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Original article

Sanders II–III calcaneal fractures fixed with locking plate in elderly patients

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ABSTRACT

Purpose: To evaluate the clinical outcomes of locking calcaneal plate in treating calcaneal fracture (Sanders II–III) in elderly patients.

Methods: From October 2012 to December 2013, 23 elderly patients suffering from calcaneal fracture (Sanders II–III) were treated and followed up. There were 15 males and 8 females with the mean age of 68.5 years (range: 65–79 years). According to Sander's classification, 16 cases (16 feet) were type II fractures and 7 cases (7 feet) were type III fractures. Anteroposterior, lateral and axial views of X-ray were taken to detect the calcaneum. CT scan was done to assess the amount of comminution and articular depression. Radiological assessment was performed using Bohler's angle and Gissane's angle. Functional outcome was assessed using the Maryland foot score.

Results: All the patients were followed up for 13.7 months on average (10–20 months). The mean time of bone union was 3.2 months (3–4 months). The mean time of complete weight bearing was 3.2 months (3.1–4.0 months). The soft tissue necrosis was found in 1 case. The mean Bohler's angle and Gissane's angle were 25.31° and 117.5° respectively. The overall excellent to good rate was 82.6%.

Conclusion: Open reduction and internal fixation with locking calcaneal plate can obtain good functional outcome for Sanders II–III calcaneal fractures in elderly patients.

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Introduction

Calcaneal fracture, accounting for 60%–65% of tarsal fractures and 1%–2% of all types of fractures, has been regarded as one of the most common fractures in foot.¹ Calcaneal fracture often results in disability in varying degrees.² At present, it is reported that better clinical effects can be achieved in treating young patients with intraarticular calcaneal fracture by operation,^{3–6} while there exists controversy on the treatment of calcaneal fracture in elderly patients.^{4,7} This study proved that the open reduction and internal fixation with locking calcaneal plate yielded satisfactory outcome in treating Sanders II–III calcaneal fracture among 23 elderly patients.

Materials and methods

General data

Totally 23 (23 feet) elderly patients with remarkably displaced calcaneal fracture (Sanders II–III) were treated from October 2012 to December 2013, including 15 males and 8 females with a mean age of 68.5 years (range: 65–79 years). Ten cases had the left foot affected, and 13 had the right foot affected. All the fractures were closed injuries, including 7 resulted from falling and 16 from car accidents. Six cases were combined with compression fractures of thoracolumbar vertebrae, 1 with pelvic fracture and 2 with intertrochanteric femur fracture or femur neck fracture. X-rays of the calcaneum in lateral and axial views, CT scan and three dimensional reconstruction were done in all patients before operation. According to imaging data, 16 were diagnosed with Sanders II fractures and 7 with Sanders III fractures. Both Bohler's angle and Gissane's angle were measured before and after operation, even in the follow-up. Functional outcome was assessed using the Maryland foot score.⁸

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Preoperative preparation

The patient's affected limb was lifted after admission and treated with detumescence and analgesia. Cold compresses were applied within 48 h after injury. The operation was not conducted until the swelling in skin was relieved, the tension blister was absorbed and the wrinkles appeared. For patients combined with spine fracture, pelvis fracture or hip fracture, the associated injury was firstly treated. Patients with high blood pressure, diabetes, or chronic bronchopneumonia received multiple disciplinary consultation to restore water-electrolyte and acid–base balance. The operation was completed within 21 d after injury, if possible, the operation should be accomplished within 14 d after injury.

Operation

Under general anesthesia or epidural anesthesia, the patient lay on his uninjured side with the affected foot lifted. The tourniquet was used. An "L"-like incision was made on the lateral calcaneus, from the middle point of the posterior margin of fibula (proximal to external malleolus) and achilles tendon to the calcaneocuboid joint. Dissect the skin and subcutaneous tissue up to the periosteum of the lateral calcaneus, cut off peroneal retinacula, and roll up the periosteum along with soft tissue, long and short muscle tendons of fibula (try to preserve sural nerve during the procedure). Then drill into the talus with 2–3 2 mm-in-diameter Kirschner wires separately and bend the wires to draw the skin and fibular tendon, in order to fully expose the subastragalar articular surface, calcaneocuboid articular surface and lateral wall of the calcaneus. To clearly display the subastragalar articular surface and posterior articular surface of calcaneus, the lateral wall of calcaneus was opened and the calcaneus was introverted. The collapsed articular surface was raised and fixed by Kirschner wires to restore the smoothness and anatomy of articular surface. For the patients with obvious bone defects, autogenous iliac bone or artificial bone was used for filling. Correct calcaneal varus and broaden deformity, recover lateral wall of calcaneus, and finally fix the locking plate of the appropriate size on the relatively intact bone fragments of sustentaculum tali, calcaneal tuberosity and medial wall with screws. The fluoroscopy was performed to measure Bohler's angle, Gissane's angle, screw size and the length of locking plate. The wound was sutured, the locking plate and long/short muscle tendons of fibula were separated by soft tissue to avoid the direct friction, and the drain tube was placed properly.

Postoperative care

Within 24 h after operation, cold compresses were applied on the wound. The patients were encouraged to do active motion of the toe, with the affected limb lifted and drain tube retained for 2–3 d according to drainage volume. Three days later, active motion of the ankle was initiated. The lateral and axial views of X-rays in the calcaneum, CT scan and three dimensional reconstruction were performed for routine checking. If the patient had darkened skin flap after operation, his affected foot should be fixed in the valgus position with a below-knee cast to reduce the stress on lateral skin flap. Weight-bearing was practiced step by step according to the fracture healing indicated by lateral and axial views of X-rays three months later.

Evaluations of clinical results

Maryland foot scale was utilized (90–100 scores were regarded excellent, 75–89 good, 50–75 acceptable, <50 poor).

Results

All the 23 patients were followed up for 10–20 months, mean 13.7 months. The duration of bone union of calcaneal fractures ranged from 3 to 4 months, mean 3.2 months. The complete weight-bearing activity of the affected foot started at postoperative 3.1–4 months, mean 3.2 months. One patient presented skin necrosis on the wound surface and recovered after dressing change. There was no loosening or breakage of the screws and the plate, or wound infection.

In the final follow-up, the mean Bohler's angle and Gissane's angle were 25.31° and 117.5° respectively. According to Maryland foot score, the excellent to good rate was 82.6% in all the patients, 81.3% in Sanders II calcaneal fractures and 85.7% in Sanders III calcaneal fractures (Table 1, Fig. 1).

Discussion

Calcaneal fracture is considered the most common tarsal bone fracture, accounting for 60%–65% of tarsal bone fracture.¹ Since 75% of calcaneal fractures are intraarticular fractures, most of them are combined with serious dislocation of posterior articular facet, leading to disabilities at varying degrees.^{2,3}

Operative and nonoperative treatment

There is a controversy on the treatment of calcaneal fracture along with intraarticular dislocation in aged patients.^{9,10} Earlier studies suggested that nonoperative treatment be more feasible.^{4,7,11}

According to some scholars, calcaneus reconstruction did not carry much importance for elderly patients diagnosed with calcaneal fracture due to their little demand for function.¹² However, with the aging of society, the treatment for calcaneal fracture in aged patients becomes more challenging. Herscovici et al¹³ studied 37 elderly patients with calcaneal fracture in the follow-up of mean 44 months, and found that operative treatment yielded favorable clinical results proved by the mean AOFAS score of 82.4 and mean SF-36 score of 52.8. Basile et al¹⁴ reported that in elderly patients with calcaneal fractures, the operative group regained better Bohler's angle and apposition of subtalar joint, higher AOFAS score and lower VAS score compared with the nonoperative group, and the differences were statistically significant between the two groups. All the results suggested that the patients who underwent operations experienced higher satisfaction, better function and less pain.

In our study, the mean postoperative Bohler's angle and Gissane's angle were 25.31° and 117.5° respectively, and the overall excellent to good rate was as high as 82.6%, which was related to normal Bohler's angle and Gissane's angle regained by operation. Thus, it confirmed that the recovered Bohler's angle and Gissane's angle were important for functional recovery of elderly patients with calcaneal fracture. Moreover, there were merely 7 cases of Sanders III fracture (30.4%), so it was easy to obtain satisfactory reduction in this group with lower severity. Thus, in elderly patients with osteoporotic calcaneal fractures, the doctor should select the right indication, adopt the optimal surgical scheme and restore Bohler's angle and the apposition of subtalar joint convolution for favorable clinical results.

Operation timing, postoperative complication and wound care

For elderly patients with osteoporotic calcaneal fracture, the treatment should aim to achieve anatomical reduction and shorten the time from injury to operation, so that the patient can return to the pre-injury condition as soon as possible. However, there exist

Table 1
Postoperative functional recovery of patients with Sanders II–III calcaneal fractures.

Fracture type	Excellent (n)	Good (n)	Acceptable (n)	Poor (n)	Excellent to good rate (%)
Sanders II	7	6	3	0	81.3
Sanders III	5	1	0	1	85.7
Aggregate	12	7	3	1	82.6



Fig. 1. X-ray images of Sander III calcaneal fracture. **A:** Preoperative lateral view of X-ray in the calcaneus showed several fracture lines of calcaneus, affecting subtalar joint surface; **B:** Preoperative axial view of X-ray in the calcaneus showed comminuted fracture in a widened calcaneus; **C:** Postoperative lateral view of X-ray in the calcaneus showed that the height of calcaneus, Bohler's angle, Gissane's angle and subtalar joint surface were recovered; **D:** Postoperative axial view of X-ray in the calcaneus showed a recovered width and normal contour of the calcaneus.

possibilities of complications such as skin necrosis and infection, if the operation is conducted before local swelling is not relieved.¹⁵

It is reported that preoperative preparation for over 14 d would influence operation procedure and clinical outcome.¹⁶ In some cases of our study, preoperative preparation exceeded 14 d while the operation was completed within 21 d after injury. There was no difficulty in reduction during operation, which may be due to osteoporosis in most of elderly patients. Meanwhile, bone healing needs a longer course, so it is relatively easy to give reduction even 14 days after operation.

In our study, one patient presented skin necrosis on wound surface and recovered after dressing change. The incidence of skin necrosis was 8.3%, lower than 32.8% reported in literature,^{4,17–20} which may be due to preoperative deswelling, excellent flap preservation, less traction and active postoperative wound care. Besides, the lower incidence might be attributed to the fact that there were only Sanders II–III calcaneal fractures in this group (Sanders II fracture accounted for 69.6%, and no Sanders IV fracture was included), with less serious damage to the surrounding soft tissue of the calcaneus. Additionally, the sample size was relatively small in this study.

Advantage of locking calcaneal plate for elderly patients with calcaneal fractures

The locking plate is an angular stabilization device, which has been widely used for the various fractures with satisfactory clinical effects, especially for the patients with osteoporosis. Redfern et al²¹ compared the stability of locking plates with that of the non-locking plates in Sanders IIB fractures, and found no significant difference in the maximum cyclic load (the important factor which resulted in fixation failure) between the two. The biomechanical experiment on 16 frozen cadaver specimens with osteoporosis conducted by Illert et al²² showed that there were no significant differences in elastic deformation load between the locking plate

and the non-locking plate in cyclic loading experiment; the non-locking plate had a much higher initial stability after fixation. However, the biomechanical experiment by Richter et al²³ confirmed that the locking plate provided a better stability than the non-locking plate did in calcaneal fractures. Stoffel et al²⁴ thought that the locking plate had the mechanical advantages of improved fixation strength and better load-bearing in elderly patients with calcaneal intraarticular fractures. Illert et al²² and Stoffel et al²⁴ accomplished their own experiments in the calcaneus model of elderly osteoporosis patients and reported the opposite results. We found some differences between the two experiments. Firstly, the two experiments focused on different types of calcaneal fractures, and the latter had bone defects. Secondly, the former adopted 6 locking screws, and the latter adopted 9 locking screws. Thirdly, no locking screws were inserted into sustentaculum tali in the former experiment. Bone mass is compact in sustentaculum tali, so it is important to use locking screws in this area to increase the holding strength. Therefore, in our opinion, compared with non-locking plate, the proper use of locking plates can yield better clinical outcome in elderly patients with osteoporotic calcaneal fractures.

In conclusion, locking plate provides good stability for calcaneal fracture, which allows weight-bearing at early stage without exerting any adverse effect on stabilization.

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