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# Evaluation of modified Ponseti technique in treatment of complex clubfeet☆

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ABSTRACT

*Background:* Complex clubfoot does not respond to ponseti method. In 2006 Ponseti et al published the results of treatment of such complex club foot by modified ponseti technique, since then it has become standard method of treatment for complex clubfoot. There has been only few published result of this method and hence, here we are evaluating our experience with 16 patients (27 clubfeet) with complex clubfeet treated at our center by modified ponseti method.
*Method:* Parents of patient fulfilling the criteria for complex clubfoot were consented and registered under the study. Pirani score at presentation, at prescription of foot abduction brace and at final follow up was noted. total number of casts required for desired correction, number of cast before and after tenotomy, need of tendoachilles tenotomy, relapse and complications were documented.
*Result:* Average follow up duration was 14.762 months (Range 6 month to 22 months). Of the total 16 patients 11 had bilateral complex clubfoot and 5 had unilateral complex clubfoot, the mean pirani score at the time of presentation was 5.5741 (range 4.5–6), Mean pirani score at latest follow up was 0.0556. Average no. of casts required for the complete correction with modified ponseti method was 7.44 (ranging from 6 to 10 casts). All 27 feet (100%) required tendo achillies tenotomy. Percutaneous tenotomy was done in 19 feet while 8 feet required Mini-Open tenotomy (due to thick pad of fat tendon was not palpable). Relapse rate was 11.11% (3 feet) [all had relapse of equinus, fore foot adduction treated by remanipulation by modified ponseti technique, retenotomy and casting]. An excellent result was achieved with at final follow-up in all 27 feet.
*Conclusion:* In our experience modified ponseti technique for treatment of complex clubfoot is a successful method of treatment if aided with tendoachilles tenotomy, also it has reduced the requirement of surgical intervention in such patients.
Level of Evidence - Level IV.



## 1. Introduction

Congenital idiopathic clubfoot is a common foot deformity and most orthopedic surgeons treat patient initially non-operatively by serial casting with correction by Ponseti method. Treatment with the Ponseti method is effective in the most of the patients. However, some feet do not respond to the standard serial casting protocol, and they have been termed as complex clubfoot.[1] Clinically, complex clubfoot are defined as having rigid equinus, forefoot adduction and supination, severe plantar flexion of all metatarsals, a deep transverse crease in the sole of the foot, a deep crease above the heel, and a short and hyperextended first toe. The achilles tendon is exceptionally taut and fibrotic up to the middle of the calf.

Correction of complex clubfoot can be achieved by a modified ponseti casting technique.[2]

Since the description of the modified ponseti method in the treatment of complex clubfoot only few reports have been published on the results of this technique, hence we are sharing our experience of correction of complex clubfoot by a modified ponseti casting technique.

☆ This study was conducted in the Department of Orthopaedics, Lady Hardinge Medical College and associated hospitals, New Delhi between November 2012 to November 2014.

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## 2. Methods

The study was conducted in the department of Orthopedics, at our institute between November – 2012 to November 2014. A special clubfoot clinic is being run in our hospital twice a week.

**Table 1**
Sex distribution.

| Sex | No. of patients | No. of Feet |
|---|---|---|
| Male | 13 (81.25%) | 21(77.77%) |
| Female | 3 (18.75%) | 6 (22.22%) |
| Total | 16 | 27 |
| M:F ratio | 4.3:1 | |

**Table 2**
Frequency distribution table of Pirani score at 1st visit.

| Pirani score | No. of Feet |
|---|---|
| 4.5 | 2 (7.5%) |
| 5 | 5 (18.5%) |
| 5.5 | 7 (26%) |
| 6 | 13 (48%) |

**Table 3**
Frequency distribution table of Pirani score at the time of FAB prescription.

| Pirani score | No. of feet |
|---|---|
| 0.00 | 17 (63%) |
| 0.50 | 10 (37%) |

**Table 4**
Changes in clinical values.

| Variables | Mean at 1st visit | Mean at the time of FAB prescription | Mean at the time of latest Follow up |
|---|---|---|---|
| Pirani Score | 5.5741 | 0.1852 | 0.0556 |

A total of 27 feet in 16 patients with clinical features of complex clubfoot and age less than 1 year were included in the study. Patients with age more than 1 year, or with history of prior intervention (surgical/ non-surgical), with associated syndromes were excluded from the study.

## 3. Treatment protocol

After inclusion in study, a thorough clinical examination of every patient was done and pirani score was assigned to each foot at every visit.

The patient underwent clinical evaluation followed by manipulation and casting application according to modified ponseti technique at a weekly interval.

Clinical improvement (Pirani score) and complication were monitored and recorded. Standard radiography was done as described by Simon et al.[3] at presentation, before prescribing foot abduction brace and at final follow-up.

**Modified Ponseti technique**

Casting (Fig. 4) was done as per the modified ponseti protocol which is described as follows.

1 Talar head was first identified and confirmed by sub-talar joint movement. The index finger of one hand was placed over the posterior aspect of lateral malleolus while the thumb of same hand applies counter pressure over the lateral aspect of the head of talus while forefoot grasped by opposite hand was slowly abducted. This manoeuvre was done while stretching and during application of below knee plaster cast. Below knee cast was then converted to above knee cast, knee was kept in 100°-110° flexion to avoid cast slippage. The subsequent casts were applied every week using same manoeuvre till the forefoot was abducted to 40° and hindfoot varus was corrected. The next manoeuvre was then performed.
2 The hyper plantar flexed metatarsals and equinus deformities were corrected simultaneously by grasping the foot from the ankle with index finger of both the hands. The thumbs of both

**Table 5**
Clinical details of patients.

| S. NO. | Pt. NO. | FEET NO. | Age in months | SEX | LATERALITY | SIDE | INITIAL PIRANI | PIRANI AT FAB PRESCRIPTION | FINAL FOLLOW UP PIRANI | TOTAL NO. OF CASTS | NO. OF CASTS BEFORE TENOTOMY | NO. OF CASTS AFTER TENOTOMY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 8 | M | BILATERAL | R | 4.5 | 0 | 0 | 7 | 6 | 1 |
| 2 | | 2 | 8 | M | BILATERAL | L | 4.5 | 0 | 0 | 7 | 6 | 1 |
| 3 | 2 | 3 | 12 | M | BILATERAL | R | 5 | 0 | 0 | 7 | 3 | 4 |
| 4 | | 4 | 12 | M | BILATERAL | L | 5 | 0 | 0 | 7 | 3 | 4 |
| 5 | 3 | 5 | 9 | M | UNILATERAL | L | 6 | 0.5 | 0 | 8 | 7 | 1 |
| 6 | 4 | 6 | 8 | M | UNILATERAL | L | 6 | 0 | 0.5 | 6 | 4 | 2 |
| 7 | 5 | 7 | 4 | M | BILATERAL | R | 6 | 0.5 | 0.5 | 10 | 8 | 2 |
| 8 | | 8 | 4 | M | BILATERAL | L | 6 | 0.5 | 0.5 | 10 | 8 | 2 |
| 9 | 6 | 9 | 1 | M | BILATERAL | R | 5.5 | 0.5 | 0 | 7 | 7 | 0 |
| 10 | | 10 | 1 | M | BILATERAL | L | 5.5 | 0.5 | 0 | 7 | 7 | 0 |
| 11 | 7 | 11 | 6 | M | BILATERAL | R | 6 | 0.5 | 0 | 6 | 4 | 2 |
| 12 | | 12 | 6 | M | BILATERAL | L | 6 | 0.5 | 0 | 6 | 4 | 2 |
| 13 | 8 | 13 | 1 | M | UNILATERAL | L | 5 | 0 | 0 | 7 | 6 | 1 |
| 14 | 9 | 14 | 5 | M | BILATERAL | R | 5.5 | 0 | 0 | 9 | 8 | 1 |
| 15 | | 15 | 5 | M | BILATERAL | L | 5.5 | 0 | 0 | 7 | 7 | 0 |
| 16 | 10 | 16 | 1 | M | BILATERAL | R | 5.5 | 0 | 0 | 6 | 5 | 1 |
| 17 | | 17 | 1 | M | BILATERAL | L | 5.5 | 0 | 0 | 6 | 5 | 1 |
| 18 | 11 | 18 | 1 | F | UNILATERAL | R | 5.5 | 0 | 0 | 10 | 9 | 1 |
| 19 | 12 | 19 | 1 | F | BILATERAL | R | 5 | 0 | 0 | 7 | 6 | 1 |
| 20 | | 20 | 1 | F | BILATERAL | L | 5 | 0 | 0 | 7 | 6 | 1 |
| 21 | 13 | 21 | 4 | M | BILATERAL | R | 6 | 0 | 0 | 10 | 7 | 3 |
| 22 | | 22 | 4 | M | BILATERAL | L | 6 | 0 | 0 | 9 | 8 | 1 |
| 23 | 14 | 23 | 4 | M | UNILATERAL | R | 6 | 0.5 | 0 | 8 | 7 | 1 |
| 24 | 15 | 24 | 10 | M | BILATERAL | R | 6 | 0.5 | 0 | 6 | 5 | 1 |
| 25 | | 25 | 10 | M | BILATERAL | L | 6 | 0.5 | 0 | 6 | 5 | 1 |
| 26 | 16 | 26 | 1 | F | BILATERAL | R | 6 | 0 | 0 | 7 | 6 | 1 |
| 27 | | 27 | 1 | F | BILATERAL | L | 6 | 0 | 0 | 7 | 6 | 1 |

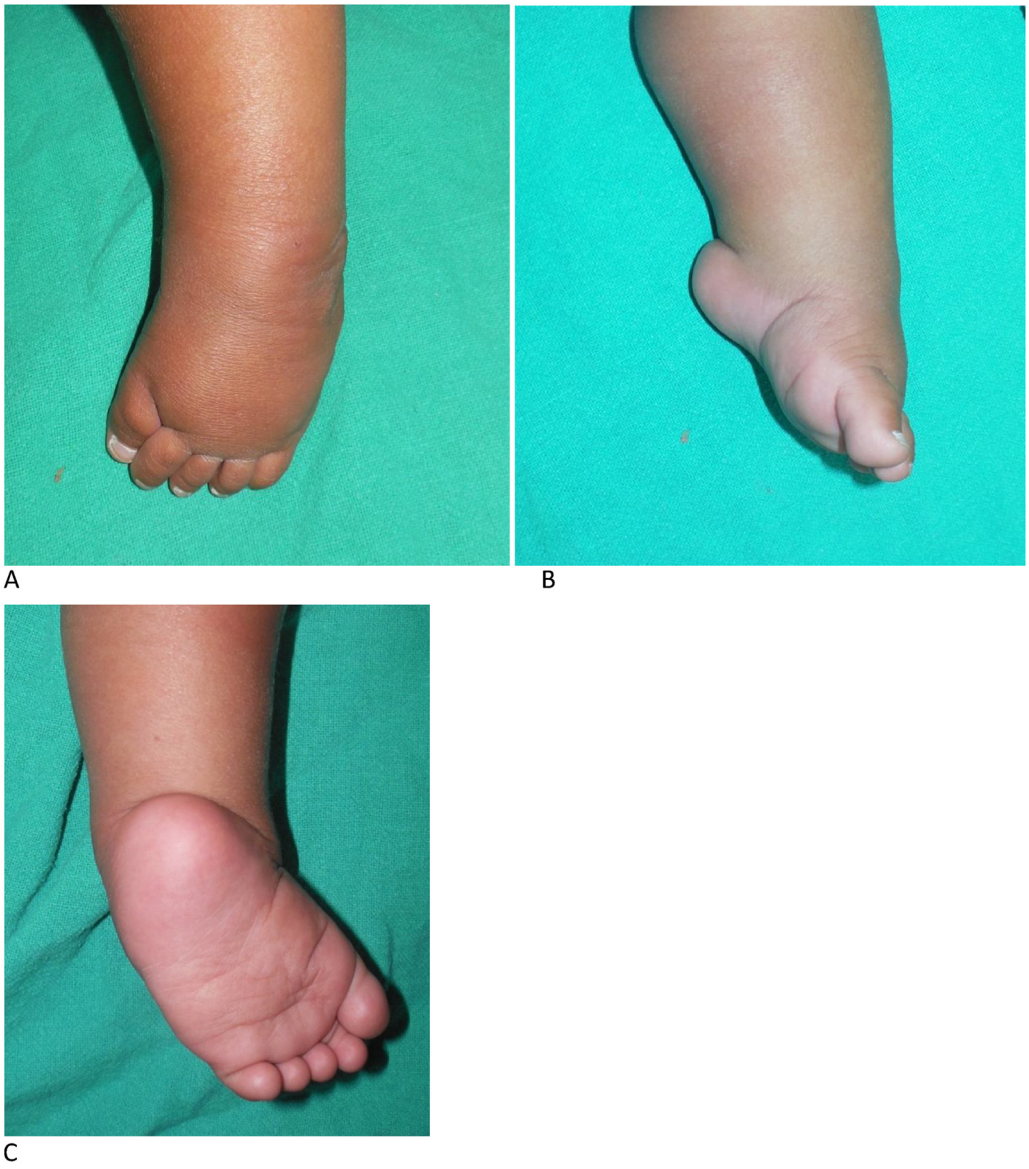


**Fig. 1.** Case number 3 at presentation.

the hands under the metatarsal heads were used to push the metatarsal heads into dorsiflexion while an assistant was stabilizing the knee in 90° flexion. Great care was taken not to create midfoot break during this manoeuvre.

3 Tendoachilles tenotomy (Fig. 6) was performed to correct the unyielding equinus when the hyperflexion of metatarsal joints has improved but the rigid equinus remained unyielding.

4 Last cast after tenotomy was given in maximum correction for 3 weeks if desired correction has been achieved, otherwise weekly change of cast was done to stretch the tendoachilles till at least 10° of dorsiflexion was achieved.

**Tenotomy of the tendo achilles**

Tendoachilles tenotomy was perfomed under general anaesthesia or local infiltration analgesia. Tenotomy was done either percutaneously (if thin tight cord could be felt) or by mini open technique (if the tendon was thick and broad and could not be felt easily) approximately 1.5 cm above the posterior skin creases of the heel. The wound was covered with a small sterile pad. If atleast 40° abduction and >10° dorsiflexion was achived after tenotomy, the final cast was given in full correction for 3 weeks. If <10° dorsiflexion was achieved even after tenotomy then the casts were changed at weekly interval till at least 10 degrees of dorsiflexion was achieved with a about 40°s of abduction.

**Splinting**

Steenbeek foot abduction brace (FAB) (Fig. 3) shoes attached on the iron bar at 40° external rotation was given to all the patients post tenotomy at 3 weeks or after the desired end point(minimum 10 degrees of dorsiflexion) free of cost to maintain the correction. It was applied for 23 h a day for first three months in all the patients and advised for sleep time use for another three years.

Cases were called for regular follow up at weekly interval for a month to check the compliance for FAB and monthly follow-ups there after.

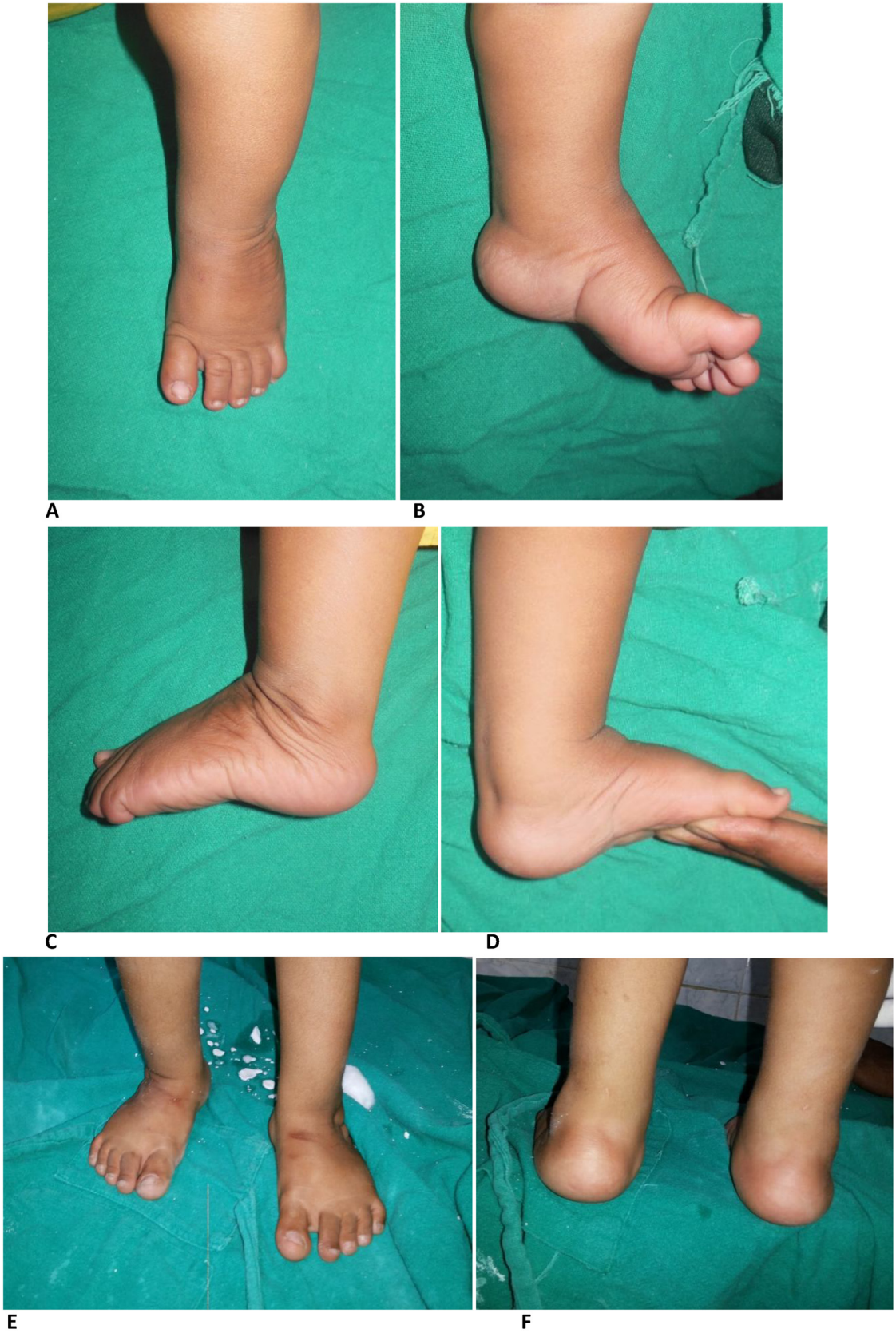


**Fig. 2.** Case number 3 at final follow-up.

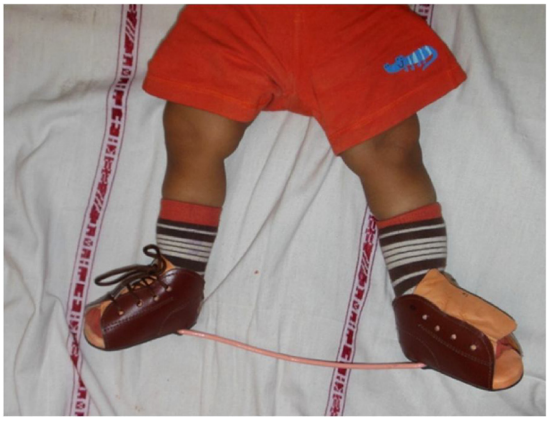

**Fig. 3.** Foot Abduction Brace.

## 4. Results

A total of 27 feet in 16 patients were included in the study. All of them were of age less then 1 year. Average follow up duration for all the 27 feet was 14.762 months (Range 6 month to 22 months)

Of the total 16 patients 11 had bilateral complex clubfeet and 5 had unilateral complex clubfeet deformity.

Out of 5 unilateral cases 2 had right side foot affected and 3 had left side involvement

The frequency of complex clubfoot was found to be about 4.3 times more common in males as compared to female.

Average age at the time of presentation of these patients was 4.77 months.

Out of 16 patients 13 were male and rest 3 were female (M: F::3.3:1). (Table 1)

All such feet were corrected in an average of 7.407 weeks with a mean of 7.44 casts (range 6–10).

Average follow up period for these patients was 14.762 months (range 6 months to 22 months).

The frequency of complex clubfoot was found to be approximately four times more common in males as compared to females in these patients.

The mean pirani score at the time of presentation was 5.5741 (range 4.5–6). (Table 2)

Mean pirani score at the time of FAB prescription was 0.1852. (Table 3)

10 patients had pirani score 0.5 at FAB prescription out of which 7 patients had persistent faint medial crease (Fig. 7B &C) and 3 patients had empty heel sign.

The difference of the mean of pirani Score at 1st visit and at the time of FAB prescription (Table 4) as well as the difference of the mean at the of pirani score at 1st visit and at the time of latest follow up are 5.389 and 5.518 respectively.

The difference of means of Pirani Scores at both the pairs are statistically significant with p values of 0.005, which is less than <0.01.

While the difference of the means of pirani score at the time of FAB prescription and at the time of Latest Follow up is 0.1296 which is also statistically significant as the p value is 0.017 which is <.05. We attribute this further improvement in pirani score to disappearance of medial crease.

19 out 27 feet (70.36%) required 7 or less casts for correction.

**No. Of casts required after tendo achiilles tenotomy**

20 feet out of 27 (62.96%) had required only 1 cast after tenotomy.

5 feet required 2 change of casts post tenotomy at weekly interval to correct residual equinus.

2 feet in 1 patient required 4 change of casts at weekly interval for correction of residual equinus after tenotomy.

So an average of 1.3 casts (range from 0 to 4 casts) were required post tenotomy.

All 27 feet (100%) required tendo achilles tenotomy. Percutaneous tenotomy was done in 19 feet while 8 feet required mini-open tenotomy.

Clinical details of patients are shown in Table 5

We have noted pressure sore over dorsolateral aspect of foot in 3 feet, plaster slippage in 3 patients and mid foot break in 2 patients. No skin or neurological complications were encountered in any of our patients.

Tenotomy related complications like bleeding complications or wound complications occur in none of our patients.

Over all some or the other complication occurred in 8 out of 27 feet (29.63%).

**Relapse**

Recurrence of the deformity occurred in 3 (11.11%) feet in 2 patients who were non compliant to monthly follow up schedule and the foot abduction brace. These two patients were brought to the clinic with relapse of the deformity and non fitting shoe size of the FAB.

Relapse were treated conservatively with modified ponseti`s technique and required retenotomy of tenodo achilles in all 3 feet.

## 5. Discussion

The complex clubfeet is short and stubby. The calf muscles are small and the tendo achilles is long, wide, and tight. The hindfoot is in severe equinus and varus. The forefoot is adducted and all metatarsals are in severe plantar flexion. There is a deep crease across the sole of the foot and another above the heel. The severe equinus is concurrent with severe plantar flexion of the metatarsals and apparent shortening of the foot and toes.[1]

In the complex clubfoot, it is the gastrosoleus and the plantar intrinsic muscles and ligaments that are more severely involved. The medial ligaments and tendons of the foot can be stretched easily, but the cavus and the equinus strongly resist correction.[1]

Ponseti et al,[1] first described the complex idiopathic clubfoot in 50 of 762 patients (6.5%–75 feet) and described a modified protocol for correcting these deformities. With this modified technique correction was achived in all patients with an average of five casts (range 1–10 casts). The average age at the last follow-up was 23 months (range 6–46 months). Seven relapses (14%) were reported that responded to casting and second tenotomy and two patients

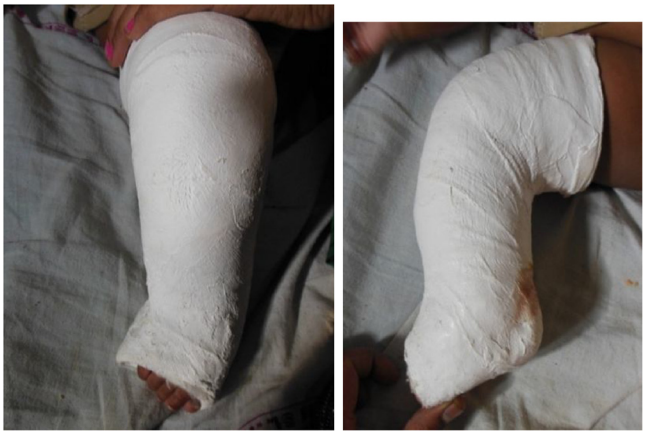

**Fig. 4.** Modified Ponseti Cast.

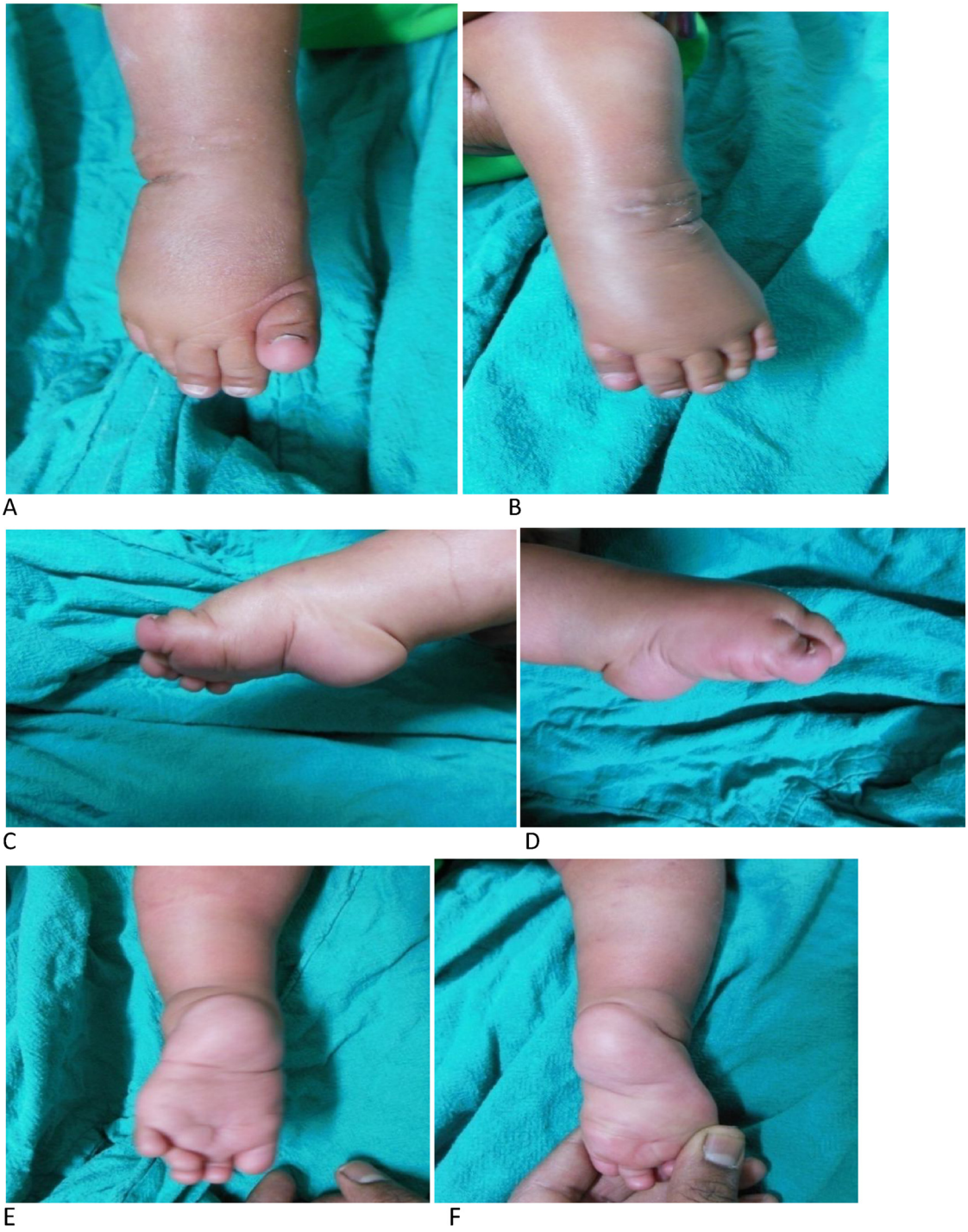


**Fig. 5.** Case number 5 at presentation.

(4%) eventually had a formal open posterior release with tendo achilles lengthening.

Göksan et al,[4] in their study series with a mean follow-up duration of 46 months, reported on a subgroup of complex clubfeet (15 patients, 21 feet) and a further subgroup with complex iatrogenic deformity as a result of improper casting techniques (seven patients, 11 feet). All were treated using the modified ponseti method. The relapse rate in these subgroups was 38 and 66%, respectively, with only one foot requiring extensive soft tissue release.

Matar et al[5] in their 11 year follow-up study on treatment of complex idiopathic clubfoot using the modified Ponseti method, identified 11 children (nine males and two females) with 17 complex clubfeet who were treated with the modified Ponseti method. The average follow-up was 7 years (range 3–11 years) and the average Pirani score was 5.5 (range 4.5–6.0). Initial correction was achieved in all children, with an average of 7 (range 5–10) Ponseti casts. Tendoachilles tenotomy was performed in all 17 feet (100%). The overall relapse rate was 53% (nine feet). Five relapses were managed successfully with repeat

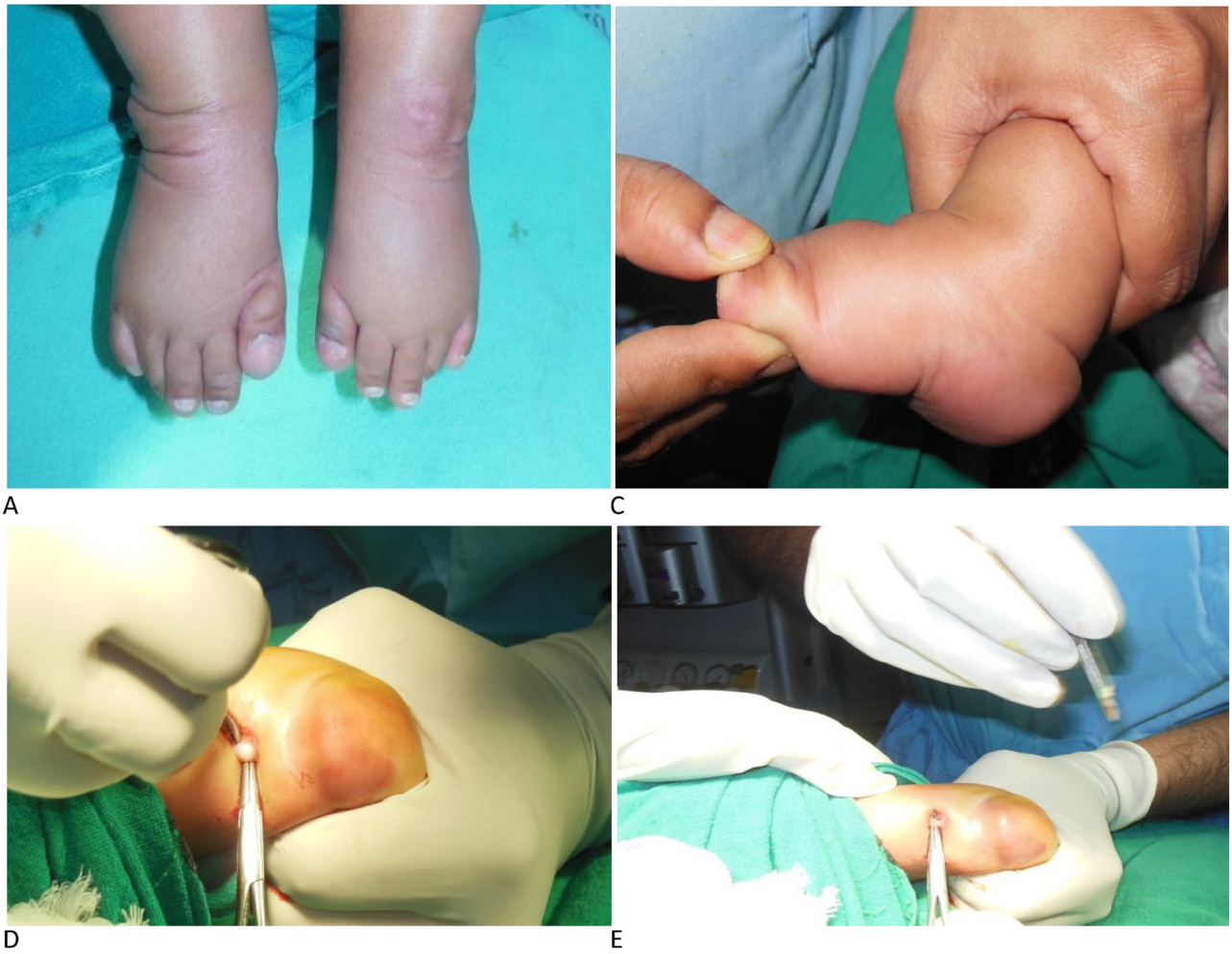


**Fig. 6.** Case number 5 at tenotomy.

casting and four feet were subjected to a second tendoachilles tenotomy. Four feet required extensive surgical releases. A satisfactory outcome was achieved at the final follow-up in 13 of 17 feet (76.5%). Two of these children (two feet) required an additional tibialis anterior transfer. In their experience, the modified Ponseti method is an effective first-line treatment for complex idiopathic clubfoot; however, such children will often require more casts than usual and have a higher rate of tendoachilles tenotomy and a higher risk of relapse requiring surgical procedures.

We have conducted our study on 27 feet, 16 patients between November 2012 to November 2014. The average follow-up was 14.762 month (range 6month to 22 months), Correction was achieved in all children with average of 7.44 (6–10) casts, Tendoachilles tenotomy was performed in all 27 feet (100%), Average cast required after tenotomy was 1.3 (0–4) casts, these casts were given at weekly interval for unyielding equines even after tenotomy.

Correction was achieved in average 7.407 weeks (average 7.44 casts), Average time of presentation was 4.77 months.

Frequency of complex club feet was 4.3 times more common in males than female.

Mean pirani score at presentation was 5.5147 (4.5–6), Mean pirani score at FAB prescription was 0.1852,Mean pirani score at latest follow up was 0.0556,The p-value of change in mean pirani score at presentation and FAB prescription was $<0.05$. The p-value change in mean pirani score at FAB prescription and latest follow up was $<0.05$.

There were three relapses who were non-compliant, they were treated conservatively with modified ponseti technique and retenotomy

Clinical images of patient-3 and patient-5 are shown in Figs. 1–7

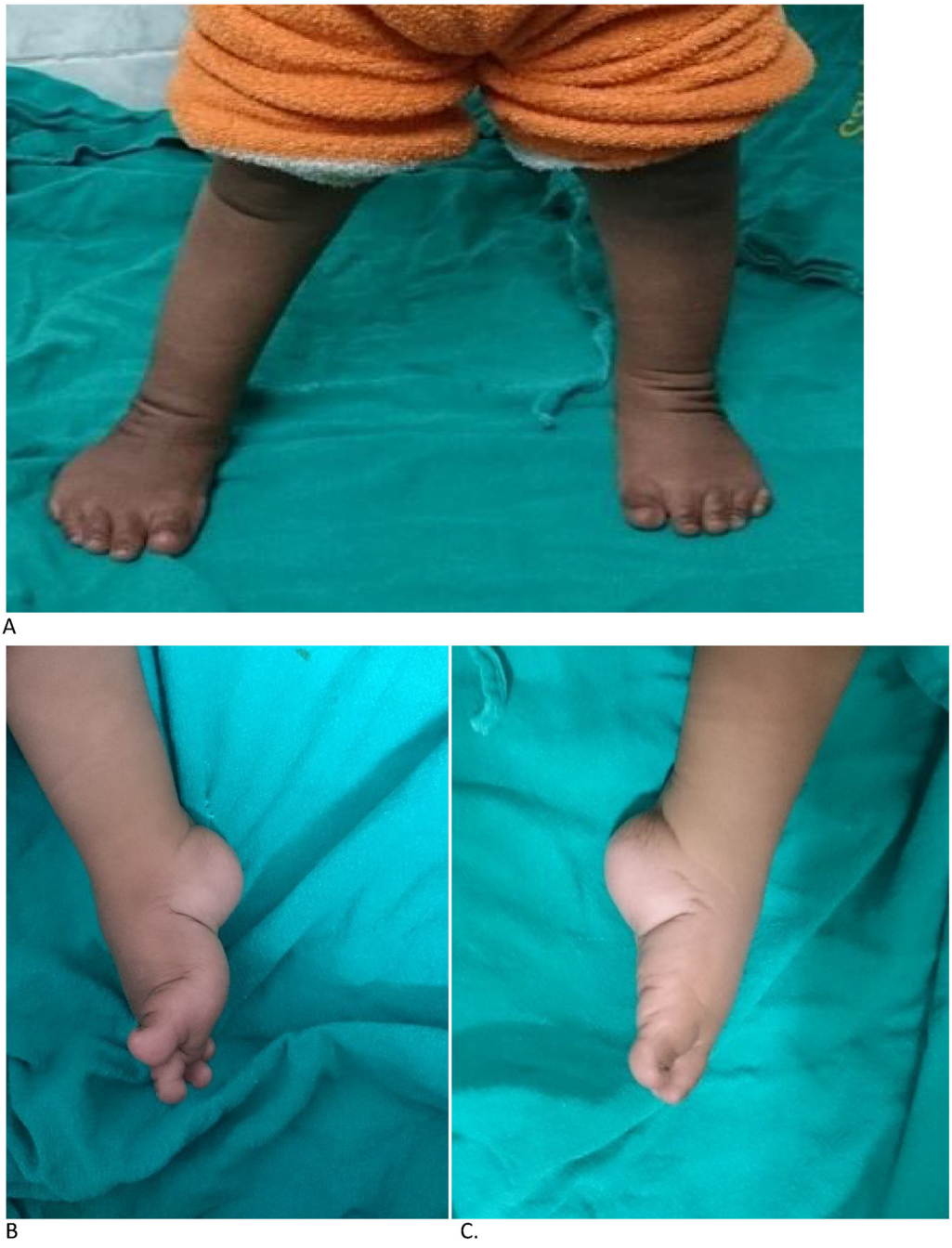


**Fig. 7.** Case number 5 at final follow-up. 7-B, 7-C Persistent Medial Crease.

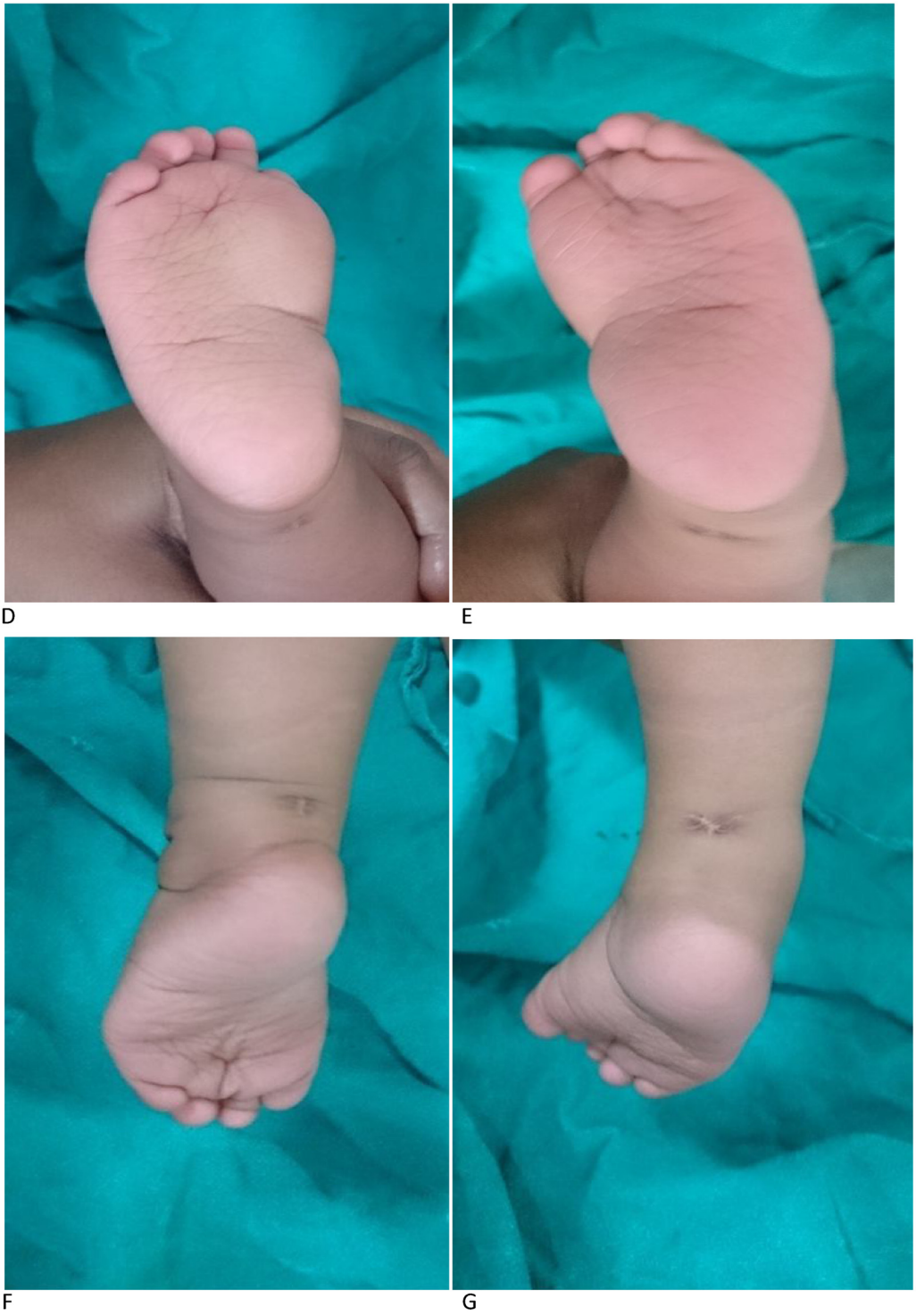


**Fig. 7.** (Continued)

## 6. Conclusion

From our study we conclude that treatment of complex clubfoot by modified ponseti method gave an excellent outcome in relatively rigid foot which are resistant to treatment with routine ponseti manipulation, although they require higher number of cast application as compared to idiopathic club foot, but the final outcome is satisfactory averting the need of complex surgical procedure in short to midterm follow-up.

A long term follow-up will be required for better assessment of relapse pattern and functional outcome.

## Funding

This study was self funded by Author A

## Conflict of interest

Author A, Author B, Author C and Author D declare that they have no conflict of interest.

## Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional ethical research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

## Informed consent

Informed consent was obtained from all individual participants included in the study.

The manuscript has been read and approved by all the authors, the manuscript represents honest work.

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