Congenital idiopathic atypical clubfoot: reordering the steps of modified Ponseti method with minor modification of the technique

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Background
The Ponseti method has shown remarkable success in treating congenital idiopathic clubfoot. However, some feet with complex or atypical presentation do not respond to the standard protocol of manipulation and casting.
Patients and methods
A total of 26 consecutive infants (39 feet) with idiopathic atypical clubfeet, diagnosed according to the clinical criteria proposed by Ponseti, were assessed. The average age at presentation was 13 weeks (range, 2–39). The classic Ponseti technique with reordering of the steps and some modifications was used.
Results
The mean follow-up was for 33 months (range, 20–60). The results of the treatment were evaluated using the Pirani and Dimeglio scoring systems. The mean precorrection Dimeglio score was 17.3 (range, 15–20), and the mean postcorrection Dimeglio score was 3.34 (range, 3–5). This difference was statistically significant ($P<0.001$). A mean of six casts (range, 5–8) were required for full correction. Three (11.5%) patients had a relapse after initial successful treatment and required a second series of manipulation, casting, and redo-Achilles tenotomy. At the latest review, all affected feet were painless, with a mean ankle dorsiflexion of 15° (range, 10–20°).
Conclusion
Reordering the steps of modified Ponseti method for complex clubfeet with some modifications can be successfully used for treatment of infants with atypically presented clubfoot.

Keywords:
atypical, complex, congenital clubfoot, Ponseti method

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Introduction

Congenital idiopathic clubfoot is a deformity that classically happens without other associated anomalies. Pediatric orthopedic reports have shown excellent outcomes in treating these feet using Ponseti technique [1–6].

Turco [7] identified a few number of clubfeet that are resistant to the usual corrective manipulation and casting. He called them atypical and warned against surgery. As a natural progression of a successful technique is to extrapolate it to other purposes through minor modifications, 12 years later Ponseti *et al.* [8] described the characteristics and treatment results for those complex atypical clubfeet. He described these feet as being short and stubby, with marked equinus and cavus deformities, a deep transverse plantar crease just distal to the heel, and apparent shortening and hyperextension of the big toe. Ponseti modified his classic technique to confront the atypical trends shown by those feet [8]. The current literature lacks any following reports exploring such atypical form or reporting the results of their treatment. In our clinic, we have been dedicated to use Ponseti technique in treating children with clubfoot. Consequently, it was crucial to highlight which of these atypical characteristics is mandatory to make the right diagnosis for congenital idiopathic atypical clubfoot (CIAC) and to evaluate our results in treating them using the classic Ponseti technique with few modifications.

Patients and methods

A prospective study of 26 patients (39 feet) with CIAC treated by Ponseti technique with minor modifications was conducted from March 2011 to August 2014 in Minia University hospitals (Table 1). The study was approved by the institutional ethics committee in the Orthopedic Department of Orthopaedic Surgery, Minia University, Cairo, Egypt. Institutional review

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board approval was obtained. Patients enrolled in the study were considered to have CIAC as they showed all characteristics of complexity as described by Ponseti *et al.* [8] (Fig. 1). A total of 16 (55%) patients had received plaster treatment elsewhere before their initial visit to us without obvious information about the technique of manipulation and casting that has been used. Overall, 17 (65%) patients were boys. Bilaterality was recorded in 13 (50%) patients. Two (7.5%) patients had a positive family history for clubfoot. The average age at presentation was 13 weeks (range, 2–39). All were Egyptian, including 22 whites and four of African descent. Thorough clinical examination of the spine and hip was routinely done. Patients aged more than 1 year at presentation and those with syndromic clubfoot were excluded.

Patients' information including characteristics and demographic data were recorded in a single sheet for each patient. Atypical characteristics were reported. Clinical photographs were taken, and severity of deformity for all feet was initially assessed using Dimeglio system [9]. Pirani *et al.* [10] severity scoring system was used to score all feet every time before manipulation and casting.

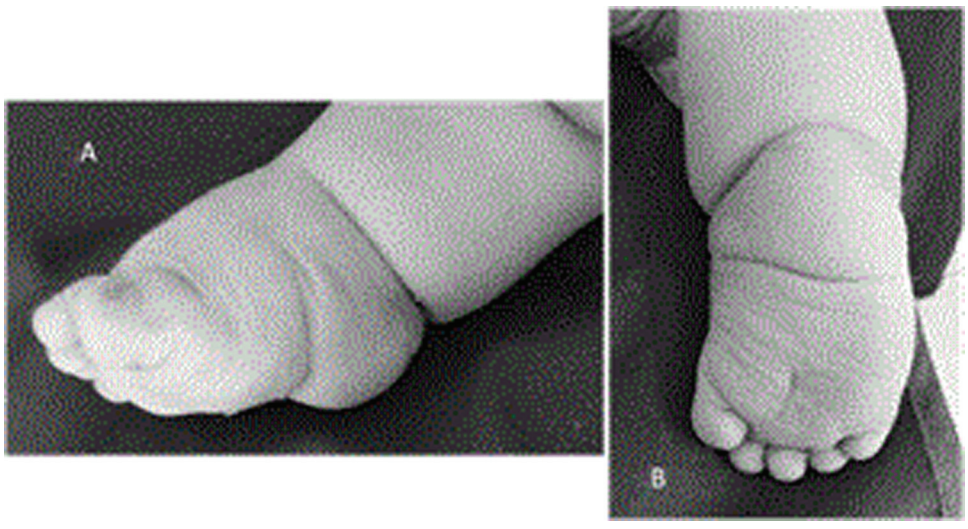
Table 1 Demographic data for all patients (*N*=39 clubfeet in 26 patients)

Variables	
Age (weeks)	13 (range, 2–39)
Male	17
Right side	19
Left side	20
Bilaterality	13 (50)

We adherently followed the modified technique of Ponseti regarding identification of the subtalar joint and localization of the talar head in complex clubfoot. However, we did not start with forefoot abduction as advised. Instead, the first two casts were solely focused on correction of the plantaris deformity. This was achieved by placing not only the index finger underneath the first metatarsal head as originally described in the classic technique but also using the neighboring middle and occasionally the ring finger to lift all dropped metatarsal heads in the dorsal wards while supinating the forefoot (Fig. 2). Fainting of the deep sole crease was used as a predicting sign to initiate forefoot abduction. Abduction of the forefoot was carried on till 70° or rarely lesser if a midfoot break at the lateral column was noticed. Groin-to-toe plaster cast was changed on weekly basis. Finally, the equinus was corrected via a percutaneous tendo-Achilles tenotomy. It was performed using local anesthetic cream, and afterward, patients were immobilized in plaster for 3 weeks. After removal of the last cast, the corrected feet were placed in a locally manufactured version of Markell abduction brace with 70° outer rotation of the affected side. The original design of the brace was modified to monitor and deal with any uprising problems (Fig. 3).

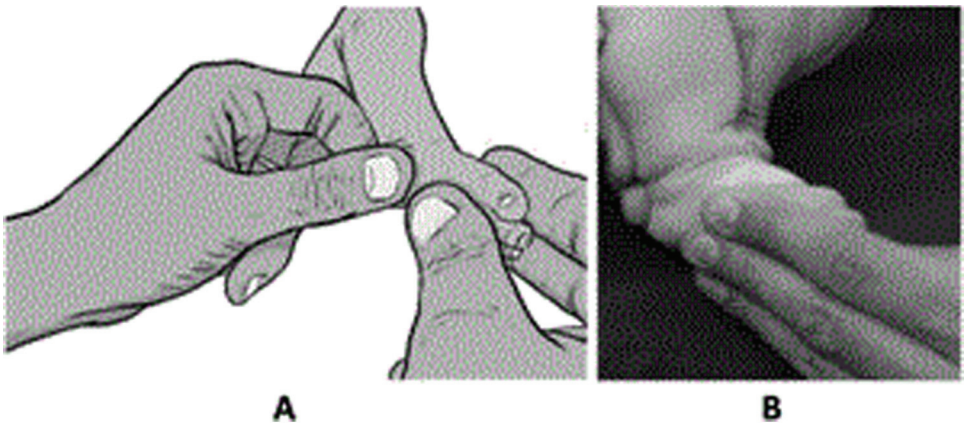
The degree of ankle dorsiflexion after tenotomy, foot length discrepancy in unilateral cases, and problems with casting and abduction brace if any were reported. After 3 months of bracing, clinical photographs were taken and feet were reassessed for deformity correction using Dimeglio score. Relapses were treated by a second series of manipulation, casting, and redoing

Figure 1



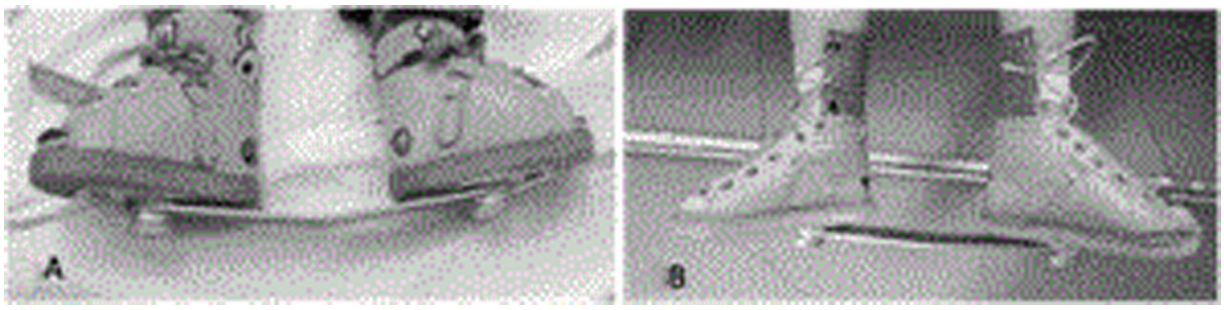
A 4-month-old infant with idiopathic atypical clubfoot. She had (a) marked equinus of the ankle and plantar flexion of all metatarsals shown by (b) a deep transverse crease above the heel and another deep plantar crease just distal to the heel.

Figure 2



(a) An illustration shows stabilization of the talar head while fully supinating the forefoot to be realigned with the hindfoot. (b) Photograph demonstrates the three-finger technique used to dorsiflex the dropped metatarsals.

Figure 3



A photograph shows (a) the locally manufactured version of foot abduction brace with small aperture at the inner aspect of the heel to monitor the heel.

of tenotomy when needed. The mean follow-up was 33 months (range, 20–60). No patients were lost to follow-up.

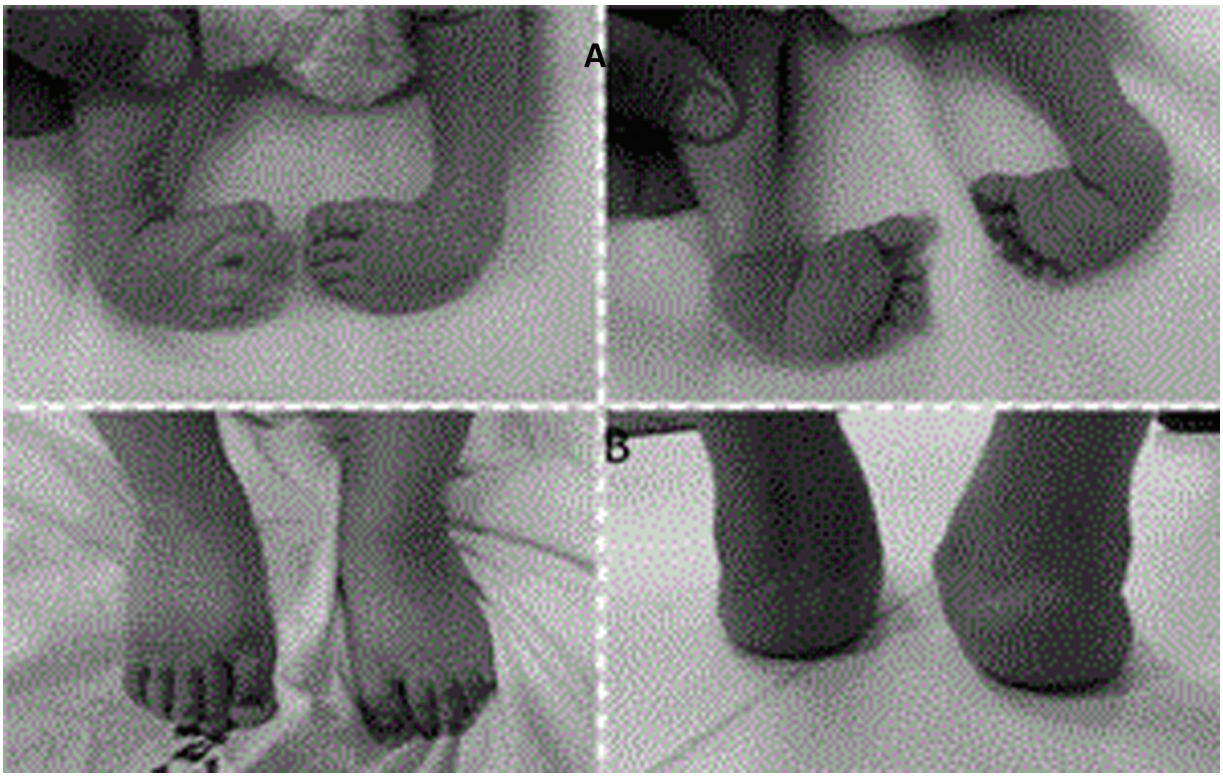
Results

Correction was obtained with a mean of six casts (range, 5–8). At the latest follow-up visit, all feet but one that had a remarkable dynamic supination were painless and nicely corrected with mean ankle dorsiflexion of 15° (range, 10–20°) (Fig. 4). There was a minimal residual cavus deformity in two patients that could be passively corrected. For all feet, the mean precorrection Dimeglio score was 17.3 (range, 15–20) and the mean postcorrection Dimeglio score was 3.34 (range, 3–5). This difference was statistically significant ($P<0.001$). Initially all feet scored six points on Pirani scoring system before doing the tenotomy, which was improved to a mean of 2.1 (range, 2–2.5) following correction. The positive final scoring recorded in all patients was attributed to hindfoot clinical signs only (Table 2). The average foot length discrepancy in unilateral cases was 1.5 cm (range, 1–2 cm).

Three (11.5%) patients had a relapse after initial successful treatment, and one had a second relapse. Recurrence was for equinus and adductus deformities only. The average time from initial correction till diagnosis of first relapse was 14 weeks (range, 6–20 weeks). Second relapse was noticed 12 weeks after the first one. Relapses were mostly linked to the abduction brace and were managed by another series of manipulation and casting (two casts for one patient, seven casts for another patient, and three casts for relapse for the patient who had two relapses). A second Achilles tenotomy was performed for two patients with the first relapse, whereas the third one had it once with the second relapse.

Six (23%) patients had minor complications [mild swelling of the forefoot and toes in two patients (resolved later), plaster sore in two patients, midfoot break in one patient, and obvious dynamic supination in the last one]. For the two patients with sore over the talar head, we stopped serial casting till the ulcer was healed and then manipulation was gently resumed; this can explain why one of them needed nine casts to

Figure 4



(a) Photographs for a newborn with atypical clubfeet before treatment. (b) At 2-year follow-up, after manipulation showing good alignment of the forefoot and hindfoot.

Table 2 Precorrection and postcorrection values (*N*=39 clubfeet in 26 patients)

Variables	Precorrection score	Postcorrection score
Dimeglio	17.1 (range, 15–20)	3.5 (range, 3–5)
Pirani	6	2.1 (range, 2–2.5)

achieve full correction. Tibialis anterior transfer is scheduled for the patient with dynamic supination once his lateral cuneiform is radiologically ossified.

Discussion

A limited number of clubfeet are very severe and difficult to treat. They have been called stiff-stiff [7] and typically score 10 on the Carroll severity scale [11].

Ponseti identified such complex feet and treated them after modifying his technique. No reports have been released since then examining the complex clubfoot or supporting his results. He noticed that equinus and cavus deformities are the most resistant for correction and attributed that to the severe fibrosis of the gastrocsoleus complex and intrinsic plantar muscles and ligaments compared with the structures on the medial side of the foot that could be stretched easily [8]. Our results support this explanation as all patients in this study had remarkable degrees of equinus and plantaris deformity besides other atypical characteristics.

In plantaris deformity, all metatarsals are pronated and misaligned with their relevant medially displaced tarsal bones. Correction of this deformity requires bringing the metatarsals, cuneiforms, navicular, and cuboid onto the same plane of supination. All these structures together form the lever arm necessary to laterally and slightly downwardly displace the navicular and the cuboid and unlock the calcaneus from underneath the talus [12]. Dr Ponseti has changed the order of his technique when he dealt with the complex feet. He abducted the forefoot before dorsiflexing the plantar flexed metatarsals and warned against forefoot abduction beyond 40°. We were determined to realign the forefoot with mid and rear foot first before abducting it. That was achieved by dedicating our first two and occasionally three manipulations and casting only to correct the cavus deformity via supinating the forefoot and dorsiflex all metatarsals using our two-finger or sometimes three-finger technique. Afterward, the tarsal bones were moving in synergy with each other and with their metatarsal counterparts, helping us to abduct the forefoot beyond 40° in the majority of patients without leaving a lateral midfoot breach.

We used Dimeglio score [9] as a quantitative measure of the deformity to differentiate between the more commonly presenting moderate and severe idiopathic clubfeet, and patients in this study who were classified very severe. Ponseti *et al*. [8] did not use a scoring system to initially assess the deformity or to monitor their progression during manipulation and casting but counted on the final shape of the foot and its range of motion only. On the contrary, we found that weekly looking at Pirani scores ensured that feet are on the right track for correction and helped us to pick up any uprising problems.

Most of the figures in our and Ponseti's work were comparable, apart from patients' sample size. In the current study, 26 patients with 39 feet were treated, whereas Ponseti had the chance to evaluate and treat almost two-folds of our patients (50 patients, 75 feet) with 68% of them had received initial treatment before presentation to his clinic.

The limitations of this study include the small sample size of the patients. However, the low incidence of such atypical style of clubfoot deformity besides short period of follow-up can explain that. There was no radiographic follow-up in this study. As Ponseti, we found that the foot's shape and dorsiflexion improved after few months; therefore, we have not found it necessary to obtain radiographs, particularly when interpretation of foot's radiographs in such young age group would be difficult and more prone to intraobserver and interobserver reliability issues. Finally, the average duration of follow-up was 33 months only. Because the majority of relapses in clubfoot will happen in the first 2 years of life, and also correction of deformities was maintained for few months after finishing cast, we think it is unlikely for a higher rate of relapse to happen in complex atypical clubfeet.

Conclusion

Reordering the steps of modified Ponseti method starting with cavus correction with some modifications will be logical for treatment of infants with atypically presented clubfoot and will ensure normal development of the foot.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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