ORIGINAL RESEARCH PAPER
Volume - 14 | Issue - 03 | March - 2025 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

RESULTS OF JESS DISTRACTOR IN THE MANAGEMENT OF CONGENITAL TALIPES EQUINO VARUS DEFORMITY IN 3 YEARS TO 15 YEARS OF AGE GROUP PATIENTS: A PROSPECTIVE STUDY AT A TERTIARY CARE CENTER.

Orthopaedics

Dr. Rajesh Kumar Sharma* Assistant Professor, Department of Orthopaedics, P.D.U. Medical College and D.B. Hospital, Churu, (Raj.) India. *Corresponding Author

Dr. Anuradha Upadhyay Senior Demonstrator, Department of Physiology, S. K. Govt. Medical College, Sikar, (Raj.) India.

ABSTRACT

Background: The principle and the methods of treatment of CTEV deformity are still debatable and the new management methods are still emerging. Intervention by different treatment modalities, has different impact on the prognosis of disease. Corrective serial casting by Ponseti method or Soft tissue release procedures alone are not sufficient to correct the late presenting neglected or relapse cases of clubfeet. This study was conducted to evaluate the results of JESS distractor in the correction of the club foot deformity and to assess the complications associated with the procedure. **Methods:** After obtaining institutional ethics committee approval, total 52 club feet (35 patients) of 3-15 years age group included in this prospective study considering inclusion and exclusion criteria. JESS distractor was applied and distraction done as per distraction schedule, followed by removal and corrective cast application. Assessment of the result was based on the Pirani score with 6 months follow-ups. **Results:** There was statistical significant (p-value <0.05) improvement in all clinical and radiological parameters after the procedure in all the post-operative patients. Pirani score improved to good score (0-2) in comparison to it's pre-operative poor score (5-6). **Conclusion:** Considering the parents compliance, JESS distractor is a good minimally invasive treatment modality for CTEV deformity in 3-15 years of age group patients, as it avoids soft tissue and bony procedures to correct the deformity, maintains the normal foot anatomy as well.

KEYWORDS

CTEV deformity, Ponseti method, JESS distractor, Pirani score.

INTRODUCTION

Congenital Talipes Equino Varus or club foot remains commonest congenital deformity, occurring in one per thousand live births[1]. The occurrence of the deformity represents bilateral in about 50% of the cases with male dominance. Dimeglio's[2] and Pirani's[3] are the most commonly used classification systems for grading the severity of clubfoot. Both the principle and the methods of treatment of this deformity are still debatable and the new management methods are still emerging.

Although initial conservative treatment with manipulative reduction and CTEV plaster casting described by Ignasio V. Ponseti[4] is widely accepted as an effective treatment method, but due to lack of understanding patho-anatomy and kinematics of clubfoot among treating clinicians introduce gross errors in the treatment of clubfoot and thus creating space for invasive and minimally invasive surgical techniques[5-8].

The most appropriate age for soft tissue surgery for a clubfoot patient is also debatable. Dimeglio and Pous[9] recommended the clubfoot surgery during neonatal age of 1-3 weeks. Lovell[10] described that if desirable correction could not be obtained conservatively within 3 months then operative procedure should be attempted. Turco[11,12] concluded that it's easier and appropriate to operate in a little older child, as the anatomical structures are easier to identify on after 6 months to 1 year of age. Posteromedial soft tissue release (PMSTR) surgery, suggested by Turco, has almost become the procedure of choice for this deformity.

Neglected, lately presented, resistant, or relapsed cases of CTEV are even more challenging to treat, as with time the deformities become fixed and the feet develops secondary adaptive bony changes. Soft tissue release procedures alone are not sufficient to correct these late presenting clubfeet, and often the bony procedures are significantly needful as well. Although, as the deformed foot is already smaller in size, close wedge osteotomy, arthrodesis like bony procedures may lead to further shortening of clubfoot.

Ilizarov ring fixator, based on principle of differential fractional distraction histogenesis, was successfully used by Grill and franke[13] (1987), and Paley[14] (1994) to correct complex three-dimensional deformities of CTEV. However, use of Ilizarov ring fixator is questionable in very young child aged below 3 years. As there is insufficient strength in cartilaginous anlage of tarsal bones[15], the tensioned wired of Ilizarov ring fixator can't be applied successfully in this age group.

Based on the principle of differential distraction, Joshi's external stabilization system (JESS) was developed by Dr B. B. Joshi et al for the correction of clubfoot deformities. JESS doesn't use tensioned wires, so it can be used even in children below three years of age. The precise viability and efficacy of JESS for the correction of clubfoot deformities from the age 3 months to adulthood has been satisfactory presented by many studies mentioned in the literature[16,17].

We conducted a study at our tertiary care center to evaluate the results of JESS distractor in the correction of club foot deformity in 3 years to 15 years of age group patients, to assess the procedure related complications, and to address the lacuna in the literature as well.

METHODS

Study type

The present study was a hospital based prospective study conducted at Govt. Medical College and D.B. Hospital, Churu (Rajasthan) between November 2022 to August 2024 after obtaining ethical approval of the institutional ethics committee.

Study Participants

In this study 52 feet in 35 patients (18-unilateral; 17-bilateral) were included for the management of old neglected, relapsed or resistant cases of CTEV foot by Joshi's External Stabilization System (JESS). 35 feet were male, and remaining 17 feet were female in this study.

Inclusion Criteria

- Both genders with age group between 3 to 15 years;
- All kinds of club foot except Neurogenic and Syndromic Patients;
- Both unilateral and bilateral cases

Exclusion Criteria

- Neurogenic and Syndromic Patients;
- Patient's age<3 years; >15 years;
- Unfit patient or parent's refusal for surgery.

On admission of the patient a careful detailed history was obtained from the parents/ attendants regarding the birth history, duration and previous treatment of the deformed foot.

The Clinical Examination Included:

Local Examination: Unilateral and bilateral presence of deformity, previous scar, skin condition, constriction bands, size of the limb (circumferential), size of the foot, medial and lateral border, presence of skin creases over medial and posterior aspect of affected foot.

Investigations: All the patients, included in the study, underwent routine blood tests, chest X-rays, etc. for pre anaesthetic purpose and

once surgical fitness obtained from anesthesia side, were taken up for surgical correction with JESS distractor.

Radiological Evaluation:
AP and stress dorsiflexion views of foot and ankle done for radiological evaluation of each patient. X rays were studied for talo-first metatarsal angle, talocalcaneal angle, and talo-Vth metatarsal angle (all in AP view); Tibiocalcaneal angle, talocalcaneal angle and Calcaneal pitch (all in lateral view).

Statistical Analysis
Online statistical software GraphPad and EpiInfo were used for calculating P values. We used Pirani scoring system in the present study to evaluate the severity of deformity and to assess the final correction achieved after complete casting. The significance of difference between preoperative and postoperative values were computed using the Student paired t – test. P value of <0.05 was taken statistically significant. The statistical significant results were within a 95% Confidence Interval.

Surgical Technique
Surgery was performed under GA or spinal anaesthesia. We used power drills in older children, while hand drills were used in smaller children. The procedure involved two major steps: Installation of K-wires, and secondly creation of hold and connection between the hold.

(i)Installation of K-wires:-
Tibial K-wire installation: On the operating table, patient's affected lower limb kept extended in supine position and two parallel K-wires passed one finger breadth below the tibial tuberosity in the proximal tibial diaphysis from lateral to medial direction and run parallel to the axis of the knee joint (Figure 2). The distance in between two K- wires was kept about 2 to 4 cm, according the length of the middle segment of Z rod. To increase the stability, 3 K-wires were passed in older children instead of 2.

Calcaneal K-wire installation: Two parallel K- wires were passed through the calcaneus from medial to lateral side avoiding any injury to neurovascular bundle on the medial side, as shown in Figure 2. To improve axial stability, one additional half pin K-wire was passed from the posterior aspect of the calcaneus along the long axis. The entry point for calcaneus wire was below the insertion of the tendo-achilles in the midline to allow fractional TA lengthening.

Metatarsal K-wire installation: One transfixing metatarsal K-wire inserted from lateral to medial direction through the necks of first and fifth metatarsal in such a fashion that this K-wire engaged 2-3 metatarsals. Two supplementary parallel K-wires were inserted from either side fascinating three metatarsals each so that the third metatarsal had occupying half pins from either side through it. The space between the metatarsal wires on either side was kept 2-3mm more than the gap between the two holes of the distractor (Figure 1).

Figure 1: Tibial K-wires, Calcaneal K-wires & Metatarsal K-wires placement along with fluoroscopic view.

(ii) Creation Of Holds And Connecting Between The Holds: -
Two 'Z' rods were connected to the tibial pins, one on each side. The wires were pretensioned before the link joints were tightened. Two transverse rods were connected to the 'Z' rods, one anteriorly and one posteriorly. Two 'L' rods were applied to calcaneal K-wires and two more 'L' rods were applied to the metatarsal K-wires one on each side with the arms of the 'L' rods facing posteriorly and inferiorly/superiorly (Figure 2).

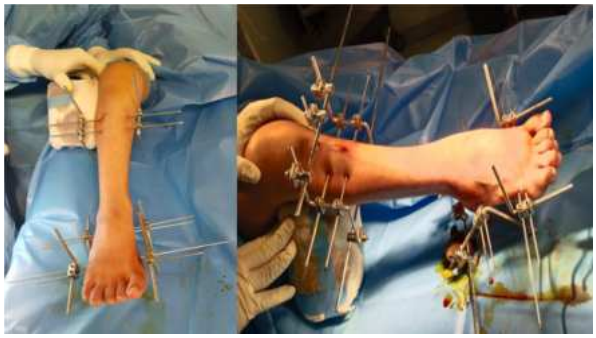

Figure 2: Placement of 'Z' rods & 'L' rods with link joints.

Calacaneo-metatarsal distractors were then connected to the K-wires on either side of the foot over L rods. One posterior transverse rod was also connected to the posterior calcaneal half pin and the posterior arms of the 'L' rods. Tibio-calcaneal distractors were applied, one on either side attaching the corresponding transverse rods posteriorly. Two another transverse rods were attached to the inferior/ superior arms of the 'L' rods which could deliver dynamic traction and support to toes. It prevents further flexion contracture of the toes as the club foot deformity was being corrected during distraction. All four distractors were distracted intraoperatively till optimal resistance was felt. Additional lengths of the K-wires were cut, and no stress was given to K-wires.

The static tibio-metatarsal connecting rod was attached on each side by the transverse anterior rod of the tibial hold and the metatarsal hold. Tension force was generated by this entire system and thus the anterior portion of the ankle joint kept open. The articular cartilage was preserved from crushing. An effective gliding mechanism to the talus was presented by this system while correcting the equinus deformity (Figure 3).

Figure 3: Placement of calacaneo-metatarsal, tibio-calcaneal distractors and connecting rods.

Our average surgical time was one hour for each foot. At the pin entry sites appropriate skin release was created and haemostasis was achieved. After cleaning of pin entry wounds, dry dressing was applied and the pointed cut ends of the K wires were covered enough to prevent further injury.

Distraction Schedule & Follow-up: -
As per our post-operative protocol for hospitalized patients, fractional calcaneo-metatarsal distraction was initiated from third post-operative

day at the rate of 0.25 mm. On medial side differential distraction 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). Whereas, parents did the distraction at the rate of 1 mm/day on medial side and ½ mm/day on lateral side as per our instructions, in non-hospitalized patients.

With the help of calcaneo-metatarsal distraction, we obtained correction of forefoot adduction at tarso-metatarsal joints, and reduction of calcaneocuboid joint by stretching the socket for head of talus. The distraction was carried out at the rate of 0.25 mm every 6 hours over medial side and 0.25 mm every 12 hours over lateral side and the end-point assessed clinically. Distraction in this position corrected equinus and varus deformity of the hindfoot. In most of the cases, full correction was obtained at the end of 5 to 6 weeks. Following the correction, JESS distractor was held in static position to allow soft tissue maturation in elongation position for almost double the time required for correction.

Whole assembly of JESS distractor was removed in single stage under general anaesthesia. After removal of the assembly, below knee plaster in well moulded position was applied in maximum correction just after removal of the assembly. The child was asked to walk with full weight bearing position in the plaster. After that, a short plaster boot was given to the child which acted as an orthotic device and allowed mobilization of the ankle joint, strengthening of tendo-achilles as well. To achieve maximum dorsiflexion of the foot, we encouraged the child to sit frequently in squatting position. At an interval of 15 days, plaster was changed for 2-3 times, followed by night splints and CTEV shoes. The bracing protocol and it's importance was explained to the parents and advised to follow it strictly. After that, a regular clinical assessment of the child was carried out at the end of every month. At the end of sex months, radiological assessment was done and analysed. The parents of all the operated children were asked to report, if they noticed relapse of any deformity. A case was enlisted as failure case if there was no or suboptimal clinico-radiological correction or rocker bottom deformity, joint subluxation like complications occurred during any follow-up.

RESULTS

Age Distribution- 50% of the patients were in the age group of 3-7 years, whereas 35%, 15% were respectively found to be distributed in the age ranges 8-11yrs and 12-15years.

Sex Distribution- In this study males predominated the study constituting 67% of cases, while male female ratio was almost 2:1. Out of total 52 feet, 35 feet were male, and remaining 17 feet were female.

Limb Involvement- In our study, bilateral involvement was seen in 65% of patients; in unilateral cases, 25% had right side alone and 10% left involvement. Out of total 52 feet in 35 patients, 17 patients were bilateral, rest 18 patients had unilateral involvement.

All 52 feet had severe clinical deformities [clinical grade III, Pirani score 5-6 and Foot and BMA <65 degrees]. Out of 52 feet, 20 feet were managed earlier by corrective manipulations with serial casting, 13 feet were treated with soft tissue release (PMSTR) procedure somewhere else and rest 19 had never received any kind of treatment. The average time taken for correction with JESS distractor was 4.2 weeks, highest being 8 weeks and least 2 weeks with a standard deviation of 2.473 weeks.

There was statistical significant (p-value <0.05) improvement in all clinical (Table-1, Figure 4) and radiological parameters in all the post-operative patients (Table-2). The study results were statistical significant within a 95% Confidence Interval. The clinical evaluation was done using Pirani score graded as good to poor outcome. Pirani score of 0–2 is denoted as good clinical outcome. In this study, we achieved good clinical correction (Pirani score 0–2) and more flexible foot, that was a good outcome. By the end of six months follow-up, the flexibility of the corrected feet remained unchanged.

Table-1: Clinical Evaluation Of Club Foot Deformities: -

S. N.	Deformities	Mean preoperative value	Mean postoperative value	p-Value
1.	Mean Adduction	32.3° Adduction	4.2° Abduction	<0.05
2.	Cavus	18.9% cases	0 case	<0.05
3.	Mean Heel Varus	43.3°	3.5°	<0.05
4.	Mean Equinus	62.7° Equinus	19.5° Dorsiflexion	<0.05
5.	Mean Pirani Score	5.2	0.6	<0.05

Table-2: Assessment Of Radiological Parameters:-

S. N.	Measurement unit with normal value	Preoperative score	Postoperative score	p-Value
1.	Talo-Calcaneal index (> 40°)	22.70° ±5.31° (range 14° -30°)	56.51° ±9.17° (range 39°-68°)	<0.05
2.	Tibio-Calcaneal angle (60°-90°)	115.05°±11.22° (range 92°-139°)	80.55°±9.39° (range 68°-100°)	<0.05
3.	Mean FBM Angle (82.5 degree) (Foot and Bimalleolar angle)	60.67° ± 3.13° (range 55-65)	80.33°±2.71° (range 77-83)	<0.05
4.	Talus First Metatarsal angle (0°-20°) (An angle above 0°reflects forefoot adduction)	26.34°±5.85° (range 10°-37°)	2.13°±6.29° (range 3°-22°)	<0.05

(a) (b) (c)

Figure 4: Comparative clinical assessment: preoperative club foot right sided (a) and post-operative clinical outcome of the foot (b,c).

Complications

Pain was the most common complication that was encountered during distraction process. Nine feet (17.3%) developed superficial pin tract infection, were managed conservatively on OPD basis. Other less common complications seen were 1st and 5th MTP subluxation, Flexion contracture of toes, Skin necrosis, intermittent swelling, occasional intraoperative pin prick injuries to surgeon and assistant. Most of the above mentioned complications resolved spontaneously after JESS distractor removal. In some patients, pain was persisted on weight bearing. Although there was no pain on resting condition and it was also subsided spontaneously in next couple of months during follow-ups. Recurrence of the deformity due to non-compliances of the parents was a dreadful issue. In this study 12 (23.1%) feet presented with relapsed forefoot adduction (corrected by manipulations and retention by plasters in all cases) and all returned to orthosis. No open correction of any component of deformity in any case at any stage was done in the study.

DISCUSSION

The present study comprised of a total 52 clubfeet in 35 patients presenting in the Department of Orthopedics, P.D.U. Medical College and D.B. Hospital, Churu (Rajasthan). The age range of the patients of our study sample was 3 years to 15 years. The majority of the patients were in the age group of 3 years to 10 years. Out of the 52 clubfeet studied, 35 (67%) were male patients, and 17 (33%) were female patients. All these findings are comparable with the studies conducted F. Grill[13], 11 boys and 7 girls; and B B Joshi[16], 14 males and 6 females. Bilateral involvement more commonly seen in the present study (65% bilateral involvement). V. J. Turco[12] treated 100 patients (200 clubfeet) with bilateral involvement out of 273 clubfeet treated (73%). So this finding of our study is also comparable with reports in literature.

The minimum duration to achieve correction was 14 days and the maximum duration was 56 days. About 48% of the patients required almost 4 weeks of distraction. The mean duration of distraction was 28.4 days in our study. Cantin and Fassier[18] described that the patients required on an average 7 weeks to overcome the deformity. C. F. Brandish and S. Noor[19] described 4 to 8 weeks as the mean period required to distract the deformity (age group 6 – 11 years). Our results are comparable with these studies.

Wherever possible, we maintained the distractor in static phase for a minimum of double the time required for distraction of deformity. The average duration of static phase in our study group was 53.7 days. The duration of static phase ranged from 30 days to 100 days. 50% of cases required less than 6 weeks of static phase. B. B. Joshi et al[16] recommended maintaining the fixator on static phase for double the period of distraction, which we also followed for our study. D. Paley[14] recommended maintaining the static phase for at least for 6 weeks.

For maintaining the correction, we applied walking corrective cast for 6 weeks. Although, in case of severe deformity, it was applied for longer period. Dr B B Joshi[16] 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, all the parents were taught foot stretching and ankle mobilization exercises. They were also asked to motivate the child to walk. During the follow-up, one 15 years old female patient asked to wear the AFO (ankle and foot orthosis) throughout the day and night but due to cosmetic reasons, she refused to wear it. Further we advised her to wear lateral shoe raise which also she didn't follow. However, the correction stayed maintained till last follow up. B.B. Joshi[16] used an AFO made of a thermoplastic material which allowed for a minor adjustments and appropriate corrective shoes for long term use. D. Paley[14] advocated an AFO to be maintained for full time for 6 months after removal.

Limitations Of Our Study

Small size of study sample and short duration of follow ups are certain limiting factors in our present study. After 6 months of follow up, few patients still under observation to identify the early signs of recurrence of the deformity, loss of flexibility of foot, and parent's compliance as well. Club foot being a musculoskeletal disease, larger sample size with further long duration follow ups are required to look for how long the correction of deformity can be maintained with good functional outcome.

CONCLUSION

Based on the findings of the study we can conclude that JESS distractor is an alternative treatment modality for CTEV deformity in 3-15 years of age group patients with precise viability and better efficacy. JESS distractor can avoid soft tissue as well as bony procedures to correct the deformity of CTEV while preserving the normal foot anatomy. Recurrence of deformity due to noncompliance is a dreadful issue that can be prevented by counselling the parents about the importance of regular follow ups till the child achieves a supple, painless, plantigrade foot.

Acknowledgements
None

Declarations
Funding: None

Conflict Of Interest: None

Ethical Approval: This study was approved by the institutional ethics committee.

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