

## Treatment with Mini External Fixator for Correction of Clubfoot

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## Abstract

**Background:** Clubfoot is one of the oldest and commonest congenital deformities of mankind since man has adopted erect posture [1]. The ideal treatment of clubfoot still remains controversial, because its cause remains unknown, its pathological anatomy is uncertain and its behavior is unpredictable [2]. Few authors concluded that there are different etiological factors responsible for resistance to correction or recurrence after correction. The goal of any type of CTEV management is to reduce, if not to eliminate all elements of the clubfoot deformity, hence achieving a functional, pain free, normal looking plantigrade, mobile, callous free and normally shoeable foot [3]. Treatment of the idiopathic clubfoot by Ponseti method is accepted as a standard treatment when patient presents early [4]. Methods available to correct a clubfoot deformity follow a sequence of treatment which includes manipulation of soft tissues, repositioning of foot, holding the position in POP or by tape. This sequence leads to dynamic functional correction. However it is not always possible to use manipulation by Ponseti for neglected, late presenters and syndromic cases. These deformities can be corrected with the use of external device in the form of universal mini external fixator (UMEX) or a JESS fixator

**Keywords:** Congenital talipes equino varus, mini fixator, distraction histogenesis

## Introduction

Clubfoot is one of the oldest and commonest congenital deformities of mankind since man has adopted erect posture [1]. The ideal treatment of clubfoot still remains controversial, because its cause remains unknown, its pathological anatomy is uncertain and its behavior is unpredictable [2]. Few authors concluded that there are different etiological factors responsible for resistance to correction or recurrence after correction. The goal of any type of CTEV management is to reduce, if not to eliminate all elements of the clubfoot deformity, hence achieving a functional, pain free, normal looking plantigrade, mobile, callous free and normally shoeable foot [3]. Treatment of the idiopathic clubfoot by Ponseti method is accepted as a standard treatment when patient presents early [4]. Methods available to correct a clubfoot deformity follow a sequence of treatment which includes manipulation of soft tissues, repositioning of foot, holding the position in POP or by tape. This sequence leads to dynamic functional correction. However it is not always possible to use manipulation by Ponseti for neglected,

late presenters and syndromic cases. These deformities can be corrected with the use of external device in the form of universal mini external fixator (UMEX) or a JESS fixator.

## What is a Mini Fixator?

Dr. B. B. JOSHI in 1990 developed a plain unconstrained simple, versatile, cheaper and light fixator system on the basis of biologic law of tissue histogenesis of all tissues when they are put under gradual stretch. This system is termed as JESS, Joshi's External Stabilization System. Universal mini external fixator (UMEX) was designed on similar principle. This fixator had a different design of the clamp to enhance stability and fixation. The concept of controlled differential distraction prevents crushing of tissues on the convex lateral side and limb lengthening along with correction of deformity takes place gradually and effectively to achieve supple foot [5].

## Where can Mini external fixator be used in CTEV?

Mini external fixator is used for instrumented manipulation in practically almost all cases with CTEV [5]. However with the other non

invasive methods like Ponseti method with similar results, mini fixator is now mostly used in late presenters, non idiopathic rigid feet (syndromes) and in cases with post surgical relapses.

Mini external fixator is useful method as the stretching is done four times in a day, repositioning is required once a week, position is hold with use of fixator and application of brace after correction is achieved to maintain correction.

## What are the advantages of using mini external fixator?

- It is a semi invasive procedure.
- Gradual differential distraction allowing simultaneous correction of all the deformities.
- Allows for three dimensional control and correction of deformity.
- Because of distraction the corrected foot achieved is longer in length.
- Excessive cartilage compression and chondrolysis of lateral growing bony structures caused by forceful manipulations is avoided.
- It is possible to correct rigid, severe, relapsed clubfoot without shortening of foot.
- It has direct purchase over distorted bony anatomy and hence better correction of bony alignment and remodeling.
- It adds to tissues by distraction histogenesis as opposed to open surgery which leads to fibrosis and shortening.
- Allows for scope of revision and rethinking.

## What are the principles of use of universal

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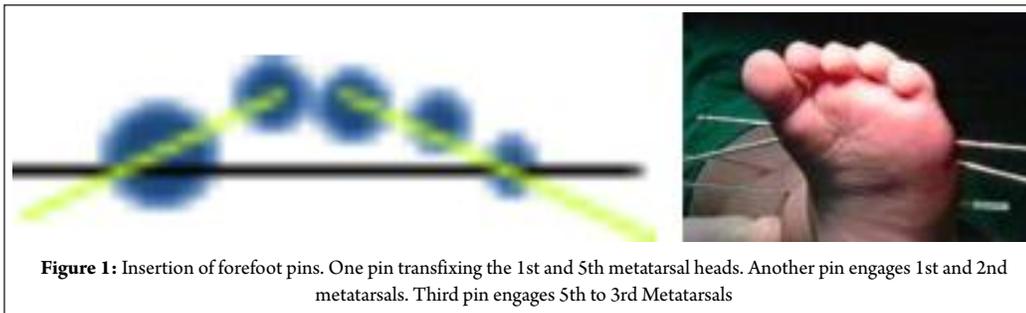


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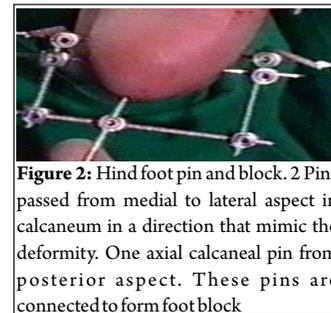


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**Figure 1:** Insertion of forefoot pins. One pin transfixing the 1st and 5th metatarsal heads. Another pin engages 1st and 2nd metatarsals. Third pin engages 5th to 3rd Metatarsals



**Figure 2:** Hind foot pin and block. 2 Pins passed from medial to lateral aspect in calcaneum in a direction that mimic the deformity. One axial calcaneal pin from posterior aspect. These pins are connected to form foot block

**mini external fixator in CTEV?**

The basic principle of universal mini external fixator is the same as advocated by Ilizarov [6]. Physiological tension and stress applied to the tissue stimulates histogenesis of tissues, while controlled differential distraction gradually corrects the deformities and realigns the bones. Correction using mini external fixator is based on understanding that clubfoot deformity has 3 components, the leg, the hindfoot and the forefoot.

Thus it is essential to achieve skeletal hold in each component thus mini fixator system in CTEV correction involves use of 3 blocks the forefoot block, the hindfoot block and the leg block.

Distraction corrects only 1 axis. Differential distraction can correct 2 axis deformity. However to correct a 3 dimensional deformity in CTEV it is necessary to uncouple the distractors from the frame leaving the three blocks intact and manipulate the foot weekly to achieve manual derotation.

Following this the blocks are reconnected using the distractors and distraction protocol is continued over a week. This process is continued till over correction.

**Technique of universal mini external fixator application-**

The procedure is carried out under general anesthesia with the patient in supine position. The procedure consists of important steps of insertion of pins and formation of blocks and attachment of distractors between the blocks. Insertion of Pins –

**Technique of forefoot pins (Fig 1)–**

One transfixing K-wire was passed through the necks of first and fifth metatarsal from lateral to medial side in such a way that the K-wire engaged the two metatarsals. Two additional wires were passed parallel to and 10 to 12 mm apart from either side, one engaging the first and second metatarsals and another engaging the fifth, fourth and third metatarsal. Take precaution that third metatarsal is not transfixated from both sides.



**Figure 2:** Insertion of tibial pin. Two parallel K wires are passed using Z rod as guide.

Fig 1. Insertion of forefoot pins. One pin transfixing the 1st and 5th metatarsal heads. Another pin engages 1st and 2nd metatarsals. Third pin engages 5th to 3rd Metatarsals.

**Technique of hind foot pins (Fig2)–**

Two parallel K-wires were passed through the tuber of calcaneum from medial to lateral side taking care that they were well away from the course of the neurovascular structures on the medial side. Pins should exactly mimic the deformity. One additional half pin K-wire was passed from the posterior aspect of the calcaneum along the long axis. The entry point was below the insertion of the tendo-achilles in the midline using distractor as the guide.

Fig 2 – Hind foot pin and block. 2 Pins passed from medial to lateral aspect in calcaneum in a direction that mimic the deformity. One axial calcaneal pin from posterior aspect. These pins are connected to form foot block.

**Technique of leg pins (Fig3)–**

With the patient in supine position and extended limb, two parallel K-wires were passed in the proximal tibial diaphyses from the lateral to the medial side. The wires were about 3 to 4 cm apart and run parallel to the axis of the knee joint at safe distance distal to tibial tuberosity. The K wires are passed using Z rod as a guide. In older children 3 wires were passed to increase the stability. Additional pin

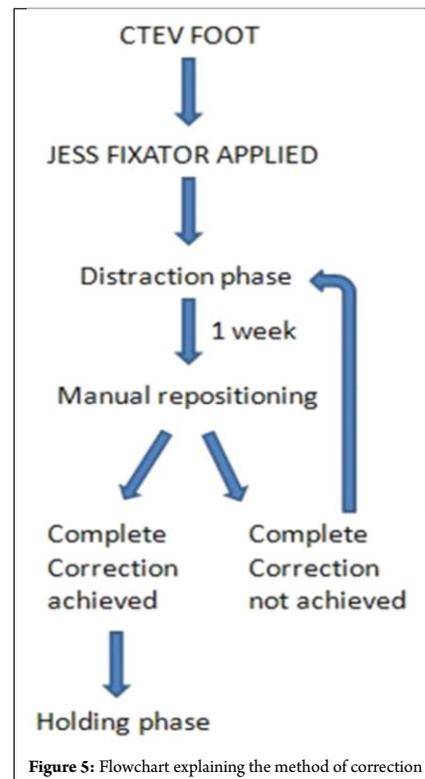


**Figure 4:** Placement of paired distractors. 2 distractors connecting leg block to hind foot block and 2 distractors connecting hindfoot block to forefoot block

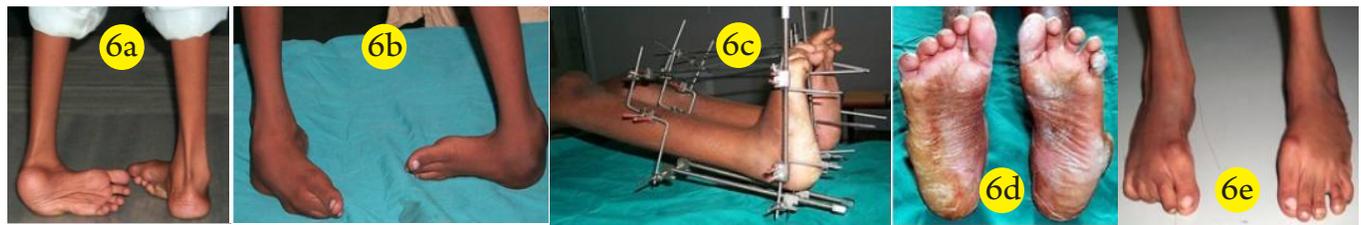
in saggital plane prevents rocking and loosening.

**Attaching Connecting rods to complete fixation blocks**

Two ‘Z’ rods were attached to the tibial pins, one on either side. The wires were prestressed before the link joints were tightened. Two transverse bars were attached to the ‘Z’ rods,



**Figure 5:** Flowchart explaining the method of correction



**Figure 6:** (a) and (b) Clinical pictures of a 15 years old boy with neglected CTEV without any treatment taken in the past. (c) Application of JESS fixator during distraction phase. (d) and (e) Clinical pictures after final correction.

one anteriorly and one posteriorly. Calcaneo-metatarsal distractors were then attached to the K-wires. Two 'L' rods were attached to calcaneal K-wires and two other 'L' rods were attached to the metatarsal K-wires one on either side with the arms of the 'L' rods facing posteriorly and inferiorly. One posterior transverse bar was attached to the posterior calcaneal half pin and the posterior arms of the 'L' rods. Two additional transverse rods were attached to the inferior arms of the 'L' rods which took the toe sling which provided dynamic traction to prevent flexion contracture of the toes as the deformity was

**Attach anterior spacer rods –**

The transverse anterior rod of the tibial block and metatarsal block was connected on either side with anterior static spacer connecting rod. This provided tension force and kept the anterior portion of the joint open. It also prevented crushing of the articular cartilage and provided better glide to the talus while correcting the hindfoot deformity of equinus.

**Protocol of distraction and correction of deformity-  
Distraction phase –**

During manual repositioning the distractors are uncoupled from the frame leaving the three blocks intact and the foot manipulated to achieve derotation. Following this the blocks are reconnected using the distractors and distraction protocol is continued over a week. This process is continued till over correction.

**Holding phase-**

It is important at the end of correction and achieved functional position to stop distraction and hold the corrected position. Holding mode is to continue frame for 6 to 8 weeks after completion of distraction phase



**Figure 7:** (a) and (b) Clinical pictures of a 5 yrs old neglected left CTEV. (c) JESS fixator applied. (d) Clinical picture at final correction

being corrected.

**Attach paired distractors (Fig 4) –**

Paired distractors were attached between the forefoot block and the hindfoot block. Also another pair of distractor was attached between the hindfoot block and leg block.

Fig 4 - Placement of paired distractors. 2 distractors connecting leg block to hind foot block and 2 distractors connecting hindfoot block to forefoot block

Medial distraction is carried out at a rate of 1/4th turn (0.25mm) four times a day (cumulative of one turn in a day which is 1mm) and lateral distraction is carried out at a rate of 1/4th turn (0.25mm) twice a day (cumulative of half a turn in a day which is 0.5mm)

**Manual Repositioning –**

Distraction is continued for 1 week following which patient is called for manual repositioning. Manual repositioning is carried out on OPD basis weekly occasionally with sedation if required.

**Bracing period –**

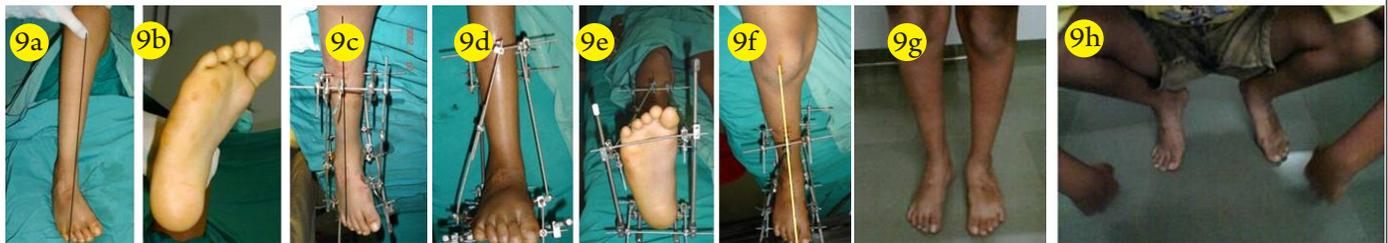
Following the removal of mini external fixator system at the end of holding phase, the child is put in a brace. Bracing is continued to maintain the corrected position.

The illustration video demonstrates the process of differential distraction and correction of deformity

Fig 5 – Flowchart explaining the method of correction



**Figure 8:** Clinical photographs (a) A case of Streeters dysplasia presented at the age of 2 years. (b) and (c) Correction achieved with JESS fixator. (d) Plaster cast applied to maintain corrected position after removal of fixator (e) Patient presented at 4 years from primary procedure with recurrence of deformity due to noncompliance with brace (f) and (g) Correction achieved after JESS fixator application for second time.



**Figure 9:** Fig 9 – Clinical photograph (a) and (b) 8 years old boy with history of surgeries done elsewhere 6 times in past with recurrence of deformity. (c) Application of JESS fixator. (d), (e) and (f) Follow up at 3 weeks with correction of deformity in all planes. (g) and (h) – Clinical photograph with functional ability at 1 year follow up from application of JESS fixator

### Problems and Complications [7,8, 16]-

The method of differential distraction using universal mini external fixator also encounters certain problems and difficulties during the procedure. The conditions which need attention during the method are described here.

Flexion or clawing of the toe is seen during the distraction phase due to shortened and stretching of the flexor tendons. This can be managed during the distraction phase by use of straps or footplate. However after removal of the distractors the clawing is markedly reduced.

Acute over distraction needs urgent attention as it causes necrosis. Thus it is mandatory to observe the child at regular intervals.

Another important issue with use of mini external fixator is possibility of pin tract infection. Pin tract infection is managed by observing the foot at regular intervals with periodic pin tract dressings with betadine, tightening of loose screw, use of short course oral antibiotics and in rare cases revision of pin if needed.

Loosening of components is frequently seen when patient is coming on regular follow up. This can be managed by periodic retightening

repositioning.

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Compliance is a problem for any type of management in CTEV. The non compliance in relation to distraction protocol, bracing after complete correction will lead to recurrence of the deformity.

### Discussion

The goal of any club foot surgery is to obtain a cosmetically acceptable foot, pliable, functional, painless, plant grade foot and to spare the parent and the child from frequent hospitalization and years of treatment with casts and braces [1, 9, and 10]. Physiological tension and stress applied to the tissues stimulates histoneogenesis, while controlled differential distraction gradually corrects the deformities and realigns the bones [11, 15]. External fixators are a versatile method of correcting complex three-dimensional deformities of the foot such as clubfoot. The major difference between the mini fixator or JESS fixators and circular fixators described by Ilizarov was that the wires in this study were not tensioned but only prestressed to prevent them from cutting through the soft bones. Mini external fixators are also lighter in weight, shorter, cheaper, and have an easier application than Ilizarov's fixators. The absence of hinges also fails to correct

rotational deformities [5]. Thus it is required to remove the distractors at regular intervals of distraction and manually reposition the foot and reattach the distractors. This continues till complete correction is achieved.

Correction by distraction has distinct advantage of histoneogenesis, lack of scar tissue formation and the absence of further shortening of the foot. There are many reports of the fixator assisted distractor correction of clubfoot with variations in the technique with good outcome (5-8). Suresh et al found JESS to be ideal for correction of residual and relapse clubfoot in their study involving 26 children with 44 clubfeet (7). Similar results were found by Oganessian and Istomina (14). Short-term assessment of results of clubfeet correction with JESS distractor by Anwar and Arun showed excellent and good results in 59.7% of cases (8).

Thus the evidence from various studies show that correction by mini external fixator is a useful method for the management of clubfoot in neglected and resistant cases.

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