubfeet, with mean age of 3.9 years and found good results in 16 feet (66.6%) without further surgery. Verma et al. evaluated Ponseti method in toddlers and found it to be very useful. Khan and Kumar treated neglected clubfoot in 21 children (25 feet) over 7 years and found good results in 18 feet (85.7%). The comparison of these studies is described in Table 1.

The mean number of casts in our study before tenotomy was 12.8 weekly casts with an average of 3 months of immobilization. Lourenço and Morcuende treated with 9 biweekly casts which meant an immobilization of about 4.5 months that was slightly more than we observed.

However, Khan and Kumar and Mehtani had treated patients in 12.1 and 10 casts, respectively, which was comparable to our study. Also, the amount of final dorsiflexion achieved in our study was slightly more than other published series [Table 1]. Spiegel et al. in their study of 260 feet in the age group of 1–6 years observed mean dorsiflexion of 12.5° up to 2 years and 9°–10° in 3–5 years of age, which is comparable to our result.

In our study, all the 41 feet treated by the Ponseti method of cast application achieved painless, supple, plantigrade, and cosmetically acceptable feet within a mean period of 3.6 months. The recurrence rate of 17.07% in our series is also is comparable to that of most of the studies done in infants.

However, there were certain striking differences between the results of Ponseti method in infants and older children. The average dorsiflexion achieved in our study was 12.26°, which is more than that achieved by Lourenço and Morcuende (5°) but less than that achieved in younger children. The feet could not be abducted to 70° as advised in younger children and passive abduction was possible up to 40° with a mean of 20.87°. Even Lourenço and Morcuende in their study mentioned that abduction was attempted to approximately 30–40° instead of 70° as recommended in infants. Despite these limitations, the patients and parents were largely satisfied with the results. We also compared the initial Pirani and Dimeglio scores for correlation with the number of casts required for correction and found that while Dimeglio score had a moderate positive correlation (0.439) with the number of casts required, the Pirani score had a low negative correlation (−0.278). Hence, Pirani scoring is not a sensitive enough tool for assessing the deformity in children of older age group and gives fallacious low values, due to low scores for empty heel and posterior crease and medial crease, despite resistant, rigid deformities. This is also shown by the scatter diagram, where the initial Pirani scores show a decreasing trend with increasing age, despite the stubborn foot deformity [Figure 9]. The number

### Table 1: Comparison of various published studies

| Published reviews | Abhinav, Anil Mehtani | Lourenço | Shah Alam | Anand Verma, Anil Mehtani |
|-------------------|-----------------------|----------|-----------|---------------------------|
| Number of feet    | 41                    | 24       | 25        | 55                        |
| Average age       | 3.02 (1.1-10 years)   | 3.9 (1.2-9 years) | 8.9 (7.5-11 years) | 24.8 months (12-36 months) |
| Mean Dimeglio pretreatment | 15.9 | -      | 14.2     |                            |
| Mean Dimeglio posttreatment  | 2.07     | -      | 0.95     |                            |
| Mean Pirani pretreatment   | 5.41     | 4-5    | Not used | 4.95                       |
| Mean Pirani posttreatment  | 0.12     | -      | Not used | 0.76                       |
| Average number of casts   | 12.8     | 9 (7-12) (biweekly) | 12.1 (10-14) | 10 (6-12)                  |
| Average dorsiflexion       | 12.26 (10-45) | 5° (0-10) | 7° (5-10) | 11.9°                      |
| Relapses (%)               | 17       | 62.5   | 24       | 27.2                       |
| Patient requiring extensive soft tissue surgery | 0       | 8      | 7        | 0                          |
of casts required for correction also showed an increasing trend with the age.

Despite the encouraging results seen in our study, there are certain limitations. Application of above knee casts is troublesome for older children. It makes an independent child totally dependent on their parents. Second, we found that older children had difficulty accepting the foot abduction brace and no definite protocol is available regarding bracing in older children. We advocated at least 1 year of night time bracing even in older children but 5 patients who didn’t tolerate the foot abduction brace had to be given a custom made ankle foot orthosis (AFO). The usefulness of the AFO, however, remains doubtful. Recurrence was seen in seven cases, but feet were still supple and responded to repeat Ponseti casting unlike surgical recurrence. Further all relapses were due to non adherence to bracing protocol. An early tibialis anterior transfer to the third cuneiform, which would act as internal bracing might be helpful in preventing the relapses. However, further study would be required to validate its role. The larger patient samples and followup period would be required to establish fully the efficacy of Ponseti method for treating neglected clubfoot but our results our encouraging. Also, the bracing protocol is difficult particularly in older children.

We feel that Ponseti method either fully takes care of this stubborn deformity or reduces the extent of residual surgical release and it should be a good alternative for treatment of neglected clubfoot.

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Conflicts of interest
There are no conflicts of interest.

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