

Management of atypical clubfoot by the modified Ponseti technique—a consecutive series of 10 cases

—Modified Ponseti technique for atypical clubfoot—

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Abstract : **[Introduction]** Complex (atypical) clubfoot represents a small proportion of idiopathic clubfoot and is characterized by deep creases above the heel, a transverse crease in the sole of the foot, rigid equinus, severe plantar flexion of all metatarsals and a fibrotic and tight Achilles tendon. These feet respond poorly to the conventional techniques of manipulation and are associated with poor surgical outcomes. Ponseti described a modification of his technique for correction of such clubfeet. We describe our experience with this modified technique in ten such feet.

[Materials & Methods] All idiopathic clubfeet presenting to our outpatient department that had atypical features were taken up for the modified Ponseti technique of correction. Percutaneous Achilles tenotomy was done in all cases. Correction was maintained in ankle foot orthoses (AFO). Results were evaluated using the Dimeglio and modified Pirani Scoring systems.

[Results] 10 clubfeet in 8 children (7 males, 1 female) in the age range of 2 weeks–11 months (mean age 5.6 months) were treated by this technique. The deformity was right sided in 6 cases and bilateral in 2 cases. At the initiation of treatment, the average Pirani Score was 4.65 (range 4–5.5) and Dimeglio Score was 15.4 (range 13–17). After completion of treatment all feet were well corrected. Relapse occurred in two feet within 6 months of treatment; both were related to poor compliance with the AFO bracing and both were managed by re-manipulations and a second percutaneous Achilles tenotomy. Extensive surgery was not needed in any case. The average duration of follow-up was 13 months (range 10–18 months).

[Conclusion] Early recognition of complex (atypical) clubfeet is of paramount importance to ensure good results. The modified Ponseti technique of manipulation gives good and predictable results in such cases and also obviates the need for extensive surgical correction.

Key words : clubfoot, casts, Ponseti

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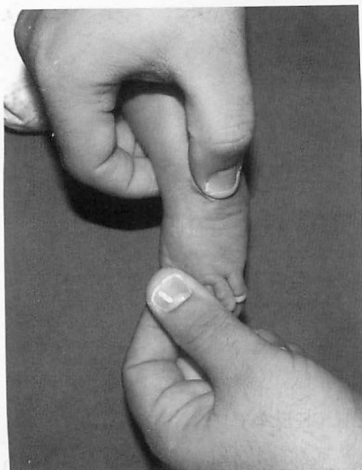


Fig. 1. Palpation for motion at the subtalar joint



Fig. 2. Manoeuvre for abduction. In addition to the thumb pressing over the talar head, the index finger should rest against the lateral malleolus.

Introduction

The treatment of idiopathic clubfoot has been revolutionized by introduction of the Ponseti technique⁷. Using this technique, various authors have reported successful correction rates ranging from 82–95%⁽¹⁵⁾⁽¹¹⁾. However, there remains a small subset of idiopathic clubfoot that resists manipulative correction and is associated with poor surgical outcomes⁸. These have been termed as ‘complex’, ‘atypical’ or ‘stiff-stiff’ feet by different authors²⁾⁽⁸⁾⁽¹⁰⁾. Ponseti identified the patho-anatomic factors that rendered such feet resistant to correction and also described a modification of his original technique for manipulative correction of these feet⁸. We describe our experience with this modified Ponseti technique in ten cases of idiopathic atypical clubfoot.

Materials & Methods

Study Design & Study Period

This prospective study was conducted in our institution from July 2009–January 2011. The study was approved by the Institutional Ethics Committee. Informed and written consent was obtained from the parents of all infants.

Inclusion & Exclusion Criteria

Consecutive cases of idiopathic atypical club-

foot less than one year of age were included in this study. Cases above one year of age and those with non-idiopathic clubfoot (neurologic or syndromic clubfoot) were excluded from the study.

The Modified Ponseti technique–Manipulation Phase

We followed the modified technique of manipulation and casting as described by Ponseti et al⁸. The key to this technique is precise identification of the subtalar joint and the head of the talus and the surgeon uses both hands during manipulation. The forefoot is grasped with one hand while the thumb and index finger of the other hand palpate the malleoli from the front with the. The thumb and index finger are then slid down to grasp the head of the talus. In this position, the navicular can be palpated on one side and the anterior tuberosity of the calcaneus on the other side. Movement at the subtalar joint can be appreciated by the thumb and the index finger when the foot is slowly abducted (Fig. 1). Ponseti reported that this motion was minimal at first but could be felt after removal of the second or third plaster cast. The steps of the modified Ponseti technique⁸ have been described below :

Step 1—Correction of forefoot adduction and heel varus : Correction begins with abduction of the foot (and not correction of the cavus, as



Fig. 3. Manoeuvre for cavus correction. All metatarsals are simultaneously dorsiflexed and the heel is slightly abducted.

done in the original Ponseti technique⁷⁾). To ensure that the pressure is applied over the talar head during abduction, the index finger should rest over the posterior aspect of the lateral malleolus while the thumb of the same hand applies counter pressure over the lateral aspect of the head of the talus (Fig. 2). Adduction of the forefoot can be corrected easily after one or two manipulations and weekly plaster cast applications. The goal is to bring the foot into a position that is between neutral to 40 degrees of abduction. Hyperabduction to 70 degrees (as done in the original Ponseti technique⁷⁾) is avoided. With the pressure correctly applied over the talar head and by using the lateral malleolus as an additional leverage point, the heel varus can be corrected simultaneously⁸⁾.

Step 2—Cavus correction : To correct the cavus of the foot, all the metatarsals are dorsiflexed forcefully simultaneously. The forefoot and heel are maintained in slight abduction (Fig. 3). Casting in this position is continued till plantar-flexion of the metatarsals decreases⁸⁾.

Step 3—Equinus correction : The equinus deformity is usually very severe in atypical clubfeet and therefore Ponseti recommends a Percutaneous Achilles tenotomy in all such cases⁹⁾. The final cast is applied in maximal dorsiflexion and slight abduction for three weeks.



Fig. 4. The custom made brace used for maintenance phase.

Maintenance Phase

In his subset of atypical feet, Ponseti performed bracing in 40 degrees of abduction in a new brace that consists of soft, premolded, and well-adjusted sandals with three straps to firmly hold the foot in place⁸⁾. However, we used an ankle foot orthoses (AFO) that consists of well fitting, custom made boots (Fig. 4). Bracing is continued for 23 hours a day for the first three months and subsequently as per the 'nights and naps' protocol (i. e. bracing during the night and when the child is sleeping during the day) till four years of age.

Outcome measures

The severity of deformity was measured by the Dimeglio and the 6 point modified Pirani scores²⁾⁶⁾. Scoring was performed before initiating treatment and subsequently at every visit. We also noted the total number of casts used, the total duration of treatment, relapses, compliance with bracing, complications and the total duration of follow-up.

Results (Table 1)

A total of 128 cases of idiopathic clubfoot presented to us within the study period. Of these, 10 feet (7.8%) in 8 infants were found to have atypical features. The mean age was 5.6 months (range 0.5-11 months). Males predominated in the study group (male : female ratio - 7 : 1).

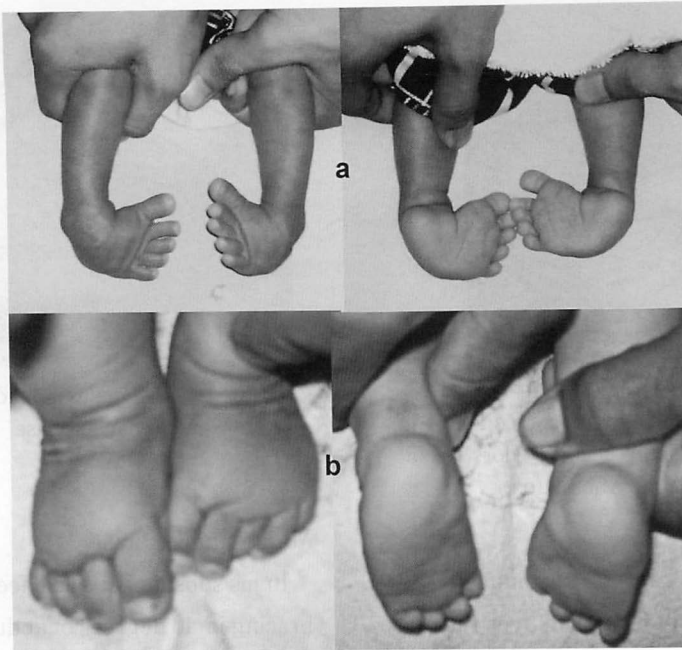


Fig. 5. 1 month old infant with atypical clubfoot treated by the modified Ponseti technique

a : Prior to manipulation

b : At the end of corrective phase. Oedema of the dorsum of foot is noted, which resolved spontaneously within 3 days.

Bilaterality of the atypical features was noted in two cases. The right side was predominantly involved (right : left ratio $-1.5 : 1$). 5 feet had never received any form of treatment and in the other 5 feet, prior manipulative correction had failed (although it was not clear which method of manipulative correction had been used). At presentation, the mean Pirani score was 4.65 (range 4-5.5) and the mean Dimeglio score was 15.4 (range 13-17). An average of 6.9 cast changes (range 5-10) was needed for correction. Percutaneous Achilles tenotomy was performed in all cases. The average duration of the corrective phase was 8.9 weeks (range 7-12 weeks). At the end of the corrective phase, the mean Pirani score was 0.4 (range 0-0.5) and the mean Dimeglio score was 0.5 (range 0-2). All feet were well corrected at treatment, however persistence of the deep plantar crease was noted in 3 cases, persistence of the posterior crease in 2 cases and a partially 'empty-heel' in 5 cases.

Relapse of all components of the deformity occurred within the first 6 months in 2 cases where the parents were non compliant with the bracing protocol. Both cases were managed by re-manipulation, casting and repeat percutaneous Achilles tenotomy. Extensive surgery was not needed in any case. Two cases developed skin ulceration and subsequent superficial wound infection that responded to topical Neomycin. In both cases, it was found that flexion of the knee beyond 90 degrees had led to formation of a sharp cast edge in the region of popliteal fossa. Oedema of the dorsum of foot was noted in two cases after removal of the last cast which resolved with elevation of the limb (Fig. 5). The average duration of follow-up was 13 months (range 10-18 months).

Discussion

Although there are no set diagnostic guidelines to label a case of idiopathic clubfoot as 'atypical',

Table 1.

SNO	AGE (months)	SEX	UL/BL	SIDE	PRIOR CASTING	PS-I	DM-I	PS-F	DM-F	TOTAL CASTS	TOTAL DURATION (WEEKS)	COMPLICATIONS	TOTAL FU (MONTHS)
1	11	F	UL	L	Y	5	15	0	0	7	9	Superficial skin infection	10
2	5	M	BL	L	N	4.5	13	0.5	1	8	10	Nil	10
3	5	M	UL	R	N	4	16	0.5	0	10	12	Nil	10
4	2	M	UL	R	N	5.5	17	0.5	2	5	7	Oedema	12
5	9	M	BL	R	Y	5	17	0.5	0	6	8	Relapse. all components	18
6	1.5	M	BL	R	N	4.5	14	0.5	0	6	8	Nil	16
7	2	M	UL	R	Y	5	17	0.5	1	8	10	Relapse. all components	14
8	0.5	M	UL	L	N	4.5	16	0.5	1	6	8	Oedema	14
9	10	M	BL	R	Y	4.5	14	0.5	0	7	9	Nil	13
10	10	M	BL	L	Y	4	15	0	0	6	8	Superficial skin infection	13

UL : Unilateral, BL : Bilateral, PS-I : Pirani Score-Initial, PS-F : Pirani Score-Final, DM-I : Dimeglio Score-Initial, DM-S : Dimeglio Score, Final, FU : Follow-up

several unique features have been described that can help in the identification of such feet. The atypical clubfoot is short and chubby. There is severe equinus deformity at the ankle and a deep posterior heel crease. All metatarsals are in severe plantar-flexion, the great toe is short and hyper-extended and a deep crease is present on the sole⁸⁾.

The treating surgeon must develop a good understanding of the patho-anatomic factors that are unique to atypical clubfoot before attempting manipulative correction. In 'typical' clubfoot, there is fibrosis of the gastrosoleus and long toe flexor muscles, fascia and posterior ankle and medial tarsal ligaments⁹⁾. However, as pointed out by Ponseti, atypical clubfoot is characterized by fibrosis primarily in the gastrosoleus and the plantar intrinsic muscles and ligaments. The medial ligaments do not show much fibrosis and therefore the forefoot adduction is easily correcta-

ble. However, fibrosis of the quadratus plantae muscle that inserts into the long toe flexors can lead to persistent hyper-abduction and worsening of the cavus after faulty manipulations. Therefore, it is important not to abduct the foot beyond 40 degrees. Cavus in a case of atypical clubfoot is attributable to the tightness and shortening of the intrinsic plantar muscles of the foot that leads to severe plantarflexion of all metatarsals. This is contrast to the 'typical' clubfoot where cavus is due to isolated plantarflexion of the first metatarsal. Therefore, it can be easily understood that cavus correction in atypical clubfoot can be achieved only by simultaneous and somewhat forceful dorsiflexion of all metatarsals. The severe equinus at the ankle is due to a long, wide, exceptionally tight Achilles tendon that is fibrotic up to the mid-calf and requires tenotomy for correction⁸⁾.

Our results with this technique, although short

term, were quite encouraging. Excellent correction was possible in all feet in a relatively short span of time. The need for major surgical release was obviated in all cases. Although relapses occurred in two cases, they were related to non-compliance with the bracing protocol and could be managed with re-manipulations and repeat percutaneous Achilles tenotomy.

Some of the difficulties that we encountered with this technique and suggestions to overcome them have been described below :

1. Palpation of the anatomical landmarks : Accurate palpation of the head of talus can be difficult small chubby feet. We therefore routinely marked all the landmarks viz. the lateral malleolus, head of talus and medial malleolus prior to manipulation.
2. Cast application : In our experience, the small and chubby feet were difficult to hold during cast application and in absence of a good hold on the foot, adequate abduction or dorsiflexion were difficult. To overcome this problem, the foot was held in the desired position of correction by the surgeon prior to starting casting. Also, care was taken to ensure that the cast application was initiated from the tips of the surgeon's fingers that were holding the foot so as to have a good hold. The excess plaster was trimmed off after setting.
3. Skin ulceration in the popliteal fossa : As described by Ponseti⁸⁾, all casts in the present study were supplemented by an anterior plaster slab and required 110 degrees of flexion at the knee to prevent slippage. The cast was applied in two stages ; in the first stage below the knee and in the second stage it is extended to above the knee along with an anterior plaster slab. We found that flexion of the knee after application of the cast produced a sharp cast edge in the region of the popliteal fossa that causes skin ulceration. To overcome this problem, we placed the knee in the desired amount of flexion prior to application of cotton wool and posterior slab. Copious and fluffy cotton wool was applied at the knee and thigh. Any attempt to change this position of the knee while the cast is setting was avoided.
4. Oedema of foot : As advised by Ponseti⁸⁾, casting was stopped in presence of oedema of the foot as it leads to frequent cast slippage and vascular compromise. Limb elevation was encouraged and casting was resumed once the oedema had subsided.
5. Residual skin changes and deformities : Residual skin changes were noted in five cases and included deep plantar crease in three cases and persistent posterior crease in two cases. A mild degree of residual heel varus, demonstrated clinically by 'empty heel' was noted in three cases. Ponseti showed that the heel varus corrects with hyper-abduction of the forefoot, due to stretching of the medial ligaments⁷⁾. We speculate that since the modified Ponseti technique discourages hyper-abduction, the heel varus may remain under corrected in some cases. The residual changes notwithstanding, we could achieve plantigrade, normal looking feet in all cases.
6. Bracing : Ponseti et al. have recommended the use of custom made sandal braces (Mitchell Brace)⁸⁾. However, such braces are not available routinely in our setup. Instead, we preferred to use well fitting customized boots fitted on adjustable bars

to control the rotation of the foot. The cost of the AFO brace that we used is approximately \$12(900 Japanese Yen).

Our results are comparable to those of Ponseti et al⁸⁾, who achieved correction in all of their atypical feet and relapses in 14% of their cases (20% in the present study). However, three of our patients had a mild degree of residual heel varus whereas this was not reported in any case by Ponseti et al. in their series. This was noted in the early cases and could represent our 'teething problems' with this technique.

In a retrospective review, Yoshioka et al. reported peroneal nerve dysfunction in 10 cases out of a total of 111 patients with atypical clubfoot. The clinical spectrum of peroneal nerve dysfunction included weakness of toes dorsiflexion, ankle dorsiflexors and foot everters. None of these patients had a hyper-extended toe, which is one of the main characteristics of atypical clubfoot. Only three feet recovered from the nerve dysfunction. However, the authors reported that the modified Ponseti technique was able to correct all such feet and obviated the need for extensive surgical procedures¹²⁾. Edmonds et al. described the 'drop-toe sign' which is indicative of peroneal nerve dysfunction. With the infant's toes resting in plantarflexion, the sole of the foot is stimulated gently. Normally, dorsiflexion of the toes occurs and absence of dorsiflexion indicates peroneal nerve dysfunction³⁾. In this study, none of the patients had a positive 'drop-toe' sign or other clinical features suggestive of peroneal nerve dysfunction.

There are several limitations of this study. Although it was a prospective study, the sample size was small owing to the fact that atypical clubfoot is rare. In absence of a control group, we cannot compare the results of this technique with

other techniques. Radiographs were not obtained routinely in our patients. However, it has been noted that radiographic parameters lag behind clinical parameters and are therefore of limited use in monitoring the response to treatment. Furthermore, it has been shown that once the foot is corrected clinically, the bones develop normally⁴⁾. Finally, the duration of follow-up in this study was short (mean : 13 months). Therefore, our results represent only the early outcomes of this technique. However, it has been shown by Ponseti that relapses are infrequent if strict adherence to bracing is maintained and correction of relapses is possible by re-manipulation and limited surgical procedures like repeat tenotomy or open lengthening of the Achilles tendon⁸⁾.

To conclude, we believe that the modified Ponseti technique is a good alternative for manipulative correction of atypical clubfoot as shown by excellent short-term results of our study. However, more studies with larger number of cases and a longer duration of follow-up are needed to convincingly prove the benefit of this technique.

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None

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