

A PROSPECTIVE STUDY ON TREATMENT OF
CONGENITAL TALIPES EQUINO VARUS
DEFORMITY BY PONSETI'S CAST APPLICATION TECHNIQUE

By

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2017

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ABSTRACT

BACKGROUND:

Congenital Talipes Equino Varus (CTEV) is the most common congenital musculoskeletal birth defect with incidence of 1-5 per 1000 live births. It has been a problem for orthopaedic surgeons to treat a case CTEV since ancient times.

Many conservative treatment modalities have been described in literature of which the most popular are, that of Kite's method and Ponseti's method.

They were accepted as the primary modalities for the treatment of CTEV, which helped in reducing the requirement of the surgical modality, for correction of only rigid cases of CTEV.

Since the introduction of conservative treatment by Kite in the year 1937, only 50 % of the patients achieved a satisfactory outcome with conservative treatment alone. The rest of the cases required a soft tissue release or osteotomy for achieving correction.

Thus, Ponseti's casting technique which was first described in 1950, was adopted for the treatment of CTEV. It had upto 90% of success rate with manipulation and casting alone.

With the use of the Ponseti's technique, the number of patients who needed soft tissue release and other extensive surgical intervention for the treatment of CTEV deformity were reduced.

The incidence of the cases of CTEV being treated in hospitals or health centres have increased in recent years due to increased awareness among the general public.

But relapses or complications are often seen due to lack of understanding of the disease by parents or non-compliance to the procedure, as it requires regular follow ups and serial casting till correction is achieved.

This study was taken up to determine the success rate of Ponseti's method for CTEV treatment in the rural population as no study data is available in Kolar region for CTEV treated with the Ponseti's technique.

MATERIAL AND METHODS:

36 feet in 27 patients (18 Unilateral and 9 Bilateral) of Congenital Talipes Equino Varus deformity within age group of 0-2 years were treated using Ponseti's method of manipulation, with serial casting, with or without tendo achilles tenotomy at Department of Orthopaedics of RLJ Hospital attached to Sri Devaraj URS Medical College, Kolar.

The severity of foot deformity was assessed according to the grading system of Pirani score before, during and after the treatment. And the number of patients requiring tenotomy were noted. Denis-Brown Splinting of foot was done after final cast removal. All cases were followed up on a short-term basis of 6 months after removal of final cast.

RESULTS:

Out of 36 feet included in this study and with a follow up of 6 months post treatment with Ponseti's method; 33 cases (91.67%) had a successful outcome, 3 cases (8.33%) had failure. Out of 3 failures, 2 feet were rigid type and 1 foot had relapse due to non-compliance to Denis- Browne splinting.

INTERPRETATIONS AND CONCLUSIONS:

Correction of deformity in Congenital talipes equino varus with conservation management with Ponseti's method yields excellent results even in a rural population. And most of the cases do not require a surgical management. The relapse seen in the study during follow up was due to improper or irregular use of Denis Browne splint following the serial casting.

INTRODUCTION



INTRODUCTION

Congenital Talipes Equino Varus (CTEV) is the most common musculoskeletal birth defect with an incidence of 1 to 5 per 1000.¹

Abnormality of bone and soft tissues around the foot causes adduction, supination, varus, and equinus deformities of the foot.¹

CTEV is not self-healing, and if treatment is not started at an early age, the deformity will aggravate until adulthood and cause adverse effects on patient's lifestyle and day to day activities.²

The exact etiology of CTEV is not known thus, treatment of the disease is done as per deformity corrections.¹

The Goal of treatment of CTEV is to obtain a painless, plantigrade foot with near normal functional outcome with cosmetically acceptable foot without the requirement of an orthotics post treatment.^{1,2}

For years, surgeons used surgical modalities to treat the deformity and to bring the affected foot to a normal acceptable anatomical alignment. But they noticed that most of the patients had loss of mobility of the foot or complained of pain over the foot. Thus, the current treatment of choice for CTEV is conservative treatment as opposed to operative management.²

CTEV treatment should be started as soon as possible with preferably a conservative method of treatment. If left untreated can present with pain, rigidity, deformity, discomfort of the foot at a later aspect of life.¹

Conservative method of choice for treatment of clubfoot is controversial as various conservative methods of treatment are in practice with variable results.³

The surgical methods are often not preferred or are practiced with limitations due to complications of surgical management.³

Serial manipulation and casting of feet have been chosen as the ideal conservative management modality in the treatment of CTEV.¹

KITE's method of treatment started in 1937 was considered as an ideal method of treatment for a long period. With an average success rate 11 to 58%.⁴

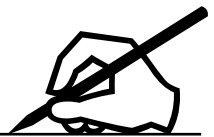
Ponseti described his casting technique in 1950. Laaveg and Ponseti later reported a 10- 27year followup of patients treated for Clubfoot as infants by his method. He reported about 90 % of patient satisfaction.

Since then Ponseti method of serial manipulation and casting has been in use, as it claims to have an average success rate of over 89%.⁴

Various studies on Ponseti's cases, with an average follow-up of upto 30 years, concluded that 78% of the patients achieved excellent or good functional and clinical outcomes.⁴

Ponseti technique, comprises of weekly manipulation and serial casting of the club foot and, if necessary, an Achilles tendon tenotomy was done to correct the equinus deformity. It has been chosen as the standard treatment of CTEV as many case can be treated conservatively itself.⁵

OBJECTIVES



OBJECTIVE OF STUDY

- To document the clinical profile of club foot- rigidity, laterality and severity.
- To assess the success rate and average duration required for correction with Ponseti's method.
- To document the number of relapse in a short term follow up of 6 months.

HISTORY

Congenital Talipes Equino Varus is a pathology which is known to mankind since ancient time.

This deformity is seen in paintings of ancient Egyptians tomb. Earliest description of the treatment of Congenital Talipes Equino Varus is seen in the ancient Indian texts at around 1000 B.C.⁶

Approximately in 400 B.C, Hippocrates described this congenital defect of foot and began to treat clubfoot. He gave ideas on how to treat the defect conservatively. He stressed on the importance of starting treatment as soon as possible after birth.⁶

He suggested using gentle and repeated manipulations with hands and then application of bandages to maintain the correct position of foot. Following the treatment, he also advised shoes which were specially made to maintain foot in correction.⁶

To an extent his methods of correction can be compared to modern day technique of conservatively correcting Congenital Talipes Equino Varus deformity of foot.⁶

In 1658 Arcanys, described his technique using two mechanical devices for correcting the deformities of clubfoot.

In 1803 Scarpas, described his ideas, which opposes the ideas of Hippocrates. He developed a technique of forceful manipulations of foot following which application of a shoe 'Scarpas shoe' was advised. But his method was not successful.⁶

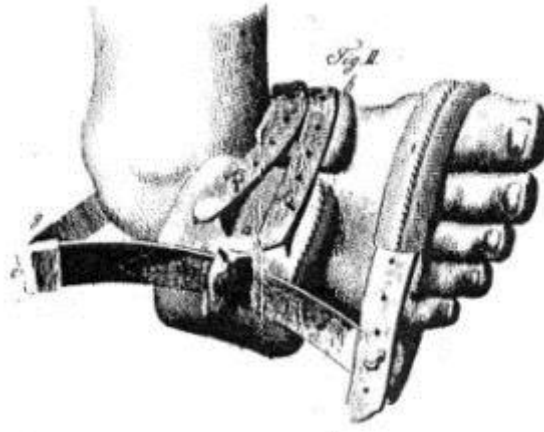


Fig1. Scarpa's shoe

In 1823, Delpech described tendoachilles tenotomy for achieving correction in a case of clubfoot. But the surgical method increased chances of infection or difficult wound healing. Later on, the methods of tenotomy were modified and were made less invasive.⁶

After 1830, many physicians gave contributions to the etiology and treatment of clubfoot, such as: Hugh Owen Thomas, Sir Robert Jones, Denis Browne, Michael Hoke, Kite, Ponseti, etc.⁶

Denis Browne, in the year 1937, advised full correction of the deformity of foot and stressed on the importance of maintaining the deformity correction. And thus, advised splinting with foot in valgus correction.⁷

Previously clubfoot was corrected by surgical modalities. Surgical correction included capsulotomy of the ankle and subtalar joints and also capsulotomy of talo-navicular and calcaneo-cuboid joints, along with lengthening of the Achilles tendon, tibialis posterior as required to achieve corrections, at approximately 1 year of life. And had poorer patient satisfaction in long term followups.⁵

Treatment of the deformity aims to obtain a plantigrade, pain-free, and cosmetically acceptable foot, with mobility close to normal, that does not require orthotics ¹.

It is widely accepted that clubfoot treatment should start as early as possible with a conservative method of treatment.¹

Conservative management modalities have also been advised in earlier literature, which included forceful manipulation and splinting of the foot to correct the deformities.⁶

The modern methods of conservative treatment involve gentle manipulations and series of casting of the foot and leg.¹

The commonest and well described techniques of reduction or correction of Clubfoot were described by: Kite and Ponseti.¹

Kite described his method of treatment in the year 1937, studies state the success rate with his method was about 90% for children below the age of 1 year old, but with this method in clinical practices, low correction and a high relapse rates were seen, with only 20% to 50% cases getting corrected conservatively were seen.¹

Ponseti described his technique in 1950, in which he achieved correction in 89% of cases of Clubfoot. Other studies done using his methods were able to get about 80% success rate with conservative method alone.¹

Recent studies done according to Ponseti's method have even achieved of about 98% of success rates.⁸

The difference between the Kite's and Ponseti's method is the point of application of counter pressure while manipulation.⁶

In the Kite method the point of counter pressure is the calcaneocuboid joint whereas in Ponseti's Method the talar head is the point of counter pressure.⁶

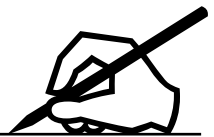
Currently Ponseti's method is the most favourable conservative treatment for Congenital talipes equinovarus deformity with minimal requirement for surgery and which is reserved for relapse or rigid cases only.⁶

Ponseti described as series of successive weekly casting of the foot followed by tendoachilles tenotomy if required and immobilisation of the foot in Denis brown splint for 3 months for about 23 hrs in a day, following which foot is immobilised in Denis brown splint during sleep till 4 years of age⁶.

In the 2000's Ponseti's technique gained popularity in major healthcare setups as the method of choice for treatment of CTEV⁶.

By 2014, most countries under united nations agreed and accepted the Ponseti's method of correction as the ideal method of CTEV correction.²

REVIEW OF LITERATURE



REVIEW OF LITERATURE

Amongst the first published literature on clubfoot was by Arcanys in 1658, described his technique using two mechanical devices in treating and correcting the deformity of foot.⁶

Scarpa in 1803, reported medial and plantar displacement of the navicular, cuboid, and calcaneus around the talus. He described that the displacement of the navicular and calcaneus produces a varus hindfoot, and the entire complex rests in equinus.⁶

Scarpa also contradicted the then prevailing Hippocrates principle of correction in clubfoot and advised forceful manipulations and use of a mechanical device known as Scarpas Shoes but his method never became popular in practice.⁶

Delpech et al in the year 1823, advised a new method of correction which included tendoachilles tenotomy to be done prior to correction of deformity. As it was a surgical procedure chances of infection of the wound was seen in some cases.⁶

The procedure of tenotomy is still in use but the method of correction has changed and has become less extensive thus reducing chance of infections.⁶

Michael Hoke (1874-1944), was the first physician to describe and use plaster of paris casts for treatment of CTEV.⁶

Denis Browne, in the year 1937, advised full correction of the deformity of foot and stressed on the importance of maintaining the deformity correction. And thus advised on splinting of the foot with foot in valgus correction.⁷

Kite in the year 1939 described a method of conservative treatment of clubfoot, he advised use of gradual manipulations and correction of deformity of the foot. He described the components of the deformity as A) Forefoot adduction B) Supination C)

Cavus D) Heel varus E) Equinus deformity. He advised sequential order of correction of adduction, supination, varus and equinus.⁶

Ponseti in 1950 in his study described a method similar to Kites method consisted of gradual and gentle manipulations with immobilisation in casts within the first days after birth or as early as possible. Manipulation and casting were performed every 7 days. The casts were applied above the knee as it prevents cast loosening and it also corrects the internal tibial torsion.⁶

In Kite's method the point of counter pressure was the calcaneocuboid joint and in Ponseti's Method pressure point is the talar head.⁶

Tendo achilles tenotomy was integral part of Ponseti's method, where it was required to treat equinus, unlike Kite's method which did not use tenotomy.

Denis Browne did study in 1937, and advised full correction of deformity and splinting of the foot. He advised separate splinting of both the foot individually and a sole plate directing the foot in valgus. He also advised the continuous use of the splint as the discontinued use may cause relapse.⁷

Hanan Waisbrod in 1973, did anatomical study on the deformities of Clubfoot and stated that it is the deformity of the talus, and specially the change in the declination angle as the major cause of Deformity in Clubfoot.⁹

Wallace B. Lehman, Dan Atar, Alfred D. Grant, Allan M. Strongwater in 1990, did a study on surgical approach and long-term results in Clubfoot. The range of poor results in clubfoot surgery is 13-50% (average:25%). They suggested that cases who underwent surgical treatment often require a revision surgery. They found that the cause of revision surgery was due to incomplete initial clubfoot release or overcorrection of deformities.¹⁰

Kohei Fukuhara, Georg Schollmeier and Hans K. Uthoff in 1994 did a study on, the pathogenesis of clubfoot. They suggested that Myofibroblast like cells present in ligaments caused contractions of foot and thus deformity of the feet.¹¹

Z. Feldbrin, et.al did a study done in 1995 on muscle imbalance in the aetiology of Idiopathic club foot. They studied electro myographies of leg for cases affected with clubfoot and normal foot. They found pathological electrophysiological findings were found in 66% of conservatively-treated patients. They concluded pathological findings in electromyographies were related to the severity of the deformity of the foot and normal studies were related to good prognosis post treatment. Thus, stating that muscle imbalance as an etiological factor for CTEV.¹²

Hiroataka Sano, et.al in 1998 did a study on Pathogenesis of soft-tissue contracture in clubfoot. In which they studied biopsy samples from 41 CTEV cases and 12 normal cadavers of deltoid ligament. They suggested the presence of Vimentin in the Ligaments of CTEV cases which maybe the cause for the contracture of the foot causing CTEV.¹³

A study done in 2001, compared, various classification methods of CTEV available to help assess the clinical outcome and duration of treatment of CTEV. They compared Ponseti and Smoley's method, Harrold and Walker's method, Catterall's method and Diméglio's method. Following which the authors concluded that ideal classification system should be reliable and reproducible, should be simple enough to apply in practice, should be able to assess the flexibility or rigidity of the deformity and should be able to usable before, during and after treatment, in children of all ages, which was not possible in the compared classification systems.¹⁴

Ignacio Ponseti in a study in 2001 on Relapsing clubfoot concluded that, of the 90 cases he had treated 14 cases presented with relapse. Most of the relapses could be

corrected with serial casting. In relapse cases, the foot is maintained in cast with abduction and as much dorsiflexion as possible. And casts are changed every 14 days. Most cases get corrected by 4 to 6 weeks, if required percutaneous tenotomy can be done. In his study, only 4 cases required surgical intervention in relapse cases treated by his method.¹⁵

S Suresh, A. Ahmed and VK Sharma in 2003 did a study on the role of Joshi's external stabilization system in treatment of CTEV. The Joshi's external stabilization system was used as a correction modality of the rigid or neglected CTEV. It works on a similar principle as Ilizarov external fixator, that is gradual distraction to correct the deformity of foot. In this study, they treated the deformity in 44 cases with the use of Joshi's external stabilization system. They found that 77% of rigid or resistant cases of CTEV treated with the Joshi's external stabilization system had excellent outcome and 13% of cases had a good outcome. And they concluded that Joshi's external stabilization system provides excellent outcome in cases of rigid type of CTEV.¹⁶

E. Ippolito, et.al., did a Study in 2004 to assess, the influence of treatment on the pathology of club foot. CT scans were done at maturity for cases treated for clubfoot in the study. They had taken 2 groups in the study. First group with an average age of 25 yrs treated with manipulation, above knee castings and an extensive posteromedial release. Second group consisted of patients with an average age of 19 years, treated with manipulations, castings and minimal posterior release as per Ponseti's technique. They concluded that the 2nd group of patients had a better clinical as well as radiological outcome even at maturity.¹⁷

Mihir M. Thacker, David M. Scher, in 2005 did a study to evaluate the importance of a foot abduction orthosis following the treatment by Ponseti's method stated and that a proper use of foot abduction orthosis is absolutely essential is achieving a favourable outcome following a conservative treatment of a congenital talipes equino varus using Ponseti's method. The foot abduction orthosis consists of two shoes and connecting bar, which maintains the foot in 15 degrees dorsiflexion and 70 degrees of abduction.¹⁸



Fig2. Foot abduction orthosis

P. J. Dyer, N. Davis in 2006 did a study to understand the role of pirani score of a foot in CTEV. They stated that scoring method should be reliable, reproducible and help in predicting appropriate treatment. They stated that Pirani scoring system devised on six clinical signs of contracture are grade as- 0, 0.5, 1 is an easy and reliable method of scoring of the feet. Where 0= no deformity, 0.5= moderate deformity, 1= severe deformity. They concluded that, Pirani scoring is very useful as it helps in estimating severity of deformity in CTEV, an average number of casts needed, need for tenotomy and duration of treatment.⁸

M. Changulani, et.al. in 2006 did a study on, treatment of idiopathic club foot using the Ponseti method and concluded that cases of CTEV treated with Ponsetis technique

have excellent outcomes. They noticed about 32% of cases with relapses in their study and they commented that relapses are seen in cases with irregular or improper use of Denis Browne splint post treatment with Ponseti's casts.¹⁹

Alok Sud, Akshay Tiwari, Deep Sharma and Sudhir Kapoor did a randomised study in 2008 Comparing Ponseti's and Kite's method for treatment of CTEV. Patients were randomised into 2 groups and 36 feet were treated with Ponseti's method and 31 feet were treated by Kite method. Of the two conservative methods of correction, they found that with the Ponseti group, 33 (91.7%) feet achieved correction, 3 feet required surgical correction and 7 relapses which were corrected conservatively. While in the Kite group, 21 (67.7%) feet achieved correction, 10 feet required surgical correction and 8 feet had relapse of which only 4 could be treated conservatively. They concluded that Ponseti's method is superior to Kite's method²⁰.

Mazhar Abbas, et.al, in 2008 did a clinical study of Congenital talipes equino varus treated by Ponseti's method. They stated with this procedure, about 95% correction rate can be expected and there is no requirement for posteromedial soft tissue release in most cases³.

Richard A. Brand in 2009 did a study on etiology and treatment of clubfoot done by Ponseti, method, at the end of study he advised conservative management with manipulations for treatment of children with CTEV. He further noted that the patients treated with surgical methods had rigid, weak and painful foot in follow ups, while the recurrence of the deformity with conservative treatment is usually mild.²¹

Ignacio V. Ponseti, Eugene N. Smoley in 2009 did a Study on Congenital Club Foot. They concluded that the treatment of severe clubfoot deformities are difficult and should be treated as early as possible as the bones are mostly cartilaginous, ligaments and joint capsules are lax. They also found that the correction can be improved by tendoachilles tenotomy. In their study 94 patients were treated and tendoachilles tenotomy was done for 53 cases. With no cases requiring bony procedure in their study, the outcome was favourable in most cases.²²

In their study in 2009, Matthew B. Dobbs, Christina A. Gurnett, suggested that exact genetic etiology of clubfoot may be helpful in determining both prognosis and the selection of appropriate treatment methods in patients and that a conservative method is advisable rather than a surgical method. They also commented that the exact etiology of CTEV is not known but it may be related to the genetic variation of PITX1 gene which is involved in lower limb development.²³

Raju Rijal, Bikram Prasad Shrestha, et.al in 2010 did a Comparative study between Ponseti's and Kite's method done, sixty feet were studied of which 30 were treated with Ponseti method and 30 by Kites method. They concluded, that Pirani scores of feet treated with Ponseti's method reduce faster than the feet treated by Kite's method⁴.

Marcos Almeida Matos, Luiz Antonio Alcantara de Oliveira in 2010 did a meta-analytic study of comparison between Ponseti's and Kite's method and stated, that CTEV is the most common musculoskeletal birth defect, with an incidence of 1-5 per 1000 live births. They also stated in Congenital talipes equino varus treatment should start as early in life with a conservative mode of treatment. In a study by Ippolito, of

the 47 feet treated with Kites method, 16 cases had failure to the procedure and 22 feet had relapse at 3 years followup, whereas in Ponseti's group of the 49 cases 5 had failure and 20 had relapse after 3 years. Sud et al had 33 cases of success of the 36 feet in Ponseti's method. And 21 feet had success of the 31 feet treated with kite's method. After Meta-analysis of various studies, they concluded that in Kite's method relapse rates were high and patients often needed surgical correction, while with Ponseti's technique correction rates were high¹.

C. R. Jowett, J. A. Morcuende, M. Ramachandran in 2011 did a systematic review of studies where Congenital talipes equino varus was treated by Ponseti method, and stated that, the current best treatment of Congenital talipes equino varus is Ponseti's method with minor adjustments, such as hyperabduction of the foot in final cast and bracing for 4 years after final cast removal²⁴.

Catherine M. Duffy, Jose J. Salazar, Lee Humphreys and Brona C. McDowell in year 2013 did a comparative study between surgical method and Ponseti conservative treatment method for treatment of Congenital talipes equino varus, 31 feet were treated surgically and 42 feet with Ponseti's approach. They concluded that with the use of Ponseti's method patients required fewer and less-invasive operations. They also concluded with the use of Ponseti's technique there was also overall gait improvement and parent satisfaction⁵.

In their study in 2013, on CTEV management with Ponseti's management, V. Pavone, G. Testa, L. Costarella, P. Pavone, G. Sessa in 2013, they studied 82 cases or 114 feet in which they achieved about 96% of success rates. They stated that Bracing (Denis Browne splint) of foot after correction with casts is important part of the treatment as

it prevents relapse. Poor compliance with Denis Browne splint was the major cause for failure of treatment in their study²⁵.

Fernandes RMP, et.al.in the year 2015 did a study on Surgical treatment of neglected clubfoot using external fixator and advised that external fixator use for treatment of a case of neglected or adult clubfoot is an excellent mode of treatment as it provided satisfactory outcome in about 90% cases.²⁶

M.A. Khan, M.A. Chinoy, R. Moosa, K. Ahmed in 2016 did a study on Significance of Pirani score at bracing- implications for recognizing a corrected clubfoot. They suggested Pirani score is helpful in predicting the course of treatment and the likely number of casts required to correct the deformity. It also predicts the need for tenotomy in the patient. And concluded that a corrected clubfoot may not have a Pirani score of zero in all patients.²⁷

Saurabh Jain, Anand Ajmera, Mahendra Solanki, Alok Verma in 2017 did a study with 5 orthopaedic surgeons to assess inter-observer variability in Pirani clubfoot severity scoring system between the orthopaedic surgeons and stated that the Pirani scoring system and got substantial reliability in assessing the clubfoot deformity²⁸.

ANATOMY ²⁹

It is important to understand the normal anatomy of foot and ankle to understand the deformities in club foot.

TARSAL BONES

Seven bones of the tarsus make up the posterior half of the foot.

The tarsal bones are arranged in proximal and distal rows, but an additional bone (navicular) is interposed between the two rows on the medial side.

The proximal row comprises the talus and the calcaneus. The talus lies above the calcaneus, but the long axis is directed forwards, medially and downwards, and its anterior end or head is medial to the calcaneus, though at a higher level.

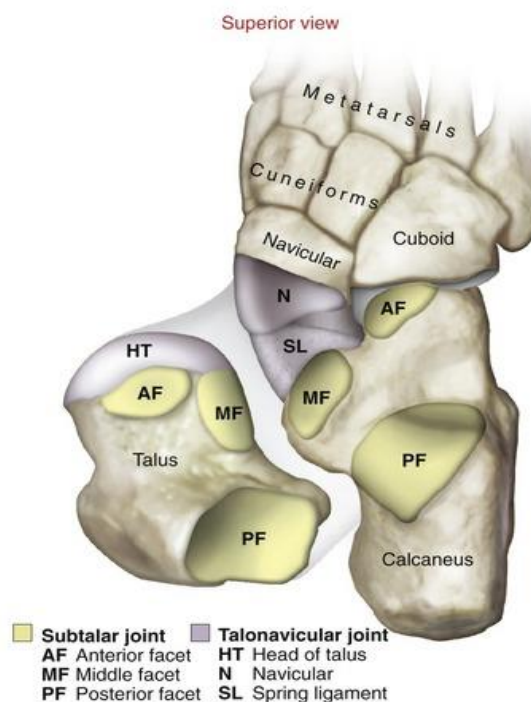


Figure 3: TARSAL BONES

The distal row contains from the medial to the lateral side- the medial cuneiform, intermediate cuneiform, lateral cuneiform and cuboid.

These lie side by side and together contribute to the formation of a transverse arch, which are convex dorsally.

On the medial side, the navicular bone is interposed between the head of the talus and the three cuneiforms.

Laterally the calcaneus articulates with the cuboid.

Talus

It is the 2nd largest tarsal bone. It is an irregular bone without any muscle attachment, and is covered by articular cartilage except for the attachments of ligaments.

It has three parts – 1. Body 2. Neck 3. Head.

The body has three articular surfaces known as trochlea.

The superior articular surface of talus is wider anteriorly than posterior from side to side.

Being broader anteriorly, it is wedge shaped.

On the posterior aspect of talus, a groove directs the tendon of flexor hallucis longus medially.

Initially in the early age, the groove is shallow, but later as the age advances the groove becomes deeper.

The lateral tuberosity on the lateral aspect of the groove gives attachment to the talofibular ligament.

Inferior surface of talus has a groove over similar groove of calcaneum. This is called tarsal canal and it contains talocalcaneal interosseus ligament.

The head anteriorly has articular surface for navicular and inferiorly it has three articular facets for calcaneum.

Calcaneus

It is the largest of all tarsal bones. Calcaneum articulates with talus and cuboid. It has three articular facets superiorly for talus. Forming three joints; anterior, middle and posterior talocalcaneal joints. Anterior and middle joint collectively called as anterior talocalcaneal joint.

The capsule of the anterior and posterior joint is divided by the calcaneal sulcus, which makes sinus tarsi and contains ligament and neurovascular structures.

On the medial border of calcaneus, there is a horizontal eminence protruding upwards, is called sustentaculum tali. It supports talar head and neck. It is located under the middle articular facet of talus.

It provides attachments to fibres of tibialis posterior, deltoid ligament, spring ligament (calcaneo-navicular ligament) and acts as pulley for flexor hallucis longus. The long axis of calcaneus is directed forwards upwards and laterally.

Navicular

It's a boat shaped bone and is located between head of talus and three cuneiform bones.

It's convex surface has three articular facets for three cuneiform bones.

It forms a ball and socket type of joint with talus. Its medial tuberosity gives attachment to the tibialis posterior tendon.

Cuboid

It's a cube shaped bone and has three articular surfaces for calcaneus, 4th and 5th metatarsals and to the lateral cuneiform. It is firmly placed between the bones by which it articulates, and it's movements are mainly with calcaneus.

Cuneiform bones

These are wedge shaped bones, arranged in the distal rows of tarsal bones.

Proximally they articulate with the navicular and distally they articulate with the first three metatarsal bones.

LIGAMENTS²⁹

The interosseous and capsular ligaments bind all the bones of the foot together and these ligaments take very little part in the maintenance of the arches.

1. The Plantar Calcaneonavicular Ligament (Spring Ligament)

It is a broad thick band extending from the anterior margin of sustentaculum tali to the plantar surface of the navicular bone.

The anterior fibers of the deltoid ligament are inserted into the superior border of the spring ligament. In clubfoot there is blending of these ligaments with talo-navicular ligaments to form a Fibrous mass called the Parker's capsule (Jones & Lovett). This ligament supports the medial arch.

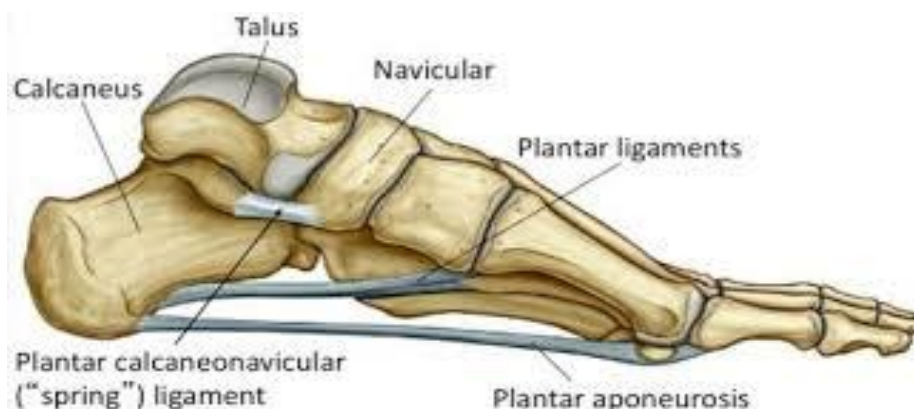


FIG 4 : Spring ligament of foot

2. The Long Plantar Ligament

It is a long, strong band and has wide attachment on the plantar surface of the calcaneum in front of the medial and lateral tubercles. It extends forwards to be attached to both lips of the groove on the cuboid. Morphologically it represents the divorced tendon of gastrocnemius.

3. The Short Plantar Ligament

It is a wide band composed of strong fibers binding the calcaneum and cuboid and lies between the long plantar ligament and cuboid supporting the lateral arch.

4. The Deep Transverse Ligaments

These are four in number. They are short, wide and flattened fibrous bands connecting the plantar ligaments of the adjacent metatarsophalangeal joints to each other.

They support the transverse arch of the foot and prevent broadening of the metatarsal heads.

5. The Plantar Aponeurosis

It is of great strength and is divided into medial, intermediate and lateral portions. The posterior end of the intermediate portion is narrow and is attached to the medial tubercle of the plantar surface of the calcaneum.

It expands as it passes forwards, and near the heads of the metatarsals splits into five processes, which proceed towards the toes and end in the fibrous sheaths covering the flexors of the toes.

The lateral and medial portions are thin bands and lateral being much thick behind. It acts like a tie beam of a roof and supports the longitudinal arch.

THE ANKLE JOINT

The ankle joint is a hinged synovial joint with plantar flexion and dorsiflexion, as the primary movements occurring at the joint.

It is formed by lower end of tibia, medial malleolus, lateral malleolus. The articular surface of distal tibia and fibula form a deep recess for the body of talus known as Mortise.

Laterally, three ligaments that stabilize the ankle joint.

1. Anterior talofibular,
2. Calcaneofibular ligament
3. Posterior talofibular ligament

Anterior talofibular ligament is attached posteriorly to the anterior border of the lateral malleolus and anteriorly to the neck of the talus and lateral articular facet.

Calcaneofibular ligament is attached superiorly to the tip of the lateral malleolus, extends deep to the peroneal tendons, and inserts inferiorly on a tubercle on the lateral surface of the calcaneus and is the only extracapsular lateral ligament of ankle.

Posterior talofibular ligament is attached anteriorly to the distal fossa of the fibula to the lateral tubercle on the posterior talar process.

Medially the ankle is stabilized, from anterior and posteriorly by strong, flat, triangular deltoid ligament.

It consisting of five components:

- A) Two deep components- The anterior and posterior deep tibiotalar ligaments, attaches to the under surface of the medial malleolus and the non articular part of medial talar surface.

B) Three superficial components- The tibionavicular component anteriorly, the tibiocalcaneal component in the middle and posteriorly the posterior tibiotalar component.

The posterior deep tibiotalar ligament is the strongest of the deltoid complex.

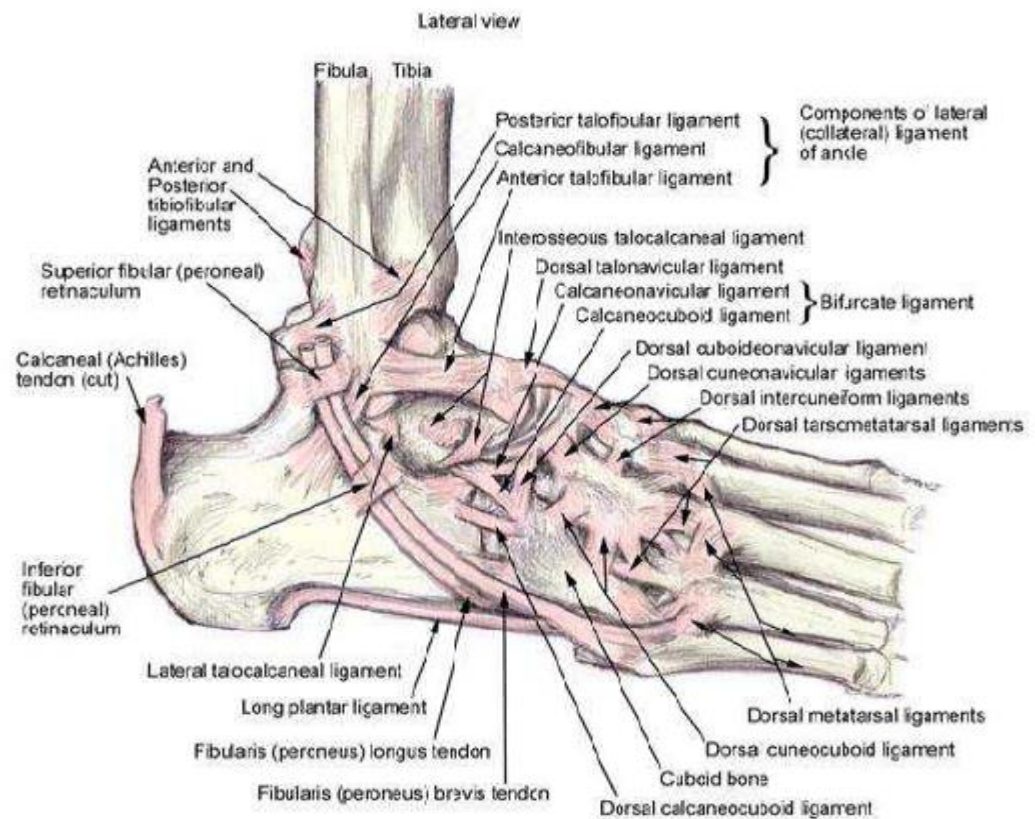


Figure 5: Lateral aspect of ankle

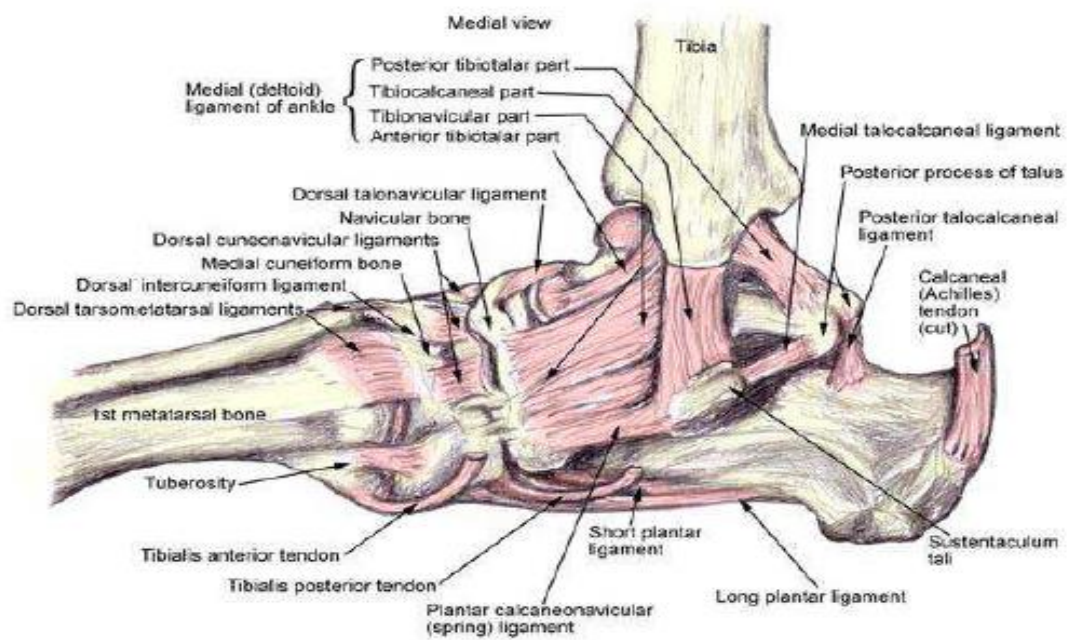


Figure 6: Medial aspect of ankle

The distal tibial and fibular syndesmosis is maintained by 4 components, they are:

- a) Anterior inferior tibiofibular ligament
- b) Posterior inferior tibiofibular ligament
- c) Inferior transverse tibiofibular ligament
- d) Interosseous tibiofibular ligament

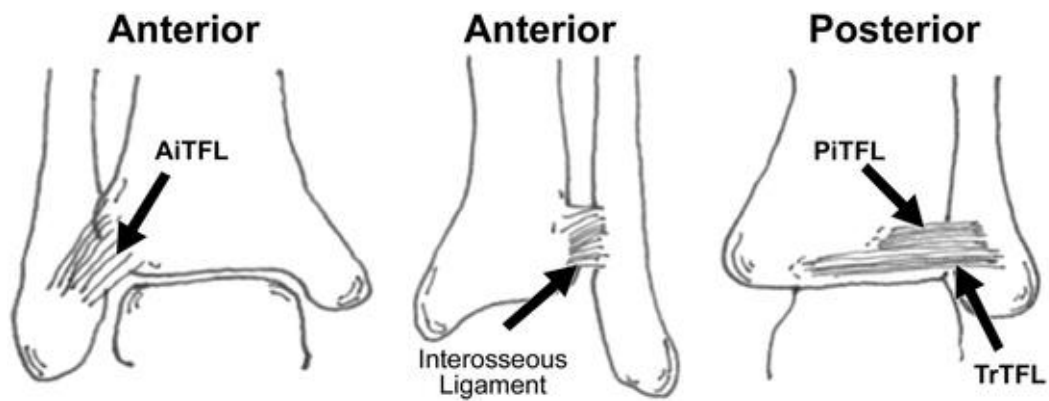


Figure 7. The distal tibial and fibular syndesmosis (AiTFL- Anterior inferior tibiofibular ligament, PiTFL- Posterior inferior tibiofibular ligament, TrTFL- Inferior transverse tibiofibular ligament)

The anterior inferior tibiofibular ligament attaches from the anterior tibial tubercle medially and extends inferior and lateral, and inserts on the anterior fibula.

The posterior inferior tibiofibular ligament is the strongest component, it runs along a similar course to the anterior inferior tibiofibular ligament.

The inferior transverse tibiofibular ligament lies deep and inferior to the posterior inferior tibiofibular ligament. On the anterior aspect, the inferior transverse tibiofibular ligament forms a labrum that articulates with the posterolateral talus.

The interosseous tibiofibular ligament attaches to the contiguous rough surfaces of the tibia and fibula and is continuous with the interosseous membrane proximally.

With dorsiflexion of the ankle, the syndesmosis of distal tibia and fibula allows the fibula to translate, rotate, and proximally migrate.

MUSCLES²⁹

Extrinsic Muscles

Extrinsic muscles are two, the gastrocnemius and soleus, collectively called as triceps surae. They are the chief plantar flexors of the foot. The insertion is by a common tendon, the tendoachilles. It is inserted on the posterior aspect of calcaneus on the tuberosity, which is placed slightly medially. So, these muscle contractions cause plantar flexion as well as little inversion of foot.

Flexor Hallucis Longus

This muscle originates from the lower 3rd of posterior surface of fibula and interosseus membrane. It is inserted over proximal phalanx of great toe.

Flexor Digitorum Longus

This originates from the posterior surface of tibia and passes behind the medial malleolus behind the tendon of tibialis posterior in separate tunnel. Distally it is joined by the quadratus plantar, and divides into four tendons which insert on the terminal phalanges.

Tendons of Flexor hallucis longus and flexor digitorum longus together form the Henry's knot at the level of the navicular. With the Flexor hallucis longus tendon going above the tendon of flexor digitorum longus.

Tibialis Posterior

Tibialis posterior is the chief adductor, inverter and flexor of foot. It originates from the posteromedial surface of the tibia, interosseus membrane and corresponding surface of fibula.

It passes posterior to medial malleolus and anterior to the tendon of flexor hallucis longus, in separate tunnel. It has got insertion on tarsal and metatarsal bones. But it is mainly inserted into the tuberosity of navicular bone, cuneiform, metatarsal base, spring ligament and sustentaculum tali. It works by making medial malleolus as fulcrum and it pulls the navicular medially and downwards.

Tibialis Anterior

It originates from the anterolateral surface of the tibia and passes below the extensor retinaculum and inserted into the base of first metatarsal and medial cuneiform. It dorsiflexes and inverts the foot.

Peroneus Muscles

Peroneus longus and brevis originate from the lateral surface of the fibula and its tendon passes posterior to the lateral malleolus. Peroneus longus turns medially to get inserted into the base of first metatarsal and the first cuneiform. Peroneus brevis gets inserted into the base of first metatarsal. These are the chief pronators of foot and plantar flexes the foot.

Intrinsic Muscles

These are the chief muscles which cause the cavus deformity of foot in CTEV. The abductor hallucis, flexor digitorum brevis, abductor digiti quinti and quadratus plantae (flexor accessories) has a common mass of muscle that arises in several successive layers from the medial and plantar surface of the tuberosity of the calcaneus and the plantar aponeurosis.

Plantar muscles of foot are in 4 layers-

1st layer: -

Abductor Hallucis

Flexor Digitorum brevis

Abductor digiti minimi

2nd layer: -

Flexor tendon sheath

Flexor digitorum accessories

Lumbrical muscles

3rd layer: -

Flexor hallucis brevis

Adductor Hallucis

Flexor digiti minimi brevis

4th layer: -

Dorsal interossei

Plantar interossei

Extensor muscles of foot: -

Extensor digitorum brevis and

Extensor hallucis brevis

OSSIFICATION CENTRES FOR THE TARSAL AND METATARSALS BONES²⁹

Talus: The talus ossifies from one centre which appears during the sixth month of intrauterine life.

Calcaneum: It ossifies from one primary and one secondary centre. The primary centre appears during the 3rd month of IUL. The secondary centre appears between 6-8 yrs to form a scale like epiphysis on the posterior surface, which fuses with the rest of the bone by 14-16 yrs.

Navicular: It ossifies from one centre which appears during the 3rd year of life.

Cuneiform: Each cuneiform bone ossifies from one centre, which appears during the first year in the lateral cuneiform, during the 2nd year in the medial cuneiform and during the 3rd year in the intermediate cuneiform bone.

Cuboid: The cuboid bone ossifies from one centre which appears just before birth.

Metatarsals: Each metatarsal bone ossifies from one primary and one secondary centre. The primary centre appears in the shaft during the 10th week of intrauterine life in the 1st metatarsal and during the 9th week of foetal life in the rest of the metatarsal.

A secondary centre appears for the base of the 1st metatarsal during the 3rd year and for the head of the other metatarsal between 3-4 years. All the secondary centres unite with the shaft by 17-20 years.

A separate centre for the tuberosity of the 5th metatarsal bone may be present. Most of the bones in the age group 0 to 3 years are cartilaginous and hence the deformities in clubfoot are mainly because of soft tissue contractures, which need to be given priority in correction.

PATHOANATOMY³⁰

Descriptions of the pathologic anatomy in clubfoot can be found in some of the earliest orthopaedic writings and continue to be essentially correct today, even as we have more sophisticated methods of imaging to quantitate that deformity.

Scarpa in 1803 reported medial and plantar displacement of the navicular, cuboid, and calcaneus around the talus. Displacement of the navicular and calcaneus produces an inverted or varus hindfoot, and the entire complex rests in equinus. Contracture of the soft tissues (ligaments, joint capsules, and tendons) maintains this pathologic malalignment of joints, described as equinovarus.

Scarpa, Adams in 1866, and Elmslie in 1920, did not implicate the talus as the main pathologic structure but emphasized on the midtarsal subluxation the navicular and cuboid displaced medially, with plantar and medial rotation of the calcaneus.

Deformity of the talar body and neck has been described in the more recent literature based on intraoperative observations and imaging studies.

Deformity in the talus itself includes medial and plantar deviation of the anterior end, with a short talar neck projecting medially from a dysmorphic, small body that is poorly placed within the ankle joint. The talar neck-body declination angle is decreased, with the neck axis approximating 90 degrees to the axis of the body as compared with the normal 150 to 160 degrees.

On the inferior aspect of the talus, the anterior and medial facets of the subtalar joint are absent, fused, or significantly misshapen, so the overall impression of talar development is consistent with the proposed primary cartilaginous defect.

Intraosseous deformity in the calcaneus, navicular, and cuboid, though similar to the dysplasia of the talus, is usually much less severe.

The contour of the calcaneus, is generally normal, although the calcaneus is small. The sustentaculum tali is usually underdeveloped, consistent with dysplasia of the talar facets above, and the anterior articular surface of the calcaneus is medially deviated and deformed because of the interosseous deformity of the calcaneocuboid joint.

Both the navicular and the cuboid have normal shapes and are misshapen only by interosseous relationships with the talus and calcaneus.

The medial tuberosity of the navicular is hypertrophied as a result of the excessively thick ligamentous structure tethering the navicular to the medial malleolus and calcaneus.

Tibial torsion can exist in the presence of clubfoot but is generally unusual. The intraarticular (interosseous) deformity is known as medial, or internal, spin. This deformity, involves the talus and the calcaneus within the mortise. The significantly dysmorphic talus was found to have a neck-body axis of 60 degrees. More important, the talar neck was found to be internally rotated 45 degrees relative to the tibia-fibula axis (ankle mortise), whereas the calcaneus was internally rotated 22 degrees. Both these rotations were approximately 20 degrees more than normal.

The talus in cases of clubfoot appeared to be externally rotated within the mortise but noted that the overall axis gave the impression of internal rotation because of the

marked intrinsic deformity of the talar neck and medial displacement of the articular surface.

Deformity of the talus around its longitudinal axis has been found to be a pronation or “intorsion” deformity, which is seen in embryonic stages. The calcaneus, is also intorted or pronated, especially its posterior segment.

The navicular is displaced medially and plantar ward on the talar head and has a false articular relationship to the medial malleolus.

The articular cartilage of the talar head may be uncovered laterally as a result of medial displacement of the navicular.

The cuboid is also displaced medially on the anterior end of the calcaneus.

Because the calcaneus is also medially rotated in relation to the ankle mortise in the transverse plane, this contributes to a significant midfoot “varus” or adductus.

Denervation and neuromyogenic changes in the tibialis posterior, peroneals, triceps surae, and long toe flexors appear to be a result of the condition itself as opposed to being the result of nonoperative or operative treatment.

Musculotendinous structures are shortened around the foot and ankle. Plantar fascia, the calcaneonavicular (“spring”) ligament, the tibionavicular ligament, and the master knot of Henry (which engages the flexor hallucis longus and flexor digitorum longus) are fibrosed.

Mobilizing the navicular depends on successfully stretching the tibialis posterior and the master knot; mobilizing the talus and calcaneus out of equinus often requires lengthening the Achilles tendon; and the ability to externally rotate the calcaneus to restore normal talocalcaneal divergence requires peripheral subtalar capsular stretching.

The increased fibrosis and contractile myofibroblasts in these “soft” tissues, the interosseous restraints maintaining deformity, must be successfully stretched or occasionally surgically released if there is to be any remodeling after anatomic correction of the bony dysmorphic structures.

Children who have first-degree relatives with clubfoot are seven times more likely to have the anomalous flexor muscle than children without first-degree relatives with clubfoot.

ETIOLOGY³⁰

Congenital talipes equino varus is a single musculoskeletal deformity in an otherwise normal infant. CTEV is a primary but local dysplasia of all tissues of the affected extremity.

The exact etiology of CTEV is not known, although neuromuscular and syndromic etiologies are always suspected. Over the recent years genetic factors have been implicated in population and family studies on clubfeet.

It is suspected that variation in the genes involving limb and muscle morphogenesis (HOXA, HOXD, and IGFBP3) and the development of the lower extremity (CAND2 and WNT7a) increase the susceptibility toward the development of clubfeet, but none are considered to be a direct cause.

Continued study in genetics may ultimately provide specific answers with regard to the etiology of clubfeet.

Many theories on the etiology of congenital clubfoot suggest that an arrest in embryonic development can cause the deformity.

In normal fetal development of the lower limb, the foot in a 6- to 8-week-old fetus has many characteristics of a congenital clubfoot, including equinus, supination, forefoot adduction, and medial deviation of the talar neck. The deformities get corrected with continued development, and the foetal foot becomes normal at 12 to 14 weeks.

Bohm proposed that an arrest in fetal development at this stage was responsible for the clinical deformities noted at birth.

Dysmorphic talar head and the medial dislocation of the navicular are not seen at any stage of normal fetal development. Thus, an arrest in normal fetal development cannot explain the primary dysplasias seen in CTEV.

The stiffness of clubfeet was clarified by Zimny, who identified myofibroblastic retractile tissue in the medial ligaments. Studies done by Ippolito and Ponseti, identified an increase in collagen fibers and fibroblastic cells in the ligaments and tendons of a clubfoot.

Thus, a second hypothesis about the etiology proposed a retractive fibrotic response, as a primary factor. This hypothesis is supported by studies demonstrating abnormal ligamentous and fascial tightening that resist correction of deformity.

Histopathologic findings explain the maintenance of a clubfoot deformity and resistance to correction, but does not point out the actual cause of the deformity. Transforming growth factor and platelet derived growth factor are at higher levels the contracted tissues.

Growth factor blockade with neutralizing antibodies is reported to have the potential to lessen the severity of the contractures and ultimately positively influence the outcome of clubfoot treatment.

A decreased density of nerve fibres in the synovium of clubfeet has been reported. This lack of sensory input may also be responsible for the fibrosis and contractures associated with clubfoot.

RADIOLOGY IN CLUBFOOT³¹

1. On an AP view xray, the talocalcaneal angle is seen. It is the angle formed between the line drawn from the long axis of the talus and the long axis of calcaneus.

In normal foot the angle is between 30 degrees to 55 degrees. While in cases of CTEV the angle is reduced below 20 degrees. This indicates hindfoot varus.



Fig 8. Talocalcaneal angle in normal patients



Fig 9. Talocalcaneal angle increased in CTEV

2. In an AP radiograph, the talo- first metatarsal angle is also seen. In normal feet the range of the angle is 0- 20 degrees.

In CTEV the long axis of talus lies lateral to 1st metatarsal. And the angle is increased.

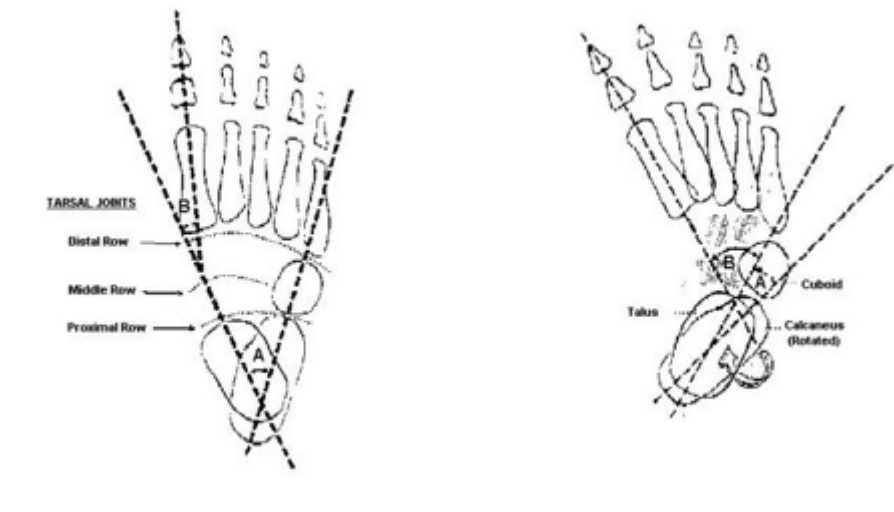


Fig 10. Talo 1st metatarsal angle

3. The lateral talocalcaneal angle is seen in the lateral view xrays, it is normally between 25-50 degrees. And is increased in cases of CTEV.

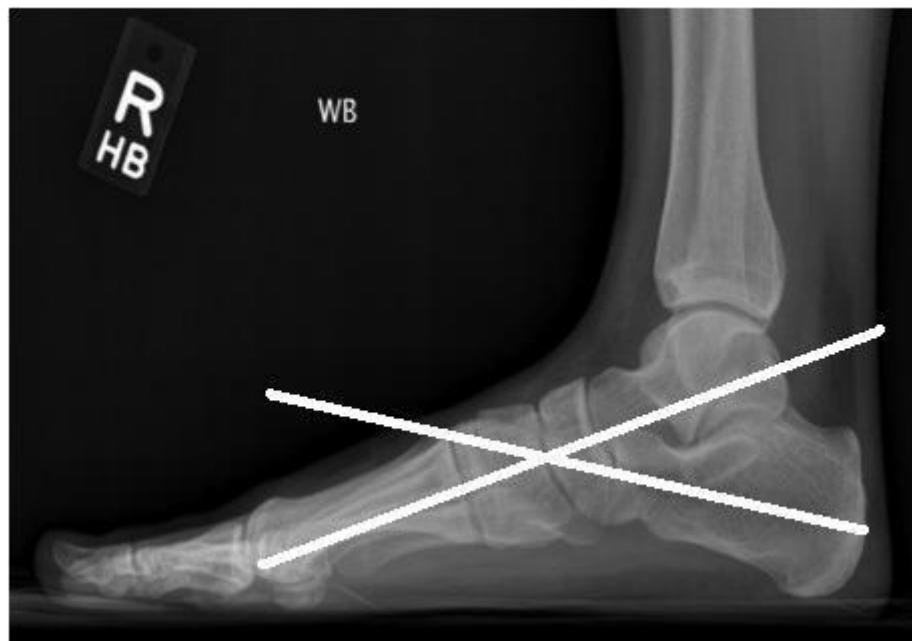


Fig 11. Lateral talocalcaneal angle

CLASSIFICATION OF CLUBFOOT

I) Ponseti and Smoley reported the results of treatment of 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 (Table I).¹⁴

Table I. The system of Ponseti and Smoley for the classification of congenital talipes equinovarus¹⁴

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

II) Harrold and Walker 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° (grade 2) or >20° (grade 3) (Table II).¹⁴

Table II. Summary of the system of Harrold and Walker for the classification of congenital talipes equinovarus¹⁴

Grade	Severity	Residual deformity with correction
1	Mild	Neutral or beyond
2	Moderate	< 20°
3	Severe	> 20°

III) Catterall 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.¹⁴

Table III. Catterall's system for the classification of congenital talipes equino varus¹⁴

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

IV) The system of Diméglio et al 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 hindfoot in the horizontal plane.¹⁴

The scale includes four additional points for the presence of 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 (Table IV). Diagrams have been produced to aid assessment.¹⁴

Table IV. The system of Diméglio et al for the classification of congenital talipes equinovarus¹⁴

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

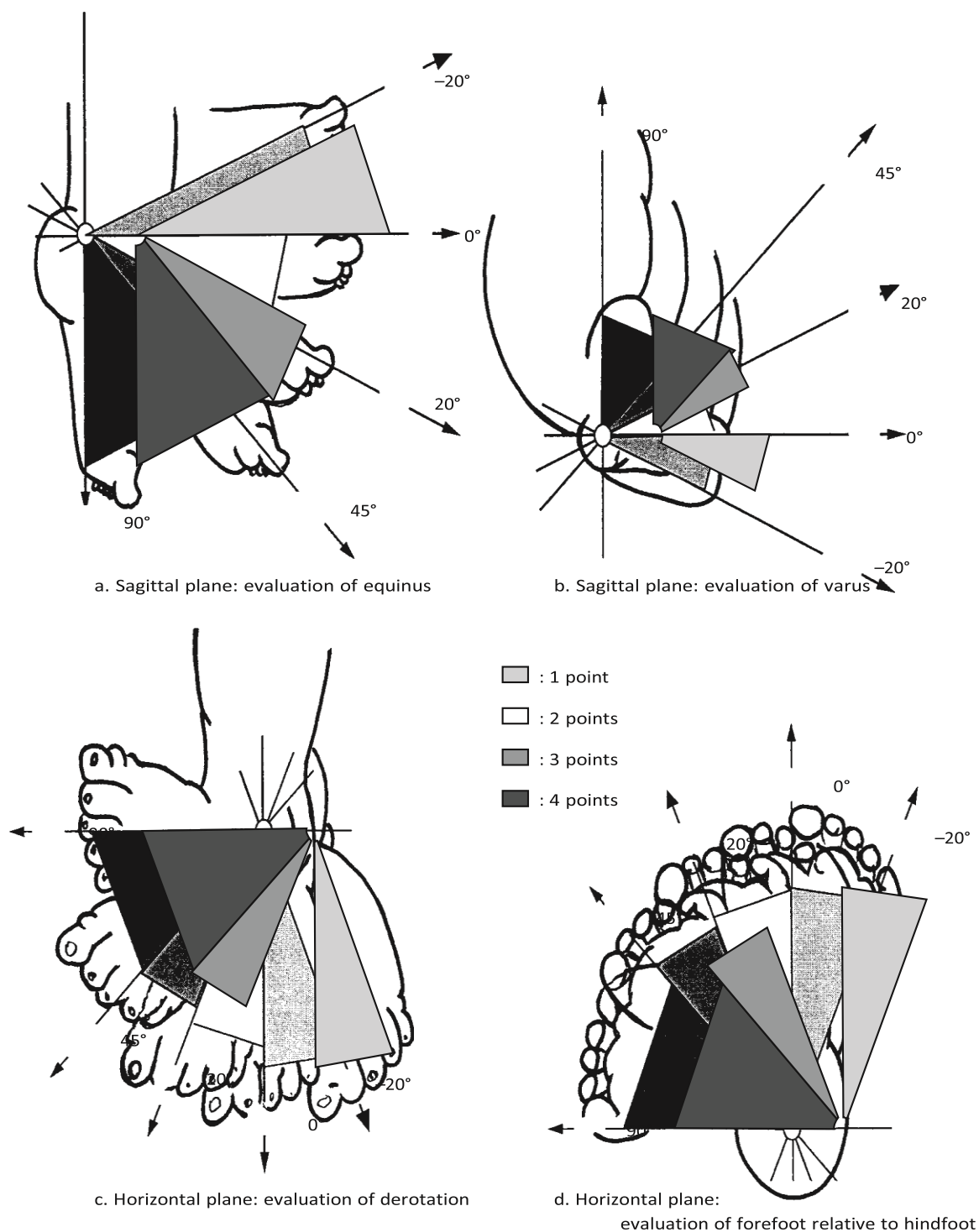


Figure 12: Diméglio et al classification of congenital talipes equinovarus

V) Minimum total score is 0 and the maximum total score is 6. A high Pirani score indicates a severe deformity. Scored as 1, 0.5, 0 as per severity.

Shafique Pirani, designed a convenient and easy tool known as the ‘Pirani Score’. The Pirani score demonstrates its importance with regards to assessing the severity of clubfoot, mainly at presentation and for monitoring patient’s progress.

The Pirani scoring system works by assessing six clinical signs of contracture, which may score 0 (no deformity), 0.5 (moderate deformity) or 1(severe deformity).⁸

Table V. Pirani Score classification³

Physical examination findings	Score of 0	Score of 0.5	Score of 1
Curvature of lateral border	Straight	Mild distal curve	Severe distal curve
Severity of medial crease (foot held in maximal correction)	Multiple fine creases	One or two deep creases	One deep crease
Severity of Posterior crease	Multiple fine crease	One or two deep creases	One deep crease
Palpation of lateral part of head of talus	Navicular completely reduces, lateral talar head not palpable	Navicular partially reduces, lateral talar head is palpable	Navicular could not be reduced, lateral talar head easily palpable
Emptiness of heel (foot and ankle in maximal correction)	Tuberosity of calcaneus easily palpable	Tuberosity of calcaneus difficult to palpate	Tuberosity of calcaneus not palpable
Rigidity of equinus	No Rigidity	Equinus can be partially corrected	Equinus cannot be corrected

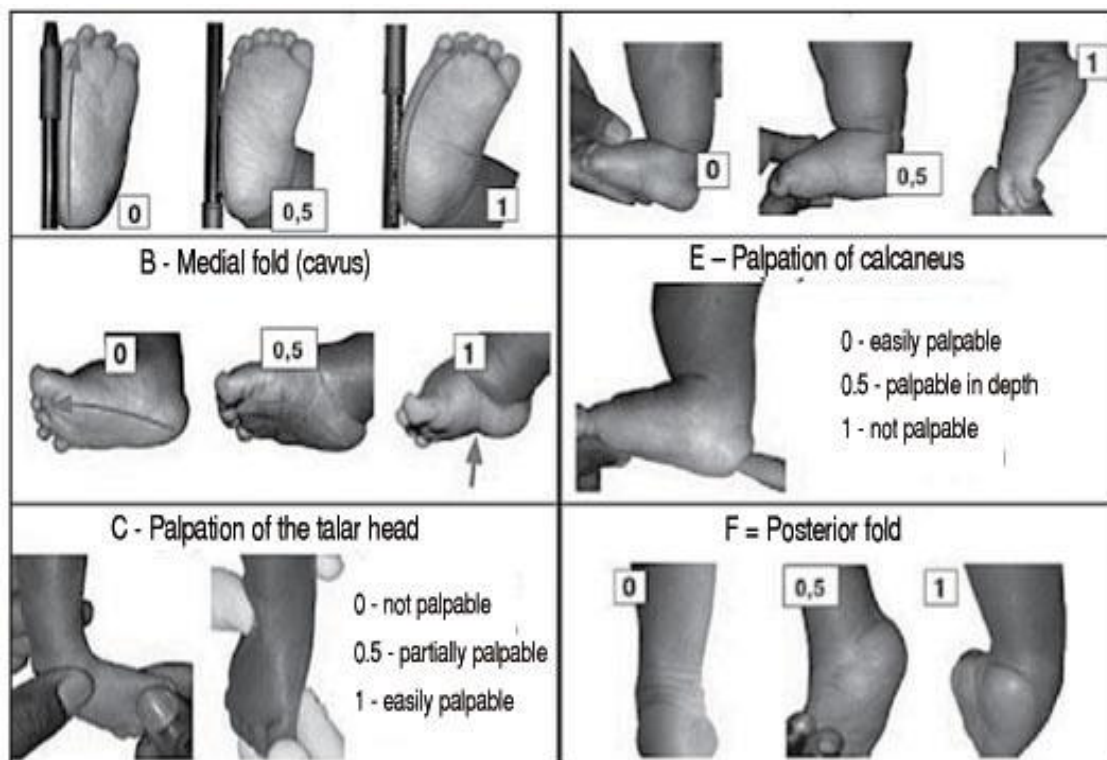


Figure 13: PIRANI'S Scoring method

TREATMENT OF CLUBFOOT

MANIPULATION WITHOUT FORCE-

Hippocrates starts the treatment of Clubfoot at around 400 BC.

He advised using gentle and repeated manipulations with hands and then application of bandages to maintain the correct position. He also advised using a special shoe to maintain the foot in correction after treatment.⁶

Denis Browne in 1937, advised that maintaining correction of the foot and keeping it at rest structure alone as treatment of clubfoot. He advised the foot to be bandaged in correction and splinted with shoes connected with a crossbar in corrected position.⁷

FORCEFUL MANIPULATION-

In 1803, Scarpa opposed the Hippocratic method of treatment of gentle manipulation of foot and advised forceful manipulations and immobilising the foot in a mechanical device known as 'Scarpa's shoe'. But his technique didn't get much popularity.⁶

SURGICAL METHODS OF CORRECTION-^{16,30}

Surgical management are generally indicated for resistant, rigid or relapsed clubfoot deformity.

The main objective of surgical correction is to obtain a plantigrade foot.

The surgical release of contractures must be extensive and all pathoanatomic structures in a resistant, relapse or rigid clubfoot need to be released from the hindfoot and midfoot.

Inadequate release may cause need for revision surgeries, which need to be avoided. As it may cause increasing stiffness, deepening of scars, and hardening of tissue from repeated surgery, as well as can cause atrophy of the foot.

Timing of the surgery is very important in determining the outcome of surgical treatment in clubfoot.

In the past, Pous and Dimeglio performed surgical releases in 1 and 6 weeks old patients with the reasoning that the earlier the fibrous medial and posterior contractures were released, the better outcome. But they later stopped early surgeries because of excessive scarring and recurrent fibrosis, which was attributed to the hypermetabolic reaction of the connective tissue in young infants.

1. One -stage posteromedial release- (Turco's procedure)

Turco recommended surgery at the age of 1 year or older, primarily because of the advantages such as, larger structures, the anatomy is easier to evaluate and correction can be achieved, and the tendon lengthening repairs are also easier to do in the patients.

Turco described the first complete one-stage posteromedial release.

He corrected the deformity of the calcaneus beneath the talus, which required complete subtalar release (lateral, posterior, and medial), as well as release of the calcaneofibular ligaments.

The surgery is performed, through a curved posteromedial incision beginning alongside the Achilles tendon above the ankle joint.



FIG 14. Turco's incision

All medial neurovascular structures and tendons are identified, with the posterior tibialis tendon being lengthened or released, the talonavicular joint opened dorsally, medially, and inferiorly and the calcaneonavicular spring ligament released. The Achilles tendon and long toe flexors are lengthened and repaired. The talonavicular joint is reduced and pinned.

Turco immobilized his patients for a total of 4 months and removed the K-wires at 6 weeks. Splinting of the foot were done for 1 year after the end of cast immobilization.

Carroll in addition to Turco's method advised plantar fascial release and capsulotomy of the calcaneocuboid joint as it helps correct forefoot adduction and cavus.

Following which posterolateral release through a posterior longitudinal incision paralleling the lateral edge of the Achilles tendon is made, through which the Achilles tendon is Z-lengthened.

A posterior capsulotomy of the ankle joint, is performed to mobilize the talus and reduce the talonavicular joint, which is done by internally rotating the talus.

2. McKay and Simons, described a more extensive procedure who used the Cincinnati incision through which majority of peritalar structures, including all hindfoot and midfoot joints, are released.

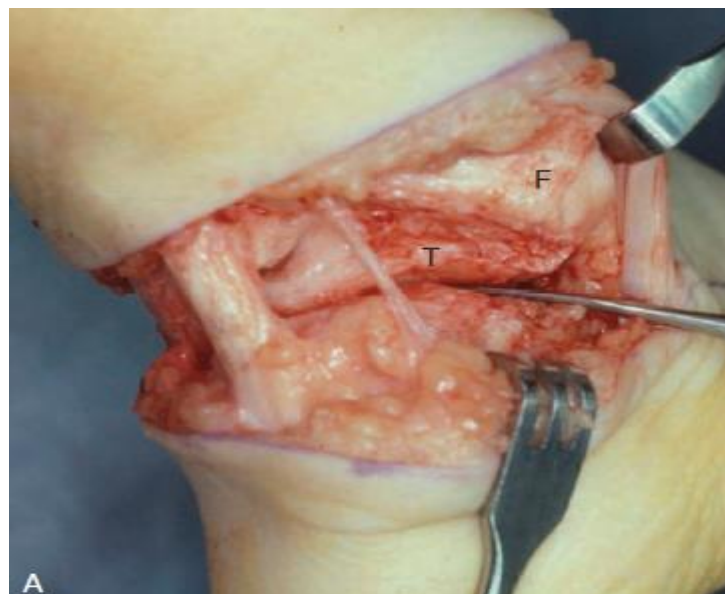


Fig15. Cincinnati incision

The procedure involves, a medial and lateral circumferential talocalcaneal release, with the lateral talocalcaneus being released from the attachment of the

calcaneocuboid joint laterally to the sheath of the flexor hallucis longus posteromedially.

Complete release of the talonavicular and calcaneocuboid is done and both these structures are pinned.

The subtalar release includes the interosseous ligament. Once the calcaneus has been adequately derotated by pushing the anterior end laterally and the posterior tuberosity medially and downward, the interosseous ligament is internally fixed.

In approximately 15% of idiopathic clubfeet, require a complete posteromedial release to correct equinus deformity.

OSTEOTOMIES-

Indications

- Rigid clubfoot deformity
- Recurrence of clubfoot deformities even after previous surgical release.

1.Evans Osteotomy- It is generally done in children with age of more than 4 years of age.

Evans suggested that obstruction to forefoot positioning and adaptive obliquity of the calcaneocuboid joint was the essential lesion of rigid clubfoot and described the use of a wedge resection of the calcaneocuboid joint to shorten the lateral column as part of treatment of the relapsed deformity.

Calcaneocuboid wedge resection is done with arthrodesis of calcaneocuboid joint

Evans procedure has become a standard technique for recurrent clubfoot deformity in which the midfoot is in varus as a result of talonavicular and calcaneocuboid medial displacement.

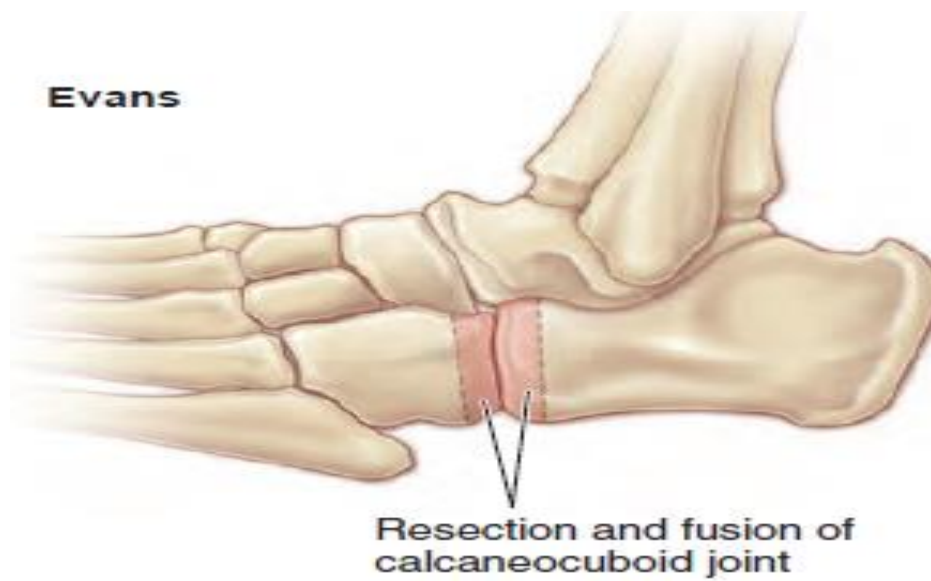


FIG.16. Showing Evans Osteotomy

2. Calcaneal Osteotomy, is done in a foot with fixed heel varus, with or without other significant residual deformity, an opening or closing wedge osteotomy or a lateral displacement osteotomy can be used.

The opening wedge technique increases the height of the heel and may therefore require Achilles tendon or other posterior release to avoid producing equinus.

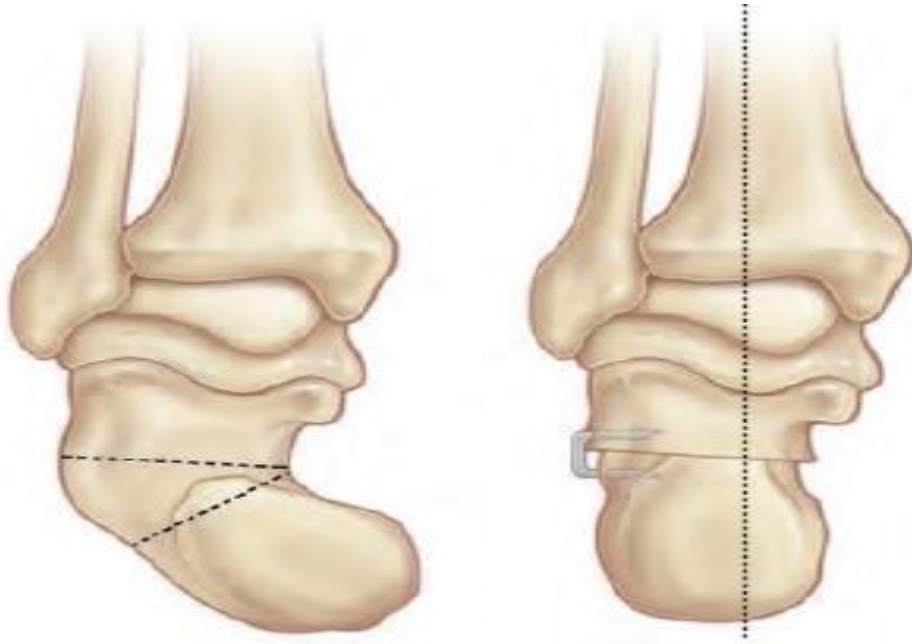


FIG.17. Showing Calcaneal osteotomy to correct heel varus deformity in rigid CTEV.

3. Other common osteotomy are- Litchblau procedure which involves resection of anterior end of calcaneus with calcaneal articular cartilage and medial soft tissue release.

It is done generally in cases of rigid clubfoot deformity in children below the age of 4 years.

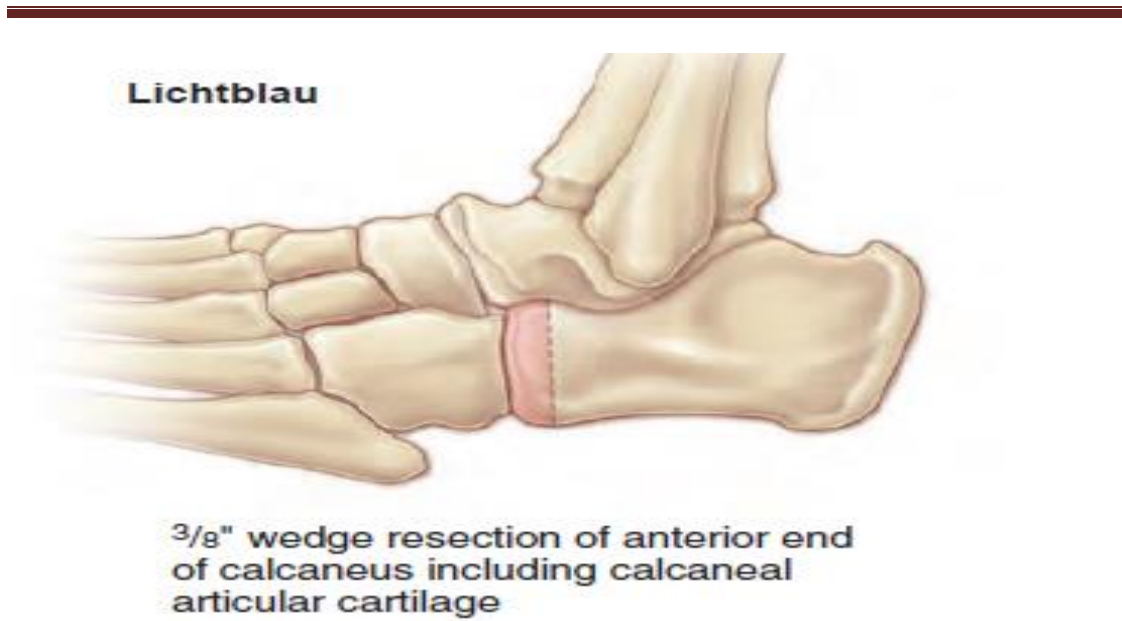


FIG. 18. Showing Lichtblau's osteotomy

4. Triple Arthrodesis. Triple arthrodesis has been the standard orthopaedic procedure for producing and maintaining correction since it was first described in the 1920.

It is done after the age of 10 years, as management of residual deformity requires bony stabilization.

After failed surgical correction of the foot with soft tissue procedures.

It is used as a salvage procedure of the foot, when previous surgical modalities have failed to correct the deformity.

Advantage of triple arthrodesis- The child will have a pain free foot. With no residual deformity.

Disadvantage of triple arthrodesis- The child will have a stiff foot

Triple arthrodesis involves fusion of 3 joints. Commonly arthrodesis of the talocalcaneal joint, the talo navicular joint and the calcaneo cuboid joints are done to correct residual deformity of foot in Clubfoot.

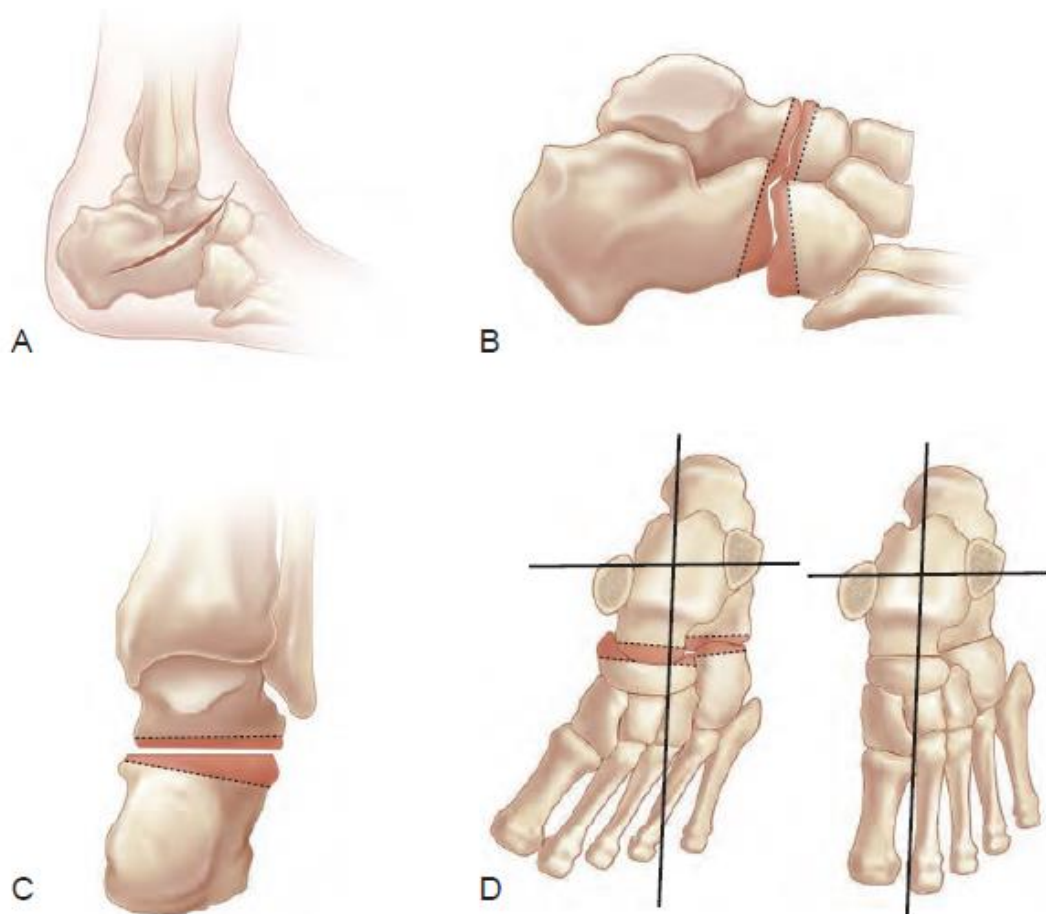


FIG.19. Triple arthrodesis of the talocalcaneal joint, the talonavicular joint and the calcaneocuboid joints

EXTERNAL FIXATORS-^{16,26,30}

These are generally used in cases of neglected CTEV or in cases with failed conservative treatment.

1. Ilizarov technique^{26,30} - Correction Using the Ilizarov Technique is applied to a neglected or recurrent deformity, especially in the presence of severe scarring because stretching plus elongation of contracted tissue is fundamental to the management of clubfoot, in this method the contracted tissues are gradually stretched by distraction.

In rigid cases of CTEV the Ilizarov construct are attached to feet and to the legs. With gradual distractions of the feet at regular intervals, the deformity is corrected over a period of time.

Disadvantage of this technique is, the bulky frame of Ilizarov which is difficult to carry around for the child.

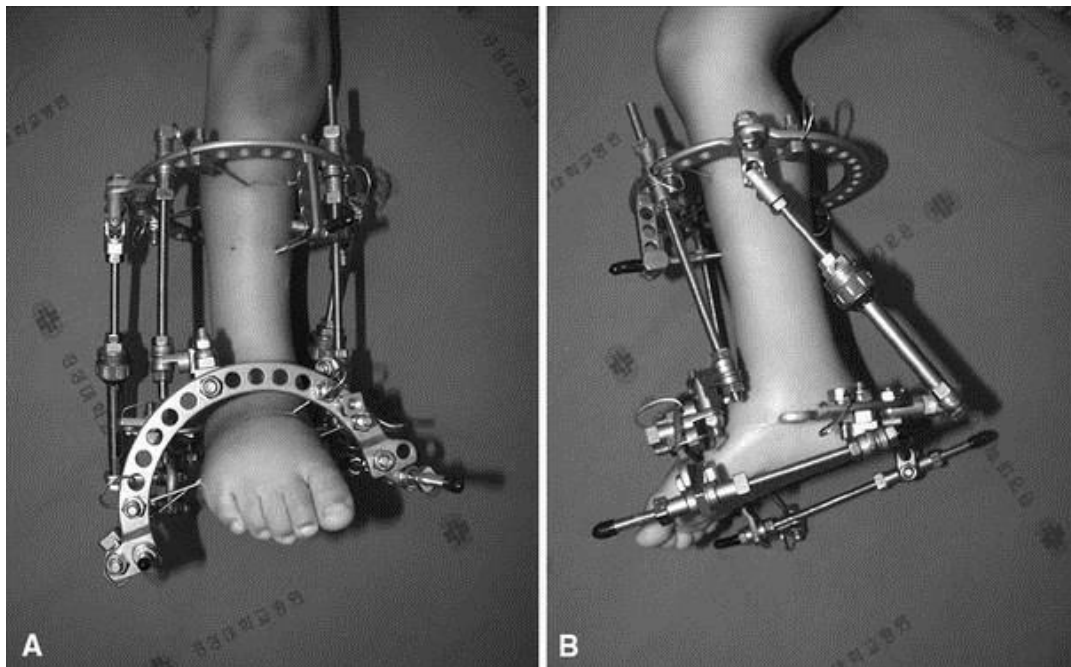


Fig 20. Ilizarov ring external fixators for correction of CTEV

2. JESS external fixators have also been used to gradually correct the deformity of foot in neglected cases of CTEV. The results with the use of JESS has also been promising.

It also works on same principles as Ilizarov technique.

The advantage of this method is that the frame is less bulky and makes mobilisation of the child easier.¹⁶

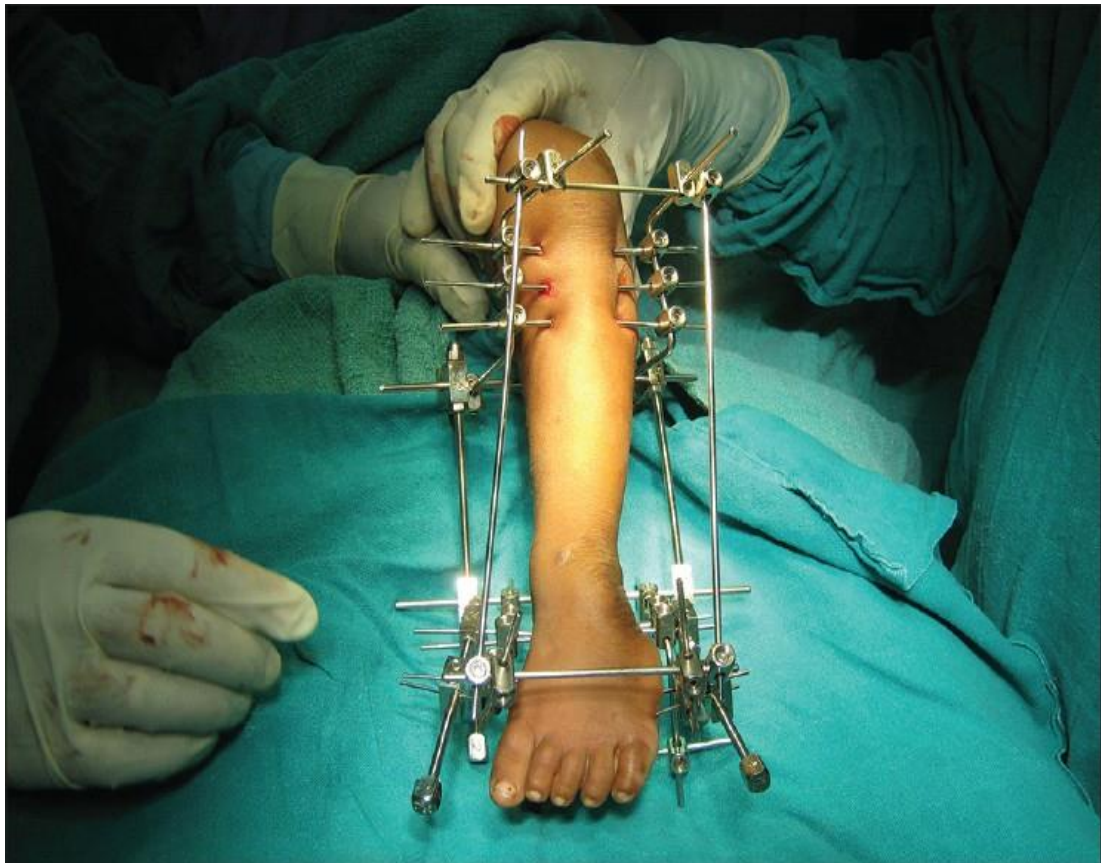


Fig 21. JESS for correction of deformity in CTEV

NON-SURGICAL METHOD OF CORRECTION-^{30,32}

A) MANIPULATION METHOD-³²

Described by Sir Robert Jones in 1900.

The principle of this method is based on gentle, passive manipulation of the feet to elongate the contracted soft tissues of foot. This procedure is done every 3 days.

Steps of this method are-

-1st step involves the stretching of posterior capsules and subtalar joint. The manipulation is done by pulling the calcaneus distally then the foot is dorsiflexed. This method helps elongate the posterior capsule, ligaments of ankle and subtalar joint. It is repeated for 20 to 30 times for about 10 seconds.

- 2nd step involves elongation of posterior tibial muscle this is done by holding the calcaneus in one hand and a distal force is applied on the forefoot and midfoot, following which foot is abducted.

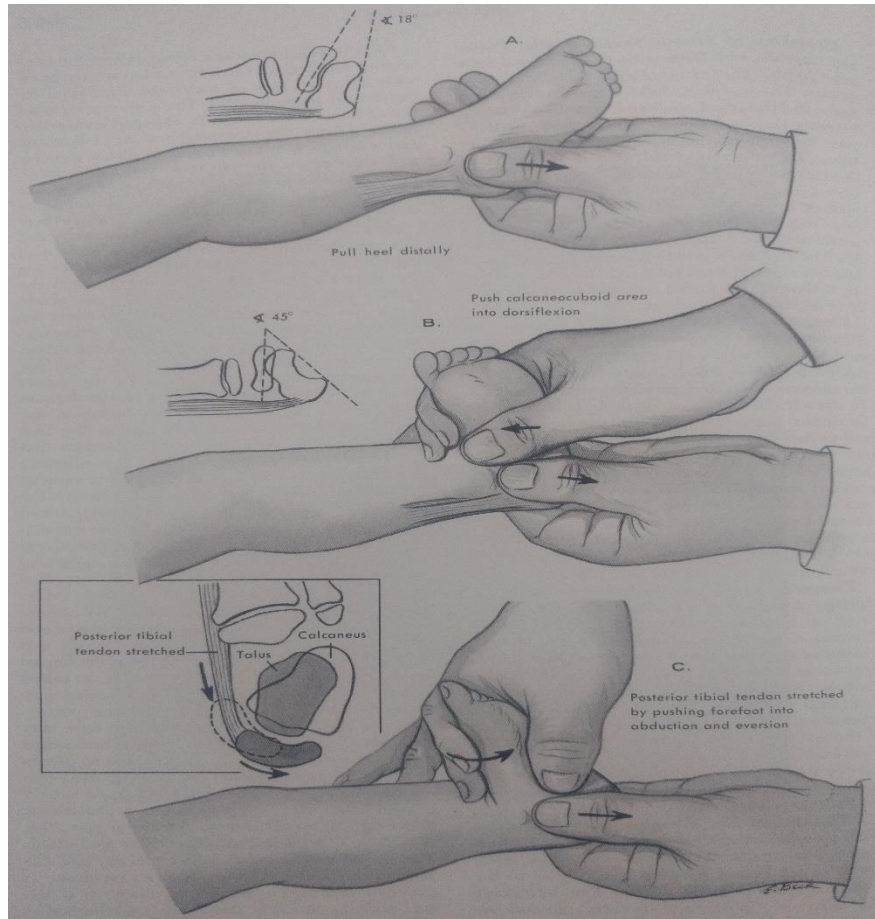


Fig 22. Showing the method of stretching the posterior capsule and ligaments and elongation of posterior tibial muscle

-3rd step involves stretching of calcaneo navicular ligament and plantar soft tissue.

This process is only done if the navicular bone is positioned over head of talus. It is done by holding the calcaneus and the midfoot is dorsiflexed.

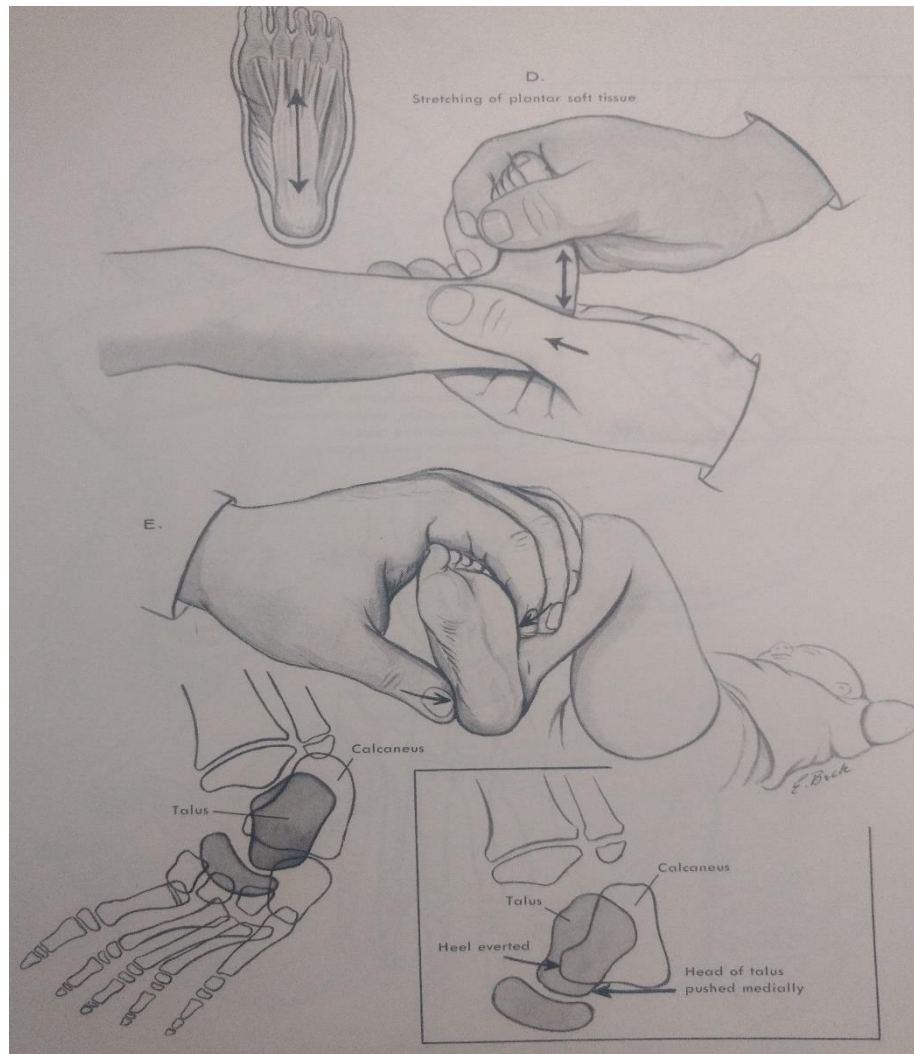


Fig 23. Showing the method of stretching the plantar soft tissues and calcaneo navicular ligament

The navicular is reduced, by holding the ankle and foot in equinus, distal traction is applied over navicular and navicular is brought laterally over talar head.

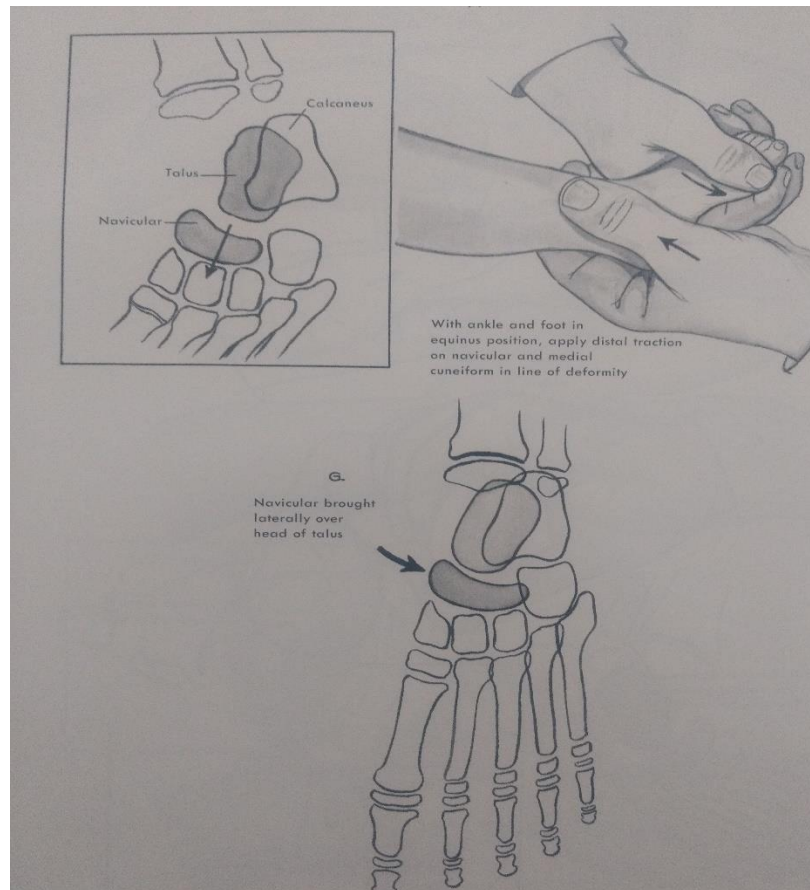


Fig 24. Showing the Method of reduction of Navicular over the head of Talus

-Following the manipulation and stretching of the contracted soft tissues, Sir Robert Jones advised, strapping of the foot and leg using an adhesive tape.

And adhesive tape is applied over a felt placed over the foot and distal end of the thigh. The foot is held in correction by dorsiflexion and eversion of foot, which is maintained by the adhesive straps.

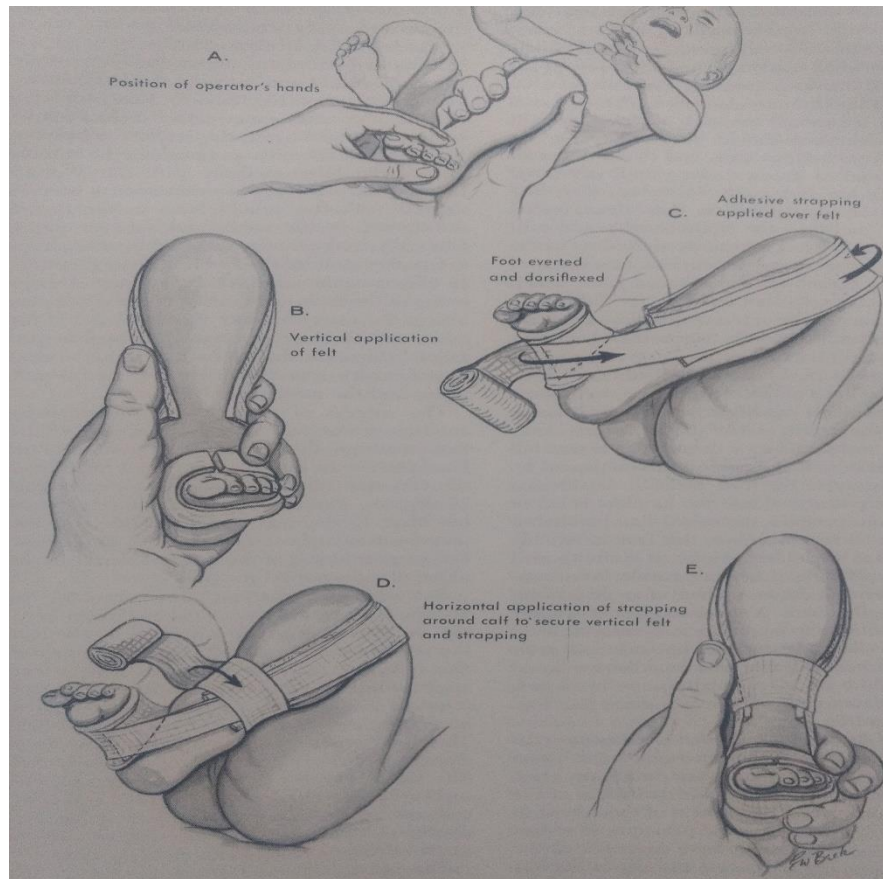


Fig 25. Showing strapping by Jones method to correct clubfoot.

B) KITE'S METHOD-

Described by J.H.Kite in 1935.

Kite described in great detail the method of manipulation and cast correction.

Kite corrected each component of the clubfoot deformity separately and in order, beginning with forefoot adduction and proceeding to correction of heel varus (inversion) and finally to correction of equinus.

Kite advised, overcorrection of forefoot before correcting equinus.

But now the technique is rarely used as the success rate with the procedure is low and also requires a lot of time to get corrected.

The primary error with Kites method was the direct abduction of the forefoot that locks the calcaneus under the talus.

In a clubfoot, the forefoot is already pronated as compared to hindfoot. But it appears supinated.

Kite further pronated the forefoot thus causing the pronation deformity to exaggerate.³¹

C) FRENCH METHOD -

Described by Masse and Bensaël in the early 1970s.

It is also known as “functional method,” and consisted of daily manipulations of the newborn’s clubfoot, stimulation of the muscles around the foot (particularly the peroneal muscles) and the reduction is maintained by passive manipulations, and temporary immobilization of the foot with nonelastic adhesive strapping.

This treatment is done for about 2 months and then progressively reduced to three sessions per week for an additional 6 months. After this period, taping is continued until the child became ambulatory, and then night time splinting is used for 2 to 3 years.

The French method aims specifically at relaxing the tibialis posterior and medial fibrous zone through a combination of progressive passive manipulations, active muscle work, taping, and splinting.

Drawback of this method is that, it consumed considerable time and expertise, and the success was dependent on skill of the doctor and cooperation of the families .



Fig 26. French technique of manipulation and taping.

Steps of manipulation are in French Method are-

- a. Manipulation to correct forefoot adductus and heel varus.
- b. Derotation of the calcaneo-pedal block and reduction of talonavicular displacement.
- c. Manipulation of heel varus. The calcaneus is then rotated medially away from the fibula while the forefoot is externally rotated.
- d. Manipulation of equinus. The taping technique maintains correction of the forefoot.
- e. Taping to maintain forefoot eversion and midfoot dorsiflexion.
- f. Additional taping maintains external rotation and dorsiflexion

D) PONSETI'S METHOD-

Described by Ponseti in 1940.

The protocol consists of stretching and manipulating the foot and applying holding casts until the next session (5 to 7 days). The correction is maintained for 5 to 7 days with a plaster cast extending from the toes to the upper third of the thigh and the knee at 90 degrees of flexion.

Cavus is the first deformity to be corrected, followed by adductus, varus and equinus.

The first goal is correction of the cavus deformity. Elevation of the first metatarsal and supination of the forefoot corrects the cavus deformity.

After cavus correction with successive manipulation and casting sessions, metatarsus adductus and hindfoot varus are simultaneously corrected by abducting the foot while counterpressure is applied laterally over the talar head.

Gradual correction of adductus deformity also correct hind foot varus.

Equinus is the last deformity to be corrected. Equinus correction should be attempted when the hindfoot is in neutral to slight valgus. Correction is done by progressively dorsiflexing the foot after the varus and adduction of the foot have been corrected. The foot is dorsiflexed by applying pressure under the entire sole of the foot. However, for a rapid correction of Clubfoot Achilles tenotomy can be done.

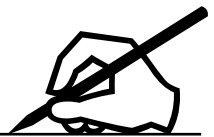
After removal of the last cast, a foot abduction orthosis/ Denis Browne bar and shoes are used to splint the foot. This prevents recurrence of the deformity.

The affected foot should be held in 70° of external rotation and 5 to 10 degrees of dorsiflexion. The normal foot is fixed in 40° of external rotation.

The orthosis is worn full time for at least 3 to 4 months, and afterward it is worn at nap and night time for 2 to 4 years.

Currently Ponseti's technique is the most widely used method of treatment, with an average success rate of 95%, with compliance to the treatment.

METHODOLOGY



MATERIALS AND METHOD

A prospective study of 27 cases with 36 feet with Congenital Talipes Equino Varus deformity within age group of 0-2 years were treated with Ponseti's method at Department of Orthopaedics of RLJ Hospital attached to Sri Devaraj URS Medical College, Kolar.

The severity of foot deformity was assessed according to the grading system of Pirani score before, during and after the treatment. And the number of patients requiring tenotomy are noted. Denis-Brown Splinting of foot were done after final cast removal. All cases were followed up on a short-term basis of 6 months after removal of final cast.

SOURCE OF DATA

36 feet with Congenital Talipes Equino Varus treated at RLJH, Tamaka, Kolar

METHOD OF COLLECTION OF DATA

- Consent of the procedure/ treatment of the child is to be taken from the Parents/ guardian prior to the initiation of the procedure.
- Collection of data from 36 feet of children with CTEV within the age group of 2 years, by detailed history of the deformity/ birth history.
- Pre treatment Pirani scoring of the feet were assessed and parents were explained about the duration of the treatment.
- Weekly casting of the feet as per Ponseti's technique till Pirani score correction was achieved.

-
- Clinical examination and scoring of feet were done before every weekly casting and
 - The cases with non-correctable equinus deformity were corrected with tenotomy of tendoachilles and cast application for 2 weeks in full correction of deformity
 - After final cast removal the limb was immobilized in Denis Browne splint.
 - All cases were followed at a short term follow up of 6 months and the correction or relapse of deformity were assessed.

INCLUSION CRITERIA

- Idiopathic cases of CTEV
- Newly diagnosed cases of CTEV below the age group of 2 years

EXCLUSION CRITERIA

- Resistant CTEV
- Relapse Cases
- Neglected Cases

PRE-TREATMENT ASSESSMENT

After taking complete history, mobility of foot was evaluated and graded for severity of clubfoot by Pirani severity scoring system, which registers the deformity of six different components of the clubfoot.

The congenital clubfoot undergoing treatment was assessed at each visit as per the Pirani scoring system (as described in table V):

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

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

TREATMENT METHOD

The Ponseti technique, was used in our hospital according to the following steps: -

1. Treatment was started as soon as possible after birth and consisted of gentle manipulation of the foot and the serial application of long leg plaster casts without the use of anesthesia, as described by Ponseti.

2. In all patients, the cavus was corrected first by supinating the forefoot and dorsiflexing the first metatarsal. Correction of the cavus deformity places the metatarsals, cuneiforms, cuboid, and navicular onto the same plane, forming the lever arm required to laterally mobilize the navicular, cuboid, and calcaneus. This will be accomplished as the tight medial soft-tissue structures (ligaments, tendons, and joint capsule) gradually yield to gentle, persistent manipulation.

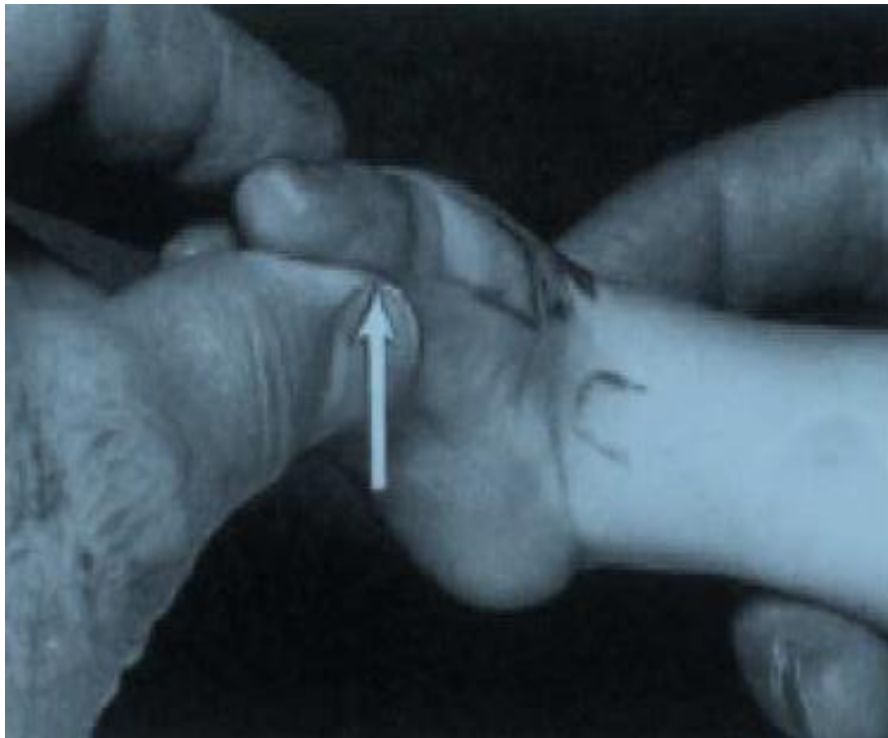


Fig 27. Cavus correction of the foot by lifting the 1st metatarsal head

3. To correct the adduction and varus, the foot in supination was abducted while counterpressure was applied with the thumb against the head of the talus. The patient returned in 7 days and the casts were removed. The mobilizations and casting were continued at each visit, with simultaneous correction of the cavus, adduction deformity, and heel varus.

4. Heel varus was corrected by abduction of the foot distal to the talus, which allowed lateral rotation of the navicular, cuboid, and anterior aspect of the calcaneus. The subtalar, talonavicular, and calcaneocuboid joints function with mechanical interdependence, and rotate around a moving, rather than a fixed axis. Abduction of the foot distal to the talus allows the heel to come out of its supinated position where it was previously locked into varus under the talus. The heel must never be forcibly everted while the calcaneus is locked under the talus because this will cause a breach in the midfoot and result in a bean-shaped foot. During mobilization and casting, the talus must be fixed in the ankle mortise by firm pressure on the lateral aspect of the talar head while the foot under the talus is abducted.

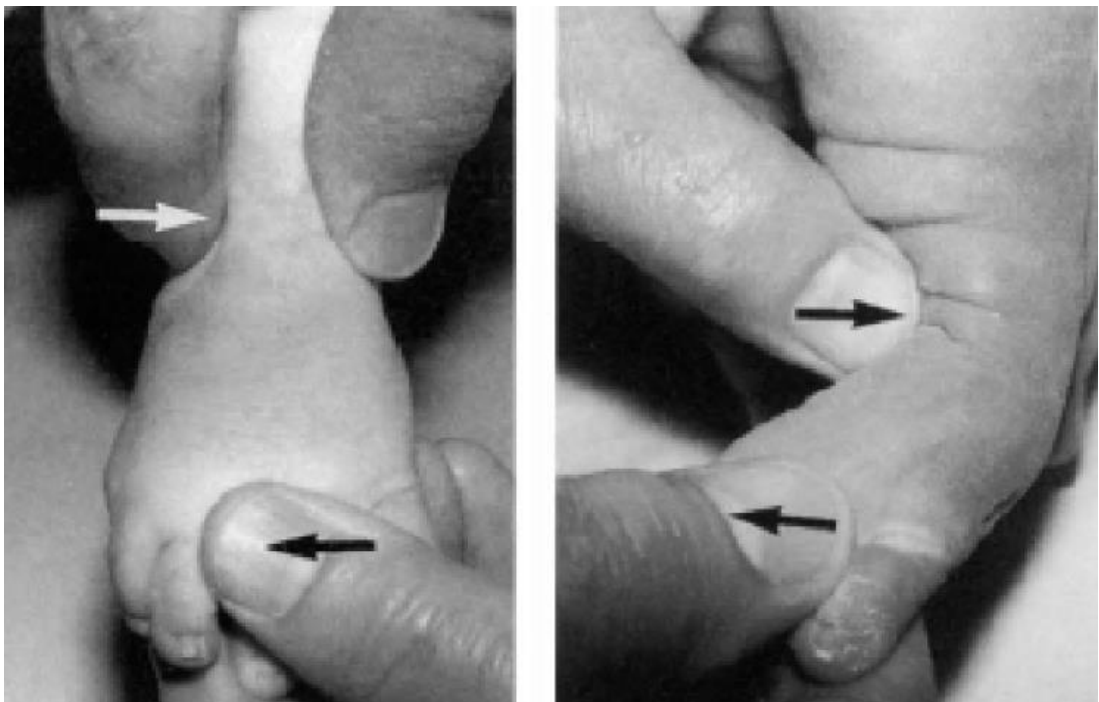


Fig. 28. Showing adduction and varus deformity correction. The point of counter pressure is at the talar head and the calcaneus is not touch at all while manipulation.

5. The equinus was not treated until all other deformities were corrected, and the foot was able to be abducted 50° to 60° on the talus. Once the anterior portion of the calcaneus had rotated laterally about the interosseous talocalcaneal ligament, dorsiflexion of the anterior calcaneus may occur. When full abduction of the foot on the talus was achieved, the equinus was corrected by percutaneous Achilles tenotomy or by casting.

Abduction of the foot under the talus allowed the anterior portion of the calcaneus to rotate out laterally from under the talar head and neck, which was preventing it from dorsi-flexion, and then correcting equinus.

If tenotomy is attempted before 50° to 60° of abduction of the foot is achieved, inadequate correction of the equines will be seen. In the last cast, the foot should be markedly abducted (70°) without pronation.

This position is crucial in obtaining complete correction and in helping to prevent early recurrence.

A Percutaneous Tenotomy of the Achilles tendon was performed if-

1-Residual equinus was observed i.e. after the adduction of the foot and the varus deformity of the heel has been corrected.

2- When 15° of dorsiflexion has not been obtained with use of casts.

The Tenotomy was performed under local anaesthesia and sedation for children below 6 months of age, and general anaesthesia for children above 6 months of age or if required.

6. Following the tenotomy the foot was immobilised in POP cast for 2 weeks in full correction of equinus deformity in 70degree abduction.

7. After achieving full correction with casts, a Foot abduction brace or Denis Brown splint, with 70-degree external rotation of the affected foot and 15degree bend of the connecting bar is given for constant use (at least 23 hrs per day) for the next 3 months.



Fig 29: Steps of tendo-Achilles tenotomy



Fig 30. Post tenotomy cast with foot in 70 degrees abduction



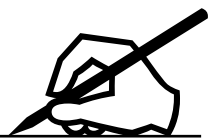
Fig 31. Denis browne splint or Foot Abduction orthrosis

8. Foot abduction brace was used to prevent relapse of the deformity. The brace was fitted on the same day as the last POP cast was removed. we used well fitted, open toe, high-top, straight- shoes attached to custom made bar of length equal to the distance between the child's shoulders, the corrected foot was maintained in 70 degrees of external rotation with ankle in dorsiflexion.

9. A painless, plantigrade foot with a Pirani score of ≤ 1 was considered as a successful outcome in follow up.

The normal foot in a unilateral deformity was placed in 45 degrees of external rotation the brace was worn for 23 hrs a day for first three months and then at night for 12 hrs for next 4 yrs.

RESULTS



OBSERVATIONS AND RESULTS

The present study includes 36 feet with idiopathic clubfoot which were managed by Ponseti method of correction and above knee POP cast application after recording the deformity with Pirani scoring and if required Percutaneous Tendoachilles Tenotomy from July 2015 to November 2017.

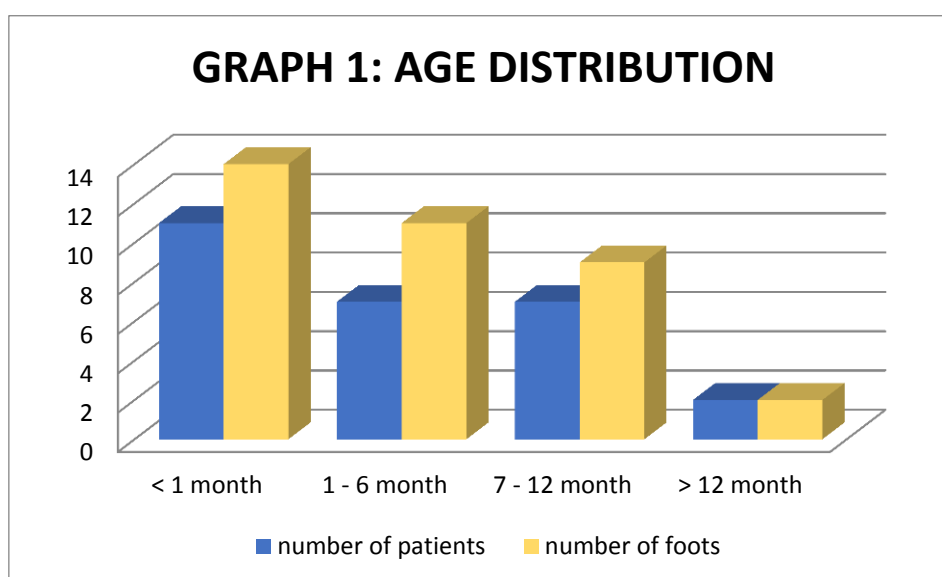
The cases were followed up after 6 months after the removal of final cast.

The following observations were made from the data collected in our study.

OBSERVATION AND RESULTS

1. Table VI. AGE Distribution

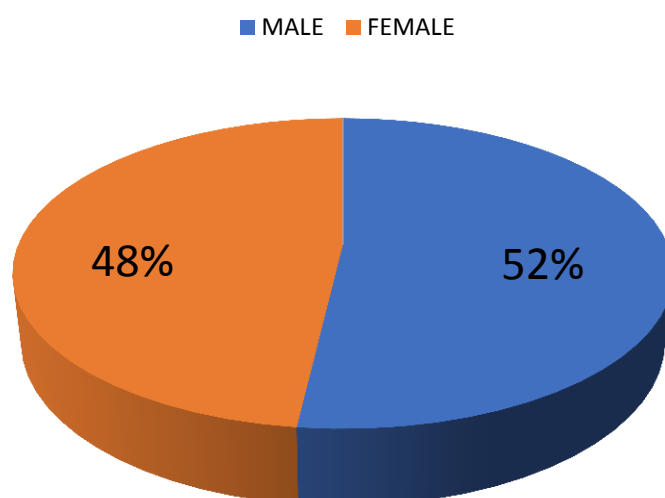
Age group	Number of patients (percentage)	Number of foot (percentage)
< 1 months	11 (40.7%)	14 (38.8%)
1 – 6 months	7 (25.9%)	11 (30.5%)
7 – 12 months	7 (25.9%)	9(25%)
> 12 months	2 (7.4%)	2(5.5%)



2. Table VII. GENDER DISTRIBUTION

GENDER	NUMBER OF PATIENTS(PERCENTAGE)
MALE	14 (51.8%)
FEMALE	13 (48.2%)

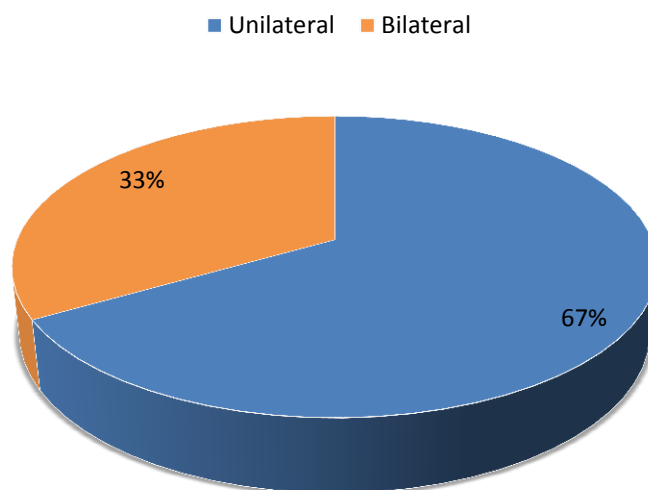
GRAPH 2: GENDER DISTRIBUTION



3. Table VIII. SIDE INVOLVEMENT

UNILATERAL/ BILATERAL	NUMBER OF PATIENTS
UNILATERAL	18 (67%)
BILATERAL	9 (33%)

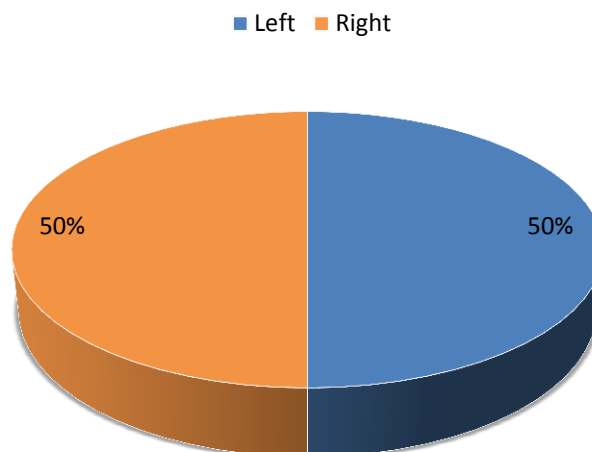
Graph 3: Unilateral and bilateral cases



4. TABLE IX. FOOT INVOLVEMENT IN UNILATERAL CASES

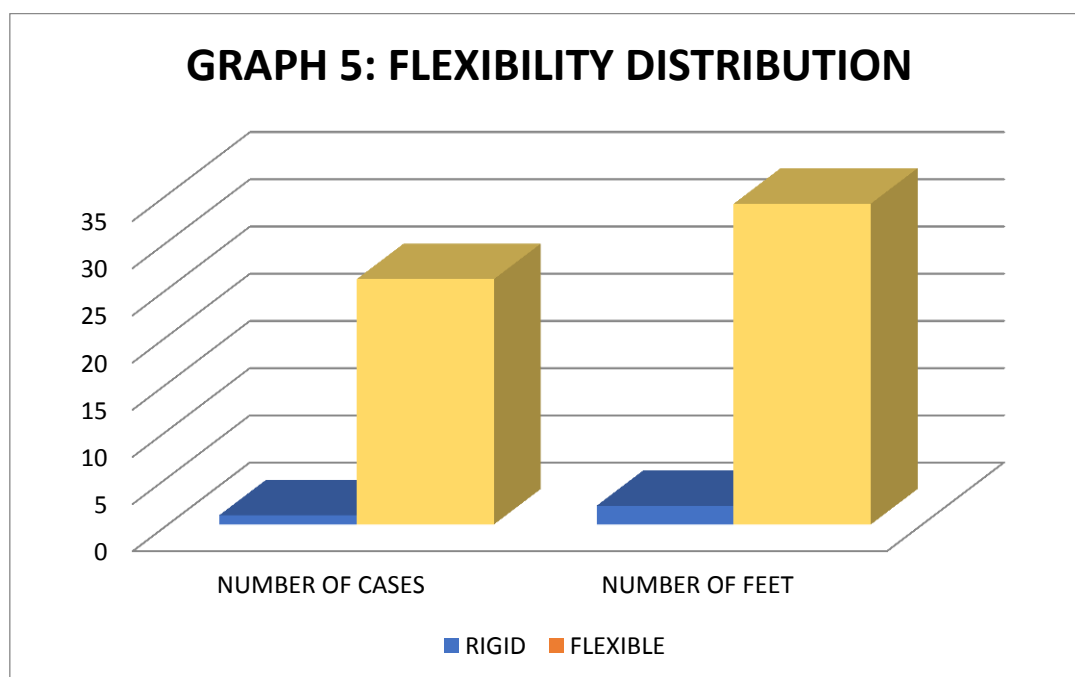
Side	Number
Left	9
Right	9

Graph 4: Foot involvement in unilateral cases



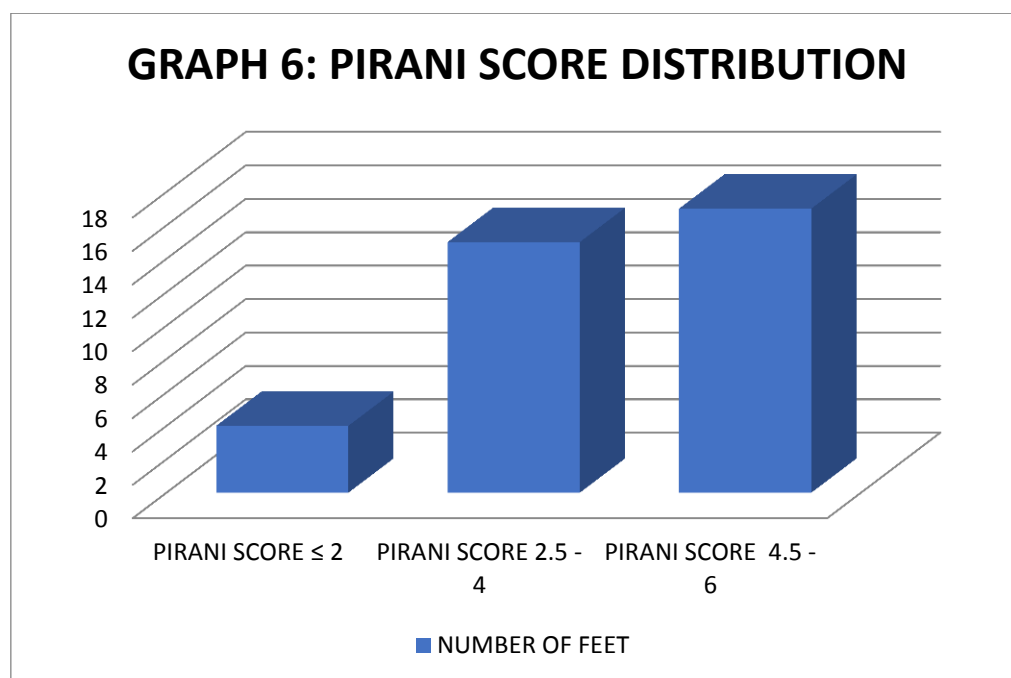
5. Table X. FLEXIBILITY OF THE FOOT IN THIS STUDY

FLEXIBLE/RIGID	NUMBER OF CASES	NUMBER OF FEET
FLEXIBLE	26 (96.3%)	34 (94.4 %)
RIGID	1 (3.7%)	2 (5.6 %)



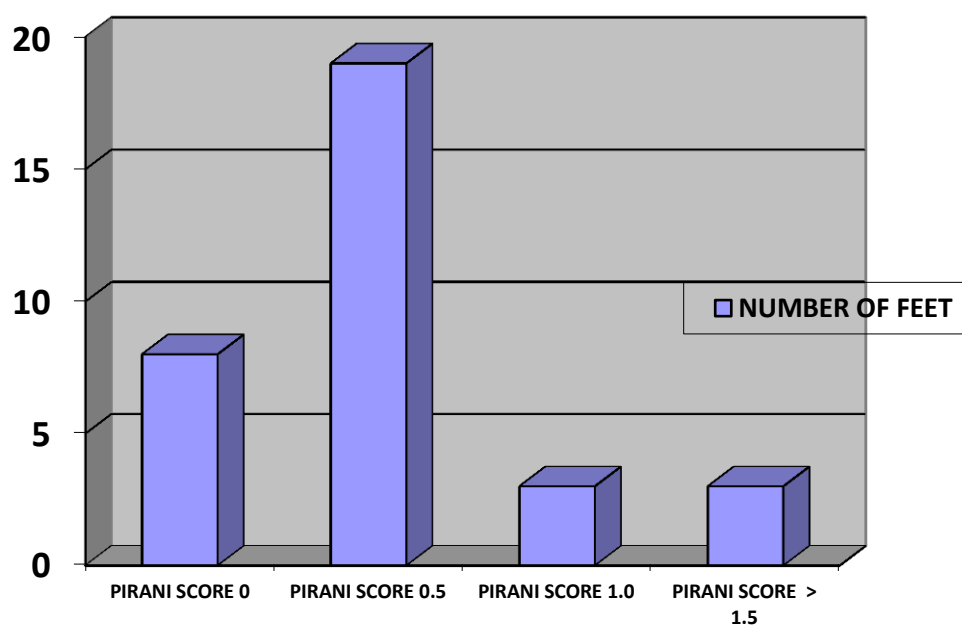
6. Table XI. PRE TREATMENT PIRANI SCORING

PIRANI SCORE	NUMBER OF FEET (PERCENTAGE)
≤ 2	4 (11.11%)
2.5 – 4	15 (41.60)
4.5 - 6	17 (47.22%)



7. Table XII. POST TREATMENT PIRANI SCORING

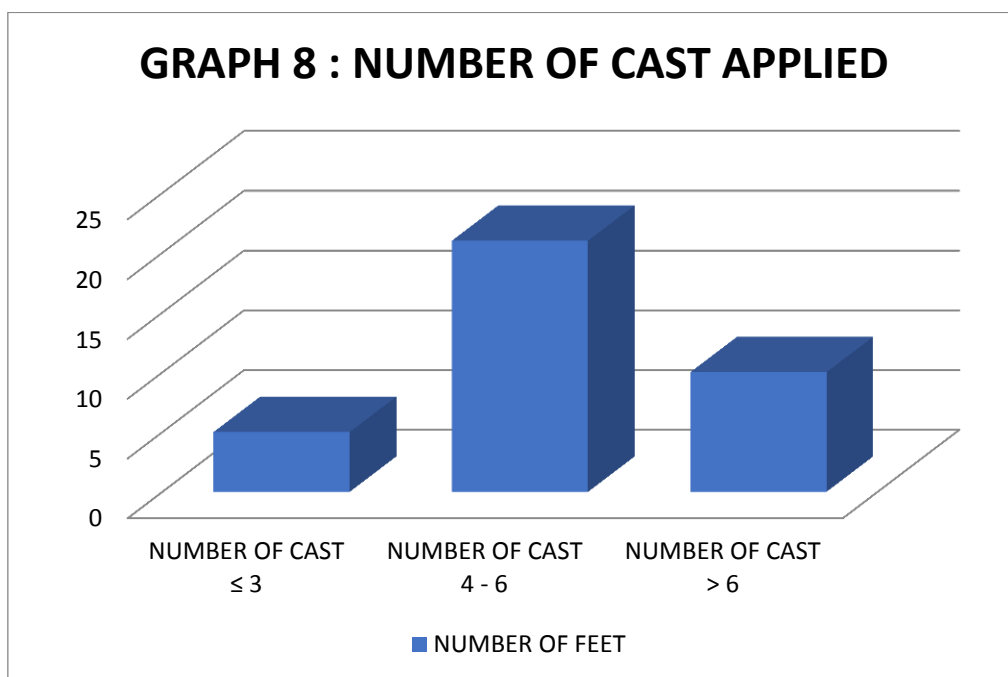
PIRANI SCORE	NUMBER OF FEET
0	8 (22.22%)
0.5	19 (52.77%)
1.0	3 (8.3%)
≥ 1.5	3 (8.3%)



GRAPH 7. POST TREATMENT PIRANI SCORE

8. Table XIII. NUMBER OF CAST APPLIED

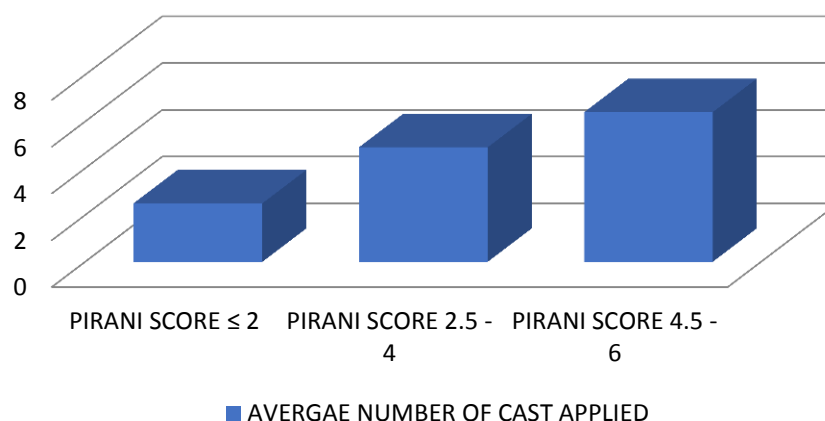
NUMBER OF CAST	NUMBER OF FEET (PERCENTAGE)
≤ 3	5 (13.88%)
4 – 6	21 (58.33%)
> 6	10 (27.77%)



9. Table XiV: NUMBER OF CAST APPLIED IN DIFFERENT PIRANI SCORE CATEGORIES

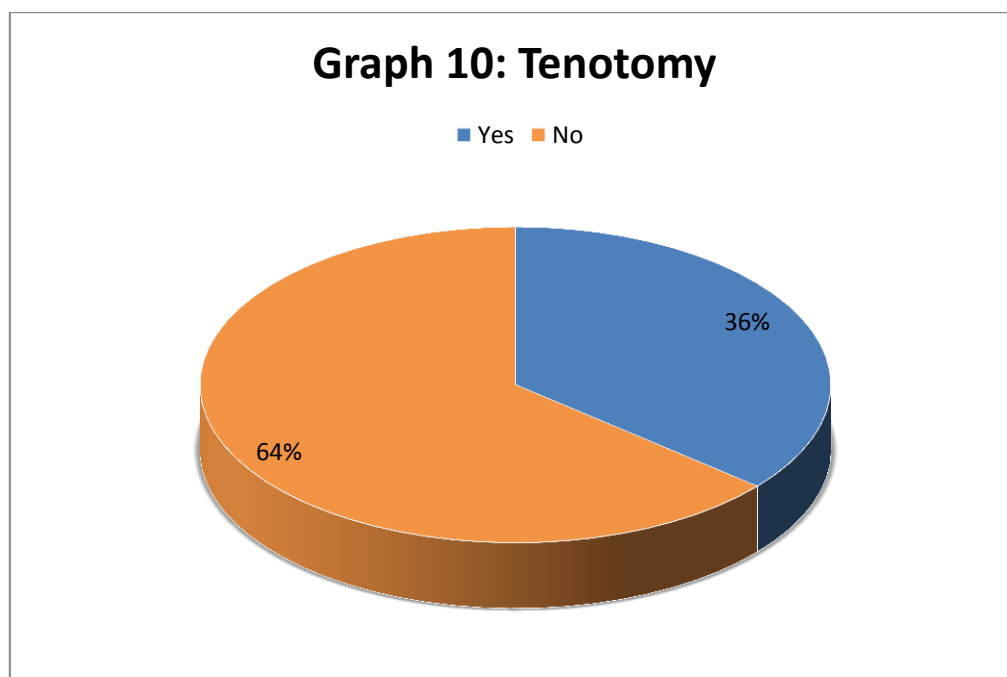
PIRANI SCORE CATEGORY	AVERAGE NUMBER OF CAST APPLIED
≤ 2	2.5
2.5 – 4	4.9
4.5 - 6	6.4

GRAPH 9 : AVERAGE NUMBER OF CAST APPLIED IN DIFFERENT PIRANI SCORE CATEGORIES.

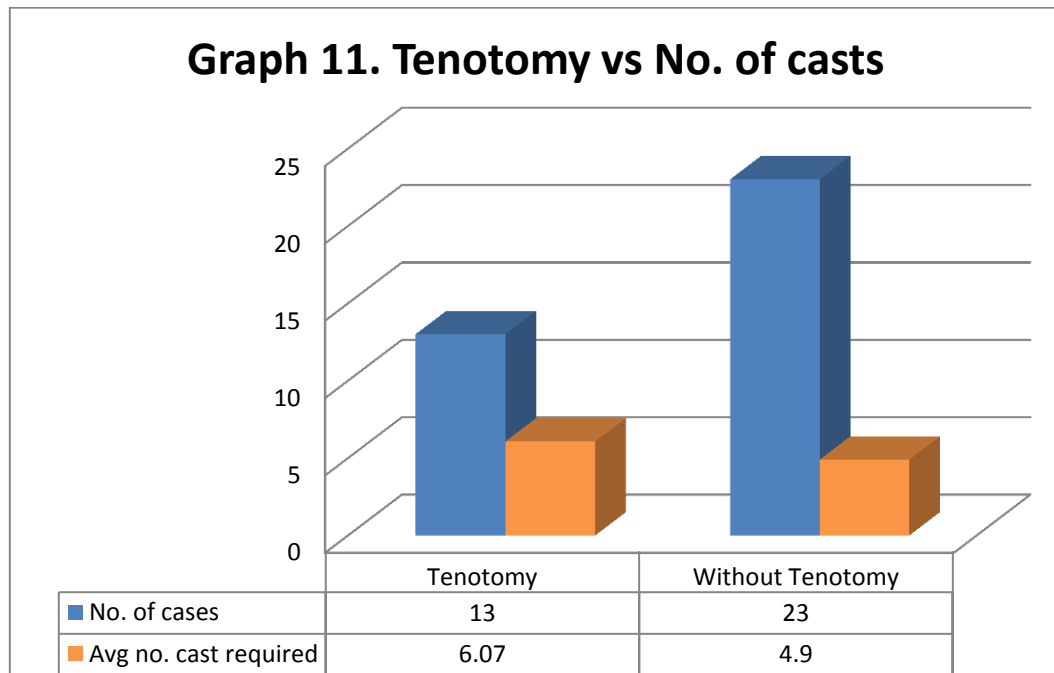


10. Table XV. NUMBER OF CASES REQUIRING TENOTOMY

TENOTOMY REQUIRED/NOT REQUIRED	NUMBER OF FEET
TENOTOMY REQUIRED	13 feet (36%)
TENOTOMY NOT REQUIRED	23 feet (64%)

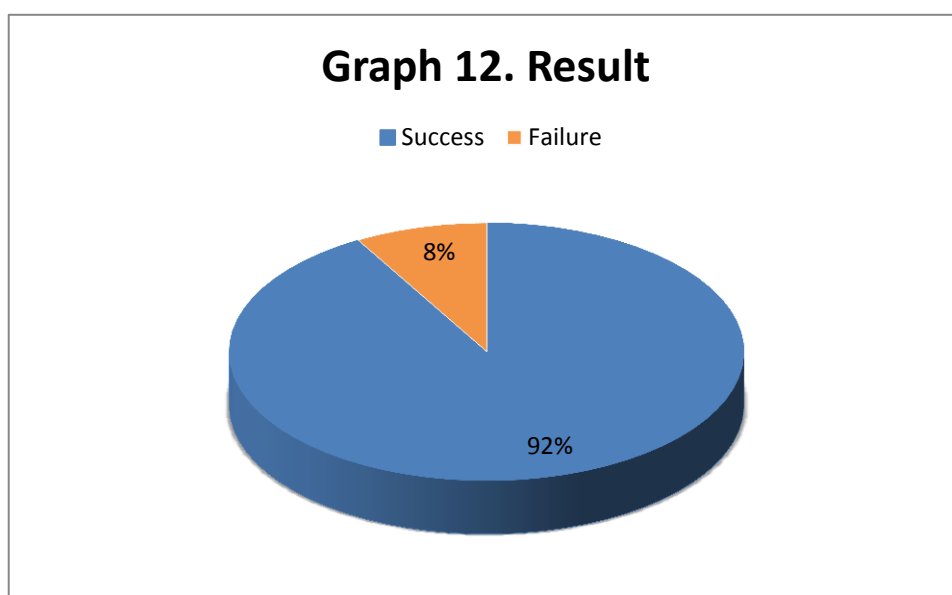


11. Table XVI: RELATION BETWEEN NUMBER OF CAST REQUIRED AND TENOTOMY DONE.



12. Table. XVII. FINAL OUTCOME

FINAL POUTCOME	NUMBER OF FEET (PERCENTAGE)
SUCCESS	33 (92%)
FAILURE	3 (8%)



DISCUSSION



DISCUSSION

Congenital talipes equino varus is a complex deformity of the foot in an otherwise normal child. It consists of 4 deformities :

- Midfoot Cavus
- Midfoot Adduction
- Heel Varus
- Ankle Equinus

The aim of treatment is to achieve a painless, plantigrade foot with good mobility with no need for special or modified shoes.¹

It is a developmental anomaly which develops after 3rd month of intrauterine life. It is induced by an unknown dysfunction in the posterior and medial aspects of the leg, ankle and foot.¹²

There is decrease in the size of the muscles and an excess of collagen synthesis with retracting fibrosis in the medial and posterior tarsal ligament, in the deep fascia and the tendoachilles and the posterior tibial tendon.^{11,12}

These changes induce severe equinus, medial displacement of the navicular, heel varus and foot adduction.¹¹

The period of dysfunction causing the deformity starts in the middle third of pregnancy lasts to the third or fourth year of life. In mild cases, it may

start in late foetal life, and remain active for only a few months after birth.¹¹

The fibrosis is most pronounced from a few weeks preceding birth, to a few months after birth. This is the period when collagen accretion is greatest in tendons and ligaments in humans.

Relapses appear to be related to the intensity of collagen synthesis as the foot grows. Thus, relapses occur commonly in premature infants and more slowly in older infants.

Relapses are less common in mild club feet and in children with loose ligaments as there is minimal fibrosis.

Treatment of clubfoot remains as controversial as the etiology. Various conservative methods of treatment have been described with variable and often irreproducible results. The surgical methods have their own limitations and complications.

After many years during which surgical methods were touted as the treatment of choice, conservative methods like the Ponseti's technique have again become popular as a treatment method of Congenital talipes equino varus.

The Ponseti's technique is based on understanding of pathoanatomy of the clubfoot. Hence, we followed Ponseti's technique in our study and

assessed the correction of deformity of foot at each follow up upto 6 months post treatment using Pirani scoring in a rural population.

Age Distribution.

The age group seen in the present study shows 11 cases (40.7%) below 1 month of age, 7 cases (25.9%) from 1 month to 6 months, 7 cases (25.9%) from 6 months to 1 year and 2 cases (7.40%) above the age of year. Which corelates with studies done by various studies done by Ignacio V Ponseti, Mazhar Abbas Owais, M Changulani and V Pavone which majority of the cases being below the age of 6 months at the time of starting the treatment.

Table XVIII. Age of patients who underwent treatment

AUTHORS	AGE GROUPS	MEAN AGE
Ignacio V Ponseti ¹⁵	52 patients = <3months 38 patients = 3months to 1 year	-
Abbas M, et al ³	-	4.5 months
M Changulani, et al ¹⁹	45 patients = < 3 months 13 patients = 3 to 6 months 8 patients = > 6months to 15 months	3 months
V Pavone, et al ²⁵	-	14 days
Present study	11 patients= < 1 month 7 patients= 1month to 6 months 7 patients= 7 months to 12 months 2 patients= above 12 months	4 months

Gender distribution.

Although the compared studies show an increased inclination towards male cases, our studies had almost similar incidence. A total of 27 patients (36 cases) were included in our study, of which 14 were male (constituting 52% of the patients) and 13 were female (constituting 48% of the patients).

Table XIX. Gender distribution

Authors	Males	Females
Ignacio V Ponseti ¹⁵	-	-
Abbas M, etal ³	80%	20%
Changulani, et al ¹⁹	75.75%	24.25%
V. Pavone ²⁵	68.29%	31.71%
Present study	52%	48%

Unilateral VS Bilateral involvement

Of the 27 patients in the study, 9 were Bilateral cases (33% of patient population), 18 were Unilateral cases (67% of patient population).

All the compared studies had similar pattern of involvement of feet.

Table XX. Unilateral vs Bilateral involvement of feet

Authors	Unilateral	Bilateral
Ignacio V Ponseti ¹⁵	-	-
Abbas M, etal ³	62%	28%
Changulani et al ¹⁹	64%	26%
V. Pavone ²⁵	61%	39%
Present study	67%	33%

Average number of casts required for correction

In our study the average number of casts required for the correction of a feet were about 5 casts. Which is quite similar to the number of casts required in the compared studies.

Table XXI. Average number of casts required for correction

Authors	Number of casts
Ignacio V Ponseti ¹⁵	5
Abbas M, et al ³	7
Changulani ¹⁹	6
V. Pavone ²⁵	7
Present study	5

Pre-treatment Pirani score

The pre-treatment average Pirani score of the compared cases had an average of 4.26 in the study by Mazhar Abbas Owais et al, 5 in the study by Changulani et al, 5.56 in the study by V. Pavone et al. In our study we found the average oretreatment Pirani score to be 4.44 which is quite similar to the compared studies.

Table XXII. Pre-treatment Pirani scoring

Authors	Pretreatment pirani score
Ignacio V Ponseti ¹⁵	-
Abbas M, et al ³	4.26
Changulani, et al ¹⁹	5
V. Pavone, et al ²⁵	5.56
Present study	4.44

Post treatment Pirani score

The Post treatment Pirani score in our study was 0.48, which is very similar to the compared studies done by Mazhar Abbas Owais, Changulani.

Table XXIII. Post treatment pirani scores

Authors	Post treatment pirani score
Ignacio V Ponseti ¹⁵	-
Abbas M, et al ³	1.3
Changulani, et al ¹⁹	0.5
V. Pavone ²⁵	-
Present study	0.48

Number of cases with relapse

Ignacio V Ponseti in his study noted 14 relapses, whereas Mazhar Abbas Owais, et al had 5 relapses, Changulani et al had 15 relapses, whereas V Pavone had 3 relapses. In our study of the 36 feet we studied we found 3 relapses at the end of 6 months of follow up.

Table XXIV. Number of cases with relapse

Authors	Relapse
Ignacio V Ponseti ¹⁵	14
Abbas M, et al ³	5
Changulani ¹⁹	15
V. Pavone ²⁵	3
Present study	3

Number of cases with tenotomy

The number of cases requiring a tenotomy in the compared studies were significantly higher as compared to our study. In our study, 13 feet (36%) of 36 feet required tenotomy, 23 feet (64%) of 36 cases did not require tenotomy. Which was done only in cases of feet which did not get corrected with casting.

Table XXV. Number of cases with tenotomy

Authors	Number of cases with tenotomy (%)
Ignacio V Ponseti ¹⁵	84
Abbas M, etal ³	96
Changulani ¹⁹	85
V. Pavone ²⁵	83
Present study	36

Outcome of the study

The success rate in our study was 92 %. Which is comparable to the studies which were done by Ignacio V Ponseti, Mazhar Abbas Owais, Changulani, V. Pavone.

Table XXVI. Outcome of the study

Authors	Success (%)	Failure (%)
Ignacio V Ponseti ¹⁵	84	16
Abbas M, et al ³	95	5
Changulani ¹⁹	96	4
V. Pavone ²⁵	96	4
Present study	92	8

In our study, we noticed that an increased number of casts were required with increase in the age.

In age below 1 month the average number of cast required was 4.9, from 1 month to 6 months the average number of cast required was 5.5, from 7 months to 1 year the average number of cast required was 5.8, whereas for age more than 1 year the average was only 5.

But the numbers are not conclusive in the age group of more than 1 year as it consists of only 2 cases and could not be commented upon.

We also noticed that, with increase in Pirani score the number of casts required for correction of the deformity was also more.

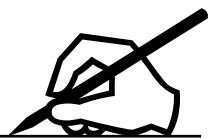
In cases with Pirani score ≤ 2 average number of casts 2.5, in cases with Pirani score 2.5-4 the average number of casts required were 4.9, in cases with Pirani score 4.5-6 the average number of casts required were 6.4.

This positive variance in the number of cast required to treat CTEV deformity with a higher pre-treatment Pirani score was also noted in study done by Abbas M et al³.

We also noticed that patients who required tenotomy required more number of casts to achieve corrections.

In our study, 13 feet (36%) of 36 feet required tenotomy, 23 feet (64%) of 36 cases required tenotomy. Probably because the manipulation of the foot with cast was attempted prior to the use of tenotomy for equinus correction.

CONCLUSION

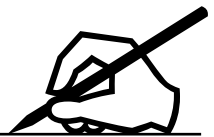


CONCLUSION

1. Ponseti's Method is an excellent conservative method for treatment of Congenital Talipes Equino Varus (CTEV) deformity.
2. Treatment must be started at the earliest possible age. Number of casts required to achieve full correction increases as the age at presentation increases.
3. Ponseti's method is effective in correction of idiopathic clubfoot in children up to 2 years of age.
4. Higher age of the patient may not necessarily mean that the deformity is resistant to correction but may necessitate a more prolonged casting period.
5. Tendoachilles Tenotomy can be safely done up to 2 years of age with no apparent adverse effect apparent at 6 month follow-up.
6. Relapse of deformity was found to be more related to the non-compliance to foot abduction brace or Denis Browne Splint.
7. Adherence to the casting technique helps in successful correction.
8. Compliance on the parent's part in the use of foot abduction brace is essential to prevent the relapse of deformity.

-
9. In a rural area of developing country like India, where poverty and ignorance still are prevalent, this technique is a very safe, easy and effective method of clubfoot management.

SUMMARY



SUMMARY

The study was a prospective, conducted in the Orthopedics department of RL Jalappa hospital from July 2015 to November 2017.

The study included 27 patients. 14 patients were male and 13 patients were female.

11 cases (consisting of 41% of all cases) were below the age of 1 month, 7 cases (consisting of 26% of all cases) were in the age of 1-6 months, 7 cases (consisting of 26% of all cases) were in age of 7 to 1 year, 2 cases (consisting of 7% of all cases) were above age of 1 year. Of the 27 cases, 9 cases had bilateral foot deformity and 18 cases had unilateral foot deformity.

Thus, a total of 36 foot from 27 cases were included in the study. Of the 18 unilateral cases, 9 cases had deformity of left side and 9 of the right side.

One case of Bilateral Congenital talipes equino varus had a rigid deformity.

In our study, we noticed that an increased number of casts were required with increase in the age. In age below 1 month the average number of cast required was 4.9, from 1 month to 6 months the average number of cast required was 5.5, from 7 months to 1 year the average number of cast required was 5.8, whereas for age more than 1 year the average was only

5. But the numbers are not conclusive in the age of more than 1 year as it consists of only 2 cases.

We also noticed that, with increase in Pirani score the number of casts required for correction of the deformity was also more. In cases with Pirani score ≤ 2 average number of casts 2.5, in cases with Pirani score 2.5-4 the average number of casts required were 4.9, in cases with Pirani score 4.5-6 the average number of casts required were 6.4.

In the cases in our study the average Pirani score of the feet were 4.44.

In our study, 13 feet (36%) of 36 feet required tenotomy, 23 feet (64%) of 36 cases required tenotomy. We also noticed that patients who required tenotomy required more number of casts to achieve corrections.

Post correction the cases were followed up till 6 months and the average Pirani score of the feet were 0.48, of which adduction was the commonest deformity noted.

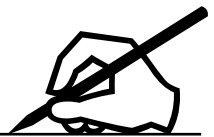
In our study we found that 33 feet (92% of cases) had successful outcome at the end of 6 months of follow up. We also found that 3 feet (8% of feet) or 2 (7.4% of the cases) cases had relapses at end of the follow up.

Both the cases (3 feet) didn't use the Denis Browne splint as advised post treatment with the Ponseti's casting technique.

Thus, we could suggest that the commonest cause of relapse is due to non-compliance/improper usage of splint post treatment. But it is difficult

to comment on the cause of relapse in our study as the number of relapses were low.

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BIBLIOGRAPHY

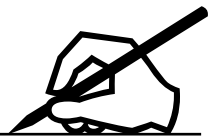
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ANNEXURE



ANNEXURE

PROFORMA

Name : Case no :

Age : Ip/op no :

Sex : DOB :

Birth wt. :

Address :

Chief complaints :

History of presenting illness :

Past history :

Family history :

Personal history

General physical examination :

Vital signs

Systemic examination

BP -	1. CVS
RR -	2.RS
PR -	3.CNS
Temp -	4.PA

Diagnosis :

LOCAL EXAMINATION:

- Inspection -

Anteriorly:-

Medially :-

Laterally :-

Posteriorly:

- Palpation :-

- **Pirani scoring of the foot:-**

<u>Physical examination findings</u>	<u>Score of 0</u>	<u>Score of 0.5</u>	<u>Score of 1</u>
Curvature of lateral border	Straight	Mild distal curve	Severe distal curve
Severity of medial crease (foot held in maximal correction)	Multiple fine creases	One or two deep creases	One deep crease
Severity of Posterior crease	Multiple fine crease	One or two deep creases	One deep crease
Palpation of lateral part of head of talus	Navicular completely reduces, lateral talar head not palpable	Navicular partially reduces, lateral talar head is	Navicular could not be reduced, lateral talar head easily

		palpable	palpable
Emptiness of heel (foot and ankle in maximal correction)	Tuberosity of calcaneus easily palpable	Tuberosity of calcaneus difficult to palpate	Tuberosity of calcaneus not palpable
Rigidity of equinus	No Rigidity	Equinus can be partially corrected	Equinus cannot be corrected

Pirani scoring during follow ups:-

Date	PIRANI SCORE

TENOTOMY PROCEDURE-Is Tenotomy required? Y/N

Type of Anaesthesia: 1) General Anaesthesia

2) Local Anaesthesia

ASSESSMENT OF RESULT:

PATIENT INFORMATION SHEET

Study title: A prospective study on treatment of congenital talipes equino varus deformity by Ponseti's cast application technique

Study site: R.L Jalappa hospital, Tamaka, Kolar.

Aim

- To document the clinical profile of club foot- rigidity, laterality and severity.
- To assess the success rate and average duration required for correction with Ponseti method.
- To document the number of relapse in a short term follow up of 6 months.

Patient with congenital talipes equino varus will be selected. Please read the following information and discuss with your family members. You can ask any question regarding the study. If you agree to participate in this study we will do weekly casting of the feet till correction is achieved and Denis Brown splinting of the feet after correction. This information collected will be used for dissertation and publication only.

All information collected from you will be kept confidential and will not be disclosed to any outsider. Your identity will not be revealed. This study has been reviewed by the Institutional Ethics Committee and you are free to contact the member of the Institutional Ethics Committee. There is no compulsion to agree to this study. The care you will get will not change if you don't wish to participate. You are required to sign/ provide thumb impression only if you voluntarily agree to participate in this study.

For any further clarification you can contact the study investigator:

Dr. Ayanakha Mallick

Mobile no: 9449667685

E-mail id: ayanax.mallick@gmail.com

CONSENT

I/WE THE PATIENT ATTENDERS HAVE BEEN EXPLAINED ABOUT OUR PATIENTS CONDITION AND THE NEED FOR THE PROCEDURE IN THE TREATMENT OF OUR CONDITION.

THESE PROCEDURES AND COMPLICATIONS HAVE BEEN EXPLAINED TO ME IN MY OWN UNDERSTANDABLE LANGUAGE. I AM WILLING TO PAY FOR THE PROCEDURE AND THE TREATMENT.

I/WE.....G/O..... IN MY FULL SENSES GIVE MY CONSENT OF MY/OUR CHILD TO TAKE PART IN ABOVE MENTIONED STUDY WHICH INCLUDE WEEKLY MANUPULATION AND CASTING OF THE FOOT AND MAY REQUIRE TENOTOMY AND THE USE OF DENIS BROWN SPLINTING. I DON'T HOLD ANY TREATING DOCTOR,NURSING STAFF AND HOSPITAL MANAGEMENT FOR ANY UNTOWARD CONSEQUENCES.

I HERE BY GIVE MY CONSENT FOR THE SAME.

SIGNATURE OF THE GUARDIAN:

DATE:

CASE REPORTS (FIGURE NO: 32)

Case 1.

Pre-treatment Photograph



Ponseti's casts applications during treatment





Post treatment corrected feet



Case 2.

Pre-treatment Photograph



Ponseti's casts applications during treatment





Foot in relapse at 6 months of followup



Case 3.

Pre treatment photograph



Ponseti's casts applications during treatment





Post treatment corrected feet



Denis Browne splinting of feet



Foot at 6 months of follow up



MASTER CHART



MASTER CHART

SL.NO.	NAME	AGE/SEX	FH of CTEV	FLEX/RIG	SIDE	Gr	Gr	N. of cts	N.of cts	T E N	TEN	RESULT/ pirani score	RESULT/ pirani score
						R	L	R	L	R	L	R	L
1	Baby of Munilaxmamma	15 days/M	N	Flexible	R	6		5		Y		Success, 0	
2	Baby of Sarita	1mths/M	N	Flexible	L		6		6		N		Success, 0.5
3	Baby of Vennela	4mths/F	N	flexible	R	4		5		Y		Failure (relapse), 2.5	
4	Baby of Manjula	5days/M	N	Flexible	R	3.5		4		N		Success, 0	
5	Jeethu Vinayak	1yr/M	N	Flexible	R	6		7		Y		Success, 0	
6	Baby of Sarojamma	5days/M	N	Flexible	R	1.5		2		N		Success, 0.5	
7	Sahadab	8 mths/M	N	Rigid	B/L	4	4	6	6	Y	Y	Failure	Failure (Rigid), 1.5
												(Rigid), 1.5	
8	Baby of Varalaxmi	7mths/M	N	Flexible	R	4		5		Y		Success, 0.5	
9	Baby of Laxmi	11mth/M	N	Flexible	B/L	6	6	6	6	Y	Y	Success, 0.5	Success, 0.5
10	Baby of Chaitra	1 day/F	N	Flexible	R	4		5		N		Success, 0	

11	Baby of Shaziya	15days/M	N	Flexible	L		4.5	4		N		Success, 0	
12	Akhil	1mths/M	N	Flexible	B/L	4.5	2.5	5	3	N	N	Success, 0.5	Success, 0
13	Afra Khanum	7mth/F	N	Flexible	L		4		4		N		Success, 0.5
14	Baby of Ayesha	5mth/F	N	Flexible	L		1.5		2				Success, 0
15	Baby of Shilpa	1day/F	N	Flexible	B/L	2	2	3	3	N	N	Success, 0	success, 0
SL.NO.	NAME	AGE/SEX	FH of CTEV	FLEX/RIG	SIDE	Gr	Gr	N.of cts	N.of cts	TEN	TEN	RESULT	RESULT
						R	L	R	L	R	L	R	L
16	Riya Shine	9 mths/F	N	Flexible	L		3		5		Y		Success, 0
17	Unes Mary	6mth/F	N	Flexible	B/L	6	6	7	7	Y	Y	Success, 0.5	Success, 0.5
18	Baby of Tanziya	1day/M	N	Flexible	B/L	5	5	7	7	Y	Y	Success, 0.5	Success, 0.5
19	Chalukya	5mth/M	N	Flexible	B/L	4	4	6	6	N	N	Success, 1	Success, 0.5
20	Shravanthi	1 yr/F	N	Flexible	R	6		8		N		Success, 0.5	
21	Baby of Saraswati	15days/F	N	Flexible	B/L	6	6	7	7	N	N	Success, 0.5	Success, 0.5
22	Baby of Damini	15Days/F	N	Flexible	L		4		5		N		Success, 0.5
23	Lokesh	1Yr6mths/	N	Flexible	R	6		6		N		Success, 1	

		M											
24	Sarawathi	2yrs/F	N	Flexible	L		3		4		N		Success, 0
25	Baby of umavati	1day/M	N	Flexible	L		4		5		N		Success, 0.5
26	Baby of Ambika	7days/F	N	Flexible	L		3.5	5		N		Success, 0	
27	Baby Payal	4mths/F	N	Flexible	B/L	6	6	7	7	N	N	Success, 0.5	Success, 1