

Radiological Outcomes of Management of Congenital Clubfoot Using JESS

G B S Varun¹, N Muralidhar², Kavya Bharathidasan³

¹Assistant Professor, Department of Orthopedics, Vydehi Institute of Medical Sciences and Research Center, Bengaluru, Karnataka, India,

²Professor and Head, Department of Orthopedics, Vydehi Institute of Medical Sciences and Research Center, Bengaluru, Karnataka, India,

³Medical Student, Department of Orthopedics, Vydehi Institute of Medical Sciences and Research Center, Bengaluru, Karnataka, India

Abstract

Background: Joshi's external stabilizing system (JESS) is a useful option to correct the deformities in patients who present to the orthopedic department with neglected congenital talipes equinovarus, plaster of Paris drop out cases, or failed surgical procedures. Anteroposterior talocalcaneal angle, lateral talocalcaneal angle, and talocalcaneal index (TCI) are useful tools to assess the outcome of such corrective operations.

Materials and Methods: A total of 16 children underwent 20 JESS procedures at the Department of Orthopaedics, J.J.M. Medical College, affiliated to Chigateri Government Hospital, Davangere and Bapuji Hospital, Davangere, during the period from September 2008 to September 2010. Patients were followed up regularly, and three dimensional corrections were achieved. Talocalcaneal angles (TCA) were measured from pre-operative and post-operative radiographs for each foot in anterior-posterior, and lateral views from which talocalcaneal indices were calculated.

Results: Excellent results were obtained in 15 feet, good results in 2 feet, fair in 1 foot, and poor in 1 foot. The average pre-operative and post-operative talocalcaneal indices were 29° and 53°, respectively. However, there was no correlation between the radiological parameters and the clinical outcome of each foot.

Conclusion: TCA and TCI are simple parameters to compare pre-operative and post-operative radiographs but cannot be used to comment on the clinical severity of each case.

Key words: Clubfoot, Congenital talipes equinovarus, External fixator, Joshi's external stabilizing system, Talocalcaneal angle, Talocalcaneal index

INTRODUCTION

Clubfoot is one of the most common congenital orthopedic anomalies that still challenge the skills of pediatric orthopedic surgeons today. This may be due to the fact that it has a notorious tendency to relapse, irrespective of whether the foot is treated by conservative or operative means. In idiopathic congenital clubfoot, the ankle is in equinus, the heel in varus and the forefoot adducted. Other morphological features include tibial torsion, lateral rotation of the talus within the ankle mortise, medial

angulation of the neck of the talus, subluxation of the talonavicular joint, shortening of the deltoid ligament, and abnormal tendon insertions.

The goal of treatment is to reduce or eliminate all the components of congenital clubfoot deformity so that the patient has a pliable, plantigrade, and cosmetically acceptable foot without calluses, and requiring no modified shoes. This can be accomplished by various methods such as by Joshi's external stabilizing system (JESS), Ponseti's technique, and Ilizarov's fixators.

Although Ponseti insisted that radiographs are not required and that ideally the orthopedic surgeon should assess the progress of any operated congenital talipes equinovarus (CTEV) foot by palpation, radiographs are the mainstay of today's procedures. Various parameters are analyzed from these radiographs such as anteroposterior talocalcaneal angle (AP-TCA) and lateral

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Corresponding Author: Dr. Kavya Bharathidasan, No. 82. EPIP Area, Nalurahalli, Whitefield, Bengaluru – 560 066, Karnataka, India.
Phone: +91-8861253938. E-mail: bkavya96@gmail.com

talocalcaneal angle (Lat-TCA) from which talocalcaneal index (TCI) can be calculated. Other parameters include talo-1st metatarsal angle, calcaneo-5th metatarsal angle, talonavicular subluxation, and tibiocalcaneal angle among many others which have not been taken into consideration for this study. There has been great controversy over which index is the most accurate evaluator of clubfoot correction. Their association with clinical outcome has also been largely disputed.¹ This study aimed to determine the pre-operative and post-operative differences in TCA (in AP and lateral view) and TCI after management of clubfoot by JESS. Furthermore, we planned to study the correlation between radiological findings and clinical outcomes as graded by the Hospital for Joint Diseases Orthopedic Institute Functional Rating System for clubfoot (Lehman *et al.*).

MATERIALS AND METHODS

This study includes 20 CTEV feet in 16 patients from the Department of Orthopedics, Bapuji Hospital and Chigateri Government General Hospital affiliated to J.J.M. Medical College, Davangere, comprising of 8 patients from each hospital. The study was conducted between September 2008 and September 2010. Out of the 16 patients, seven patients were neglected cases, three patients recurrent or relapsed cases, and six patients plaster-of-Paris (POP) dropout cases of idiopathic clubfoot and were surgically treated by JESS fixator. The patients were between 1 and 3 years old, and those who were medically unfit for surgery were excluded from the study.

Correction was carried out using JESS by insertion of K-wires, attachment of “Z” and “L” rods, connecting the segmental hold, and connecting the anterior stabilizing rods based on the principle of distraction histogenesis. On the 3rd post-operative day, differential fractional calcaneometatarsal distraction on the medial side was started at twice the rate than that on the lateral side (medial - 0.25 mm every 6 h; lateral - 0.25 mm every 12 h). The tibiocalcaneal distraction was carried out in two positions: (1) The distractors mounted between the inferior limbs of the ‘Z’ rods and posterior limbs of the calcaneal ‘L’ rods lying parallel to the leg and just posterior to the transfixing calcaneal wires (medial - 0.25 mm every 6 h; lateral - 0.25 mm every 12 h) and (2) the distractors 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 (both - 0.25 mm every 6 h). The end point for distraction was assessed clinically and radiologically. The above-explained distraction was very clearly demonstrated to the patient’s attender and

supervised for 2 days. 7 days following the surgery, the patient was fit enough to be discharged and was advised for a regular follow-up at weekly intervals for 6 weeks to look for progressive correction of the deformity, persistent edema, rule out pin tract infections, and tighten the loosened link joints.

Following the correction, the assembly was held in static position for further 3-6 weeks to allow soft tissue maturation in the elongation position. Single stage removal of the whole assembly was done under general anesthesia, and a well-molded above-knee plaster cast was applied in maximum correction for 2 weeks. Once the pin tracts healed completely, a below knee cast was applied, and the patient was asked to ambulate with full weight bearing in the plaster. It was removed after 4 weeks.

Full correction of forefoot adduction, varus, and equinus was achieved, usually at the end of 6 weeks. X-ray of the operated foot with ankle anteroposterior and stress dorsiflexion views were taken finally after the removal of the below knee plaster and TCI calculated. For all patients, CTEV corrective shoes were advised for 5 years to maintain the correction and prevent recurrence. Using the Hospital for Joint Diseases Orthopedic Institute Functional Rating System for clubfoot (Lehman *et al.*) and Carroll’s assessment, the results were classified as excellent 85-100, good 70-84, fair 60-69, and poor <60 (out of a total score of 100) at follow-up intervals of 3, 6, and 9 months. The parents care and compliance played an important role in the success of this procedure.

Stress radiographs of all feet were taken preoperatively and postoperatively, usually after 6 weeks of the operation when the patient first came for first follow up. AP-TCA and lateral stress radiographs were taken, using the standard technique of radiography as described by Simmons in 1978. Anteroposterior view was taken by keeping the foot flat on the plate when the deformity was maximally corrected by the surgeon and the X-ray tube was kept 30° to the vertical axis of the tibia and the beam was focused on the talus. Lateral view was taken with the lateral border of foot touching the plate with the foot maximally dorsiflexed and the tube directed vertically downward. Since the clinical outcome was good in almost all the cases, radiographs were not taken in subsequent follow-ups.

TCA for each foot was measured by drawing one line through the long axis of the talus and another line through the long axis of calcaneus parallel to its lateral border. This angle shows the divergence between the long axis of the talus and calcaneus (Figures 1-3). Normal angle was taken to be around 20°-40°. <20° indicates hind foot varus. In



Figure 1: Radiographs for a Case of Neglected Clubfoot



Figure 3: Radiographs for a Case of Neglected Clubfoot

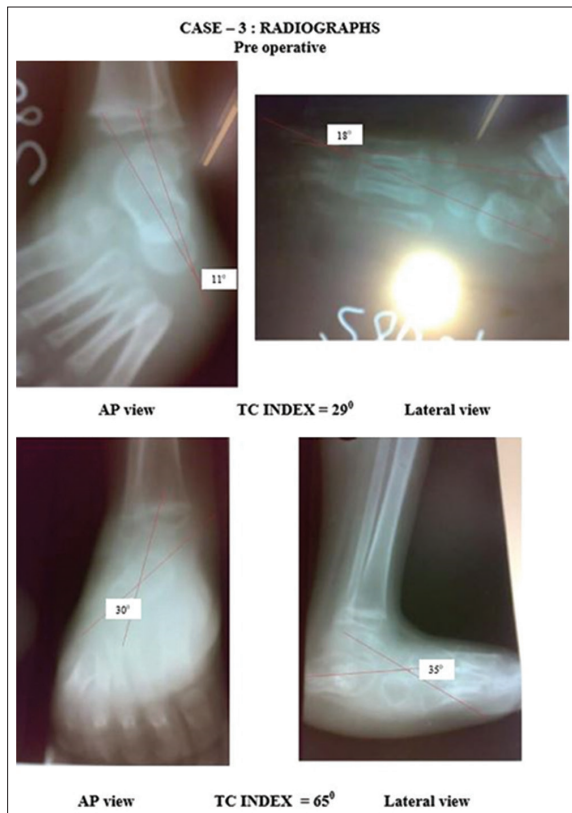


Figure 2: Radiographs for a Case of Recurrent Clubfoot

lateral view, it varies from 25° to 50° (<20° in clubfoot). TCI is the sum of the TCA in AP and lateral views (normal values >40°). In clubfoot, this index will generally be <40°.

As part of the statistical analysis, the mean difference between pre-operative and post-operative values for these three parameters was found along with standard deviation. The correlation between radiological outcome and clinical grading was calculated using Spearman Rank Correlation Coefficient.

RESULTS

The age of these patients ranged from 1-3 years with an average of 1.9 years. There were 8 feet (40%) belonging to neglected cases, 8 feet (40%) to POP dropout cases, and 4 feet (20%) relapsed/recurrent cases. 15 feet (75%) were excellent, 2 feet (10%) were good, 2 feet (10%) were fair, and 1 foot (5%) was poor as graded by the Hospital for Joint Diseases Orthopedic Institute Functional Rating System for clubfoot (Table 1).

The average pre-operative angles were 13° and 18° (AP and lateral, respectively) and TCI was 29°. Postoperatively, AP and Lat-TCA were 23° and 30°, respectively, and TCI was

53° (Table 2). The average difference in pre-operative and post-operative AP and lateral TCA was $9.8^\circ \pm 3.487$ and 11.6 ± 3.839 . Mean difference in TCI was 21.9 ± 7.021 .

None of the radiological parameters showed any correlation with the clinical scores as graded by the hospital for joint diseases orthopedic institute functional rating system for clubfoot. AP talocalcaneal angle showed the highest correlation among the three ($r = 0.246$), though not high enough to be considered significant.

DISCUSSION

Radiographs are a reliable and easily reproducible method for comparing results, particularly in the management of CTEV.² TCA in AP and lateral views and lateral tibio-calcaneal angle are the mostly commonly used parameters used to evaluate progress, lateral view being preferred due to less radiation exposure.³ The average post-operative angle values in our study were comparable to those obtained by Graham and Dent,⁴ Ryöppy and Sairanen⁵ and were found to be better than those obtained by Lau *et al.*⁶ as well as Strömquist *et al.*⁷ (Table 3). When

comparing mean improvement between pre-operative and post-operative measurements, our study showed drastic improvement as compared to the study by Radler *et al.*, in which only tibio-calcaneal angle showed a mean increase of 16.9° .⁸

TCI was found to have a strong association with clinical results in the study by Khanna and Kumar.⁹ Similarly, there was strong clinical correlation between TCA (both AP and lateral) as well as TCI in Prasad *et al.*¹ However, in our study, as well as in the study done by Bhargava *et al.*, there was no significant correlation.¹⁰ This variation in findings may be attributed to the difficulty in obtaining radiographs in children, inaccuracies in measurement, use of different functional rating systems, or different patient inclusion criteria.¹ It may not have been possible to correlate radiological finding with clinical outcomes due to the large range of measurements within a single grading severity group.¹¹

The validity of TCA in assessing clubfoot correction was studied by comparing the values from radiographs with three-dimensional computer tomography (CT) scan reconstruction which proved it to be misleading in 36 cases (out of 48 total studied cases). Hence, a wide range of radiological parameters should be preferred when analyzing any case series to give a better assessment as a whole.^{1,12}

CONCLUSION

Using TCA in AP and lateral view as well as TCI as assessment tools, we were able to find that there was a significant improvement in the values from pre-operative to post-operative radiographs. However, there was no correlation with the clinical grading of our cases as per the hospital for joint diseases orthopedic institute functional rating system for clubfoot. To validate our findings, there is a need to study the relationship of other radiological parameters as well as the efficacy of using different imaging modalities such as CT or sonography to correlate clinical findings.

Table 1: Clinical results

Clinical result	Number of cases	Number of feet	Percentage (%)
Excellent	12	15	75
Good	2	2	10
Fair	1	2	10
Poor	1	1	5
Total	16	20	100

Table 2: Summary of talocalcaneal parameters

Pre-operative			Post-operative		
Talocalcaneal angle		Talocalcaneal index	Talocalcaneal angle		Talocalcaneal index
AP view	Lateral view		AP view	Lateral view	
13°	18°	29°	23°	30°	53°

Pre-operative TC index <40°. Post-operative TC index >40°, TCI: Talocalcaneal index, TCA: Talocalcaneal angle

Table 3: Comparison of results from various studies

Series	Pre-operative (in degrees)			Post-operative (in degrees)		
	AP	Lateral	Index	AP	Lateral	Index
Graham and Dent	-	-	-	25	20	45
Lau <i>et al.</i>	-	-	-	16	22	38
Strömquist <i>et al.</i>	-	-	-	15	24	39
Ryöppy and Sairanen	-	-	-	26	30	56
Present study (2010)	13	18	29	23	30	53

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