

## Research Article

### Clinical Experiences and Midterm Results of the Treatment of Clubfoot with the Ponseti Method

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#### Abstract

**Introduction:** Among the current treatment options for Talipes Equinovarus (TEV), also known as clubfoot, is the Ponseti method, which is currently the most popular treatment method worldwide. The aim of this study is to report our results of using the Ponseti method in the treatment of TEV patients.

**Materials and methods:** We reviewed 92 feet from 60 patients who were treated with the Ponseti method and evaluated their conditions via the Pirani and Dimeglio scoring systems. Of the 60 patients, 32 patients (53%) had clubfeet bilaterally, 18 (30%) patients were affected in only the right foot, and 10 (17%) patients were affected in only the left foot. Furthermore, 43 (72%) of the 60 patients were males and 17 (28%) were females. Lastly, 10 (16%) patients had a family history of the disease. The mean age for starting treatment was 7.55 days. The mean number of casts applied per patient was  $5.73 \pm 0.8$ . The mean follow-up duration was 31.2 months.

**Results:** The mean Pirani score for the 92 feet studied was  $3.62 \pm 0.58$  before the treatment. This score dropped significantly to  $0.36 \pm 0.42$  after the course of treatment ( $p < 0.05$ ). The mean Dimeglio score was  $14.75 \pm 1.55$  before therapy and  $4.76 \pm 0.91$  after the course of treatment ( $p < 0.05$ ). Fifty-five patients (92%) required a percutaneous achillotenotomy. At the time of the follow-up examinations, 25 feet from 17 patients (28%) required additional interventions beyond achillotenotomy. Regarding responsiveness to treatment, we found no statistically significant differences between males and females, left and right feet, and those with or without a family history for the disease ( $p > 0.05$ ).

**Conclusion:** Although the Ponseti method requires a significant effort for both clinician and family, every orthopedist should know and apply the Ponseti method in the treatment of clubfoot due to its successful results.

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#### Introduction

Talipes Equinovarus (TEV) is a fairly common birth defect in which males are affected twice as often as females and 50% of the cases show bilateral defects [1]. In the United States, the overall prevalence of clubfoot is 1.29 per 1000 live births [2].

Although the Ponseti method of treatment was first described many years ago, it recently became the standard method of treating TEV due to its successful long-term results.

Several scoring methods have been developed to assess the foot before, during, and after treatment for TEV. For this study, we incorporated data from two of the most commonly used scoring systems, Dimeglio and Pirani. Dimeglio and his colleagues divide a clubfoot deformity into four measurable anatomical features, or subgroups, which are scored on a scale of 20 points. These subgroups are equinus in the sagittal plane, varus deviation in the frontal plane, derotation around the talus of the calcaneo-forefoot block, and adduction of the forefoot on the hindfoot in the horizontal plane. Each subgroup is assessed in severity from 1 to 4 points. In the presence of a posterior or medial fold, extreme cavus and/or muscle weakness, another point is added to each category for a possible total of 5 points [3]. The second scale, the Pirani scoring system, evaluates six parameters of the foot separately as normal (0 points), moderate to severe (0.5 points), or severe (1 point). These anatomical parameters are the curvature of the lateral border of the foot, degree of medial skin fold, covering of the head of talus, degree of posterior skin fold, equinus or extreme plantar flexion at the ankle joint, and the presence of a free heel [4]. The Dimeglio and Pirani scoring systems are useful in evaluating the degree of correction of the foot as well as the potential for the prognosis of the disease.

In the following study, we examine the components of the Ponseti method and share our experiences and results.

#### Materials and Methods

In this study, we analyzed 92 feet from a total of 60 patients with idiopathic talipes equinovarus. Of the total, 43 patients were males and 17 were females. All patients started treatment with the Ponseti method on the same day that they presented to our clinic. Patients with accompanying anomalies or dysmelias were excluded. The patients' families were given detailed information regarding the clubfoot deformation as well as the Ponseti treatment process, other available treatment options, the usage of orthoses, possible complications, and the potential prognosis. We explained how crucial the family's compliance and cooperation are to the success of the treatment and collected the family's fully informed consent.

For casting the legs after manipulation, we used the classic casting method of combining 5 or 10 cm of cotton with plaster of Paris. No synthetic casting materials were used. A trained orthopedic surgeon and a resident performed the Ponseti manipulations. We encouraged feeding of the infants prior to cast molding and placement.

We followed up with all patients for at least one hour after each cast was set in order to check for proper circulation to the leg. Additionally, we explained the symptoms of failed circulation to family members and instructed them to contact our emergency services in case they were unsure about interpreting the patient's symptoms correctly.

A new cast was set on each patient once per week. Old casts were removed at the clinic just before the new ones were applied. When we observed a full recovery in the cavus, adductus, and varus components of the foot, we evaluated the dorsiflexion of the foot to see if an achillotenotomy was necessary. If residual equinus was observed after the correction of other components, an achillotenotomy was performed blind in a percutaneous way with the patient in the operating room under local anesthesia. Although tenotomy does not require suturing, we used a single suture to close the wound and prevent additional bleeding. Afterwards, a long leg cast was applied with 15 degrees of dorsiflexion and 70 degrees of abduction. Patients were watched for 24 hours at the clinic to ensure the legs received proper circulation. There were no further complications during or after surgical interventions. Sutures were taken out after the removal of the casts at the end of the third week of treatment.

Patients started using orthoses the same day we removed the casts at the end of the third week. Each orthosis was made of a pair of laced boots and an iron bar that connected them, which is also known as a "Denis Browne bar". The back and front of the boots were left open in order to see the feet from outside the boots and to be sure they were fitted properly. The orthoses had no medial arch supports. If the disease affected only one foot, the boots were set to 75 degrees of external rotation on the deformed side and 45 degrees of external rotation on the normal side. If a patient exhibited bilateral deformities, both boots were set to 70 degrees of external rotation. The iron bars were thick enough and long enough to maintain the distance of the heels at about shoulder width. Boots that became too small for patients were renewed at follow-up meetings.

Orthoses were used 24 hours a day for the first three months. Families were allowed to remove the orthoses only once in a 24-hour period for taking baths. Parents were trained to fit and remove the orthoses on their children. For any problems or difficulties with the orthoses, parents were instructed to contact us. After the third month, the orthoses were used 12 hours per day until the age of three. To make compliance easier, parents were encouraged to use the orthoses when the babies were sleeping. Follow-up meetings with the patients were scheduled every three months during the first year and then every six months for subsequent years (Figure 1). Every treated foot was monitored and evaluated using both the Dimeglio and Pirani scoring systems. Statistical analyses were conducted by using a chi-squared t-test to assess the distribution of scores with 1 degree of freedom. A p value of  $p < 0.05$  was selected as the level of statistical significance.

## Results

The following results indicate the degree of correction experienced by the study subjects according to the Pirani and Dimeglio scores. A total of 129 feet from 84 patients treated with the Ponseti method were initially reviewed for this study. From that total, 24 patients (contributing 37 feet) were excluded from the study due to inaccessibility during the follow-up meetings or were diagnosed with additional dysmelia syndromes. Therefore, we analyzed data for 92 feet from 60 patients enrolled in this study. As stated earlier, 43 (72%)



Figure 1: Photographs before and after treatment with the Ponseti method.

patients were males and 17 (28%) were females. Additionally, 32 patients (53%) had bilateral clubfoot involvement, whereas 18 (30%) had right foot deformities and 10 (17%) had left foot deformities. From the group, 10 patients (16%) had a family history for TEV.

Of the 43 males in the study, 13 (30%) had deformities in the right foot only, 5 (12%) had deformities in the left foot only, and 25 (58%) had bilateral involvement of the disease. Of the 17 females in the study, 5 (29.5%) had deformities in the right foot only, 5 (29.5%) had deformities in the left foot only, and 7 (41%) had bilateral involvement of the disease. The distribution for occurrence of the deformity between legs was more homogeneous in females than in males.

The mean age for commencement of the treatment was 7.55 days. Excluding one late-onset patient, whose treatment began in third month of life, the mean age for patients when they presented was 6.45 days.

The mean number of casts applied was  $5.73 \pm 0.8$ . The mean number of casts applied before the achillotenotomy was  $4.81 \pm 0.76$ . Fifty-five patients (92%) required a percutaneous achillotenotomy in conjunction with treatment. The other five patients (8%) did not need an achillotenotomy because they did not experience dorsiflexion restriction. The mean follow-up period was 31.2 months.

The mean Pirani score for the 92 feet from all 60 patients was calculated to be  $3.62 \pm 0.58$  before treatment. After treatment, the mean score fell to  $0.36 \pm 0.42$  on the Pirani scale. The mean Dimeglio score was calculated as  $14.75 \pm 1.55$  prior to treatment; this mean fell to  $4.76 \pm 0.91$  after treatment (Table 1).

	Before the treatment	After the treatment	p
Pirani Score	$3.62 \pm 0.58$	$0.36 \pm 0.42$	$p < 0.05$
Dimeglio Score	$14.75 \pm 1.55$	$4.76 \pm 0.91$	

Table 1: Mean scores ( $\pm$  standard deviation) for the Pirani and Dimeglio scoring systems before and after treatment.

For males alone, the mean Pirani scores before and after treatment were  $3.59 \pm 0.58$  and  $0.33 \pm 0.4$ , respectively. The mean Pirani scores for the females alone before and after treatment were  $3.71 \pm 0.58$  and  $0.44 \pm 0.47$ , respectively. The mean Dimeglio scores for the males alone before and after treatment were  $14.6 \pm 1.51$  and  $4.71 \pm 0.85$ ,

respectively. The mean Dimeglio scores for the females alone before and after treatment were  $15.17 \pm 1.63$  and  $4.92 \pm 1.05$ , respectively (Table 2).

		Before the treatment	After the treatment	p
Pirani Score	Male	$3.59 \pm 0.58$	$0.33 \pm 0.4$	p<0.05
	Female	$3.71 \pm 0.58$	$0.44 \pm 0.47$	
Dimeglio Score	Male	$14.6 \pm 1.51$	$4.71 \pm 0.85$	
	Female	$15.17 \pm 1.63$	$4.92 \pm 1.05$	

**Table 2:** The mean Pirani and Dimeglio scores ( $\pm$  standard deviation) according to the gender.

There were no statistically significant differences between the mean Dimeglio and Pirani scores of males and females before and after treatment ( $p>0.05$ ). No statistically significant difference was found between the mean Pirani and Dimeglio scores for left and right feet before and after treatment ( $p>0.05$ ). Moreover, there were no statistically significant differences between the mean Dimeglio and Pirani scores before and after treatment for patients who had a family history of the disease and those who did not ( $p>0.05$ ) (Table 3).

	Gender	N	Mean	Std. Dev.	p
Pirani Score before the treatment (Right)	Female	12	3.58	0.6	0.874
	Male	38	3.55	0.58	
Pirani Score before the treatment (Left)	Female	12	3.83	0.58	0.322
	Male	30	3.63	0.59	
Pirani Score after the treatment (Right)	Female	12	0.5	0.52	0.17
	Male	38	0.3	0.39	
Pirani Score after the treatment (Left)	Female	12	0.38	0.43	0.954
	Male	30	0.37	0.41	
Dimeglio Score before the treatment (Right)	Female	12	14.83	1.64	0.466
	Male	38	14.46	1.5	
Dimeglio Score before the treatment (Left)	Female	12	15.5	1.62	0.192
	Male	30	14.79	1.52	
Dimeglio Score after the treatment (Right)	Female	12	5.08	1.24	0.163
	Male	38	4.64	0.84	
Dimeglio Score after the treatment (Left)	Female	12	4.75	0.87	0.885
	Male	30	4.79	0.86	

**Table 3:** The comparison of the patients according to the gender and the side.

At the follow-up examinations, 25 feet (27%) from 17 patients (28%) required intervention in addition to the percutaneous achillotenotomy because of relapse. Of these patients requiring additional interventions, 12 feet from 8 patients had a posteromedial release, 8 feet from 5 patients had a complete subtalar release, and 5 feet from 4 patients had an anterior tibial tendon transfer.

## Discussion

Since Ponseti reported the successful results of his technique in 1980s, the Ponseti method has gained popularity [5]. Morcuende, Colburn, and Ablegavad report over 90% of initial correction rates [6-8]. Although surgical interventions such as posteromedial release and anterior tibial tendon transfer are still needed, surgical treatment should be considered only after recurrences in which patients are resistant to recasting. We presented a final success rate of 72% without surgery in this study. This rate might reflect forgoing a second round of the Ponseti method in favor of surgery.

Comparing the results in males and females, right and left feet, and the presence or absence of family history revealed no significant differences. However, the results showed males had better improvements after treatment. Although left feet had higher Pirani and Dimeglio scores before the treatment, left feet in females and right feet in males showed better improvements after treatment. Left feet had higher Pirani and Dimeglio scores in patients with and without a family history of TEV. Left feet had better improvements in the group without a family history, whereas right feet had better improvements in the patients with a family history. Although many studies investigate the outcomes of clubfoot, none reveals differences according to gender, side, or family history. Likewise, this study found no statistical differences. However, the homogeneous distribution according to side in females and higher scores and improvements of the left foot should be investigated by other studies including larger case studies.

Although Ponseti recommended initiating treatment in the first days of life due to the properties of fibroelastic connective tissue in the structure of tendons, ligaments, and joint capsules, Iltar and colleagues propose initiating treatment one month after birth or when the length of the involved foot is 8 cm or more [9]. A study by Alves and colleagues investigates the initiation of treatment with the Ponseti method before and after patients are six months old and finds no significant difference in the correction rates, number of casts, recurrence rates, and the need for tenotomy or other surgical interventions [10]. In another study, Yagmurlu et al., show that initiating the Ponseti treatment after 20 months results in less improvement of varus, adductus, and medial rotation of the calcaneopedal block [11]. Through our clinical experience, we find that early initiation and continuous treatment and observation results in higher correction rates. We therefore recommend that specialists such as radiologists, gynecologists, and pediatricians should be informed about the importance of early treatment in order to correct the deformity. They should be proactive in referring patients to orthopedists in the first day of a patient's life, if possible, despite the finding that the Ponseti method produces good results in neglected patients as well [12].

Family members are commonly asked to soften a patient's cast by soaking it or to remove the cast at home in order to shorten the time between new casts. Lafargue and Morcuende show a significant preference for removing the cast at the clinic rather than removing the cast the previous night at home. Accordingly, removing the cast at the clinic reduces the number of casts required for correction, the duration of correction, and the number of recurrences [13]. We strongly suggest that an old cast should be removed at the clinic just before the new one is applied to limit the amount of time that the foot is not held in a manipulated position.

Although the Ponseti method prescribes weekly casting intervals, some authors, including Ponseti himself, report that two or three castings per week have the same efficiency as weekly castings [14-16]. In addition, two or three castings a week can be safely applied to patients who live nearby or to patients whose families travel from long distances and stay near the clinic or hospital during treatment.

Achillotenotomy is the only part of the Ponseti method that involves surgical intervention. Before achillotenotomy, all deformities except equinus must be corrected. Percutaneous achillotenotomy is a minor intervention compared to other major surgical techniques. Several achillotenotomy techniques are described in medical

literature. Dogan et al., compares percutaneous achillotenotomy and lengthening with Z-plasty in rats and finds no biomechanical difference [17]. Many surgeons prefer to perform a tenotomy under local anesthesia to avoid possible adverse effects of general anesthesia. However, a retrospective study by Prada et al., reports no apnea or general anesthesia-related complications in a series of tenotomies for 182 patients [18]. The most important complication of percutaneous achillotenotomy is neurovascular injuries. Dobbs et al., reports 2% of 200 patients had serious bleeding complications, which were all controlled with compression only [19]. Throughout our clinical experience performing the procedure, we have not encountered cases where patients suffered neurovascular injuries or complications related to anesthesia. It is our opinion that an achillotenotomy should be performed (under general or local anesthesia) as soon as possible when plantar convexity of the foot is first achieved.

The use of orthosis after surgical correction has an important role in the Ponseti technique. The rate of success decreases without the proper use of orthosis [20-21]. In addition, using the appropriate orthosis is equally as important. A study comparing a Denis Brown orthosis with an ankle foot orthosis reveals that patients wearing the Denis Brown orthosis have significantly fewer recurrences [22]. However, Hemo et al., find no significant difference between Denis Brown and Mitchell braces after a minimum two-year follow-up period [23]. Furthermore, there is no scientific proof about the timing of ending the use of orthoses. They can be used three years for patients with a mild deformity or four years for patients with a severe deformity.

If a deformity recurs, the patient's foot should be placed in a cast as soon as possible because the deformity has not yet been treated. Although a number of studies support the finding that surgical treatments have good results after recurrences [24-26], the Ponseti method should be tried before surgery to avoid fibrosis, scar tissue, and possible anesthetic complications. The success rate of the Ponseti method has been corroborated after recurrences of the deformities. This is the case even if the primary treatment technique was the Ponseti method itself. Nagaraju report that when treating 18 feet from 13 patients via the Ponseti method, they achieve well-formed plantigrade feet where previously they had used the Kite method and experienced recurrences of the disease [27]. Nogueira reports that for patients who had unsuccessful surgical treatments, 71 out of 83 feet (86%) were corrected with the Ponseti method and the patients developed plantigrade, fully corrected feet [28]. Recurrences of the deformity are characterized as metatarsus adductus, abduction of foot, loss of dorsiflexion, and dynamic supination, which appears during gait analysis when the patient is walking. Dynamic supination is due to weakness in the peroneal muscles and overcontraction compensation by the tibialis anterior muscle.

## Conclusion

While talipes equinovarus is relatively easy to treat, mistreated or untreated clubfoot disease can cause severe disability, ranking it among the worst musculoskeletal diseases. No conservative method to treat orthopedic diseases is as effective as the Ponseti method. At the present time, the Ponseti method should be the first choice in the treatment of both primary cases of clubfoot and recurrences whether the physician prefers surgical or nonsurgical treatments. In our clinic, we found that while some cases do require surgical management, the first choice in clubfoot treatment should always be the Ponseti method because of its relative success rates, cost-effectiveness, safety, and reduced healing time.

The literature so far clearly points to the Ponseti method as being the gold standard in clubfoot treatment. We therefore feel that the efficacy of new methodologies should be compared with the Ponseti method in order to evaluate their benefit.

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