

Original Article

Open calcaneal fractures with medial wound: mid-term results

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Abstract

Objective: Present the clinical and radiographic results of a series of patients with open calcaneal fractures with medial wound.

Methods: Retrospective study based on medical records of ten patients treated for open calcaneal fractures with medial wound from 2014 to 2020. All included patients had a minimum one-year follow-up. The variables analyzed were age, sex, laterality, associated diseases, mechanism of trauma, fracture according to Gustilo Anderson and Sanders classifications, associated fractures, surgeries performed, complications, and functional evaluation according to the AOFAS scale and radiographic evaluation.

Results: The mean age of the patients was 47.3 years, nine men and one woman. According to Gustilo Anderson's classification, eight cases were grade IIIA and two grade II; in Sanders' classification, four were type II and six were type III. No case evolved with chronic osteomyelitis or required amputation. After a mean 31.3 months follow-up, all fractures showed consolidation in the radiographic evaluation, with a mean Bohler angle of 4.1 degrees. According to the AOFAS scale, the mean value was 77.7 in the functional evaluation.

Conclusion: Open calcaneal fractures with medial wound are often treated in a non-standard manner. The functional and radiographic results followed the high variability of the treatments performed.

Level of Evidence IV; Cases series; Retrospective Study.

Keywords: Fractures, open; Calcaneus; Treatment.

Introduction

Open calcaneal fracture is uncommon but has the potential for serious complications such as chronic osteomyelitis and amputation. The most common open fracture site is the medial, found in about 90% of cases⁽¹⁻⁴⁾.

Due to its rarity, knowledge about treating open calcaneal fractures is based on small case series⁽¹⁻¹⁴⁾. The first studies showed a bleak scenario with complication rates above 60%, including lower limb amputations in 29% and osteomyelitis in 19%–39% of cases⁽¹⁻¹⁴⁾.

With the standardization of emergency care and the creation of different flowcharts to guide the treatment of

these fractures, the results presented in the most recent literature have improved considerably. Most authors agree that in the initial care, in addition to wound cleaning, debridement, and irrigation, only a temporary stabilization of the fracture should be performed^(4-6,9,10). After sufficient time for soft tissue recovery from the exposed area, the fracture is reduced and permanently fixed. The L-extended side is the most frequently used side access approach⁽¹²⁾.

The objective of this study is to analyze the types of treatment employed and the clinical and radiographic results of a series of patients with open calcaneal fractures with medial wound treated in a public hospital from January 2014 to December 2020.

Study performed at the Department of orthopedics and traumatology of Dr. José de Carvalho Florence Hospital, São José dos Campos, SP, Brazil.

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Methods

This is a retrospective study based on the medical records and radiographic files of patients with open calcaneal fractures with medial wound treated in a public hospital from January 2014 to December 2020. All surgically treated calcaneal fractures are monitored by the Foot and Ankle Group, so the selection of cases was made based on the Group's case files. The study was approved by the Institutional Research Board under the number 4,960,116. All patients signed the informed consent form.

The cases had the initial open wound treatment performed urgently by the orthopedics team of the hospital's emergency room. All patients were submitted to wound cleaning, debridement, and irrigation with saline solution to prevent infection and wound closure with nylon suture threads. Conventional dressings with sterile bandages were used. The conduct regarding the urgent fracture fixation was made by the physician responsible in the emergency room. Patients were hospitalized and received intravenous antibiotic prophylaxis for infection with gentamicin 240mg and clindamycin 900mg for 48 hours, followed by oral cephalexin for seven days. The tetanus prophylaxis was performed following the health guidelines of the Ministry of Health⁽¹⁵⁾. The imaging analysis was performed through radiographs and computed tomography in all cases. After this first approach, the cases were transferred to the Hospital's Foot and Ankle Group.

The conduct regarding the definitive treatment of the fracture was decided after analysis of the following parameters: wound and limb condition, fracture type, fracture deviation after initial surgical treatment, and general condition of the patient. One group of patients had only surgery to treat the open wound without fracture fixation. In the second group, fixation was performed through the wound created. In these cases, the fracture reduction and fixation with Kirschner wires, screws, or plates were performed only medially, using the wound or enlarging it when necessary (Figure 1).

In the third group, a lateral tarsal sinus approach (Figure 2) was associated with a rectilinear incision initiated at the distal end of the lateral malleolus and directed to the axis of the fourth metatarsal. After skin and subcutaneous opening, fractures of the posterior facet of the calcaneus and sidewall were identified. The fibulocalcaneal ligament was sectioned to allow greater access to the deviated joint surface and facilitate its reduction.

The initial conduct was defined by the physician in the emergency room. The three groups initially received exhaustive wound cleaning, and after some familiarity with calcaneal fracture treatment, the fixation was performed. After the antibiotic therapy and wound care period, the foot group defined the definitive fixation. The approach choice was based on the fracture pattern. Fractures with large displacement or comminution of the support were approached medially, and those with central or medial sinking were approached laterally. The delay in soft tissue improvement defined the treatment of the group that received only cleaning.



Figure 1. Direct reduction and osteosynthesis through the medial wound.



Figure 2. Lateral approach to the sinus tarsus for reduction and osteosynthesis.

The reduction control in all cases was by intraoperative radioscopy. All incisions were closed with subcutaneous and skin sutures, and a compressive dressing was applied.

Postoperatively, patients were placed in an immobilizer boot and bandaged in the outpatient clinic until the wound healed completely. Joint mobility exercises were stimulated from the start of treatment, and gait load was released only after signs of fracture consolidation. Outpatient visits were scheduled at 1, 2, 3, 6, 12, 26, and 52 weeks. The Kirschner wires were removed after six weeks. After one year, returns were scheduled every six months. All included patients had a minimum one-year follow-up and functional and radiographic evaluations were performed.

At the end of the follow-up period, the data collected for analysis were age, sex, laterality of the lesion, associated diseases such as hypertension or diabetes, mechanism of trauma, fracture classification according to Gustilo Anderson^(16,17), fracture classification according to Sanders⁽¹⁸⁾, associated fractures, urgent and definitive surgeries, secondary surgeries, complications, functional evaluation according to the American Orthopaedic Foot and Ankle Society (AOFAS) scale of the hindfoot⁽¹⁹⁾ and radiographic evaluation with consolidation analysis and Bohler angle measurement, which reflects the loss of height of the posterior facet.

Results

Ten patients were treated, nine men and one woman, with a mean age of 47.3 years (minimum 15, maximum 57, and median 47.3). The right side was affected in seven patients

and the left in three. There were no cases with bilateral involvement. The trauma mechanism was fall from height in nine cases and car accident in one case. According to Gustilo Anderson's classification, the distribution showed eight cases of grade IIIA and two cases of grade II. No patient had associated lesions on the same limb. According to Sanders' classification, the distribution showed four cases of type II and six cases of type III (Table 1).

Six patients were submitted to emergency surgery at admission for cleaning and debridement with saline solution. In four cases, the fracture was not fixed; one was fixed with Kirschner wire, and one a lateral approach to the tarsal sinus was associated. In this case, the fracture was fixed with a medial plate with lateral screws.

In addition to the emergency surgery, the other four patients were reoperated after a mean of nine days (minimum 2, maximum 19, median 9). In one case, the medial wound was reopened and the fracture was fixed medially. In the other three patients, a lateral approach to the tarsal sinus was associated with fracture reduction and fixation (Tables 2 and 3).

The median follow-up time was 31.3 months (minimum 12, maximum 61, median 31.3). Two patients required subtalar arthrodesis throughout the follow-up period, performed with 64 months and 68 months of fracture evolution. These patients received only surgical cleaning as initial treatment. All fractures evolved with radiographic consolidation and the

Table 1. Open wound degree and fracture classification

Patient	Sex	Age	Side	Trauma mechanism	Gustilo Anderson*	Sanders*
1	Men	41	Right	Car accident	IIIA	III
2	Woman	57	Right	Fall from height	IIIA	II
3	Men	15	Right	Fall from height	IIIA	II
4	Men	57	Right	Fall from height	II	III
5	Men	52	Left	Fall from height	IIIA	II
6	Men	49	Right	Fall from height	IIIA	III
7	Men	49	Left	Fall from height	II	II
8	Men	54	Right	Fall from height	IIIA	III
9	Men	56	Left	Fall from height	IIIA	III
10	Men	43	Right	Fall from height	IIIA	III

*Classifications.

Table 2. Group with secondary surgery

Patient	Urgent surgical treatment	Second-time definitive osteosynthesis: access approaches	Fixation type	Follow-up	Final Bohler angle	AOFAS	Complications
1	Cleaning only	Tarsal sinus	Medial plate and longitudinal screws	21	15	85	No
2	Cleaning only	Tarsal sinus and medial	Medial plate and screws	12	22	92	Superficial necrosis without infection
3	Cleaning only	Medial	Medial screws	13	34	100	No
4	Cleaning only	Tarsal sinus and medial	Medial screws	12	-30	89	Superficial necrosis

AOFAS: American Orthopaedic Foot and Ankle Society.

Table 3. Urgent surgery-only group

Patients	Urgent surgical treatment	Fixation type	Follow-up	Final Bohler angle	AOFAS	Complications	Secondary surgeries
5	Cleaning + plate and screw + tarsal sinus	Medial plate and screws	38	17	81	No	No
6	Cleaning and K-wire	K-Wire	30	21	58	No	No
7	Cleaning only	No	35	19	89	No	No
8	Cleaning only	No	44	1	59	No	No
9	Cleaning only	No	47	-34	62	No	Subtalar arthrodesis
10	Cleaning only	No	61	-24	62	No	Subtalar arthrodesis

AOFAS: American Orthopaedic Foot and Ankle Society.

Bohler angle measured in the last evaluation had a mean of 4.1 degrees (minimum -34 degrees, maximum 34, median 16 degrees). In the functional evaluation according to the AOFAS scale, the mean value was 77.7 (minimum 58, maximum 100, median 83), and the two cases submitted to subtalar arthrodesis were considered the values before surgery.

Two patients had medial wound healing problems with superficial necrosis without infection. No case evolved with chronic osteomyelitis or required amputation due to complications. One patient had a definitive injury to the tibial nerve and its branches in the tarsal tunnel caused by the accident.

Discussion

Regardless of the fracture mechanism, the axial compression forces of the talus on the calcaneus consistently produce two primary fracture patterns⁽²⁰⁾, sagittal and coronal planes, which divide the calcaneus into different fragments, among them the superomedial comprising the talus support with the medial wall of the calcaneal body. At the posteroinferior limit of this fragment, the fracture trace defines a tapered edge of the bone, visible on axial calcaneus radiographs (Figure 3). Lawrence⁽²⁾ proposes three different mechanisms of calcaneal open wound on the medial aspect of the hindfoot. With the application of axial load on the foot, as the calcaneus rests on the ground at a point lateral to the mechanical axis of the tibia, the deformity generated at the time of trauma is in valgus and, in extreme conditions, can lead to rupture of the medial skin, exposing the fracture. Another possibility of rupturing the medial soft tissues would be the action of the fractured edge of the superomedial fragment described above, which would cause a laceration from the inside out. The third mechanism would be by direct action of a penetrating object such as a projectile or lawnmower blade. Analyzing the precise location of the medial wound, we noticed that in some cases, the second mechanism was responsible because the approach to the lesion gave direct access to the superomedial fragment, being easy to reduce by direct fracture visualization. In others, the wound did not have an alignment with the fracture focus, and the first mechanism would more correctly explain the open wound.



Figure 3. Axial calcaneus radiograph demonstrating the tapered edge of the superomedial fragment.

The conduct regarding the treatment in our cases varied due to the lack of a well-defined guideline on conducting fracture reduction and fixation at different times of patient care. Still, we understand that the surgical cleaning performed in the emergency room improved the prognosis of these injuries. Six patients were submitted only to one open wound surgery, and in four, no fixation was performed; in one case, fixation was performed with Kirschner wire, and in one case, a medial fixation with a plate associated with a lateral osteosynthesis at the same time. In the other four cases, osteosynthesis was performed a second time, and in three, a lateral approach of the tarsal sinus was associated. This same variability of approaches is described in the systematic review by Spierings et al.⁽⁶⁾, which included 18 studies related

to different exposed calcaneal fractures with a total of 616 cases. In our study, the different treatment approaches had conservative treatment, temporary or permanent external fixator, percutaneous fixation, minimally invasive fixation, Kirschner wires, osteosynthesis through the open wound, a tarsal sinus approach, or an extensive lateral approach. It is clear that open calcaneal fractures are treated in different ways, and there is no consensus on the ideal method. This variability in treatment is greater in retrospective studies, such as our study, since a conduct protocol had not been previously established. There is a need to develop a flowchart with well-defined protocols based on the highest quality studies to guide the medical teams involved in the care of these patients. In the first surgery for wound debridement and irrigation, it seems that the tuberosity fragment should always be reduced in relation to the posteromedial segment (sustentacular) to decompress the medial soft tissues, thus favoring their recovery. The fixation can be temporary with Kirschner wires^(5,10), or definitive with screws⁽²¹⁾ or possibly small plates placed on the medial surface of the calcaneus using the wound as an access approach. After some time, with the regression of edema, we propose the definitive osteosynthesis by a lateral approach to the tarsal sinus. The preference for the tarsal sinus approach to the extensive lateral approach is because there are fewer complications with soft tissues when the former is used to treat closed calcaneal fractures^(22,23).

The mean value of the AOFAS scale in our study was 77.7 points, which is compatible with studies that evaluated open calcaneal fractures, whose values ranged from 72.5 to 80.7 points^(9,24-26).

The mean 4.1 Bohler angle found in our cases was influenced by three cases that had highly negative values (-24, -30, and -34 degrees). In two of them, the fracture was not reduced, neither at the time of surgery to treat the open wound nor later, and these are the two cases that required subtalar arthrodesis.

There are some limitations to our study. The sample is small, and the study is retrospective, with high variability in the treatment performed. Surgeries were not performed by a single surgeon. The follow-up time was short for some cases, and there was no control group to compare the results. However, few publications address open calcaneal fractures with medial wound. Our observations suggest that standardization to care for these fractures, as proposed above, may lead to better results.

Conclusions

Open calcaneal fractures with medial wound are often treated in a non-standard manner. The functional and radiographic results followed the high variability of the treatments performed.

Authors' contributions: Each author contributed individually and significantly to the development of this article: MHS *(<https://orcid.org/0000-0001-7969-0515>), and JMPB *(<https://orcid.org/0000-0002-5280-1673>) Conceived and planned the activities that led to the study, performed the surgeries, interpreted the results of the study, participated in the review process, bibliographic review, clinical examination, approved the final version; KMM *(<https://orcid.org/0000-0003-0804-4078>) Data collection, statistical analysis, formatting of the article; ACRL *(<https://orcid.org/0000-0002-9677-4048>), and GCCF *(<https://orcid.org/0000-0001-8628-4072>) Formatting of the article, data collection, clinical examination; GM *(<https://orcid.org/0000-0003-0351-0009>) Formatting of the article, data collection, clinical examination. All authors read and approved the final manuscript.*ORCID (Open Researcher and Contributor ID) 

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