

Original Research Article

The effect of postoperative immobilization in a plaster of Paris back-slab on the surgical wound-healing following the open reduction and plate and screw fixation of the closed calcaneal fractures: a randomised controlled study

Anindya Debnath^{1*}, Debjita Debnath², Nitesh Rathi³, Santanu Suba⁴, Dinesh R.⁵

¹Department of Orthopaedics, Agartala Govt. Medical College, Agartala, Tripura, India

²MRHRU, Khumulwng, Tripura, India

³Department of Orthopaedics, Saveetha Medical College, Thandalam, Tamil Nadu, India

⁴Department of Plastic Surgery, AIIMS, Bhubaneswar, Odisha, India

⁵Department of Orthopaedics, Chennai, Tamil Nadu, India

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*Correspondence:

Dr. Anindya Debnath,

E-mail: anindya_dn@yahoo.com

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ABSTRACT

Background: Intraarticular calcaneal fractures often need open reduction and internal fixation with plate osteosynthesis. Wound complication is one of the common problems encountered following this. It affects the outcome adversely. Our study was done to assess if a postoperative back-slab can offer any significant difference in the incidence of wound complications.

Methods: Out of 42 patients with unilateral intraarticular calcaneal fractures, 20 were provided postoperative slab and continued for six weeks. The remaining 22 patients were not provided any plaster. All patients were followed-up for two years.

Results: The incidence of wound dehiscence was 2 in the plaster group as well as 8 in the non-plaster group and this was statistically significant ($p=0.02$). Also, significantly lower heel widening was reported in the plaster group ($p=0.03$). Although there was no significant difference in the patient-reported outcome (Maryland Foot Score) and the incidence of pain between the two groups, the occurrence of neurological deficit following surgery and the postoperative range of movements were comparable in these two groups.

Conclusions: Thus, it may be concluded that postoperative plaster application for the initial six weeks could be a low-cost yet effective way to reduce wound complications following plate osteosynthesis in intraarticular calcaneal fractures.

Keywords: Calcaneal, Fractures, Wound, Complications, Plating, Reduction, Fixation, ORIF

INTRODUCTION

Calcaneus is the largest tarsal bone. It is one of the most important bones in the foot and ankle region with a crucial role in weightbearing and supporting the arches of the foot. It is also the most common bone in this region to get

fractured. Road traffic accident and fall from height are the two most common mechanisms of injury and lead to more than 90% of all the calcaneal fractures.³ It has got four articular facets with the posterior facet playing the most important role in weightbearing. More than two-thirds of the calcaneus fractures are intraarticular and achieving a

good clinical outcome in such fractures remains a challenging task.⁶

There has been extensive debate regarding the management of such fractures with literature supporting various treatment modalities ranging from conservative through percutaneous pinning to open reduction and internal fixation with plate osteosynthesis. However, the status of the soft tissues needs special attention especially after open reduction and plate osteosynthesis. The extended lateral approach is the most frequently used approach for the open reduction of a displaced intraarticular fracture. However, the surgical wound-related complications have been reported with variable incidence rates following this. These wound-related complications can be grossly divided into minor and major complications. Examples of minor complications are superficial infection, wound edge necrosis, wound dehiscence, etc. while deep infection, plate fistula, osteomyelitis are the major complications.¹¹ Raising a thick flap of soft tissue as well as careful soft tissue handling has been advocated to minimize soft tissue insult and thereby the wound complications. However, despite all these precautions soft tissue necrosis, wound dehiscence and wound infection continue to be the complications that are still significantly affecting the clinical outcome in the long run (up to 32% of cases).¹⁰ It has been a well-known fact that immobilization with controlled intermittent movements helps in better tissue healing.⁴ This principle has been successfully applied for optimum healing of the fractured bones and the torn ligaments and tendons. However, not much evidence is there in the literature regarding its application for the healing of the calcaneal surgical wounds. This study was done to assess the effect of postoperative immobilization with limited intermittent movements in slab on the healing of surgical wounds following open reduction and internal fixation of intra-articular calcaneal fractures with plate osteosynthesis.

METHODS

This was a randomised controlled study done on the patients who were admitted with unilateral intraarticular fractures and operated from February 2019 till October 2020 at a tertiary healthcare setup (Saveetha Medical College and Hospital, Thandalam, Tamil Nadu, India). Approval was obtained from the Ethical Review Board of the hospital prior to this study. We included the patients in the age group of 15 to 45 years only. Exclusion criteria were bilateral calcaneal fractures, open fractures, Smoking, obesity (BMI>30 kg/m²), diabetes mellitus, connective tissue disorders, any other immunocompromised conditions. A valid written informed consent was a must to participate in the study. Whereas irregular follow-up, in compliance to the treatment provided, or the investigations advised rendered a patient unsuitable for the study. We used a pneumatic tourniquet in all our cases. Fifty-eight patients who were operated in the mentioned duration (Feb 2019 to Oct 2020)

initially fulfilled these criteria. All of them were initially subjected to pre-operative radiological investigation in the form of a plain radiograph of the bilateral heels in axial and lateral views as well as a CT scan. All patients were initially assessed for swelling at the operative site. If the swelling was significant, a preoperative below-knee slab was applied, a window made for regular inspection, the limb was rested in elevation at the level of the heart, Tab. Chymoral Forte (Trypsin-Chymotrypsin 100000 AU) three times daily was started, active toe movements were encouraged and cryotherapy was given every two hourly with each session lasting for about twenty minutes. After the swelling had subsided (as confirmed by the appearance of the 'wrinkle sign') the patients were listed for the theatre.

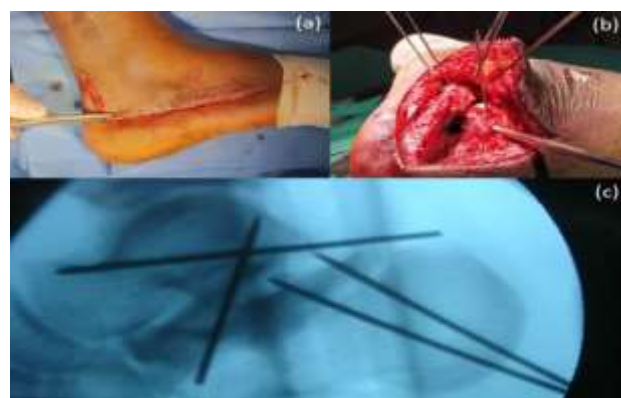


Figure 1: a-c) Intraoperative photographs.



Figure 2: a, b) Intraoperative photographs.

Under general anesthesia, open reduction, and internal fixation with plate osteosynthesis was done in all these patients. They were placed in the lateral decubitus position and the standard lateral approach was used with an attempt to raise the thickest flap of tissue to preserve the vascularity (Figure 1). We used K-wires to retract the soft tissues and never used Langenbeck or any other conventional retractor for this purpose. The K-wires were passed into the surrounding tarsal bones as needed and then bent away from the operating field to ensure a safe and easier surgical access. Open reduction was achieved

using one or two Schanz screw(s) (or, thick K-wires) as joy-sticks. Temporary fixation was done with K-wires (Figure 1). Articular congruity, correction of the Bohler's angle, and the Gissane's angle, as well as the restoration of accurate calcaneal height, were assessed under direct vision and/or in the intra-operative fluoroscopy images (Figure 1). Only after a satisfactory reduction, final fixation with the plate and screws was made, followed by the removal of all the K-wires. We used specially configured calcaneal plates in all our cases (Figure 2). Subtalar movements were checked under the fluoroscopy image. The pediatric drain was used in all cases. The closure was done in two layers with the deeper layer by the absorbable no. 1 Vicryl® suture (Polyglactin 910) and the skin by No. 2-0 Ethilon™ suture (monofilament polyamide). In both layers, simple interrupted sutures were applied without putting much tension (Figure 2). Aseptic dressing with one layer of gauze and one small Gamgee pad was done. 20 patients were randomly provided below-knee plaster of Paris (POP) slab before reversal of the anesthesia and the slab was continued till the suture removal, followed by fresh application of another below-knee POP back-slab (Figure 3).



Figure 3: Postoperative below knee POP back-slab.

This slab was then continued for another four weeks. Remaining 22 patients were provided simple wound dressing with no form of additional external support. Postoperatively, the limb was kept elevated at the level of heart till the swelling subsided. Active toe movements and non-weightbearing mobilization were started as soon as the effect of anesthesia was over. Wound inspections were done on the postoperative days (POD) 2, 5, and 14. Sutures were removed either on the 14th or the 17th postoperative day (depending upon the wound healing status). Ankle pump exercises were started at 6 weeks postoperative. Non-weightbearing mobilization was continued till 3 months after the surgery followed gradually by partial to full weightbearing. Patients were routinely followed-up at the 1.5 months, 3 months, 6 months, 1 year, and the 2 years with provision for any other unplanned visit if needed. During each follow-up, clinical and radiological assessments were done. The clinical assessment comprised of wound status, any neurological deficit (done during the POD2 wound inspection), heel widening (in comparison

with the uninjured side), pain on weightbearing (when applicable) and documentation on a VAS system and the range of ankle and subtalar movements (when applicable). Heel widening was measured with the patient standing barefooted and examiner using a caliper at the widest part of the heel seen from the posterior aspect. The overall clinical assessment was done at the 2 years follow-up using the Maryland Foot Score (MFS) system. Radiological assessment warranted the use of plain radiographs (X-ray heel axial and lateral views), measurement of Bohler's and Gissane's angles, the union at the fracture site, and the appearance of degenerative changes if any. All these assessments were performed by an independent blinded assessor (Figure 4).



Figure 4: Measurement of Bohler's and Gissane's angle on X-ray image.

Statistical analysis was done on the 2 years postoperative findings using the Chi-Square test and the student's t-test.

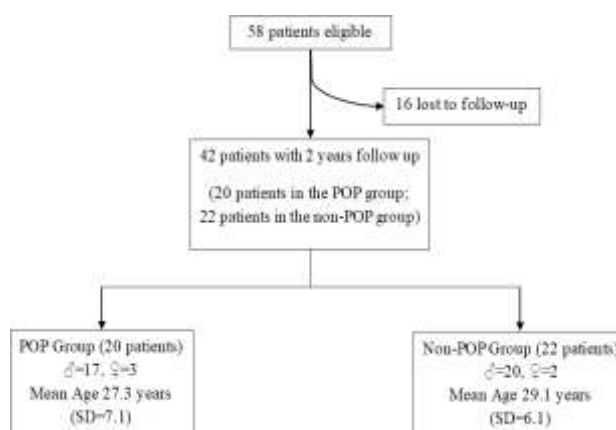


Figure 5: Distribution of patients.

RESULTS

Among the 58 patients, 16 were lost to follow-up before completing 2 years since the surgery. Hence these 16 patients were excluded from the study. Remaining 42 patients constituted the final study population. There were 37 male and 5 female patients with their ages ranging from

18 to 43 years (average age being 28.5 years). Out of the 20 randomly selected patients who received POP slab, 17 were male and 3 were female patients and the remaining 20 male and 2 female patients did not receive any postoperative immobilization. There was no gender bias in the plaster application ($p=0.74$). While the average age in the POP group was 27.3 years ($SD=7.1$), the same in the non-POP group was 29.1 years ($SD=6.1$) (Figure 5). The difference in age between these two groups was insignificant ($p=0.38$). The average tourniquet time in the POP group was 90.8 min while the same in the non-POP group was 88.2 min. There was no significant difference between these two averages ($p=0.57$).

Wound dehiscence

Ten patients had wound dehiscence at some point or the other during the 2 years of follow-up. Among them, two had received postoperative slab and the remaining eight had not received any. Among them four needed flap coverage, rest was managed conservatively (three of them needed VAC dressing, remaining three were managed by alternate day aseptic dressing till the wound healed up) (Figures 6, 7).



Figure 6: Wound dehiscence in a patient.



Figure 7: Flap coverage.

None of our patients required amputation for wound-related complications. None developed chronic osteomyelitis during the 2 years follow-up period. There was a statistically significant relationship between slab application and wound dehiscence ($p=0.02$) and the relationship is very strong (Phi coefficient >0.3). (Table 1).

Neuro-deficit

Four patients (two patients from each group) had postoperative neuro-deficit. All of them had only sensory deficits along the sural nerve distribution. Three of them eventually recovered in 3 months with oral methylcobalamin supplementation. The other one refused any treatment for neuro-deficit.

Heel widening

At the end of two years, there were average 6mm ($SD=2.6$) heel widening in the POP group and the same was 7.8mm ($SD=2.7$) in the non-POP group. The difference was found statistically significant ($p=0.03$) (Table 2).

Pain (VAS)

Nine patients reported some pain at the injured heel (VAS 1 to VAS 3) while bearing weight on the operated limb after their initial three months of postoperative care. Their distribution has been illustrated in the chart below (Figure 8). There was no significant difference between the two groups of patients in terms of pain occurrence and its VAS scoring ($p=0.69$). All these patients were managed by analgesics, electrophysiological therapies intermittently. Remaining 33 patients did not have any pain at follow up.



Figure 8: Residual Pain at 3 months after surgery.



Figure 9: Ankle plantar and dorsiflexion after surgery.

Table 1: Wound status comparison between two groups.

Parameters	POP group	Non-POP group	Total	P value (χ^2 test)	Phi co-efficient
Wound dehiscence	2	9	11	0.023	-0.351
Normal Wound	18	13	31		
Total	20	22	42		

Table 2: Comparison of various parameters between two groups.

Parameters		POP group	Non-POP group	P value (t-test)
Movement (Avg. ROM in degree)	Plantarflexion	36.9	35	0.31
	Dorsiflexion	14.6	14.7	0.86
	Inversion	28.2	25.9	0.12
	Eversion	18.3	18	0.87
Angular measurement (degree)	Bohler (Preoperative)	31.4	30.8	0.53
	Gissane (Preoperative)	131.7	132.2	0.74
	Bohler (Postoperative)	30.1	28.9	0.23
	Gissane (Postoperative)	134.5	134.7	0.89
Heel widening (mm)		5.9	7.8	0.02
Average MFS		85.2	83.1	0.31

Maryland foot score (MFS)

We measured the final clinical outcome using this scoring system at the 2 years follow-up and the clinical status was classified into four different grades.

An MFS of the range of 90 to 100 (inclusive of both the extreme values) was labelled as “Excellent”. Similarly, a score between 75 and 89 was labelled as “Good”, between 50 and 74 as “Fair”, and an MFS less than 50 was labeled as “Poor”.¹² In the POP group average MFS was 85.2 (SD 5.4), whereas in the non-POP group it was 83.1 (SD 7.7). However, the difference was not statistically significant ($p=0.31$) (Table 2, 3).

Range of movements (ROM)

We measured the range of various movements (ROM) at the ankle and the subtalar joint (viz. Plantarflexion, Dorsiflexion, Inversion, and Eversion) (Figure 9). No significant difference could be noted between these parameters in the POP and the non-POP groups. The details of our findings can be found below (Table 2).

Angular measurements

Considering the symmetry between the two limbs, the Bohler’s and Gissane’s angles measured in the contralateral (uninjured) limb were assumed to be the same as the measurements in the fractured calcaneus before the injury. Based on this assumption, there were significant changes noted in these angular measurements following fixation of the fractures ($p<0.05$) (Table 4).

However, no significant difference noted between these measurements in the POP and the non-POP groups (Table 3).

Table 3: Outcome as per MFS in two groups.

MFS Grading	POP group	Non-POP group	Total
Excellent (90-100)	4	6	10
Good (75-89)	15	13	28
Fair (50-74)	1	3	4
Poor (<50)	0	0	0
Total	20	22	42

Table 4: Comparison of preoperative and postoperative angular measurements.

Angular measurement	Preoperative (degree)	Postoperative (degree)	P value (t-test)
Bohler (POP group)	31.45	30.15	0.001
Gissane (POP group)	131.7	134.5	0.003
Bohler (non-POP group)	30.8	28.9	<0.001
Gissane (non-POP group)	132.2	134.7	0.002

DISCUSSION

Wound complications following surgical repair of the calcaneal fractures are encountered very commonly in clinical practice. Even in today’s world despite applying the finest operative techniques and the utmost aseptic precaution, such incidences are still confronted in a considerable number. The incidence of various wound complications is reported to range from 3.3% through 33.3%.^{1,2,5,7} In our study, 23.8% of patients had wound

complications at some point or other during the 2 years follow-up and this corresponds to the literature. Various authors have tried to figure out the factors affecting the wound healing process after the operative treatment of a calcaneal fracture. Al-Mudhaffar et al retrospectively reviewed 33 calcaneal fractures operated by ORIF. In 18.1% of them wound complications (infection, hematoma, dehiscence, and heel necrosis) were reported. A fall from more than 3.4 m height, surgical intervention within a week of the injury, more than 2 h of operating time and the tourniquet time above 1.5 h were few of the significant risk factors for developing wound complications.¹ On the other hand, Ding et al found that the fracture type as per Sander's classification system, diabetes mellitus, smoking, number of residents or fellows present during the case, operating time and the volume of blood loss influence the incidence postoperative wound complication in the closed calcaneal fractures following ORIF. Whereas, the use of tourniquet was found to decrease the risk.⁸ In our study, patients were randomly provided postoperative slab, i.e., we did not allocate the patients into the two study groups based on Sander's type of their fracture. None of our patients had diabetes mellitus. Any patient with the habit of smoking was excluded from our study. All our cases were operated by a fixed team of surgeons and supporting staff. We used the tourniquet in all of our cases, so blood loss was predictably low. Average tourniquet time has been comparable in both the groups and approximately 1.5 hours. These help in avoiding the confounding factors of wound healing in calcaneal fractures, as mentioned in the literature.^{1,8}

Dias et al used the Modified Rowe Scoring System and found a significant correlation between the anatomic restoration of Bohler's angle and the functional outcomes.⁷ In our study, we found no significant difference in the reconstructed Bohler's and Gissane's angles between the POP and non-POP groups. However, we have noted a significant improvement in these angular measurements from preoperative to postoperative values. This corresponds to the overall postoperative improvement in MFS. Out of the 17 displaced intraarticular calcaneal fractures reported by Dias et al, ORIF with plating was done in 4 cases and all of these 4 patients were given postoperative slab for 6 weeks. The remaining cases were managed by CRIF with K-wires. Results were excellent or good in around 65% of cases. Wound necrosis was reported in 17.6% of all cases.⁷ Similarly, we have noted a significant reduction in the wound dehiscence in the postoperative POP group compared to their non-POP counterpart. The average Maryland Foot Score was also better in the POP group of patients compared to that in the non-POP group; though the difference was not significant from the statistical point of view. Joshi et al operated 34 calcaneal fractures among which 26 joint depression fractures were managed by ORIF with plating through lateral approach (remaining 8 were treated by CRIF with percutaneous pinning and postoperative slab application). They used the Maryland foot score for the follow-up

evaluation. Good or excellent results were reported in around 90% of the patients in their study. No poor result was reported.⁹ This is quite similar to our study as excellent and good outcomes were observed in 95% patients of the POP group and 86% of the non-POP group of patients; thereby 90.5% of the total study population showing excellent or good clinical results at the end of the first two postoperative years. We also did not find any poor results based on the MFS system.

The average MFS in the POP group was 2 points higher than the average of the non-POP group. However, this difference was found to be statistically insignificant ($p=0.31$). We did not do an a priori sample size calculation at the commencement of the study and with the available numbers, the post hoc power of this study comes as 51.7%. To the best of our knowledge, no study so far has exclusively examined the effect of postoperative immobilization over the incidence of wound complications. Our study thus pioneered a possible low-cost care plan to reduce the incidence of wound complications following calcaneal plating. Further studies with different ethnic groups of people and larger sample size would throw more light on this.

CONCLUSION

The use of plaster of Paris slab for the immobilization of the affected foot helps to reduce the postoperative wound complications significantly. Also, there occurs significantly less widening of the heel with this protocol. Though the overall clinical outcomes remain similar, the slab applied during the initial six weeks of postoperative care leads to better wound healing after open reduction and internal fixation with plate osteosynthesis in the closed intra-articular calcaneal fractures.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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