

ISSN: 2395-1958  
IJOS 2018; 4(1): 92-97  
© 2018 IJOS  
www.orthopaper.com  
Received: 11-11-2017  
Accepted: 12-12-2017

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## Management of idiopathic clubfoot by Ponseti's technique

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DOI: <https://doi.org/10.22271/ortho.2018.v4.i1b.16>

### Abstract

**Background and objective:** Idiopathic Congenital Talipes Equinovarus (CTEV) is a complex deformity that is difficult to correct. The treatment of clubfoot is controversial and continues to be one of the biggest challenges in paediatric orthopaedics. Most orthopaedicians agree that the initial treatment should be non-surgical and should be started soon after birth. We aimed to study a short term follow up of 30 patients treated by the Ponseti method at the department of Orthopaedics, Mahatma Gandhi Medical College & Research Institute, Pondicherry to assess the efficacy of Ponseti's technique for the treatment of CTEV.

**Methods:** 30 patients were selected from the Out-Patient section of the Department of Orthopaedics and Traumatology, M.G.M.C & R.I, Pondicherry for correction of idiopathic CTEV using the Ponseti technique from June 2011 to March 2013. Children included in the study were assessed for the severity of the deformity using the Pirani severity scoring system and clinical photographs were obtained. Casting of the foot was started by the technique described by Ponseti. Before cast placement every week, the foot deformity severity was assessed using the Pirani scoring system. These patients were followed up in a prospective manner for a period of minimum of six months.

**Results:** At 6 months' follow-up, Ponseti's technique gave us 64.86% excellent results, 29.72% good results and a 5.4% poor results.

43.24 % required pecutaneous tenotomy, while 56.76% did not require tenotomy.

There was an incidence of 8.1% for postero-medial soft tissue release.

**Interpretation and conclusion:** The Ponseti method is a safe and cost effective treatment modality for congenital idiopathic clubfoot which gives excellent results, and radically decreases the need for extensive corrective surgery.

**Keywords:** Ponseti; CTEV; Idiopathic clubfoot

### 1. Introduction

Congenital Talipes Equinovarus (CTEV) or Clubfoot as it is commonly known, is one of the most common congenital pathological condition. The term was first described by Hippocrates [1]. It was Nicolas Andry in his "Orthopaedicia" described the term "Pedis Equinal" which meant the foot resembling the foot of a horse. The term "talipes equinovarus" is derived from latin: Talipes, a combination of words- Talus (ankle) and pes (foot); equinus meaning "horse like" (the heel in plantar flexion) and varus meaning inverted and adducted.

Incidence is 1-1.4 cases per 1000 live births. Boys are affected twice as often as girls. Bilateral involvement is found in 30-50% of cases [2].

The etiology of club foot is still obscure although too many theories have been proposed. Many studies report a higher incidence of CTEV in patients with a positive family history [3]. The theories proposed in the etiology of CTEV are mechanical factors in utero, neuromuscular defect, primary germ plasma defect, arrested fetal development, hereditary, and so on.

The goal of treatment is to reduce or eliminate these deformities so that the patient has a functional, painfree, plantigrade foot with good mobility and without calluses and does not need to wear modified shoes.

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

Over the years many different forms of treatment ranging from gentle manipulation and

strapping, serial plaster corrections, forcible manipulations including the use of mechanical devices to surgical correction have been tried.

There has been much debate in the past as to whether a non-operative or operative treatment was more effective in the treatment of clubfoot. Those feet usually which have had numerous manipulations and operations, are stiff, deformed and rigid due to scar tissue formation.

The recommended treatment of CTEV ranges from non-operative casting & stretching to complete peritalar surgical release and bony procedures for neglected CTEV cases.

The methods of J.H. Kite<sup>5</sup>, Ignacio V. Ponseti<sup>[1]</sup> and French methods as described by Masse & Bensahel are examples of non-operative methods of correction of CTEV.

The technique of gradual and simultaneous correction of all deformities of CTEV using manipulation and casting at weekly interval and a possible percutaneous Achilles tenotomy described by Dr. Ignacio V. Ponseti has gained wide acceptance throughout the world. He introduced it in North America in the late 1940s and has become a primary treatment option in many countries more recently<sup>[1]</sup>.

Now, most Orthopaedic surgeons agree that the initial treatment of congenital clubfoot should be non-operative, beginning from the first day of life when the deformity can be easily dealt to achieve a plantigrade foot at the earliest because it gives better functional results. The mainstay at present, in management of clubfoot is to diagnose the condition as soon as possible and then to deal with the deformity at the earliest to realign the foot biomechanically stable. The cooperation of the parents and their education regarding the condition is another important but neglected aspect in achieving successful results<sup>[6]</sup>.

In this study, we have attempted to analyse the functional outcome of Idiopathic clubfoot using Ponseti's technique in children presenting to us within the first year of age without any prior treatment.

## 2. Materials & Methods

Eligible patients were selected from the Out-Patient section of the Department of Orthopaedics and Traumatology, M.G.M.C & R.I, Pondicherry and subjected to Ponseti's technique of idiopathic CTEV correction between the period from June 2011 to March 2013. These patients were followed up in a prospective manner for a period of minimum of six months. The severity of the deformity was assessed using the Pirani severity scoring system, and clinical photographs were obtained. Casting after manipulation was started by the technique described by Ponseti.

A thorough general & local examination was carried out & the deformity was scored according to Pirani's classification at each visit before applying cast.

Manipulations were done by Ponseti's method followed by corrective casts at weekly interval without anaesthesia.

Children were evaluated and graded for severity of clubfoot by Pirani severity scoring system<sup>[7]</sup>, which registers the deformity of six different components of the clubfoot.

The congenital clubfoot undergoing treatment was assessed at each visit and assigned;

- a. A Midfoot Score (MS) of up to 3 (0=normal, 3= severe deformity)
- b. A Hindfoot Score (HS) of up to 3 (0=normal, 3= severe deformity)
- c. A Total Score (TS) of up to 6 (0=normal, 6= severe deformity)

Consequently, the total Score was from 0 to 6 points, with 6

representing the most severe deformity. Every clubfoot under Ponseti management was "Scored" at each week for HS, MS, and TS (Total Score).

The Scores were plotted on a graph to know how the foot was recovering on the roadmap of treatment.

Tenotomy was indicated when HS > 1, MS < 1, and the head of the talus was covered.

Assessment was made using the Pirani Severity Score at initial presentation and at weekly interval, during follow up and it was noted in the proforma specially made for it.

### 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.

- Group-I: feet with a Pirani Score of 1.5 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 >5 points.

### Inclusion criteria

- Isolated idiopathic CTEV.
- Age less than 1 year.

### Exclusion criteria

Neglected clubfoot.  
Relapsed clubfoot.

Clubfoot associated with any other congenital abnormality.  
Arthrogyposis Multiplex Congenita.

## 2.1 statistical methods

Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on mean and SD (min-max) and results on categorical measurements are presented in number (%). Significance is assessed at 5% level of significance. The following assumptions on data is made: 1) dependent variables should be normally distributed, 2) samples drawn from the population should be random, cases of the samples should be independent.

Analysis of variance (ANOVA) has been used to find the significance of study parameters between three or more groups of patients, student t test (two tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups inter group analysis) on metric parameters. Chi-square/ fisher exact test has been used to find the significance of study parameters on categorical scale between two or more groups.

### Significant figures

- + suggestive significance (p value: 0.05 < p < 0.10)
- \* moderately significant (p value: 0.01 < p > 0.05)
- \*\* strongly significant (p value : p > 0.01)

Statistical software: SAS 9.2, SPSS 15.0, Stata 10.1, Medcal 9.0.1, Systat 12.0 and R Environment ver.2.11.1 were used for the analysis of the data and Microsoft Word and Excel have been used to generate graphs, tables etc.

## 3. Results

The study includes treatment and follow-up of 30 children with idiopathic CTEV, treated using Ponseti's technique, between June 2011 and March 2013, at Mahatma Gandhi Medical College & Research Institute, Pondicherry. The following results were observed from the data collected in our study.

**Table 1:** Age Distribution of Patients

Age in years	No. of patients	%
<1 month	15	40.5
1m-6months	16	43.2
> 6 months	6	16.2
Total	30	100.0

**Table 2:** Gender Distribution of Patients

Gender	No. of patients	%
Female	11	36.7
Male	19	63.3
Total	30	100.0

**Table 3:** Side of Feet Involvement

Side	No. of feet	%
Left	12	40
Right	11	36.7
Bilateral	7	23.3
Total	30	100.0

**Table 4:** Number of Casts required for correction

No. of casting	No. of feet	%
1-2	0	0.0
3-5	8	21.6
6-10	29	78.4
Total	37	100.0

**Table 5:** Frequency of PT required for correction

PT	No. of feet	%
No	21	56.8
Yes	16	43.2
Total	37	100.0

**Table 6:** Evaluation based on Pirani score

	PIRANI score				Significance		
	Before treatment	After treatment	6 months Follow up Scoring		Before – After	Before-Follow up	After Rx-Follow up
Min-Max	2.00-6.00	0.00-1.50	0.00-2.00	Difference	4.71	4.73	0.014
Mean ± SD	5.00±1.06	0.28±0.38	0.27±0.47	P value	<0.001**	<0.001**	0.800

**Table 7:** Requirement of PMSTR

PMSTR Req'd	No. of feet	%
No	34	91.9
Yes	3	8.1
Total	37	100.0

**Table 8:** Initial Pirani score Vs. No. Of casts required

Initial PIRANI score	No. of feet	%	Mean PIRANI score ±SD	Mean No of Casts ±SD
Group I: 1.5-2.5	2	5.4	2.00±0.00	3.00±0.00
Group II:3.0-4.5	12	32.4	4.21±0.39	5.75±1.91
Group III:5.0-6.0	23	62.2	5.67±0.36	7.04±1.22
Total	37	100.0	5.00±1.06	6.41±1.77
P value	-	-	<0.001**	0.001**

**Table 9:** Initial Pirani score Vs. Age of presentation

Initial PIRANI score	No. of feet	Age in years		
		<1 month	1- 6months	>6 months
Group I: 1.5-2.5	2	0	2(100.0%)	0
Group II:3.0-4.5	12	5(41.7%)	2(16.7%)	5(41.7%)
Group III:5.0-6.0	23	10(43.4%)	12(52.1%)	1(4.3%)
Total	37	15(40.6%)	16(43.4%)	6(16.2%)
P value	Initial Pirani score significantly more associated with age in years with p=0.011*-			

**Table 10:** Age distribution Vs. No. Of casts required

Age in years	No. of patients	Mean no of casts	SD
<1 month	15	6.07	1.58
1m-6months	16	6.25	1.77
More than 6 months	6	7.67	1.66
Total	30	6.41	1.77

**Table 11:** Initial Pirani score Vs. PT

PIRANI score	No. of feet	Percutaneous Tenotomy	
		No	Yes
Group I: 1.5-2.5	2(5.41%)	2(9.52%)	0(0%)
Group II: 3.0-4.5	12(32.43%)	10(47.62%)	2(12.5%)
Group III: 5.0-6.0	23(62.16%)	9(42.86%)	14(87.5%)
Total	37(100%)	21(100%)	16(100%)

PIRANI score is significantly more associated with PT with P=0.019\*

**Table 12:** Post treatment Pirani scores

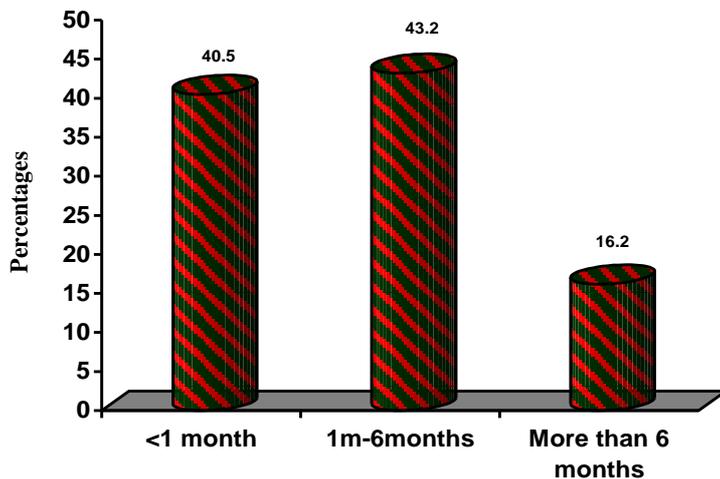
Post-treatment PIRANI score	No. of feet (n=37)	%
After treatment		
• Excellent (0)	21	56.8
• Good(0.5-1.0)	15	40.5
• Poor(>1.0)	1	2.7
6 months follow up		
• Excellent (0)	24	64.8
• Good(0.5-1.0)	11	29.7
• Poor(>1.5)	2	5.4

**4. Discussion**

A clinical study on the most common congenital deformity of foot, which is CTEV, was carried out in the Department of Orthopaedics, MGMC & RI, Pondicherry, to evaluate the early results of the conservative treatment using Ponseti technique. We studied thirty children (37 feet) who were treated by Ponseti’s technique.

**4.1 Age**

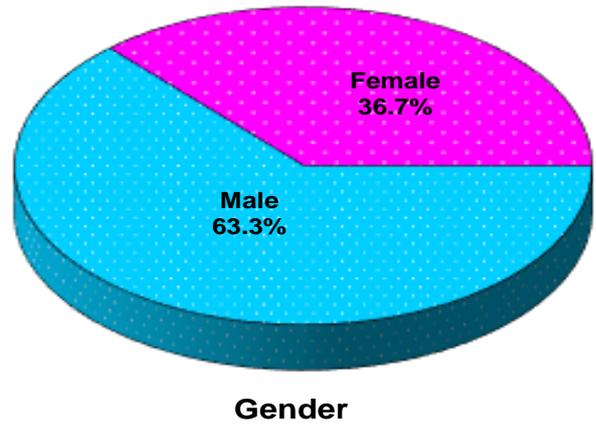
In our study, it was seen that a large number of patients presented to very early in life. The youngest patient in the study was 2 days old and the oldest was 10 months old. 16 patients (43.2%) were in the age group between 1-6 months which is closely followed by 15 patients (40.5%) who were less than a month old.



**Graph 1:** Age distribution

**4.2 Sex Incidence**

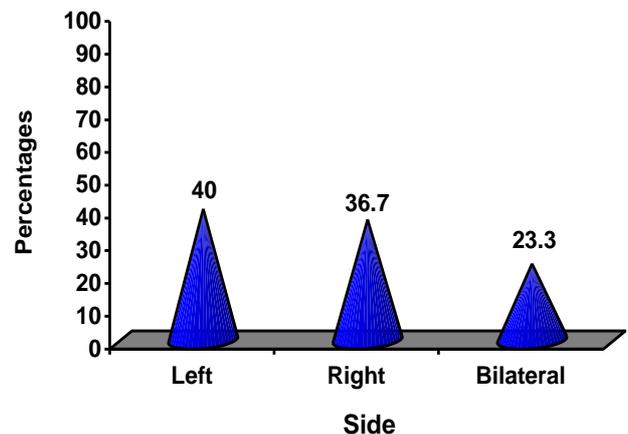
Our study had 19 males (63.3%) and 11 females (36.7%). Kite in the series of 1509 cases reported 70% males and 30% females [8]. Raju Rijal *et al.* in his series reported 76.2% males and 33.8% females [9]. M Changulani *et al.* in his series reported 75.7% males and 24.3% females [10].



**Graph 2:** Sex distribution

**4.3 Laterality**

Our study had 12 (40%) right side feet, 11 (36.7%), 11 left side feet and 7 (23.3%) adding to a total of a 23 (76.6%) unilateral side involvement and 7 (23.3%) feet were bilateral involvement. This is comparable to the study by Herzenberg *et al.* [11] who reported a prevalence of unilateral clubfoot (74%) than bilateral clubfoot (26%).



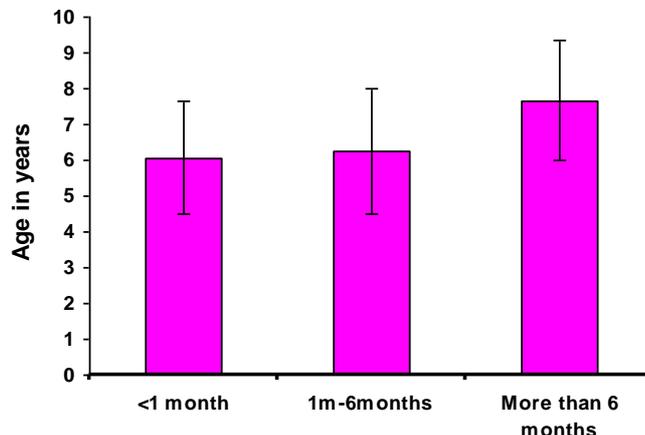
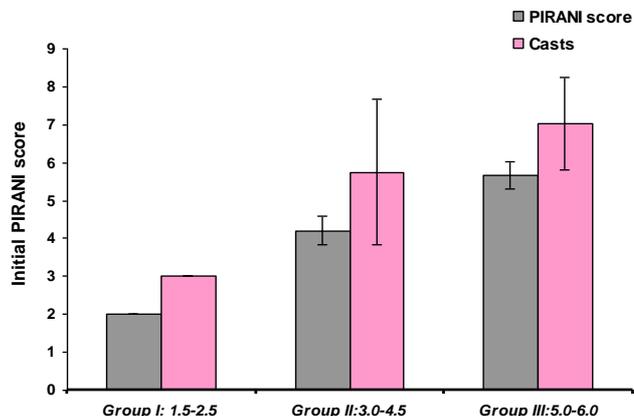
**Graph 3:** Laterality

**4.4 Mean Pirani score at initial presentation:**

In the present study clubfoot deformity was classified, according to the Pirani scoring system into 3 groups. Group-I with a score of 1.5 to 2.5 points was seen in two feet (5.4%), Group-II with a score of 3 to 4.5 points were seen in twelve feet (32.4%) and group-III with a Score of ≥5 points was seen in twenty-three feet (62.2%) which was found to be the majority. Overall mean Pirani score was found to be 5.0, which is similar to the mean score of 4.6 in the study by Lehman *et al.* [12].

**4.5 Mean Pirani score Vs number of casts:**

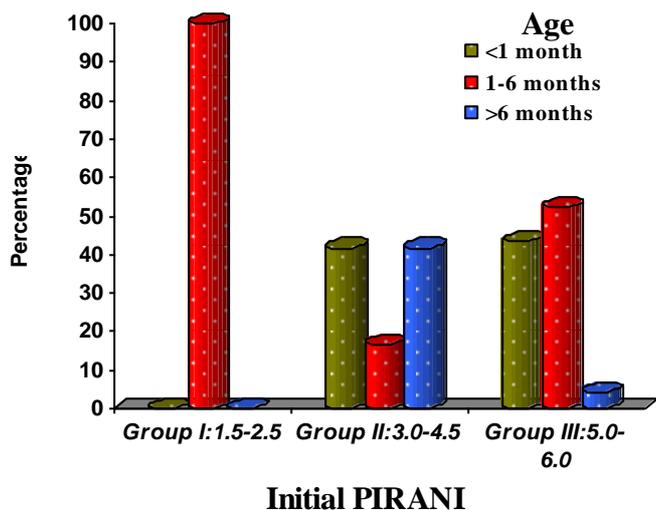
If we categorize the feet on the basis of initial Pirani Score, we find that those feet which had lower initial score 3 to 4 (that is less severe and less rigid deformity) were more amenable to correction and responded relatively early when compared to those with higher initial score 4.5 to 6 (i.e. more severe and more rigid deformity). The mean number of casts required in Group I was found to be 3, whereas, Group II required a mean of 5.75 casts and Group III required a mean of 7.04 casts. This shows that Group I and Group II required fewer casts than those in Group III to achieve full correction. 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 [13].



Graph 5: Age distribution Vs. Number of casts

**4.6 Initial Pirani score Vs. age:**

Another point which is worth noting is that in patients who were seen at early age of life, the initial scores were lesser. This may be due to the fact that in early days of life because of generalized laxity of ligaments due to effect of maternal 'relaxin' hormone the deformity is suppler. This implies that deformity can be corrected with greater ease when treatment is started in the initial days of life taking advantage of favourable fibroelastic properties of connective tissue and ligaments. Initial Pirani score was significantly more associated with age in years with a p value of 0.011.



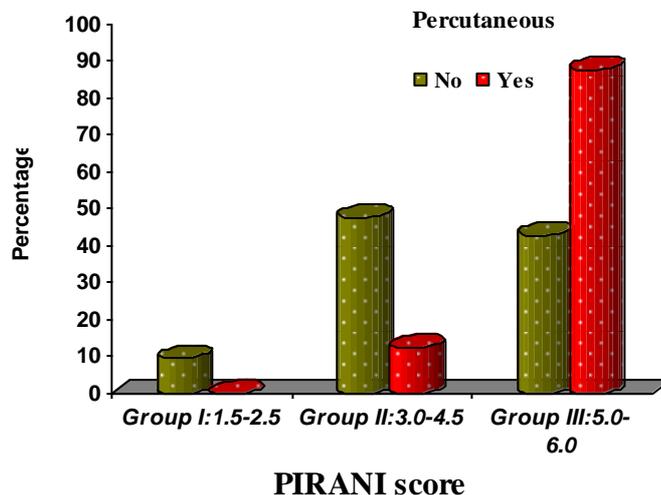
Graph 4: Initial Pirani score Vs. Age

**4.7 Age distribution VS. Number of casts:**

If we look 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 7.67 in the age group above 6 months compared to 6.07 in patients less than one month old and 6.25 in patients in the age group of 1-6 months.

**4.8 Initial Pirani score Vs. PT:**

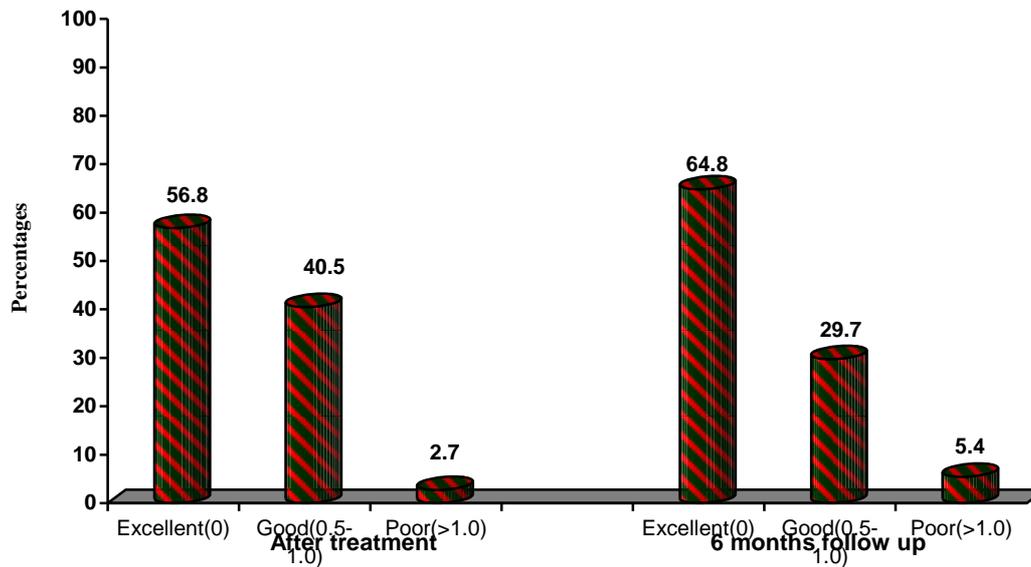
It was found that higher the initial Pirani score at presentation, there was a higher chance of need for PT. Of 23 feet who had a Pirani score of more than 5, 87.5% had PT done. This is in concordance with a study by Scher *et al.* [14] who revealed that 27 feet with initial Pirani scores more than 5.0, 85.2% required a tenotomy.



Graph 6: Initial Pirani score Vs. PT

**4.9 Post treatment Pirani scores:**

21 feet (56.8%) had excellent results, 15 feet (40.5%) had good results and only 1 foot (2.7%) had a poor outcome at the end of treatment. At 6 months follow up, the results were more or less similar with only 2 feet (5.4%) landing up with a poor result, 24 feet (64.8%) having excellent result and 11 feet (29.7%) with good result. This proves that Ponsetis technique is indeed an ideal method in treating idiopathic CTEV. In the present study follow-up was of short duration, however we anticipate equal results in the long run. Clearly, the true functional outcome of these patients cannot be determined until the child has completed growth, and perhaps not until later in life. Still, the results of treatment at the end of casting, using this validated scoring system, allow an accurate assessment of the ability of casting and Achilles tenotomy to correct the clubfoot to a supple, plantigrade position.



Graph 7: Post treatment Pirani scores

## 5. Conclusion

Treatment of idiopathic clubfoot is either conservative or surgical. Despite long term experience in many centers, there still are outcome controversies surrounding both alternatives. Controversies persist because of lack of a) standards for evaluating functional outcomes, rendering comparisons between treatment groups problematic, and b) long-term follow-up studies showing results.

Ponseti devised his method of conservative treatment of Congenital Talipes Equino Varus which starts from day one of age and is based on the fundamentals of kinematics and pathoanatomy of the deformity. This method successfully realigns clubfoot in infants without extensive and major surgeries. This method has correct biomechanical basis for realigning deformed ankle and foot joints and corrects deformity due to favourable fibroelastic properties of the connective tissue and the ligaments. So, it does not aim at anatomical and radiological correction and can be evaluated critically on the basis of clinical correction.

### Highlights of this study

- Based on the above results, we have concluded that Ponseti's method of serial corrective manipulation of CTEV is an effective way of correcting the deformities and giving the child a functional, pain free, plantigrade foot with good mobility
- Most clubfeet, when treated shortly after birth, can be easily corrected by manipulation and application of five or six plaster casts (the Ponseti method).
- Pirani score is effective in evaluating the outcome.
- 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 T.A tenotomy was almost always required when the child presented with a hind foot score of 2.5 or more.
- Strict adherence to the casting technique helps in successful correction and to minimize complications.
- Duration of the study is not sufficient to predict the long-term results, but early results are certainly encouraging.

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