International Journal of Research in Orthopaedics
Mahajan N et al. Int J Res Orthop. 2018 Jul;4(4):614-622
http://www.ijoro.org

Original Research Article

DOI: http://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20182734

Ponseti technique: efficacy in idiopathic clubfoot in Indian population

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Received: 29 December 2017
Revised: 17 May 2018
Accepted: 18 May 2018

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ABSTRACT

Background: The number of operations for clubfoot is many, but the results are not encouraging and more complications are encountered after operative treatment. Most surgeons believe manipulation to be easy; however they rarely complete the treatment and abandon it and go on to surgery. In the confusing scenario Ponseti Method evolved and proved across the world to be one of the most promising ways to correct club foot with low cost minimum surgery and good result in short period of time.
Methods: 50 cases of idiopathic clubfeet (76 feet) were enrolled from a period of May 2006 to May 2008 in the department of Orthopaedic. Out of 50, 42 patients were followed-up for two years. Post tenotomy follow-up done every monthly for 3 months. At every visit babies were checked for any relapse and parents were counselled for the strict compliance with Foot Abduction Brace. The results of correction in 42 patients (64 feets) evaluated and compared with Ponseti's observation and other form of conservative management.
Results: The analysis of results of correction of clubfeet deformity by Ponseti's method reveals around 95.30% of good to acceptable result as compared with Ponseti's observation of around 99% which is comparable. We have observed 4.69% of poor result as compared with 1% observed by Ponseti.
Conclusions: It is safe, efficient, Economical and most effective treatment for clubfoot which decreases the need for extensive corrective surgery. This technique can be used in children up to one year of age even after previous unsuccessful non-surgical treatment.

Keywords: Clubfoot, Idiopathic clubfoot, CTEV, Ponseti's method

INTRODUCTION

The clubfoot is one of the commonest congenital abnormalities found in children all over the world. Voluminous literature available from esteemed surgeons all over the world only emphasizes the confusion and divergent opinions that exist regarding the etiology, pathogenesis, treatment and prognosis.[1] The encompassing term "congenital" too is non-descript, as the deformity, can occur as an isolated idiopathic deformity or as a local manifestation of systemic congenital syndrome such as arthrogryposis, meningo-myelocoele or a muscular dystrophy.[2] At the same time, the importance of accurate and complete treatment of the clubfoot cannot be overemphasized especially in a country like India where any deformity become a cause of social ostracism. The psychosocial aspect of the deformed foot only drives the surgeons, toward his goal of obtaining a lasting correction that is, a plantigrade, pliable, functional, cosmetically acceptable foot.[3] Clubfoot is one of the commonest congenital anomaly with an incidence of 1/1000 live births.[4] The congenital

clubfoot is a complex three dimensional deformity having four components — equinus, varus adductus and cavus.[5]

Several surgical methods were tried but the results have not proven to be superior and more complications have been reported after surgery. Dr. I. V. Ponseti, Prof. Emeritus University of Iowa, U.S.A. has been the pioneer of manipulation and casting for the management of this problem. This technique is gathering momentum all over the world due to its advantage of low cost, minimum surgery and good results in a very short period of time if properly done. Although Kite was the leading advocate of the conservative treatment of clubfoot for many years and should be commended for his lifetime efforts to try to resolve the clubfoot problem without surgery, his treatment was lengthy and short of satisfactory.[6] Ponseti was determined to discover the flaws that prevented him from reaching Robert Jones claimed results. In 1960, he visited Kite in Atlanta for a few days to observe his method of treatment. In 1965 they gave course together in Caracas, Venezuela, during which each of them applied plaster casts. Their methods differed greatly. Kite corrected each component of the deformity separately instead of simultaneously, and although he managed to correct the cavus and avoid foot pronation and its harmful consequences, the correction of the heel varus took him an inordinate amount of time since he did not realize that the calcaneum must abduct so it can be everted.[7] From Ponseti's observation in his clinic and in the operating room, he realized that the orthopaedist's failures in the treatment of clubfoot were related, in part, to a poor understanding of the functional anatomy of the normal foot as well as of the clubfoot. By the late fifties, he reviewed his patients for a short term follow-up article (Ponseti and Campos 1963).[8]

In the confusing scenario Ponseti technique evolved and proved across the world to be one of the most promising way to correct club foot with low cost minimum surgery and good result in short period of time. With different methods of treatment available, how does a young and discerning orthopaedic surgeon decide which method of treatment to adopt for clubfoot. The answer is simple. Choose the technique that:

1. Has a firm scientific foundation.
2. Has a clear understanding about the biology of soft tissue behaviour.
3. Follows the kinesiology of joints to achieve correction of foot deformities.
4. Uses the simplest and least invasive methods to treat the tiny babies and
5. Has proved to give excellent results more than 40 years later.

Only the Ponseti technique fulfils all of these criteria. The Ponseti technique is gathering momentum all over the world due to its advantages of low cost, minimal surgery and good results in trained hands.[9]

METHODS

A prospective study conducted in department of orthopaedic surgery, Grant medical college and sir JJ Group of hospital, Mumbai from 2006-2008. All parents attending the orthopaedic department whose patients met the inclusion criteria were counselled regarding the disease and the study and those willingly consenting to participate in the study were selected. Informed and written consent was obtained with consent form approved by the Institutional ethical committee. A total of 50 subjects (76 feet) were consecutively recruited for the study.

Inclusion criteria

Inclusion criteria were idiopathic clubfoot, age less than two years, willingness to take part in the study

Exclusion criteria

Exclusion criteria were age more than two years, earlier treated with other methods of plaster cast application, earlier operated for clubfoot, concomitant major illness, atypical or secondary clubfoot and unwillingness to take part in the study.

Out of 50 patients, 8 patients (12 feet) lost follow-up at the end of the treatment and rest of 42 patients were followed-up for two years.

Material

- For casting: POP bandage and cotton roll.
- For tenotomy: lignocaine 2% solution, sterile syringe and needles, 15 no. surgical blades.
- For maintenance of correction: STEENBEEK foot abduction splint

Case selection

- Total No. of 50 patients were treated using Ponseti's method of manipulation and casting over a period of two years (May 2006 to May 2008). All cases were selected from orthopaedic OPD and indoor patients from hospital.

Method

A) History:

All the parents of the children were questioned regarding.

I) Presence of defect since birth.
II) Presence of either neuromuscular or skeletal defects.
III) Maternal history of the pregnancy with special regard to
   a) Any abnormality in the prenatal check-up like oligohydramnios, polyhydramnios.

b) Any radiological exposure, excluding an ultrasonography.
c) Any history of drug intake, besides haematinics.
d) Any history of maternal illness.

IV) Both the parents were questioned about positive family history.

V) Both were asked for the evidence of consanguinity prior to marriage. Although the objective of this study was not to decipher the etiology of this deformity, we did try to obtain an oversight into the genetics of this deformity. Regarding the treatment received previously, the parents were questioned regarding the mode, duration and reason for dropout from conservative management. The parents were extensively counselled as regards the nature of the deformity, the theories of aetiologies (so that they would not blame each other for it), the treatment plan, the goal of achieving a cosmetically acceptable and plantigrade foot and the importance of follow up.

B) Clinical examination

The patients were all examined in detail with special regards, so as to rule out a neuromuscular defect like meningocoele or a skeletal defect like arthrogryposis keeping the body fully undressed both in supine and prone position. The degree of the following anomalies was recorded; heel equinus, heel cord tightness, calf circumference and proximal retraction of the gastrocnemius muscle, adduction and inversion of the calcaneum and the extent to which the talar head is subcutaneous in front of the lateral malleolus. The angle of forefoot adduction can best be measured from the sole of the foot (Alexander 1990). The metatarsus adductus is easily differentiated from clubfoot because it has no equinus. The most important factors to be considered in determining the degree of severity of the clubfoot are the reduction in size and degree of proximal retraction of the calf muscles; the severity of the equinus and varus of the heel; the rigidity of the adduction of the forefoot; the degree of medial displacement of the navicular and the depth of the skin creases in the posterior aspect of the ankle and medial aspect of the foot.

Ponseti technique

Manipulation of feet: It should be started soon after birth if possible. Infant was made to feed during manipulation and casting. Although in our treatment all components of the clubfoot deformity except for the equinus are treated simultaneously, for greater clarity we will describe their correction separately; first the cavus followed by the varus and the adductus and lastly the equinus, which must be dealt with after the other components of the deformity are corrected. All manipulations should be very gentle. The deformity should be corrected slowly and the ligament should never be stretched beyond their natural amount of stretchebility. The foot is manipulated for 3-4 minutes and after that casting is done to maintain the correction achieved during manipulation. This is done every week.

Correction of cavus: The first portion of the plaster cast should extend to the knee and maintain the whole foot in equinus, in supination, and in a much abduction as possible while mild counter pressure is applied over the lateral aspect of the head of the talus in front of the lateral malleolus. After the plaster sets, the cast must be extended to the upper third of the thigh with the knee flexed to 90 degrees. An attempt to correct the supination of the foot by forcibly pronating the forefoot increases the cavus deformity since the first metatarsal is further plantar flexed. The cavus deformity remains uncorrected in this situation. In fact, it tends to increase and become more rigid when the forefoot is immobilized in pronation with respect to the hindfoot.

Correction of varus and adduction: The talocalcaneal, the talonavicular, and the calcaneo cuboid joints operate in a strict mechanical interdependence. This is the reason it is necessary to simultaneously correct the tarsal displacement in the clubfoot. This manipulation abducts the foot held in flexion and supination so as to accommodate the inversion of the tarsal bones while counter-pressure is applied with the thumb on the lateral aspect of the head of the talus. The heel should not be constrained so as to allow the abduction of the calcaneus under the talus. After two or three minutes of gentle manipulation a thin, very well moulded plaster cast is applied over a thin layer of soft cotton. In the first cast, the plantar flexed foot is in supination and in the following two or three casts the supination can be gradually decreased to correct the inversion of the tarsal bones while the foot is further abducted under the talus. One must obtain 70 degrees of abduction of the foot by the last cast after correction of the equinus.

In order to maintain a strong abduction of the foot under the talus while the talus is firmly immobilized against rotations in the ankle mortise a toe-to-groin plaster cast is mandatory. A cast extending to just below the knee cannot immobilize the foot in firm abduction under the talus. Furthermore, short-leg casts tend to slip off the foot. To prevent this, the orthopaedists often apply the casts too tightly around the calf and the malleoli, causing sores. Below-the-knee casts are not only useless but detrimental.

Correction of equinus: While the foot is extended with one hand placed flat under the entire sole the heel is grasped with the thumb and finger of the other hand and pulled downwards. The index finger over the tendoAchilles insertion can also exert considerable pressure downwards. Two or three plaster casts applied after manipulations, carefully moulding the heel are usually needed to correct the equinus deformity. Care

should be taken not to cause a rocker bottom deformity which can occur when the orthopaedist attempts to dorsiflex the foot by applying pressure under the metatarsal heads rather than under the entire sole of the foot. When at least 15 degrees of ankle dorsiflexion or more when possible have been obtained the last plaster cast is applied and worn for three weeks with the foot in 70 degrees of external rotation. Special care should be taken never to pronate the foot in the slightest degree so as to avoid a relapse of the cavus, a breach in the midfoot and a backward displacement of the lateral malleolus. To facilitate the correction of the equinus when the tendon feels very tight after the first manipulation to dorsiflex the ankle, a simple subcutaneous tenotomy of the tendoachilles can be performed under local anaesthesia to obtain 15 degrees of ankle dorsiflexion.

Correction of tibial torsion: Normal children have mean external tibial torsion of 40 degrees whereas children with clubfeet have a mean external tibial torsion of only 18 degrees. Children with clubfeet, therefore, have no medial tibial torsion deformity but rather half the amount of external tibial torsion than children with normal feet. The relative medial torsion associated with clubfoot will persist if below the knee casts are used in the treatment. Tibial torsion, varus deformity of the heel and adduction of the foot can be gradually corrected if toe-to-groin plaster casts are applied with the knee in 90 degrees of flexion and the foot externally rotated under the talus.

Plaster cast application: The plaster cast is applied to maintain the correction obtained by manipulation. The baby often cries during manipulation and must be picked up from the table by the mother or the surgeon, patted and comforted, then placed at one end of the table to allow room for the assistant and the mother on either side and relaxed with a bottle of warm milk or a pacifier. If the baby is breast-fed, he or she should be nursed before manipulation. The mother should remain close to the baby during all manipulative procedures. During plaster cast application an assistant holds the thigh with one hand and the toes with the thumb and index finger of the other hand, maintaining the knee in 90 degrees of flexion. A-2 inch-wide rolled bandage of soft cotton is wrapped overlapping by half the width, starting at the toes and proceeding upwards to the upper thigh. A two-inch plaster bandage moistened in lukewarm water, is wrapped over the assistant fingers to prevent crowding the toes. The plaster cast should extend to below the knee at first. Now, the assistant releases the toes as the surgeon takes hold of the foot to mould the plaster cast. Proper moulding of the clubfoot necessitates a clear visualization of the position of each one of the bones in the foot. The surgeon should keep in mind an image of a clubfoot. The plaster cast must be moulded with gentleness and anatomical precision. The cast over the toes should be flattened to keep them in neutral alignment. The heel prominence should be emphasized by moulding around it instead of pressing on it. The heel should never even rest on the surgeon's hand so as not to flatten it. A flat cast at the heel is a sure indication that it has been improperly applied. When the foot is abducted to correct the adduction and supination, counter pressure is applied with a thumb over the lateral aspect of the head of the talus. However, the thumb should never rest there for long, to avoid creating a dent on the plaster as it sets. The correction is maintained not through pressure but through moulding. At the same time, the ankle and malleoli are gently moulded. The heel should be moulded in a neutral position taking care that it is not pushed into valgus. The heel varus corrects when abducting the foot. To help correct the equinus in the cast, the heel is moulded downwards with the bent index finger over the tendo Achilles. After the foot and leg are moulded and the cast is set, the leg should be supported by the surgeon's hand under the calf without even touching the heel. The plaster cast covering the toes should be trimmed to allow the toes to extend freely, but a platform of plaster should be left underneath the toes to prevent them from flexing.

Percutaneous tenotomy: This was required to correct equinus deformity and was required in 80% of our patients. Done under LA, mother is allowed to stay and breast fed the baby. This procedure is done when:

- Abduction of 60 to 70 degrees of foot is achieved.
- MFC score of Pirani is 0

Additional 10-150 of dorsiflexion is achieved. Above knee cast is applied with foot in fully corrected position of 60-70 degrees of abduction and 10-20 degrees of dorsiflexion. This cast is kept for 3 weeks and after 3 weeks cast is removed and Steenbeek foot abduction brace is applied immediately.

Splinting: Following correction of the clubfoot deformity splinting for many months is indispensable to prevent relapse. Since the main corrective force of the varus and adduction of this clubfoot is abduction, a splint is needed to maintain the foot in the same degree of external rotation as it was in the last plaster cast. This is best accomplished with the feet in well-fitted, open —toed, high—top shoes attached in external rotation to a bar of about the length between the baby's shoulders.

Post bracing follow up was done at monthly interval for three months, then three monthly for one year and six monthly thereafter. At each visit patient was examined clinically for any relapse. Pre-treatment and during treatment evaluation of severity of deformity and correction after each manipulation and casting was done with Pirani score.

Advantage of Pirani score

- Pirani score is ideal.
- Objective and easy to use.
- Helps to document on-going correction.

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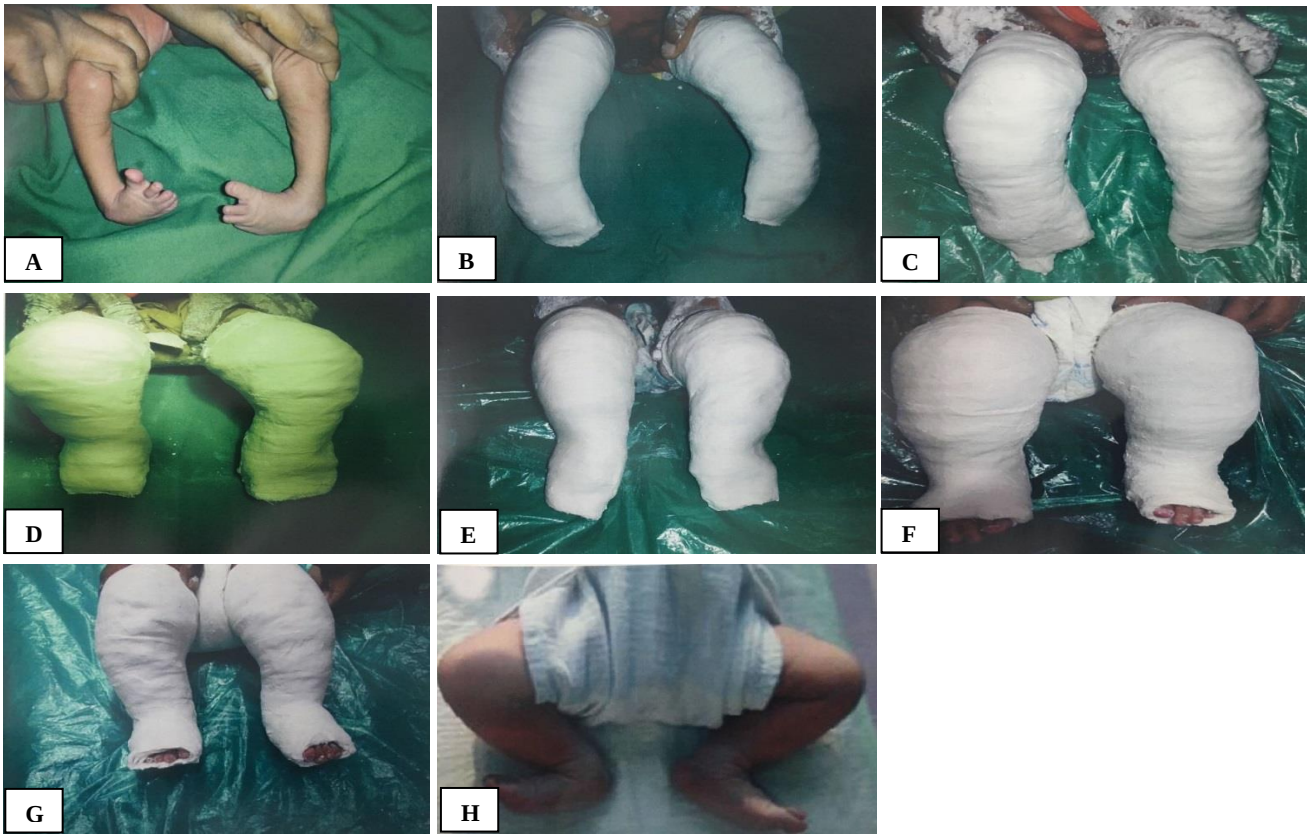

Figure 1: Pre-treatment; (B) after first cast; (C) after second cast; (D) after third cast; (E) after forth cast; (F) after fifth cast; (G) after Tenotomy cast; (H) after treatment.

Table 1: Follow up.

		Score 0	Score 0.5	Score 1
A)	**Midfoot**			
1.	Curved lateral border	Straight	Mid distal curve	Curve at calcanocuboidal joint
2.	Medial crease	Multiple fine crease	One or two deep creases	Deep crease, change in contour of arch
3.	Talar head coverage	Navicular completely reduces, lateral head talus cannot be felt	Navicular partially reduces, lateral head less palpable	Navicular does not reduce, lateral head easily felt
B)	**Hindfoot**			
1.	Posterior crease	Multiple fine crease	One or two deep creases	Deep crease, change in contour of arch
2.	Rigid equinus	Normal ankle dorsiflexion	Dorsiflexion beyond neutral but not fully	Dorsiflexion not upto neutral
3.	Empty heel	Calcaneal tuberosity easily palpable	Calcaneal tuberosity difficult to palpate	Calcaneal tuberosity not palpable

Figure 2: Steenbeek foot abduction brace.

Table 2: Pirani score parameters.

Parameters	Normal	Moderate	Severe
A) Midfoot			
1 Curved lateral border	0	0.5	1
2 Medial crease	0	0.5	1
3 Talar head coverage	0	0.5	1
B) Hindfoot			
1. Posterior crease	0	0.5	1
2. Rigid equinus	0	0.5	1
3. Empty heel	0	0.5	1

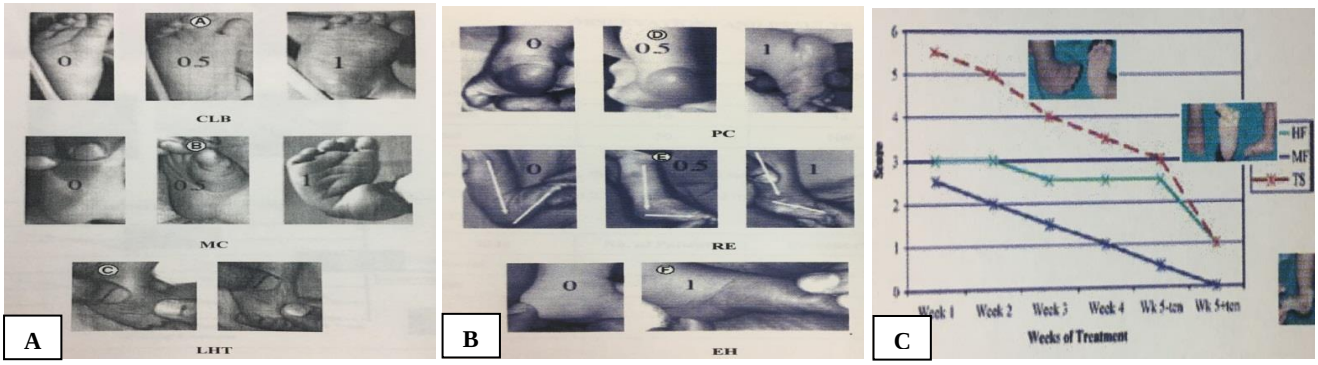

Figure 3: (A) Signs of midfoot contracture; (B) signs of hindfoot contracture[i] (C) the roadmap of Ponseti treatment.[7]

RESULTS

Table 3: Sex ratio.

Sex	Number	Percentage (%)
Male	34	68
Female	16	32
Total	50	100

In our series, the male: female ratio was 2.1: 1 which correlates well to 2.5: 1 of Turco's series and 2.33: 1 as observed by Kite.

Table 4: Laterality.

Side	No. of patients	Percentage (%)
Bilateral	26	52
Right	14	28
Left	10	20
Total	50	100

The prevalence of laterality correlates well to Turco's series of 55.98% bilateral, 22.22% right sided and 21.79% left sided.

Although the aim of study was not to deal with the etiological aspect in detail, the above observation point towards a genetic cause, to the clubfoot. The fact, that some patients had more than one of the above factors from etiological history point of view, accounts for the percentage being greater than 100%.

Table 5: Etiological factors.

Factors	No. of patients	Percentage (%)
First born child	34	68
Other sibling affected	4	8
Consanguineous marriage of parents	32	64
Abnormality in pregnancy	6	12
Positive family history (up to second degree)	19	38

Table 6: Previous treatment given.

Method of treatment	No. of Patient	Percentage (%)
Casts (plaster of paris)	Il	22
Strapping and POP casts	4	8
POP casts and TA lengthening	2	4

34% of clubfeet had been treated earlier of which 22% have been treated by cast alone, pointing towards the popularity of this modality of treatment.

In our series 79.7% of feet required percutaneous TA tenotomy as compared with Ponseti's series (I.V. Ponseti 1965 J. B. J. S.) who reported 85%.

Table 7: Percutaneous TA tenotomy.

Type of treatment	No. of patient	Percentage (%)
TA Tenotomy	51	79.7
Manipulation and cast	13	20.3
Total	64	100

Evaluation of results

Out of 50 patients, 8 lost follow-ups. The results were analysed in the remaining 42 patients (64 feet). The mean follows up was 18.1 months with lowest being 2.1 months and highest being 26 months.

Table 8: Result of Ponseti method.

Ankle dorsiflexion	Heel varus	Adduction of forefoot	Tibial torsion	Results
> 10	0	0- 10	Mild	Good
0- 10	0- 10	10-20	Moderate	Acceptable
<0	Over 10	Over 20	Severe	Poor

Table 9: Analysis of results in 64 feet.

		Percentage (%)
Good	45	70.30
Acceptable	16	25
Poor	3	4.69
Total	64	99.99

Results have been categorised in 3 groups on the basis of 4 parameters.

The analysis of results of correction of clubfeet deformity by Ponseti's method reveals around 95.30% of good to acceptable result as compared with Ponseti's observation of around 99% which is comparable. We have observed 4.69% of poor result as compared with 1% observed by Ponseti. The feet in which poor result was observed (one bilateral and one unilateral clubfeet), were short, chubby and rigid. All 3 feet were treated with posteromedial release. The average number of casts required by each patient was 6.1 casts/feet.

Observation of relapse

Table 10: Observation of relapse.

Type of treatment	No. of patient	Percentage (%)
Conservative	12	63.16
Tibialis anterior transfer	3	15.79
TA Lengthening	3	15.79
Subcutaneous fasciotomy	1	5.26
Total	19	100.00

19 feet (30%) had relapse, 12 treated conservatively by re-manipulation and casting and bracing and 7 feet by surgery3 feet required transfer of tibialis anterior tendon to third cuneiform for persistent forefoot adduction and dynamic supination and 3 feet required TA lengthening for equinus deformity and I feet by subcutaneous plantar fasciotomy for cavus.

Complication

Major complication: One patient developed necrosis of dorsum of both feet at anterior part of the head of the talus. This patient was treated conservatively by dressing and had uneventful result.

Minor complication: In form of plaster ulceration in thigh and oedema of feet was observed in three and five feet respectively. This complication was treated by dressing and foot elevation and loose cast application for 2-3 weeks.

DISCUSSION

Congenital talipes equinovarus, despite being known to the medical world since the time of Hippocrates, continues to perplex and astound generation of orthopaedic surgeons.[9] The number of operations for clubfoot are many, but the results are not encouraging and more complications are encountered after operative treatment. Moreover, there is no long term studies supporting surgical treatment.[10]

Dr. Ignacio Ponseti: The Pioneer, published 1st article in JBJS 1963.[11] His work went unnoticed till 1995 when he published results with 35 yrs. follow up. The only disadvantage of Ponseti technique is strict patient compliance and regular follow up to detect early relapse which become difficult in our country because of lack of awareness regarding the care of correction and high prevalence of illiteracy which can easily overcome by inclusion of community health worker and pre-treatment counselling of the parents.[12] A well conducted orthopaedic treatment, based on a sound understanding of the functional anatomy of the foot and on the biological

response of young connective tissue and bone to changes in direction of mechanical stimuli, can gradually reduce or almost eliminate these deformities in most clubfoot. Less than 5% of infants with very severe, short fat feet with stiff ligaments unyielding to stretching will need surgical correction.[13] The parents of all the other babies may be reassured that their baby, when treated by expert hands will have a functional plantigrade foot which is normal in appearance requires no special shoes, and allows fairly good mobility. The guidelines for the clubfoot method of treatment which Ponseti developed in 1948 are as follows:[11]

1) All the components of the clubfoot deformity have to be corrected simultaneously with the exception of the equinus which should be corrected last.
2) The cavus, which results from a pronation of the forefoot in relation to the hindfoot, is corrected as the foot is abducted by supinating the forefoot and thereby placing it in proper alignment with the hindfoot.
3) While the whole foot is held in supination and in flexion, it can be gently and gradually abducted under the talus secured against rotation in the ankle mortise by applying counter-pressure with the thumb against the lateral aspect of the head of the talus.
4) The heel varus and foot supination will correct when the entire foot is fully abducted in maximum external rotation under the talus. The foot should never be everted.

Table 11: Results of past techniques in percentage.

Series	Type of Conservative Treatment	Good Results	Poor Results
Kite[13]	Manipulation and casting	90	10
Frip and Shaw[14]	Dennis-Brown splints, manipulation and stretching	71	29
Dangle major[15]	Manipulation and casting	40	60
Ponseti[12]	Manipulation and casting	99	1
Present series	Manipulation and casting	95	5

Results of present series are comparable with Ponseti's series 95% versus 99% of good to acceptable results. This result is comparable with Kite, but the time taken in Kite's method is much longer (about 6 months) as compared with Ponseti's method (about 6 weeks). Ponseti's method is safe and effective treatment for clubfoot and radically decreases the need for extensive corrective surgery. This technique can be used in children up to one year of age even after previous unsuccessful non-surgical treatment.

CONCLUSION

It is safe and effective OPD basis treatment for clubfoot. No major surgery is required and radically decreases the need for extensive corrective surgery. 96% good to excellent result with 35 years follow up done by Dr Ponseti. This technique can be used in children up to one year of age even after previous unsuccessful non-surgical treatment to achieve a functional, pain free, normal looking, plantigrade feet with good mobility, without callosities and requires no modified shoes. It is very efficient treatment with complete correction in 2 months.

ACKNOWLEDGEMENTS

We would like to acknowledge residents of radiology and Paediatrics for contributing to this case series.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

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Cite this article as: Mahajan N, Ramteke U, Gavhale S, Palange N, Mane A, Dave H. Ponseti technique: efficacy in idiopathic clubfoot in Indian population. Int J Res Orthop 2018;4:614-22.