Correction of Resistant/Relapsed/Neglected Clubfeet by Differential Distraction with a Simple Unconstrained Ilizarov Construct

¹Giriraj Harshavardhan, ²Ganesan Ram Ganesan

ABSTRACT

Introduction: External fixators were used to correct difficult clubfeet by the principle of differential distraction. Following the distraction phase, the fixator was conventionally maintained for a prolonged period to prevent recurrence. The purpose of the study was to analyze whether early removal of the fixator followed by Ponseti's technique of manipulation is compatible with good result and maintenance of correction at long-term follow-up.

Materials and methods: A total of 21 children with resistant/relapsed/neglected clubfeet in the age group of 2 to 13 years were treated by an unconstrained Ilizarov frame and differential distraction. Once the deformity was clinically corrected, the distraction was stopped and the fixator was removed after 3 weeks. During removal of the fixator, the feet were manipulated according to Ponseti's principles and if necessary a posterior TendoAchilles lengthening/tenotomy was done to obtain more dorsiflexion. Above-knee plaster casts were applied for a period of 3 weeks. Following removal of casts, measurements were taken for foot abduction orthosis and a below-knee cast was applied till the foot abduction orthosis was ready. The foot abduction orthosis was used at nighttime. Parents were taught to manipulate the feet after each meal.

Results: Good clinical correction was obtained in all feet. At 2 years follow-up, correction was well maintained, implying that there is no risk of recurrence if the fixator is removed early during the static phase. The use of Ponseti's technique at fixator removal may also help in reducing the risk of recurrence.

Conclusion: Clubfeet can be easily corrected by differential distraction using external fixators. Early removal of fixator followed by the application of Ponseti's technique of manipulation gives good correction of deformity and does not increase the rates of recurrence.

Keywords: Clubfoot, Differential distraction, External fixator, Ponseti technique/method.

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INTRODUCTION

Relapsed/resistant/neglected clubfeet is a common problem in developing countries. Differential distraction of soft tissues by means of an external fixator has been used with success in the correction of these difficult feet.¹⁻³ But the correction is usually associated with stiff feet similar to that of open surgical releases even though the length of the foot can be improved. Most of the studies recommended that the fixator be maintained for a period of at least 4 to 6 weeks following the distraction dynamic phase to prevent recurrence. But prolonged period in a frame may increase the stiffness and incidence of reflex sympathetic dystrophy. The fixator does not allow much calcaneal rotation as it has a hold on the calcaneus; this is very important as envisaged by Ponseti. Hence to decrease the risk of stiffness and to apply the principle laid down by Ponseti for the correction of clubfoot, we removed the fixator early in a series of cases and applied Ponseti's technique.

AIM

The purpose of the study was to follow up Resistant/Relapse/Neglected clubfoot and to assess whether the correction of the deformity could be achieved and maintained by early removal of the fixator in the static phase and applying Ponseti's methods.

MATERIALS AND METHODS

This was a prospective study done in Sri Ramachandra Medical College from January 2011 to 2015. After obtaining approval from the Institutional Ethics Committee, 23 children were studied. Inclusion criteria included resistant, relapsed, and neglected clubfeet and children aged up to 13 years. The exclusion criteria were the presence of equinovarus deformity secondary to poliomyelitis, spina bifida, and other neurological disorders and children less than 2 years of age as the feet and legs were small and the patient's tolerance was poor. There were 15 boys and 8 girls, and one girl had bilateral clubfoot; this makes our series 24 children. Out of the 24 children, one child was removed from the study population due to distal tibia fracture with Ilizarov fixator *in situ* following a fall from the bed and another child was

^{1,2}Associate Professor

^{1,2}Department of Orthopedics, Sri Ramachandra Medical College, Chennai, Tamil Nadu, India

Corresponding Author: Ganesan Ram Ganesan, Associate Professor, Department of Orthopaedics, Sri Ramachandra Medical College, Chennai, Tamil Nadu, India, Phone: +919444779755, e-mail: ganesangram@yahoo.com

lost to follow-up. Six feet had relapsed after posteromedial releases. Four feet had relapsed after plaster casting. Twelve feet were neglected and had not undergone any treatment. Age group in this series varies from 2 to 13 years with a mean age of 5 years.

All patients were assessed preoperatively using Carrol's criteria⁴ clinically and radiologically as per the guidelines provided by Simon.⁵ The mean Pirani score⁶ was 5 before correction. Functional rating system score for clubfoot was used to assess the functional outcome.⁷ As per functional rating system score, a score of 85 to 100 points is "excellent," 70 to 84 points "good," 60 to 69 points "fair," and less than 59 points "poor." The mean pre-operative Carrol's score was 8 before correction.

Ilizarov fixation is usually criticized for its complexity and difficulty in application by surgeons who are not experienced in this technique. We used a simple unconstrained Ilizarov frame (SRMC construct described below), which can be easily constructed by any surgeon. This construct was used in all feet. The differential distraction (medial distractors/rods—90° four times a day, lateral distractors/rods—90° two times a day) was usually started on the 2nd or 3rd day and till the deformity (pes cavus, forefoot adduction, and heel varus) appeared clinically corrected based on Pirani's score. Parents were taught to distract the rod, and the children were reviewed every 2 weeks. Parents were told to gently manipulate the toes into extension after every meal to prevent flexion contracture of toes. Parents were allowed to bathe the children daily without covering the frame. The parents cleaned pin tracts daily after bath with sterile gauze and Betadine solution. In order to prevent the development of a rocker bottom foot, we did not add an anterior tibiometatarsal rod. The distraction was completed in a mean period of 6 to 14 weeks. The fixator was retained for 3 weeks following completion of distraction phase to allow the elongated soft tissues to mature. The fixator was then removed under anesthesia. Following removal, it was noted that the pes cavus was well corrected in all cases. The foot was supple and a minimum of 50° of foot abduction could be obtained by manipulation under anesthesia. But in most of the cases, the dorsiflexion was limited. In these cases, posterior tendo-Achilles tenotomy⁸ or lengthening was done so that the range of dorsiflexion could be improved. Above-knee cast was applied with the foot in maximum abduction and dorsiflexion (manipulated according to Ponseti's technique). As the feet were pliable, the final stage of correction could be done. The above-knee cast was removed at 3 to 4 weeks to take measurements for a foot abduction orthosis. A below-knee cast was again applied to the foot in maximum abduction and dorsiflexion. Once the foot abduction orthosis was ready, the below-knee cast

was removed. Parents were advised to put foot abduction orthosis whenever the child slept. They were taught to gently manipulate the feet into full abduction and maximum dorsiflexion for at least 5 minutes after each meal. The child was advised to use normal footwear. They were followed up every 3 months for a minimum period of 2 years. Child's ability to walk, run, climb stairs, squat, and use the Indian toilet was noted. Pirani's score was documented at each visit. Photographic documentation was also performed.

We named our construct as SRMC construct, which had five components. The first is tibial component (hold). It has a tibial full ring at the junction of proximal and middle third tibia fixed to the tibia with a medial face wire (anterolateral olive wire), transverse wire and a Schanz screw perpendicular to medial face wire. The second hold is in the calcaneum. It has a posterior half-calcaneal ring extended distally by connection plates parallel to horizontal axis of calcaneum and one medial olive wire. Third component is Metatarsal. It has a metatarsal half ring perpendicular to forefoot on the dorsal aspect and one medial olive wire through all metatarsals or through 1st and 5th metatarsals. Fourth is the tibio calcaneal component. It has one medial and one lateral rod. Rods have to be posteriorly tilted to prevent anterior subluxation of tibia during distraction, hence calcaneal ring has to be placed slightly posterior to tibial ring and tilted plantarwards. Proximally conical washers are used on the rod on each side of tibial ring to allow posterior tilt along with distraction nuts. Distally the rod is connected to calcaneal ring with two double axis joints constructed with 2 hinges such that the proximal joint is in the sagittal plane and distal joint is in the coronal plane (the purpose of these joints is to accommodate changes in the plane of the rings during differential distraction and not as hinges as in constrained frame). The fifth component was Calcaneo metatarsal construct. It has one medial and one lateral rod, proximally connected to calcaneal ring with a joint in the horizontal plane and distally connected to forefoot ring with distraction nuts. No wires were passed through talus. Only tibial wires were tensioned.

RESULTS

The functional rating system score for neglected and relapsed clubfoot were tabulated as in Table 1. Pes cavus and heel varus were well corrected in all feet and did not require any additional procedure at the time of ring removal. There was inadequate dorsiflexion following ring removal in eight feet, which required additional TendoAchilles tenotomy, or lengthening. In all the other cases, the deformity was well corrected. All children had restricted movements of subtalar and ankle joint in

Table 1: Functional assessment

Type	Excellent	Good	Fair	Poor
Relapsed/resistant (10)	5	4	1	0
Neglected (12)	4	7	0	0
Total (22)	9 (41%)	11 (50%)	1 (9%)	0

Table 2: Mean radiological parameters

Ankle/index	Pre-operative	Post-operative	Mean change
Anteroposterior talocalcaneal angle	16.77 ± 5.13	30.00 ± 4.47	13.33
Lateral talocalcaneal angle	11.38 ± 4.42	23.30 ± 7.47	11.92
Anteroposterior talar first metatarsal angle	31.46 ± 6.28	10.85 ± 4.9	20.61
Talocalcaneal index	28.15 ± 9.37	53.30 ± 6.84	25.15

spite of early ring removal. Four of the children had no dorsiflexion (all of them were post posteromedial release relapses). Thirteen children had only 10° of dorsiflexion (most of them in the older age group). Five children had 20° of dorsiflexion. But all of them had no functional disability. The radiological parameters were tabulated as per Table 2. We had two cases of pin-tract infection and flexion contracture of toes in two children. Good clinical correction was obtained in all feet. In the 2 years follow-up study correction was well maintained implying that there is no risk of recurrence if the fixator is removed early during the static phase.

DISCUSSION

Ilizarov external fixator was a useful tool for correcting resistant/relapse/neglected clubfoot. Conventional surgeries were usually limited; beyond 4 years of age, it had to be combined with bony procedures such as wedge resection, osteotomies, and arthrodesis, which ultimately resulted in badly scarred, stiff, and unacceptable small

Fig. 1: Pre-operative relapsed congenital talipes equinovarus **Fig. 2:** Ilizarov *in situ*

foot. In our series, we had 91% excellent (Figs 1 to 3)/good (Figs 4 to 6) results, which can be compared to various published literatures.⁹⁻¹¹ The functional rating system developed by Atar and Lehman combined subjective and objective clinical criteria, functional parameters,

Fig. 3: Two-year follow-up **Fig. 4:** Neglected CTEV pre-operative

Fig. 5: Post-operative Ilizarov *in situ*

Fig. 6: Four-year follow-up

and radiographic assessment in the evaluation system. It is easily reproducible with less interobserver errors, and it can be used effectively to compare the results of similar studies.

In our study, we used a simple unconstrained Ilizarov construct for differential distraction. It is difficult to apply a constrained frame to the foot because of the multiple joints beyond the ankle. Even with an unconstrained frame, anterior subluxation of the talus can occur with distraction. The important principle to prevent this is to posteriorly tilt the tibiocalcaneal connecting rods, which is emphasized in this frame. Ponseti's method can be performed by the Ilizarov method itself by avoiding the calcaneal wire and using only a talar wire. But it is difficult to apply a talus wire in a deformed foot. Many times in congenital talipes equinovarus deformity, the dorsalis pedis artery may be absent. Inserting a talus wire can damage the posterior tibial artery, which may be the sole blood supply to the foot. Hence we used the differential distraction technique with the Ilizarov frame followed by Ponseti's method of manipulation after early removal of the frame.

Pin tract infections occurred in two children, which responded well to cleaning and oral antibiotics. None of the children required change of wires as the duration in the frame was reduced. As we had added double axis joints distally to the tibiocalcaneal rods, the stress on the calcaneal wire was probably less; hence, there was no cut out of the calcaneal wire. Flexion deformities of the toes are a painful problem. Parents were taught to gently manipulate the toes into extension to prevent this. But two children required a K-wire fixation of the great toe to correct this.

In spite of early removal of the fixator, all feet had some degree of stiffness of the ankle and subtalar joint. The degree of stiffness increases with the age of the child. But most children had at least 10° of dorsiflexion. All the

children were able to squat probably because of compensatory movements at the mid-tarsal joints. They had no pain and were able to perform all high-demand activities such as jumping, running, and climbing stairs. Dynamic supination foot deformity was noticed in two children during follow-up for which lateral transfer of tibialis anterior was done. Two children gradually developed recurrence of deformity. Both the children were more than 10 years of age and needed additional procedures. In both children, there was no loss of correction till 2 years of follow-up. Even with soft tissue releases/osteotomies/limited fusions, the feet were generally stiff even though cosmetically corrected. Using the method described in this article, it is possible to get a good correction of deformity without the expertise required for performing soft tissue releases/osteotomies/limited fusions with similar functional outcomes. Shortening of the corrected feet may also be less, but this requires further studies.

CONCLUSION

Ilizarov fixation is useful in the correction of neglected/relapsed clubfoot. The simple unconstrained frame (SRMC construct) is adequate even in severe deformities without open soft tissue releases/osteotomies. Most of the time, especially in younger individuals, adequate correction can be obtained without soft tissue release. In case of inadequate correction after Ilizarov fixation, second-stage soft tissue releases/osteotomy/arthrodesis can be done. The amount of soft tissue release or bone resection required to completely correct the deformity is minimized by prior Ilizarov fixation and differential distraction. In clubfeet corrected by differential distraction by external fixation, early removal of the fixator after completion of the distraction phase and following Ponseti's technique of manipulation leads to good correction of deformity and maintenance of correction.

REFERENCES

1. Bradish CF, Noor S. The Ilizarov method in the management of relapsed club feet. *J Bone Joint Surg Br* 2000 Apr;82-B:387-391.
2. Grill F, Franke J. The Ilizarov distractor for the correction of relapsed or neglected clubfoot. *J Bone Joint Surg Br* 1987 Aug;69-B:593-597.
3. Mehrafshan M, Rampal V, Seringe VR. Recurrent clubfoot deformity following previous soft-tissue release: midterm outcome after revision surgery. *J Bone Joint Surg Br* 2009 Jul;91-B:949-954.
4. Carroll NC, McMurtry R, Leete SF. The pathoanatomy of congenital clubfoot. *Orthop Clin North Am* 1978 Jan;9(1): 225-232.
5. Simon GW. A standard method for radiographic evaluation of clubfeet. *Clin Orthop Relat Res* 1978 Sep;(135):107-118.
6. Pirani S, Outerbridge HK, Sawatzky B, Stothers K. A reliable method of clinically evaluating a virgin clubfoot evaluation. *Proceedings of the 21st SICOT World Congress*, Sydney, Australia, April 1999.
7. Atar D, Lehman WB, Grant AD,. Revision surgery in clubfeet. *Clin Orthop Relat Res* 1992 Oct;(283):223-230.
8. Parade SA, Baird GO, Auffant RA, Tompkins BJ, Caskey PM. Safety of percutaneous TendoAchilles tenotomy performed under general anesthesia on infants with idiopathic clubfoot. *J Pediatr Orthop* 2009 Dec;29(8):916-919.
9. Oganessian OV, Istomina IS, Kuzmin VI. Treatment of equinovarus deformity in adults with the use of a hinged distraction apparatus. *J Bone Joint Surg Am* 1996 Apr;78(4): 546-556.
10. Wallander HM. Congenital clubfoot. Aspects on epidemiology, residual deformity and patient reported outcome. *Acta Orthop Suppl* 2010 Feb;81(339):1-25.
11. Bradish CF, Noor S. The Ilizarov method in the management of relapsed clubfeet. *J Bone Joint Surg Br* 2000 Apr;82(3): 387-391.