

Management of clubfoot by Ponseti's technique – Our Experience at TMCH

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Abstract

Background and objective: Congenital Talipes Equinovarus (CTEV) also known as Clubfoot^[1] is one of the common congenital orthopaedic foot deformity in children. It is a complex deformity that is hard to correct & the management is arguable and continues to be one of the significant challenges in paediatric orthopaedics. It is believed that the initial treatment should be non-surgical which is started soon after birth within the first 2 weeks of life. Our aim is to assess the efficacy of Ponseti's technique^[2,6] for the treatment of CTEV in our institute over a period of 6 years.

Methods: 180 patients between 2 weeks to 12 years of age who had attended in the CTEV clinic of Department of Orthopaedics of our medical college in the last 6 years, till the December 2020 were taken for the study to correct idiopathic CTEV using the Ponseti technique^[2,6]. Children included in the study were assessed every week before cast placement for the severity of the deformity using the Pirani scoring system^[7]. Once a week, Manipulation & serial casting of the CTEV foot was started by the technique described by Ponseti^[2,6]. Patients were followed up on weekly interval till forefoot & midfoot deformities were corrected. Percutaneous Achilles Tenotomy^[16] was done to prevent rocker-bottom deformity & for correcting Equinus deformity after correction of other deformities. All patients were maintained on Foot Abduction Brace (FAB) post correction till 4 years of age or more.

Results: At 6 months' follow-up, Ponseti's technique^[2,6] gave us 84.81 % excellent results, 13.07 % good results and a 2.12% poor results. 86.57% required percutaneous tenotomy^[16], while 13.43 % did not require tenotomy.

Interpretation and conclusion: The Ponseti technique^[2,6] is still a safe, economical and convenient treatment modality for congenital idiopathic clubfoot^[1] which gives successful results, and thus radically decreases the need for extensive corrective surgery even in older children

Keywords: CTEV; Ponseti; Idiopathic clubfoot; Pirani scoring system; Percutaneous Achilles tenotomy

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I. INTRODUCTION

Congenital Talipes Equinovarus (CTEV) which is commonly known as Clubfoot^[1], is one of the most common congenital orthopaedic deformity. It is characterized by four components of foot deformities: midfoot cavus, forefoot adduction, hindfoot varus and hindfoot equinus. The clubfoot has always remained a debatable and confounding problem for the Orthopaedicians to treat successfully. Mostly, orthopaedicians are now of the belief that the initial primary treatment of clubfoot should be non-operative and should be as soon as possible preferably in the first 2 weeks of life in order to take the advantage of favourable viscoelastic properties of the connective tissue forming the joint capsules, ligaments and tendons. The term "clubfoot" was first described by Hippocrates^[1] in the year 400 BC. It was Nicolas Andry in his "Orthopaedicia" expressed the term "Pedis Equinal" which meant the foot bear a resemblance with the foot of a horse. The term "talipes equinovarus" is obtained from latin: Talipes, a combination of words- Talus (ankle) and pes (foot); equinus meaning "horse like" (the heel in plantar flexion) and varus meaning adducted and inverted. Incidence of about 1-1.4 cases per 1000 live births. Males are affected twice as often as females. Almost in 50% of the clubfoot cases have bilateral involvement^[2].

Numerous studies have reported a higher prevalence of clubfoot in cases with a positive family history^[3] in Autosomal dominant with incomplete (40%) penetrance. The theories proposed in the aetiology of CTEV are mechanical factors in utero, primary germplasm defect, arrested foetal development, neuromuscular defect, hereditary, and so on. The goal of treatment is to get rid of these deformities so that the patient has a

painless, functional, plantigrade foot with good mobility and without calluses and does not need to wear modified footwear.

Management of this deformity dates back to fifth century B.C, by Hippocrates and has since then undergone enormous changes largely due to a better perception of the deformity^[4].

The proposed treatment of clubfoot ranges from non-operative serial casting & stretching to complete peritalarsoft tissue surgical release and bony procedures for neglected clubfoot cases.

The procedure of Ignacio V. Ponseti^[1], J.H. Kite^[5] and French methods as expressed by Masse & Bensahel are examples of non-operative methods of correction of clubfoot.

The technique of gradual synchronous correction of all the deformities of clubfoot using manipulation and serial casting once weekly and a feasible percutaneous Achilles tenotomy described by Dr. Ignacio V. Ponseti has attained wide acceptance throughout the world. In the late 1940s, Ponseti had initiated his technique in North America and has become a chief treatment option in multiple countries more recently^[1].

At present, the mainstay in the management of clubfoot is to diagnose the condition promptly and then to deal with the deformity at the earliest to reconfigure the foot & make biomechanically stable foot. Parent's cooperation and their knowledge regarding the condition is another crucial but neglected aspect in achieving successful outcome^[6].

In this study, we have attempted to analyse the functional outcome of Idiopathic clubfoot using Ponseti's technique^[2,6] without any prior treatment in the age group between 2 weeks to 12 years in our institute over a period of 6 years.

II. MATERIAL AND METHODS

A Cross Sectional study of secondary data was done from the records of CTEV Clinic, Department of Orthopaedics of our medical college on 180 patients who were enrolled in the study after fulfilling the criteria were available for final follow-up. All the clubfoot patients are evaluated by Pirani score^[7] and treated by Ponseti method^[6] free of cost under Cure India Initiative.

Inclusion criteria:

- Age between 2 weeks to 12 years
- Patients who are willing and motivated for Surgery, Physiotherapy and Rehabilitation

Exclusion criteria:

- Age less than 2 weeks and more than 12 years
- Operated cases
- Patient who are not willing and motivated for Surgery, Physiotherapy and Rehabilitation

Study period: December 2014 – December 2020

Pre-operative Assessment:

- Detailed physical examination and proper history to exclude regarding the presence of syndromic club foot.
- The severity of the deformity was assessed using the Pirani severity scoring system^[7], and clinical photographs were obtained. The deformity was evaluated according to Pirani Severity Score^[7,15] at each visit before application of Ponseti cast. Manipulations were done by Ponseti's technique^[2,6] followed by serial corrective casts at once weekly interval without anaesthesia. Children were evaluated and graded for severity of clubfoot by Pirani severity scoring system^[7], which registers the deformity of six(6) different components of the clubfoot. All the clubfoot cases which were undergoing Ponseti treatment was evaluated at each visit and assigned;
 - ❖ Midfoot Contracture Score (MFCS) of up to 3 (0=normal, 3= severe deformity)
 - ❖ Hindfoot Contracture Score (HFCS) of up to 3 (0=normal, 3= severe deformity)
 - ❖ Total Score (TS) of up to 6 (0=normal, 6= severe deformity)

All the CTEV cases undergoing Ponseti management was "Scored" at each week for HFCS, MFCS, and TS. Percutaneous Achilles Tenotomy was indicated when HFCS > 1, MFCS < 1, and there was talus head coverage, Heel was in valgus and Foot was in abduction. Evaluation was made using the Pirani Severity Score^[7,15] at initial presentation and subsequently at once weekly interval, during follow up and it was noted in the proforma specially made for it by CURE INDIA INITIATIVE.

Radiological assessment:

- For detection of radiologically evident deformities.
- Measurement of Talocalcaneal angle for heel varus in AP view on Plantar flexion and Lateral view on Dorsiflexion
- Measurement of Tibiocalcaneal angle for equinus on stress Lateral view
- Measurement of Talus-1st metatarsal angle for forefoot adduction in AP view

Method of correction: All the eligible patients from CTEV clinic were selected and managed with the Ponseti Method in two stages a) Treatment & b) Maintenance phase.

A) Treatment Phase: Guidelines of the treatment were as follows:-

1. Except the equinus which was corrected at the last, all the other components of clubfoot deformity were corrected simultaneously at first.
2. At the 1st visit, Cavus deformity was corrected by aligning the forefoot with the hindfoot, supinating the forefoot to bring it in the line with the heel, and then elevating the head of 1st metatarsal (Figure 1).
3. The cast should be applied in two stages: first, a short leg cast to just below the knee, then extension above the knee when the plaster sets. Long leg casts are essential to maintain a strong external rotation force of the foot beneath the talus, to allow adequate stretching of the medial structures, and to prevent cast slippage.
4. At 2nd visit, the first cast is removed, and after about 1 minute of manipulation, the next toe-to-groin cast is applied. Manipulation & casting at this stage are focused on abducting the foot around the head of the talus, with care to maintain the supinated position of the forefoot and avoid any pronation (Figure 1 & Figure 2).
5. During these manipulations, the navicular can be felt reducing over the talar head by a thumb placed over it. It is crucial that forefoot derotation occur about the talus rather than the calcaneo-cuboid joint, & the heel should not be directly manipulated
6. Manipulating forefoot supination throughout the process & correcting the talonavicular subluxation without producing a rocker-bottom deformity will cause the calcaneus to abduct & evert
7. Manipulation & casting are continued weekly for the next 2 to 3 weeks to abduct the foot gradually around the talar head.
8. The foot should never be actively pronated; however, the amount of supination is gradually decreased over these several casts until the forefoot is in neutral position relative to the longitudinal axis of the foot
9. Final correction of residual calcaneus deformity can then be achieved with a percutaneous Achilles tenotomy. This procedure is done under local skin anesthesia under aseptic & antiseptic conditions in the CTEV clinic (Figure 3)
10. The final Post Tenotomy cast is applied with the foot in the same maximally abducted position of approximately 70 degrees & dorsiflexed 15 degrees for 3 weeks (Figure 4)

B) Maintenance Phase: On removal of final post tenotomy cast, the infant is placed in a brace that maintains the foot in its corrected position (abducted & dorsiflexed). The Steenbeck Foot Abduction Brace consists of shoes mounted to a bar in a position of 70 degrees of external rotation & 15 degrees of dorsiflexion. The distance between the two shoes is set at 1 inch wider than width of the infant's shoulder (Figure 5). The brace is worn 23 hours each and everyday for the first 3 months after casting and then 14 hours a day or while sleeping for the next 4 years of age. Frequent follow-up of during the bracing period is essential to encourage continued compliance and to detect early recurrence.

Categorization of feet: The feet were then classified into three categories with respect to the severity of the deformity on basis of initial Pirani Score^[7,15].

- ❖ Group-I: feet with a Pirani Score of 0.5 to 2.5 points
- ❖ Group-II: feet with a Pirani Score of 3 to 4.5 points
- ❖ Group-III: feet with a Pirani Score of \geq 5.0 points.

III. RESULTS AND DISCUSSION:

Our study includes treatment and follow-up of 180 children (283 feet) with idiopathic CTEV, treated using Ponseti's technique, between December 2014 – December 2020 in our medical college. The following results were observed and discussion had been drawn from the data collected in our study.

Table 1: Age Distribution of Patients

Age of presentation (in Months)	No. of patients	%
<1 months	15	8.33333333
1-6 months	115	63.88888889
>6 months	50	27.77777778
Total	180	100.00%

In our study, it was seen that only 8.33% presented to very early in life who were less than 1 month old. 63.89% had presented in the age group between 1-6 months which is followed by 27.78% who were more than 6 months old. The youngest patient in our study was 15 days old and the oldest was 144 months (12 years).

Table 2: Gender Distribution of Patients

Gender	No. of patients	%
Male (M)	126	70
Female (F)	54	30
Total	180	100.00%

In our study, we had 70% males and 30% females which are indicating that there is a genetic predilection for male sex as a strong risk factor for clubfoot^[8,9]. It is in concordance with following studies:

- Kite in the series of 1509 cases reported 70% males and 30% females^[10].
- Raju Rijal et al. in his series reported 76.2% males and 33.8% females^[11].
- M Changulani et al. in his series reported 75.7% males and 24.3% females^[12].

Table 3: Side of Feet Involvement

Laterality/Side	No. of patients	% patient	No. of Feet	% Feet
Left {L}	32	17.77777778	32	11.30742049
Right {R}	45	25	45	15.90106007
Bilateral {BL}	103	57.22222222	206	72.79151943
Total	180	100.00%	283	100.00%

In our study, we had 57.22% patients with Bilateral CTEV and rest 42.78% patients with Unilateral CTEV. Among the unilateral cases, 25% of them had Right sided affliction and 17.78% had their Left side involved.

This is in concordance with a study by Ignacio Ponseti et al^[2] with the literature, who revealed that 50% around have bilateral involvement. Also, it is similar to the previous studies with an increased prevalence of right sided clubfoot deformity^[8,13] in Unilateral Clubfoot.

Table 4: Number of Casts required for correction

No. of Cast reqd.	No. of patients	% (Patient)	No. of Feet	% (Feet)
1-2	17	9.444444444	24	8.480565371
3-5	35	19.44444444	51	18.02120141
6-10	89	49.44444444	141	49.82332155
>10	39	21.66666667	67	23.67491166
Total	180	100.00%	283	100.00%

In our study, 49.82% of the total number of feet had required 6-10 casts for correction.

Table 5: Frequency of Percutaneous Tenotomy

Tenotomy	No. of Patients	%	No. of Feet	%
Done	156	86.66667	245	86.57244
Not Done	24	13.33333	38	13.42756
Total	180	100.00%	283	100.00%

In our study, 86.67% of the total cases had undergone Percutaneous Tenotomy^[16].

This is in concordance with a study by Patwardhan S et al.^[17] who revealed on his case reports that Tenotomy of the tendo-achilles is required in almost 85% of cases of CTEV treated with Ponseti technique^[1,18].

Table 6: Initial Pirani score Vs. Percutaneous Tenotomy

Initial PIRANI score	No. of feet	Percutaneous Tenotomy		Mean PIRANI score ±SD	Mean No. of Casts ±SD
		Not Done	Done		
Group I: 0.5 - 2.5	29 (10.24735%)	0 (0%)	29 (100%)	1.74 ± 0.64	4.24 ± 2.97
Group II: 3.0 - 4.5	58 (20.4947%)	10 (17.24%)	48 (82.76%)	3.70 ± 0.49	7.18 ± 4.47
Group III: ≥5.0	196 (69.25795%)	28 (14.29%)	168 (85.71%)	5.91 ± 0.25	9.17 ± 4.02
Total	283 (100%)	38	245	5.03 ± 1.46	7.40 ± 3.85

		(13.43%)	(86.57%)		
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It was found that higher the initial Pirani score at the time of presentation, there was a higher chance of need for Percutaneous Tenotomy. Of 196 feet who had a Pirani score of more than 5, 168 feet (85.71%) had done Percutaneous Tenotomy. This is in concordance with a study by Scher et al.^[16] who revealed that 27 feet with initial Pirani scores more than 5.0, 85.2% required a tenotomy.

If we categorize the feet on the basis of initial Pirani Score, we find that those feet which had lower initial score 3 to 4 (that was more supple, less severe and less rigid deformity) were more amenable to correction and responded relatively early when compared to those with higher initial score 4.5 to 6 (i.e. less supple, more severe and more rigid deformity). The mean number of casts required in Group I was found to be 4.24, whereas, Group II required a mean of 7.18 casts and Group III required a mean of 9.17 casts. PJ Dyer and N Davis in their series showed at least 4 casts were required for full correction of initial Pirani score of 4, similar to our study^[15].

Table 7: Initial Pirani score Vs. Age of presentation

Initial PIRANI score	Age (in months)			No. of feet
	<1 m	1-6 m	>6 m	
Group I: 0.5 - 2.5	2	19	8	29
Group II: 3.0 - 4.5	3	38	17	58
Group III: ≥5.0	20	124	52	196
Total	25	181	77	283

Another point which is worth mentioning is that in patients who were seen at early age of life, the initial pirani scores were lesser. Because of generalized laxity of ligaments due to effect of maternal 'relaxin' hormone in initial days of life, the deformity was suppler. So, it implies that correction of the deformity can be better with greater ease when treatment is started in the initial days of life taking favourable advantage of fibroelastic properties of connective tissue and ligaments as compared to later stages of life.

Table 8: Age distribution Vs. No. Of casts required

Age (in Months)	No. of patients	Mean No. of Casts	Standard Deviation(SD)
<1 months	15	5.266666667	2.153623746
1-6 months	115	7.408695652	3.852307698
>6 months	50	10.14	4.642351621
Total	180	7.605120773	3.549427688

When we observe at the age wise distribution it is obvious that most of the patients who had reported within the first month of their life responded better with lesser number of casts. Patients who belonged to the age group of more than 6 months required more number of casts than those who belonged to the age group of less than 6 months. The mean number of casts was 10.14 in the age group above 6 months compared to 5.27 in patients less than one month old and 7.40 in patients in the age group of 1-6 months.

Table 9: Post treatment Pirani scores

Post-treatment PIRANI score (After Treatment)		
	No. of feet (n=283)	%
Excellent(0)	227	80.21201413
Good(0.5-1.0)	36	12.72084806
Poor(>1.0)	20	7.067137809
Total	283	100.00%
Post-treatment PIRANI score (6 months follow up)		
	No. of feet (n=283)	%
Excellent(0)	240	84.80565371
Good(0.5-1.0)	37	13.07420495
Poor(>1.0)	6	2.120141343

Total	283	100.00%
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At the end of treatment, 227 feet (80.21%) had excellent results, 36 feet (12.72%) had good results and 20 feet (7.067%) had a poor outcome.

At 6 months follow up, the results were better with only 6 feet (2.12%) landing up with a poor result, 240 feet (84.81%) having excellent result and 37 feet (13.07%) with good result. This demonstrates that Ponseti's technique is actually an ideal and best possible method in treating idiopathic CTEV.

Clearly, the true functional outcome of these patients cannot be determined until the child has completed growth, and perhaps not until later in life. But, the results and consequences of treatment at the end of ponseticasting^[2,6], using this validated Pirani scoring system^[7,15], allow an accurate evaluation and assessment of the ability of casting and Achilles tenotomy^[16] to correct the rigid clubfoot to a supple, plantigrade position.

IV. CONCLUSION:

- Based on the above results of our study, we have concluded that Ponseti's method of serial corrective cast manipulation is still a safe and cost effective way of correcting the most common congenital orthopaedic idiopathic clubfoot deformities of CTEV and giving the child a pain free, functional, plantigrade foot with good mobility.
- Treatment of idiopathic CTEV should begin as early as possible, optimally within first 2 weeks of life; however, older children also can be treated non-operatively.
- Most of the clubfoot, when treated as soon as after birth, can be easily corrected by manipulation and serial application of five or six plaster casts of 1 week duration each by the Ponseti method.
- Pirani score is effective in evaluating the functional outcome of clubfoot. The patients who had lower Pirani score at initial presentation (i.e. more supple, less rigid and less severe deformity) respond better and faster to the conservative treatment as compared to those who had higher Pirani score at initial presentation (i.e. more rigid and more severe deformity)
- On the basis of initial Pirani score, feet with scores less than 4 required lesser number of casts for correction (less than 4), whereas when the score was more than 4.5, they required more number of casts.
- Percutaneous Tendo-Achilles tenotomy was almost always required when the child presented with a hind foot score of 2.5 or more.
- Strict adherence to the good casting technique helps in successful correction and to minimize complications of recurrence or relapse.
- In the present study follow-up was of shorter duration, however we anticipate and predict similar outcome in the longer run.

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Figure 1





Figure 3. Percutaneous Achilles Tenotomy



Figure 4.
Post – Tenotomy Cast



Figure 5. Steenbeck Foot Abduction Brace

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