"A PROSPECTIVE STUDY ON DELAYED PRESENTING CTEV CASES MANAGED BY JOSHI'S EXTERNAL STABILISATION SYSTEM"

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CERTIFICATE

This is to certify that the work *"A* ***PROSPECTIVE STUDY ON DELAYED PRESENTING CTEV CASES MANAGED BY JOSHI'S EXTERNAL STABILISATION SYSTEM****"* which is being submitted for M.S. Orthopaedics, is a bonafide work of **Dr. KENNETH MARTIN.W** , Post Graduate Student at Department of Orthopaedics, Madurai Medical College, Madurai.

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DECLARATION

I, **Dr.KENNETH MARTIN.W**, solemnly declare that the dissertation titled *"A* ***PROSPECTIVE STUDY ON DELAYED PRESENTING CTEV CASES MANAGED BY JOSHI'S EXTERNAL STABILISATION SYSTEM****"* has been prepared by me. This is submitted to **"The Tamil Nadu Dr. M.G.R. Medical University, Chennai,** in partial fulfillment of the regulations for the award of M S degree branch II Orthopaedics.

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INTRODUCTION

Clubfoot is the most common congenital foot disorder,with an incidence of 0.9 /1000 live births[1] in India . The etiology, pathological anatomy, and treatment of ctev remains controversial.

Club foot may result from an osseous, muscular or neuropathic error, or idiopathic. Of these the last is by for the most frequent. Many theories have been advanced, including intrauterine moulding, developmental defects and anomalies of other systems (neurogenic, myogenic, vascular). Both genetic and environmental factors (especially maternal smoking) have been implicated.

There are many tissue abnormalities in CTEV, including deficiency of calf muscle bulk, changes in muscle histology, bone and joint deformities (e.g. talus and calcaneocuboid joint) and vascular hypoplasia.

The right age to perform surgical procedure is still on debate,with most surgeons delay it till infant is 4 to 6 months old [2] .Procedures of soft tissues are usually done up to first 2 years till maximum of 4 years, after which it has been

combined with wedge resection ,osteotomies and arthrodesis ,due to changes in growing bones and incongruity of joints[3]. But these feet during the end of treatment were far from normal and usually are small scarred and stiff[3]

However with advancement and enthusiasm shown in complex deformity correction using ilizarov technique ,paediatric and foot surgeons have applied the same principles of distraction histiogenesis in treatment of ctev[4]. This provided a good alternative to those feet which would have needed extensive surgical procedures,with an added advantage of less stiffness and shortening,that occurred due to extensive surgeries.

Dr.B.B. joshi [5]designed an external fixator by use of simple k-wires,link joints,distractors for correction of equinovarus deformities. This works on basis of controlled fractional differential distraction. Its advantage is that it can even applied in small non ambulatory children.

AIM OF THE STUDY

The aim of treatment in CTEV is to obtain a painless, pliable. Plantigrade,perfect sized and cosmetically acceptable foot.[7]

With various treatment modalities available,so far the end result has been a stiff, small and painful foot .The past few decades have witnessed an emphasis on extensive surgical release and new incisions with unsatisfactory results [7]

Till now there is no comprehensive evaluation system available which includes all the factors in achieving the aim. Hence various clinical and radiological findings have been used to evaluate the results.

This study aims at evaluating the result using FUNCTIONAL RATING SYSTEM[8] after controlled differential distraction using the JESS apparatus in delayed presenting cases and to evaluate the efficacy of the Functional Rating System in assessing the surgical results so that it can be compared with other studies

HISTORICAL REVIEW

- **HIPPOCRATES** described clubfoot as early as **300 BC.**[9] He thought that the cause may be intrauterine mechanical compression
- **Mc GUERIN –in 1836** first used POP in the treatment of Clubfoot[10]
- Surgical Management of CTEV was initiated by **LITTLE** by performing subcutaneous tenotomy of tendo achilles
- **SOLLY** - 1857 first introduced a bony procedure-(partial cuboidectomy.) (11)
- **PHELPS** - 1891 performed a technique of posteromedial release.[12]
- **DENNIS BROWN** - 1934 introduced a metal splint for correction of the deformity.[13]
- **HIRAM KITE** – widely popularised serial plaster casting for correction of deformity[14]
- **DILLWYN EVANS**-1961 described shortening of lateral column by resecting a wedge from calcaneo cuboid joint [15]
- **DWYER - 1962** described medial open wedge osteotomy for varus deformity of heel.[16]
- **IRANI and SHERMAN - 1963** proposed that the medial deviation of neck of Talus was the basic deformity in club foot [17]

- **TURCO 1971** advocated a single stage posteromedial release which he modified in 1979 by adding stabilisation with k-wires [18]
- **LITCHBLAU - 1972** suggested lateral relase in addition to medial release for correction[19]
- **MCKAY 1982** advocated a complete subtalar release ,leaving behind posterior talofibular ligament and interosseus talo-calcaneal ligament intact[7]
- **SIMONS - 1985** described a subtalar release and release of both posterior talofibular and inteerosseous talocalcaneal ligaments to aid in derotation of the calcaneum beneath the talus [21]
- **ILIZAROV[22] - 1960** s began using his circular external fixator. His research resulted in the theory of distraction histoneogenesis
- Using this principle **B.B. JOSHI[5]** invented his Joshi's External Stabilisation system for correction of CTEV by controlled fractional differential distraction in 1994 .

ETIOLOGY

The literature is flooded with theories as to the causation of club-foot but there still remain few facts on which to base these conclusions

1. Heredity

Evidence from genetic studies indicates a mixed genetic and environmental causation (WYNNE DAVIES - 1974)[23].She considered the incidence in relation to first degree relatives and found 2.9% of siblings affected as against 1.2 per 1000 in general population.She also found that there is a change of 1.3% incidence if an identical twin is involved.

2. Intrauterine Mechanical factors

fetal malposition during intra uterine life was suggested by Hippocrates and later elaborated by Parker shattock (1884)[24] and Nutt (1925) [25]. This is not well supported as the incidence of Clubfoot is not increased in the overcrowded uterus like twins,hydramnios and oligohydramnios.

3. .Neuromuscular Factors

The etiology later shifted towards peroneal nerve lesion caused by pressure in the uterus and concomittant evertor weakness WHITE[26] (1929)

ISSACS 1977[27] showed histochemical and electron microscopic study of muscles in CTEV which suggesting neurogenic abnormality.They proposed a theory of abnormal innervation but later were unable to detect any abnormality in muscle.

4. Primary Germplasm Defect

Proposed by IRANI and SHERMAN[28], as they found out constant defect in the anterior part of talus in dissected specimens of still births.

5. Musculo Ligamentous factors

IPPOLITTO and **PONSETTI** (1980)[29] found a significant increase in fibrous tissue in muscles, tendonsheaths and fasciae of the posterior and medial aspect of the leg with thickening of TA and tibialis posterior tendon. They also detected decrease in number and size of muscle fibres in the posterior and medial group of muscles of leg .

6. Vascular factor

In an arteriographic study ATLAS [30] noted an ischemic area at level of sinus tarsi and proposed a vascular factor may contribute to the etiology of CTEV.

7. Arrested development[31]

During 9th and 10th weeks of intrauterine life the embryonic foot has characteristics of well developed, equinus, inversion and adduction. So it was suggested that arrest of the talus development at that period may be the cause for deformity.

PATHOLOGICAL ANATOMY

The following Pathological changes occur in soft tissues, joints and bones of the feet[(28),(30) ,(32)

Ligament changes

Posterolateral contractures –noted in

- Superior peroneal tendon sheath,
- Calcaneo fibular ligament ,posterior
- talo calcaneal ligament.

Posterior contractures –seen in

- Posterior talo-fibular ligament,
- Sub-talar Joint capsule.
- Ankle joint capsule,

Medial contractures were seen in- -

- Deltoid ligament
- spring ligament
- Talonavicular capsule.
- Dorsal talo navicular ligament.

Plantar contractures were noted in-

- Bifurcated 'Y' ligament.
- Long plantar ligament,
- plantar calcaneo - cuboid ligament.
- Navicular cuboid ligament.

Muscles and tendon changes :

In late uncorrected cases,the clinical appearance show wasting of calf and atrophy of gastrosoleus complex.

A reduction in the number and size of fibres associated with an increase in fibrous connective tissue in gastrosoleus and in their tendon sheaths was noted

Altered ratio of Type I and Type II fibres and atrophy of fibres suggestive of altered innervation were seen in triceps surae, tibialis posterior and flexor hallucis longus

The tendo achilles is short and its medial portion fans out to get inserted on the medial surface of the calcaneus which produces both equinus and hind foot varus.

The tibialis posterior tendon is thickened distal to the medial malleolus and there is broadening of its insertion into plantar surface .

Owing to the inversion and adduction of foot, the extensor hallucis longus is displaced medially

The flexor hallucis longus does not groove the talus since it is displaced forwards and it passes almost vertically downwards over the inner surface of the calcaneum.

JOINT CHANGES :

Ankle joint

The antero-superior articular surface of the talus is increased in breadth and the posterior part is poorly developed. Only 1 /3rd of the lateral facet is in contact

with the fibula. the anterior 2/3rd remains uncovered.The medial surface is fully opposed to the medial malleolus but it becomes oblique.

Posterior talo calcaneal joint

The talar articular surface is concave and the calcaneal articular surface is convex These articular surfaces are smaller than normal and are less than the anterior talo calcaneal surfaces. In the horizontal plane the calcaneus rotates medially so that its anterior end lies beneath the head and neck of the talus

Talo navicular joint

This joint is grossly abnormal,the navicular is displaced medially and articulates with the medial side and plantar surface of the head of the talus The joint is not actually dislocated but is in extreme position of medial and plantar displacement.The navicular bone often develops a new facet medially when it may form an articulation with the sustentaculum tali of the calcaneum

Calcaneo - cuboid joint

Cuboid is displaced medially under the navicular and cuneiform bones. The calcaneus does not articulate fully with it.

The remaining joints of the fore foot show some adduction.

BONY CHANGES

Calcaneum

The calcaneus is involved in all of the components of the deformity and is grossly normal except that the three facets on the dorsal surface are flattened and the sustentaculum tali is hypoplastic.

Talus

The talus is smaller and plantar flexed .The neck of the talus is short and medially deviated at an angle of more than 45° relative to the body of the talus compared with the normal 25° The medial surface of the talus is grossly deformed and small.The anterior articular facet faces inwards and downwards.

Navicular

The navicular is rotated so that its long axis is nearly vertical and its tubercle may come into contact with the medial malleolus. The remaining foot bones show very little change in the newborn.

Radiology

X-rays are not routinely ordered at birth as few bones in the foot are ossified.

X-rays, if done at all, are taken after three to four months of age.

Role of radiology in ctev:[(33)]

- To assess degree of subluxation of talo-calcaneal and talo-navicular joints and severity before treatment.
- To guide progress during conservative or operative treatment.
- To ascertain whether reduction and joint alignment have been obtained.
- To determine whether alignment has been maintained.

Technique:

The patients feet must be placed in identical and maximally corrected position while taking standard pictures.

For AP view the child is placed in a sitting position with hips and knee flexed and feet resting on the cassette with medial borders parallel.AP view is taken with the beam directed cranially 30 degree.from the perpendicular towards the dome of the talus

For taking lateral view in stress dorsiflexion,in standing age group and cooperative children they were made to stand on one foot place over small stool and true lateral weight bearin xrays were taken. In non standing or un cooperative children we used either wooden plank or cloth or bandage roll to give dorsiflexion

Normal appearance:

- In lateral view the axis of the talus is aligned downwards and in line with the axis of the first metatarsal. The axis of calcaneus is aligned slightly upwards. The lines drawn along the axis of these bones meet at an angle of 20-40(talo-calcaneal angle)

- In AP view the long axis of talus passes through the long axis of I st metatarsal.The long axis of calcaneum passes through iv th metatarsal.

- The AP and lateral talo calcaneal angles when summated forms the talo calcaneal index which is usually more than 40 in corrected foot.

The appearance in the club foot varies with severity of the deformity

R**adiological angles**

Normal range (in degrees)

Anteroposterior view	**normal values**
Talocalcaneal	20-40
Talo-1st metatarsal	0-20
Calcaneal-2nd metatarsal	15-20
Lateral view	
Talocalcaneal	35-50
Tibo-calcaneal	**60-100**
Talacalneal index	**≥40**

- The anterior talocalcaneal angle and Lateral talocalcaneal angle are indicators of hindfoot varus.
- talus – first metatarsal angle is an indicator of adduction deformity
- Calcaneus – second metatarsal angle is an indicator of forefoot adduction
- The lateral tibiocalcaneal angle is an indicator of equinus at hindfoot

MANAGEMENT OVERVIEW

The literature regarding management of complex club feet, which either neglected or which have relapsed after full correction can be summed under the following subheadings.

A. Problems in the assessment of severity of deformity and adequacy of correction

B Surgical options available, their principles indications and limitations.

C. Role of soft tissue distraction.

Problems in assessment of severity and adequacy of correction :

The lack of universally accepted method of evaluating the severity of deformity prior to correction and the improvement after treatment has hindered the assessment of the validity of various concepts of treatment

While earlier literature documented both the severity of the deformity and results of the treatment based on clinical criteria, the development of a standardised method for the radiographic evaluation of the club foot by SIMONS (1978)(33) and the use of this method of analytical radiography in identifying various deformity combinations have contributed significantly to the objective assessment of severity. MCKAY (1983)[7] developed an overall rating system for rating the

results of his circumferential release which was based on an arbitrary assignment of

180 points to a normal foot Deformity, loss of ankle mobility. loss of function and pain were assigned values proportional to their deviation from the normal foot and subtracted from the standard

CATTERALL (1991)[(34)] has developed a method of assessment of at foot deformity based on a dynamic concept of the foot, a thorough knowledge of movements of foot and by defining a particular foot in terms of its fixed deformities. The method of assessment helped to identify a resolving pattern of club foot and club foot resulting from either a tendon contracture or joint contracture.

CARROLL[(35)] basing his criteria on essentially the same factors as Catterall, developed a 10 points scoring system for preoperative evaluation which consisted of 10 anatomic criteria.The presence of any of these criteria would secure one point each with a maximum score of 10 indicating the presence of all the criteria.The advantage of this system is its simplicity.

ATAR,LEHMAN et al (1990)[8] devised a functional rating system (FRS) for evaluating the results of operated club feet.The rating combined subjective and objective clinical assessment and radiographic criteria with a normal foot being

100 points. The results could be evaluated as excellent with 85-100 points. good with 70-84 points, fair with 60-69 points and poor being less than 60 points

CUMMINGS [6] in an extensive and pioneering work reviewed the literature from 1966 to 1990 and found 85 different parameters were used by different authors. 37 of these 85 criteria were evaluated for inter obsrever error in assesssment. Certain fallacies of assessment were namely the range of ankle motion both active and passive was difficult to differentiate from subtalar and midtarsal movements. Radiographically difficulty was found to draw the long axes of ossific nuclei of calcaneus and talus in immature children.

The surgical procedures

The Surgical procedures that are currently in use can be divided into four basic groups.

A. **Procedures involving soft issue alone**.

Posterior release.

Postero medial release.

Cicumferential release.

Tendon transfers.

Tarso metatarsal capsulotomies.

B. Procedures involving bone alone.(16)

Oseteotomy of the metatarsals

Calcaneal osteotomy – Dwyer's procedure.

Triple arthrodesis.

C. Procedures involving both bone and soft tissue.[15][19]

Dillwyn Evans procedure.

Lichtblau procedure.

Decancellation of cuboid.

D. Distraction histogenesis:

Although the literature abounds with description by various authors regarding innumerable techniques and their variations in the primary correction of severe,resistant clubfoot, only very few reports are a available which primarily address the problems in delayed presenting CTEV.

These feet very often subject to previous surgeries, single or multiple and present with problems peculiar to them and require a much more complex line of management.

Salvage of these feet in the past has always consisted of massive soft tissue releases combined with varying methods of osteotomies and fusions of foot and ankle to produce a plantigrade and somewhat functional foot The resulting foot

often has been fore shortened, stiff and nothing more than a cosmetically acceptable but functionally poor foot.

BROCKMAN (1930)[36] and DILLWYN EVANS (1961)[15] thought that a club foot did not relapse after treatment. but in such cases the initial correction was inadequate EVANS proposed a wedge resection of calcaneo-cuboid joint in addition to medial and posterior soft tissue release This procedure permitted the mid part of the foot to be moved through the mid tarsal joints, shortened the lateral column. permitted the released navicular to become reduced on the head of the talus and corrected the 'talus inclination of heel Evans found the best age for operation was between 4-8 years

ABRAMS (1969)[37] in a review of the results of Evans' operation also concluded that incomplete correction was the main reason for failures rather than true relapses. His results with this surgery in relapsed case are almost identical with those of Evans' and were much better than additional soft tissue procedures done after the age of two years. He concluded that it would be best to employ nonsurgical holding procedures between the ages of 2-4 and then perform the Evans' procedure

FREDRICK DWYER[16](1963)concluded that persistence of a small inverted heel in a club foot was the singular factor which prevented and promoted relapse of deformity after full correction He proposed medial opening wedge osteotomy of calcaneus using a wedge shaped graft from upper tibia along with TA lengthening performed at the ages of. 3-4 years as a mean to set right this primary anomaly

HEROLD and TOROK (1973) [38] proposed a two stage procedure. a soft tissue, procedure comprising medial release, resection of abductor hallucis sectioning of tibialis posterior tendon and TA lengthening constituting the first stage. This was followed by an intermediate period of manipulations and maintenance in POP cast. The second stage comprised of bony repair resulting in realignment of articular surfaces of the tarsus and ranged from osteotomies to triple arthrodesis Evaluation of results showed encouraging results on the cosmetic aspects with functional improvement being inadequate

TURCO (1971, 1979)[18]suggested that surgical correction of resistant clubfoot should be performed in a single stage and hypothesised that failure to achieve the correction and maintenance of the same were the factors responsible for recurrence of the deformity.

THOMPSON et al (1982)[39] evaluated the various protocols in the surgical management of resistant CTEV and compared the two schools of thoughts namely

a) a limited release confined to those structures which caused resistance to correction and were responsible for relapses and

b) Release of all components of the deformity as propagated by Turco. They concluded that better results were ahcieved with release of all components of the deformity.

ADDISON et al (1983)[40] performed a modification of the Dilwyn Evan's operation on 45 feet in 37 patients whose age ranged from 3 1/2 to 14 years.42 of these feet had been previously operated. Results were assessed with a scoring system, which considered predominantly the functional ability 30 feet were treated successfully not needing any further operation, most feet were stiff but free from pain and able to fit into normal shoes.

ATAR. LEHMAN et al (1991)[8] evaluated the success rate of primary surgical correction, achieved by soft tissue release. performed by experienced surgeons and found that they ranged from 50-87% with average failure or recurrence rate of 25%. Assessing the various causes of failure they developed a protocol to be followed as a guideline while planning revision surgery.

They emphasised that even the best results cannot be regarded as normal looking foot since shortening of the affected foot and hypoplasia the calf were constant and permanent findings.

KUMAR (1993) [41] evaluated the late results of 36 feet in 26 patients who had been operated upon by Dwyer himself in the 1950s The long term results were good with the osteotomy Plantigrade foot as achieved in 88% of cases

The Role of soft tissue distraction

The use of various techniques for limb lengthening was not considered for the treatment of complicated foot deformities until few decades ago.Although Codivilla had first described limb lengthening as early as 1950 and Wagner had popularised his technique of leg lengthening with use of a special distractor, treatment of complicated foot deformities remained confined to various osteotomies with or without soft tissue release before skeletal maturity and variations of triple arthrodesis after skeletal maturity.

ILIZAROV in the soviet union in the early 1950s developed the concept of regeneration of tissues by controlled distraction and by this way new bone could be formed (distraction osteogenesis) as well as regeneration of vessels, muscles, tendons and nerves could be achieved (distraction histoneogenesis)

In the 1960s and 1970s the Italians streamlined the Ilizarov distraction osteogenesis technique and Italian names were given. Such as Callotasis for Distraction of bone and chondrodiastasis for distraction of physis.

Gradually with the acceptance and success of these techniques attention was focused in their use in the correction of complex foot deformities

FRANKE,GRILL[22], ATAR & LEHMAN(8). OGANESIAN & ISTOMINA[42] were the pioneers in applying successfully the principles of distraction histoneogenesis in the treatment of neglected and relapsed club feet, both primary and secondary.

Club foot in 18 patients. whose ages ranged from 7-16 years was corrected between 1980 and 1990 with the Ilizarov technique without any osteotomy. [Grill, Franke[22] (1987). These included idiopathic CTEV - both neglected and relapsed. post trau-matic deformities, deformity secondary to Charcot - Marie - Tooth dis-ease and arthrogryposis multiplex congenita. Plantigrade foot was achieved with satisfactory radiological appearance in all but two of the 18 patients

The assembly consisted of 'K' wires passed through metatar-sals calcaneus and tibia. half rings, connecting rods and hinges at appropriate levels. Distraction was commenced 2-3 days after application The duration of the correction depended on the severity of the deformity and varied from 4 to 10 weeks following which the

device was retained for 8 to 10 weeks in a fixed position. Then the limb was immobilised in a plaster cast for 3 months to prevent relapse.

The Ilizarov method permitted simultaneous correction of all com-ponents of the deformity and avoided the delay until full skeletal growth which was needed if arthrodesis were to be performed for correcting the deformity

Hinge distraction devices were used by several Russian surgeons to correct severe forms of club foot deformity BATALOV 1990(44). ISTOMINA 1990[42] .While Batalov used his device exclusively in the correction of severe congenital club foot, Istomina & Kuzmin reported the successful use of soft tissue distraction in lieu of bony resections in the treatment of equinovarus deformities of diverse etiology

Volkov Oganesian Povarov (VOP) distraction apparatuses were used in 65 patients. 34 of whom had various neurotrophic disturbances The results were good in 61 feet, satisfactory in 18 feet and bad in 4 feet The efficiency of this form of treatment has led to the conclusion that this would be the only form of treatment in aggravated forms of foot deformity, especially if there is associated neurotrophic disturbances

OGANESIAN and ISTOMINA[42] applied the VOP apparatus for correcting the deformities of ankle and foot joints. The device is applied under anaesthesia

and correction commenced between days 5 and 7 after surgery. Correction is continued for 4-5 weeks until a predetermined over corrected result is obtained. The apparatus then remains for an additional 2 months to allow stabilisation of the correction The authors defined the following indications for application of apparatus i) a marked deformity of such an extent that operative intervention would require a wedge resection resulting in an unacceptably short foot ii) deformities coincident with soft tissue pathology., such as scarring or trophic ulcers iii) a previous history of osteomyelitis in the deformed extremity iv) a bilateral deformity amenable to concurrent correction

GRANT ATAR and LEHMAN (1992)[44]described in detail the principal of distraction histo-neogenesis by use of the Ilizarov technique and the method of application of the same principles in treating foot deformties. The ability to stimulate the process of normal incremental growth of bone in axial direction is the essence of the discovery of Ilizarov. In defining incremental growth, Ilizarov recognised that the rate and frequency necessary for new bone growth had limits. beyond which bone generation would be deterred. The observations made about the elongation and rearrangement of adjacent soft tissues concurrently with the elongation of bone has led to the safe use of distraction or compression to correct problems that are primarily soft tissue in nature.

PALEY (1994)[45] recommended the use of llizarov device in the correction of club foot deformities either as a means to distract soft tissues alone or in conjuction with osteotomies The primary criterion for selecting the non-osteotomy llizarov approach was the age of the patient. Most deformities in children below 8 years could be corrected by Ilizarov soft issue distraction without osteotomy Paley observed the following advantages and disadvantages with lizarov technique.

Advantages

1. Less likelihood of neurovascular compromise.
2. Improved foot length maintenance.
3. The probability of less stiffness than with other procedures.
4. The possibility of correcting associated deformities along with the main deformity.
5. Safer procedure than surgery when performed on previously operated foot.
6. Adjustability of the apparatus even after full correction obtained, makes it possible to achieve the exact position of the foot desired by the patient.

The disadvantages involve

1. The presence of an external fixation device with its inherent pin tract complications.
2. prolonged duration of foot immobilisation in the fixator

3. Mild to moderate pain during the lengthening process.
4. inability of the procedure to improve stiffness

DE LA HUERTA (1994)[46] achieved complete correction using gradual distraction through Ilizarov external fixator to correct neglected club foot deformity in 12 feet of 7 adult patients It required 5-8 months to the achieve the correction. The mean age of the patients treated was 25 years range 19-42 years) and the followup ranged from 2-5 years. Residual adduction deformity and stiffness of the feet were noticed in a fee teems

B.B.JOSHI et al (1994)[5] developed an external fixator which could be used even in younger paediatric age group. The principles of treatment being essentially same The difference from other modes of external fixation lay in the application of the device in early childhood as a tria l method prior to surgical release The authors have reported correction of 14 out of 16 cases. with only two cases warranting repeat application of the device Three of the corrected cases were under 1 year of age

MATERIALS AND METHODS

Patients who are diagnosed as neglected, relapsed or recurrent CTEV

aged between 1-6 years who are admitted at govt rajaji hospital,madurai

were taken up for this study.

14 feet in 14 children were treated by controlled differential distraction technique with the help of external fixator based on JOSHI'S APPARATUS during period from oct 2015 to sep 2017.

Totally 15 cases were taken for study out of which one was lost to follow up,hence excluded from the study. No bilateral case was taken up for the study. In 8 children Right side was affected. In 6 children Left side was affected. Among the 14 cases 6 cases had no previous surgical exposure. The remaining cases had posteromedial release done earlier.

Preoperative assessment

All patients were thoroughly evaluated preoperatively both clinically and radiologically as per proforma (Appendix I) .The clinical assessment comprised of detailed history with emphasis on known factors associtated with CTEV and a thorough physical examination. Clinical evaluation of the foot was done using modified pirani scoring system and dimeglio's scoring system.

Radiologically the foot was evaluated as per guidelines laid down by simons.[33]

Fig 1

Technique which we used for taking AP views in younger children (fig 1)

Fig 2

fig 3

Technique we used for taking stress dorsiflexion views in younger Children.(fig2,3)

Fig 4 (Technique which we used for taking stress dorsiflexion views in older Children)

INSTRUMENTATION: (fig 5)

Instrumentation includes

1. Link joints - 27
2. Connecting rods (3mm)

   Straight rod 4” - 3

6" - 2

8” - 2

‘Z’rods - 2

‘L’ rods

large - 2

small - 2

3. Distractors (6mm)

4" calcaneo metatarsal - 2

6" tibio calcaneal - 2

4. Foot plate - 1

5. ‘K’ Wires

2mm X 6” - 2

1.8 m m x 6” - 6

Distraction Devices

It has a threaded rod on which is mounted a static block and a translating block. Each block has two holes for passage of 'K' wires or a connecting rod The

threaded rod has a distraction knob at the end. A 360^{o} rotation of the knob produces a translation equal to the pitch of the rod (1mm)

This is the basic holding unit. K wires drilled in to the bones are clamped in to a connecting system by a link joint. The joint has two holes at right angles, one hole is higher than the other. A recessed hexagonal nut is used to tighten the 'K' wire or the connecting rod passed through the link joint.

Fig 5 (components of jess fixator)

Operative Technique

This technique of differential distraction using external fixator is popularized by B.B. ;Joshi of Mumbai (India). The principles were based on reports in

literature about fractional distraction using llizarov's apparatus for older children and adolescents.

Procedure

The operation is performed under general anaesthesia with the patient in supine position with or without tourniquet control. We prefer to operate without 'T' control.

The length of the foot and the leg are assessed preoperatively to determine the lengths of disractors required.

Metatarsal wires

One transfixing wire is passed from the fifth metatarsal to the first metatarsal engaging atleast the fifth and first metatarsal at the level of the neck.

Two separate wire one from medial and the other from the lateral aspect are inserted parallel to the first wire fig(6). These two wires engage two or three

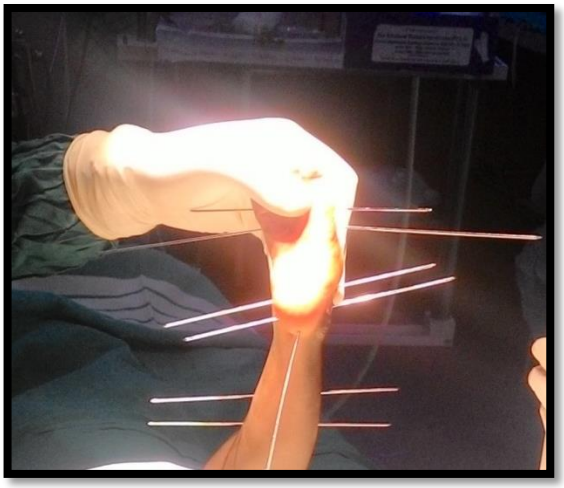
metatarsals on their respective sides. All the metatarsals should be fixed atleast by one of the wires.

(fig 6) metatarsal wire insertion

Calcaneal wires

Two transfixing parallel wires are passed into the tuberosity of the Calcaneum, from the medial side avoiding posterior tibial vessels.

The position of the calcaneus is assessed using the pre operative X-ray as a guide and the axial calcaneal wire is passed from posterior to anterior. The point of entry is just distal to the insertion of Tendo Achilles.(fig 7)



(fig 7)(calcaneal wire insertion)

Tibial wires : Two parallel transfixing wires are passed in the tibia. perpendicular to the longitudinal axis .(fig.8)The distance between two 'K' wires corresponds to middle segment of ‘Z' rod

fig 8(application of tibial wires)

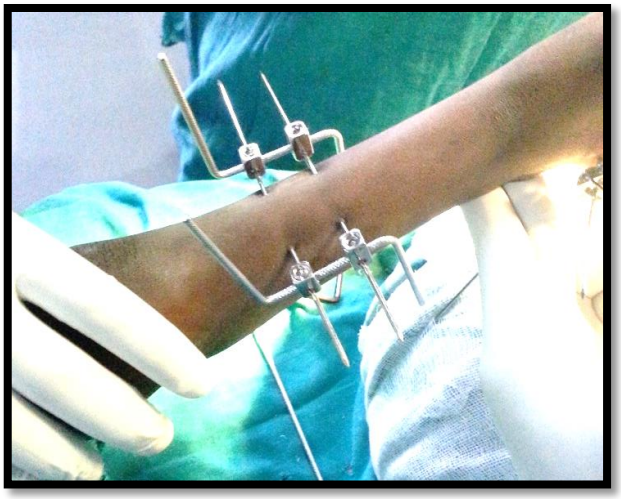
ASSEMBLING OF THE APPARATUS

Attachments of ‘Z' rods

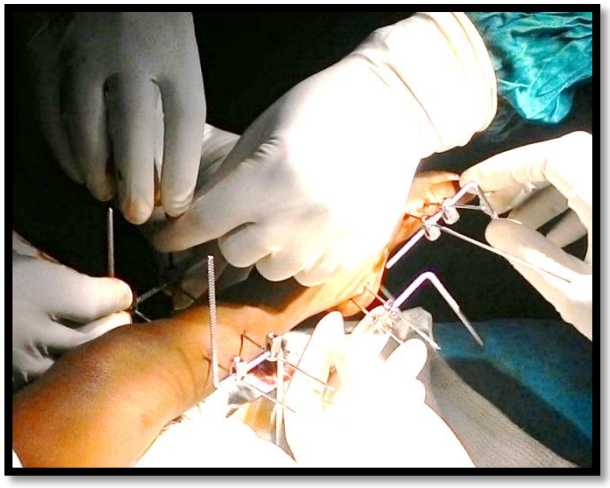
The tibial wires are attached to the middle segment of the ‘Z’ rods by link joints on the medial and lateral aspects.(fig 9)

Attachment of ‘L’ rods

Two small L' rods are attached to the metatarsal wires on medial and lateral aspects of foot with the limb projecting plantarwards and angle of is placed distally. (fig 10)Plantar projections are connected by a connecting rod to provide support for the foot plate



Attachment of z-rods (fig 9)



Attachment of l-rods(fig 10)

Then large `L' rods are attached to the transfixing calcaneal wires on either side of the heel Behind the foot these rods are connected to each other by a connecting rod on which the axial calcaneal wire is clamped. Plantar projections of the rods are connected by a connecting rod which forms the second support for the foot plate

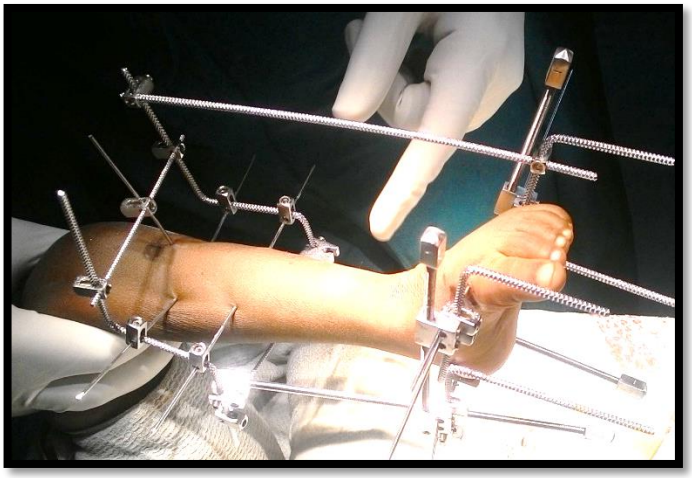
Attachments of calcaneal metatarsal distractors

A pair of appropriately sized distractor are attached to the calcaneal and metatarsal wires on either side of the foot keeping the distraction knob anteriorly.(fig 11)

Attachments of calcaneal metatarsal distractors(fig 11)

Attachment of tibio calcaneal distractor

The posterior limb of 'Z' rods are connected to the larger 'L' rods of calcaneus, by a distractor or either side.(fig 12)



Attachment of tibio calcaneal distractor(fig 12)

Tibio metatarsal connection

The anterior limb of ‘Z’ rods are attached by a pair of connecting rods to one of the metatarsal wires on either side of the foot.

Tibial stabilization

The anterior and posterior parts of ‘Z’ rods are connected with transverse bars. This provides stability to the assembly against twisting forces.

Foot plate attachment : The plantar projections of the metatarsal and calcaneal ‘L’ road are attached separately with straight rods. These connections provide a slot for the foot plate. The plate prevents flexion contracture of the toes.

The calcaneal metatarsal, and tibio calcaneal distractors are distracted till resistance is felt. This takes up the slack in the assembly and puts the soft tissues at the optimal stretch. Care should be taken to prevent skin necrosis and there should be no blanching of the skin.

Foot plate attachment(fig 13)

POST OPERATIVE MANAGEMENT

Pin site care

Dressing is perfomed thrice a week with povidone iodine solution. Scabs if any are removed.

Distraction Schedule

Distraction commences on the 3rd to 7th postoperative day depending on the settling down of edema.

The calcaneo – metatarsal distraction

This proceeds at the rate of

1mm/Day on the medial side and

0.5 mm/Day on the lateral side.

This is achieved by clockwise rotation of the knobs on the distractor and can be conveniently divided into small increments every 6 or 12hours or can be done at a single sitting.

End point: Clinical and radiological correction of fore foot deformities

This calcaneo metatarsal distraction:

Corrects fore foot adduction

Reduces calcaneo cuboid joint

Stretches the socket for head of Talus

Tibio calcaneal distraction

It is carried out in two positions. The distractors are mounted between the inferior limbs of the ‘z’ r ods and posterior limbs of the calcaneal ‘L’ rods.

Distraction ;in this position corrects varus of the hind foot and the equinus.

Medial 1 mm/day

Lateral 0.5 mm/day

It is essential to ensure complete correction of the varus of the heel before embarking on the second step. The distractors are rearranged at this stage.

The tibio calcaneal distractors are now shifted posteriorly and connected above to the transverse bar – connecting posterior limbs of 'Z' rods and below to the posterior calcaneal bar connecting the limbs of 'L' rods and axial calcaneal wire. The distracters lie on either side of axial calcaneal wire. Distraction is this postion corrects hind foot equinus.

Both distractors are distracted at the rate of 1 mm/day. End point assessed clinically and radiologically

The Static Phase

Following correction the assembly is held in static position for twice the period of distraction to allow soft tissue maturation in elongated position. The longer the static period is held the lesser the chance of recurrence.

Removal of the fixator

After the static period whole assembly is removed under anaesthesia, and an above knee plaster cast is applied with knee 90^{o} flexion and foot in maximum corrected position. After 3 weeks the cast is converted into below knee walking cast which is changed twice at 2 weeks interval.

Orthotic devices

Club foot boot are fitted to maintain the corrected position to prevent recurrence. Physiotherapy to strenghthen the muscles and gait training given. Light massage and manual stretching is continued to keep the foot supple and aligned.

METHOD OF EVALUATION

Correction achieved at the end of treatment is documented clinically and radiologically and assessment of the maintenance of the correction is done at regular intervals. The correction is evaluated by the functional rating system score (Appendix III) once the foot is stable without pain and limitation of joint motion directly attributable to the fixator.

The observations made of the preoperative severity and adequacy of post operative correction are tabulated and analysed to comment on the efficacy and limitations of the fixator.

Analysis and results :

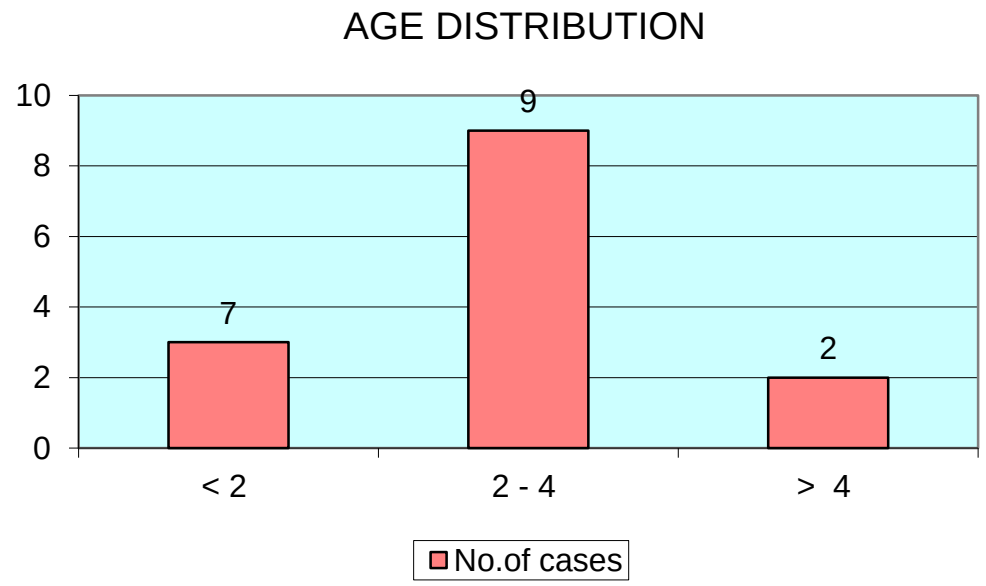
In our series 12 feet (85.7%) had excellent and good results and 2 feet (24.3%) had fair and poor results.

In one case of poor result the patient aged 3½ yrs had undergone posteromedial release three times earlier and had an extensive scar over the posteromedial aspect of foot and leg .All the deformities were fixed and foot was very stiff . the foot was distracted for 4 ½ weeks and when the feet appeared corrected the apparatus was removed after 8 weeks of static phase.Post operatively the x-ray showed the spurious correction with varus on Right side and function of the feet were very much limited.

In another case aged 2 yrs the apparatus was removed at the initial period of static phase due to deep pintract infection and the pop frequently removed for dressing purpose. This resulted in under correction.

When comparing with similar studies which also used external fixator for correction of deformed foot our results were found comparable

In our study mean age of patients was 2.82 yrs and most of them were in the age group of 2-4 yrs(64.3 %)(fig 14). Among the sex distribution, 9 cases were male (64.3%) of the 14 cases (fig 15). And among side distribution 8 were right sided and were left sided(fig 16)



(fig 14)

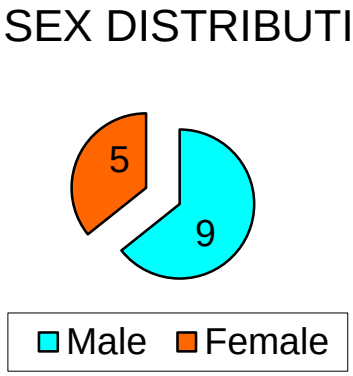


Fig (15)

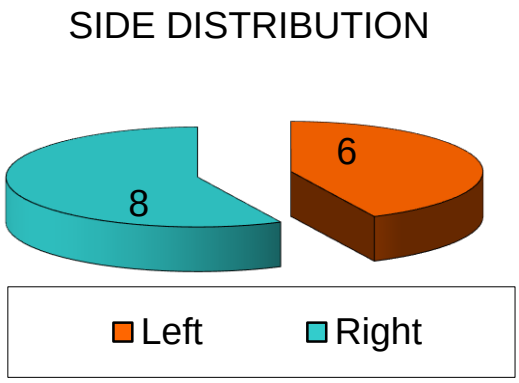
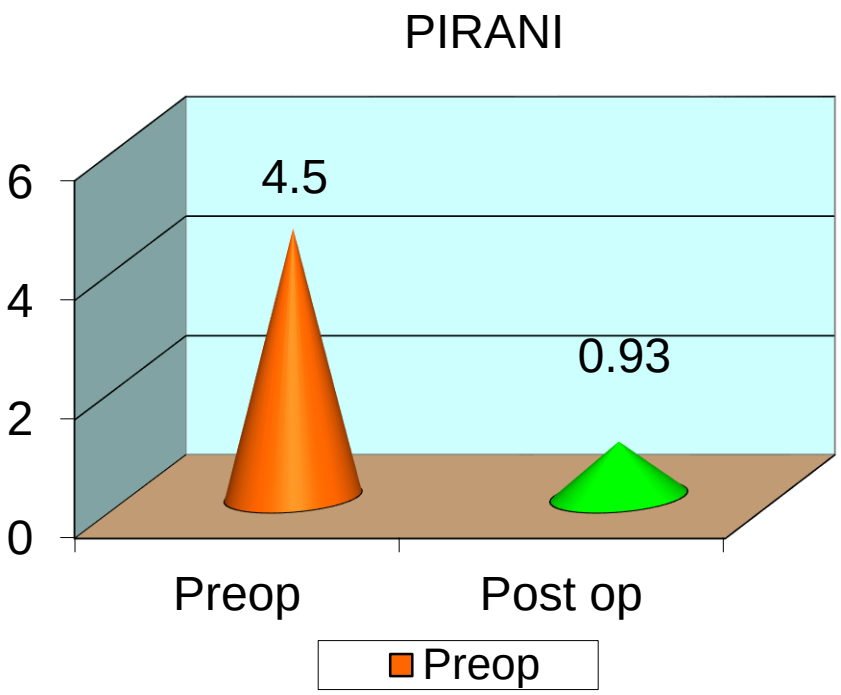


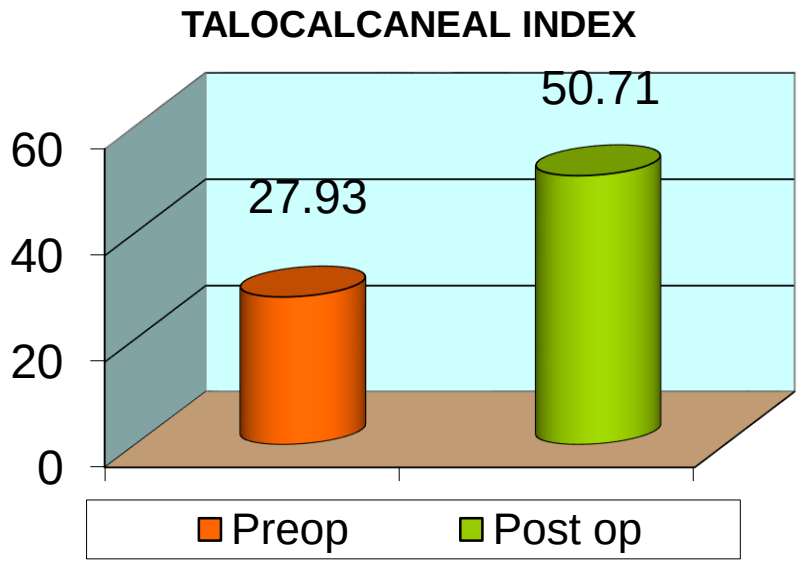
fig (16)



(Fig 17)

In our study pre-op and post op evaluation was done by modified pirani ,dimeglio,and radiological angles.the average pre op pirani score was 4.5 and post op score of 0.93 with p-value <0.001 which was statistically significant (fig 17). The average preop dimeglio score was 12 (stage iii) which statistically improved post op (p-value <0.001) to 5 (stage 1). The average talocalcaneal angle in AP view was 19.9 and in lateral view was 8.02.The average talocalcaneal index pre op was 27.3 which statistically improved(p value <0.001) post op to 50.7(fig 18) . The average talus-first metatarsal angle pre op was 28.9 and post op was 15(fig 19).(p-value <0.001)which was statistically significant. The mean correction period was

14 weeks with average distraction phase of 5 weeks and static phase of 9 weeks(fig-20). By post op functional rating system score evaluation the maximum score obtained was 90 in two patients aged(<2 years). 7 patients had good results with average score of 78,and poor results in one patient with score of 50 and fair result in one with score of 60. (fig 21)



(Fig 18)

We had 6 cases of residual deformities post fixator removal three cases of heel varus , two adduction and one equinus deformity.(fig 22)

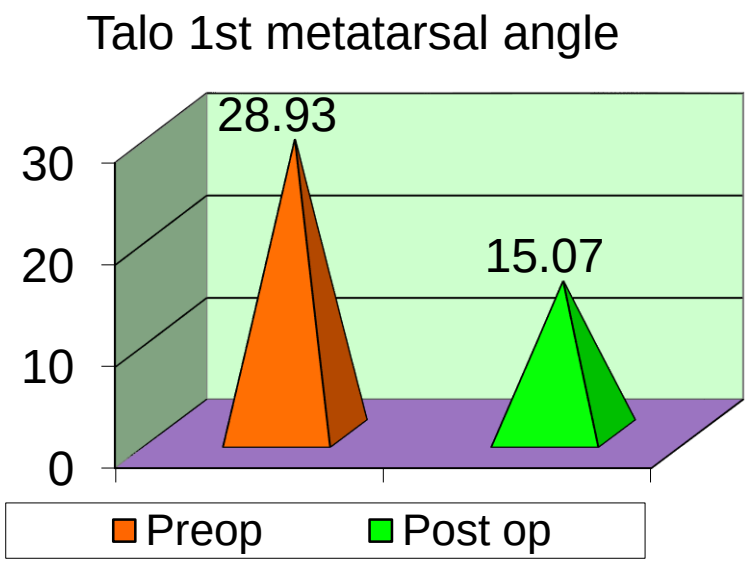

Talo 1st metatarsal angle
28.93
15.07
30
20
10
0
Preop
Post op

fig 19

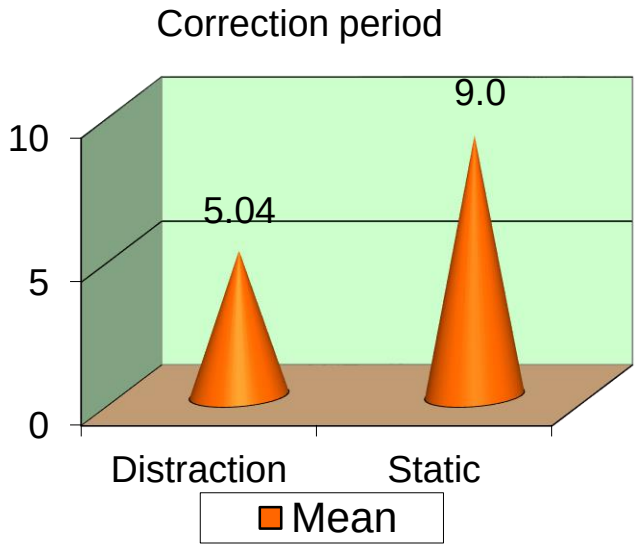

Correction period
9.0
5.04
10
5
0
Distraction
Static
Mean

fig 20

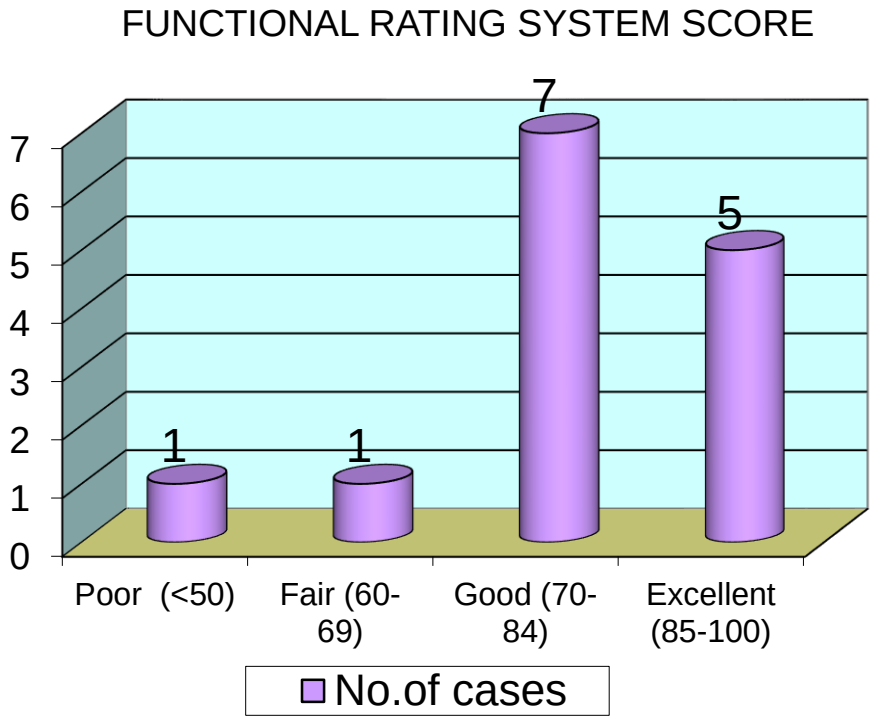

FUNCTIONAL RATING SYSTEM SCORE
7
6
5
4
3
2
1
0
1
1
7
5
Poor (<50)
Fair (60-69)
Good (70-84)
Excellent (85-100)
No.of cases

Fig-21

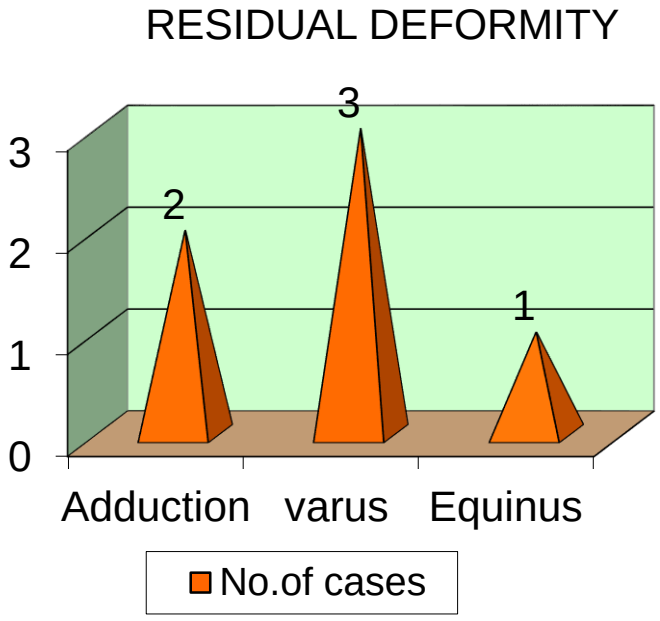

RESIDUAL DEFORMITY
3
2
1
0
2
3
1
Adduction
varus
Equinus
No.of cases

Fig 22

The most common complication in our study was temporary edema of the foot followed by superficial pin tract infection(fig 23)

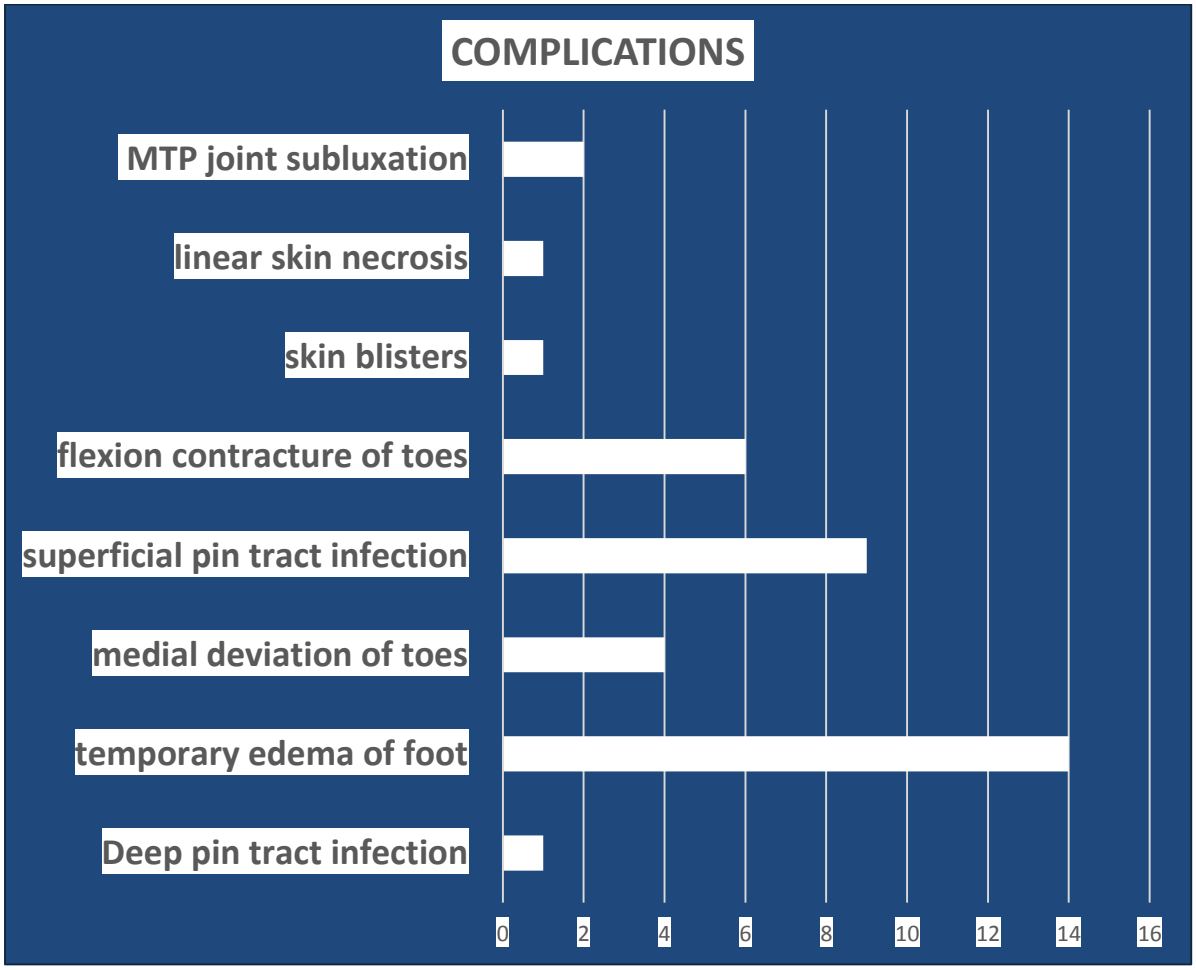


Fig 23

Case illustration

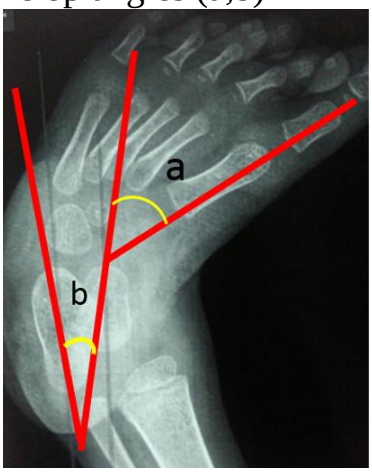
Case I (s.no 1)

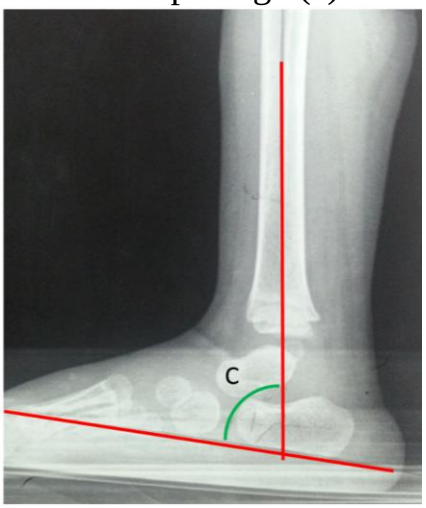
- NAME:selvam
- AGE/SEX: 2/mCH.
- DIAGNOSIS:B/L IDIOPATHIC CTEV

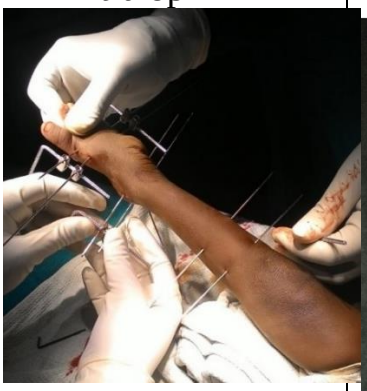
  right side corrected

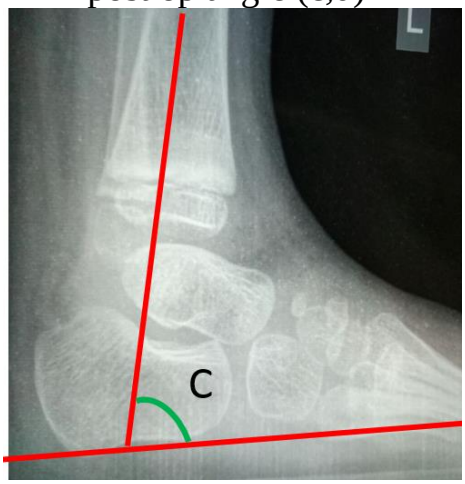
  left side relapsed .

	Pirani score	Dimeglio	Tc index	Talo I mt angle	Tibio calcaneal angle
Pre op	5	iii	18	46	85
Post op	0.5	I	54	14	88

<table>
<tr>
<td>Pre op
  </td>
<td>Pre op angles (a,b)
 

a= 46º
b=15^0</td>
<td>Pre op angle(c)
 

C= 85º</td>
</tr>
<tr>
<td>Intra op
  </td>
<td>Post op angle (A ,B)
 

A=14
B=38</td>
<td>post op angle (c,d)
 

c=88</td>
</tr>
</table>

18 months post op	Final outcome (18 months)	Same patient view from behind
		

Functional rating score 85(excellent)

Note: a-AP talo calcaneal angle A- AP talo calcaneal angle(post op)

b-talus first metatarsal angle B -talus first metatarsal angle(post op)

c-tibio calcaneal angle lateral C- tibio calcaneal angle lateral(post op)

CASE II (s no 4)

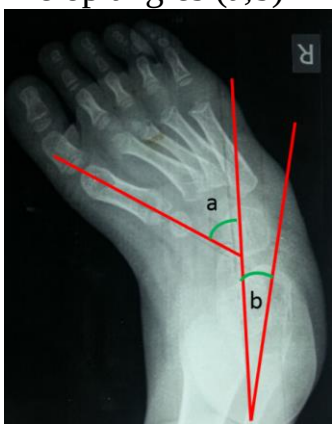
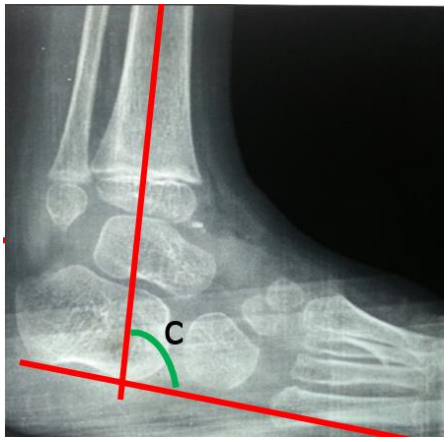
NAME:joshini

- AGE/SEX: 3 ½ /f CH.
- DIAGNOSIS:B/L IDIOPATHIC CTEV

Left side corrected

Right side relapsed

	Pirani score	Dimeglio	Tc index	Talo I mt angle	Tibio calcaneal angle
Pre op	4	iii	15	42	101
Post op	0.5	I	51	12	86

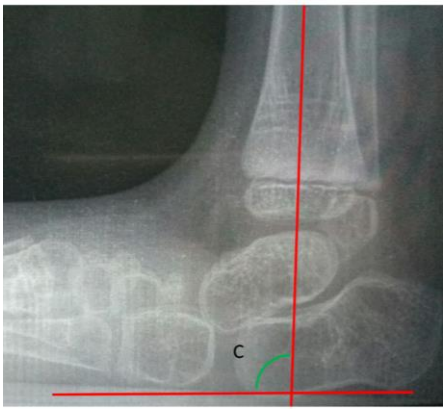
Pre op	Pre op angles (a,b)	Pre op angle(c,)
	 **a= 42^{o}** **b=15^{0}**	 C=101

Post op 18 months

Post op angle (A ,B)

A= 12º
B=38^0

post op angle (C)



C=86

Final outcome (18 months)

Same patient view from behind

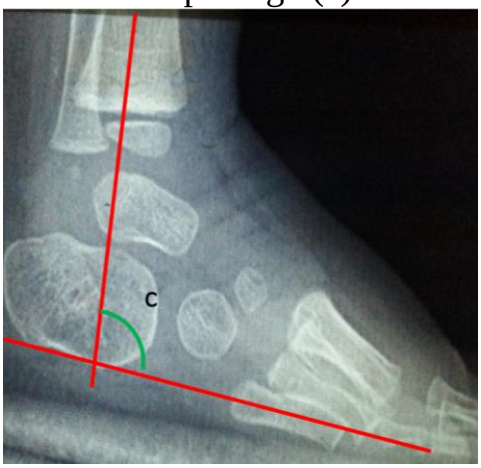
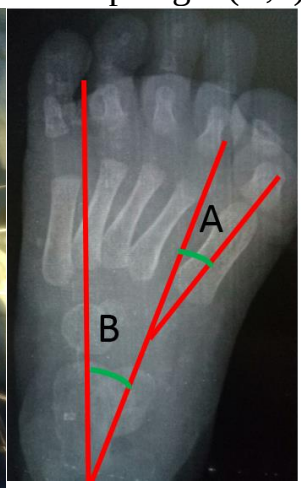
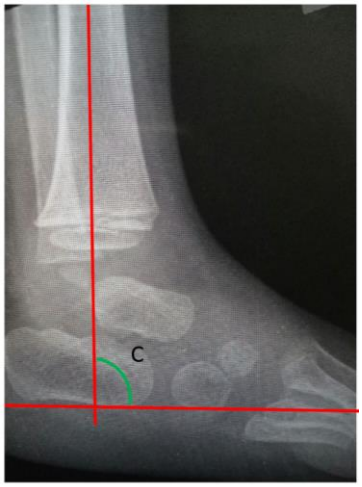
Functional rating score 85(excellent)

CASE III(s.no 5)

- NAME: damodaran
- AGE/SEX: 1 ¾ / mCH.
- DIAGNOSIS:B/L IDIOPATHIC CTEV

Scoring for lt foot

	Pirani score	Dimeglio	Talocalcaneal index	Talo I mt angle	Tibio calcaneal angle
Pre op	5	iii	21	34	115
Post op	0.5	I	51	17	84

Pre op 	Pre op angles (a,b)  **a= 34º** **b=11^0**	Pre op angle(c)  c=115º
Intra op 	Post op angle (a ,b)  **A= 17º** **B=41^0**	post op angle (c,d)  **C=84º**

18 months post op	Final outcome (18 months)	Same patient view from behind
		

Functional rating score 85(excellent)

CASE IV(s no 6)

NAME: kavisaran

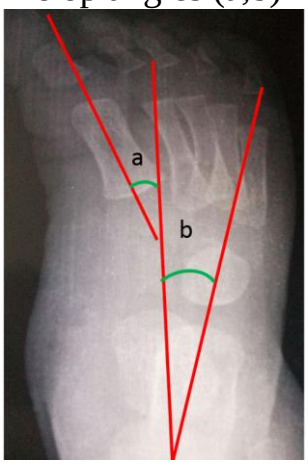
- AGE/SEX: 3 ½ / mCH.
- DIAGNOSIS: rt relapsed ctev

	Pirani score	Dimeglio	Tc index	Talo I mt angle	Tibio calcaneal angle
Pre op	4	Iii	28	26	112

Post op	0.5	I	51	17	87

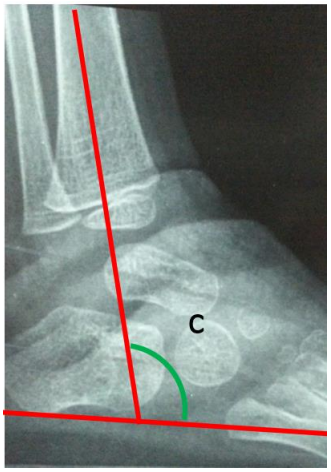
Pre op

Pre op angles (a,b)



a= 26º
b=21^0

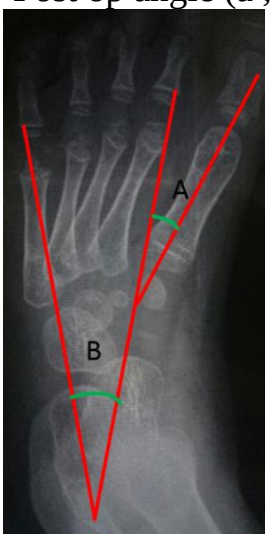
Pre op angle(c,)



c=112º

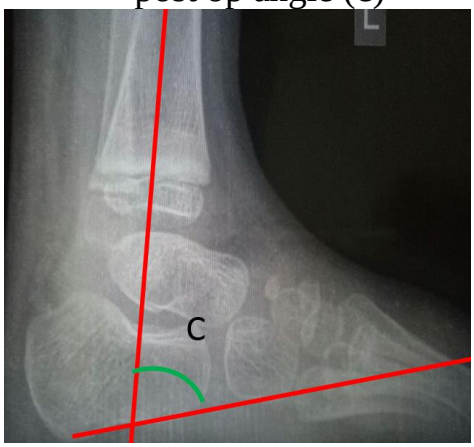
Intra op

Post op angle (a ,b)



A= 17º
B=31^0

post op angle (c)



C= 87

Final outcome (18 months)	Same patient view from behind
	

Functional rating score 85(excellent)

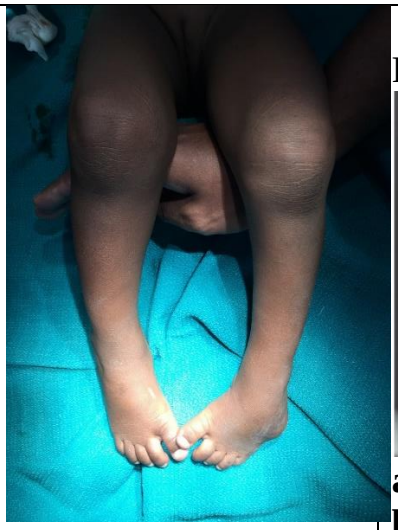
CASE V(sno 7)

- Name :sivaranjani.
- Age /sex :2 fch.
- Diagnosis :b/l idiopathic ctev

right side corrected

left side relapsed .

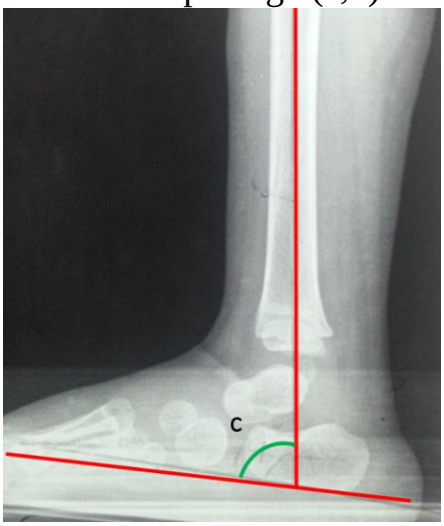
	Pirani score	dimeglio	Tc index	Talo I mt angle	Tibio calcaneal angle
Pre op	5	Stage iii (11)	15	35	85
Post op	0.5	Stage 1	61	13	80



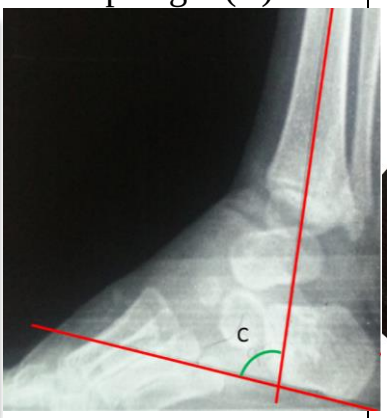
Pre op angles (a,b)

a= 35º
b=11^0

Pre op angle(c,d)



c= 85º

Intra op	Post op angle (C)	post op angle (c,d)
	 **C= 80º**	 **A= 13º** **B=41^0**
Final outcome (14 months)		
		

Functional rating score-90(excellent)

CASE VI(sno 10)

- Name :haricharan
- Age /sex :5 ½ mch.
- Diagnosis :b/l idiopathic ctev

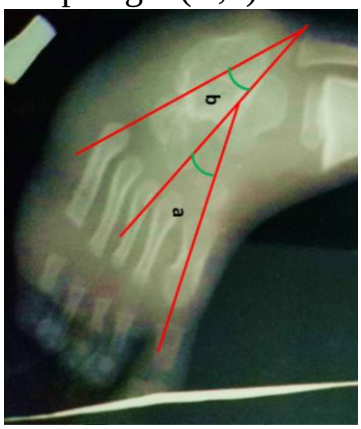
right side corrected

left side relapsed .

	Pirani score	dimeglio	Tc index	Talo I mt angle	Tibio calcaneal angle
Pre op	5	Stage iii	19	38	81
Post op	1.	Stage ii	47	12	89

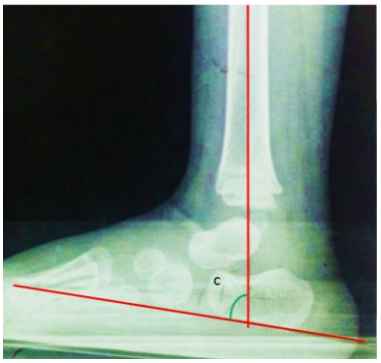
Intra op

Pre op angle (a ,b)



a= 38^{o}
b=12^{0}

pre op angle ©



c=81

Intra op	Follow up 12 months
	

Functional rating score-70 (good)

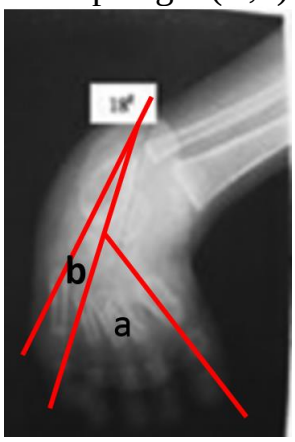
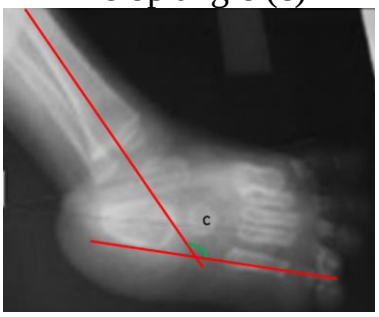
CASE VII (sno 11)

- Name :muneeshwaran
- Age /sex :2 mch.
- Diagnosis :b/l idiopathic ctev

right side corrected

left side relapsed .

	Pirani score	dimeglio	Tc index	Talo I mt angle	Tibio calcaneal angle
Pre op	4.5	Stage iii	33	27	121
Post op	1	Stage i	48	12	99

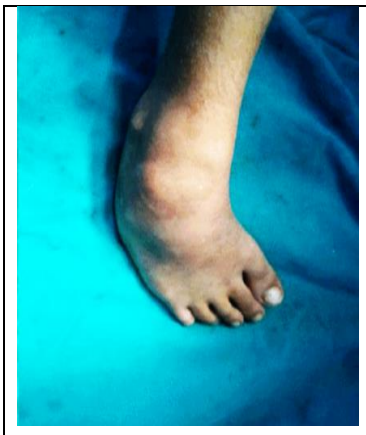
pre op 		Pre op angle (a ,b)  **a= 27º** **b=33^0**		Pre op angle (c)  c=121º	
		 Follow up 12 months			

Functional rating score-90(excellent)

- CASE VIII (s no 12)
- Name :GOKUL
- Age /sex :5 mch.
- Diagnosis :

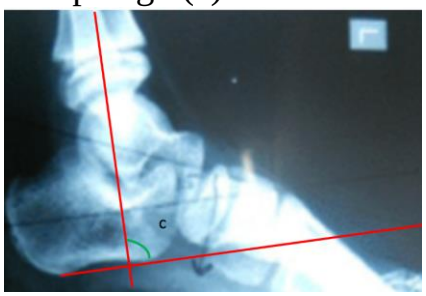
  left side relapsed CTEV

	Pirani score	dimeglio	Tc index	Talo I mt angle	Tibio calcaneal angle
Pre op	4.	Stage iii	39	19	98
Post op	1	Stage i	51	16	86



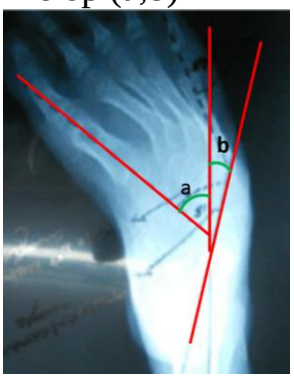
Pre op

Preop angle(c)

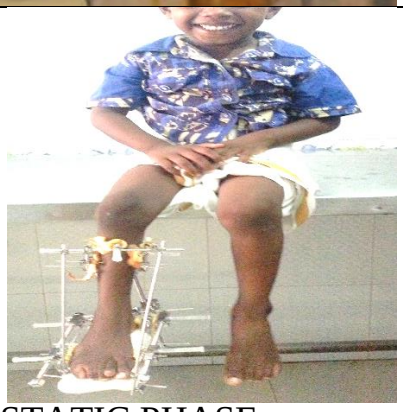


C=98^{o}

Pre op (a,b)



a= 19^{o}
b=33^{0}

INTRA OP 	POST OP  A=16 B=35	POST OP  C=86^{o}
 STATIC PHASE	12 MONTHS POST OP 	12 MONTHS POST OP 

Functional rating score-90(EXCELLENT)

CASE : IX(s no 13)

- Name :RISHIKA
- Age /sex : 3 ½ fch.
- Diagnosis:

left side relapsed .CTEV

	Pirani score	dimeglio	Tc index	Talo I mt angle	Tibio calcaneal angle
Pre op	4.5	Stage iii	19	31	85
Post op	1	Stage 1	55	16	80

PRE OP

PRE OP angle (a,b)

a=31
b=16

PRE OP angle(c)

c=85

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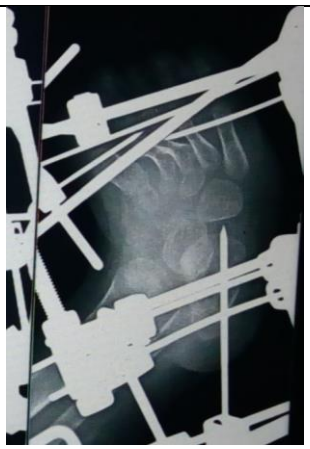
<td>  </td>
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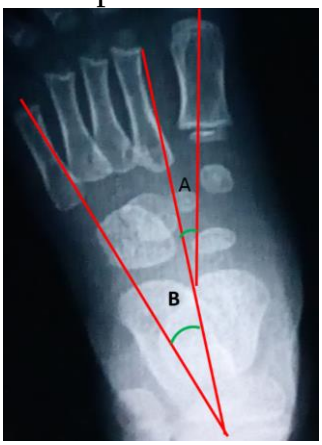
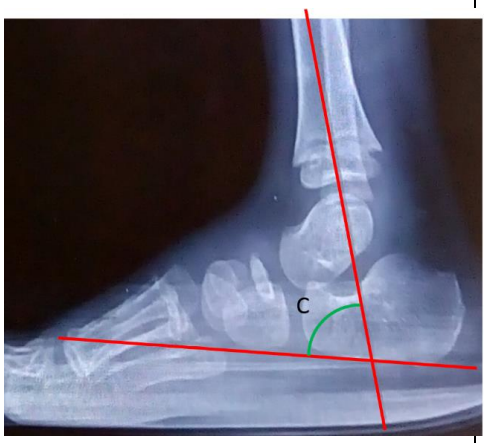
 

A=16º
B=35^{O}</td>
<td>POST OP
 

C=80º</td>
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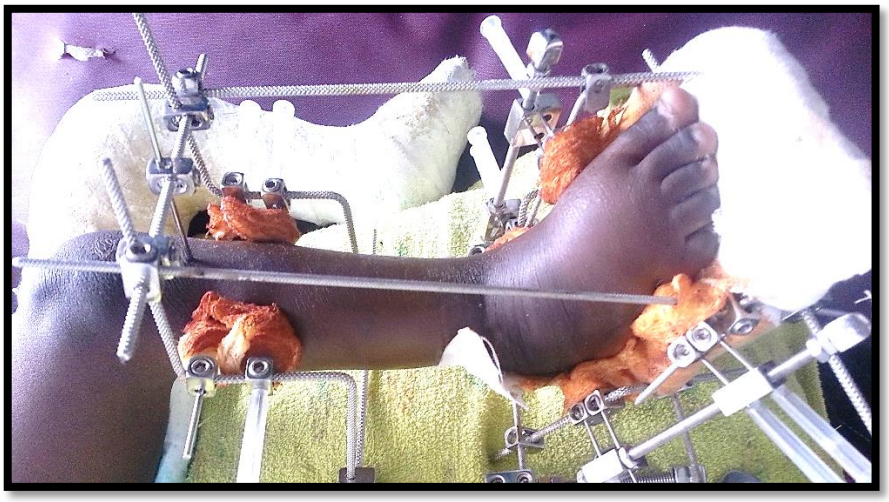
<tr>
<td>DISTRACTION PHASE
  </td>
<td> 
10 MONTHS FOLLOW UP</td>
<td> 
10 MONTHS FOLLOW UP</td>
</tr>
</table>

FUNCTIONAL RATING SCORE 80 GOOD

COMPLICATIONS

Temporary edema 100% : This occured in all the cases, during the immediate post operative period and persisted for 4-10 days(fig c-1).The initial edema was reduced by elevation of the foot.



(Fig c-1)

Flexion contracture of toes.

This complication occured in 6 cases. This occurred due to relative inelasticity of the flexor tendons during distraction phase(fig c-2,3). Eventhough we used a adequately padded foot plate to prevent this, it did occur. However once the apparatus was removed the toes were corrected by passive stretching and including toes during pop application ,but one case did require percutaneous tenotomy for correction.

(Fig c-2) (fig c-3)

Medial deviation of toes

Pathogenesis of this deformity was similar to that of flexion contracture of toes. As the adduction deformity was getting corrected, the stretched abductor hallucis produced this deformity (fig c -4). Most of these deformities were corrected by passive stretching and including the toes in the P.0 P cast during post operative followup.

(fig c -4)

Superficial pin tract infection .

Superficial infection occurred in 9 cases of our series(fig c-5). The dressings were changed once in 2 days with betadine gauzes. But 5 cases required oral antibiotics and more frequent dressings to control infections.

(Fig c-5)

Pressure sore over medial aspect of foot

Due to the pressure of the link joints in the calcaneal wires over the medial aspect of foot as the correction was progressing one foot developed a pressure sore.

Deep infection at the pin tract site

This complication occurred in one case .The patient developed constitutional symptoms and not responded to antibiotic treatment. And was associated with pin

loosening .Hence the apparatus wss removed prematurely with just three weeks of static phase. This resulted in under correction of the deformity with a poor result.

Skin blisters:

This ocuured in one case(fig c-6). This occurred at posterolateral aspect of leg. The blisters settled down as the distraction was withheld and the distraction was restarted after the lesion subside

Linear skin necrosis:

This occurred in one case at the medial border of the foot(fig c-7). Further progression of necrosis was avoided by holding the distraction for few days or by reducing the rate of distraction till skin heals.

Fig(c-6) superficial skin blisters over posterior aspect of leg

(Fig c-7) linear skin necrosis

Subluxation of metatarso phalangeal joint:

Apart from the usual complications , MTP joint subluxation occurred in two cases, these were thought to be due to high pressure of toes over the foot plate as they were going in for flexion which subsequently resulted in subluxation of joint(fig c-8,9)

fig c-8 subluxation of metatarsophalangeal joint of fourth toe

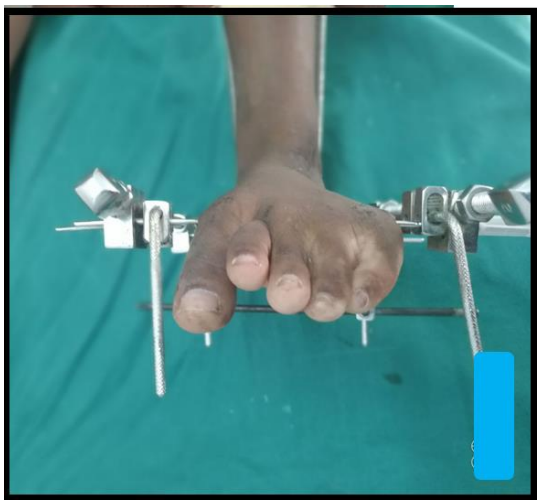


fig c-9 subluxation of metatarsophalangeal joint of second toe

Residual deformities in our study

adduction deformity of left foot

Residual varus right side

Residual heel varus rt side

DISCUSSION

The management of relapsed and neglected CTEV with distraction system has obvious advantages in that it causes minimal injury to soft tissues including neurovascular structures, preserves the pliability of the foot. improves the range of motion of foot and ankle joints and maintains the foot length. More over it does not prevent the foot from being treated surgically at a later date if needed

Most studies have shown the efficacy of Ilizarov fixator in achieving good results in neglected and relapsed club foot. But it can be applied only to older children and adolescents. Our study has shown that JESS fixator using simple k-wires and distractors can be used successfully even in younger children at one to five years of age

While evaluating the results. a system used for evaluation should be simple yet comprehensive and could be easily done. It should have as many objective criteria as possible and could be used for comparision with other similar studies. In previous studies only clinical appearance was considered in evaluation of the surgical results. The achievement of plantigrade foot was considered as having good result. So these studies documented higher percentage of success rate though the feet were small, stiff and functionally very poor. The evaluation of results improved considerably after the development of analytical radiology by

SIMMONS[33]. But still the functional improvements of the foot were not considered in the evaluation system

The fuctional Rating System, developed by ATAR and LEHMAN [8] combines subjective and objective clinical criteria. functional parameters and radio graphic assessment, in the evaluation system. It is easily reproducible with less interobservor errors and it can be used effectively to compare the results of similar studies

In our study 72.8% had Excellent and Good results, 18.2% had Fair results and 9.1% had Poor results,which compares favourably with other studies.

There was no major complications in our series. Superficial pintract infections occurred in 32.75% of patients which were cured with antibiotics. Medial deviation of toes occured in 27.3% of patients which were corrected with inclusion of toes in plaster cast.

Deep infection at the pintract site in 9.1% of patients and pres-sure sore over medial aspect of foot in one patient (4.55%) necessiated earlier removal of fixator and contributed to the less satisfactory results.

These complications in our study is comparable with earlier studies. De La Huerta[46] noted pintract infections in 17% of his patients. Grant[44] reported 35% incidence of pintract infections. Oganesyan [42] re-ported 12% incidence of pintract

infection Similar complications were reported by Joshi [5] also On the basis of our results we feel JESS fixator can be applied to correct relapsed and neglected club foot with reasonable success in younger children of 1-4 years also and Functional Rating System can be used effectively to compare the results of treatment of club foot.

COMPARATIVE ANALYSIS

Study	**Age**	**Etiologies**	**Evaluation**	**Result**
Grill (20 feet) 1994 (llizarov apparatus)	7-16 years	CTEV neglected/ relapsed Post-traumatic deformities,	No grading or evaluation system	Planti grade foot with satisfactory radiological appearance in 16 out of 18 patients.
Joshi – et al 23 feet 1994 (JESS)	3 months – 9 years	Club foot	No grading / Evaluation system	Plantigrade foot in all cases. Rocker bottom deformity in 1 foot recurrence in 1 foot

Suresh et al 2003[47] Jess	10 months - 5 yrs	relapsed and neglected	Radiographic and carolls scoring	77%-excellent 13%-good 9%-poor
Anwar and Arun [48]2004(jess)	9 months-4 years	Neglected and relapsed clubfoot	Radiographic and carolls scoring	Excellent and good in 59.7% cases
Our study 14 feet (JESS)	1-6 years	Relapsed / recurrent/Neglected CTEV	Functional rating system	Excellent – 35.7% Good - 50 % Fair - 7.5% Poor - 7.5 %

Eventhough we had many complications following JESS application, they were amenable to treatment.

The better results of this present study can be attributed to enthusiastic and compliant parents and longer hospitalisation during post-operative period. Anwar and Arun (48)found a strong correlation between better results and children who strictly follow the distraction-static phase protocol and the final outcome, stressing the fact that parent involvement is an essential component in treating neglected and relapsed clubfeet . A longer period of post-operative stay provided a controlled environment for the static period and reduced the risk of pin-tract infection and other complication.

One drawback we noted in our study was that hind foot varus was not effectively corrected by JESS, According to ponsetti technique where the entire forefoot and midfoot has to undergo full abduction and external rotation for talus to be reduced and subsequent reduction of hindfoot varus. Here in JESS we use medial and lateral distraction in 2:1 ratio and varus correction by another different distractor in 2:1 ratio,the correction of hind foot varus remains questionable. In our study we had three cases of isolated heel varus.

CONCLUSION

Correction of deformities in relapsed and neglected Clubfoot by various soft tissue and bony procedure produced less satisfactory results. with the resultant foot being smaller,stiffer, painful and nonpliable

With Ilizarov fixator satisfactory correction has been documented in older children above 7 years of age

By Controlled differential distraction using JESS apparatus, a painless. pliable, plantigrade. perfect sized and cosmetically acceptable foot has been obatained even in children 1 year to 4 years

From our study we can come to a conclusion that :

- Eventhough jess apparatus has inherent complications of external fixator,they were amenable to treatment.
- Controlled differential distraction using JESS fixator has got a definite role in the management of relapsed, and neglected CTEV.
- it does not prevent the foot from being treated surgically at a later date if needed .
- parent involvement is an essential component in treating neglected and relapsed clubfeet

APPENDIX - I

Proforma for assessment of severity of CTEV and evaluation of correction with JESS fixator

Name Age/ Sex

Hospital Number

Address

Date of Admission

Date of Discharge

Diagnosis

History

- birth H/o, H/o consanguineous marriage
- Family H/o CTEV .
- Developmental H/O
- Previous Treatment

Pirani scoring system

Paramaters	**RIGHT**	**LEFT**
Midfoot		
• Curved lateral border		

- Medial crease
- Talar Head coverage

Hindfoot

- Posterior crease
- Rigid equines
- Empty heel

Dimeglio scoring:

- Sagittal plane evaluation of equinus:
- Frontal plane evaluation of varus:
- Horizontal plane evaluation of cp block:
- Horizontal plane evaluation of ff to hf:
- Posterior crease:
- Medial crease:
- Cavus :
- Poor muscle function:

- Score and grade:

Radiographic Assessment :

` AP - Talocalcaneal Angle

LAT - Talo Calcaneal Angle

Talo Calcaneal Index

Talo - 1st Metatarsal Angle

Tibio calcaneal angle

Treatment Details

Date of Fixator Application

Date of Fixator Removal

Distraction commenced on

Any additional procedure

Duration of correction

- Distraction Phase

- Static Phase

Complications

Shoes After Treatment

Post Operative Evaluation

Residual Deformity

Pirani scoring:

Dimegio scoring:

Radiographic Assessment

A-P T C Angle

LAT T C Angle

Talo Calcanel Index

Talus- 1st Metatarsal Angle

Tibio calcaneal angle

Functional rating system for clubfoot surgery

1. Ankle motion (passive)	
Arc from neutral >20^0	15
Arc from neutral >10^0	5
Arc from neutral 0-10^0	0
2. Subtalar joint motion(passive)	
>15^0	10
<15^0	5
stiff	0
3.position of heel when standing	
0-5^0 valgus	10
>5^0 valgus	5
varus	0
4.forefoot(appearance)	
neutral	10
<5 abduction/adduction	5
>5 abduction/adduction	0
5.gait	
Normal heel toe	10
Cannot heel walk	6
Cannot toe walk	6
Flatfoot gait	5

6.radiographic angle	
Tc index	
>40	5
<40	0
Talus-I mt angle	
<10	5
>10	0
7.shoes	
Regular (no complaints)	5
Regular(with complaints)	3
Orthopaedic shoes/brace	0
8.function	
Not limited	15
Occasionally limited	8
Usually limitted	0
9.pain	
Never	10
Occasionally	
usually	0
10.Flexor tendons	
Full function	5
Partial function	2
No function	0

.

points	**rating**
85-100	excellent
70-84	Good
60-69	Fair
<59	Poor

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