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Functional outcome of serial cast correction of congenital talipes equinovarus by ponseti method

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Abstract
Vast number of children are born with congenital clubfoot every year. Incidence of CTEV being one per 1000 live births. Most of these are kids born in countries where they remain untreated or poorly treated reducing their quality of life. CTEV has been existent and known since time immemorial to mankind and so are the controversies it carries within itself. Many research has been done on these subjects and they all have contributed understanding the pathoanatomy and deciding upon the appropriate treatment. Still the literature states that treatment of club-foot is in general one of unvarying success. In our study we have recorded the functional outcome of serial cast correction of CTEV by Ponseti method.

Keywords: CTEV, ponseti method, functional outcome

Introduction
As per current consensus, the initial management of CTEV should always be non-surgical, starting from day one of life when the deformity can be easily corrected to achieve a plantigrade foot at earliest and it gives better functional & cosmetic results. So at present the mainstay in management of clubfoot is to diagnose the deformity as soon as possible and then to deal with the deformity as early as possible to realign the foot biomechanically. The involvement of the parents and their education regarding the disease is another important but often neglected aspect in achieving successful results.

Aim of the Study
To analyse the Functional outcome of serial cast correction of congenital talipes equinovarus by ponseti method.

Materials and Methods
This study was done at our "CTEV Clinic" conducted at Govt. Mohan Kumaramangalam Medical College, Salem. Study was conducted from July 2013 to September 2014.

Study design
The study is a prospective study,

Source of Data
All the children from birth to 12 months of age with congenital idiopathic clubfoot attending the CTEV Clinic from August 2013 to August 2014 at our hospital and who are willing to undergo treatment.

Inclusion criteria
1) Infant from birth to 12 months of age with clubfoot deformity
2) Infants with idiopathic clubfoot.

Exclusion criteria
1) Infants with Non-idiopathic clubfoot like myelodysplasia, complex idiopathic clubfoot, paralytic clubfoot.

2) Previously operated for clubfoot
3) Age more than 12 months

38 cases being selected from the registered patients in the "CTEV Clinic with untreated deformed foot and age at presentation less than 12 months.
Each patient was registered and detailed personal history was recorded including the age, sex, father's & mother's name, address, date of first reporting, age of reporting, detailed history of previous treatment, etc. A thorough general & local examination was carried out & the deformity was scored according to Pirani's classification at each visit before applying cast.
The score was plotted against the time and the trend of score was noted with reference to effect of manipulations or other interventions on deformity.
Manipulations were done by Ponseti's method followed by corrective casts at weekly interval without anaesthesia. Depending upon the response of the deformity to serial casting as evident by improvement in Pirani Scoring since institution of treatment, the treatment was either continued or modifications were recommended. Patients were followed up weekly for corrective casting till tenotomy and corrective cast was applied for 3 weeks after final correction or percutaneous Tendo Achilles tenotomy. We performed the tenotomy under anesthesia. Then the patients were advised regarding bracing with Dennis Browne splints for 3 months and followed-up to instruct regarding night time bracing for 3- 4 years. Modified CTEV shoes in children who had started bearing weight on lower limbs were given.

The Ponseti Technique [4]
The treatment is started as far as possible in the early neonatal period itself. The child should be kept comfortable through the casting process so that the casting can be done comfortably and perfectly.

Reduction of cavus
The first aspect of serial cast correction is correction of high arch of the foot by aligning the fore foot to the hind foot perfectly. The high medial arch (cavus), results from a pronated forefoot with respect to the hind foot..Cavus is usually supple in neonates and correction requires only supinating the forefoot by elevating first metatarsal to achieve a normal longitudinal arch of the foot. It is necessary to bring forefoot in the same plane as that of hindfoot, because only when this is achieved, the whole foot can be manipulated as a single unit keeping talus as the fulcrum.
The forefoot is supinated to the extent that visual inspection of the plantar surface of the foot reveals a normal appearing arch—neither too high nor too flat.

Manipulation
The manipulation comprises of abduction of the foot below the stabilized head of talus. First the talar head is located. The heel varus and fore foot adduction are corrected simultaneously. To achieve this, the talar head is located, and this serves as the fulcrum for correcting the deformity. The talar head is identified by palpating anteriorly from the lateral malleolus. Underneath the talar head the anterior part of calcaneum can also be identified as the foot is laterally rotated with the talar head stabilized, the movement of the navicular bone can also be assessed. The manipulated position is held with least possible pressure for about a minute and released. The foot in this sequence is not pronated at any stage

Second, third, and fourth casts
The heel varus and fore foot adduction are progressively corrected through these stages. The equinus slowly corrects with correction of fore foot adduction and heel varus. This is due to the tendency of the calcaneum to dorsiflex under the talus. No attempt is made to correct the equinus by manipulation at this stage

Foot appearance after the fourth cast
The fore foot adduction and heel varus will be corrected at this stage. Equinus though reduced is not adequate, for which a heel cord tenotomy is usually necessary. Sometimes in the very supple foot, equinus is managed with few additional cast corrections without tenotomy. If the progress is uncertain tenotomy is performed.

The Technique of Cast Application
Manipulation before casting:
The foot is manipulated each time prior to application of the cast. The foot should be held by the toes. Holding the calcaneum is avoided to allow it to abduct along with foot abduction

Application of soft cotton roll padding
A very thin layer of cast padding is applied around the foot after manipulation. Throughout the application of soft cotton roll around the leg the foot is held by the toes with the talar head stabilized with one finger.

Cast application
Initially the cast is applied as a below knee cast and then converted into an above knee cast with knee in 90 degree flexion. The plaster is applied smoothly. Too much tension while applying the cast is avoided. The Plaster is rolled over the surgeons finger also so that finally there will be adequate room for the toes to move about

Moulding the cast
This is done using mild pressure. Continous pressure is best avoided over the talar head. The pressure is applied and relaxed alternatively good moulding is done to maintain the arch of the foot to prevent any possibility of rocker bottom foot. Both the malleoli are moulded. The entire process of moulding should be a dynamic one and static pressure at any particular point is avoided as much as possible. The moulding process is continued till the plaster hardens.

Conversion to above knee cast
Adequate padding is given at the upper thigh to avoid skin irritation. The Plaster of Paris may be layered over the front of knee to reinforce the cast. The cast is finally trimmed to allow enough room for toes

Cast Removal
The cast is removed in the subsequent visit at the CTEV clinic just before the application of new cast. Early cast removal is to be avoided as considerable correction may be lost in the period when the child is out of the plaster. Usually we use a plaster knife to cut the plaster.

Assessment of the need for tenotomy
A critical point in the treatment protocol is to decide whether adequate correction has been obtained to go ahead with the heel-cord tenotomy. This is assessed as the stage when the anterior calcaneus is abducted out under the talus This abduction allows the foot to be safely dorsiflexed without crushing the talus between the calcaneus and tibia. In uncertain situations a further few castings can be done till the foot is in sufficient abduction to undergo the tenotomy.

Features of a well abducted foot [4]
It is mandatory to verify that the foot is adequately abducted to bring the ankle into 0-5 degrees of dorsiflexion prior to tenotomy. This is best assessed by the ability to feel the anterior process of calcaneum under the talus.

The final outcome
The end result should be foot over-corrected in abduction. It is actually a full correction of the foot into maximum normal abduction. This helps prevent relapses.

Equinus Correction [4]
It is made certain the Pre-requisites forequinus correction have been met.
a) Pirani score for Mid foot contracture is 1 or less
b) Heel in valgus
c) Talar head measures 0
d) Foot in abduction

Percutaneous heel cord tenotomy [4]
Skin preparation
The foot is prepared thoroughly from midcalf till midfoot with an antiseptic the foot is held by the assistant from the toes with the fingers of one hand and the thigh is held with the other hand.

Anaesthesia
We performed the tenotomy under general anaesthesia / local anaesthesia

Equipment
No.11 or any other small blade is used.

Heel cord tenotomy
The tenotomy is performed around 1.5 cm above the calcaneuum with the assistant holding the foot in maximal dorsiflexion. A “pop” is felt as the tenotomy is completed. A further 20 to 25 degrees of dorsiflexion is usually gained after the Heel-cord tenotomy.

The final cast after tenotomy

The final cast is applied with the foot in 60-70 degrees of abduction. After tenotomy the limb is immobilized in the above knee cast for 3 weeks

Removal of the cast
At the end of third week the cast is removed. Thirty degrees of dorsiflexion should now be possible, and the surgical scar is minimal. This foot is now ready for brace application

Pirani's Method of Clubfoot Evaluation [36, 37]
Dr. Shafique Pirani, Clubfoot Clinic of Royal Columbian Hospital,
University of British Columbia, Canada developed this valid, user friendly and reliable method of clinically evaluating the severity of a virgin club foot deformity.
He had identified 6 well described clinical signs of clubfoot. Three of these signs indicate primarily Hind Foot Contracture (HFC) and three signs indicate primarily Mid Foot Contracture (MFC).
The abnormal area on the involved foot is compared to normal side (if deformity is not bilateral) and scored:

0 = No deformity
0.5 = Moderate deformity
1 = Severe deformity

Hind Foot Contracture (HFC)
1. Posterior crease (PC)
2. Rigid Equinus (RE)
3. Empty Heel (EH)
Possible HFCSbetween 0 and 3

Mid Foot Contracture (MFC)
1. Curved lateral border
2. Medial crease
3. Coverage of the talar head
Possible MFCS between 0 and 3

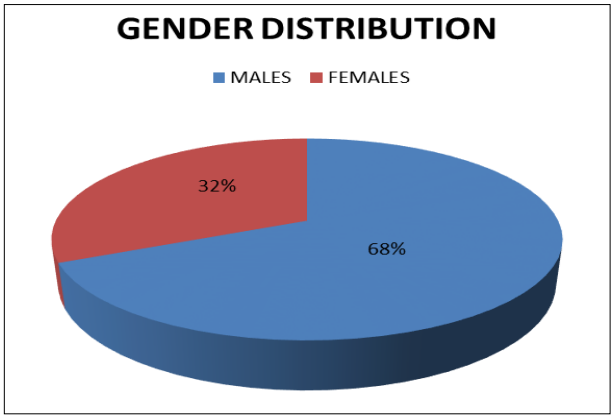
Bracing Protocol
Babies were then shifted to Maintenance phase 3 weeks after tenotomy by bracing them in dennise browne splint; The splint is to be used 23 hours a day for the first 3 months and then atleast14 hours a day for 3 years.

Results
All 38 patients were managed by serial cast correction by ponseti technique using the Pirani scoring for assessing the results. The following were the observations made during the study.

Gender Distribution

Table 1

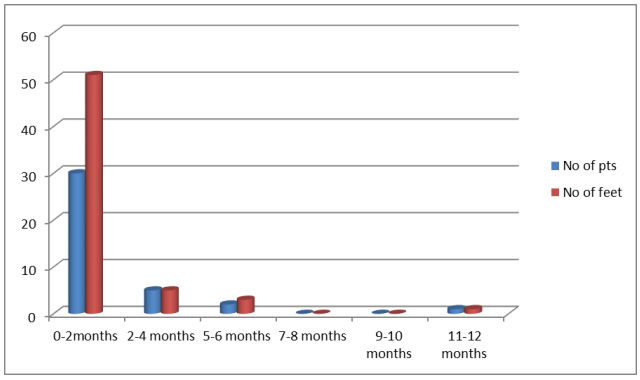
Male	Female
26	12



Age Distribution

Age at Presentation (In months)	No. Of Patients	No. of Feets
0-2 months	30	51
3-4 months	05	05
5-6 months	02	03
7-8 months	0	0
9-10 months	0	0
11-12 months	01	01

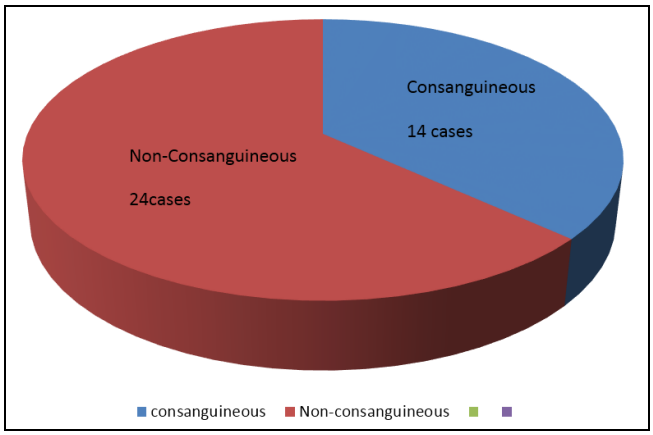
Of the children who presented to us, Table - 2 79% (30 out of 38 babies) were below 2 months of age and 30% above 2 months



The age at presentation has significance with respect to outcome. Those children who presented less than 2 months had good results manifested by the difference between initial and final Pirani.

Consanguinity

Consanguineous	Non-consanguineous
14	24



Of the 38 cases only thirty seven percent were born out of consanguineous marriage.

Side of Involvement [81]

Side	Left	Right	B/L
No. of cases	6	10	22

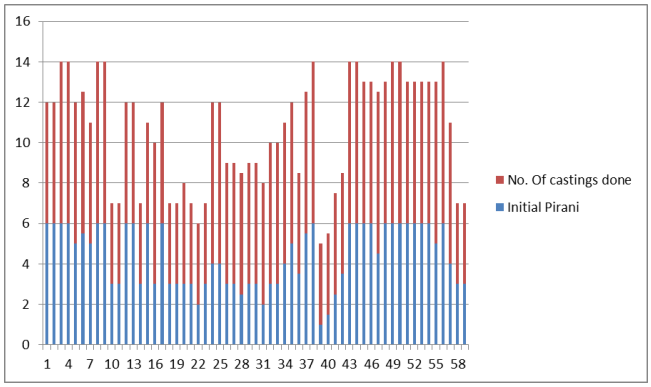
In our study predomininant bilaterality was seen in 57.89% of cases.
15.78% were left sided and 26.3% were right sided. The Ponseti Method for the Management of CTEV – 10 year Results Presented in National Medical Students Paediatric Conference (NMSPC) 2014, Brighton, UK reports a 50% bilaterality

Relationship between Age at presentation and Final result

Age at Presentation (In months)	Mean initial Pirani	Mean final Pirani score
0-2 months	4.098	0.088
3-4 months	3.6	0.40
5-6 months	12	0.25
7-8 months	-	-
9-10 months	-	-
11-12 months	06	0.5

The younger age (<2mon) group fared better in terms of results on comparing the mean initial pirani score and the mean final pirani score.

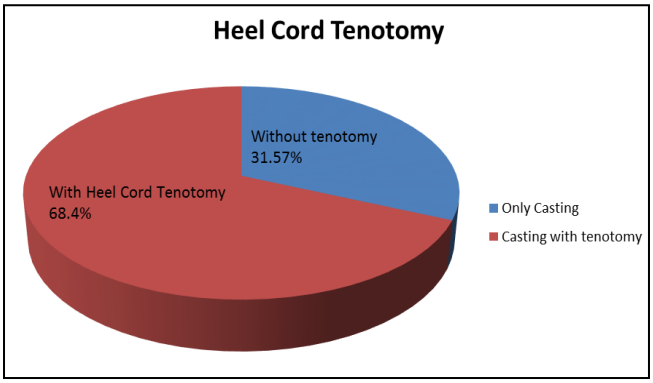
Initial Pirani and No. of Castings needed



It is observed that the lesser the Pirani score at presentation – the lesser will be the number of castings needed for correction. The average Number of casts per foot was 6.15.

Percutaneous Tenotomy

Treatment	No of cases	Percentage
Only Casting	12	31.57%
Casting &Tenotomy	26	68.4%



In our study we were able to achieve correction in 31.57% of the cases without resorting to heel cord tenotomy.

Associated Conditions

Conditions	No of patients
Cleft Lip	2
DDH (B/L)	1
Omphalocele	1

In our study the most common associated finding was cleft lip seen in two of our cases.

Complications

Complication	No of patients
Superficial sores	3
Crowding of toes	2

Minor complications were noted in 13.15% of our cases. The superficial sores were managed with further castings with adequate soft padding and allowing the skin to heal. The crowding of toes was managed but allowing enough space for the toes especially the dorsum for free toe movements.

Case – I

Name	:	B/O Sangeetha
Age at presentation	:	7/365 days
Sex	:	Female child
Laterality	:	Bilateral
Consanguinity	:	Yes
Tenotomy	:	Done
Bracing	:	Applied

At Presentation

Third Visit


Tenotomy Followed By Brace Application

At 1 Year Follow-Up

Case – I

CASE – II

Name	: B/O Thangaponnu	Laterality	: Bilateral
Age at		Consanguinity	: Yes
Presentation	: 19/365 days	Tenotomy	: Done
Sex	: Male child	Bracing	: Applied


At Presentation



Second visit

Tenotomy Followed By Brace Application

At 5 Months Follow-Up

Case – II

Discussion

In our series, we have treated 38 babies with idiopathic clubfoot by ponseti method by serial casting. Of the 38 babies 22 had bilateral affection and 16 had unilateral. 26 of the babies were male and 12 were female. Out of the 38 babies, 30 presented within first 2 months with 51feets, 5 babies presented between 3rdand 4thmonth with 5feets and 2 of them presented later at 5-6 weeks with 3 feet. One Unilateral CTEV patient presented late around 10 months of age.

Ponseti has reported a relapse rate of 78% in patients noncompliant with the straight-last shoe and abduction bar regimen and a relapse rate of 7%

in compliant patients. All of the noncompliant patients in Ponseti's series were corrected with recasting. We had recurrence of fore foot adduction in 6 of our patients (15.7%) probably reflecting a better compliance with brace. Porsche etal[80] described a relapse rate of 28% in his study. The relapsed foots required additional castings but finally all the feet were supple and fitted properly within the Dennise Browne splint.

Study group		Relapse rate (%)
Ponsetti	Brace compliant	7
	Brace Non-compliant	78
Porsche *et al.*		28
Our study		15.7

Gender Distribution

In our series the male to female ratio is not very high (Male: female = 2.2:1).in comparison to the series of Yamamoto [41] (male: female, 3:1), Chesney D *et al.* 42(2:1). Palmer [43] found the sex correlation to be insignificant. Ignorance, social bias and increased. Attention towards males in our region can account for the higher incidence in males in Indian setup.

Study group	Males	Females
Yamamoto *et al.*	3 : 1	
Chesney D *et al.*	2:1	
Palmer *et al.*	Insignificant	
Our study	2.2:1	

The number of cast per feet in our study was four to seven (average 6.15 casts per foot). In another study by Laaveg *et al.* [45] the mean number of casts during their treatment was seven. Morcuende [46, 47] reported that 90% of the patients required five or fewer casts. Over a period of time, as part of the learning curve people have started changing plaster casts at shorter intervals and fewer casts per feet give faster results. Those feet which required a greater number of casts in our study had a high Pirani score at the onset of treatment. Also we found correlation between late presentation and the higher number of casts. The duration initially was high which decreased over time reflecting a steady learning and started getting faster correction.

Of the children who presented to us, 79% (30 out of 38 babies) were below 2 months of age and 30% above suggesting a probably deficient referral system in our area and ignorance on the part of the parents.

Tenotomy

Tenotomy was required in 68.4% of the cases (26 out of 38 feet). Pirani carried out tenotomy in over 90% of his clubfoot patients. Laaveg *et al.* did tenotomy in 78% cases. In the study by Dobbs *et al.* tenotomy was required in 91% cases;

Relapse / Reccurence

Of the 38 cases 6 feet had recurrence of forefoot adduction, which required additional castings but finally all the feet were

supple and fitted properly within the Dennise Browne splint.
3 babies had developed pressure sores because of cast which healed uneventfully. Repeat correction and casting was done after 2 weeks for them. Wallace. B.L ehman in his study on club foot puts the incidence of compilcations to be 10.2%. Alexis bandore shsville *et al.* in their study gave an complication rate of 50%.

Conclusion

The ponseti method of serial cast correction for CTEV is an excellent method as per our study. In a developing country like India, the method is very safe, economical, and easy and result oriented method.

- The earlier the child presents the quicker will be the correction and better will be the result.
- The less severe types with low pirani scores achieves a quicker correction with less number of casts.
- Correction initiated by ponseti technique at an earlier age and adhered to regular weekly casting protocol tends to give better functional and cosmetic results.
- Even relapses can be managed with further castings alone.

"Thus we conclude that the Ponseti method is a very safe, efficient and economical treatment for the correction of club foot that radically decreases the need for extensive corrective surgeries. The Ponseti method of cast correction is important especially in developing countries as it is effective and inexpensive. The results are excellent when treatment is begun early"

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