

Minimally invasive treatment and internal fixation vs. extended lateral approach in calcaneus fractures of thalamic interest

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Abstract. The extended lateral side approach is a common technique in the surgical treatment of calcaneal fractures, with thalamic collapse offering a good exposure of the fractured site; however, it can be burdened with complications due to soft tissue trauma. The present study aimed to compare patients treated with minimally invasive osteosynthesis through a minimum lateral approach and internal fixation with patients that were treated using internal fixation with an extended lateral side approach in cases of intra-articular calcaneal fractures with thalamic fracture. Patients were evaluated preoperatively and postoperatively by performing clinical and imagistic examinations, with radiography scans of the anterior-posterior calcaneal profile and computer tomography. Furthermore, preoperative and postoperative analyses of the Böhler angle on the radiological profile, complications and duration of the hospital admission for both groups were performed. There were 36 patients (39 calcaneal fractures) in group 1 and 24 patients (29 calcaneal fractures) in group 2. The results demonstrated no statistically significant differences in the preoperative ($P=0.72$) and postoperative ($P=0.20$) Böhler angle values. The postoperative Böhler angle average values were 26.9 in group 1 and 29.3 in group 2. A total of 11 patients were treated with Kirschner wires inserted in the calcaneus, and in 2/11 cases, one of the brooches registered a migration movement. There were no cases of material migration in the fractures that were stabilized by inserting Kirschner brooches up to the astragalus and cuboid bones. Taken together, the results of the present study demonstrated no significant differences in the Böhler angle values between the minimally invasive and

open reduction techniques. However, the antibiotic therapy period, as well as the infection rate were lower in patients that were treated using the minimally invasive technique, suggesting that this technique was superior with respect to lower complication rates and improved functional results.

Introduction

Calcaneus fractures represent >2% of all fractures, and 90% of these fractures are found in men aged 21-45 years (1). After high-energy trauma, intra-articular calcaneus fractures are common, and there are a range of treatments for anatomic reduction and surgical fixation. The most effective method to treat displaced intra-articular calcaneus fractures is a hotly debated topic that has piqued researchers' interest for the past two decades (2-4). Only a few studies have proven that surgical treatment of intra-articular calcaneus fractures improves functional results and patient satisfaction when compared to non-surgical treatment (5,6).

The extended lateral side approach is a common technique in the surgical treatment of calcaneal fractures with thalamic collapse, offering a good exposure of the fractured site. However, it can be burdened by complications due to soft tissue trauma (7). The most common complications include dehiscence of the incision, calcaneus osteomyelitis and sural nerve damage in 15% of the cases (8). Restoring the local anatomy, preventing the appearance of the subtalar arthrosis and restoring the joint function are the main objectives of the surgical treatment (9). As a result, less invasive procedures, such as limited-incision sinus tarsi open reduction and internal fixation, percutaneous fixation, and arthroscopic-assisted fixation have been developed in recent years (10,11).

The minimally invasive technique consists of positioning the patient in lateral decubitus, with the knee at 90° of flexion (12). The minimum calcaneal lateral approach is 5 cm proximal and in line with the base of the fifth metatarsal to provide lifting the collapsed thalamic surface, followed by introduction of percutaneous K. wires and screws under roentgenographic guidance (Fig. 1) (13). Stabilization of the fracture is achieved following restoration of the thalamic surface with a steinmann nail, K. brooches or percutaneous screws. To prevent migration of the wires, as well as to give an additional

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stability to the fracture, the K. brooches are stabilized in the cuboid or talus bone (14).

The present study aimed to compare patients who were treated with minimally invasive osteosynthesis through a minimum lateral approach and internal fixation with patients who were treated using internal fixation, with an extended lateral side approach in cases of intra-articular calcaneal fractures with thalamic collapse. A total of 68 calcaneal fractures were retrospectively analyzed with respect to surgical technique and minimally invasive technique when compared with the classic technique, and showed effective results regarding the reduction and postoperative complication rates.

Patients and methods

This retrospective cohort study included 60 patients (68 calcaneal fractures) for a period of 3 years (between January 2017 and December 2020). All patients were admitted and treated at the Division of Trauma and Orthopedic Surgery of the Bucharest Emergency University Hospital. A total of 39 calcaneal fractures were treated with minimally invasive osteosynthesis through a minimum lateral approach and internal fixation with Kirschner brooches and screws (group 1), while 29 calcaneal fractures were treated with internal fixation, with the extended lateral side approach (group 2) (Fig. 2). The inclusion criteria were as follows: Heel fractures with displacement involving the thalamic surface and closed fractures without post-traumatic skin injuries (closed fractures). The exclusion criteria were as follows: Patients with fractures without displacement, extra-articular fractures and open fractures of the calcaneus. Patients who failed to regularly attend the clinical evaluations were also excluded from the present study.

Group 1 consisted of 36 patients (39 calcaneal fractures), while group 2 consisted of 24 patients (29 calcaneal fractures). There were seven women and 29 men in group 1, while in group 2, there were four women and 25 men. The patients included in the present study were aged 19-71 years, with an average age of 46.8 years.

Patients were evaluated preoperatively and postoperatively by performing clinical and imagistic examinations, with radiography scans of the anterior-posterior calcaneal profile and computer tomography (CT). CT scans are performed prior to surgery to decide the type of procedure used (15). The present study performed preoperative and postoperative analyses of the Böhler angle on the radiological profile for a good quantification of the reduction control of the thalamic surface. During the evaluations at the hospital and at the periodic examinations, local complications were assessed in both groups. All patients were evaluated at 6 weeks, 3 and 6 months after surgery between January 2017 and December 2020. Functional results were measured with The American Orthopedic Foot and Ankle Society (AOFAS) score at 3 months after surgery for both groups.

Results

There were 36 patients in group 1 (39 calcaneus fractures) and 24 patients in group 2 (29 calcaneus fractures). The early surgery intervention was the main option in choosing the right time for the surgical procedure. In most cases, the early surgical

procedure was chosen (in 24 cases the early surgical intervention was performed in the first 48 h); therefore, the chances for local complications, such as blisters, were reduced (16). The average time from hospitalization to surgery was 2-3 days, and the associated lesions were similar in both groups.

The most common injuries (7 cases, 11.6%) were associated with fractures of the lower limb, followed by injuries involving the head and spine (5 cases, 8.3%). These results were consistent with previous findings (17). Patients were evaluated preoperatively and postoperatively using clinical examinations and radiology examinations, including x-rays in antero-posterior and profile incidence and CT scans.

The most frequent investigation was the measurement of the Böhler angle on the profile incidence of the x-ray, preoperatively and postoperatively, which was used for reduction control (Fig. 3). For a good functional quantification, the AOFAS score at 3 months after surgery was used in both groups. The average score was 82.95, indicating good and excellent results. There were no significant differences from a functional point of view between the two groups. The average AOFAS score was 83.25 for group 1 and 85.65 for group 2 ($P=0.179$). The postoperative average values of the Böhler angle were 26.9 degrees in group 1 and 29.3 degrees for group 2.

Patient distribution within both groups exhibited a relatively symmetrical distribution, and there were no statistically significant differences in the preoperative Böhler angle and the applied techniques (Fig. 4). The period of antibiotic therapy after surgery was shorter in group 1 compared with group 2 (2.6 days vs. 3.2 days; $P=0.02$) (18). Furthermore, no septic complications were recorded in group 1, while one case was recorded in group 2. In the studied groups, bone grafts were used in only 7 cases (Fig. 5). The type of bone graft used was autograft from the iliac crest due to better integration (19). No differences were observed from a statistical point of view for the post-surgery restoration of the thalamic height (restoration of the Böhler angle) and the collapse of the thalamic surface in the post-surgery controls. A total of 11 patients were treated with Kirschner brooches inserted only in the calcaneus and, in two cases, migration of a brooch occurred. Notably, stabilization of the fracture on the level of the cuboid and talus prevented early migration of the osteosynthesis material. There were no cases of migration of the osteosynthesis material in the fractures that were stabilized by introducing Kirschner brooches to the talus or cuboid.

Discussion

The results of the present study demonstrated that preoperative evaluation using CT scans assisted with the determination of the type of treatment used. Furthermore, early surgery procedure (surgical treatment in the first 24 h) decreased the rate of local complications. The most frequent lesions associated in the two groups, considering the high energy trauma, were found at the lower limbs and the spine. No statistically significant difference was observed in the AOFAS functional score at 3 months between patients treated with closed reductions compared with those treated by extended lateral approach. The satisfaction rates and functional scores when an extensile approach is used are optimal at 3 months, but only after following strict inclusion criteria (20). For patients

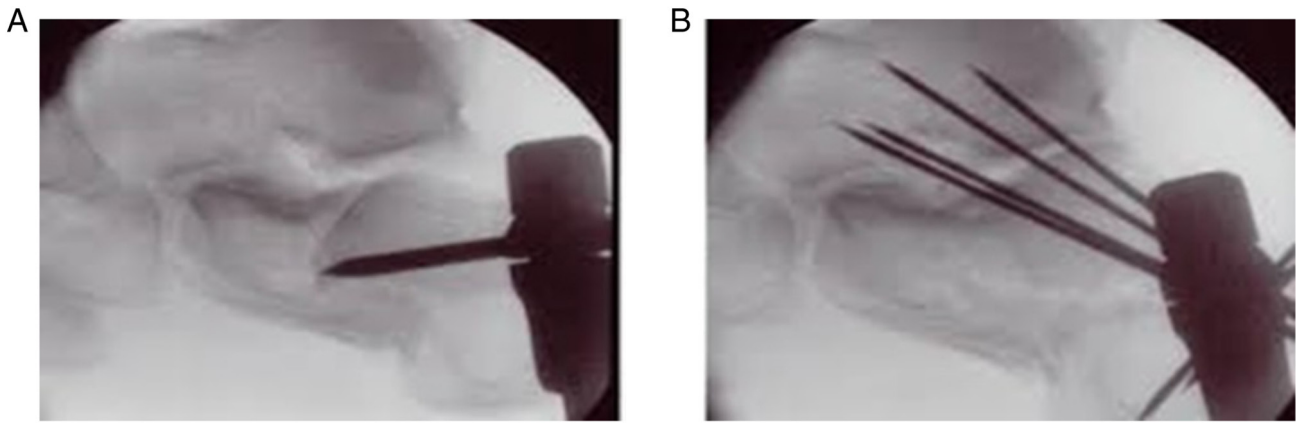


Figure 1. Reduction and fixation of a fracture with Kirschner wires (intraoperative images). (A) Percutaneous reduction and (B) percutaneous fixation.

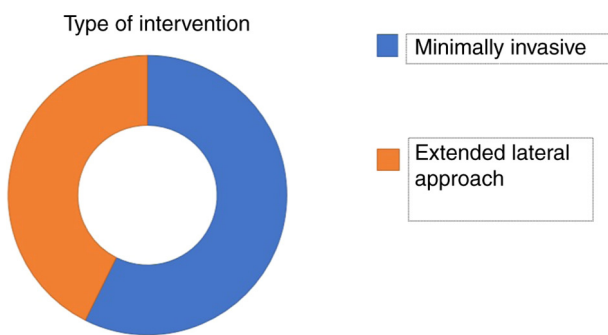


Figure 2. Distribution in groups depending on the surgical technique used.

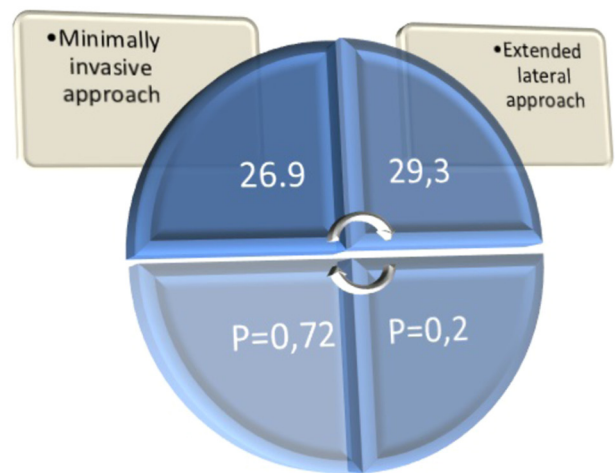


Figure 4. Results of the Böhrer angle values (G1 and G2) before and after surgery.

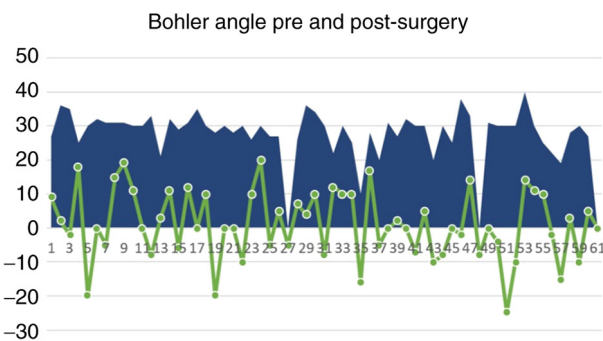


Figure 3. Böhrer angle before and after surgery.

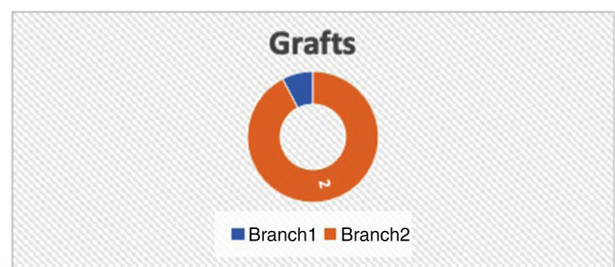


Figure 5. Uses of the bone autografts.

with Sander's type IV, peripheral vascular disease, prior foot surgery, skin infections, patients with diabetes and known smokers an extensive lateral approach may lead to important local complications.

Notably, no significant difference was observed in the Böhrer angle between the minimally invasive technique and the open reduction procedure (G1=26.9; P=0.72 and G2=29.3; P=0.20). Taken together, the results of the present study suggest that the minimally invasive technique is a reliable method, with good functional postoperative results, which decreases the rate of local complications.

Current literature presents similar results with the current study when minimally invasive techniques are used for the treatment of calcaneal fractures, with low local complication

rates and good functional results. One study compared these two approaches in a group of 125 intra-articular calcaneal fractures and found that the minimally invasive approach minimized complications, and achieved and maintained extra-articular reductions, as well as the standard extensile open reduction and internal fixation compared with that for open reduction (21). Another important study, that included a large number of fractures (112), found that the minimally invasive approach had a significantly lower incidence rate of wound complications and secondary surgeries compared with that with the extensile approach (22).

In selected cases the minimally invasive approach is a valuable method for the treatment of intra-articular calcaneal fractures, with low complication rates and the results are comparable to those treated with an extensile approach (23). These results are similar to those obtained in the present study

Compared to other publications, the present study has an important limitation, the small number of patients recruited. Analyzing a larger group of patients will provide clear results as to which technique is effective with respect to proper reduction and lower complication rates.

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Availability of data and materials

All data generated or analyzed during this study are included in the published article.

Authors' contributions

AC, BC and CC were responsible for conceiving and designing the study. AC, SI, BS and CC acquired the data and performed the analysis. BC, CGS, MP and CO interpreted the data, and wrote and revised the manuscript. BC and CO reviewed and edited the manuscript. AC, BC and BS confirm the authenticity of all the raw data. All authors have read and approved the final manuscript.

Ethics approval and consent to participate

Not applicable.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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