The Effect of Repeat Ponseti Casting on Previously Failed Clubfoot Treatment

Abstract
Background: Closed treatment using Ponseti casting technique is the standard method of management for clubfoot deformity. The aim of this study was to investigate the efficacy of repeat use of Ponseti technique in late cases that had not achieved correction following previous attempts.

Method: A prospective study was conducted on patients with clubfeet aged over 3 months who had not achieved correction with previous casting and were referred for surgery to our clinics. The baseline and final Pirani scores were compared in a 4.5-year average follow-up. The functional scores, recurrence rates, and additional procedures required for correction were also documented.

Results: 79 feet in 53 patients aged from 3 months to 9 years were studied. They had mean Pirani scores of 4.4 and had previously received 7.8±2.5 castings. Nine patients had Achilles tenotomy. A mean of 4.3±1.7 (range: 2–8) castings and 32 Achilles tendon lengthening were needed to achieve complete correction in 77 feet (98%). Relapse of deformity was seen in 42 (53%) feet, which led to 89% correction rate in the final follow-up. However, the functional score at the end, was good or excellent in 93% of the cases.

Conclusion: Accurate re-use of Ponseti technique in cases of previously failed clubfoot casting has high success rate, even in late referrals.

Level of Clinical Evidence: Level 4
Keywords: Clubfoot; Congenital Foot Deformity; Treatment; Plaster Casts

Introduction

The closed treatment using Ponseti technique has now become the standard management strategy for clubfoot deformity1–3. The best time for starting this treatment is during the first month after birth4. There have been many studies on this subject, including those conducted among different ethnic groups5–8. Ponseti treatment is also used for the syndromic and also for the postsurgical recurrences of clubfoot9,10. Since the original description, there have been few modifications of the technique including modifications on the period and frequency of casting and cast change, the timing and frequency of Achilles tendon lengthening, the post-treatment braces or corrective shoes, and the treatment of recurrences3,11–13. In spite of good initial correction of more than 90%, recurrence remains a true possibility3,14. The recurrence rates of clubfoot deformity have been reported to be between 11% and 56%14,15. Poor compliance of the families to the use of post correction bracing is one of the reasons for this recurrence. Ponseti technique can still be used in recurrences5,16,17. The treatment process involves Achilles tenotomy in 71–86% of the cases3,4,17,18. Repeat tenotomy, particularly in recurrences, may become necessary. A few studies have investigated the fate of the lengthened Achilles tendon and its subsequent healing and function after lengthening19,20.
The results of Ponseti casting for the treatment of the feet that had failed the initial casting manipulation, or even the surgical treatment, have not been extensively addressed in the literature\(^{(16,22)}\). The present study was conducted to investigate the use of Ponseti technique for the feet that had previously undergone unsuccessful manipulative casting treatment. The hypothesis was that even in the failed casting treatment of clubfoot, when extensive surgery seems to be the last choice, another trial with meticulously performed Ponseti technique would be warranted.

### Methods

Patients with uncorrected congenital clubfeet who had failed the initial conservative treatment in other centers, and had been advised to have open surgery, and had referred for a second consultation to our referral center were recruited during an 8-year period (2004 to 2012). Only the idiopathic cases that had received at least 3 months of manipulation and casting treatment, but the feet had never achieved full correction were chosen for this study. None of the cases had achieved full correction. This point about “correction" was confirmed by reviewing the office notes of the referring physicians, and also by questioning the parents and the referring physicians in detail, to find whether they had noticed a normal foot that would rest straight on the floor, following casting by the original physician. If the answer to the latter part of this question was “yes”, the foot would be considered as “relapse “and was excluded. The syndromic cases were also excluded from the study.

The step-by-step Ponseti treatment was instituted by the authors in the clinic, in accordance with the original Ponseti technique in all the cases\(^{(4,22)}\). Achilles tenotomy, if necessary, was performed under local anesthesia in the clinic for children younger than 1 year of age. Tenotomy was performed up to 2 years of age, and Z-lengthening was performed for beyond that age. This was followed by the application of foot abduction orthosis for 2 years. A daily foot exercise was also instructed to the parents (abducting the forefoot and then stretching the ankle into dorsiflexion with one thumb on talar head).

We scored the feet at the beginning of our casting, using the Pirani system\(^{(24)}\), and also at the end of the treatment. The number of castings, the possible need for tendo-Achilles tenotomy, the compliance with foot abduction orthosis, and recurrences were documented in accordance with Ponseti technique\(^{(19)}\). The Laavege and Ponseti functional scale was used in the follow-up assessment\(^{(15)}\).

Statistical analysis was done using the SPSS software version16.0 (SPSS Inc. Chicago, IL, USA). Qualitative data were expressed as number and percentage, which were analyzed using the Chi-square test. Quantitative data were presented as mean and standard deviation, which were analyzed using independent sample t test. P values<0.05 were considered as statistically significant.

### Results

During the 8-year study period, out of the 540 uncorrected clubfeet that were referred to the authors’ clinics, 53 children with 79 feet met the inclusion criteria and were considered for the study.

The characteristics of the 53 children were as follows: There were 35 boys and 18 girls, with a mean (±SD) age of 10.6 (±16.9) months (range: 3 months to 9 years). 26 children had bilateral, 12 had right- and 15 had left-sided clubfeet. They had already received a mean (±SD) of 7.8 (± 2.5) castings (range: 4–14 castings) before their referral to our clubfoot clinics. The Pirani score at the time of referral was 4.4 (range: 2-6).
In our clinic, the patients received a mean (±SD) of 4.3 (±1.7) (range: 2–8) castings with a positive correlation between the severity of clubfoot and the number of castings (P<0.001). Achilles tendon lengthening became necessary in 32 feet (29 underwent tenotomy, 3 received Z-lengthening), while tenotomy had been already performed by the initial surgeon in 9 feet (apparently before achieving correction of the other components of clubfoot deformity). Therefore, in total, first-time tenotomy (by the initial surgeon or by us) was performed in 41 feet (52%), and 38 feet reached full correction without any tenotomy. The need for tenotomy had a positive correlation with the Pirani score in the initial visit by the authors (P<0.001). Age did not have any significant effect on the need for tenotomy (P=0.9).

The Ponseti treatment performed in our clinics achieved complete correction (Pirani score: 0-0.5) in 77 feet (98%) (Figure 1). The remaining feet, in two 8- and 9-year-old children, obtained good hind foot correction, but required midfoot osteotomy for their static forefoot adductus.

Later recurrence, however, was seen in 42 feet (53%) within 25.3±12.2 months. Altogether, forefoot adductus deformity, alone or in combination with other deformities, was the most frequent deformity to recur in 23 feet (29%) followed closely by heel varus and equinus (27% and 21%, respectively) (table 1). Out of the 28 feet in patients who did not use the recommended foot abduction orthosis, 19 (68%) developed recurrence, whereas in the 51 feet of the patients who wore the orthosis, recurrence was observed only in 23 (45%) feet. The 42 feet with recurrence of deformity were further compared with the 37 that did not show recurrence. There was no statistically significant difference between the two groups, in terms of age at referral, original Pirani score, or the number of castings necessary to achieve the correction by the authors (P>0.05) (table 2).

<table>
<thead>
<tr>
<th>Deformity</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forefoot adductus</td>
<td>14</td>
<td>33.3</td>
</tr>
<tr>
<td>Equinovarus</td>
<td>6</td>
<td>14.3</td>
</tr>
<tr>
<td>Heel varus + forefoot adductus</td>
<td>6</td>
<td>14.3</td>
</tr>
<tr>
<td>Equinus</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>Equinocavovarus</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>Heel varus</td>
<td>3</td>
<td>7.2</td>
</tr>
<tr>
<td>Heel varus+cavus+forefoot adductus</td>
<td>1</td>
<td>2.3</td>
</tr>
<tr>
<td>Forefoot adductus+cavus</td>
<td>1</td>
<td>2.3</td>
</tr>
<tr>
<td>Equinus+forefoot adductus</td>
<td>1</td>
<td>2.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>42</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

The 42 cases with recurrences received the following treatments: repeat casting for 13, stretching by parents and orthotic shoe for 17, and correction with casting followed by minor
surgery for 12 feet i.e., Achilles tenotomy or lengthening in 12, and tibialis anterior tendon transfer (TATT) in 7. Eight feet in patients younger than 4 years with forefoot adductus, were fully corrected by reverse- last shoes along with intermittent exercises, with no need for TATT.

At the final follow-up evaluation of 4.5 years (3–10.3 years), the children were at the age of 4 years and 10 months (range: 3 years and 3 months -12.5 years). A total of 70 feet achieved correction with normal functioning and plantigrade feet (table 2). Nine feet had some mild equinus or forefoot adductus for which repeat casting or scheduling for Achilles tendon lengthening (ATL) or TATT were recommended.

The Lavvege and Ponseti functional scale in this group of patients (failed initial clubfoot casting) was excellent in 71 (90%), good in 4 (5%), and fair in another 5% of the patients. The four “fair” cases had poor brace compliance and poor clinic attendance.

### Table 2: The shape of the treated feet at the final follow-up

<table>
<thead>
<tr>
<th>Foot shape</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal foot</td>
<td>50</td>
<td>63.3</td>
</tr>
<tr>
<td>Mild dynamic forefoot adductus</td>
<td>20</td>
<td>25.3</td>
</tr>
<tr>
<td>Equinovarus</td>
<td>4</td>
<td>5.1</td>
</tr>
<tr>
<td>Forefoot adductus + heel varus</td>
<td>4</td>
<td>5.1</td>
</tr>
<tr>
<td>Heel varus</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>Total</td>
<td>79</td>
<td>100</td>
</tr>
</tbody>
</table>

Studies on the failure of treatment of clubfeet following Ponseti technique have been addressed only in few articles (12,16). The cases we assessed in this study are unique, because they were not recurrences of any achieved correction and were not “virgin” clubfeet, but had failed their previous casting treatment. The 98% correction in our initial treatment was achieved in the cases that had been all advised by their primary orthopedic surgeons to have full surgical releases. We were unable to accurately analyze the technical reasons for failure of the initial casting of the referred cases. It, however, seemed to have been partly due to the following reasons: Some surgeons do not believe in the Ponseti technique and easily give up casting for surgery, and also some surgeons try to make short-cuts in the technical principals by jumping to the next step before full correction of a previous part of the deformity (for example Achilles tenotomy when foot is not adequately abducted). The present authors believe that the original Ponseti steps in manipulative casting should be

**Figure 2:** A one-year-old boy with the history of 8 castings. a. Standing photograph b. after 4 castings and 6 months follow-up.
followed in every idiopathic or treatment-failure clubfoot case, and also consider every foot as a new case requiring full step-by-step correction. The present study included failed Ponseti casting in children aged 3 months to 9 years who in our hands, achieved good correction with properly applied treatment. Recurrence was observed in 53% of the cases that had achieved complete correction. Similar to the findings of Dobbs and colleagues\(^\text{17}\), we found that age at the beginning of treatment, the severity of deformity, and any previous treatment had no effect on recurrence. Ponseti and Smoley reported a 56% rate of first recurrence occurring at a mean age of 2.5 years\(^\text{4}\). Similarly, Laaveg and Ponseti observed “at least one” recurrence in 47% of the feet of children at a mean age of 39 months\(^\text{15}\), and also Haft and co-workers reported 41% recurrence rate\(^\text{5}\). Morcuende and colleagues\(^\text{14}\), achieved complete correction in their study on children who were referred late, with 11% recurrence- an observation that was also reported by Bor and others\(^\text{12}\). All the above reports were, however, on “virgin” feet. Richards and colleagues reported 94.4% initial correction, 37% relapsing once, 52% relapsing twice, and a third relapse in 60%. They also observed the need for posteromedial release in 16% of the cases\(^\text{26}\).

Ponseti in his first report suggested that 78% of the cases would require an Achilles tenotomy; though, rates varying from 73% to 100% have been reported in the literature\(^\text{4, 7,12,17,25,26}\). In the present study, only 52% of the cases needed tenotomy. This might have been caused by their prior manipulations, or due to the routine use, by the authors, of two extra castings of feet in dorsiflexion when all other deformities were completely corrected. This was a point that was previously recommended by Ponseti as well\(^\text{4}\). Achilles tenotomy in the older children probably takes longer time to heal and may end up in more adhesion and fibrosis, resulting into poor outcome\(^\text{20}\). This is probably due to excess epimysial and intramuscular fat replacement\(^\text{21}\). The oldest child who underwent tenotomy in our cases was 2 years old and all the older patients received ATL.

The usual recommendation for the time of clubfoot treatment is within the first week of birth\(^\text{4}\). However, late treatments with acceptable results have been also performed\(^\text{7,12}\). Zionts and co-workers describing patients whose treatment started 6 weeks or more after birth, found that the relapse rate was unrelated to the age at treatment\(^\text{27}\). Lourenco and colleagues treated 24 clubfeet after walking age (mean age: 3.9 years) and all were corrected, but with a high rate of tenotomy (100%), re-tenotomy (29%), and posterior capsular release plus tenotomy (33% [62% recurrence of equinus]). They also observed 17% dynamic forefoot adductus that needed no treatment\(^\text{7}\).

Spiegel and co-workers assessed Ponseti treatment in 260 neglected clubfeet in 171 children aged 1-6 years\(^\text{8}\), and reported that 86% tenotomy or ATL and 8% posterior release in the older age children were necessary to achieve correction. They observed no difference in the number of castings required for correction in different age groups. In the treatment of relapses, McKay and others reporting on 60 such cases showed that 89% needed TATT\(^\text{10}\). Masrouha and colleagues\(^\text{28}\), also reported relapse after TATT in 15% of cases, commonly in children who received the transfer at a younger age. In our study, 16 of the 23 cases of residual forefoot adductus (FA) at a younger age responded to stretching and reverse-last shoes, and we avoided TATT for children below 4 years of age due to the reasons mentioned in the article by Masrouha and others\(^\text{28}\). Forefoot adductus deformity has a tendency to improve with time, and might not require TATT\(^\text{29}\). McKay and colleagues reported 55% mild FA after relapses, while we observed 29% in our case\(^\text{16}\). Tendon transfer is suitable for the more severe ones that remain after 4 years of age\(^\text{28}\).
The final functional outcomes of 93% excellent or good result in the present report are better than 74% reported by Laaveg and colleagues\(^{15}\). Faulks and Richards\(^{30}\), and Richards and co-workers\(^{26}\), using a different functional scale had reported 73% and 76% excellent or good results, respectively. In the final assessment, 70 of our treated feet were plantigrade or had a minimal dynamic forefoot adductus, which is a commendable result.

One of the limitations of this study is that the casting technique used by the primary surgeon and his/her familiarity with the Ponseti technique could not be ascertained. The severity of the initial deformity was not clear to the authors either.

In conclusion, in cases of conservatively treated and failed clubfeet, the accurate use of Ponseti casting can initially correct the deformity in 98% of the cases, even in late referrals. Achilles tenotomy or ATL may be needed in about 52% of such feet. Recurrences in this type of scenario are to be expected in about 53% of the feet, especially when poor brace-compliance is present. The recurrence could mostly be managed by the same Ponseti technique, even in older children, though more number of castings or minor surgical procedures may become necessary. After all, a good or excellent functional outcome of 93% can be expected.

References


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