Is Distraction Bone Block Arthrodesis better than Subtalar Arthrodesis for Malunited Calcaneal Fractures with Subtalar Arthritis? A Retrospective Case Series

Silvampatti Ramaswamy Sundararajan¹, Rajagopalakrishnan Ramakanth², Venkatachalam Shreeram³, Joseph B Joseph⁴, Shanmuganathan Rajasekaran⁵

ABSTRACT

Aim and objective: To compare the clinoradiological outcome between *in situ* and distraction bone block arthrodesis in patients with malunited calcaneal fracture.

Materials and methods: Patients presenting with painful subtalar joint arthritis between January 2015 and March 2018 were included after thorough clinical and radiological evaluation. *In situ* group I had 22 patients and distraction group II had 14. All patients were evaluated at final follow-up for functional outcome with American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot score, and radiological parameters including talocalcaneal height (TCH), calcaneal pitch (CP), lateral talocalcaneal angle (LTCA), and talar declination angle (TDA).

Results: Mean follow-up was 19.26 months for *in situ* and 12.91 months for distraction group. AOFAS ankle-hindfoot score improved postoperative in both groups, but the difference between the groups was not significant (p value = 0.371). Statistically significant improvement was observed in radiological parameters of talocalcaneal height (p value = 0.006), calcaneal pitch (p value = 0.025), lateral talocalcaneal angle (p value = 0.078), and talar declination angle (p value = 0.02) in the distraction group.

Conclusion: Distraction arthrodesis restores hindfoot radiological parameters better compared to the *in situ* group; however, there is no significant difference in functional outcome between the groups.

Keywords: Distraction arthrodesis, *In situ* arthrodesis, Malunited calcaneal fracture, Subtalar arthritis.

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INTRODUCTION

Displaced intra-articular calcaneal fractures is a challenging situation to perform and to obtain a satisfactory reduction and internal fixation for optimum results. Inadequate reduction/mismanagement/conservatively managed displaced calcaneal fracture leads to subtalar arthritis, broadening of heel, loss of hind foot height, and hindfoot malalignment (varus/valgus deformity).¹ The incidence of subtalar arthritis following conservative treatment of calcaneal fracture is reported to be between 27% and 54% in two short-term studies^{2,3} and as high as 91% in a 15-year follow-up study reported by Ibrahim et al.⁴ Various symptoms with which patients present due to these associated delayed complications are painful heel, heel widening, loss of heel height, anterior tibiotalar, and peroneal impingement.⁵⁻⁷ Decreased hindfoot height leads to limb shortening and leads to the lever arm dysfunction of the Achilles tendon, and increased hindfoot width may cause subfibular peroneal tendon impingement. Ankle impingement of any type can also occur after calcaneal fracture, including posterior ankle impingement, which may arise from the bone spike immediately posterior to the depressed posterior calcaneal facet.^{8,9} Painful subtalar arthritis from the incongruous joint due to malunited intra-articular calcaneal fractures has been treated successfully with arthrodesis across the joint.¹⁰ Isolated subtalar arthrodesis was considered as effective treatment for hindfoot pathology by Joveniaux et al.¹¹ While Carr et al. described the technique of distraction bone block arthrodesis and demonstrated effective correction of hindfoot malalignment and good clinic-radiological

¹⁻⁴Department of Arthroscopy and Foot and Ankle, Ganga Hospital, Coimbatore, Tamil Nadu, India

⁵Department of Orthopaedics, Ganga Hospital, Coimbatore, Tamil Nadu, India

Corresponding Author: Rajagopalakrishnan Ramakanth, Department of Arthroscopy and Foot and Ankle, Ganga Hospital, Coimbatore, Tamil Nadu, India, e-mail: ramjesh64@yahoo.co.in

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outcome.^{10,12} There are no studies comparing the clinical and radiological outcome of *in situ* fusion vs distraction arthrodesis in the recent literature. The only comparative study for *in situ* fusion is in 1999 by Huang et al.,⁸ where he had compared the *in situ* fusion vs sliding corrective osteotomy. Is restoration of hind foot alignment possible in all cases and does the restoration of radiological parameters affect clinical outcome needs to be studied. The present study is aimed at comparing the results between the *in situ* and the distraction group based on clinical scores and radiological parameters. Our hypothesis is clinical results of the distraction arthrodesis is better than in-situ fusion from the available literature.

MATERIALS AND METHODS

This study is a retrospective study of patients who were operated during January 2015 and March 2018 and included all the patients who presented with malunited calcaneal fracture and subtalar arthritis. All patients with previous history of calcaneal fracture, treated either surgically or conservatively, with symptoms of subtalar arthritis and painful subtalar movements and/ anterior and lateral ankle impingement were included for the study. Patients with adjacent joint arthritis, bilateral involvement, and those who had undergone arthrodesis of adjacent joints were excluded from our study.

We had a total of 36 patients who underwent either of the two procedures, *in situ* or distraction bone block arthrodesis with minimum follow-up of 6 months. All the patients who presented during early study period from January 2015 to November 2016 were operated with *in situ* fusion and patients during later half December 2016 to March 2018 underwent distraction arthrodesis. This is a retrospective comparison study of two procedures done with all patients during different periods of time, where group I had 22 patients underwent *in situ* arthrodesis and group II had 14 patients underwent distraction bone block arthrodesis by a single orthopedic surgeon. Preoperative range of movements of the ankle and subtalar joint were assessed using a goniometer. Follow-up was done at 6 weeks, 3 months, 6 months, 1 year, and final follow-up. Functional scores, (hind foot AOFAS), radiological assessment to compare the pre- and postoperative parameters, were done at final follow-up.

Surgical Procedure

All patients were operated under spinal anesthesia and tourniquet control in supine position with a pillow support under the leg. Extended lateral approach (Fig. 1) to the subtalar joint was used. Implants from previous surgical interventions were removed in few cases through separate incision or extension of the same approach. Subtalar joint was denuded of articular cartilage using osteotome/with oscillating saw and bone nibbler. In the *in situ* group, through separate stab incision in the calcaneal tuberosity, fixation with 6.5-mm cannulated cancellous screws was performed, which spans across the subtalar joint, passed from the calcaneum to the talus, under intraoperative image guidance. In the distraction group, the desired amount of distraction was achieved using a laminar spreader/Hindermann's retractor, (from the preoperative radiological calculation) and the gap was filled with tricortical strut autograft from ipsilateral iliac crest. Fixation was done in a similar manner with two cancellous screws across the graft. Wounds were closed in layers over a suction drain, and the patient was immobilized with a below-knee cast.

Adequate analgesia was given in the postoperative period with elevation in the limb. Patients were mobilized nonweight bearing from first postoperative day and advised active toe movements. Patients were discharged on second postoperative day to be reviewed for removal of sutures and cast completion on 12th day. Until 6 weeks, nonweight-bearing walking was continued, after which cast was removed, assessed radiologically, and then mobilized partial weight bearing with modified custom-made footwear (MCR—Microcushioned rubber) with heel raise until 10–12 weeks. Clinical assessment was done for the wound healing and assessment of the scar, any localized signs of infection, tenderness at the subtalar or adjacent joints, and movements of the ankle joint. Full weight-bearing walking was allowed only at the end of 12 weeks. Serial radiological assessment was done at 3 months, 6 months, and 1 year to assess union of arthrodesis/implant failure/late collapse. Radiological parameters, talocalcaneal height (TCH), lateral talocalcaneal angle (LTCA), calcaneal pitch (CP), and talar declination angle (TDA) (Fig. 2), were calculated at final follow-up to be compared with preoperative values. Functional outcome was analyzed using American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot score¹³ at 6 months and final follow-up.

RESULTS

In situ group included 17 males and 5 females with mean age of 44 ± 12.99 (range, 24–76), whereas the distraction group had 10 males and 4 females with mean age of 37 ± 9.91 (range, 24–57). Mean follow-up in the *in situ* group was 19.26 ± 10.66 months and distraction group was 12.91 ± 4.48 months. All patients from both the groups reported better subjective outcome in the operated limb, 24% as excellent, 51% as good, 19% as average, and 6% as poor. All patients achieved levels of independent mobilization without support at an average of 4.5 months. Active dorsiflexion improved from mean of 9° preoperatively (range, $4\text{--}17^\circ$) to 11° postprocedure (range, $6\text{--}16^\circ$), whereas plantar flexion decreased from mean of 29° (range, $20\text{--}37^\circ$) to 23° (range, $16\text{--}26^\circ$) postoperatively at final follow-up. In the *in situ* group, two patients had superficial infection with wound gaping in 1, were managed conservatively with a course of oral antibiotic and regular dressings. In distraction group, 1 patient had a superficial infection at the operative site, one had a late collapse but had a good functional result. Functional assessment done using AOFAS scores showed statistically significant improvement postoperatively in both groups when compared to preoperative scores with p value <0.005 . In the *in situ* group, the mean score postoperatively was 73.83 ± 17.33 SD when compared to 80.33 ± 3.65 in the distraction group (Table 1). Although the score improved in the distraction group as with *in situ* group, the difference was

Figs 1A to C: Clinical photographs depicting the landmarks for (A) Extended lateral approach; (B) Exposed subtalar joint; (C) Joint after denudation of articular cartilage

not statistically significant (p value 0.371). Assessing radiological parameters in the *in situ* group and distraction groups, there was no significant improvement postoperatively as shown in Table 2. All the radiological parameters (Figs 3 to 5) in the distraction group showed better restoration than the *in situ* group parameters, but the difference was not statistically significant.

DISCUSSION

The most important finding from our study is distraction arthrodesis restored the hind foot radiological parameter better than the *in situ* fusion; however, there was no significant difference in the clinical outcome of these patients. Treatment modalities for painful subtalar arthrodesis in patients with malunited calcaneal fracture have been

widely discussed in the literature.^{1,7,14–16} Selecting an appropriate procedure should be catered on the symptoms that are needed to be addressed, such as extent of pain, duration of symptoms, limitations of daily activities, clinical hindfoot malalignment, and hindfoot height loss. *In situ* arthrodesis has been traditionally used by many surgeons around the world successfully for treatment of isolated subtalar arthritis, but presence of heel widening, gross depression, and malalignment in various planes require additional interventions to alleviate the patients symptoms. Carr et al.¹² reported the technique of distraction arthrodesis in cases of loss of talocalcaneal height, and the procedure has been replicated in several studies since then. Indication for distraction arthrodesis was recommended when the loss of talocalcaneal height (TCH) was more than 8 mm by Myerson et al.,¹⁷ while others have included signs of anterior tibiofibular impingement as the indication.⁸ In our study mean TCH was more than 8 mm in both the groups, *in situ* fusions were done in our earlier cases, and later we have moved to distraction arthrodesis in all the cases. Yu Guang-Rong et al.¹⁸ suggested that the vertical sliding osteotomy with subtalar arthrodesis may be needed for the reconstruction of calcaneal

Table 1: Comparing postoperatively American Orthopaedic Foot and Ankle Society ankle-hindfoot score

	Postoperative	p value
Distraction	80.83 ± 3.65	0.3719 (n.s)
<i>In situ</i>	73.83 ± 17.33

Figs 2A to C: Lateral weight-bearing radiographs depicting radiological parameters: (A) Talocalcaneal height (TCH) and lateral talocalcaneal angle (LTCA); (B) Calcaneal pitch (CP) angle; (C) Talar declination angle (TDA)

Table 2: Comparison of radiological parameter between *In-situ* and distraction groups

	<i>In situ</i> group		<i>Distraction</i> group		p value
	Preoperative (mean $\pm$ SD)	Postoperative (mean $\pm$ SD)	Preoperative (mean $\pm$ SD)	Postoperative (mean $\pm$ SD)	
Calcaneal height	7.08 ± 0.58	6.86 ± 0.49	6.62 ± 0.69	7.19 ± 0.51	0.150
Lateral talocalcaneal angle	27.86 ± 7.37	28.1 ± 6.03	21.88 ± 9.39	29.53 ± 4.90	0.126
Calcaneal pitch	21.38 ± 5.34	20.62 ± 4.02	20.34 ± 4.35	17.84 ± 3.52	0.885
Talar declination angle	8.91 ± 4.78	8.05 ± 4.75	5.43 ± 4.66	13.65 ± 4.36	0.115

Figs 3A to C: Distraction arthrodesis Lateral radiographs of 42-year-old male patient showing a difference of 16 mm of talocalcaneal height (TCH) in preoperative X-ray (A) as compared to contralateral side (B), postoperative (C) radiograph showing restoration of TCH to 74.45 mm from 62.70 mm and good union of the distraction site with implants *in situ*

Figs 4A and B: *In situ* arthrodesis Lateral radiographs of 51-year-old male patient showing preoperative and postoperative status with good union at arthrodesis site at 1-year follow-up

Figs 5A to D: Follow-up clinical measurement: (A) Hind foot height of affected side; (B) Hind foot height of unaffected side; (C) Clinical hind foot alignment difference in distraction group; (D) Good union in lateral and axial views at 2-year follow-up

thalamus and subtalar arthrodesis.¹⁸ However, none of our cases needed additional calcaneal osteotomy to correct the hind foot deformities.

We observed satisfactory union in both the groups, and we had 100% union in the *in situ* group, which was similar to the study by Joveniaux et al.¹¹ One case in the distraction group had a late collapse but was asymptomatic and had good functional outcome at 1-year follow-up. Iliac crest autograft was used for all cases of distraction arthrodesis and did not have nonunion. After harvesting tricortical iliac graft, multiple drill holes in the graft was done to improve the chances of bone graft incorporation to the opposing bone surfaces. In bone block distraction arthrodesis, using an interpositional graft, concern has been raised pertaining to union of the intervening bony surfaces.¹⁹ The union rate of the arthrodesis varied from 90 to 100% in various studies.²⁰

A few studies have reported a rate of union to be 100%^{5,21–27} which is similar to our series, where subtalar fusion is achieved by distraction arthrodesis. Allograft usage has demonstrated nonunion as shown by Trnka et al. and hence generally not preferred.¹⁹ Lateral wall exostosis is commonly seen in calcaneal malunion due to height collapse, and its removal to restore the calcaneal width and peroneal tendon impingement is advocated. Many authors performed subtalar distraction arthrodesis using the longitudinal posterior approach just lateral to the Achilles tendon,^{28,29} where the lateral wall exostosectomy/excision was not addressed, while others^{12,30} performed through posterior approach. In our series, we preferred to use the lateral approach to easily perform excision of the lateral wall and to ensure adequate peroneal tendon release in all our cases. In all, 5.40% of patients had reported paresthesia over the lateral border of

foot in distraction group at initial follow-up which recovered at final follow-up; this is in accordance with literature that has reported 0 to 17% incidence of sural nerve neuralgia.^{12,14,19,27} The present study observed good results and reproducibility with the extended lateral approach, whereas literature has shown use of posterior approach in few studies.^{19,27} The comparison between the *in situ* and distraction group showed higher AOFAS ankle-hindfoot score postoperatively in the distraction group, but the difference was not statistically significant. Further, distraction arthrodesis restored the hindfoot alignment better than the *in situ* arthrodesis. However, these anatomical improvements did not seem to have clinical benefits which was also observed by Joveniaux et al.¹¹ Clinical outcomes obtained with distraction subtalar arthrodesis are similar to those obtained with *in situ* subtalar arthrodesis.^{5,15,21,31} Several studies did not show statistical correlation between the heel height and the global outcomes.^{15,17} Higher incidence of malunion and non-union has been reported with distraction arthrodesis in the literature¹⁹ which is contrary to our study, where we had 100% union in both the groups. There are few limitations in this study, where sample size is small, follow-up is shorter, and it is a retrospective study. Prospective randomized trials are needed to clearly differentiate the superiority of one technique over the other.

CONCLUSION

Distraction arthrodesis in malunited calcaneal fractures with painful subtalar arthritis shows restoration of radiological parameters better compared to the *in situ* group; however, there is no significant difference in functional outcome.

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