e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2023; 15(11); 577-582

Original Research Article

Assessing Radiological, Clinical, and Patient-Reported Outcomes of Patients with Surgically Repaired Intraarticular Calcaneal Fractures: An Observational Study

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Received: 05-06-2023 Revised: 22-07-2023 / Accepted: 25-08-2023
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Conflict of interest: Nil

Abstract

Aim: The aim of the present study was to evaluate the radiological, clinical and patient-reported outcomes of patients with intraarticular calcaneal fractures treated surgically.

Methods: The current investigation was a single-center, prospective, and observational study undertaken at the Department of Orthopaedics . The study focused on patients with calcaneal fractures. The study from December 2019 to Nov 2021. In the current research, a total of 44 patients, with 50 calcaneal fractures, underwent surgical intervention. Follow-up assessments were conducted for a duration of 18 months after the surgical procedure.

Results: The average age in the current research was 44.6 ± 14.46 years. The prevalence of male cases was 72.72%, while female cases accounted for 27.28% of the total. The majority of fractures seen in the study were classified as Sander's type 2, accounting for 84% of the cases. The majority of fractures seen were unilateral, accounting for 81.81% of cases, whereas bilateral fractures accounted for 8 (18.18%) cases. In 36.6% of instances, concurrent injuries were seen. The mean duration till surgery was found to be 5.5 ± 1.3 days, while the average length of hospital stay was determined to be 8.2 ± 3.7 days. In the current investigation, it was observed that 10% of the patients had a pre-operative Bohler's angle of 20° or more, while the remaining 90% of the cases had a pre-operative Bohler's angle below 20°. The majority of patients had a commendable AOFAS (American Orthopedic Foot and Ankle Society) score at the 18-month postoperative assessment ($p>0.05$) The prevalence of Allmacher grade 0 and 1 was seen in the majority of patients from both groups ($p>0.05$). The study included a comparison of Bohler's angle before and after surgery, namely at the 18-month postoperative follow-up. In instances where the pre-operative Bohler's angle was equal to or more than 20 degrees, it was observed that the post-operative Bohler's angle ranged from 25 to 29 degrees in 80% of cases. In instances where the pre-operative Bohler's angle was less than 20°, a post-operative Bohler's angle of 25-29° was seen in 84.44% of cases ($p<0.05$).

Conclusion: The preferred approach for treating joint depression type and Sanders Type II/III fractures of the calcaneus is surgical care using open reduction with internal fixation. This treatment method has shown favorable outcomes during short-term follow-up.

Keywords: calcaneal fracture, operative management, displaced intra-articular calcaneal fractures (DIACFs), ORIF

Introduction

Calcaneus fractures, also known as fractures of the heel bone, account for around 2% of all fractures and are the most prevalent kind of fracture among the tarsal bones. [1] Certain calcaneal fractures might be classified as mild injuries, while a significant number of them are characterized as severe, high-energy fractures. Typically, these more severe injuries tend to manifest subsequent to a fall from an elevated position, sometimes involving scaffolding or a ladder, or as a consequence of a vehicular

collision. The calcaneal injuries have a destructive nature, characterized by the complete fracture and dislocation of the whole bone and its associated joint surfaces. Notably, the subtalar joint may experience significant disruption. In cases when conservative therapy is used, it is common for the fracture fragments to undergo healing; nevertheless, the calcaneus typically retains its deformity, resulting in incongruity of the joint surfaces and loss of alignment between the leg, ankle, and heel. Severe and debilitating osteoarthritis of the subtalar joint often ensues. The process of recovery is sometimes protracted, with an average duration of two years. Despite this, the majority of patients have discomfort, stiffness, and foot deformities, rendering them unable of wearing conventional footwear. Walking becomes a laborious endeavor, often necessitating the use of a walking aid. [2]

Calcaneal fractures, while infrequent, are injuries that significantly impair an individual's quality of life. After prolonged durations of rehabilitation, it is possible that individuals may have limitations in their range of motion. [1,3] Fractures of this kind often occur as a consequence of falling from elevated surfaces and have a higher prevalence among men compared to females, with the highest frequency seen within the age range of 30 to 39 years. [4,5] The prevalence of calcaneal fractures that are displaced intra-articular fractures is estimated to be as high as 90%. Additionally, it has been shown that in about 75% of individuals with calcaneal fractures, there are concomitant injuries present. Compound and bilateral forms are related with increased severity and morbidity. [4,6] The diagnosis is verified by the use of lateral and anteroposterior view foot radiographs, as well as Harris view (axial) calcaneal radiographs. [7] Computed tomography (CT) is recommended in instances of intra-articular fractures to enhance comprehension of the injury. [7,8] The treatment approach is determined by considering the specific features of the fracture, any accompanying injuries, and the state of the local soft tissues. [9,10] The establishment of the normal anatomy is correlated with the good functional outcome. [10,11] In cases of extra-articular injuries or little intra-articular involvement, conservative therapy is often recommended, particularly when there is minimal or no deviation. Surgery is needed in cases when there is a notable presence of severe joint involvement, substantial deviation, and complex lesions. [10] The aforementioned inquiry was addressed by the implementation of the UK heel fracture study, a substantial pragmatic randomized controlled experiment carried out inside the National Health Service. [12] The study's findings indicated that, over a two-year period, operational intervention did not provide any discernible benefits in terms of symptom relief or functional improvement compared to nonoperative therapy. Moreover, the likelihood of experiencing problems was shown to be greater among those who had surgery.

The objective of the current research was to assess the radiological, clinical, and patient-reported outcomes of individuals who had surgical treatment for intraarticular calcaneal fractures.

Materials and Methods

The current investigation was a single-center, prospective, and observational study undertaken at the Department of Orthopaedic Surgery, Indira Gandhi Institute of Medical Sciences, Patna, Bihar, India. The study focused on patients with calcaneal fractures. The study was carried out from December 2019 to Nov 2021. A total of 44 patients, with 50 calcaneal fractures, had surgical intervention. The patients were then followed up for a period of 18 months after the operation.

Inclusion Criteria

- Patients of age >20 years, of either sex, with displaced intra-articular fractures with minimal or no soft tissue compromise/swelling at the time of surgery, underwent surgical treatment with minimum follow-up of 18 months.

Exclusion Criteria

- Calcaneal fractures which were open, extraarticular,
- Calcaneal fractures associated with other significant injuries
- Calcaneal fractures older than 10 days, pathological fractures
- Lost to follow up
- Not willing to participate

Prior to obtaining written informed permission, patients were provided with a detailed explanation of the surgical method as well as other treatment options for fractures with comparable patterns. The patients completed a comprehensive process of obtaining detailed medical history and conducting a thorough physical examination. The first approach was administering conservative therapy for a duration of around seven days, with the intention of allowing the soft tissue swelling to subside to a sufficient extent that the skin would exhibit wrinkling. Prior to the procedure, the necessary preoperative examinations were conducted, including the evaluation of Bohler's angle and the breadth of the calcaneum. Following a thorough anaesthetic check-up and counseling, the patients were scheduled for surgery. All patients received a surgical procedure known as open reduction and internal fixation, in which screws were used. The surgeries were performed with the patients positioned either in the lateral decubitus or prone position, and under either spinal or general anesthesia. Indirect reduction is often accomplished by the use of a closed strategy, using bilateral JESS

distracters. This approach generally involves the elevation of a depressed fragment by means of a tiny lateral window. The procedure involves the percutaneous insertion of three or more cannulated hip screws in a posterior to anterior orientation, with occasional mediolateral placement, for internal fixation. Following the completion of the treatment, distracters were eliminated.

Limb kept elevated in POP below knee back slab till subsidence of pain and edema, usually 10–12 days. Vigorous ankle mobilization exercise was started. Non-weight bearing crutch walking or protected weight bearing in a synthetic cast was started after 3 weeks post-operative and continued for the next 6 weeks. Cast removed and partial weight bearing crutch walking upto radiological or clinical evidence of fracture healing- then gradually full weight bearing along with physiotherapy. Patients were evaluated by a unified scoring system, the American Orthopedic Foot and Ankle Society (AOFAS) clinical rating system, the ankle hindfoot scale for the calcaneal area, and Allmacher grading for subtalar arthrosis.

Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Difference of proportions between qualitative variables was tested using chi- square test or Fisher exact test as applicable. P-value less than 0.5 were considered as statistically significant.

Results

Table 1: Patients details

Parameters	**No. of cases (Percentage) / Mean ± SD**
Age (in years)	44.6 ± 14.46
Gender (N=44)	
Male	32 (72.72)
Female	12 (27.28)
Sander's type (N=44)	
Type 2	37 (84.10)
Type 3	7 (15.90)
Fracture site (N=44)	
Unilateral	36 (81.82)
Bilateral	8 (18.18)
Other factors	
Associated injuries	16 (36.36)
Time till surgery (in days)	5.5 ± 1.3
Duration of hospital stay (in days)	8.2 ± 3.7

Mean age in present study was 44.6 ± 14.46 years. Male cases (72.72%) were more than female cases (27.28%). Most of fractures were Sander's type 2 (84.10%). Most fractures were unilateral (81.81%) as compared to bilateral 8 (18.18). Associated injuries were noted in 36.6% cases. Mean time till surgery was 5.5 ± 1.3 days and average duration of hospital stay 8.2 ± 3.7 days.

Table 2: Distribution according to pre-operative Bohler's angle and AOFAS score

Pre-operative Bohler's angle	**AOFAS (American Orthopedic Foot and Ankle Society) score (at 18 months post-op)**			
	Excellent	**Good**	**Fair**	**Poor**
Pre-operative Bohler's angle ≥20° (n=5)	4	1	0	0
Pre-operative Bohler's angle <20° (n=45)	35	10	0	0

In present study 10% cases had pre-operative Bohler's angle ≥20° and 90% cases had pre-operative Bohler's angle < 20°. Excellent AOFAS (American Orthopedic Foot and Ankle Society) score was noted at 18 months post-op in majority of patients. No statistically significant difference was noted in AOFAS score among two groups.

Table 3: Allmacher grade in respect of pre-operative Bohler's angle

Pre-operative Bohler's angle	**Allmacher grade**				
	0	**1**	**2**	**3**	**4**
Pre-operative Bohler's angle ≥20° (n=5)	4	1	0	0	0
Pre-operative Bohler's angle <20° (n=45)	30	7	6	2	0

Allmacher grade 0 and 1 was noted in majority of patients from both groups. No statistically significant difference was noted among two groups.

Table 4: According to pre-operative and post-operative Bohler's angle

Pre-operative Bohler's angle	Post-operative Bohler's angle 20–24°	Post-operative Bohler's angle 25–29°
Pre-operative Bohler's angle ≥20° (n=5)	1	4
Pre-operative Bohler's angle <20° (n=45)	7	38

We compared pre-operative and post-operative Bohler's angle, at 18 months post-op follow up. In cases with Pre-operative Bohler's angle ≥20°, Post-operative Bohler's angle 25–29° was noted in 80% cases. While in cases with Pre-operative Bohler's angle <20°, post-operative Bohler's angle 25–29° was noted in 84.44% cases and statistically significant difference was noted among two groups.

Table 5: Postoperative Complications

Postoperative Complications	**N%**
Heel pain	16 (32)
Stiffness	5 (10)
Wound infection	4 (8)
Gait abnormality	3 (6)
Plaster sores	1 (2)

In present study post-op complications noted were heel pain (32%), stiffness (10%), Wound infection (8%), Gait abnormality (6%) and Plaster sores (2%). All complications were managed conservatively.

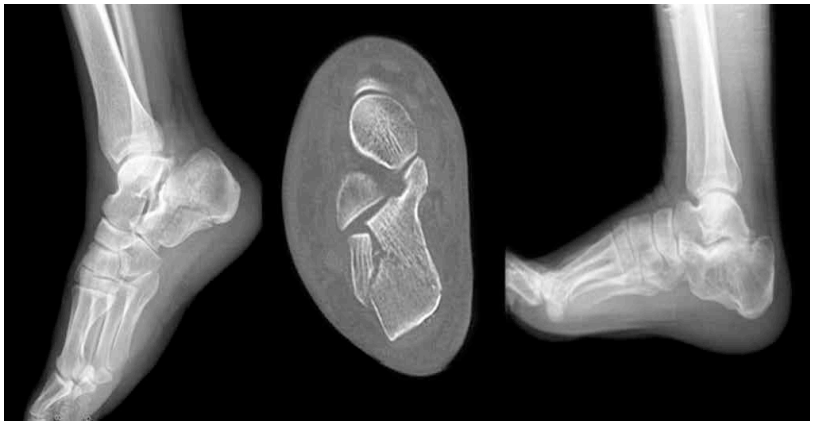

Figure 1: Initial lateral X-ray (a), computed tomography scan (b) and follow-up lateral X-ray (c) images of a conservatively treated patient

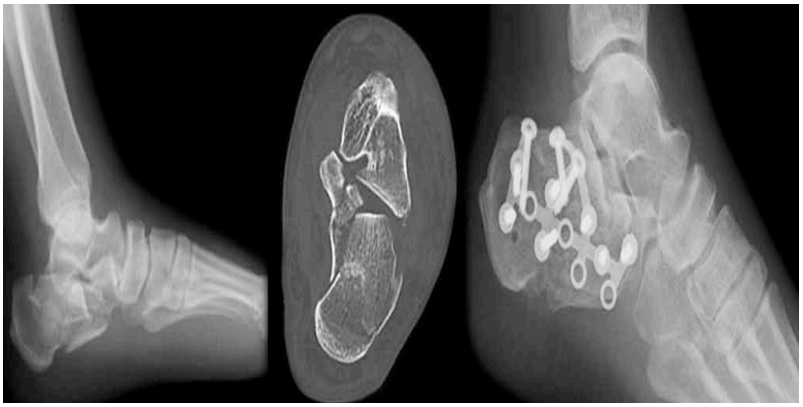

Figure 2: Preoperative lateral X-ray (a), computed tomography scan (b) and follow-up lateral X-ray (c) images of a surgically treated patient

Discussion

The Calcaneus, also referred to as the heel bone, is a substantial osseous structure that provides the fundamental support of the posterior region of the foot. Calcaneal fractures are infrequent and constitute around 1 - 2% of all fractures seen in the human body, while comprising 60% of injuries affecting the tarsal bones. [13] Intra-articular fractures, which make up around 75% of calcaneal fractures, have traditionally been linked to unfavorable functional outcomes. [14] The fractures discussed are consistently attributed to an axial stress mechanism, such as a fall or a motor vehicle

collision, and might potentially be accompanied by additional axial load injuries, including lumbar, pelvic, and tibial plateau fractures. [15] Potential concerns associated with subtalar joint stiffness and arthritis include heel widening, peroneal impingement, implant-related difficulties, and heel pad discomfort. [16] The literature presents many therapeutic options for the management of this condition, including no therapy, conservative treatment, open reduction and internal fixation, primary subtalar arthrodesis, delayed primary arthrodesis, and calcanectomy. [17]

The average age in the current research was 44.6 ± 14.46 years. The proportion of male patients (72.72%) exceeded that of female cases (27.28%). The majority of fractures were detected in young male patients (84.6%), with an average age of 36.8 years, which aligns with findings reported in existing scholarly literature. [9,18] The majority of fractures seen in the study were classified as Sander's type 2, accounting for 84% of the cases. The majority of fractures seen in the study were unilateral, accounting for 81.81% of cases, whereas bilateral fractures accounted for 8 (18.18%) of cases. According to the findings of several research, it has been shown that bilateral calcaneal fractures exhibit a more significant drop in Böhler angle and are linked with higher rates of complications, related injuries, and worse outcomes in comparison to unilateral fractures. [19,20] In 36.6% of instances, concurrent injuries were seen. The available data about linked injuries in the literature exhibit diverse findings [21], with some research reporting a substantial occurrence, while others provide statistics that lack statistical significance. Mean time till surgery was 5.5 ± 1.3 days and average duration of hospital stay 8.2 ± 3.7 days.

In the current investigation, it was observed that 10% of the patients had a pre-operative Bohler's angle greater than or equal to 20°, while the remaining 90% of the cases showed a pre-operative Bohler's angle below 20°. The majority of patients exhibited a commendable AOFAS (American Orthopedic Foot and Ankle Society) score at the 18-month postoperative assessment. There was no statistically significant difference seen in the AOFAS score between the two groups. In research conducted by Mukherjee et al. [22], it was shown that 80% of participants received outstanding results, while the other 20% achieved good results based on the AOFAS scale, indicating functional outcomes. The prevalence of Allmacher grade 0 and 1 was seen in the majority of patients from both groups. There was no statistically significant difference seen between the two groups. The study included a comparison of Bohler's angle before and after surgery, namely during the 18-month postoperative follow-up period. In instances where the pre-operative Bohler's angle was found to be equal to or greater than 20 degrees, it was observed that the post-operative Bohler's angle ranged from 25 to 29 degrees in 80% of the cases. In instances where the pre-operative Bohler's angle was less than 20°, a post-operative Bohler's angle of 25-29° was seen in 84.44% of cases. A statistically significant difference was observed between the two groups.

Two patients exhibited superficial wound infections, however, no patients needed a revision operation. [23] It is well recognized that underlying co-morbidities, such as peripheral vascular disease, diabetes, and smoking, have a negative impact on wound healing after surgical intervention. [24] In the current investigation, the researchers observed many post-operative problems, including heel pain (32%), stiffness (10%), wound infection (8%), gait abnormalities (6%), and plaster sores (2%). All problems were treated using conservative management strategies. The management of calcaneal fractures requires careful consideration of several criteria, including the nature of the trauma, categorization of the fracture, state of the skin, and method of damage. Effective assessment, thorough preoperative planning, and suitable treatment strategies contribute to improved outcomes. [25]

Conclusion

The preferred therapy for joint depression type and Sanders Type II/III fractures is the surgical repair of calcaneal fracture with open reduction with internal fixation. This approach has shown favorable outcomes during short-term follow-up.

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