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Original Article

Clinical Experience of Close Reduction and Internal Fixation of Displaced Intra-articular Fractures of Calcaneum

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Abstract

Background: Displaced intra-articular fractures of calcaneum require conventional surgical treatment using open reduction and plate screw fixation which are technically demanding and result in several soft tissue complications and morbidity.

Aims and Objectives: An attempt has been made to adopt close reduction and internal fixation without opening the fracture under fluoroscopic control avoiding the complications of open reduction.

Materials and Methods: A total of 30 patients presented with displaced calcaneum fractures of age varied from 19 years to 60 years, of which 25 males and 5 females were operated between December 2013 and August 2015. Under spinal anesthesia, in prone position, K-wires were passed through calcaneum and talus for Joshi's External Stabilisation System (JESS) distraction. Some patients required elevation of subtalar articular fragment by a small window from the lateral side. After restoring the articular anatomy, three CHSs passed under fluoroscopic control. Then, distracters were removed. Some patients needed an additional lateral-to-medial screw fixation for holding sustantaculamtali fragment. Conventional post-operative regimen was followed with weight bearing after 3 months.

Results: The patients were followed for 8 months to 1.5 yrs. The patients were studied using clinico-radiological parameters - wound status, Bohler's angle, the American Orthopedic Foot and Ankle Society score, and Allmacher grade. All patients recovered satisfactory functions in longest follow-up.

Conclusion: This method is technically easy, soft tissue friendly with least complications and may be advocated for the provision of surgical treatment for displaced intra-articular calcaneum fractures.

Key words: Calcaneal fractures, JESS, Percutaneous screw fiation

INTRODUCTION

Calcaneum is the most common bone to be injured during fall from height. Calcaneum is a weight-bearing bone and it has four articular surfaces. Hence, special care is needed during treating calcaneal fractures. For years, it was seen that outcomes in patients with calcaneal fractures were not as good as outcomes in patients with other orthopedic conditions and were significantly worse than in patients with other major health issues.[1]

Particularly, intra-articular fractures account for approximately 75% of calcaneal fractures and historically have been associated with poor functional outcome.[2] These fractures are uniformly caused by an axial load mechanism, such as a fall or a motor vehicle accident, and may be associated with other axial load injuries, such as lumbar, pelvic, and tibial plateau fractures.[3]

The Essex–Lopresti[4] system has been used for many years, is useful in describing the location of the secondary fracture line, and can be evaluated by plain X-ray.

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Although computed tomography (CT)-guided Sanders classification[5-7] is helpful for the location and number of fracture lines through the posterior facet, it also cannot give clue regarding descriptions of other important aspects of these fractures including heel height and width, varus-valgus alignment, and calcaneocuboid involvement. Besides, CT scan may underestimate sagittal plane rotation of the depressed fragment, and due to the poor economic status of our study population, we have selected cost-effective Essex–Lopresti classification for this study.

It was seen that non-operative treatment for calcaneal fractures often led to pain and loss of function, which increased in the second decade after injury.

MATERIALS AND METHODS

This is a prospective study performed on randomly selected 25 male and 5 female patients (35 calcaneal fractures) aged 19–60 years (average age 32), in our institution from December 2013 to August 2015. All the fractures were displaced intra-articular with minimal or no soft tissue compromise/swelling at the time of surgery. Calcaneal fractures which were open, extra-articular, associated with other significant injuries, or older than 10 days were excluded from the study. A clearance was obtained from the Ethical Committee of IPGMER and SSKM Hospital, and a detailed consent was taken from each of the patients explaining pros and cons of the surgical procedure involved along with pros and cons of other treatment modalities for similar fracture patterns. All the patients were followed up for 1½ years. All the operations were performed by the same surgical team.

Usually, we had to wait 5–10 days (average 7 days) to allow soft -tissue swelling to resolve enough for the skin to wrinkle. Appropriate pre-operative investigations were done, and patients were put up for operation after proper anesthetic checkup and counseling.

All patients were operated in lateral decubitus/prone position under spinal/general anesthesia. Its peroperative assessment of Bohler's angle and width of calcaneum was done. Indirect reduction achieved by closed method using bilateral JESS distracters, often with an elevation of depressed fragment by small lateral window. Internal fixation with 3 or more cannulated hip screws given percutaneously in posterior to anterior direction and occasional mediolaterally. Distracters were removed after the procedure.

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.

RESULTS

We have selected 30 adult patients (25 males and 5 females) with closed displaced intra-articular fractures of calcaneum of <10 days. All cases were operated by closed reduction and percutaneous internal fixation by minimally invasive surgery under spinal or general anesthesia. We analyzed the radiograph at 3 months, 6 months, 9 months, and 1 year after the operation. The late complications and patient's satisfaction were evaluated at regular outpatient examination. Patients were evaluated by a Unified Scoring System at 1 year postoperatively.

Clinical Criteria

a. AOFAS clinical rating system, the ankle hindfoot scale for calcaneal area (100 patients - total, 90–100 patients - excellent, 80–89 patients - good, 70–79 patients - fair, and <70 patients - poor).
b. Allmacher grading for subtalar arthrosis.

Radiological Criteria

Measurements of post-operative Bohler's angle at 1 year are as follows.

Patients with pre-operative Bohler's angle ≥20° (n = 3) achieved excellent-to-good results in three cases (100%); patients with pre-operative Bohler's angle <20° (n = 32) achieved excellent-to-good results in 32 cases (100%) [Table 1 and Chart 1].

In our study, 80% (n = 28) achieved excellent results, whereas 20% (n = 7) achieved good results functionally according to the AOFAS scale.

Patients with pre-operative Bohler's angle ≥20° (n = 3) achieved no clinically significant subtalar arthrosis (Allmacher grade 0–1). Patients with Bohler's angle <20° (n = 32) suffered clinically significant subtalar arthrosis (Allmacher grade 2–4) in 7 (20%) cases [Table 2 and Chart 2]. Both were assessed at 1-year follow-up.

Table 1: Classification of patients according to pre-operative Bohler's angle: AOFAS score 1 year postoperatively

Pre-operative Bohler's angle	Excellent	Good	Fair	Poor
Pre-operative Bohler's angle ≥20°	3	0	0	0
Pre-operative Bohler's angle <20°	25	7	0	0

P: 0.6903, so statistically not significant. AOFAS: American Orthopedic Foot and Ankle Society

Table 2: Comparison of Allmacher grade in respect of pre-operative Bohler's angle

Pre-operative Bohler's angle	0	1	2	3	4
Pre-operative Bohler's angle ≥20°	3	0	0	0	0
Pre-operative Bohler's angle <20°	15	10	4	3	0

P: 0.04367, so statistically significant

Table 3: Comparison of patients 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°	0	3
Pre-operative Bohler's angle <20°	8	24

P: 0.03903, so statistically significant

Patients with pre-operative Bohler's angle ≥20° (n = 3) achieved post-operative Bohler's angle at 1 year at a range of 25°–29° in three cases (100%); patients with pre-operative Bohler's angle <20° (n = 32) achieved post-operative Bohler's angle at 1 year at a range of 20°–24° in 8 cases (25%) and at a range of 25°–29° in 24 cases (75%) [Table 3 and Chart 3].

In our study, there were no wound dehiscence or soft tissue complications irrespective of age and sex. There were no incidences of non-union. All patients had clinical and radiological evidence of union in mean duration of 14 weeks (11–17 weeks). There were only two incidences of screw loosening, which was removed well after fracture union.

DISCUSSION

In the past two decades, close reduction and percutaneous internal screw fixation of displaced intra-articular calcaneal fractures have become a standard surgical method with low complication rate and better quality of life after the surgery. Brauer's cost-effectiveness analysis of surgery versus conservative treatment for intra-articular calcaneal fractures showed an economical advantage of open reduction and internal fixation (ORIF).[8] In 2004, the comparison of five multicentric studies regarding conservative and operative treatment (issued in Medline between January 1999 and March 2004) was published. Results of these comparative studies also favored operative treatment over the conservative one. Most of the conservatively treated patients underwent arthrodesis procedure. Poorer health and social prognosis are related to males, heavy workers, and patients with B-angle smaller than 0° and bilateral fractures. Conclusions of Bajammal *et al.* who analyzed 20 publications dealing with operative versus conservative treatment showed significant benefits of surgical therapy for females, young males, patients with lighter workload, and patients with initially high B-angle or with simple, minimally dislocated fractures, whereas older males and those who have an occupation involving heavy workload had benefited from the conservative therapy.[9] Buckley[10] (analysis of 559 calcaneal fractures) and Tufescu *et al.*[11] reported similar findings and both definitely recommended operative treatment. Herscovici *et al.*[12] proved that there were no significant risks of wound healing for patients older than 65.

In 2004, Zwipp *et al.*[13] presented one of the biggest studies of calcaneal fracture treatment: 496 patients with 553 fractures (90% treated operatively, 95% lateral approach, 1.5% bilateral approach, 1% medial approach, 2.2% percutaneous mini-invasive osteosynthesis, and 0.3% primary fusion). He used intraoperative open arthroscopy to control articular joint reduction. In this study, the implanting of locking compression plate (LCP) enabled to decrease the use of bone grafting from 53% (non-locking plates) to 3.8% (LCP). In the group of 453 fractures treated by ORIF apical wound necrosis was noticed in 6.7%, evacuated hematoma in 4.7%, soft tissue infection in 4.3% and bone infection in 2.2%.

In our analysis, we confirmed a correlation between the Bohler's angle size and patient satisfaction. This fact, proved and verified by a lot of other authors, confirms the role of Bohler's angle size as a predictive factor for subsequent late complications.[14] Loucks and Buckley[15] in a prospective randomized study pointed out that the initial negative size of Bohler's angle negatively influences post-operative results irrespective of therapy choice. In accordance with other[16] authors, by intra-articular calcaneal fracture[17] treatment, we emphasize right operation timing, knowledge in anatomy and articulations of calcaneum, non-touch technique, perfect posterior facet fragment reduction in subtalar joint, and restoration of calcaneal height, width, and length with calcaneal-cuboid joint revision. Most of them use AOFAS score and Allmacher grade as clinical criteria and post-operative Bohler's angle as radiological criteria.[18-20]

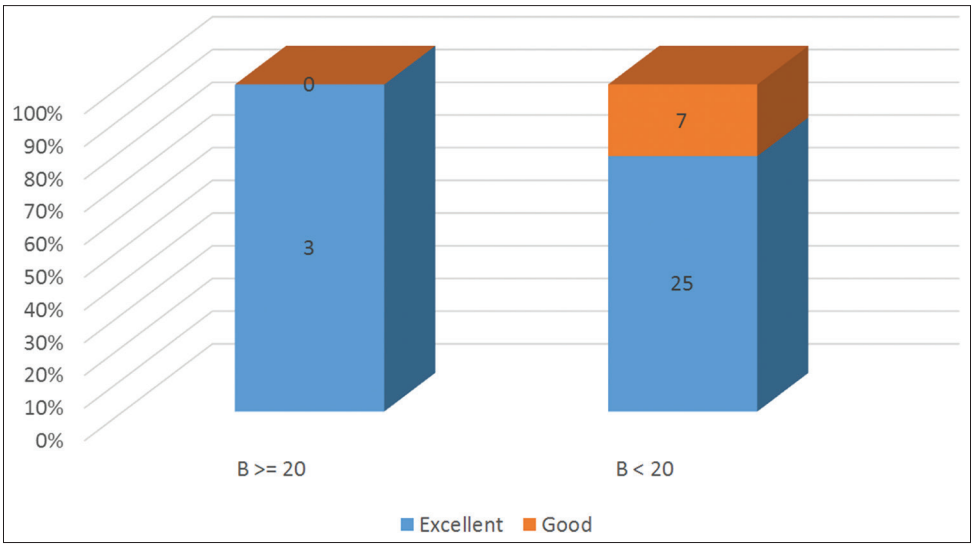


Chart 1: Classification of patients according to pre-operative Bohler's angle and American Orthopedic Foot and Ankle Society score 1 year postoperatively

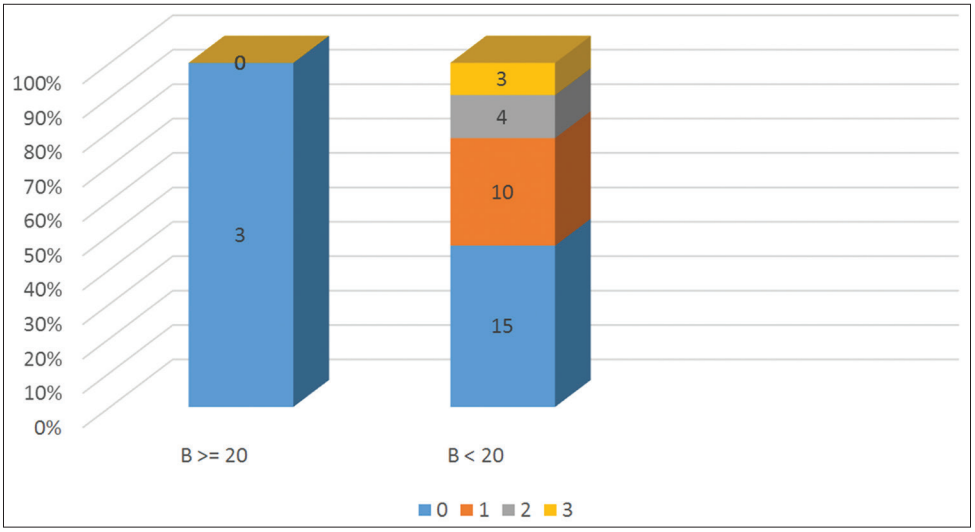


Chart 2: Comparison of Allmacher grade in respect of pre-operative Bohler's angle

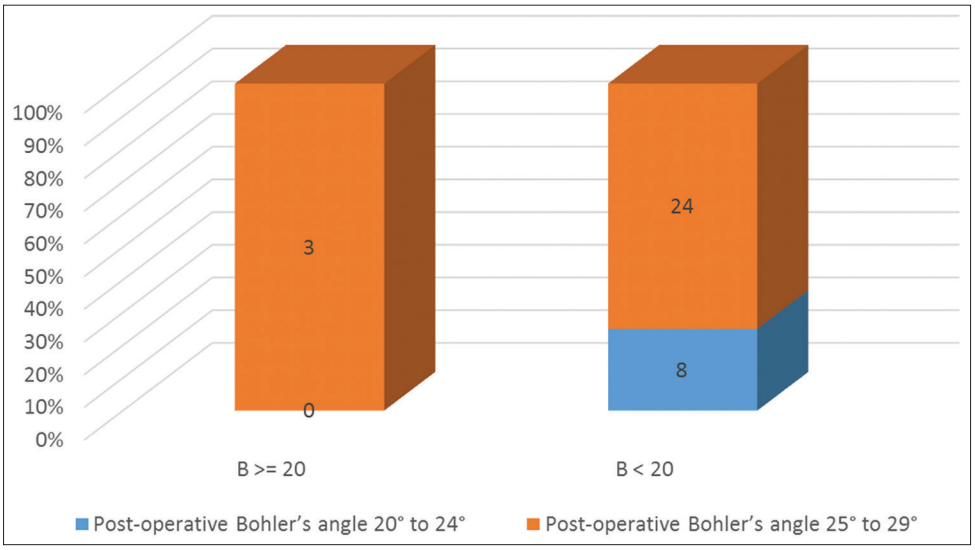


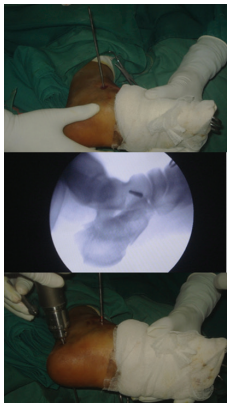
Chart 3: Classification of patients according to post-operative Bohler's angle

From different papers, it is established that success of this technique depends on meticulous selection of cases, early intervention and different method of closed reduction, proper knowledge of anatomy, articulation of calcaneum, principles of ligamentotaxis, restoration of Bohler's angle under fluoroscopic guidance, and most importantly post-operative rehabilitation.

CONCLUSION

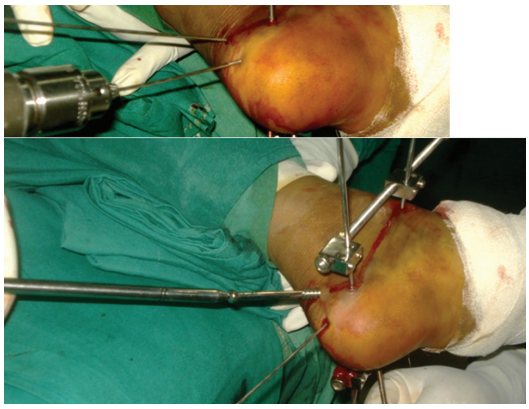
Different types of indirect reduction technique may be sufficient in restoring the articular anatomy. Intact soft tissue envelope allows early rehabilitation and satisfactory functional recovery with least complications. Hence, this technique can be considered as a biological viable option for displaced intra-articular calcaneum fracture even with compromised soft tissue. Considering the rare incidence of these fractures and due relevant experience, the primary management of these injuries as well as complication treatment should be centered in specialized department of orthopedics or traumatology.

Pre-operative X-ray



Operative steps - pin placement

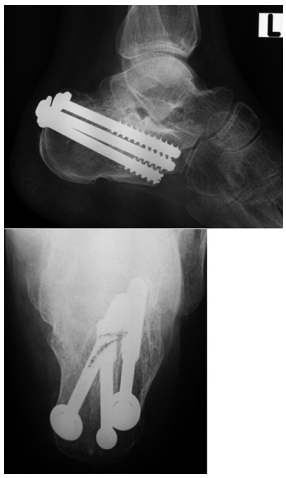
Operative steps - distraction and reduction



Operative steps - internal fixation

Operative steps - closure

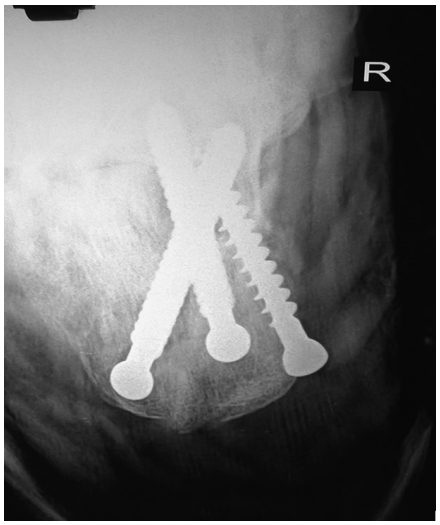
Case 12



Pre-operative and post-operative

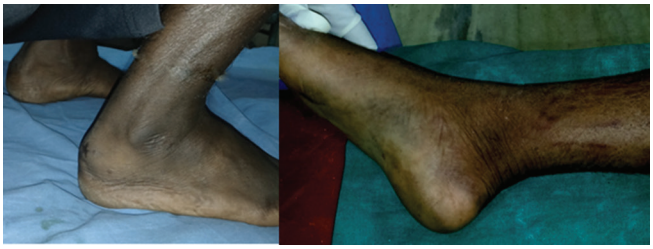
6-month follow-up

Case 20



Case 23

Pre-operative and post-operative



6-month follow-up

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