doi: https://doi.org/10.5704/MOJ.2607.003

Early outcomes of Modified Ponseti Method of Manipulation for Management of Cases of Atypical Clubfoot in Children

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Date of submission: 22nd December 2024
Date of acceptance: 18th June 2025

ABSTRACT

Introduction: Atypical clubfoot forms a small subset of idiopathic clubfoot, features of which are more severe, is difficult to treat using normal Ponseti casting, and treatment often requires modifications. We therefore undertook this study to evaluate the role of modified Ponseti method of manipulation in management of atypical clubfoot.

Materials and methods: We evaluated 30 atypical clubfeet in a prospective, descriptive study conducted at a tertiary care centre in central India and used modified Ponseti casting for its management. Achilles tenotomy was performed in all patients, followed using a foot abduction brace. All children of age less than three years, presenting with features of atypical clubfoot were included in the study. Children with typical or having secondary clubfoot or with history of previous surgical treatment were excluded from the study. Children were followed-up for minimum of six months after tenotomy. Severity assessment was done using Pirani score.

Results: Our study included 30 feet in 18 children (12 bilateral and 6 unilateral) and Male to Female ratio was 2:1 (12:6). On an average 9.44 casts were required for correction in each foot and mean treatment duration was 11.44 weeks. Three patients had excellent results, 25 had good and 2 had poor results. Second tenotomy was required in two cases. Complications included pressure sores in 8 patients, cast slippage in 13/267 casts and relapses in 2 patients.

Conclusion: Management of Atypical Clubfoot is a challenge for orthopaedic surgeon, early identification and treatment with modified Ponseti technique provides good to excellent results in most of the patients and reduces the need for major surgical intervention.

Keywords:
atypical clubfoot, modified ponseti method, pirani scoring, tenotomy

INTRODUCTION

Clubfoot or Congenital talipes equino varus is amongst the most common congenital deformity in paediatric population with incidence of 1.18 per 1000 live births (range 0.9-1.8)[1]. Ponseti's[2] casting technique is a well-known method, which avoids corrective surgery in 90% of cases[3]. It works on the principle of kinematic coupling[4] and the concept of a calcaneo-pedis unit[5]. For practical purposes, we can imagine the foot to be having two major moving components. The entire foot except the talus behaves as a single unit, i.e. the Calcaneal-pedal unit and movement occurs between this unit and a tibio-talo-fibular unit. Serial manipulation is started as soon as the lanugo sheds off, cavus is corrected first, followed by simultaneous correction of forefoot abduction and heel varus by abducting the feet using Talwar head as the fulcrum. Equinus is corrected at last by doing a percutaneous tendo-Achilles tenotomy.

Atypical clubfoot was first identified by Ponseti himself, where he reported 50 out of 762 consecutive patients (7%) with the deformity[6,7]. Incidences are reported between 9-17% in other papers[7,8]. It represents a spectrum of non-neurogenic, non-syndromic feet, which is difficult to treat with normal Ponseti casting method. Clinically, atypical clubfoot was defined as having short, stubby feet with rigid equinus, severe plantar flexion of all metatarsals and a short and hyperextended first toe. The Achilles Tendon is exceptionally tight and fibrotic up to the middle of the calf[5]. History of cast slippage is usually present.

Etiology of atypical clubfoot is not clear, initially it was thought to be iatrogenic, where it was believed that idiopathic clubfoot become atypical because of improper casting technique. Application of poorly moulded, rigid cast on stubby foot results in forced plantar flexion of the foot inside the cast, additionally, non-conformability of the

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plaster material result in secondary deformities, erythema and swelling of the foot[7]. Of late, intrinsic factors such as fibrosis in muscles or a short gastric-soleus is thought of as a causative factor in predisposed feet after an ill-fitting cast. Severe fibrosis of quadratus plantae and intrinsic ligaments around the foot were also described as the culprits by Ponseti[6].

Ponseti *et al*[6], Mandlecha *et al*[9], and Gupta *et al*[10] demonstrated good outcomes of modified Ponseti's technique of manipulation in atypical clubfoot. Hence, this study was done to assess the early outcomes and efficacy of this technique of casting in management of such atypical clubfoot.

MATERIALS AND METHODS

The study was a prospective, descriptive study, done at Department of Orthopaedics and Traumatology, MGM Medical College, Indore, between September 2022-September 2024 in 30ft with features of atypical clubfoot. Minimum follow-up was done for six months after tenotomy. Children presenting with clubfoot in out-patient department were screened and following atypical features were noted (Fig. 1): history of slippage of well applied cast, plantaris crease (transverse crease across the sole), small and cocked up great toe, short, swollen and chubby foot, deep crease in the skin above the heel, foot rigidly flexed plantarwards with a tight, wide and long heel cord. Such children with age less than three years and at least three features were included in the study. Children above three years were excluded from the study, as most of them, by the time of presentation at our setting develop secondary features because of walking on deformed feet, which might have created bias in the study. Children with typical idiopathic clubfoot, secondary, neurogenic or syndromic clubfoot and with history of previous surgical treatment were excluded from the study.

All casts (plaster of paris 6-inch rolls cut in half) were applied by the first, second, and third authors, of which, two are consultant in orthopaedics and one is a senior resident in same department. Patients were treated with following modifications to Ponseti's technique[6,11]: (1). Four finger Ponseti protocol (Fig. 2) was used, (2). All casts were applied with hyper flexion of knee (110°), (3). Cavus and hind foot equinus were corrected simultaneously by holding the foot by the ankle with both hands, keeping index fingers on both sides of talus, while pushing with two thumbs under metatarsal heads, (4). Cast was well moulded, careful moulding was done at popliteal fossa, anterior tibia and ankle joint (5). Toes were aligned with plantar support, (6). Foot abduction was gradually done up to 40°, until talar head coverage was complete, (7). Percutaneous tendoachillis tenotomy was performed in all cases under general anaesthesia. Patients were called weekly for change of casts and Pirani Scoring[12,13,14] was done on all visits. A Pirani score of 0.5 was taken as excellent, score of 1 and 1.5 was taken as good and a score of more than or equal to 2 was taken as poor result. Tenotomy was done when score of lateral head of talus was zero, heel was in valgus and foot was in 40° abduction (midfoot score of < 1 and hind foot score of more than or equal than 1). Following tenotomy, an above knee corrective modified Ponseti cast was applied for three weeks, after which, a Steenbeek type foot abduction brace was given in maintenance phase. Brace was set at 40° of external rotation on affected side in both unilateral and bilateral cases. Bracing was advised for 23 hours per day for the initial 12 weeks, followed by nighttime and during the naps use for 3 years. Once the brace was applied, the child was first called two weeks after application of brace, thereafter monthly till at least six months after tenotomy. In case of a relapse, manipulation and casting was started again, a second tenotomy was done if the foot failed to achieve 5° of dorsiflexion. The total number of casts required, duration of treatment in weeks, co-relation of age at presentation with treatment duration, improvement in Pirani's score and number of relapses were noted and taken into account while analysing outcomes of modified Ponseti casting in this atypical clubfoot.

RESULTS

Our study included 30 atypical clubfeet, total 18 patients (30ft), out of which 2 patients (3ft) dropped out. Twelve cases were bilaterally affected and six were having unilateral affection (including dropouts). There were 12 males (20ft) and 6 females (10ft) (2:1). Twelve cases were bilateral and six were unilateral (Fig. 3). Average age at presentation was 4.5 months. Average number of casts required for correction was 9.44, the mean time of 11.4 weeks for correction. In general, a greater number of casts were required with increasing age at presentation, at the same time, increasing the duration of treatment in such children. A total of 21 feet in our study who presented at an age of less than 3 months required an average of 6.9 casts and 8 weeks for correction. On the other hand, those who presented late i.e. after 6 months required an average of 14 casts and 16 weeks to achieve similar results (Fig. 4 and Table I).

Four patients (7 feet) out of those had been treated elsewhere with corrective Ponseti casting, all had a history of slippage of cast, 4 had all atypical features described previously, all patients had short and hyperextended first toe (30), 26 had a deep plantar crease. Prevalence of atypical features in our study population is described in Table II.

Tendoachillis tenotomy was done in all patients, two patients required a second tenotomy. The mean Pirani score at first visit was 4.81 and at 6 months, it was 0.9, which was significant (p-value <0.05). Three patients had excellent results, 25 had good and 2 had poor results at the end of 6 months after tenotomy, based on Pirani scoring (Table III).

Table I: Relationship of average number of modified Ponseti casts and duration of treatment for correction of atypical clubfoot with age at presentation.

	Age at presentation	Average number of casts required	Mean treatment duration
1	< 3 months (21 feet)	(145 casts)	8 weeks
2	> 6 months (5 feet)	13.5 (61 casts)	15.5 weeks

Table II: Prevalence of atypical features in study population.

	Atypical features	Number (feet)	Percentage
1	History of slippage of cast/ previous treatment with Ponseti cast	7	23.3%
2	Short, hyperextended 1st toe	30	100%
3	Deep plantar crease (plantaris)	26	86.6%
4	Swollen, chubby foot	27	90%
5	Rigid equinus	11	36.6%
6	Deep posterior crease above heel	20	66.6%
7	Tight, wide and long heel cord	14	46.6%

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Table III: Pirani scores at six months after tenotomy.

Pirani scores at six months	Grade	Number	Percentage
<1	Excellent	3	10%
1- <2	Good	25	83.3%
>/= 2	Poor	2	6.7%

Table IV: Comparison of variables with other similar studies.

	Ponseti *et al*[6]	Mandlecha P *et al*[9]	Gupta *et al*[10]	Rangasamy et al15 – meta-analysis (10 studies)	Our study
No. of feet	75	27	16	354	30
Mean age (months)	3	4.7	3.2	4.89 (9 studies)	4.5
Male : Female	1.6 : 1	4.3 : 1	1.6 : 1	1.8 : 1 (9 studies)	2 : 1
Average casts required	5	7.4	7	6	9.4
Pre-treatment Pirani	-	5.6	-	5.5 (average of 6 studies)	4.8
Post-treatment Pirani	-	0.06	-	0.24 (average of 4 studies)	0.9
Tendo-achilles tenotomy	100%	100%	100%	98.3%	100%
Relapse rate	14%	11.1%	0%	19.8%	6.7%
Mean follow-up (months)	-	14.76	24	38.9 (average of 9 studies)	8

Two patients had relapse of the disease (equinus deformity in both cases), pressure sores were seen in 8 out of 30ft (26.6%) over skin on the lateral head of talus which was managed by giving cast holiday for 1 week and recasting was done after the healing of skin, cast slippage occurred in 13 of total 267 casts applied (4.8%) which was managed by proper moulding around bony prominences by taking extra care when recasting was initiated. Mean follow-up was of eight months after tenotomy.

Fig. 1: Features of atypical clubfoot: plantaris crease, short chubby feet, short hyper- extended first toe, rigid, severe equinus.

DISCUSSION

Atypical clubfoot is a subset of clubfoot which has proved to be difficult to treat for orthopaedic surgeon. Ponseti himself recognised the problem and had recommended modifications to his casting protocol[6]. Applying casts by standard Ponseti method does not correct deformities in these cases. Most consistent feature of atypical clubfoot observed in our series was short and hyperextended first toe, followed by a swollen, chubby foot and a deep plantar crease. These three together were seen in over 85% of all the patients. Proportion of other consistent finding is shown in Table II. We observed early identification and initiation of treatment by modified Ponseti protocol resulted in early correction of the deformities (Table I) and decreased the treatment duration. One possible reason that one can relate to is as these children with atypical clubfoot start crawling and walking with increasing age, they are more prone to develop some secondary features like callosities at the pressure points, increased rigidity of foot etc., at the same time, it was observed that bigger children are not as compliant to casting and bracing, when compared to those of lesser age. Males were affected twice as commonly as females in our study as seen in other similar studies (Table IV). All cases required the tendoachilles tenotomy for correction of equinus. This trend was also duplicated in other studies. Four patients (7 feet) had been treated before elsewhere with casting and all had a history of slippage of cast, thus probable iatrogenic causes were accounting for over 1/5th of total feet included in our study. Our average of 9.4 casts required for correction was more than in studies done by Ponseti *et al*[6], Mandlecha *et al*[9] and Gupta *et al*[10]. Most of our patients were from low socio-economic background with low education status. Cast care in such patients was not proper and many times they presented to OPD with soiled and broken casts at follow-ups. This might be contributing to more number of casts and longer duration of treatment in our study. Final mean Pirani score in our study was 0.9, which was also greater than in the study done by Mandlecha *et al*[9], however we had a relapse rate of 6.6% which was lesser than all other studies, which might be

Fig. 2: Four finger technique of manipulation (modified Ponseti technique).

Fig. 3: Unilateral case of atypical clubfoot managed with modified Ponseti casting. The child has atypical clubfoot with a prominent plantaris crease, the final position of foot six months after tenotomy is also shown.

due to a short follow-up duration of eight months, equinus deformity was observed in both relapse cases and had poor adherence. Longer follow-up and better adherence criteria are required to better comment on this.

Rangasamy *et al*[15] conducted a meta-analysis in 2022, in which he considered a total of 10 studies. Comparison of his meta-analysis with our and other studies are shown in Table IV.

In our study, the primary complications observed during Ponseti method-based treatment included pressure sores, cast slippage, and relapse in the form of equinus deformity, pressure sores were managed by giving the child a cast

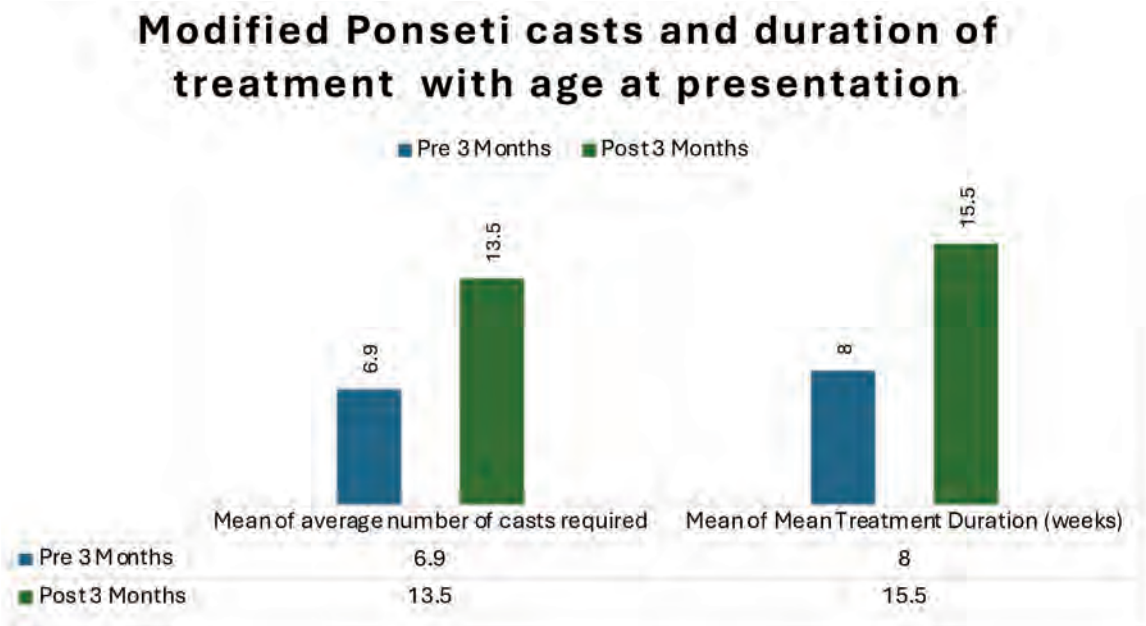

Fig. 4: Modified Ponseti casts and duration of treatment with age at presentation.

holiday of few days, while in the meantime, parents were advised to continue with manipulation of the feet. Cast slippage was addressed by reapplying a fresh above-knee cast with the knee positioned in hyperflexion and an anterior slab was applied over the knee to strengthen the cast. Relapse of equinus deformity was managed by reinitiating the modified Ponseti protocol. In cases where conservative measures were insufficient, a repeat percutaneous Achilles tenotomy was performed to achieve adequate dorsiflexion and restore functional alignment.

For study limitations, the mean follow-up duration was relatively short, averaging eight months, which may not adequately capture long-term outcomes or recurrence rates associated with modified Ponseti casting in atypical clubfoot and the sample size was limited to 30 feet, which restricts the statistical power and generalisability of the findings. Future studies with larger cohorts and extended follow-up periods are necessary to more comprehensively evaluate the efficacy and durability of this treatment approach.

CONCLUSION

Treatment of atypical clubfoot takes longer duration and a greater number of casts than idiopathic clubfoot, early identification of atypical features and starting modified Ponseti casting in children with this type of clubfoot has good-excellent results and in hands of an experienced orthopaedic surgeon, it decreases the need for surgical intervention.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

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Cite this article:

Kumar M, Ajmera A, Solanki M, Pal A, Ahirrao KD. Early outcomes of Modified Ponseti Method of Manipulation for Management of Cases of Atypical Clubfoot in Children. *Malays Orthop J.* 2026; 20(2): 17-23. doi: 10.5704/MOJ.2607.003