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# OUTCOME OF ACCELERATED PONSETI TECHNIQUE IN THE TREATMENT OF IDIOPATHIC CLUBFOOT

By

**DR. A. RAGHU VEER CHANDER M. B. B. S**

Dissertation submitted to

THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY,
CHENNAI,

In partial fulfilment of the requirements for the degree of

**MASTER OF SURGERY IN ORTHOPAEDICS**

**Under the guidance of**

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**Professor & HOD**

**DEPARTMENT OF ORTHOPAEDICS,**

**PSG INSTITUTE OF MEDICAL SCIENCES AND RESEARCH**

**COIMBATORE**

**2014**

# DECLARATION BY THE CANDIDATE

**I** hereby declare that this dissertation entitled **"OUTCOME OF ACCELERATED PONSETI TECHNIQUE IN TREATMENT OF IDIOPATHIC CLUBFOOT"** is a bonafide and genuine research work carried by me under the guidance of **Dr.B.K. DinakarRai, M.S Ortho,** Prof and HOD, Department of Orthopaedics, PSGIMS & R, Coimbatore.

**Place:**

**Date:** **Dr. A. Raghu veer chander**

# CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled **"OUTCOME OF ACCELERATED PONSETI TECHNIQUE IN TREATMENT OF IDIOPATHIC CLUBFOOT"**is a bonafide work done by Dr. ALLURI RAGHU VEER CHANDER in partial fulfilment of the requirement for the degree of M.S. (Orthopaedics)

**Place**

**Date**

**Dr.B . K. DinakarRai**
**M.S. (Ortho)**
**Professor & HOD,**
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**Coimbatore.**

**ENDORSEMENT BY THE HOD/PRINCIPAL OF THE INSTITUTION**

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| | |
|---|---|
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| Date | Date |
| Palce | Place |

# Acknowledgement

At the outset. I thank the god for giving me the strength to perform all my duties.

It is indeed a great pleasure to recall the people who have helped me in the completion of dissertation .naming all the people who have helped me in achieving this goal would be impossible, yet I attempt to thank a selected few who have helped me in diverse ways.

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# PSG Institute of Medical Sciences & Research

## Institutional Human Ethics Committee

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November 22, 2012

To
Dr Raghuveer Chander Alluri
II Year Post Graduate
Department of Orthopaedics
PSG IMS & R
Coimbatore

**Ref.:** Study titled: Efficacy of accelerated ponseti plaster method for the treatment of idiopathic congenital talipes equinovarus

**Sub.:** Ethics Committee Approval

Dear Dr Raghuveer Chander,

In the Institutional Human Ethics Committee meeting held on 26.10.2012, at the College Council Room, PSG IMS&R, between 2.00 pm and 5.00 pm, the documents related to the above proposal were reviewed and discussed.

The following documents were received for review:

1. Duly filled application form
2. Informed Consent forms in English and Tamil
3. Data Collection Tool
4. CV

The members who attended the meeting at which your study proposal was discussed are as follows:

| Sl. No. | Name of the Member of IHEC | Qualification | Area of Expertise | Gender | Affiliation to the Institution Yes/No | Present at the meeting Yes/No |
|---|---|---|---|---|---|---|
| 1 | Dr. S. Bhuvaneshwari (Member-Secretary, IHEC) | MD | Clinical Pharmacology | Female | Yes | Yes |
| 2 | Mrs. R. Geetha | + 2 | Lay person | Female | No | Yes |
| 3 | Mr Gowpathy Velappan | BA., BL | Legal Advisor | Male | No | Yes |
| 4 | Mrs G Malarvizhi | M Sc | Nursing | Female | Yes | Yes |
| 5 | Mr. R. Nandakumar (Vice-Chairperson, IHEC) | BA., BL | Legal Expert | Male | No | Yes |
| 6 | Dr. G. Rajendiran | DM | Clinician (Cardiology) | Male | Yes | Yes |
| 7 | Dr. V. Ramamurthy | Ph D | Biotechnology | Male | Yes | Yes |
| 8 | Dr. M. Ramanathan | M Pharm, Ph D | Non-Medical (Pharmacy) | Male | Yes | Yes |
| 9 | Dr. P. Sathyan (Chairperson, IHEC) | DO, DNB | Clinician (Opthalmology) | Male | No | Yes |

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| | | | | | | |
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| 10 | Dr. Seetha Panicker | MD | Clinician (Obstetrics & Gyanaecology) | Female | Yes | Yes |
| 11 | Dr. S. Shanthakumari | MD | Pathology, Ethicist | Female | Yes | Yes |
| 12 | Dr. Y.S. Sivan | Ph D | Social Scientist (Sociology) | Male | Yes | Yes |
| 13 | Dr. Sudha Ramalingam (Alternate Member-Secretary, IHEC) | MD | Public Health, Epidemiology, Genetics, Ethicist | Female | Yes | Yes |
| 14 | Mrs. K. Uma Maheswari | M Sc, M Phil. B Ed | Botany | Female | No | Yes |
| 15 | Dr. D. Vijaya | M Sc, Ph D | Basic Medical Sciences (Biochemistry) | Female | Yes | Yes |

After due consideration, the committee has decided to approve the above proposal.

The approval is valid for one year.

**We request you to intimate the date of initiation of the study to IHEC, PSG IMS&R.**

We hereby confirm that neither you nor any of your study team members have participated in the voting/ decision making procedure of the committee. The members of the committee who have participated in the voting/ decision making procedure of the committee do not have any conflict of interest in the referenced study.

This Ethics Committee is organized and operates according to Good Clinical Practice and Schedule Y requirements.

Non-adherence to the Standard Operating Procedures (SOP) of the Institutional Human Ethics Committee (IHEC) and national and international ethical guidelines shall result in withdrawal of approval (suspension or termination of the study). SOP will be revised from time to time and revisions are applicable prospectively to ongoing studies approved prior to such revisions.

PIs are required to send progress reports (in the form of an extended abstract with publications if any) to the IHEC every six months (and a month before expiry of approval date, if renewal of approval is being sought).

Request for renewal must be made at least a month ahead of the expiry of validity along with a copy of the progress report.

Yours truly,

22-11-12

**Dr S Bhuvaneshwari**
**Member - Secretary**

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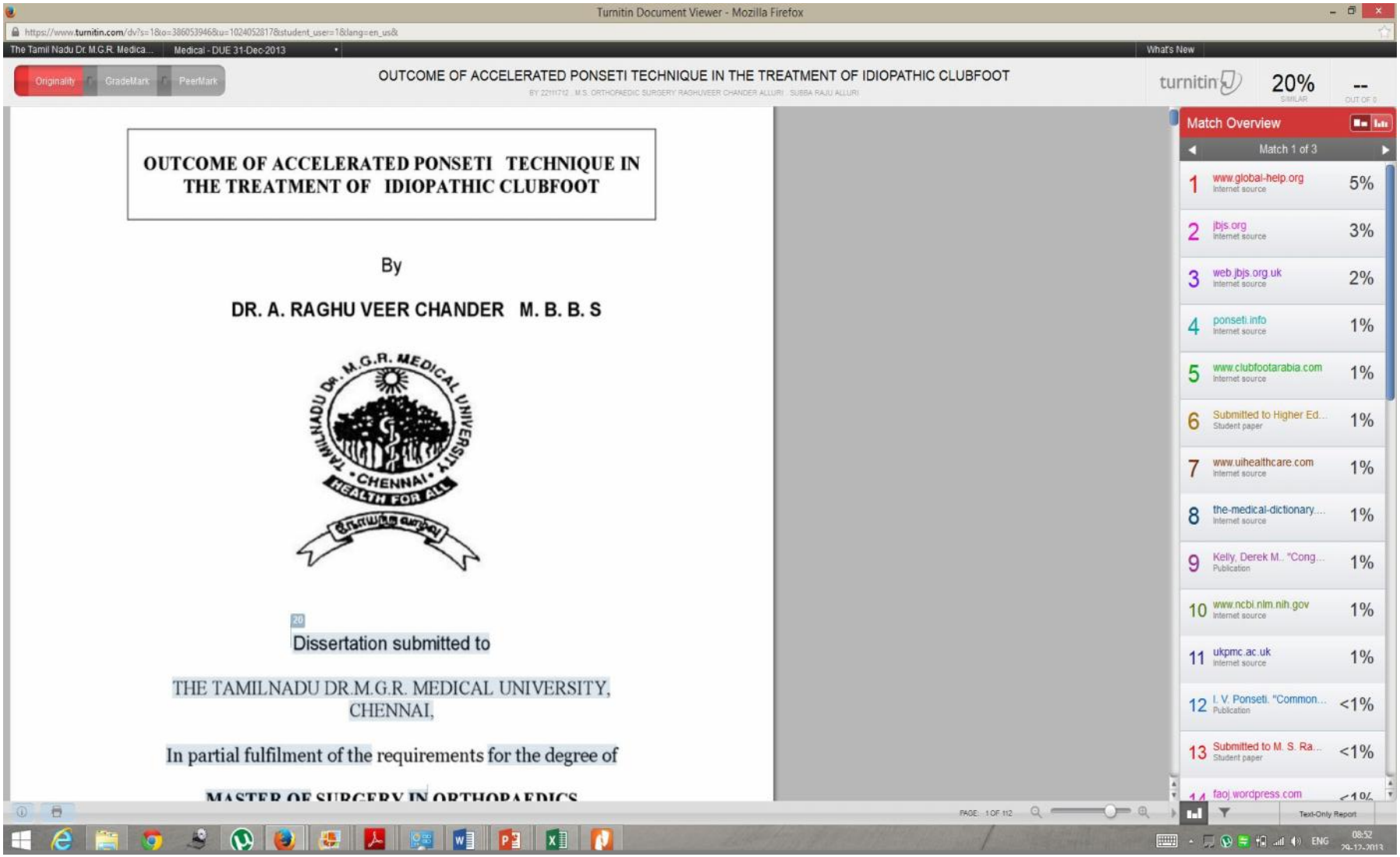
***Proposal No. 12/171***

# PLAGIARISM CHART



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# Outcome of accelerated ponseti technique in the treatment of idiopathic clubfoot.

**Dr. A.Raghu veer chander : reg. no: 22111712**

# ABSTRACT

**Introduction:**

The standard Ponseti method described for the treatment of idiopathic CTEV requires a serial manipulations and castings at weekly intervals. Few published results stated that correction can be achieved in a shorter period of time with multiple manipulations and castings per week.

**Objective:**

This study was to evaluate the outcome of accelerated ponseti technique for idiopathic clubfoot by manipulations and casting done twice a week.

**Materials & methods:**

The study included the modified group 21 patients with 25 idiopathic clubfeet treated with the accelerated Ponseti method twice a week.

**Results:**

The average age of the patients at the time of treatment was 21days.All aspects of the deformity with the exception of the equinus were corrected in average of 14 days and average of 4.71 casts with one case of relapse, 7 cases only required tenotomy for correcting equinus.

**Conclusion:**

The accelerated Ponseti method of treatment program with twice a week manipulation and casting is safe and effective. It significantly shortens the timeframe for the treatment and compliance of parents towards the treatment. The results obtained in our study showed good correction of deformity in very shorter period of treatment when compared to standard method, which helps reducing economic concerns, cast complications and improving patients compliance.

# INTRODUCTION

Congenital talipes equino varus is the most common congenital foot disorder.

Talipes is derived from Latin word talus meaning ankle and pes meaning foot (the deformity causes the patient to use ankle as foot).

It is also called clubfoot as it resembles to the club of a golf stick

Incidence of idiopathic clubfoot is about 1-2 per 1000 live births. The severity of the deformity may vary from very mild to completely rigid foot.

Clubfoot may also present with conditions like neuromuscular disease, arthrogryposis. Etc., among all, idiopathic clubfoot is the common presentation which occurs in otherwise normal infants.

Female to male ratio is of 3:1 and about 40% cases are bilateral.

Etiology of clubfoot has been explained in many theories among them first described was mechanical theory by **Hippocrates.**

Neuromuscular theory, histological theory, germplasm theory, theory of retraction fibrosis, arrested foetal development, hereditary and so on.

No theory has explained clearly the response of clubfoot to the treatment given.

Club foot incidence in India is 0.9 per 1000 live births; a higher association of family history is noted in patients with clubfoot.

The anatomic abnormalities associated with clubfoot are equinus at ankle, equinus and inversion at subtalar joint; medial migration of navicle with prominent talar head dorsolateral.

The main goal of any management regimen is to correct all the deformities and to achieve a pain free, functional, plantigrade foot with good mobility.

Many treatment methods are described for the management of clubfoot. Ranging from strapping, stretching & casting, surgical release of soft tissues, bony procedures and finally arthrodesis.

# AIMS AND OBJECTIVES

- The aim of the treatment of idiopathic clubfoot is to achieve pain free, flexible, plantigrade & cosmetically acceptable foot.
- Many treatment modalities are described to achieve the correction of all deformities and each treatment has its own drawbacks and in most of the modalities all the deformities are not corrected completely.
- Among the treatments described, Ponseti method of manipulation and serial casting is the most acceptable treatment method at present day.
- The present research is to analyze the outcome of accelerated ponseti technique in the management of idiopathic clubfoot, thereby reducing the course of casting treatment.

# REVIEW OF LITERATURE

It will be interesting to trace the history of clubfoot. Even before **Hippocrates** described this condition in 300 BC, ancient Egyptians documented clubfoot deformity in their wall paintings.

The term **'talipes'** was proposed by **Little** in **1839** derived from Latin –talus means ankle, pes means foot.

In the middle of 17tth century **Arcaeus, Pare** and **Fabrig** recommended repeated stretching of foot by the use of a mechanical device.

In the 17$^{th}$century, **Nicholas Andre** introduced the subject of preventing the deformities in children.

In 18$^{th}$ century **Cheselden** of England used repeated stretching and bandaging to maintain correction, the bandage was made of several pieces of linen rag in a mixture of egg white and flour.

In **1782 Lorenz** in Frankfurt did subcutaneous tenotomy of the tendoachilies and **Stromeyer (1831)** popularized it.

In **1796 Bruckner** first recommended forcible manipulation.

In **1803 Scarpa** described pathological anatomy in memoir on the congenital clubfoot in children.

In **1838 Guerrin** reported the use of plaster of paris in the treatment of clubfoot.

In **1857 Solly** performed the first bony procedure in CTEV. He removed part of cuboid in an attempt to correct the deformity with limited success, subsequently **Dillwyn-Evans** modified the operation by doing osteotomy of cuboid.

In **1866 Adam** differentiated the acquired talipes equino varus from the congenital variety. He also noted that the head and neck of talus deviated medially. He felt that this was a secondary adaptive change and not a primary defect.

In **1872 Lund** did talectomy for clubfoot.

**H.O Thomas** from Liverpool used a wrench to forcibly manipulate and correct the deformity, which was discarded later.

In **1890 Phelps** introduced open surgery in which he released all structures on the medial side of the foot.

In **1892 Washington** and **Hughes** stated that pathological anatomy of clubfoot is due to germplasm defect of the head of the talus.

In **1896 Roentgen** invented the x-rays which made little difference to the treatment of clubfoot, since the standard radiographic views have been described only recently.

In **1906 Codvilla** described medial soft tissue release.

In **1908 Robert Jones** carried out osteotomy and resection of tarsal bones to correct CTEV.

**Denis–Brown** described wedge resection of talus from the lateral side and also recommended section of the metatarsal bones to correct the forefoot adduction

**Dwyer** advanced his views on calcaneal osteotomy to correct the inverted and equinus heel.

In **1930 Kite** popularized non operative treatment with serial manipulation and plaster cast immobilisation.

In **1930 Brockman** in his classic monogram described the morbid anatomy of clubfoot and also described the two stage soft tissue release for correction.

In **1934 Denis–Brown** renewed interest in mechanical pressure as a cause of deformity, he advised forceful manipulation before application of **D-B splint**.

In **1947 McCauley** reported about the treatment of clubfoot .he stated that x-rays standards of correction are more reliable than clinical appearance.

In **1950‘s Ignacio Ponseti** introduced a new method of conservative treatment, he used head of talus as the fulcrum for correction.

In **1960 Bost** asserted the importance of releasing contracted plantar structure in recurrent clubfoot.

In **1979 Turco** carried out one stage posteromedial release with internal fixation.

In **1983 Ghalie** et al advocated the correction of hindfoot and forefoot deformity by the plantar release surgery at one stage.

In **1987 Simons** described total subtalar release based on **mckay’s** concept.

**French methods** – physical therapy and taping

**Bensahel (1990)** and **Dimeglio (1996)** described method of physical therapy, continuous passive motion machine, splinting.

## Etiology of club foot:

Various theories were proposed to explain the etiology of idiopathic clubfoot, however there were no consensus regarding the exact etiopathogenesis of the clubfoot deformity.

**Several theories proposed are:**

1) **Theory of arrest of development.**
2) **Theories based on genetic concept**

    a) Multifactor inheritance

    b) Inheritance in Mendelian fashion

    c) Chromosomal abnormalities

    d) Defects in germplasm.

3) **Environmental Factors**

a) Mechanical

    b) Maternal and nutritional defects

    c) Infectious diseases during pregnancy

    d) Toxic factors

    e) Maternal metabolic disorders

f) Maternal pelvic irradiation

g) Maternal hormonal factors

h) Unknown factors

**4) Myogenic theory**

a) Neurogenic theory

b) Myodystrophic

**5) Atavistic theory**

**6) Archiopterygial**

## Pathoanatomy:

The main joints involved in clubfoot are the ankle joint and the joints of the foot. The exact nature of the deformity in club foot is still controversial. **Kites** quote from **Ecclesiastes (200 BC)** is most apt: `` how the bones do grow on the womb of her is with child``[1]. Most authors consider the principal deformity to be congenital dislocation of the talonavicular joint" but it may be possibly better considered to be fixed exaggeration of the normal equinovarus position. The major deformity is believed to be an inward rotation of the whole foot upon the talus. This rotation takes place primarily at the talocalcaneonavicular joint but also at the calcaneocuboid joint.[2]

Most of the information about the pathoanatomy in cases of clubfoot has been obtained from

1) Cadaveric studies of human fetus having clubfoot.
2) Samples of muscles and bone obtained during surgeries in case of club foot [2].

Routine radiographs yield only truncated information as the infants' foot is only partially ossified. They do not solve the problem whether the skeletal abnormalities are primary or whether soft tissue abnormalities and muscle imbalances produce the changes seen in club foot. Now most of the workers believe that the soft tissue abnormalities are the main cause of the deformities in club foot and that the bony changes occur secondary to the soft tissue abnormalities. [2]

**Antonio Scarpa (1803)** in his 'memoria chirurgica sui piedi tori congeniti' described the "twisting" of calcaneum, navicular and cuboid around the talus as a "congenital dislocation of talonavicular joint". He believed that anomalies of the muscle, tendons and ligaments of the foot and leg are secondary to the skeletal deformity [3]

**Adams (1866)** called attention to abnormal shape of the head and neck of the talus which he felt was the result rather than the cause of deformity.[4]

**Elmslie (1920) Bohm (1935) Bechtel and Mossman (1950)** and **settle (1963)** said that the chief factor in the various parts of the deformity was inward and plantar obliteration of neck of the talus. [5,6,7,8]

**Ober (1920)** – described outward rotation of the tibia and backward displacement of the lateral malleolus, the os calcis being subluxated or rotated inwards beneath the astralagus, the position then maintained by muscle spasm[10].

**Brockman (1930)** - showed congenital atresia of talonavicular joint leading to talonavicular subluxation medially.[9]

**Mau (1930)** proposed neuro-muscular contracture i.e., the contractures of the adductors and invertors of the foot as the cause inspite of lack of histological proof.[11]

**Scherb (1940)** showed abnormal insertion of the peroneus brevis to the extensor digitorum brevis and abnormal insertion of tibialis anterior and posterior.[12]

**Irani and Sherman (1963)** found that the neck of the talus was always short and sometimes not identifiable so that the head seems directly fused to the body of the talus. The angle which the fore part of the talus made with the body was 155 to 135 degrees (normal 150 – 155 degrees) .They also found that the anterior portion of the talus was rotated

in a plantar direction so that the auricular surface no longer faced directly forwards.[13]

**Evans (1961)** felt that the essential abnormalities lie in the mid tarsal joints.[14]

**Kleger (1962)** – reported that in severe deformity the navicular and sustentaculum tali almost articulate with medial malleolus, a thick fibrocartilagenous disc is often interposed between malleolus and the tarsal bones .He also stated that there is external tibial torsion.

**Dwyer (1963 – 64)** showed that the heel was small and the calcaneus is major element which prevents complete correction and promote relapse. The calcaneal tendon is continuous with plantar fascia and because the plantar fascia was not properly stretched by weight bearing; it gets contracted and produces pes cavus deformity. [15]

**Vincent j. Turco (1971)** – fibrosis of the medial structures forms a mass of indistinguishable scar tissue on the medial side so that it obscures the mid tarsal and subtalar joints. This maintains the tuberosity of the navicular and sustentaculum tali in close proximity to medial malleolus. In the resistant foot, the mass of scar tissue prevents the forward and

anterior migration of the navicular and the eversion and lateral movement of anterior end of calcaneum. [16]

**Waisbrod (1973)** – found deformity of the talus which can't be corrected by manipulation as most striking finding. There was also abnormal insertion of the tibialis posterior tendon. Ossification centres were small and eccentric in the clubfoot but normal in unaffected foot.[17]

**Catterall (1984)**[18]– considers the foot to consists of two rays a lateral ray formed by the os calcis and fifth metatarsal and medial ray consisting of talus, navicular , medial cuneiform and first metatarsal. The two rays are connected by a link mechanism. The center of rotation is the interosseous ligament. When the foot is placed in equino varus, the lateral ray tends to lie underneath the medial ray and various structures adapt by shortening. In the plantar flexed position, the talus moves out of the front of the mortise and is also medially rotated around a vertical axis. When the foot is dorsiflexed, there is external rotatory movement of the os-calcis under the talus so that approximately 70% of rotatory movement of the foot occurs in relation to tibia. In clubfoot the structures preventing the rotation are calcaneo – fibular ligament and peroneal retinacular tissue, these forms the posterolateral tether. To allow normal movements

of the medial ray on the lateral ray the under surface of the body link must be released.

## Clinical features-

Talipes, the term initially was applied indiscriminately to all deformed feet. In 1839, little proposed the generic term talipes - derived from the Latin talus (ankle) and pes (foot) – to describe all foot deformities stating “I have proposed to employ the classical word talipes as a generic term, to include all those deformities of the foot produced by contraction of certain muscles and to use the term varus, valgus and equinus to designate the specific forms of these disease”. Thus clubfoot became talipes equino varus, a definition that is universally accepted. [19]

The typical clubfoot consists of a deformed foot in equinus, varus, and adduction and in some cases a cavus component. Varying degree of severity can be seen in the new-born, in addition to varying degree of associated rigidity .some feet which are extremely rigid, are usually smaller, stubby with a short first metatarsal ray. Feet that are less rigid and more pliable on manipulation are usually longer than those rigid deformities. Deformities that can be almost fully corrected on initial manipulation should be considered mild positional deformities. Equinus

deformity of the foot is accompanied by an inversion of the heel, adduction and varus of the forefoot. The medial border of the foot is concave and elevated and its plantar surface faces upwards; the lateral border of the foot is convex and depressed downwards. The posterior tuberosity of the heel is pulled upward, inverted, difficult to palpate and less visible. The older child may have a callosity on the dorsal aspect of the fifth metatarsal. The bony prominence visible and palpable on the dorso-lateral aspect of the foot is the talar head, which are partially uncovered because the navicular and the calcaneum have been displaced medially. [2, 14]

Stiffness or limitation of motion in joints other than the feet indicates bad prognosis because they often signify limited forms of arthrogryposis. Short and very rigid clubfeet may be the only manifestation of peripheral arthrogryposis. [2, 14]

**Skin abnormalities:**

The skin on the dorso-lateral aspect of the foot is usually stretched out, thin and atrophied. Some feet have a deep cleft on the medial plantar surface usually they have a severe cavus deformity with a fore foot contracture. Some feet that are rigid and have a severe equinovarus

deformity also have a single deep cleft in the skin just above the heel and the prominence of the heel is obscured. The skin along the medial aspect of the foot below the medial malleolus is contracted and ‘notorious poorly nourished’ an important consideration in surgical treatment.[2, 14]

**The knee and lower leg:**

At birth knee appears normal with the usual knee flexion contracture. A hyper-extension at the knees become evident later as a consequence of a fixed equinus deformity of the foot. Genu valgum is commoner in the older child with a severe uncorrected bilateral equinovarus deformity: this is a compensatory acquired adaptation as the child attempts to place the more deformed foot in a plantigrade position. [2, 14]

**The ankle:**

In the normal foot, the ankle mortise faces slightly laterally. In the clubfoot this external rotation of the mortise is increased. In resistant feet, this lateral orientation of the tibiofibular unit increases with age. Another factor is the child’s attempts to compensate for the varus adduction deformity of the foot by rotating the leg externally on the weight bearing and walking. The lateral malleolus is palpable posteriorly, which is to be

expected with the increased external rotation of the mortise. The medial malleolus is usually underdeveloped and appears to be slightly anterior to its normal position.[2,14]

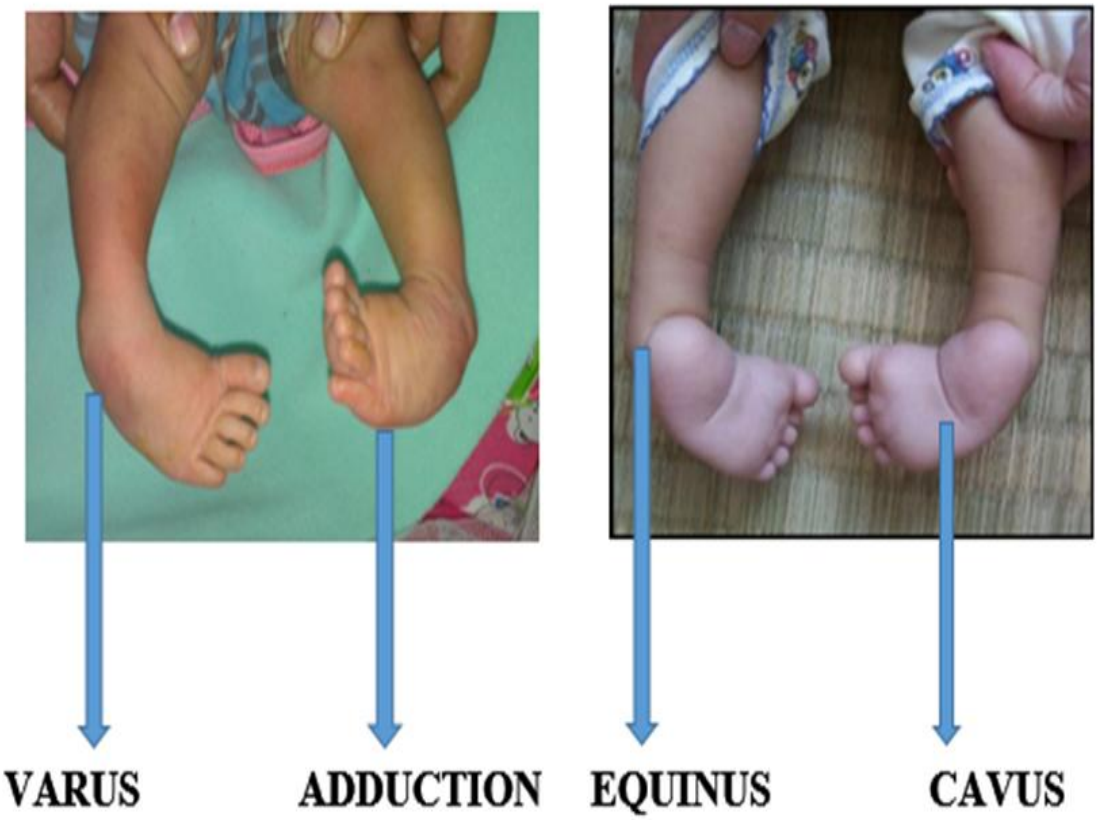
**Components of the deformity**[2, 14]

**Equinus:** The foot is fixed in plantar flexed position. Equinus deformity is a composite of ankle joint equinus, inversion at the talocalcaneonavicular complex, and plantar flexion of the forefoot.

**Varus:** The hind foot is rotated inwards. This occurs primarily at the talocalcaneonavicular joint. The whole tarsus except the talus, is rotated inwards with respect to the lower leg. Since the forefoot follows the inverted hind- foot, its medial border faces upwards, there by contributing to the composite varus deformity.

**Adduction:** The foot is rotated inward. This medial displacement occurs at the talonavicular and the anterior subtalar joint. In addition some medial deviation occurs at the tarso-metatarsal area and contributes to the deformity.

**Cavus**: The fore foot plantar flexion which Brockman described as plantaris causes a cavus deformity and also contributes to the composite equinus.




**Osseous deformities-**

Many investigators have observed that the overall size of all tarsal bones is smaller in the clubfoot than in normal foot thus producing asymmetric size in a unilateral deformity. Both legs are usually equal in length.[14]

**The Talus** – While the talus is the least displaced, it undergoes the most severe and consistent changes in form. The talus has no muscle attachments and is passively forced into equinus by its articulations and attachments to the calcaneum and navicular.[14]

**Body of the talus** – In the equinus position, only the posterior half of the trochlea articulates with the tibia; the forward portion of the trochlea is out of the mortise anteriorly. In a club foot the anterior wider portion of the body probably never enters the ankle joint, therefore this portion of the trochlea never have the opportunity to respond to physiological stress. As a consequence the anterior trochlea is prone to develop the adaptive morphological changes.[14]

**Neck of the talus:-**The most important constant distortion is found in the neck and head of the talus. Normally, the long axis of neck and head of talus is directed slightly medially in relation to body of talus (about 150 degrees) in clubfoot the medial deviation if the neck and head is increased to form a more acute angle with the axis of the talar body; the degree of talar deviation is quite variable (115 to 130 degrees).In addition, the neck is foreshortened and the usual constriction of the neck is absent. This

heaping up of bone in this part of the trochlea and neck of the talus, plus the medial deviation of the neck, form a bony mass that impinges on the anterior lip of the tibia in dorsiflexion; thus the entrance of the talus into the mortise is impeded, contributing to the equinus deformity.[14]

**Head of the talus:-**The round head of the talus normally faces forwards and is covered by the concave surface of the navicular. In the clubfoot, the head of the talus and the facet for the navicular face medially, the talonavicular articulation is oriented in a more sagittal plane compared to normal coronal orientation. The head of the talus is usually broader than normal with varying degrees of distortion. Correlating the talar head deformity with prior treatment suggests that some of the distortion may be attributed to iatrogenic compression of the cartilaginous anlagen by manipulative treatment. [14]

**Bio-kinematics:**

The correction of severe displacements of the osseous structures in CTEV requires a good knowledge of the functional anatomy of talus.

There are controversies regarding axis of motion of subtalar joints. According to **Farabuef, Virchow H, Huson** and **Siegler**, there is no fixed axis of motion of subtalar joint. This is in contrast to the concept by

**Hicks, Elfnan** and **Inman** which emphasis that subtalar joint moves around a fixed axis. [2]

A better understanding of the tarsal mechanics in the normal foot was given by **Huson** in his thesis "A functional and anatomical study of tarsus". He demonstrated that tarsal joints do not move as a single hinge but rotate about a moving axis as in the case of the knee. Each joint of the foot has specific motion pattern of its own. These are described by means of discrete arcs, representing the successive portion of a particular moving axis. This successive position is followed by a fixed pattern which is characteristic for the joint concerned.[29]

He described "Constrained Mechanism" in which motion of the tarsal joints occur simultaneously. If one of the joint movements is blocked the other joint movements also get blocked. The ligaments play an important role as "Kinematic Constraints" of joints apart from their share in forced transmission to support the elastic vault structure of the foot.[2]

The concept of passage of axis of rotation from anteromedial to posterolateral was given by **Inman**.[57]

.

**Seigler**[2] described “Kinematic Coupling” as there is no separation between the motion of the ankle joint and subtalar joint in living objects. Motion of the foot shank complex in one direction occurs by the combined motion of both joints. Contribution from ankle joint in dorsiflexion and plantar flexion is more than that of subtalar joint while subtalar joint has more contribution in inversion and eversion than that of ankle joint. Both joints contribute equally in internal and external rotation.

**Ponseti**[36] gave a new concept to the kinematics around the talus. He described that, the anterior part of the calcaneus lies beneath the head of the talus in clubfoot which results in varus and equinus deformity of the heel. Attempts to push the calcaneus into eversion without abducting will press the calcaneus against the talus and will not correct the heel varus. Lateral displacement (abduction) of the calcaneus to its normal relationship with the talus will correct the heel varus deformity of the clubfoot.

He emphasized that the congenital talipes equinovarus deformity occurs mainly in the tarsal bones of the foot, which are mostly made of cartilage, and are in extreme positions of adduction, inversion and flexion at the time of birth. The talus position will be in severe plantar flexion,

and its neck is medially and plantarly directed. Head of the talus head is wedge shaped. The navicle is medially displaced, and is close to the medial malleolus. Navicle articulates with the medial surface of the head of the talus. The calcaneum is in adducted and inverted position under the talus.The tarsal joints is functionally depending on each other. The movement of each tarsal bone involves simultaneous movement in the adjacent tarsal bones. Joint motions are determined by the curvature of the joint surfaces and by the orientation and structure of the binding ligaments. Every joint has specific motion pattern. Correction of medial displacement and inversion of the tarsal bones in congenital equinovarus requires a simultaneous gradual lateral shift of the navicle, cuboid and calcaneum before they can be everted and brought to neutral position.[36]

**Radiographic examination:**

Although radiographic examination has been used to demonstrate the deformities of tarsal bones in clubfeet, the images are hard to reproduce, evaluate, and measure. There are several reasons for this: (1) it is difficult to position the foot, particularly when it is deformed and stiff, in a standard fashion in the x-ray beam; (2) the ossific nuclei do not represent the true shape of the mostly cartilaginous tarsal bones; (3) in the first year of life, only the talus, calcaneus, and metatarsals may be ossified, the

cuboid is ossified at six months; the cuneiforms, after one year; and navicular, after three years and later; (4) Rotation distorts the measured angles and makes the talar dome appear flattened ; and (5) failure to hold the foot in the position of best correction makes the foot look worse than it is on the radiograph.[53,54,55,55,20.]

To optimize the radiographic studies, the foot should be held in the position of best correction, with weight bearing, or, if an infant is being examined, with simulated weight bearing. Since the anteroposterior and lateral talocalcaneal angles (Kite's angles)[55] are the most commonly measured angles, the x-ray beam should be focussed on the hind foot (about 30° from the vertical for the anteroposterior radiograph , and the lateral radiograph should be trans-malleolar with the fibula overlapping the posterior half of the tibia, to avoid rotational distortion.)[20]

For an older child, it may be useful to focus the x-ray on the midfoot as this view allows assessment of dorsolateral subluxation and narrowing of the talonavicular joint. Lateral dorsiflexion and plantar flexion radiographs may be useful to assess the ankle motion and

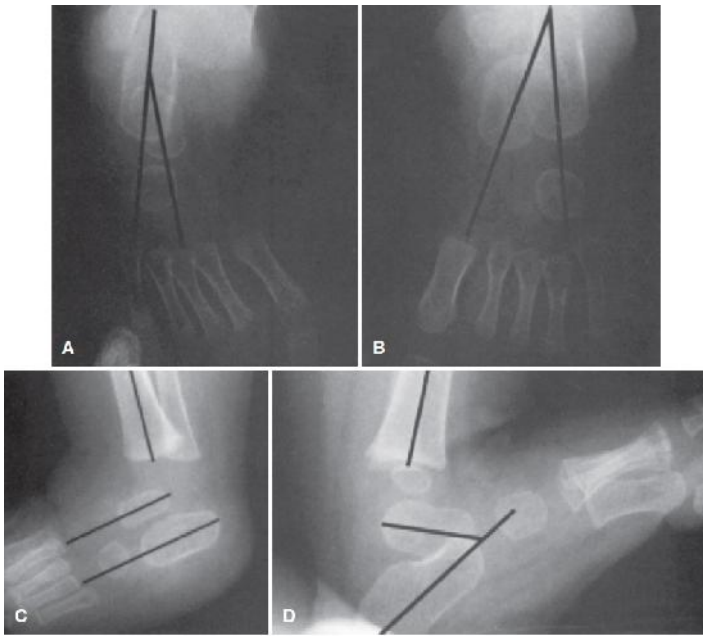
**Common radiographic measurements:**

Three measurements should be made on the anteroposterior radiograph:

(1) The anteroposterior talocalcaneal angle (usually < 20º in a clubfoot),

(2) The talar-first metatarsal angle (up to about 30º of valgus in a normal foot and mild to severe varus in a club foot), and

(3) Medial displacement of the cuboid ossification center on the axis of the calcaneus or medial subluxation of the cuboid on the calcaneus.[20]




**A, Anteroposterior view of right clubfoot with decrease in talocalcaneal angle and negative talus-first metatarsal angle.**
**B, Talocalcaneal angle on anteroposterior view of normal left foot.**
**C, Talocalcaneal angle of 0 degrees and negative tibiocalcaneal angle on dorsiflexion lateral view of right clubfoot.**
**D, Talocalcaneal and tibiocalcaneal angles on dorsiflexion lateral view of normal left foot**.

To make the lateral radiograph, the foot should be held in maximum dorsiflexion with lateral rotation but without pronation. The x-ray beam should be focused on the hind foot. The foot should be positioned with the radiographic plate placed laterally against the posterior half of the foot. The club foot is bean shaped, and placement of the radiographic plate medially forces the foot to be rotated laterally in the x-ray beam. Two measurements should be made:

(1) The talocalcaneal angle (typically < 25° in a clubfoot), and
(2) The talar-first metatarsal angle. Plantar flexion of the forefoot on the hind foot indicates contracted plantar soft tissues or midtarsal bone deformity(a triangular navicular)[20]

**Classification:**

The lack of standardization in the classification of congenital talipes equinovarus has led to confusion in comparing the results of several modalities of treatment. Making the evaluation more complex are the multifactorial etiology of this deformity and a wide range of severity at presentation. Thus a universally accepted classification system which is simple, reproducible and useful in planning of the treatment and prognosis is still lacking.[21]

**George W Simons** stressed the importance of differentiating – between classification and evaluation. According to him classification applies to clinical examination at birth to establish a prognosis and to the re-examination following recurrence of the deformity to establish a new prognosis[22].

Evaluation applies strictly to treatment phases to determine the specific treatment to be undertaken and to monitor the results. However, this differentiation is not widely accepted or known and the two terms are frequently used interchangeably by most of the authors.

**Steven and Meyer** postulated that an ideal grading of severity would be:-

1. Reproducible
2. easy to learn
3. Co-related to the treatment and prognosis
4. Application to all forms of clubfoot
5. Not be related to the age of the patient

Many workers have made attempts to classify the clubfoot and each system has its own merits as well as de-merits.

**Ponseti and Smoley (1963)** reported the results of treatment congenital talipes equinovarus. Their classification system was based on ankle dorsiflexion, heel varus, forefoot supination and tibial torsion. Feet were classified on the basis of these measurements as either good, acceptable or poor.[2]

The system of **Ponseti** and **Smoley** for the classification of congenital talipes equinovarus.

| **Ankle dorsi-flexion (degrees)** | **Heel varus (degrees)** | **Adduction of the fore part of the foot (degrees)** | **Tibial torsion (degrees)** | **Result** |
|---|---|---|---|---|
| >10 | 0 | 0 – 10 | 0 | Good |
| 0 - 10 | 0 - 10 | 10 - 20 | Moderate | Acceptable |
| 0 | >10 | > 20 | Severe | Poor |

**Hersh Classification (1967):**[21]

**Extrinsic or flexible:-**In this type - the foot lies in equino varus but is flexible by manual pressure. This type is postural variety and is probably associated with the intrauterine posture. Although there are abnormal bony relationships, they are not gross and severe shortening of the soft tissue is not present at first. The heel is prominent; there are skin creases at the outer side of the ankle.

**Intrinsic or Rigid:** In this type, the foot is much more rigid, the deformity can only be partially corrected by digital pressure. Abnormal bony relationships are present at birth. Unilateral deformities are less severe than bilateral deformities. Heel is small because the posterior end of the calcaneum is displaced upwards and lies deeply against the posterior aspect of the lower end of the tibia. The skin of the foot is thrown into creases on the medial side and is stretched and thinned out on the outer side and the dorsum of the foot.

**Harold and walker (1983)**[24] considered the ability to correct the deformity. The grade of deformity was determined by whether the foot could be held at or beyond the neutral position (grade 1), or whether there was fixed equinus or varus of $< 20^{0}$ (grade 2) or $< 20^{0}$ (grade 3).

Summary of the system of **Harold** and **walker** for the classification of congenital talipes equinovarus:

| Grade | Severity | Residual deformity with correction |
|---|---|---|
| I | Mild | Neutral or beyond |
| II | Moderate | < 20° |
| III | Severe | >20° |

**Cummings and Lovells Classification :( 1987).**[25]

They classified clubfoot into 5 types of varying severity:

**1. Supple clubfoot: -**In this type, the deformity of Foot is easily corrected and will respond well to conservative methods of treatment.

**2. Relapsed clubfoot: -**Foot in which deformity was getting corrected but has again occurred during the course of the treatment

**3. Recurrent clubfoot: -** Occurrence of a deformity after the attainment of a plantigrade foot i.e. after the completion of the treatment.

**4. Neglected clubfoot: -** Foot which has not received any treatment till the age of 18 months after birth.

**5. Rigid clubfoot: -** Severe deformity not correctable by conservative means and requires surgical treatment for correction.

**Catterall (1991)[26]** described four patterns depending on the evolution of the deformity which was classified as resolving, caused by tendon or joint contracture, or secondary to a false correction. Several clinical features are used for this classification.

| Foot | Resolving pattern | Tendon contracture | Joint contracture | False |
|---|---|---|---|---|
| Hindfoot | | | | |
| Lateral malleolus | Mobile | Posterior | Posterior | Posterior |
| Equinus | No | Yes | Yes | Yes |
| Creases medial | No | No | Yes | No |
| Posterior | No | Yes | Yes | Yes |
| Anterior | Yes | No | No | Yes |
| Forefoot | | | | |
| Lateral border | Straight | Straight | Curved | Straight |
| Mobile | Yes | Yes | No | Yes |
| Cavus | +/- | +/- | +/- | No |
| Supination | No | No | Yes | No |

**Catteralls system of classification of congenital talipes equinovarus**

**N.C.Carroll (1993)**[21] took a broad view and recommended examination in five parts:

1.'Birds eye view' of the whole child

2. Detailed neurological examination with ultrasound examination spine

3. Doppler examination of the foot

4. Radiographic assessment of the foot

5. Clinical assessment of the foot with child in the supine and prone position.

This system is based on the presence or absence of the following 10 criteria.

These were given one point each if present and zero when absent. Treatment and prognosis were co-related to the score.

**A).Inspect the foot for:**

1. Calf atrophy
2. Lateral malleolus is posteriorly displaced (as seen with patient prone and knee flexed to 90 $^{0}$)
3. Medial or posterior creases.

4. Curved lateral border

5. Cavus

**B) Palpate the foot to see if:**

6. The navicle is fixed to the medial malleolus

7. The calcaneus is fixed to the fibula.

**C) Manipulate the foot to see if there is:**

8. Fixed fore foot supination.

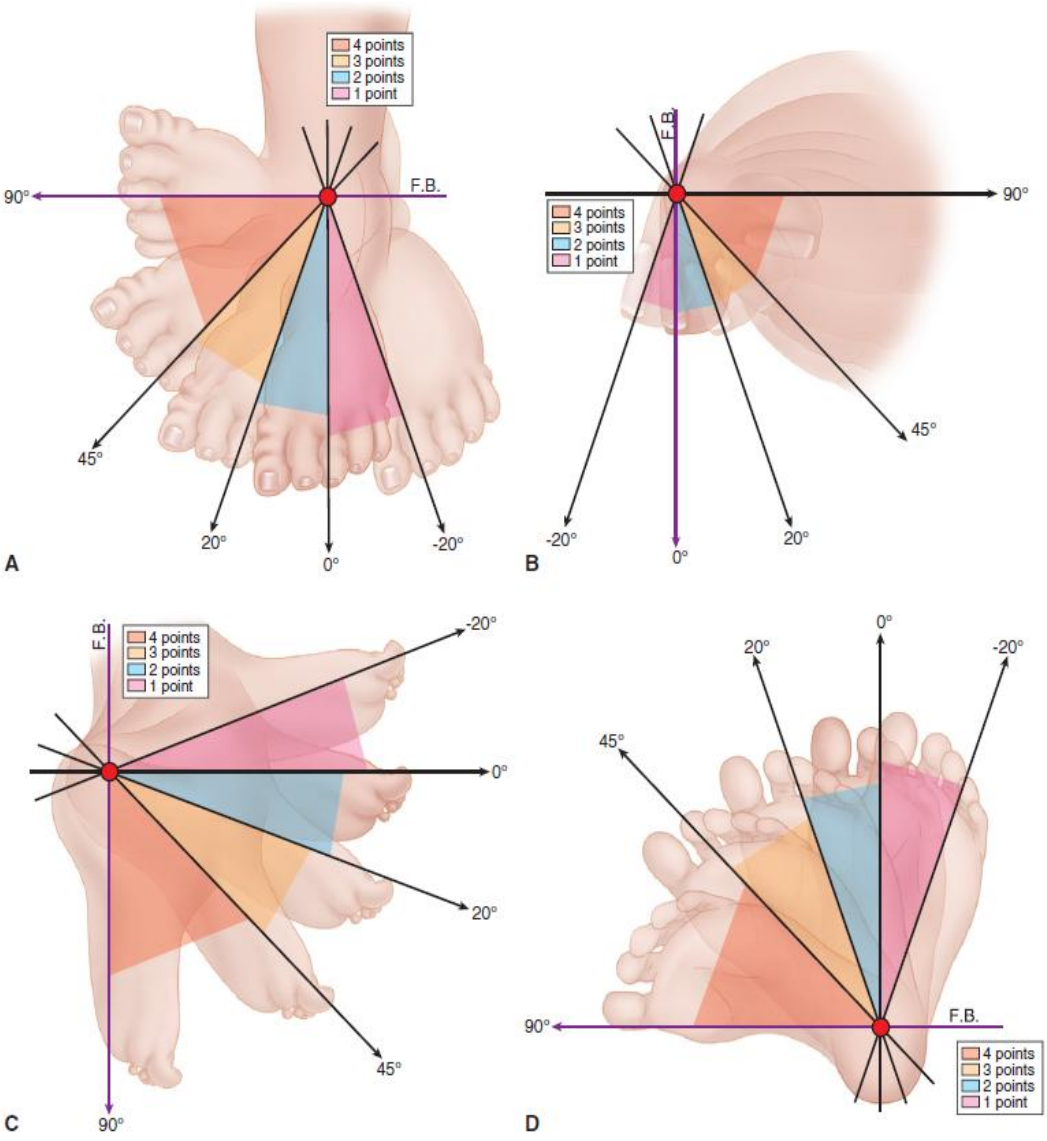
9. Fixed equinus

10. Fixed adductus

The system of **Dimeglio et al** [27] is derived from a detailed scoring system based on the measurement of four parameters: 1) Equinus in the sagittal plane 2) Varus deviation in the frontal plane 3) 'derotation' around the talus of the calcaneoforefoot block; and 4) adduction of the forefoot on the hind foot in the horizontal plane. The scale includes four additional points for the presence of the medial creases, a posterior crease, cavus and poor calf musculature. From the score, which has a maximum of 20 points, the deformity can be graded as benign, moderate, severe or very severe.

**The system of Dimeglio et al for the classification of congenital talipes equinovarus:**

| Classification grade | Type | Score | Reducibility |
|---|---|---|---|
| I | Benign | < 5 | > 90% soft-soft, resolving |
| II | Moderate | 5 – 10 | > 50% soft-stiff, reducible, partly resistant |
| III | Severe | 10 - < 15 | < 50% stiff-soft, resistant, partly reducible |
| IV | Very severe | 15 - < 20 | < 10% stiff-stiff, resistant |




**Dimeglio et al classification for congenital talipes equinovarus(source campbell 12th edition)**

# TREATMENT

The spectrum of treatment options for CTEV is large .It ranges from non-operative methods including manipulation, strapping, repeated stretching and POP casting on one side to operative methods like soft tissue surgery and bony procedure.

## Forcible manipulation

The concept of forcible manipulation was first described by Bruckner [28]. **Thomas** did immediate forcible correction with a wrench and application of a splint to hold the foot in corrected position [28]. Forcible corrections at one or two sittings were carried out **by Lorenz** using a modified **Thomas wrench** and later used a padded pyramid correcting a deformity over its apex.

**Thomas wrench used for correcting club foot**

**Tubey** was the first person to give details of the manipulation technique. He advised abduction and eversion at talocalcaneonavicular, calcaneocuboid joint with dorsiflexion of whole foot at ankle [28].

**Harreustein** feared damage to distal tibial and fibular epiphysis during forcible manipulation [28].

**Splint**

**Pare** advocated splint alone as a device to correct all or part of the deformity [28]. **Scarpa** used shoes to correct the deformity and emphasized that varus should be converted into equinus. **Trelat, Shaffer** have described various devices for manipulative correction. In 1897, **Gibnery** practiced wrenching to convert the equinovarus into equinovalgus.He then reduced the equinus by tenotomy and manual force, immobilizing the foot in plaster of paris cast long enough for the bones on the outer side to atrophy and for those on the inner side to hypertrophy [28].

**Dennis Brown** in 1934 gave a breakthrough by introducing metal splint for the correction of the deformity[28].

Forcible manipulation has fallen to disrepute owing to the stiffness of the joints, deformities of bones and spurious correction providing a rocker bottom foot which developed following this form of treatment.

**Repeated stretching:**

The emphasis on treating new-born with CTEV was first given by Hippocrates who advocated repeated manual correction and application of strong bandages during manipulation. Over correction was considered to be an essential part of the procedure [28].

**Sofield** departed from forcible manipulation and started using elastic traction for the correction of the deformity [28]. Brown supported this principle and claimed that useful feet and leg can be obtained without use of the force. He based his thoughtful account on three well known hypotheses: continuous traction will gradually tire a muscle, a contracted muscle put on stretch will gradually lengthen, if relaxed, will shorten and return to the contracted state as per the **Law of Davis**[37]**.** Hence over correction is a must.

**J. Hiram Kite**[1, 2, 28] was a strong advocator of non-operative treatment of clubfoot. His original technique consists of manipulation and casting followed by wedging of the cast to correct individual deformities. Later

he advised repeated change of the whole cast with manipulative stretching at each stage. He said "Whatever is gained without force is achieved without harm".

**Jones** and **Lovett** [29] said that: "In very young children it is probable that every case can be cured without operation with the exception of a possible tenotomy of the tendo achilles in the final stage after constantly repeated manipulations by the parents carefully taught by the surgeon".

**Plaster of Paris casts:**

**Guerin** was the first to describe the use of plaster of paris casts in the treatment of CTEV [28]. This was followed by **Thomas, Jones, Little, Bradford** and **Lovett (1899)** and **Whitman (1910).Soule** [28] practiced manipulative reduction followed by retention in adhesive strapping incorporating the strapped limb in plaster of paris cast (1930). **Elmslie** used plaster of paris casts without splinting**. Trethowan** and **Dunn** said that it is practically impossible to maintain the correction by POP cast. **Lord** introduced the above knee cast to avoid slipping and to aid in the correction of inversion. [28]

**Adhesive strapping:**

It is not known who first described adhesive strapping to retain the correction, but **Whitman**[28] was one of the most effective advocates of adhesive strapping for correction of the deformity. **Masse** and **Bensahel** has popularized this concept in recent times [31].

**Kite's method:**

The initial technique of Kite as described above was modified by himself in which he advocated repeated stretching and applying a new cast instead of wedge correction for individual deformities. After full correction, Phelps splint is used for maintenance of CTEV correction [31, 30]. This method was derived from the concept three-point pressure, where manipulations are done by applying counter pressure over calcaneocuboid joint and abduction of whole foot under the talus. Ponseti described this as 'Kite's error' as by applying counter pressure over calcaneocuboid joint he blocked abduction of the calcaneus under the talus. This is very essential in the correction of the heel varus as the calcaneus cannot be everted unless it is fully abducted under the talus [2]. Although this method is effective in most cases, due to long duration of treatment, the practice changed and surgical management is

recommended for those patients with residual deformity after three months of manipulation and casting[31].

**French method:**

This non-operative method of correcting CTEV was developed by **Masse** and **Bensahel** in France in 1970 [31]. It is also known as **"Functional Method"** of CTEV deformity correction. Followers of this method believe that retraction of posterior tibial muscle and weak peroneal muscle are the primary factors responsible for clubfoot. It consists of daily manipulation of the new-born clubfoot, stimulation of weak peronei, and temporary immobilization with non-elastic adhesive strapping. Daily treatment is continued for approximately two months and then sessions are progressively reduced to three sessions per week for an additional six months, after which strapping is continued until becomes ambulatory. Night time splinting is used for an additional two to three years [31]. In 1990 a continuous passive motion machine was developed in France only for clubfoot treatment[58]. Manipulations are done on daily basis by the trained physiotherapist. Daily two sittings of continuous passive motion for foot and ankle are advocated. This treatment is very lengthy, expensive and a lot depends on the skill of the physiotherapist.

For those who still require surgery, the procedures are usually restricted to posterior structures only.

This method fails to correct the deformity in a quarter of the cases [31, 32]. Parents' compliance is very essential as daily visits to the clinic are required for the treatment and if patient is living far from the hospital, successful outcome becomes less likely.

**Ponseti technique:**

Ponseti published his first article on CTEV correction in ***The Journal of Bone and Joint Surgery*** in March 1963 which was not widely accepted. However his article in 1995 on the long term follow up of CTEV cases by his technique created a new path in the treatment of CTEV by non-operative method [36].

It consists of serial manipulation and casting with gradual and simultaneous correction of all deformities of CTEV. Manipulations and casting are done at weakly intervals with POP immobilization. Equinus is the only residual deformity, which is to be corrected by percutaneous tenotomy of tendo Achilles[33, 34, 35]. This is followed by POP casting for three weeks. Then the baby is subjected to bracing protocol for full time

for the first three months and twelve hours at night and two to four hours in the middle of the day for a total of fourteen to sixteen hours during each twenty four hour period [36].

**Sequence of deformity correction in ponseti Technique:**

**Cavus:**

The first component of management is cavus deformity correction by holding the forefoot in proper alignment with hindfoot. The cavus deformity is due to pronation of the forefoot in relation to the hind foot. This deformity will be supple in new-borns, which requires only supinating the forefoot to achieve a normal longitudinal arch of the foot. The forefoot is supinated to the level that, on visual inspection of the sole of the foot reveals a normal looking arch – neither cavus nor planus. Alignment of the forefoot with the hind foot and achieving a normal arch is required for effective abduction of the foot to correct varus and adductus.

**Manipulation:**

**Location of the head of the talus:**

The head of the talus is palpated in front of the lateral malleolus as its lateral part is barely covered by the skin. The anterior part of the calcaneus is felt beneath the talar head.

**Stabilize the talus:**

Stabilizing the talus provides a pivot point around which the foot is abducted.

**Manipulation of foot:**

Next with the foot in supination and talus stabilized, the foot is abducted as far as can be done without causing discomfort to the infant. The correction is held with gentle pressure for about 60 seconds and then released.

**Subsequent casts:**

During this phase of treatment, the adductus and varus are fully corrected. The equinus deformity gradually improves with correction of adductus and varus. This is part of the correction because the calcaneus

dorsiflexes as it abducts under the talus. No direct attempt at equinus correction is made until the heel varus is corrected.

**Decision to perform tenotomy:**

A major decision point in management is determining when sufficient correction has been obtained to perform a percutaneous tenotomy to gain dorsiflexion and to complete the treatment. This point is reached when the anterior calcaneus can be abducted from underneath the talus. It has to be confirmed that the foot is sufficiently abducted to safely bring the foot into 0 to 5 degrees of dorsiflexion before performing tenotomy. This abduction allows the foot to be safely dorsiflexed without crushing the talus between the calcaneus and the tibia .If the adequacy of the abduction is uncertain, another cast or two is applied to be certain.

**Maintenance of deformity correction:**

The brace is applied immediately after the last cast is removed, three weeks after tenotomy. The brace consists of open high-top straight last shoes attached to a bar. For unilateral cases, the brace is set at sixty to seventy degrees of external rotation on the clubfoot side and thirty to forty degrees of external rotation on the normal side. In bilateral cases, it is set at seventy degrees of external rotation on each side. The

bar should be of sufficient length so that the heels of the shoes are at shoulder width. The bar should be bent five to ten degrees with convexity away from the child, to hold the feet in dorsiflexion.

The brace should be worn full time (day and night) for the first three months after the last cast was removed. After that the child should wear the brace for twelve hours at night and two to four hours in the middle of the day for a total of fourteen to sixteen hours during each twenty four hour period. This protocol continues until the child is three to four years of age

The rational behind this bracing is that the medial soft tissues remain stretched out only if the brace is used after the casting. In the brace, the knee are left free, so that the child can kick them straight to stretch the gastronemius tendon. The abduction of the feet in the brace, combined with the slight bend causes the feet to dorsiflex. This helps maintain the stretch on the gastronemius muscle and Achilles tendon. [36]

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**Relapse:**

Relapse is detected when slight equinus and varus deformity of the heel is observed, usually without increased cavus and adduction deformity of the fore foot [37]. Relapses are rare after five years and

extremely rare after seven years of age regardless of whether the deformity is fully corrected or not[2]. Following are the guidelines described by Ponseti for treatment of relapsed CTEV [2].

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1. For correction of second or third relapses in children older than two-and-half years of age, when tibialis anterior has a strong supinatory action, transfer of tibialis anterior to third cuneiform is advocated. Transfer of the tibialis anterior tendon averts further relapse, maintains the correction of heel varus and thus greatly reduces need for medial release operation. The tibialis anterior tendon should never be split so as not to lose its eversion power, nor should it be transferred to fifth metatarsal or to the cuboid since this may excessively evert the foot causing severe forefoot pronation and heel valgus. To prevent bow stringing of tendon under the skin in front of the ankle, the tendon must be left under the superior retinaculum.

2. Ligament and joint release surgeries are necessary only in few cases. It should not be done before the age of six months. Ponseti advocates sectioning of only tight ligaments to achieve proper alignment of bones, since a perfect reduction is unattainable owing to the incongruity of the joint surfaces and changes in the shape of the bones.

Lengthening of tendon of tibialis posterior was done by technique described by **Coleman**[38].

**Cavo-varus** is the commonest residual deformity of treated CTEV, in which tarsus remained in some degree of varus while forefoot is pronated. The plantar fascia becomes shortened and thickened, thus aggravating the deformity. Coleman's lateral block test [2:].The rigidity of heel varus is assessed by Coleman's lateral block test. For correction of cavo-varus deformity, if heel varus corrects within five degrees of the neutral position with the Coleman's block test, following series of procedures advocated by **Reginald R. Cooper 3** is used for best correction of the deformity-

1. Severance of plantar fascia percutaneously.
2. A small dorsolateral wedge of bone is resected from the base of the first metatarsal.
3. Jones procedure.
4. The tendon of peroneus longus is severed in the plantar aspect of the foot and sutured to the tendon of peroneus brevis.
5. Transfer of tendon of tibialis anterior to the third cuneiform.
6. Lengthening of the tendo achilles.[2]

**Triple arthrodesis:**

This is a salvage procedure. This is to be done in patients at or nearing the skeletal maturity. It is indicated when ankle joint motion is fairly good but the tarsal joints are very rigid in supination.[2, 37.]

**Talectomy:**

It is indicated in severe cases of very stiff club foot with little or no ankle motion that have relapsed after extensive tarsal release operation. It gives satisfactory results when performed between ages of one to six years.[2]Talectomy can be done as a primary procedure in patients with severe club foot and poor or absent leg muscles, who are suffering from arthrogryposis or myelomeningocele.

Due to structural abnormalities of the talar bones and joints, a clubfoot cannot be corrected fully and hence completely normal foot is neither desirable nor expected [28, 33, 42, and 43].

## MATERIALS AND METHODS:

This is a prospective study including all children with congenital idiopathic clubfoot of age less than 2 years from October 2011 to October 2013 registered at our hospital and is willing for treatment and with following inclusion and exclusion criteria.

### Inclusion criteria:

1. All idiopathic congenital clubfoot
2. Age less than 2 years.
3. Previously untreated clubfoot.

### Exclusion criteria:

1. Syndromic clubfoot
2. Neglected clubfoot
3. Relapsed clubfoot.
4. Postural clubfoot.

Detailed personal history was recorded and a thorough general & local examination was carried out and deformity was scored according to pirani severity scoring at time of presentation and at each visit before

applying cast. The score was plotted against time interval and the trend of score was noted with reference to effect of manipulations or other interventions on deformity.

An accelerated ponseti method casting was followed in management of these study population which the standard weekly manipulation and change of plaster was accelerated to twice a week manipulation and change of cast and at the end equinus deformity is corrected percutaneous tenotomy. Patients were followed up weekly for corrective casting till tenotomy and corrective cast was applied for three weeks after final correction or percutaneous tendoachilies tenotomy. We performed tenotomy under anesthesia. The patients were started on bracing protocol with Dennis Browne splint till walking age

Results were assessed using pirani severity scoring at the end of treatment and on regular follow-ups.

**Accelerated ponseti protocol:**

**M**any conservative management methods described for management of clubfoot like kites method ,French method , adhesive strapping require a longer time frame for treatment course which leads to frequent complications like pressure sores, ankle strains, ”torquing” of

tibia. Prolonged treatment methods have economic concerns and non-compliance towards treatment for parents, which affects the patients. The timeframe of treatment in French method more when compared ponseti method. Continuous motion and repeated manipulation was not able to give better biomechanical environment for chondro-osseous structures to change their growth pattern. In contrast, ponseti method provides continuous stretch by the cast which helps in better remodeling of the cells and tissues until the foot reaches its normal shape.

What should be the time frame required between the manipulation and casting? Is 1week described by ponseti is better to get good results? or can we achieve similar results by decreasing the timeframe which helps to reduce the treatment time significantly thereby increasing the compliance towards treatment, decreasing the economic concerns and cast complications.

In a study done by **Morcuende et.al**.[46] the time interval between the manipulation & casting was decreased to 5 days and found the results attained by this accelerated method has no difference when compared to the results of standard ponseti method. They also stated that less than 5 days' time interval causes discomfort to the patient and complications like foot and toe edema.

**P.Harnett et. al.**[47] in their series stated that weekly thrice change of casts had showed similar results as of standard ponseti method and reported no increased incidence of complications. **Rui Jiang Xu, MD**[52] in his study stated that weekly twice manipulation and casting was also equally effective as standard ponseti method and reported no complications as stated by **Morcuende et.al.** [46]

In this study we use the accelerated ponseti method in which weekly twice manipulation and casting was done till the deformity corrects.

## Ponseti method of correction:

Initially a layer of cast padding was applied from groin to toe and the surgeon hold the foot in corrected position. An assistant applied the cast using fast setting plaster in two sections. The first one comprised of below knee plaster to hold the foot incorrected position.

The next section consisted of extending the cast above knee to convert into a groin to toe plaster cast. During this, the knee was held in 90 degree flexion. After application of the cast the child was observed for about 30 minutes for any signs of limb ischemia. The parents were educated about possible complications like cyanosis,

swelling, excess cry and the contact number in case of emergency were provided. They were then advised to report for the next cast after 7 days.

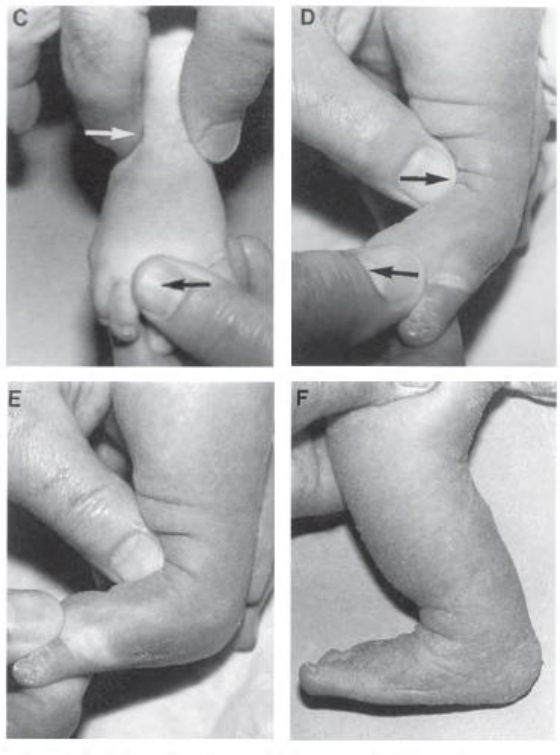
The first cast was aimed at correcting the cavus deformity by supinating the fore foot there by bringing the fore foot in alignment with the hind foot.


**Cavus corrected by dorsiflexing inner part of fore foot.**

**Source: the clubfoot by I.V.Ponseti , oxford press.**

In the second and subsequent casts, the foot in supination was abducted while the surgeon applied counter-pressure on the head of the talus.

The calcaneus abducts by rotating and sliding under the talus. Simultaneously it extends and everts there by correcting the heel varus. To stretch the medial tarsal ligaments fully, the foot was severely abducted to an angle of about60 degrees. A maximum of 10 casts were fixed a send point for correction of cavus, hind foot varus and adduction deformity.




**Manipulation**

**Source: the clubfoot by I.V.Ponseti , oxford press.**

After correction of the above deformities, passive dorsiflexion of the foot to 15 degree above neutral with the examiner applying a single finger pressure was attempted; If achieved, a final cast was

applied in the final corrected dorsiflexed position for three weeks. If dorsiflexion more than 15degrees was not possible, a percutaneous tenotomy of the tendo-achilles was done under general anaesthesia. After this tenotomy, the foot was placed in the final corrected dorsiflexed position for three weeks.

**Percutaneous tenotomy**

**Post tenotomy cast application**

After the last cast was removed, correction was maintained by using Dennis-Browne splint. The brace was worn fulltime (day and night) for the first three months after the last cast was removed. After that, the child should wear the brace for 12hours at night and 2-4 hours in the middle of the day for a total of 14-16 hours during each 24-hour period. This protocol continues until the child is 3-4 years of age.

The patients were reviewed at 14 days after application of Dennis-Brown splint to assess the compliance of the parents. In subsequent visits patients were reviewed once in three months. The parents were given contact numbers and were advised to contact us regarding the maintenance of Dennis Browne splint.

**Application of DB-splint**

**Common errors in correction of clubfoot according to ponseti are:** [2]

Pronation or eversion of the foot which increases cavus and locks the adducted calcaneus under the talus, while the midfoot and forefoot are twisted into eversion.

- External rotation of the foot to correct adduction while the calcaneus is in varus. This causes a posterior displacement of the lateral malleolus by externally rotating the talus in the ankle mortise. The posteriorly displaced lateral malleolus, seen in poorly treated clubfoot, is iatrogenic deformity.
- Abducting the foot at the midtarsal joints with the thumb pressing on the lateral side of foot near the calcaneocuboid joint (kite's major error). By abducting the foot against the pressure at the calcaneocuboid joint the abduction of the calcaneus is blocked, thereby interfering with correction of the heel varus.
- **Attempts to obtain a perfect anatomical correction:** It is a wrong assumption that early alignment of the displaced skeletal element results in a normal anatomy and good long term function

of the clubfoot. There are many studies showing no correlation between the radiographic appearance of the foot and long term function.In severe clubfoot, complete reduction of the extreme medial displacement of the navicular may not be possible by manipulation as the medial tarsal ligaments cannot be stretched sufficiently. Hence in infants, the medial ligaments should be gradually stretched as much as they will yield rather than cut, regardless of the whether a perfect anatomical reduction is obtained or not.

With the partially reduced navicular, the forefoot can be brought into proper alignment with the hind foot because the ligament in front of the navicular and the bifurcate ligament will yield, allowing lateral displacement and lateral angulation of the cuneiform and of the cuboid with proper positioning of the metatarsals. The calcaneus can be abducted sufficiently to bring the heel into a normal neutral position. This anatomically imperfect correction will provide good functional and cosmetic results avoiding many of the complications of major surgical release.

**Piranis method of clubfoot evaluation [39, 40].**

**Dr.Shafique Pirani** had identified 6 well described clinical signs of clubfoot. Three of these signs indicate primarily hind foot contracture (HFC) and three signs indicate primarily midfoot contracture (MFC)

The abnormal area on the involved foot is compared to the same area on the normal foot (if the deformity is not bilateral) and scored:-

0 = no deformity

0.5= moderate deformity

1.0= severe deformity

Hind foot contracture (HFC);

1. Posterior crease (PC)
2. Empty heel (EH)
3. Rigid equinus (RE)

Possible HFCS between 0 - 3

Mid foot contracture (MFC)

1. Curvature of lateral border of foot (CLB)
2. Medial crease (MC)
3. Lateral part of head of talus (LHT)

Possible MFCS between 0 - 3

**Method:**

The foot is evaluated every week during serial cast treatment. The infant is kept supine and is examined while feeding & relaxed.

**Look:**

CLB (Curved lateral border)

MC (Medial Crease)

PC (Posterior Crease)

**Feel:**

LHT (Lateral Head of Talus)

EH (Emptiness of Heel)

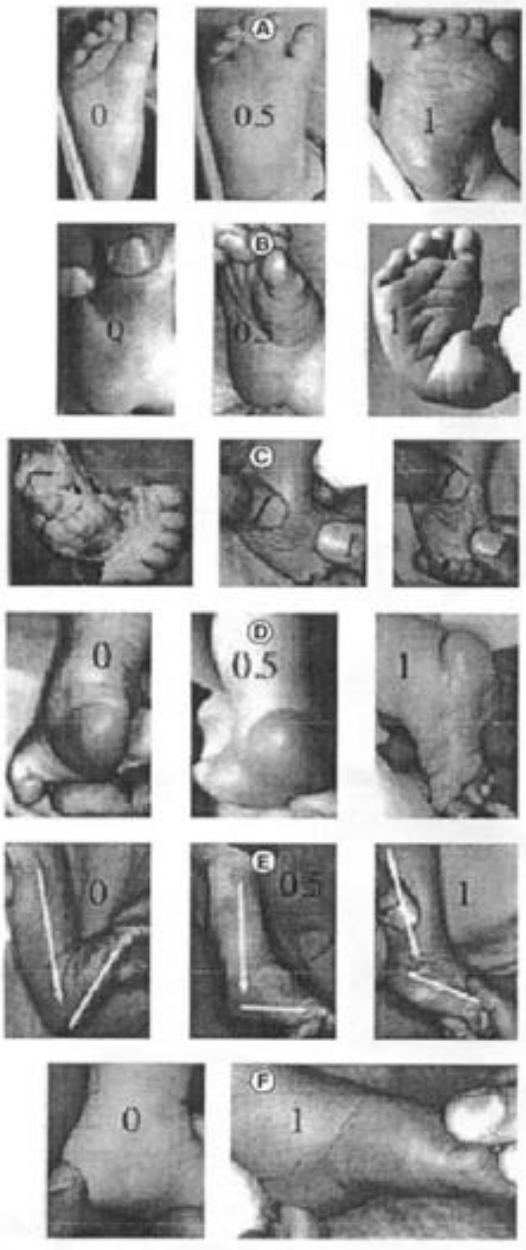
**Move:**

RE (Rigidity of Equinus)

# PIRANI SEVERITY SCORING

**Scores six clinical sings**

*0* *normal*
*0.5* *moderately abnormal*
*1* *severely abnormal*




**Midfoot score**

Three signs comprise the Midfoot Score (MS), grading the amount of midfoot deformity between 0 and 3.

***Curved Lateral border (A)***
***Medial crease (B)***
***Talar head coverage (C)***

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**Hindfoot score**

Three signs comprise the Hindfoot Score (HS), grading the amount of hindfoot deformity between 0 and 3

***Posterior crease (D)***
***Rigid equinus (E)***
***Empty heel (F)***

## Statistical analysis

The results were analyzed using SPSS 7.4 software.

T-Test paired samples analysis was done to find out the difference between the means of values.

# RESULTS

In this prospective study total 25 feet (21 patients) were treated by accelerated method and end point of casting treatment is taken as ten casts. 17 unilateral and 4 bilateral cases among 21 cases. Post casting treatment heel cord tenotomy was done if needed and started on bracing protocol.

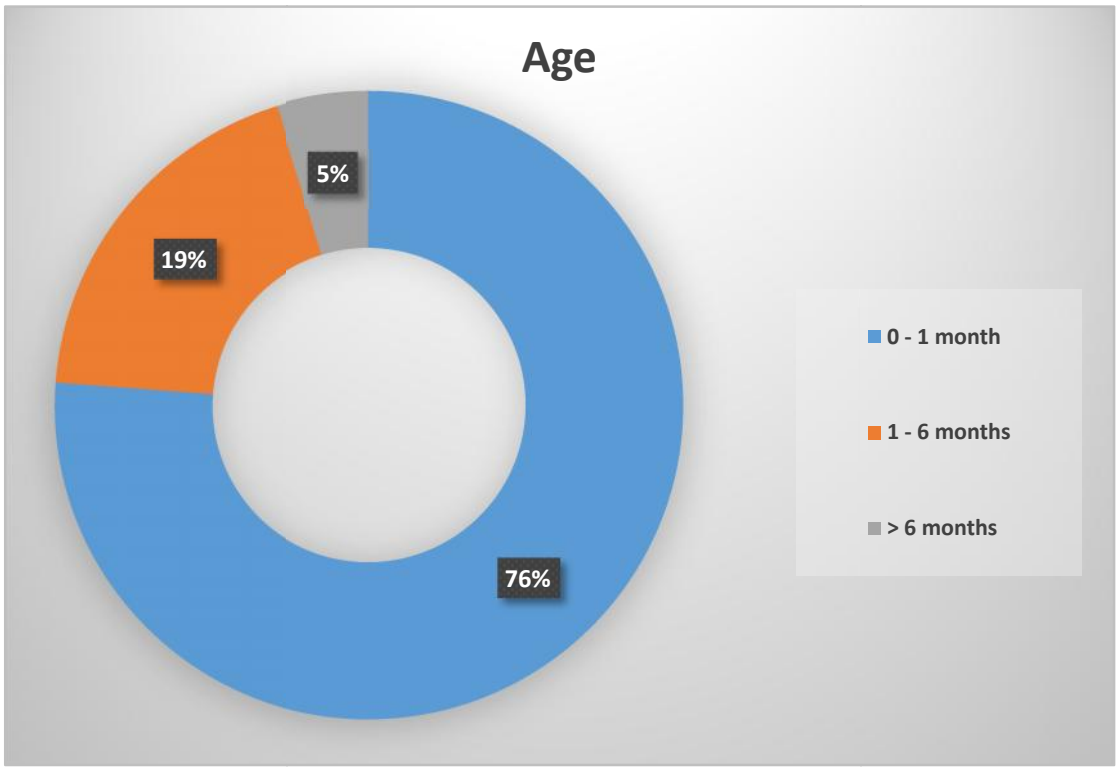
The mean age at start of treatment for 21patients (25feet) was 22 days (range2 days to 7 months).

The mean initial Pirani severity score for 37 feet was4.52. After correction by accelerated ponseti technique the final mean score at follow up was found to be 0.00and the mean change in score was found to be 4.52. This was analysed by the paired t test and the p value was <0.0005which is significant.

The mean value of Pirani score at months follow up was 0.02 which shows a change of 4.50 from the initial score. This change also has a p value of <0.0005 which is significant.

| Age | Frequency | Percent |
|---|---|---|
| 0–1months | 16 | 76 |
| 1 - 6 months | 4 | 19 |
| > 6 months | 1 | 5 |
| **Total** | **21** | **100** |

The most common age group was 0– 1 monthwith 16 (76%) patients and most of the patients (95%)were less than 6 months of age.



## Details of age of subjects in days

| | **Age in days** |
|---|---|
| Mean | 21 |
| Median | 5 |
| Minimum | 2 |
| Maximum | 210 |

Theminimumage–2days

The maximum age –21days (7 months).

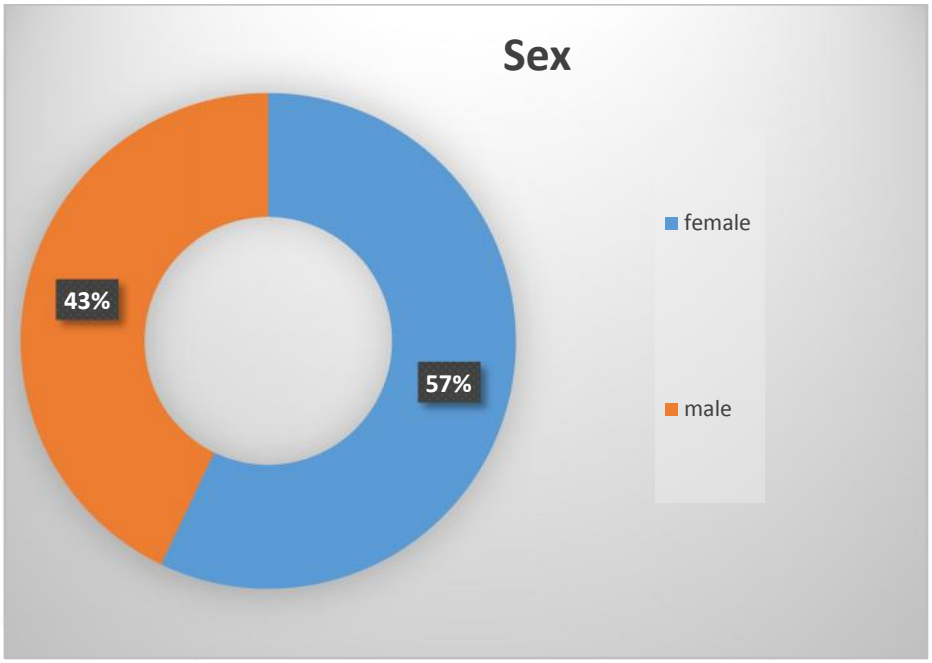
The mean age at initiation of treatment for the 21 patients was 21 days.

The median age at initiation of treatment for 21 patients was 5 days.

(Range 2 days–210 days).

**Distribution of Sex**

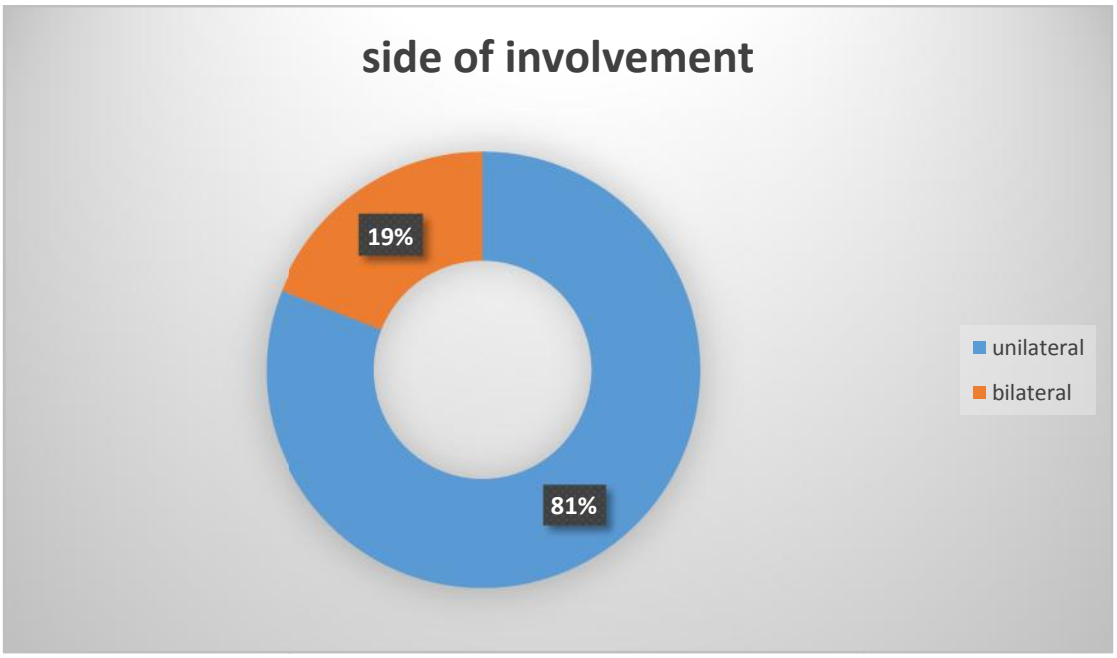
| Sex | Frequency | Percentage |
|---|---|---|
| Female | 12 | 57 |
| Male | 9 | 43 |
| Total | 21 | 100 |




There were 12 females (57 %) and 9 males (43 %). The female to male ratio was1.3:1

**Side of involvement**

| | Frequency | Percent |
|---|---|---|
| Bilateral | 4 | 19 |
| Unilateral | 17 | 81 |
| Total | 21 | 100 |




4 cases were bilateral (19%) and 17 (81 %) cases were unilateral. Right: Left ratio was found to be 4.3:1

## Correlation between side and sex

| | | unilateral | |
|---|---|---|---|
| | | **Right** | **left** |
| Male | 2 | 4 | 3 |
| Female | 2 | 5 | 5 |

## Details of Percutaneous tenotomy done

| **Tenotomy** | **Frequency** | **Percent** |
|---|---|---|
| Done | 7 | 33 |
| Not done | 14 | 67 |

24% of patients needed percutaneous tenotomy of tendo-chilies at the end of casting.

**Correlation between Percutaneous tenotomy and sex**

| **Tenotomy** | **Sex** | | **Total** |
|---|---|---|---|
| | **Female** | **Male** | |
| Done | 4 | 3 | 7 |
| Not done | 8 | 6 | 14 |
| Total | 12 | 9 | 21 |

33% of male patients and 33% of female patients needed percutaneous tenotomy.

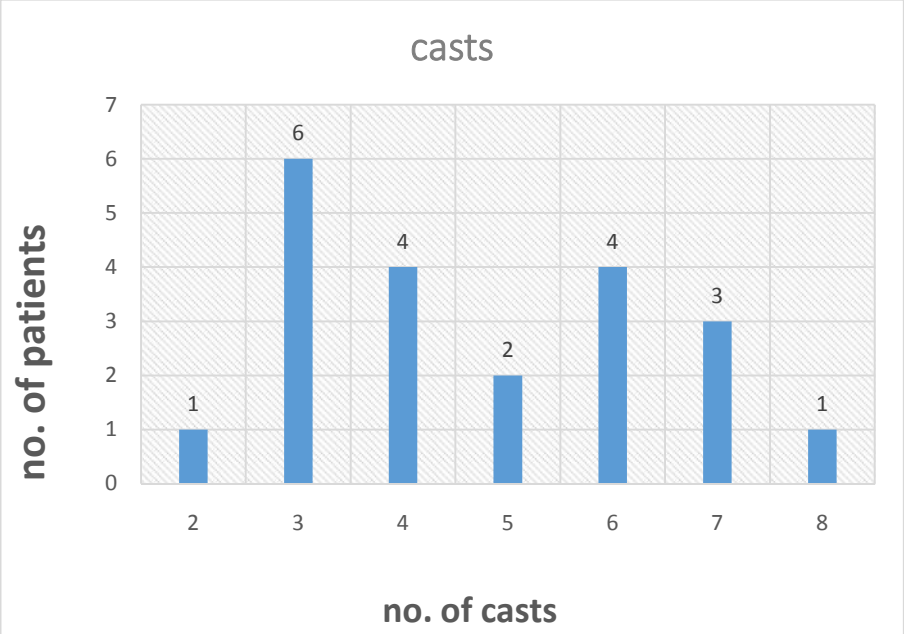
1. Mean Pirani score before treatment -4.52(range– 1.5– 6.0)
2. Mean Pirani score after treatment - 0.45 (range – 0.0 – 2.0)
3. Mean Pirani score at 6months follow-up -0.02(range–0–0.5)
4. Mean change in Pirani score 4.07 (before treatment and after treatment)

P value<0.0005(highly significant)

**Casts**

| No. of casts | No. of casts | Percent |
|---|---|---|
| 2 | 1 | 4.8 |
| 3 | 6 | 28.6 |
| 4 | 4 | 19.0 |
| 5 | 2 | 9.5 |
| 6 | 4 | 19.0 |
| 7 | 3 | 14.3 |
| 8 | 1 | 4.8 |
| total | 21 | 100 |

5. Total number of casts required for the study was 99 with a mean of 4.71.



No patient has undergone extensive surgery like postero-medial soft tissue release or bony procedures to correct the deformity.

Only one recurrence is recorded which was due to noncompliance towards brace. He was treated with manipulation and pop cast followed D-B splint.

There is no significant difference between the age and pirani score at start of treatment, end of treatment and follow up. (P value > 0.05)

# DISCUSSION

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

**Lloyd-Roberts** [41]wrote "clubfoot will doubtless continue to challenge the skill and ingenuity of orthopaedic surgeons, **Prof. Ignacio ponseti** [2]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 fibro elastic properties of the connective tissue and ligaments.so this

method does not aim at anatomical and radiological correction and can be evaluated critically on the basis of clinical correction.[2]

The longest published follow-up is the 30year follow-up of 45 patients treated with the **ponseti method of manipulation and casting** at the university of Iowa hospital and clinics between 1950 and 1967.[59]

**Highlights of this study are:**

Most clubfeet when treated shortly after birth, can be easily corrected by weekly twice manipulation and application of five or six plaster casts. (Ponseti method)

Accelerated ponseti method will significantly reduce the cast treatment time and is equally effective as standard ponseti method.

The timely and well treated clubfoot is compatible with normal active life.

This study was carried out on an outpatient basis at our institute from the period of OCTOBER 2011 – OCTOBER 2013 with 21 patients (25 feet) participating in the study.

**Sex incidence:**

There were 12 female and 9 female in our series with a male to female ratio of 1:1.3. The male: female ratio in Kite's [45]series was 2.07:1and in series of **Wyne Davis [44] was** 2.17: 1. In **Jose A. Morcuende et.al[46]** series male to female ratio was 2.02:1 .In P.**Harnett et.al[47]**series male to female ratio was 1:1, this study has smaller study population when compared to other studies. The ratio obtained from our study is quite different from the literature in age distribution. This difference may be due smaller study population.

**Laterality:**

As regards laterality, the ratio of bilateral to unilateral clubfoot is 1:4.25 (19 % bilateral and 81 % unilateral) which is in concordance with other series presented by workers like **Wyne Davis [44] (**44% bilateral and 56% unilateral**),** in Mckay (1983) series an incidence of unilateral to bilateral ratio 1:1.7,**P.Harnettet.al[47](** 52.5% bilateral and 47.5% unilateral**) , Jose A. Morcuende et.al[46] (** 38 % bilateral and 62 % unilateral**).**

**Associated congenital anomalies:**

In the present series out of 21 patients only one patient had congenital urogenital anomaly. **G.S.Vyas and Pradeep Verma (2004)**[48]in their series of 43 patients had 6 patients with other congenital anomalies with one patient having anal atresia, one patient with spina bifida, one patient with congenital dislocation of hip, one with umbilical hernia and two patients with hydrocephalus.

**Mital RL** [49] **(1988)** in his study of 67 cases observed 2 patients with Arthrogryposis multiplex congenita.

**Age:**

When the feet were divided on the basis of the age at first presentation, it was seen that a large proportion of patients seen were less than one month old and among them child less than a week old are more. The youngest patient included in this study was 2 days old and the eldest was 7 months old.

**Number of casts required vs Age:**

If we look at the age wise distribution it is obvious that most of the patients who had reported in first month of their life, all the patients both less than a month and more than a month showed no difference in

response i.e., both mid foot and hind foot scores got corrected and did so quickly (P > 0.05). The average number of casts given was 4.71.

**Pirani Scores Vs Number of Cast Required:**

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 were more amenable to correction and responded relatively early when compared to those with higher initial score 4.5 -6 ( i.e., more severe and more rigid deformity). The average number of cast application required to achieve full correction of the deformity in patients with Pirani score of 4.5 to 6.0 was 5.7 and the average number of casts required to achieve full correction of deformity in patients with Pirani score less than 4.5 are 3.1.

**Tenotomy:**

In our study 7 patients required percutaneous tenotomy of tendo achilles .usually by literature 80% of the clubfoot treated by ponseti method requires percutaneous tenotomy ,but the difference in our study may be due to early presentation of patients ( < week ) and faster change of casts. However due to smaller number of study population we are not able to conclude on it.

We performed the percutaneous tenotomy under general anaesthesia using strict aseptic precautions. There are reports of excessive bleeding with the procedure but we found no such complications in our series.

**Complications of cast treatment:**

The cast application in infants and neonates has to be done with utmost care and delicacy. This form of treatment can nonetheless give rise to following complications;

**Too tight cast**: this is potentially most dangerous complication if not identified early and followed by prompt removal of the cast.in our series, this complication is observed in 1 out of 99 cast applications. This complication needs proper patient counselling for early identification. All

Efforts were taken to ensure that the parents of each and every patient who leaves the clubfoot clinic after application of cast are explained thoroughly using layman language about this complication. They were taught to observe the colour of the toes and compare it with the other side, to look for swelling of toes and to bring the child immediately if he

or she is crying excessively or having one of the above signs. Importance of keeping limb elevated was also stressed.

**Excoriation of skin:**

A peculiar observation in neonates and infants in first 1-2 months was excoriation of skin. This could be prevented by application of powder over the delicate skin before application of the cast.

**Residual deformity and recurrence:**

Out of 21 patients we had one child with recurred deformity at 5 months follow-up due non-compliance towards brace for which two more corrective casting was done.

**Outcome of our study corroborates with the studies carried out by the following authors:**

**Wallace B Lehman [50] MD,** studied 50 patients with idiopathic clubfoot deformity treated by Ponseti protocol and reported over 90% of cases will require no other treatment except for percutaneous tenotomy of achilles tendon and almost similar outcome when compared with our study.

**John E Herzenberg[51] MD** showed 88% good to excellent results and 3 % recurrence in his series of 46 clubfoot treated by Ponseti method which correlates with the result of our study and the number of days in cast treatment was significantly less.

**Jose A. Morcuende et.al.**[46](2005) in their study by accelerated method of ponseti treatment stated that ponseti treatment is very effective in treating clubfoot deformity and the deformity can be corrected in shorter period time than standard method by decreasing the time interval between the manipulation and cast. The average number of casts required in their study was 4 casts which is coinciding with our result which is about 4.71 casts. However, the time interval between the cast used by them was 5 days, the result was corroborates with result of our study. (P> 0.05).

| | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| **No. of casting** | **21** | **4.7143** | **1.73617** | **.37886** |

| | Average no. casts in Morcuende et. al., study = 4 | | | | | |
|---|---|---|---|---|---|---|
| | t | df | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference | |
| | | | | | Lower | Upper |
| **No. of casting** | **1.885** | **20** | **0.074** | **0.7143** | **-.0760** | **1.5046** |

In a prospective study done by **P.Harnett et.al.**[47] using accelerated method of ponseti treatment the standard protocol of weekly once manipulation and charge of cast was accelerated to thrice a week. The median of number of casts required in this study was 5. The median baseline Pirani score was 5.5 and median pirani score after treatment was 0.5. Which was almost equal to the median number of casts and median baseline and after treatment Pirani score. ($P > 0.05$, difference is insignificant).

**NPar Tests median test (run test):**

**Before treatment:**

| | Before treatment |
|---|---|
| Median Pirani score (a) | 5.5000 |
| Total Cases | 21 |
| Number of Runs | 10 |
| Z | -.193 |
| Asymp. Sig. (2-tailed) | 0.847 |

**After treatment:**

| | After treatment |
|---|---|
| Median Pirani score(a) | 0.5000 |
| Total Cases | 21 |
| Number of Runs | 14 |
| Z | 0.908 |
| Asymp. Sig. (2-tailed) | 0.364 |

In another study done by **Rui Jiang Xu ,MD**[52] (2011) stated that, by making the weekly manipulation and casting protocol to twice a week

manipulation and casting, the correction attained was as effective as the standard method and significantly reduces the timeframe of casting treatment. In this study the average number of casts taken for the correction of deformity is 5, which was almost equal to the average number of casts of our study which is 4.71. (P> 0.05, difference is insignificant)

**T test:**

| | **No. of patients** | **Mean** | **Std. Deviation** | **Std. Error Mean** |
|---|---|---|---|---|
| **No. of casting** | **21** | **4.7143** | **1.73617** | **0.37886** |

| | **Average no. of casts in Rui Jiang Xu, MD study = 5** | | | | | |
|---|---|---|---|---|---|---|
| | t | df | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference | |
| | | | | | Lower | Upper |
| No.of casting | -.754 | 20 | 0.460 | -.2857 | -1.0760 | 0.5046 |

# CONCLUSION

**Based on above study we conclude that:**

1. Accelerated Ponseti method is an excellent conservative method of treatment of Congenital Talipes Equino varus which is safe and as effective as standard Ponseti method.
2. The patients who have lower Pirani score at initial presentation respond better and faster to the treatment as compared to those who have higher Pirani score at initial presentation.
3. Treatment must start at the earliest possible, and by accelerated method the casting time frame can be reduced significantly.
4. Compliance of parents and patient towards the treatment was better than the standard method, due to reduced casting time frame and there was no lack.

**AT PRESENTATION**

**CAVUS CORRECTION CAST**

**CAST IN ABDUCTION**

**AFTER CAST CORRECTION**

**TENDOACHILIES TENOTOMY**

**POST TENOTOMY CAST**

**BRACE MAINTAINENCE**

**1 YEAR FOLLOW UP**

# Clubfoot management protocol

**NAME:**

**AGE :** **SEX:** **IP .NO/OP. NO:**

**ADDRESS/PH.NO:**

**SIGNIFICANT BIRTH HISTORY:**

| **Date** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Day** | **0** | | | | | | | | | | | | | |
| **Cast no:** | **1 st cast** | | **2 nd cast** | | **3 rd cast** | | **4 rth cast** | | **5 th cast** | | **6 th cast** | | **7 th cast** | |
| **Pirani score** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** |
| | | | | | | | | | | | | | | |

**TENOTOMY PLAN: DATE : / / .**

**POST TENOTOMY CAST : WEEKS.**

**REVIEW DATE : / / .**

**BRACING PROTOCOL :**

**START DATE: / / .**

| **DAY** | **4 WEEKS** | **2 MONTHS** | **3 MONTHS** | **5 MONTHS** | **8 MONTHS** | **1 YEAR** | **1 ½ YEARS** | **2 YEARS** |
|---|---|---|---|---|---|---|---|---|
| **PIRANI SCORE** | | | | | | | | |
| **BRACE CHANGE IF ANY** | | | | | | | | |

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# Master chart

| S.No. | Name | Age | Sex | Side UL/BL | Pirani Severity score Before Rx | After Rx | No. of Casting | PT | PMSTR | FOLLOW UP |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MANIMEGLALAI | 40 days | M | R | 2.5 | 0.0 | 3 | N | N | 0 |
| 2 | SUDHARSHAN | 1 MON | M | B/L | 5.5/5.5 | 0 | 6 | N | N | 0 |
| 3 | SREE ANANYA | 20 DAYS | F | L | 4.0 | 1.5 | 4 | Y | N | 0 |
| 4 | GANAPATHY | 7 MON | M | L | 4.5 | 0.5 | 6 | N | N | 0.5 |
| 5 | B/O LATHIKA | 15DAYS | M | B/L | 6.0/6.0 | 2.0/1.5 | 8 | Y | N | 0 |
| 6 | B/OCHANDRAKALA | 2 DAYS | M | L | 5.5 | 1.0 | 7 | Y | N | 0 |
| 7 | B/O DHANALAXMI | 3 DAYS | F | R | 4.5/4.5 | 0/0 | 5 | N | N | 0 |
| 8 | B/O ANANDHI | 3 DAYS | F | B/L | 2.5 | 0 | 3 | N | N | 0 |
| 9 | B/O MANORANJANI | 2 DAYS | F | R | 5.5 | 0 | 4 | N | N | 0 |
| 10 | B/O SARITHA | 2 DAYS | F | B/L | 6.0/6.0 | 1/1 | 6 | Y | N | 0 |
| 11 | THARIKA | 42 DAYS | F | L | 2.5 | 0 | 3 | N | N | 0 |
| 12 | B/O SUMITHA | 2 DAYS | M | R | 1.5 | 0 | 2 | N | N | 0 |
| 13 | NAYANA PREETHI | 18 DAYS | F | L | 5.5 | 0.5 | 7 | N | N | 0 |
| 14 | B/O MARIAMMAL | 2 DAYS | M | R | 4.0 | 1.0 | 3 | Y | N | 0 |
| 15 | B/O SUDHA | 2 DAYS | F | R | 4.0 | 0.5 | 4 | N | N | 0 |
| 16 | B/O DIVYA | 45 DAYS | F | L | 2.0 | 0 | 3 | N | N | 0 |
| 17 | B/O GOWRI | 11 DAYS | M | R | 4.5 | 0.5 | 5 | N | N | 0 |
| 18 | B/O MANORANJANI | 2 DAYS | F | R | 5.5 | 0.5 | 4 | N | N | 0 |