

# Can operations achieve good outcomes in elderly patients with Sanders II–III calcaneal fractures?

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## Abstract

The aim of this study was to compare the clinical effect of operative treatment and nonoperative treatment for elderly patients with Sanders II–III calcaneal fractures.

The study consisted of 60 patients with Sanders II–III calcaneal fractures who were treated in our institution from January 2007 to April 2012. The clinical effect between the operative treatment group of 32 patients and the nonoperative treatment group of 28 patients was studied. Böhler angle, Gissane angle, subtalar joint motion, calcaneal width, and calcaneal height were measured before and after treatment, and these indexes were also measured on the uninjured foot. All patients were followed-up for at least 2 years, and at the last follow-up, we evaluated foot function that was assessed with the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot score system. A 10-cm visual analog scale (VAS) was used to measure the degree of pain.

Böhler angle, Gissane angle, calcaneal width, and calcaneal height, which were preoperatively and postoperatively measured, had a significant difference in the operative group ( $P < .001$ ), but there was no significant difference between pretreatment and post-treatment in the nonoperative group. Subtalar joint motion was measured pre-treatment and post-treatment and had a significant difference in the 2 groups. When we compared the values of Böhler angle, Gissane angle, subtalar joint motion, calcaneal width, and calcaneal height between post-treatment and the uninjured foot, there was no significant difference in the operative group, but there was a significant difference in the nonoperative group. The values measured after treatment in the 2 groups had a significant difference. Finally, the AOFAS score in the operative group and the nonoperative group were  $83.4 \pm 9.7$  and  $74.7 \pm 10.3$ , respectively, and there was a significant difference ( $P < .001$ ). Also, the 10-cm VAS had a significant difference between the 2 groups.

Good clinical result could be obtained with operative treatment in elderly patients with Sanders II–III calcaneal fractures. Open reduction and internal fixation should be performed if there is no surgical contraindication.

**Abbreviations:** AOFAS = American Orthopaedic Foot and Ankle Society, DVT = Deep venous thrombosis, VAS = visual analog scale.

**Keywords:** calcaneal fractures, elderly, operation, outcome, Sanders II–III

## 1. Introduction

Calcaneal fractures, which account for 60% to 65% of tarsal fractures and 1% to 2% of all types of fractures, have been regarded as one of the most common fractures of feet.<sup>[1]</sup> Inappropriate treatment can lead to severe complications.<sup>[2]</sup> Traditionally, nonsurgical treatment was used to treat intra-articular calcaneal fractures.<sup>[3,4]</sup> However, with the development of surgical techniques and orthopedic material, especially the application of a special plate to the calcaneus, operations on calcaneal fractures have been accepted. The aim of the operation

is to restore the articular surface and reconstruct the hindfoot and gastrocnemius-soleus biomechanics<sup>[5]</sup> and decrease the rate of complications. A series of studies on the effect of surgery was performed, and agreement was reached that open reduction and internal fixation can obtain a better outcome than nonsurgical treatment in young patients.<sup>[6–8]</sup> However, there is controversy about operation or nonoperation in elderly patients with calcaneal fractures.<sup>[7,9]</sup> Therefore, in order to describe the controversy more comprehensively, we designed this control trial and analyzed the data to illustrate which method is better for treatment of Sanders II–III calcaneal fractures in elderly patients.

## 2. Patients and methods

Permission for this study was obtained from the Medical Ethics Committee of The General Hospital of Jinan Military Command.

There were 311 patients with Sanders II–III calcaneal fractures who were treated in our institution from January 2007 to April 2012.

Entry criteria for all patients enrolled in the trial were patients older than 60 years, Sanders II–III calcaneal fractures, without prior injury or surgery of the bilateral foot and ankle, maintaining normal activities before injury and with only 1 injured foot when admitted, without rheumatoid arthritis and osteoarthritis, without uncontrolled high blood pressure and diabetes, and with a minimum follow-up of 2 years.

The cases who met the criteria were grouped according to the different treatments. We gathered the data on each patient,

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including sex, age, injury mechanism, fracture type, treatment course, and complications. X-rays of the calcaneus in lateral and axial views were taken of the injured foot before treatment and after treatment. A computed tomography (CT) scan and a 3-dimensional reconstruction were made on the injured foot before treatment, and X-rays were also taken of the uninjured foot. Böhler angle, Gissane angle, calcaneal width, and calcaneal height were measured on the basis of these imaging examinations. Subtalar joint motion was also measured before and after treatment.

Several classifications exist for calcaneal fractures; we used the Sanders classification system to classify the bone injury. In brief, Sanders II–III calcaneal fractures are defined as fractures with 2 or 3 articular fragments. Many criteria are used to assess patient outcome. The American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot score<sup>[10]</sup> is the most popular. In brief, pain, function, walking distance and surface, hindfoot motion, and ankle-hindfoot stability were scored. Scores of 90 to 100 indicate an excellent result, 80 to 89 indicate a good result, 70 to 79 indicate a fair result, and 69 and below indicate a poor result. The 10-cm visual analog scale (VAS)<sup>[11]</sup> was validated in several trials to measure the degree of pain.<sup>[11–13]</sup> The patient was asked to mark the horizontal line at a point on or between the endpoints, with 0 mm indicative of no pain, and 100 mm indicative of very severe pain. The score was determined by measuring the distance from the left-hand end to the point marked by the patient. All data of the AOFAS score and VAS score were obtained at the last follow-up visit.

The injured feet that were treated without surgery were lifted to reduce the swelling, rest and gradual rehabilitation followed. Short-leg plaster fixation was used to protect soft tissue for 3 weeks, motion of toes was encouraged to promote swelling relief, and full weight bearing was avoided until 12 weeks after fractures. Patients who were treated operatively underwent open reduction and internal fixation with a plate and screws. However, the operation was not performed until the swelling was reduced. The associated injuries, including spinal fractures, pelvic fractures, or hip fractures were first treated. Patients with high blood pressure and/or diabetes were appraised for toleration of surgery. An “L”-like incision was made on the lateral calcaneus to expose the periosteum of the lateral calcaneus. Protection of soft tissue is important. Two to three 2 mm diameter Kirschner wires were drilled into the talus to draw the skin and tendon. The subastragalar articular surface, calcaneocuboid articular surface, and lateral wall of the calcaneus were clearly exposed. The collapsed articular surface was raised and fixed by Kirschner wires to restore the smoothness and anatomy of the articular surface. Restoration of the width and height of the calcaneus are important. A bone graft is of benefit to restore the articular surface. The use of a bone graft, either an autograft or an allograft, was chosen by the operating surgeon. The appropriate size plate was fixed on the lateral wall of the calcaneus by screws. Fluoroscopic examination was necessary to evaluate Böhler angle, Gissane angle, and adjust the screw size and the length of the locking plate. The wound was sutured and a drainage tube was placed. Rivaroxaban, a safe anticoagulant drug, was used within 12 to 24 hours after surgery to avoid deep venous thrombosis (DVT). Short-leg plaster fixation was also used for 3 weeks, and full weight bearing could be performed 12 weeks after the operation. The operation should be completed within 14 days after the fracture.

Statistical analysis was performed with SPSS software (version 12.0; SPSS Inc., Chicago, IL). Continuous data are described by

the mean with standard deviation. The Student *t* test was used to compare the results between 2 groups for continuous numerical data, and the Wilcoxon rank sum test was used to compare categorical data. A 2-sided significance level of 0.05 was used for all statistical tests.

### 3. Results

#### 3.1. General data

In total, 60 elderly patients with displaced calcaneal fractures (Sanders II–III) were treated from January 2007 to April 2012, including 47 males and 13 females with a mean age of  $68.7 \pm 5.7$  years (range 60–79 years). All the fractures were closed injuries, with 41 patients suffering from left calcaneal fractures and 19 patients suffering from right calcaneal fractures. The main mechanism of injury was a fall that accounted for 85% of the injuries ( $n=51$ ), and the other 15% ( $n=9$ ) were caused by traffic accidents. The associated injuries included spinal fractures ( $n=11$ ), intertrochanteric fractures ( $n=5$ ), femur neck fractures ( $n=3$ ), and pelvic fractures ( $n=1$ ). Complicating diseases included high blood pressure ( $n=30$ ), diabetes ( $n=12$ ), and coronary heart disease ( $n=11$ ). According to imaging data, 39 cases were diagnosed with Sanders II fractures and 21 cases with Sanders III fractures.

#### 3.2. Comparison between pre-treatment and post-treatment

In the operation group, the mean Böhler angle, Gissane angle, subtalar joint motion, calcaneal width, and calcaneal height in the injured foot before operation were  $11.6 \pm 4.0$  (range 5.3–13.9),  $93.2 \pm 2.6$  (range 89.7–95.3),  $5.1 \pm 1.3$  (range 4.6–5.9),  $43.2 \pm 3.5$  (range 40.0–44.3), and  $35.0 \pm 2.3$  (range 33.9–36.6), respectively, and the mean values after operation were  $33.6 \pm 4.1$  (range 31.0–35.8),  $124.4 \pm 1.3$  (range 122.3–125.9),  $22.5 \pm 3.1$  (range 20.8–24.0),  $36.1 \pm 2.7$  (range 34.3–37.2), and  $44.1 \pm 2.4$  (range 43.0–45.9), respectively. When we compared the values between before treatment and after treatment, there was a significant difference ( $P < .001$ ). In the nonoperative group, the mean Böhler angle, Gissane angle, subtalar joint motion, calcaneal width, and calcaneal height in the injured foot before treatment were  $10.9 \pm 2.9$  (range 5.5–12.3),  $94.8 \pm 3.0$  (range 88.6–96.8),  $5.3 \pm 1.9$  (range 4.3–5.6),  $42.3 \pm 4.5$  (range 39.7–44.3), and  $35.3 \pm 2.0$  (range 33.9–36.4), respectively, and the mean values after treatment were  $11.3 \pm 1.2$  (range 6.5–12.9),  $95.9 \pm 2.2$  (range 88.9–97.5),  $10.4 \pm 3.1$  (range 9.5–11.2),  $40.9 \pm 2.7$  (range 39.1–43.8), and  $35.6 \pm 1.9$  (range 33.9–36.1), respectively. Only subtalar joint motion had a significant difference between pre-treatment and post-treatment ( $P < .001$ ) (Table 1).

#### 3.3. Comparison between post-treatment and the uninjured foot

To evaluate the outcome of treatment, we also measured these indexes of the uninjured foot and compared them with the value of the injured foot measured after treatment. In the operative group, the mean Böhler angle, Gissane angle, subtalar joint motion, calcaneal width, and calcaneal height of uninjured foot were  $34.1 \pm 2.9$  (range 33.8–37.9),  $123.3 \pm 2.0$  (range 121.7–124.4),  $23.8 \pm 3.0$  (range 22.4–25.9),  $35.2 \pm 1.6$  (range 33.6–36.3), and  $44.3 \pm 1.1$  (range 43.9–45.0), respectively. There was no significant difference between the uninjured foot and

**Table 1**  
Comparison between pre-treatment and post-treatment.

Group	Variable	Pre-treatment	Post-treatment	P
Operation (n=32)	Böhler angle, °	11.6±4.0	33.6±4.1	<.001
	Gissane angle, °	93.2±2.6	124.4±1.3	<.001
	Subtalar joint motion, °	5.1±1.3	22.5±3.1	<.001
	Calcaneal width, mm	43.2±3.5	36.1±2.7	<.001
	Calcaneal height, mm	35.0±2.3	44.1±2.4	<.001
	Böhler angle, °	10.9±2.9	11.3±1.2	.503
Nonoperation (n=28)	Gissane angle, °	94.8±3.0	95.9±2.2	.124
	Subtalar joint motion, °	5.3±1.9	10.4±3.1	<.001
	Calcaneal width, mm	42.3±4.5	40.9±2.7	.164
	Calcaneal height, mm	35.3±2.0	35.6±1.9	.567

postoperation injured foot. In the nonoperative group, the mean Böhler angle, Gissane angle, subtalar joint motion, calcaneal width, and calcaneal height in the uninjured foot were 33.9±2.3 (range 33.2–36.8), 123.2±3.1 (range 121.3–125.0), 23.3±2.9 (range 22.5–25.3), 34.7±2.3 (range 33.0–35.9), and 44.0±1.4 (range 43.4–45.1), respectively. There was a significant difference between the uninjured foot and post-treatment injured foot. In addition, we compared the value of the uninjured foot between the operative group and the nonoperative group, and there was no significant difference between the 2 groups (Table 2).

**3.4. Comparison between 2 groups**

We also compared the values of Böhler angle, Gissane angle, subtalar joint motion, calcaneal width, and calcaneal height of the injured foot between the operative group and the nonoperative group, and the values of post-treatment had a significant different between the 2 groups; all the P values were less than .001. When we compared the value of the uninjured foot between the 2 groups, there was no significant difference (Table 3).

We followed-up all patients for more than 2 years with the mean follow-up time being 26.4±3.3 (range 24–31) months. All patients achieved bone healings, the incisions were healed except 2 patients, 1 patient suffered skin necrosis and was treated by flap graft and finally healed, and the other patient suffered wound edge necrosis and was healed by local wound care. The complete weight-bearing activity of the injured foot started at postoperative 3.3±1.4 (range 3.1–5.2) months. There was no

**Table 2**  
Comparison between uninjured foot and injured foot after treatment.

Group	Variable	Uninjured foot	Post-treatment	P
Operation (n=32)	Böhler angle, °	34.1±2.9	33.6±4.1	.096
	Gissane angle, °	123.3±2.0	124.4±1.3	.114
	Subtalar joint motion, °	23.8±3.0	22.5±3.1	.093
	Calcaneal width, mm	35.2±1.6	36.1±2.7	.110
	Calcaneal height, mm	44.3±1.1	44.1±2.4	.670
	Böhler angle, °	33.9±2.3	11.3±1.2	<.001
Nonoperation (n=28)	Gissane angle, °	123.2±3.1	95.9±2.2	<.001
	Subtalar joint motion, °	23.3±2.9	10.4±3.1	<.001
	Calcaneal width, mm	34.7±2.3	40.9±2.7	<.001
	Calcaneal height, mm	44.0±1.4	35.6±1.9	<.001

**Table 3**  
Comparison between the operative and nonoperative group.

Variable	Operation (n=32)	Nonoperation (n=28)	P
Age	67.9±4.4	69.5±6.1	.661
Gender			.226
Male	23	24	
Female	9	4	
Fracture type			.564
Sanders II	21	18	
Sanders III	11	10	
Böhler angle, °			
Uninjured foot	34.1±2.9	33.9±2.3	.771
Injured foot after treatment	33.6±4.1	11.3±1.2	<.001
Gissane angle, °			
Uninjured foot	123.3±2.0	123.2±3.1	.881
Injured foot after treatment	124.4±1.3	95.9±2.2	<.001
Subtalar joint motion, °			
Uninjured foot	23.8±3.0	23.3±2.9	.516
Injured foot after treatment	22.5±3.1	10.4±3.1	<.001
Calcaneal width, mm			
Uninjured foot	35.2±1.6	34.7±2.3	.328
Injured foot after treatment	36.1±2.7	40.9±2.7	<.001
Calcaneal height, mm			
Uninjured foot	44.3±1.1	44.0±1.4	.357
Injured foot after treatment	44.1±2.4	35.6±1.9	<.001
AOFAS	83.4±9.7	74.7±10.3	.001
VAS	19.5±12.6	35.9±17.6	<.001

AOFAS = American Orthopaedic Foot and Ankle Society, VAS = visual analog scale.

loosening or breakage of the screws and the plate at the last follow-up visit.

We also measured the AOFAS scale score at the last follow-up visit. The scores in the operative and nonoperative groups were 83.4±9.7 (range 78–98) and 74.7±10.3 (range 66–83), respectively, while the excellent and good rate in the operative and nonoperative groups were 94% (n=30) and 43% (n=12), respectively. Patients in the operative treatment group (n=32) scored higher. The difference was significant between the 2 groups (P=.001), which implied better function and satisfaction in the operative group. In addition, the VAS score in the operative group was less than in the nonoperative group. The difference was significant (P<.001) and indicated that patients treated by operation suffered less pain (Table 3). We also gathered long-term complications of patients. In the operative group, all patients could walk by themselves, while 2 patients needed to walk with a cane because of pain. However, in the nonoperative group, only 20 patients could walk independently with or without a cane, and 8 patients suffered persistent and severe pain. They were diagnosed with subtalar joint arthritis and 4 of them were finally treated by subtalar joint fusion. In addition, 5 patients were diagnosed with impingement syndrome. Surgical treatment was recommended, but they refused treatment.

**4. Discussion**

With China becoming an aging society, the number of elderly patients with orthopedic diseases is rising, especially bone fractures. The calcaneus is the biggest tarsal bone, and calcaneal fractures are regarded as one of the most common fractures in the foot.<sup>[1]</sup> However, calcaneal fractures are uncommon in elderly owing to lack of activity. Once it occurs and is not appropriately treated, it could lead to severe complications.<sup>[2]</sup> This not only

causes physical suffering and psychological agony but also causes a serious social economic load. However, in recent decades, there has been controversy over the treatment of operation or nonoperation in elderly patients.

Essex-Lopresti<sup>[14]</sup> suggested that an age of more than 50 years was a contraindication to surgery because of unfavorable outcomes in elderly patients. A randomized controlled trial that compared operative versus nonoperative treatment of calcaneal fractures concluded that there was no significant differences in the functional outcome between the 2 groups, and furthermore, many complications could have occurred in patients who were surgically treated.<sup>[15]</sup> Several scholars supported this view.<sup>[3,7,9,16]</sup> On the contrary, Herscovici et al<sup>[17]</sup> reviewed 42 patients who were 65 years or older and concluded that open reduction and internal fixation was an acceptable method of treatment for displaced intra-articular calcaneal fractures in elderly patients. However, Basile<sup>[18]</sup> thought the trial lacked a control group for comparison of the outcome, so he designed another controlled trial and suggested surgical treatment could restore Böhler angle, improve subtalar joint motion, and achieve a good outcome. Similarly, Randle et al<sup>[8]</sup> did a meta-analysis and suggested that operations could obtain a better outcome.

Janzen et al<sup>[19]</sup> first reported that a loss of Böhler angle was associated with a poor clinical outcome in 1992, and now Böhler angle is commonly assessed when evaluating calcaneal fractures. A lower Böhler angle implies that higher energy injuries were exerted on the foot and caused more bone and soft tissue injury.<sup>[20]</sup> Many articles proved that Böhler angle is significantly correlated with the function of an injured foot.<sup>[18,20]</sup> Therefore, restoration of Böhler angle is necessary. Similar to Böhler angle, Gissane angle was also used to assess the outcome after treatment of calcaneal fractures. However, there were few studies about it. In 1952, Essex-Lopresti<sup>[14]</sup> introduced Gissane angle and used it to measure the depression of the posterior subtalar facet. Anghong et al<sup>[21]</sup> reported that Gissane angle should be restored to obtain a good outcome. In the current study, we concluded that operation could perfectly restore Böhler angle and Gissane angle, and the difference was significant between preoperation and postoperation. Also, the difference between postoperation in the operative group and the nonoperative group was significant, but there was no significant difference between postoperation and the uninjured foot. On the contrary, nonoperation did not obtain an ideal outcome.

Subtalar joint motion is also used to evaluate the outcome of displaced intra-articular calcaneal fractures and it is also significantly correlated with the outcome.<sup>[22,23]</sup> Basile<sup>[18]</sup> reviewed 33 elderly patients and compared the subtalar joint motion between operative and nonoperative groups. He concluded that there was a strong positive correlation between higher AOFAS scores and a wide range of subtalar motion, while a lower VAS score was negatively correlated with a wide range of subtalar motion. Similar results from the present study support this conclusion. We compared the subtalar joint motion between pre-treatment and post-treatment. The difference was significant in the operative group and not significant in the nonoperative group, while the range of subtalar joint motion in the operative group was wider than in the nonoperative group, and the difference was significant between the 2 groups. We also compared post-treatment with the uninjured foot, and interestingly, there was a significant difference between pre-treatment and post-treatment in the nonoperative group. On the basis of our experience, this phenomenon was caused by acute pain in the early phase after injury.

It is necessary to restore the height and width of the calcaneus.<sup>[24,25]</sup> An increased width of the heel could impact the lateral malleolus and shoe wearing, while a decreased height of the heel could greatly affect talar inclination with ankle impingement and result in equinus deformity.<sup>[24]</sup> In the current study, the height and width were restored through operations, and the values measured after operations were similar to the uninjured foot. The difference was significant between operative and nonoperative groups.

The most common short-term complication is superficial wound-edge necrosis.<sup>[17]</sup> The rate was 6.7% (n=2) in the current study, which was lower than the rate reported in previous studies.<sup>[7,26,27]</sup> We analyzed this phenomenon and suggested that the development of surgical techniques and attention to the soft tissue is crucial. The most common long-term complication is subtalar arthritis.<sup>[17,26]</sup> This complication often leads to persistent foot pain and disabled patients. In the operative group, there was no one diagnosed with subtalar arthritis, but 8 patients were diagnosed with it in the nonoperative group. This discrepancy resulted from a bad reduction of the articular surface. The AOFAS scale score and VAS score were different between the 2 groups, which further illustrates that an operation can achieve a good outcome in elderly patients with calcaneal fractures.

Elderly patients with calcaneal fractures usually have other chronic diseases. We did not describe them in detail, because management of chronic diseases was beyond the scope of this study. Osteoporosis is a constant syndrome that could largely affect heal bone, but it is difficult to quantify osteoporosis and compare it between different groups, so this is a limitation. Another limitation was that the present study was not prospective but retrospective.

## 5. Conclusion

Böhler angle, Gissane angle, calcaneal width, calcaneal height, and subtalar joint motion can be restored by operations. Good clinical result can be obtained with operative treatment in elderly patients with Sanders II–III calcaneal fractures. Therefore, age is not a crucial factor to determine how to treat Sanders II–III calcaneal fractures in elderly patients. Open reduction and internal fixation appear to be an acceptable method if the patients are in good general condition.

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