Subtalar distraction bone-block fusion for the management of malunited calcaneal fractures

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Aim of the work

Theaim of this study was to evaluate the results of subtalar distraction bone-block fusion for the management of subtalar arthritis due to malunited calcaneal fractures.

Patients and methods

Subtalar distraction bone-block fusion was performed for the management of malunited calcaneal fractures in 20 patients (20 feet) between May 2006 and December 2009 at the Orthopedic Department, Faculty of Medicine, Zagazig University. The mean age of the patients was 30 years. Patients included 15 men and five women. Each patient completed a standardized questionnaire, based on the hindfoot-scoring system of the American Orthopedic Foot and Ankle Society, which was reviewed both clinically and radiologically. No staples or screws were used for fixation of the graft taken from the iliac bone.

Results

All patients showed solid fusion at the end of follow-up. The mean hindfoot score (maximum of 94 points) increased from 22.0 points preoperatively to 75.7 points at the final follow-up. The mean talocalcaneal and calcaneal pitch angles were 22 and 5.2° preoperatively, which improved to 26.2 and 8.0°, respectively, at the final follow-up. The mean talocalcaneal height increased from 65.5 mm before operation to 71.0 mm at the final follow-up. Three patients had sural nerve neuralgia and one patient had superficial infection at the graft donor site.

Conclusion

Subtalar distraction bone-block fusion can be used for the treatment of subtalar arthritis resulting from malunited calcaneal fractures to restore heel height and normal position of the talus, as well as to relieve pain resulting from arthritis, without the use of screws or staples to fix the graft, yielding similar results to those of techniques using screws or staples to fix the graft.

Keywords:

malunited calcaneal fractures, Subtalar distraction bone-block, subtalar fusion

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Introduction

Fractures of the calcaneum, which are intra-articular in 56–75% of cases, are complex injuries, with extensive damage to bone and soft tissue [1]. Displaced intra-articular fractures of the calcaneum when treated conservatively or reduced inadequately may cause serious malalignment of the hindfoot. The most common problems include painful subtalar arthritis, loss of calcaneal height with subsequent tibiotalar impingement and flattening of the longitudinal arch, increased calcaneal width causing fibulocalcaneal abutment and impingement of the peroneal tendons, and axial malalignment of the hindfoot [2,3]. These features are responsible for the alteration of the distribution of pressure in the adjacent joints and the transfer of load onto the midfoot and forefoot, which results in pathological gait [3]. Subtalar fusion eliminates the pain that occurs as a result of residual movement with severe joint incongruity [4,5]. Decompression of the lateral wall of the calcaneum may relieve impingement of the peroneal tendons and fibulocalcaneal abutment. Decreased heel height with tibiotalar impingement and axial malalignment of the hindfoot can be corrected by reorientation of the hindfoot [1,6,7]. Subtalar distraction bone-block fusion was first described by Carr *et al.* [6]; it has been reported to be effective in correcting malalignment of the hindfoot due to various causes, as well as in improving the functional outcome [7–12].

The aim of this study was to evaluate the results of subtalar distraction bone-block fusion for the management of subtalar arthritis due to malunited calcaneal fractures.

Patients and methods

Between May 2006 and December 2009, 20 patients with 20 fractures of the calcaneum were operated upon using the subtalar distraction bone-block fusion technique. All had initially been treated conservatively (from 8 to 12 months). The patients included 15 men and five women; their mean age at the time of follow-up was 30 years (22–60 years). The initial trauma was a fall from a height in 14 patients and a car accident in six patients. Two patients had open

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injuries. The indications for surgery were severe pain and disability in an incongruent subtalar joint. Five patients showed impingement on the fibula and entrapment of the peroneal tendons. These patients did not showimprovement on conservative treatment such as use of orthotics and walking aids, immobilization in a plaster cast, and administration of NSAIDs and corticosteroids.

Operative technique

The patient was positioned in the lateral position. The iliac crest and the leg were draped. Under a tourniquet, a slightly curved incision over the sinus tarsi was used for exposure of the subtalar joint. The fat was excised from the sinus tarsi and the anterior and posterior parts of the subtalar joint were exposed. A laminar spreader was used to distract the subtalar joint; the residual cartilage was debrided and the subchondral surfaces were prepared. The subtalar gap was measured and corticocancellous bone grafts of the correct size were taken from the iliac crest and driven across the subtalar joint. Cancellous bone grafts were used to fill any space remaining in the subtalar joint. No screws or staples were used for graft fixation. Shingling of the lateral wall of the calcaneum was performed in the five patients with fibulocalcaneal impingement. A non-weight-bearing cast was retained postoperatively for 6 weeks, followed by a weight-bearing cast for another 6 weeks.

All notes were reviewed and a questionnaire, based on the hindfoot score of the American Orthopedic Foot and Ankle Society (AOFAS) [13], was administered to create a preoperative database (Table 1). Patients were asked to describe the site and to score the severity of pain, both before and after the surgery, on a scale from 0 to 10. Other questions cover smoking habits; medication at the time of surgery; height, weight, and occupation before and after the operation; numbness; paresthesia; and other complications of the operation. A follow-up questionnaire was administered, which combined the results of the physical examination and interview. Of the 100 points on the hindfoot score, the maximum possible score for a patient with subtalar fusion is 94 because of the loss of subtalar movement. Dorsiflexion and plantarflexion of the ankle were measured using a goniometer, and the feet were examined for altered sensation. Alignment of the ankle and hindfoot was assessed from a posterior view of the standing patient.

Radiological analysis was based on lateral view radiographs taken before and after the operation at follow-up. The talocalcaneal angle was measured using a line representing the long axis of the talus and its intersection with the longitudinal axis of the calcaneus; it represents the relationship between the bones of the hindfoot (normal range 25–45°). The calcaneal pitch angle, represented by a line at the planter cortex of the calcaneus and its intersection with the floor, and the talar declination angle, which is formed by the axis of the talus to the plane of support, were measured. The talar declination angle indicates the horizontal plane assumed by the talus; low values of the talar declination angle are often seen in patients with tibiotalar impingement (normal range is 18–24°) [14]. The talocalcaneal height, measured from the dome of the talus to the base of the calcaneus, was also assessed before and after the operation (Fig. 1).

Table 1 The questionnaire based on the hindfoot score of the American Orthopedic Foot and Ankle Society

	Points
Pain	
None	40
Mild, occasional	30
Moderate, daily	20
Severe, always present	0
Maximum walking distances (blocks)	
>6	5
4–6	4
1–3	2
<1	0
Gait abnormality	
None, slight	8
Obvious	4
Marked	0
Hindfoot movement (inversion + eversion %)	
75–100	6
25–74	3
<25	0
Alignment	
Good, plantigrade foot, ankle hindfoot well aligned	10
Fair, plantigrade foot, some degree of malalignment, no symptoms	5
Poor, nonplantigrade foot, severe malalignment	0
Activity limitations, support requirements	
No limitations	10
Limitation of recreational activity	7
Limited daily, cane	4
Severe limitation, crutches	0
Walking surfaces	
No difficulty on any surface	5
Difficulty on uneven surface	3
Severe difficulties	0
Sagittal movement (flexion–extension)	
Normal or mild restricted (>29°)	8
Moderate restricted (15–29°)	4
Severe restriction	0
Ankle hindfoot stability	
Stable	8
Definitely unstable	0

Results

At a mean follow-up of 24 months (12–36 months), all patients showed solid fusion with a mean time to fusion of 20 weeks (16–26 weeks). The mean AOFAS hindfoot score for these patients was 22.0 points (7–44 points) before operation and 75.7 points (15–85 points) at the final follow-up. All 20 patients

Figure 1

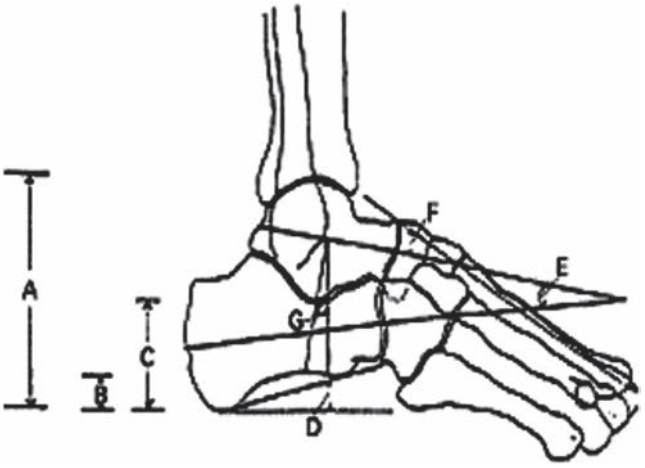


Diagram showing the radiological measurements: (a) talocalcaneal height; (b) cuboid to floor distance (the distance from the most inferior aspect of the cuboid to the floor on a weight-bearing lateral radiograph); (c) navicular to floor distance (the distance from the most inferior aspect of the navicular to the floor on a weight-bearing lateral radiograph); (d) calcaneal pitch angle; (e) talocalcaneal angle; (f) talus-first metatarsal angle; and (g) talus declination angle [15].

were heavy manual workers: 16 of them returned to the same type of occupation and the other four assumed lighter working conditions. Of the 20 patients (20 feet), 18 had less pain and two had similar pain. On a pain scale from 0 to 10, the mean score was 8.4 points (6.5–10 points) before operation and 2.5 points (0–8 points) at the final follow-up. Evaluation of function and walking distance showed that in 18 patients (18 feet) the walking distance and activity improved after surgery. At the final follow-up, the mean planter flexion of the ankle was 30° (7–50°) and dorsiflexion was 10° (8–20°). The majority of patients (18 feet) stated that they would undergo the surgery again.

Radiological results

The mean preoperative talocalcaneal angle of 22° (7–40°) and the mean calcaneal pitch angle of 5.2° (15–18°) were corrected postoperatively to a mean talocalcaneal angle of 27.2° (13–46°) and a mean calcaneal pitch angle of 8.6° (6–27°).

The corresponding values at final follow-up were 26.2° (11.2–44.4°) and 8° (5–25°), respectively.

The mean preoperative talocalcaneal height was 65.5 mm (52–77 mm), which improved postoperatively to 72.6 mm (62–80 mm). The mean preoperative talar declination angle was 6.2° (8–20°), which improved postoperatively to 25° (13–34°). The corresponding values at final follow-up were 71 mm (60–77 mm) and 24.2° (12–32°), respectively.

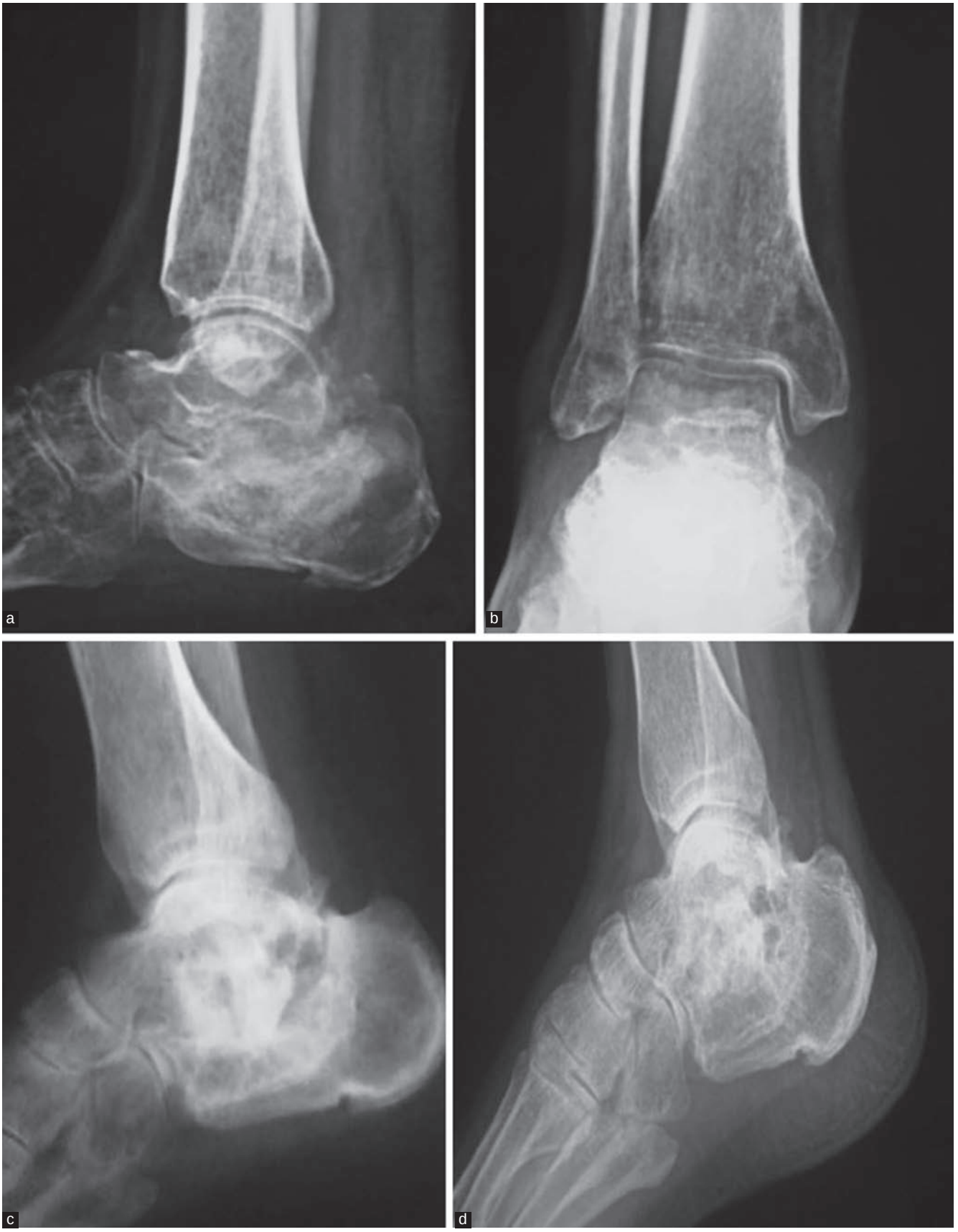
Complications

Three patients complained of sural nerve neuralgia at their final follow-up; two patients had open injuries that were mostly related to the cause of neuralgia. One patient had superficial infection at the graft donor site, which was treated successfully by daily dressing and using antibiotics.

Discussion

Malunited calcaneal fractures can result in painful subtalar arthritis secondary to joint incongruity and also in hindfoot malalignment. This condition can be treated by in-situ subtalar fusion [4,5,16–19], often combined with decompression of the lateral wall to relieve symptoms that arise from calcaneofibular abutment and subtalar impingement. However, in-situ fusion cannot restore physiological heel height, the talocalcaneal angle, or the talar declination angle in injuries or deformities that involve collapse at the subtalar joint [7]. Subtalar distraction bone-block fusion was first described by Carr *et al.* [6] to restore satisfactory orientation of the hindfoot. The results of this procedure have been favorable. Carr *et al.* [6] reported satisfactory preliminary functional results in six of eight patients followed up for more than 1 year. Several other authors have reported results of using the same technique with longer follow-up periods. Meyerson and Quill [1] noted good results in seven of 14 patients after this operation. Amendola and Lammens [8], on the basis of the visual analog scale, reported that 11 of 15 patients were satisfied with the operation. Chan and Alexander [10] noted an improvement in the mean AOFAS hindfoot score from a preoperative value of less than 50 to 76.5 points at follow-up. Burton *et al.* [12] reported a mean AOFAS hindfoot score of 76.1 points for the 15 feet (14 patients) in their study at a mean follow-up period of 47 months. The results in this series were similar to those of previous reports; the mean AOFAS hindfoot score improved from 22.0 points preoperatively to 75.7 postoperatively. There is concern with regard to the rate of union after bone-block distraction fusion. The rate of union in this study was 100%, which is similar to that reported by some of the previous studies [1,8,10,12]. Carr *et al.* [6], in their original study, reported one nonunion. Trnka *et al.* [7] noted that in four of five cases of nonunion, an allograft had been used and concluded that the routine use of allografts for bone-block distraction fusion should not be recommended. Chen *et al.* [11] suggested that inadequate decortication was responsible for the one case of nonunion among 32 fusions. There is consensus that viable bone must be present at the interfaces of the site of fusion after resection of all sclerotic, nonviable

Figure 2



(a) Preoperative lateral radiograph showing loss of heel height, a horizontal talus, and subtalar arthritis. (b) Preoperative anteroposterior radiograph. (c) Postoperative lateral radiograph (6 months) showing fusion and restoration of near normal heel height. (d) Follow-up lateral radiograph (1 year) showing complete fusion of the subtalar joint.

Figure 3

(a) Preoperative lateral radiograph obtained after a malunited calcaneal fracture showing loss of heel height and subtalar arthritis. (b) Preoperative anteroposterior radiograph showing fibulocalcaneal abutment. (c) Radiograph obtained 3 months after subtalar distraction fusion. (d) Radiograph obtained 12 months after subtalar distraction fusion showing complete bony fusion.

bone to achieve solid union [4,7,11]. Neuralgia of the sural nerve is a commonly reported complication after distraction fusion of the subtalar joint, with an incidence varying from 0 to 17% [1,6,7,12]. In this study, three patients had neuralgia of the sural nerve (15%); this finding was similar to that of the study by Myerson and Quill [1], who raised caution about the risk of entrapment of the tibial nerve. However, Trnka *et al.* [7] reported this problem in six of their 35 patients; in addition, Burton *et al.* [12] reported one case of sural neuralgia in a series of 15 distraction fusions. A curved lateral incision was used in this study, with no problems with wound healing. However, some authors reported that the curved lateral approach is more liable to wound dehiscence and is difficult to close distally [6,8]. Other authors recommend the posterolateral (Gallie) approach, as no wounds developed on using this approach [7,9,10,12]. No staples or screws were used for fixation of the graft; hence, no complications, such as those reported by other studies that used screws or staples for fixation, were reported. In the series by Rammelt *et al.* [15], seven patients (22.6%) reported occasional heel pain, which was resolved when the screws used for fixation were removed. Radiological evaluation of the talocalcaneal angle, talar declination angle, and talocalcaneal height suggests that bone-block distraction improves alignment of the hindfoot in the sagittal plane. The mean preoperative talocalcaneal angle improved from 22 to 26.2° at follow-up; this is similar to the results of other studies [6,9,12]. The improvement in the talar declination angle from 6.2 to 24.2° at final follow-up and the improvement in the talocalcaneal height from 65.5 to 71.0 mm at follow-up were more than that reported by other authors [6–9,12]. Although the operation of distraction fusion was successful, it was associated with complications, and there is a debate on whether its outcome was better than that of in-situ fusion combined with decompression of the lateral wall. Myerson and Quill reviewed the late complications of calcaneal fractures and compared the results of various treatments after devising a treatment algorithm; they concluded that bone-block distraction fusion is preferable to in-situ fusion for patients with loss of heel height.

In this series, minimal loss of hindfoot alignment was noted on comparing immediate postoperative radiographs with those obtained at final follow-up. However, this did not significantly affect the final functional outcome or the patients' satisfaction with the procedure as the majority of patients (18 feet) stated that they would undergo the surgery again.

Conclusion

The results of this series support the use of bone-block distraction fusion for the treatment of subtalar arthritis due to malunited calcaneal fractures; no screws or staples were used for fixation of the graft. The end results of this study are similar to or even better than those of some other studies (Figs 2 and 3).

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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