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## Club foot correction by ponseti's method, its functional effectiveness and clinical evaluation: A prospective study

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### Abstract

**Introduction:** Club foot or CTEV (congenital talipes equinus varus) is a complex foot deformity of childhood, which has an emotional and socio-economic impact to the family. The aim of management should be to gain results in form of painless, plantigrade and functional foot without any disability. With availability of all the treatments modalities, the Ponseti's method of conservative treatment with or without tenotomy is the preferred method in current scenario. We evaluated the effectiveness of Ponseti's technique with reference to functional outcomes in form of Modified Pirani severity scores and goniometric calculations of club feet treated by this method.

**Material and Methods:** We have studied 150 feet (60 bilateral and 30 unilateral) of idiopathic club feet (CTEV) at our tertiary center in the department of Orthopaedics with collaboration of Obstetrics and Gynecology (OBG) department. All the subjects were managed with Ponseti's method of conservative treatment.

**Results:** Out of 150 feet, 140 feet had excellent functional outcome (Pirani score-0 to 0.5), 30 had good (Pirani score-0.5 to 1) and 5 had satisfactory outcomes (Pirani score-1 or more).

**Conclusions:** Ponseti's method has low rate of complications, cost effective and having high success rate among all the modalities of treatment. This method has great potential for the treatment of clubfoot among different cultures in both developed and underdeveloped countries.

**Keywords:** club foot, ponseti's method, pirani scoring, foot deformities, conservative treatment

### Introduction

Congenital club foot or congenital talipes equinovarus (CTEV) incidence is estimated to be 1 to 2 per 1,000 live births <sup>[1, 2]</sup> It is the complex deformity that is difficult to correct. The deformity has four components, equinus, hind foot varus, forefoot adducts and mid foot cavus. The deformities have morbidities both cosmetic as well as functional with associated pathoanatomical changes including hypoplasia of skin and underlying tissues, musculoskeletal tissues (muscles, tendons, bones, and ligaments) and neurovascular bundle on the posterior and medial side, which resulting as hypoplastic and smaller foot than normal one.<sup>1,2</sup> Herzenberg described bony deformities of club foot with 3-D computed tomography scans, which reveal severe medially displaced navicular, talus in severe planter flexion and external rotated, adducted and inverted calcaneus and distorted calcaneocuboid joint with cuboid displacement under beneath the navicular bone<sup>[3]</sup>. The primary aim of management should be to gain results in form of painless, plantigrade and functional foot without any disability <sup>[1, 2]</sup> There are several conservative and surgical methods/modalities described in literature for management of CTEV foot but none of them approved as an universal and ideal method to achieve the final outcome as described. Most of the studies described early conservative method with serial casting followed by surgical intervention in form of soft tissue balancing of bony procedures depending upon the age, presentation and deformity of foot <sup>[4-8]</sup> Now a day early intervention with serial supervised cast with or without percutaneous tendoachilles tenotomy became very effective and most valuable modality of treatment in these cases, which was described by Ponseti. This is supported by excellent results in documented studies in past with success rate of 90- 96% in short, mid and long-term results <sup>[6-10]</sup> We evaluated the effectiveness of Ponseti's method of serial casting with or without percutaneous tenotomy for the management of idiopathic congenital clubfoot in children.

## Materials and Method

This prospective study was conducted in Government Doon Medical College Dehradun from March 2016 to February 2018. The department of Orthopaedics enrolled patients in outdoor department (OPD), while Obstetrics and Gynecology department maintained a registry for referral of newborns with club foot. A nongovernmental organization (NGO) and nonprofit organization "Cure International India Trust (CITI)" working in collaboration with State Government Uttarakhand runs clubfoot awareness programs with posters, home visits, parent educational programs and have trained supervisors who educate the masses about the deformity in child and guide them to report those cases and refer them to our hospital as feasible. We run parallel special clubfoot clinics twice a week, where families of follow up children share their experiences with the parents of new cases and motivate them about early treatment and regular follow up. Patients with clubfeet associated with syndromes including paralytic components (polio, neurological weakness), congenital deformation of spine (Meningocele or Meningomyelocele), arthrogryposis multiplex congenita (AMC) or muscular dystrophies and other congenital disorders were excluded from study. All the parents/attendants were counselled about disease and its sequelae, while consent was taken from all for treatment and study. All the patients were first assessed clinically. History was taken from patient's attendant for his name, age, sex, address and family history of clubfoot. Enquiry was also taken to know regarding the time of presentation of deformity and patient had taken any treatment or not, before reporting to our hospital. After that they were examined systemically for any associated congenital deformity. There after examination of foot was done, first normal and then clubfoot. The severity of foot was graded using Pirani scoring system at the time of admission. All the subjects were evaluated with different variables including total cast applied, complications related to cast applications (skin allergy, plaster sore, bleb or blisters), Pirani's scoring at every visit, timing of tenotomy and its complications.

**Details of the Ponseti technique and follow up:** The corrective process as described by Ponseti can be divided into two phases, the treatment phase and maintaining phase. We also underwent with the same protocol as described by the Ponseti casting technique (Fig. 1-3). It included gentle manipulation of the foot and the serial application of long leg cast in flexed knee position (above knee plaster casts) at weekly intervals<sup>[1,4]</sup>.

**A. The treatment Phase:** The initial manipulation with hands was done for a minute by the assistant, holding the foot in corrected position followed by plaster cast application was done by doctor. This was repeated at weekly intervals for 4 to 12 times for simultaneously correction of cavus, adducts, varus and finally equinus. The limb was evaluated as complete corrected stage with foot abducted up to 70 degrees or more without pronation in the last cast. If there was some residual equinus left, it was corrected by percutaneous tendoachilles tenotomy (Fig 2, 3).

**Percutaneous tenotomy:** After proper positioning with or without local anaesthesia spray/cream, No.15/11 blade was placed parallel to tense tendoachilles, approximately 1 cm above the insertion at calcaneus. Then blade turned to 90 degree perpendicular to the tendoachilles tendon and tendon was cut from medial to lateral to avoid injury to neurovascular

bundle. A popping sound with sudden released was felt as the tendon is released with additional gain of 10 to 15 degree of dorsiflexion. Position of foot was maintained by POP cast (Above knee) for three weeks.

**B. Maintenance Phase:** It was maintained by foot abduction splint (Steinbeck splint or Denis Brown splint). The splinting was started after the removal of final cast or tenotomy cast which is usually 3 weeks after tenotomy. The parents or the attendants were advised to make the child wear splint initially for 3 months for at least 23 hours of a day and then 12 to 14 hours of a day up to 3 to 4 years of age (Fig 3).

The treatment phase repeated every week; while patient followed on a monthly interval for three months after abduction foot splint application followed by visit every three months interval upto 3-4 years of age. The parents advised to visit clinic at least upto school going age of child biannually or early if observed any recurrence of deformity or non-compliance of treatment. The results were interpreted in reference to modified Pirani's scoring reflecting excellent with score 0 to 0.5, good with score 0.5 to 1 and poor results with score exceeding more than 1. Patient having poor results evaluated further for etiology and treated accordingly with surgical treatment.

## Results

Total 175 feet in 110 (60 males and 50 females) patients (65 bilateral, 45 unilateral) were reported in hospital and only 150 (60 bilateral and 30 unilateral) were followed and evaluated for present study. There were 55 males and 35 females with mean age of presentation 42 days (03 days to 20 months of age) at first visit. There was right side predominance with 20 cases out of 35 in unilateral affection. Mostly children presented at early age with shuffle, non-rigid feet (90), while defaulters and delayed presentations had rigid (60 feet) variety. At the time of initial enrollment, mean Pirani score was 4.89 (range 2.5 to 6) with no major differences between two types (rigid and non-rigid, 5.2 and 4.7 respectively). The total number of plasters for conservative treatment of clubfoot ranged from 4 to 12 (average 6.7) with average cast 4.8 for non-rigid and 9.2 for rigid variety. The children only treated by plaster cast were 20% (30 feet) and 80% (120 feet) were treated with plaster cast along with percutaneous tenotomy. Tenotomy was more required in rigid type as compare than non-rigid one. 130 feet out of 150 were managed efficiently with Ponseti's method, while 20 feet required additional interventions either POP cast or surgical modality. 10 patients presented with skin complications including skin allergy, blister formation, excoriation in three patients each and skin ulcer in one patient. These all were managed even with Ponseti method after dermatological treatment and yielded successful outcomes. Average Pirani score at the final follow up of the study group was 0.3 with score 0.42 in rigid variety and 0.2 score in non-rigid one.

## Discussion

Club foot is a complex musculoskeletal deformity of foot, which required a multidisciplinary approach to gain a full functional, plantigrade and painless foot. There are different approachable modality of treatments has been proposed by different surgeons with variable successful outcomes. Earlier studies revealed more complex surgical interventions for congenital clubfoot but there were a number of surgical complications included recurrence of the deformity, overcorrection, long-term joint stiffness, and pain.<sup>[7, 8]</sup> The

final goal of treatment was to reduce or eliminate this deformity in a child in a fruitful manner. In our study, the male to female ratio was (M: F= 5.5:3.5) in accordance with the series of Cowell and Wein<sup>9</sup> and Yamamoto<sup>[10]</sup> (male: female 3:1). There are some controversy regarding higher incidence in males as per Palmer<sup>[11]</sup> *et al* study, females have more predisposing factors than males to have a clubfoot. The more attention to male child, more reporting and social norms in developing countries may be the cause of higher incidence in males.

Ninety percent (90%) children with clubfoot presented to us within 4 weeks of birth because of good referral system and involvement of social NGOs. The earliest cast applied was at an age of 1 week. The maximum age at which a cast was applied was at 9 months. Ponseti claims to avoid open surgery in 89% of cases by using his technique of manipulation, casting, and limited surgery<sup>[5]</sup> An average of 30 years of follow-up of Ponseti's cases (Cooper and Dietz), showed 78% of the patients had achieved excellent or good functional and clinical outcomes compared with 85% in a control group without congenital foot deformity<sup>[6]</sup>.

The conventional treatment of club foot (CTEV) used to be serial plasters at two weekly or three weekly intervals and repeated up to 7-8 plasters with or without surgery<sup>[1, 4]</sup> These procedures had different complications like inadequate correction, stiffness, weak foot, severe scarring, small feet and often painful foot. On the other hand Ponseti technique convincingly produced satisfactory anatomical and functional results with simple, effective, minimally invasive, inexpensive treatment protocols which were ideally suited for all countries and cultures. The success of serial casting varies with the age of the patient, severity of deformity, skill and understanding of deformity by the Orthopaedic surgeon. Early intervention in the form of conservative means is the key to success for better functional outcome and minimum morbidity<sup>[14, 15]</sup>.

In our study the number of casts per feet was 4-12 (average 6.7) as compared to 5-10 (average 7.6) in a series by Ponseti *et al*<sup>[12]</sup> and average of 7 in another study by Laaveg *et al*. Morcuende reported that 90.0% of the patients required five or fewer casts<sup>[14]</sup> As we mastered the technique with time with more experience, the number of casts decreased and better results were seen. All the studies in medical literature also favored more cast visits for rigid feet than non-rigid one, which is comparable to present study. We observed mean Pirani score (4.89), which is comparable to studies documented in past, especially for the mix population of children (neonates as well as later age included in present study). There was also similarity of more value for rigid variety than non-rigid one, which is comparable to previous studies. In present study 80 % children needed percutaneous tenotomy as compared to 91% of Dobbs's study<sup>[16]</sup>. Less need of tenotomy might be due to less number of rigid feet in study or better serial casting after adequate manipulation by orthopaedics surgeon. Most of the studies proposed need of percutaneous tenotomy in range of 80% to 95% according to their patient selection and serial casting method<sup>[10-14]</sup>. There was difficulty in maintainance phase, which included customized bracing protocol Upto School going age of

children. There was non-compliance in form of restlessness, stranger sensations and irritation to children in initial days after brace application. Mostly patients were accommodated within two weeks of bracing, for that period adequate counselling and training of parents should be started regarding benefits of proper bracing and its successful results to prevent recurrences.

Around 95% of CTEV feet were managed successfully with Ponseti's method in present study. The complication rate was very low and supported by literature. There were two patients in infancy and four patients in later age had deformity recurrence/resistant, required soft tissue release in form of posteromedial soft tissue release (PMSTR). All the feet treated by methods presented very well and with full of functional outcomes and reported successful results in range of 80% to 95%. Application of plaster casts supported by limited operative intervention (Percutaneous tenotomy) yielded satisfactory functional results in 94% of the foot in Ponseti clinic by Ponseti technique<sup>[1, 4]</sup> In some centers early and even primary operative treatment of club foot is practiced but often some failure are common such as wound infection, necrosis of the skin, severe scarring, stiffness of the joint, overcorrection and under correction, dislocation of navicular, flattening and breaking of talar head, talar necrosis, weakness of planter flexor or ankle with major disturbance of gait. Some people believe as Ponseti does that "The successful non operative or limited operative treated foot is much better than the successful surgically treated foot"<sup>[16, 17]</sup>.

## Conclusion

The treatment of congenital club foot (CTEV) by Ponseti's serial plaster technique is very efficient modality having excellent outcomes with minimum morbidity. This method is simplest of all and a very cost effective with minimal invasive interventions and ideally suited for all the countries and cultures. The method can be easily performed even in peripheral settings as in developing countries like India with less sources and equipment without any assistance and complex operation theatres.



**Fig 1:** Pre and post correction of Club foot after serial casting and percutaneous tendoachilles tenotomy with full correction of deformities at foot



**Fig 2:** Manipulation of foot and serial casting showing deformity correction at different cast application before tenotomy; Further full correction after subcutaneous tendoachilles tenotomy.



**Fig 3:** Pictures showing deformities before casting; correction after Ponseti's method by serial casting; maintenance in abductor foot splint (Steinbeck splint/DB splint)

**Table 1:** Modified Pirani scoring of all enrolled patients at the time of initial presentation at hospital.

Total no of CTEV feet (150)	Rigid variety (60)	Non-rigid variety(90)	Modified Pirani score
5	1	4	2.5
10	2	8	3.0
30	5	25	3.5
38	10	28	4.0
20	8	12	4.5
21	18	3	5.0
13	7	6	5.5
13	9	4	6.0

**Table 2:** Modified Pirani scoring of all treated patients with Ponseti technique at the time of final presentation at hospital.

Total no of CTEV feet (150)	Rigid variety (60)	Non-rigid variety(90)	Modified Pirani score
80	29	51	0
60	25	35	0.5
5	3	2	1.0
5	3	2	1.5
0	0	0	2.0

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**Conflict of interest:** None.

**Ethical approval:** Not required

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