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Functional outcome after calcaneus fractures: a comparison between polytrauma patients and isolated fractures

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ABSTRACT

Background: Displaced intra-articular calcaneal fractures (DIACFs) can have long-term consequences in terms of foot pain and disability. This injury frequently occurs in the context of polytrauma patients and its influence in long-term functional prognosis is well known. The purpose of this study is to compare the etiology, severity, and functional outcome of the operated DIACFs between polytrauma patients and isolated cases.
Methods: Eighty-six patients with operated displaced intra-articular calcaneal fractures through open reduction and internal fixation (ORIF) were managed at our institution between January 1, 2008 and December 31, 2015. Eighty patients completed the follow-up, nine of them with both calcaneus operated (89 calcaneus) by ORIF with a plate. Two groups were established; one included 11 (14%) polytrauma patients, three of them with operated bilateral calcaneus, and 69 (86%) patients without polytrauma diagnosis. Severity of trauma, injury patterns, psychiatric background, associated fractures, second surgeries and functional questionnaire (adjusted American Orthopedic Foot and Ankle Society – AOFAS – ankle–hindfoot scale and SF-36) were collected. A detailed comparative statistical analysis is provided.
Results: There was significant statistical relationship between polytrauma patients and those with psychiatric comorbidities, severe trauma or severe injury, but not with second surgeries, later subtalar arthrodesis or outcome measures. Only calcaneal fractures with comminution according to Sanders classification was associated with second surgeries and later subtalar arthrodesis. The AOFAS score was solely related to trauma severity (71.5 vs 77; $p = 0.29$) and calcaneal fracture's comminution according to Sanders classification (79.4 type II and 79.3 type III vs 69.2 type IV; $p = 0.000$ and $p = 0.008$, respectively) and SF-36 score only with trauma severity (67.4 vs 78.1; $p = 0.00$) and psychiatric comorbidities (62.2 vs 75.8; $p = 0.048$).
Conclusion: No differences in outcome measures and second surgeries were found between polytrauma patients and isolated fractures. For DIACFs, the severity of the impact was correlated with a higher number of second surgeries and worse functional outcomes. Following a DIACF, patients with psychiatric comorbidities presented worse health-related quality of life than people without this background.

Introduction

The calcaneus is the most frequently fractured bone in the foot, representing approximately 75% of the fractures affecting the foot and 1–2% of all body fractures. Around three-quarters of calcaneal fractures are intra-articular displaced (DIACs), being the main cause of these fractures a fall from a height. Calcaneus fractures present associated injuries in 40% of cases, typically in a polytrauma context. Most frequent associated injuries include spine fractures (10–20%), opposite calcaneus fractures (7–10%), and various extremity injuries (26%) [1–3]. DIACFs sequels often lead to chronic pain and long-term disability.

Open reduction and internal fixation (ORIF) with an extensile L-shaped approach has been established as a standard surgical treatment for DIACFs due to its simple access for fracture manipulation and fixation [4].

It is known that the outcome of multiply injured patients with foot injuries is significantly worse than that of patients without [5,6], but only Aktuglu *et al.* [7] and Tran *et al.* [8] focused their attention on the

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functional outcome of DIACFs between isolated and polytrauma patients. However, they compared the results including conservative and operative methods.

The purpose of the present study is to evaluate the functional outcome and patient satisfaction after DIACFs treated exclusively through ORIF, comparing polytrauma and isolated fractures to discern if the results are due to injury severity or to the polytrauma context.

Methods and patients

From January 2008 to December 2015, 86 patients with DIACFs were operated through ORIF at Consorcio Hospital General Universitario of Valencia. Twenty-one (24%) patients had a bilateral calcaneal fracture, and twelve out of them were operated bilaterally. All patients were contacted by telephone, in order to ask them to take part in the study.

Six patients were not included in the study because of different reasons. Therefore, 89 cases (80 patients) under the diagnosis of DIACFs operated through ORIF were finally included in this study. We retrospectively reviewed prospectively collected data.

For each patient, the following information was included in a database: patient demographics, mechanism of the accident, injury severity score (ISS) at admission, fracture classification according to Sanders *et al.* [2], additional injuries, comorbidities, and further reconstructive surgeries.

The inclusion criteria for patient selection included intra-articular calcaneal fracture Sanders type II to IV, age of 16–70 years operated exclusively through ORIF by a standard extended lateral approach and internal fixation with a plate.

The exclusion criteria included all extra-articular fractures, fractures operated by different surgical technics, as well as fractures treated with either primary arthrodesis or conservative treatment. We did not exclude any comorbidity.

In order to classify the severity of the impact, we divided the fracture causing mechanism into four groups: (A) fall from the same height, (B) fall from a height lesser than 3 meters, (C) fall from a height higher than 3 meters (e.g. falls and jumpers), and (D) direct crush (e.g. traffic accidents). Afterwards, to better study the consequences of the most severe calcaneal mechanism, we established two additional groups: one included falls from a height higher than 3 meters and crushed limbs, and another with the rest of the patients.

According to the ISS score [9], we defined two groups: polytrauma group with a ISS score higher than 16 and injured at least in two body regions according to the Abbreviated Injury Scale (AIS 1998), and an isolated calcaneus fractured group.

Calcaneal fractures were classified based on their severity using computer tomography scans according to Sanders' classification. Type I, non-displaced intra-articular fractures were excluded of the study. Type II includes one fracture line in the posterior facet (two-part fractures), type III includes two fracture lines in the posterior facet (three-part fractures) and type IV comminuted fractures with three or more fracture lines in the posterior facet (four or more fragments). Subdivision of type II and III on A, B, or C groups was not recorded because it was considered not to be relevant for the purpose of our study.

Concomitant injuries commonly appeared associated to calcaneal fractures in cases of severe trauma. We grouped the injuries in bilateral fractures, multiple injured, pelvis fractures, spine fractures, and other extremity fractures.

Special comorbidities are very common in a group of patients who have jumped from a height. We also paid attention to psychiatrics background (in treatment with psychiatric drugs), opioids addiction or alcoholism.

All secondary surgeries were also recorded.

Functional outcome evaluation

Participants were evaluated using functional outcome questionnaires such as the American Orthopedic Foot and Ankle Society ankle–hindfoot scale (AOFAS score). AOFAS consists of both a subjective component provided by patients and an objective clinical component scored by the surgeon. In order to focus our study into the treatment functional outcome – the objective of the study, only the subjective component was included in the questionnaire. The AOFAS score was divided into four categories: a score between 90 and 100 was graded as excellent; 80–89 as good; 70–79 as fair; and less than 70 points as poor [10,11].

The Short Form-36 Health Survey (SF-36) is one of the most widely used and evaluated generic health-related quality of life questionnaires [12]. The SF-36 is a generic multipurpose health survey that ultimately yields physical and mental health summary measurements. This score ranges from 0 to 100, with higher scores representing better outcomes.

The mean time of patients' review was 48 months after the operation (range 15–62).

Surgical procedure

All cases were operated on by the same team (two foot surgeons). A standard extended lateral approach with L-shaped incision was used in all cases. The vertical limb of the incision was placed midway between the fibula and Achilles tendon. The horizontal limb was placed in line with the base of the fifth metatarsal. The incision was made directly to the bone in order to create a full-thickness flap. Then the retinaculum was divided and the fibulocalcaneal and talocalcaneal ligaments detached from the bone in order to expose the fracture. A direct reduction and fixation with screws and plates was performed in all cases. Depending on the fracture pattern we filled up the bone defect with iliac bone graft.

Data was analyzed by a blinded member of our team using the Statistical Package for the Social Sciences, version 22 (SPSS, Chicago, IL). Continuous data were found to deviate from a standard normal distribution (determined by test of Kolmogorov–Smirnov), and expressed as the median and standard deviation. ANOVA test was performed to assess the statistical significance of continuous data (test scores), Chi-square (χ^2) for categorical variables and Student's t-test was used to compare outcomes for parametric data. A p value <0.05 was taken as the threshold of statistical significance.

Results

Demographics data

Using our inclusion criteria, 80 patients with 89 DIACFs treated by ORIF were available, as 9 out of them (10%) were operated bilaterally (Table 1). Fifty-six (71%) were male and 24 (29%) female; the average

Table 1
Demographic profile for all patients.

Age	n	Mean (years)	Median (years)	Range (years)
	80	48.4	47	16–74
Gender	n	Female	Male	Total
	80	24 (29%)	56 (71%)	80
Etiology	Fall from same height	Fall from <3 m	Fall from >3 m	Direct crush
	12 (13%)	49 (56%)	26 (29%)	2 (2%)
Sanders classification	Type I	Type II	Type III	Type IV
	0 (0%)	17 (19%)	50 (56%)	22 (25%)
Concomitant injuries	Multiple injuries	Pelvic fractures	Spine fractures	Other extremities
	21 (26.5%)	4 (5%)	8 (10%)	11 (14%)
Psychiatric comorbidities	In treatment with psychiatric drugs, opioid addicts, or alcoholism			
		29 (36.2%)		