Correction of Relapsed and Neglected CTEV by Controlled Differential Fractional Distraction Using Jess (Joshi's External Stabilization System

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ABSTRACT

Introduction: *JESS* (Joshi's External Stabilization System) is a simple versatile external fixator system which can be used for the correction of club foot in older children. Study aimed to evaluate clinically the correction of the deformities in Neglected and Relapsed clubfeet by ligamentotaxis using Joshi's external stabilizing system (JESS).

Materials and Methods: The study was conducted at Sheri Kashmir Institute of Medical Sciences, (SKIMS) MCH, Srinagar J&K between July 2012 to September 2013. The study included 20 clubfoot deformities treated by Joshi's System of External Fixation.

Results: The present study comprised of a total 20 clubfeet in 18 patients presenting in the Department of Orthopedics, SKIMS MCH, Srinagar. The age of the patients varied from 3 years to 15 years. The majority of the patients were in the age group of 3 year to 10 years. Out of the 20 clubfeet studied, 13 (65%) were male patients and 7 (35%) were female patients. Bilateral deformity was more commonly seen (about 72%). The minimum duration to achieve correction was 13 days and the maximum duration was 63 days. 60% of the patients required less than 4 weeks of distraction. The mean duration of distraction was 28.4 days.

Conclusion: The deformity is clinically well corrected by the principles of differential distraction. But the loss of ankle and subtalar movements is an issue. Loss of correction can occur as the child grows which can be addressed by ala carte procedures depending on the recurrent deformity and importantly parents of these children are immensely satisfied with the correction.

Keywords: CTEV**,** Club Foot, JESS, Resistant

INTRODUCTION

The term clubfoot has no precise scientific definition. Clubfoot as defined in English dictionary of Oxford is the name given for various distortions of the foot giving the foot a lumpy, club like appearance. Traditionally it used to include all varieties of deformed foot under this heading, whether congenital or acquired. However, over the time this term rather has become synonymous in the minds of most surgeons with the commonest congenital deformity of foot — Talipes equino varus.

The term Talipes equino varus is derived from Latin - *Talipes* -a combination of words "Talus"(ankle) and "pes"(foot), *Equinus* meaning "horse like" (the heel in planter flexion) and *varus* meaning inverted and adducted. It's a common congenital deformity occurring in 1 to 2 per thousand live births; seen more commonly in males and is bilateral in about 50% of the cases[1]

Since Hippocrates' time (300 BC), the clubfoot has remained one difficult and perplexing problem for the Orthopaedic surgeons to treat successfully. A review of voluminous literature shows the immense amount of thought that has been invested into this condition, but there is still great divergence of opinion concerning both the principle and the methods of treatment and new treatment options are still emerging and being devised. Moreover, there is no uniformly acceptable classification or grading system for CTEV, which makes it more difficult to assess the results of various treatment modalities. Out of the innumerable classification systems described in the literature for grading of severity of clubfoot Dimeglio's[2] and Pirani's[3] are the ones which are most commonly used.

In the available literature many surgeons have recommended the most appropriate age at which to subject a clubfoot for soft tissue surgery. Turco (1971)[4] has indicated that it is easier if the child is operated on after 6 months to 1 year of age, as the structures are easier to identify in a little older child. Pous and Dimeglio (1978)[5] proposed neonatal surgery (1-3 weeks). Lovell (1970)[6] suggested that if correction could not be obtained conservatively within 3 months then surgery should be attempted. Since when Turco[7,4] described posteromedial soft tissue release (PMSTR), the procedure has almost become procedure of choice for most clubfeet that need surgical correction.

The management of relapsed or neglected clubfoot unlike that of virgin cases is even more challenging because with time the deformities become fixed and the feet develops secondary adaptive bony changes. These feet usually are not

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amenable to correction by soft tissue release procedures alone and often need some bony procedures as well. However, bony procedures (closing wedge osteotomy, arthrodesis) lead to further shortening of an already smaller foot of CTEV[8]

Especially for these cases presenting late or after relapse, which constitute quite a major proportion of clubfoot patients in developing countries like ours, another treatment option has emerged from bony procedures towards ring external fixator system based on principle of Differential Fractional Distraction Histogenesis of G. A. Ilizarov. A number of workers like Grill and franke[9] 1987, Paley[10] 1994 have successfully used llizarov fixator to correct complex three-dimensional deformities of clubfoot.

However, in order to successfully use the tensioned wires required of llizarov fixator, child must have attained the age of 3 years because prior to this age there is insufficient strength in cartilaginous anlage of tarsal bones[8] Dr B. B. Joshi et al of Mumbai based on this principle has developed a simpler construct for the correction of clubfoot deformities known as JESS (Joshi's external stabilizing system), which can be used even in children below three years of age because it doesn't use tensioned wires. With JESS, the author has shown successful management of clubfoot deformities from the age of 3 months to adulthood.[11,16]

Unfortunately, the present era of medical discoveries and sophisticated technologies has not altered the incidence of clubfoot and even the results of corrective procedures of CTEV have not changed substantially.

Therefore, it is always pertinent to examine and evaluate the methods of treating clubfoot available and recommended, in search of best treatment for this unsolved mystery of a disease in Orthopaedics.

The present study was taken up to assess the results of JESS fixator in correction of deformities in neglected, resistant or relapsed cases of clubfoot.

MATERIAL AND METHODS

The study was conducted at Sheri Kashmir Institute of Medical Sciences, (SKIMS) MCH, Srinagar J&K between July 2012 to September 2013. The study included 20 clubfoot deformities treated by Joshi's System of External Fixation.

Inclusion Criteria

- All Relapsed cases (post-surgical and post-corrective cast)
- All Neglected deformity cases
- Idiopathic CTEV
- Both genders
- Unilateral and Bilateral

Exclusion Criteria

- Neurogenic and Syndromic Patients.
- Age < 3 years.
- Age > 15 years.

All the patients were admitted and a detailed history with particular reference to the age, sex, evolution from birth, exposure of the mother to radiation or drugs, birth order, type of delivery, birth asphyxia, previous intervention and prematurity was sought from the parents.

The clinical examination included:

General: Gender, general examination, respiratory, CVS, alimentary, locomotor and nervous systems. Special emphasis will be put on ruling out spina bifida, meningocele, cerebral palsy, ataxia, CDH, constriction bands or arthrogryposis.

Local Examination included;

1. Unilateral and bilateral presence.
2. Previous scar
3. Skin condition
4. Constriction bands
5. Size of the limb (circumferential)
6. Size of the foot
7. Medial and lateral border
8. Presence and severity of posterior and medial skin creases.

Clinically the foot was graded into the Dimeglio.[2]

Investigations: The patient underwent routine hematologic tests, Chest radiography, etc. as a part of Pre anaesthetic checkup and once cleared for anesthesia were taken up for JESS fixation.

Surgical Technique

The operation was performed under general anaesthesia. Hand drill or a hand chuck was used in smaller children and in older children, power drill was used. The procedure involved two major steps 1) Insertion of K- wires and 2) Creation of hold and connection between the hold. Figure 1 shows the components of the construct used as fixation device.

Insertion of K-wires

Tibial K-wire placement: 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 kept about 2 to 4 cm apart depending upon the length of the middle segment of Z rod and run parallel to the axis of the knee joint one finger breadth distal to tibial tuberosity as shown in Figure 3. In older children 3 wires were passed to increase the stability.

Calcaneal K-wire placement: Two parallel K- wires were passed through the tuber of calcaneum from medial to lateral side taking care that they were away from the course of the neurovascular structures on the medial side, as shown in Figure 2 below. 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.

Metatarsal K-wire placement: 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 parallel wires were passed from either side engaging three metatarsals each so that the third metatarsal had engaging half pins from either side through it. The distance between the metatarsal wires was kept 2-3mm more than the distance between the two holes of the distractor.

Creation of holds and connecting between the holds

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 rods were attached to the 'Z' rods, one anteriorly and one posteriorly. Two 'L' rods were attached to calcaneal K-wires and two more 'L' rods were attached to the metatarsal K-wires one on either side with the arms of the 'L' rods facing posteriorly and inferiorly/superiorly. Calacaneometatarsal distractors were then attached to the K-wires on each side of the feet over L rods. One posterior transverse rod was attached to the posterior calcaneal half pin and the posterior arms of the 'L' rods.

Tibiocalcaneal distractors were applied, one on each side connecting the corresponding transverse rods posteriorly. Two additional transverse rods were attached to the inferior/ superior arms of the 'L' rods which could support toes/ take the toe sling that provide dynamic traction to prevent flexion contracture of the toes as the deformity was being corrected. All four distractors were distracted till resistance was felt. Extra lengths of the K-wires were cut, and no tension was created in them.

The transverse anterior rod of the tibial hold and metatarsal hold was connected on either side by static tibiometatarsal 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 gliding to the talus while correcting the equinus.

Adequate skin release was made at the pin entry sites. Haemostasis at the pin entry wounds was achieved with pressure. Dry dressing of the pin entry wounds was done after cleaning. The sharp cut ends of the K wires were protected. The operative time was on an average one hour.

Distraction schedule

In all hospitalized patients, fractional calcaneo-metatarsal distraction was applied from third post-operative day at the rate of 0.25 mm. Differential distraction on medial side was performed twice the rate than that on the lateral side (0.25 mm every 6 hours medially and 0.25 mm every 12 hours laterally). In non-hospitalized patients, parents did the distraction at the rate of 1 mm/daily on medial side and ½ mm/daily on lateral side. By calcaneo-metatarsal distraction, we achieved correction of forefoot adduction at tarso-metatarsal joints, stretching the socket for head of talus and reduction of calcaneocuboid joint.

The tibio-calcaneal distraction was carried out in two positions. Initially, the distractors were mounted between the inferior limbs of the 'Z' rods and posterior limbs of the calcaneal 'L' rods. The distractors lied parallel to the leg and just posterior to the transfixing calcaneal wires. The distraction was applied at the rate of 0.25 mm every 6 hours medially and 0.25 mm every 12 hours laterally and the end-point was judged clinically. Distraction in this position corrected varus of the hindfoot and equinus. The tibio calcaneal distractors were then shifted posteriorly and connected above to the transverse bar connecting the posterior limbs of 'Z' rods and below to the posterior calcaneal bars connecting the posterior limbs of 'L' rods and axial calcaneal pin. The distractors lied on the either side of the axial calcaneal pin. Distraction in this position provided thrust force to stretch posterior structures and corrected hind food equinus at the ankle and subtalar joints. Both distractors were applied at the rate of 0.25 mm every sixth hourly and the end point assessed clinically.

Visual correction of the deformities was noted during the distraction phase. Full correction was achieved, usually at the end of 5 to 6 weeks. Following the correction, assembly was held in static position for double the time required for correction usually extra three to six weeks to allow soft tissue maturation in elongation position. Single stage removal of the whole assembly was done under general anaesthesia. After removal of the assembly, a well moulded below knee plaster was applied in maximum correction. The child was allowed to ambulate full weight bearing in the plaster. Later, a short plaster boot was applied which not only acted as an orthotic device but also allowed mobilization of ankle joint and strengthening of tendoachilles. Squatting was encouraged to achieve dorsiflexion of the foot. Plaster was changed for 2-3 times at an interval of 15 days.

At next follow up, the child was given night splints and CTEV shoes.

The child was then called for regular follow up every month.

RESULTS

This study was conducted in the Department of Orthopaedics,

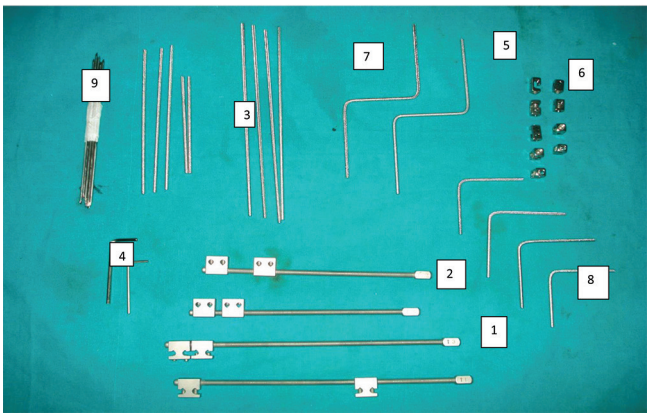

Figure-1: Components of the fixator: (1) distractors, tibio calcaneal; (2) distractors, Metatarso calcaneal; (3) knurled rods, various lengths; (4) Allen keys, large and small; (5) beta-clamps, add-on (fish-mouth type); (6) beta-clamps; (7) Z rods; (8) L rods, large and small; and (9) K-wires, 1.8 mm and 2 mm.

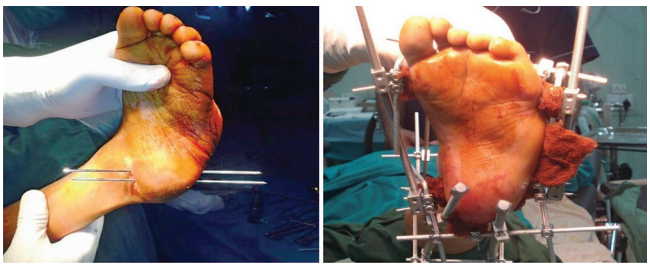

Figure-2: Left Image showing the wires passed parallel and from medial to lateral to avoid NV injury. Right image showing the wires held in the entire built frame at the completion of the procedure

Figure-3: Upper left and right images show the Tibial wires before and after the Z-rod assembly, respectively. Below Two units of frame can be seen before final assembly and reduction.

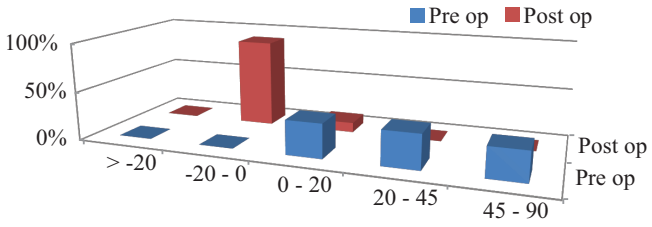

Figure-4: Equinus

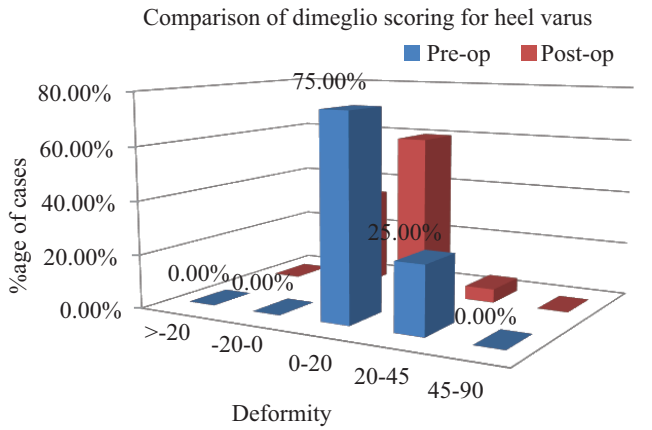

Figure-5: Heel varus

SKIMS MCH Srinagar from December 2012 to December 2013. A total of 20 feet were included in the study.

Age Distribution- 50% of the patients were in the age group of 3-5 years and 25%, 15% and 10% were respectively found to be distributed in the age ranges 6-8yrs, 9-11yrs and 12-15years

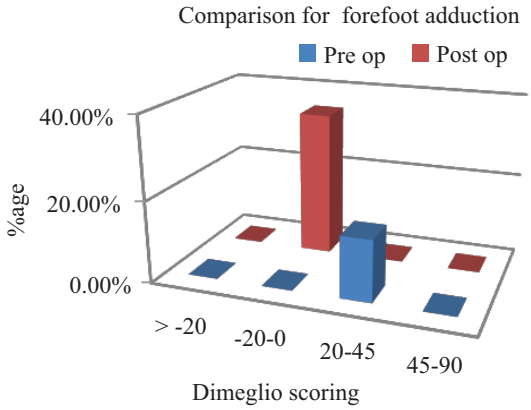

Figure-6: Forefoot adduction

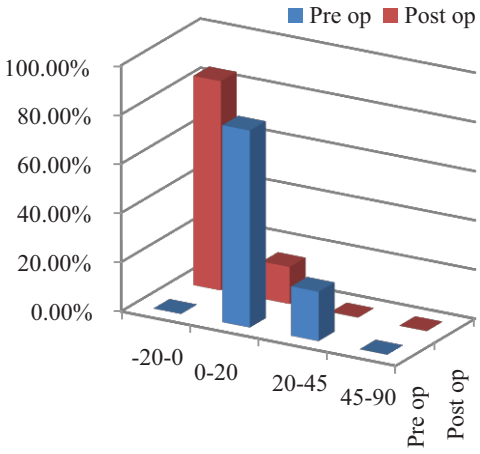

Figure-7: Calcaneal forefoot block

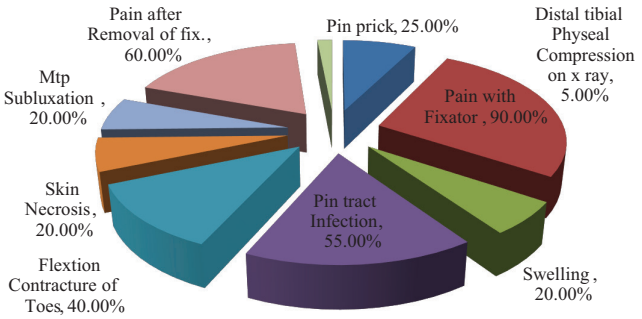

Figure-8: Complications

Sex Distribution- Males predominated the series constituting 65% of cases. The male female ratio was 2:1.

Limb Involvement- In our series, Bilateral involvement was seen in 75% of patients; 15% had Right side alone and 10% Left involvement.

Clinical evaluation of deformities

Equinus of ankle was preoperatively found to be present in 11 feet (37%) as Grade 4 Dimeglio which is 45-90 degrees of equinus. Accordingly, Grade 3 and Grade 2 Dimeglio were seen in 9 (30%) and 10(33%) feet respectively as depicted in the Fig 4 by Blue blocks as under. None of the feet had Grade 0 or 1 pre-op. These findings translated Post-operatively at the time of JESS removal as shown in the same Figure by Red blocks as 0(0%), 0(0%), 4(13%), 26(87%) and 0(0%) feet in Dimeglio grades 4, 3, 2, 1 and 0 respectively

Varus of Heel preoperatively had all feet having either Grade 2 or 3 deformity according to Dimeglio scoring with respective numbers as 21 (70%) and 9 (30%) feet which corrected to postoperative finding of 13 (43%), 16(54%) and 1(3%) into Grades 1, 2 and 3 respectively, as shown in Figure 5.

Similarly, Forefoot adduction and Calcaneal forefoot block finding were found to correct these deformities after JESS fixation. Pre-op finding in case of Forefoot Adduction had 83% and 17% of feet having grade 2 and 3 deformities respectively which corrected to 40% and 60% respectively as grade 0 and 1, postoperatively. Find the comparison in the Fig 6 below. Calcaneal Forefoot block rotation had 80% and 20% respectively in Grade 2 and 3 and postoperatively corrected to 70% and 30% as grade 1 and 2 respectively as depicted in Figure 7.

Complications

Most common complications, inter-alia have been Pain during distraction as well as after removal of fixator and pin-tract infection on and off. Other complication although less commonly seen were Flexion contracture of toes, MTP subluxation, Skin necrosis, intermittent swelling, occasional pin prick to surgeon and assistant during the procedure. Almost all of the aforementioned complications resolved spontaneously after fixator removal, except pain in some cases (around 60%) persisted which took on an average of couple of months to subside. Pain after fixator removal was rarely resting and mostly on weight bearing. Below is the pie-chart representing all the complications encountered in our study.

DISCUSSION

The present study comprised of a total 20 clubfeet in 18 patients presenting in the Department of Orthopedics, SKIMS MCH, Srinagar. The age of the patients varied from 3 years to 15 years. The majority of the patients were in the age group of 3 year to 10 years. Out of the 20 clubfeet studied, 13 (65%) were male patients and 7 (35%) were female patients. This bears with other series. F. Grill[97] (1994), 11 boys and 7 girls; N S Lauds, 10 boys and 3 girls; B B Joshi[11], 14 males and 6 females.

Bilateral deformity was more commonly seen (about 72%). This is almost in conformity with reports in literature. V. J. Turco[7] (1971) treated 100 patients with Bilateral involvement out of 273 clubfeet treated (36%). The minimum duration to achieve correction was 13 days and the maximum duration was 63 days. 60% of the patients required less than 4 weeks of distraction. The mean duration of distraction was 28.4 days.

Cantin and Fassier[12] (1994) reported that the patients required 7 weeks distraction on an average. C. F. Brandish and S. Noor[13] (2000) reported 4 to 8 weeks as the mean period required to distract the deformity (age group 6 – 11 years). They required more duration of distraction probably because their patients were on an average older than our study group. The fixator was maintained in static phase for a minimum of double the time required for distraction of deformity wherever possible. The average duration of static phase in our study group was 47.8 days. The duration of static phase ranged from 28 days to 98 days. 50% of cases required less than 6 weeks of static phase.

B B Joshi et al[11] (1994) recommended maintaining the fixator on static phase for double the period of distraction, which we also followed for our study. D Paley[10] (1994) recommended maintaining the static phase for at least for 6 weeks.

In our series the static phase was cut short in some patients (20%) by early removal of the fixator because these patients didn't tolerate it or didn't cooperate.

Walking plaster cast to hold the correction was maintained for 6 weeks. But in cases with severe deformity we applied the corrective cast for more than 6 weeks in order to maintain correction for longer period.

Dr B B Joshi kept his patients in walking cast for 6 weeks and later changed it to a boot allowing ankle movements and maintained it for another 6 weeks.

After stopping corrective casts in all but one case, an AFO (ankle and foot orthosis) made of thermoplastic material was prescribed to be used throughout the day and night. Parents were taught foot stretching and ankle mobilization exercises and were asked to motivate the child to walk.

One of the patients, who was 15 years old refused to wear the corrective shoes due to cosmetic reasons, so we advised him to wear lateral shoe raise which also he didn't follow. However, the correction stayed maintained till last follow up.

B B Joshi[11] (1994) used an AFO made of a thermoplastic material which allowed for a minor adjustments and appropriate corrective shoes for long term use.

D Paley[10] (1994) advocated an AFO to be maintained for full time for 6 months after removal.

The average duration of follow up was 4.7 months.

CONCLUSION

All the deformities were seen to get corrected by the intervention (JESS). Most of the feet which were found to have deformity graded as Severe (90% of feet) or Very Severe (10%) got corrected to either grade 1, mild (13%); 2 moderate (83%) or few as 3, Severe (3%).

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