



EVALUATION OF FUNCTIONAL OUTCOME OF CLOSED REDUCTION AND PERCUTANEOUS INTERNAL FIXATION FOR CLOSED INTRA ARTICULAR DISPLACED FRACTURE OF CALCANEUM IN ADULTS BY MINIMAL INVASIVE SURGERY

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ABSTRACT

Introduction- Calcaneum is the commonest bone to be injured during fall from height. Calcaneum is a weight bearing bone and it has four articular surfaces. Particularly Intra-articular fractures account for approximately 75% of calcaneal fractures and historically have been associated with poor functional outcome. It was seen that nonoperative treatment for calcaneal fractures often led to pain, loss of function, which increased in the second decade after injury. This prospective study with 35 patients with closed intra-articular depressed calcaneum fracture was conducted to achieve satisfactory biological reduction and stable internal fixation using minimal implants by minimal invasive technique. **Material & Methods:** This prospective study was conducted at a tertiary care hospital, catering patients from eastern and middle zone of India with 35 adult patients with closed displaced intraarticular fracture of calcaneum selecting randomly less than 10 days duration attending outdoor and emergency from December 2021 to 2023. Operative procedure conducted using C-arm, 2.5 mm k wire, Steinmann pin and 6.5 mm full threaded cannulated cancellous screws, 6.5mm CHS, instrumentation set. Postoperative follow up was made both clinically and radiologically at the end of one and six weeks, three, six, nine and twelve months; and six months thereafter. **Results:** Excellent to good results noted in 3 (100%) patients with preoperative Bohler's angle larger or equal to 20° (n = 3) whereas patients with preoperative Bohler's angle smaller than 20° (n=32) achieved excellent to good results in 32 cases (100 %). overall 80% of patients achieved excellent results and rest 20% achieved good results. There were no postoperative complications like wound dehiscence peroneal tendinopathy or sural nerve palsy. **Conclusion:** 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 cantered in specialised department of orthopaedics or traumatology.

KEYWORDS

Intra-articular Fracture, Close Reduction, Bohler's angle, CHS

INTRODUCTION-

Calcaneum is the commonest bone to be injured during fall from height. calcaneum is a weight bearing bone and it has four articular surfaces. So special care is needed during treating calcaneal fracture. 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 and is useful in describing the location of the secondary fracture line and can be evaluated by plain X ray. Though CT guided Sander's classification^(5,7) is helpful for 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 poor economic status of my study population I have selected cost effective Essex-Lopresti classification for my study. It was seen that nonoperative treatment for calcaneal fractures often led to pain, loss of function, which increased in the second decade after injury. Goals to percutaneous reduction and internal fixation by minimal invasive surgery of calcaneal fractures are to restore congruency of the posterior facet of the subtalar joint, Bohler angle, height and width of the calcaneus, decompression of the subfibular space available for the peroneal tendons, realignment of the tuberosity into a valgus position, and reduction of the calcaneocuboid joint if fractured.

The main aim of this study is to achieve satisfactory biological reduction and stable internal fixation using minimal implants by minimal invasive technique, evaluation of efficacy, limitations, and complications of such procedure, and to observe functional outcome of close reduction and percutaneous internal fixation for closed intraarticular displaced fracture of calcaneum in adults by minimal invasive surgery.

MATERIALS AND METHODS:

This prospective study was conducted at a tertiary care hospital, catering patients from eastern and middle zone of India with 35 adult patients with closed displaced intraarticular fracture of calcaneum selecting randomly less than 10 days duration attending outdoor and emergency from December 2021 to 2023. Average age of patients was 32. Range :19-60 yrs. There were 25 males & 10 females. Serious medical ailments were excluded from this study. All patients were evaluated before and after management by clinical parameters and X-rays. Operative procedure conducted using C-arm, 2.5 mm k wire, Steinmann pin and 6.5 mm full threaded cannulated cancellous screws, 6.5mm CHS, instrumentation set. Postoperative follow up was made both clinically and radiologically at the end of one and six weeks, three, six, nine and twelve months; and six months thereafter. Initially Limb kept elevated in POP below knee back slab till subsidence of pain and edema, usually 10 to 12 days. Vigorous ankle mobilization exercise started. Nonweight bearing crutch walking or Protected weight bearing in a synthetic cast started after 3 weeks post-op and continued for next 6 weeks. Cast removed and partial weight bearing crutch walking up to radiological or clinical evidence of fracture healing- then gradually full weight bearing along with physiotherapy. All Patients were evaluated by a unified scoring system AOFAS clinical rating system, the ankle hind foot scale for calcaneal area (100 pts total ,90-100 pts excellent ,80-89 pts good ,70-79 pts fair, <70 pts poor).

RESULTS & ANALYSIS:

35 adult patients were operated (25 males and 10 females) with closed displaced intra articular fractures of calcaneum of less than 10 days. All cases were operated by close reduction and percutaneous internal fixation by minimal invasive surgery under spinal or general anaesthesia (Picture 1). We analysed the radiograph at 3 months, 6 months (picture 2), 9 months and one 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 post operatively. All machers Arthrosis Rating Scale were used for the evaluation of posttraumatic posterior facet degenerative changes. Primarily 35 of all 35 wounds (100%) healed without any form of wound complications. Excellent to good results noted in 3 (100%) patients with preoperative Bohler's angle larger or

equal to 20° ($n=3$) whereas patients with preoperative Bohler's angle smaller than 20° ($n=32$) achieved excellent to good results in 32 cases (100%). Overall 80% of patients achieved excellent results and rest 20% achieved good results (Table 1). Clinically significant subtalar arthrosis (Allmarcher grade 2-4) noted in 7 cases (20%) cases with Bohler's angle smaller than 20° ($n=32$) [Table 2]. Patients with preoperative Bohler's angle larger or equal to 20° ($n=3$) achieved post-operative Bohler's angle at 1 year at a range of 25° to 29° in three cases (100%); patients with preoperative Bohler's angle smaller than 20° ($n=32$) achieved post-operative Bohler's angle at 1 year at a range of 20° to 24° in 8 cases (25%) and at a range of 25° to 29° in 24 cases (75%) [Table 3]. There were no postoperative complications like wound dehiscence peroneal tendinopathy or sural nerve palsy. Therapeutic success of such fracture depends on early close reduction and internal fixation with proper fracture reduction and early rehabilitation.

DISCUSSION:

In the last two decades, close reduction and percutaneous internal screw fixation of displaced intra-articular calcaneal fractures has become a standard surgical method with low complication rate and better quality of life after the surgery. Brauers cost-effectiveness analysis of surgery versus conservative treatment for intra-articular calcaneal fractures showed economical advantage of ORIF⁽⁶⁾. 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 favoured operative treatment over conservative one. Most of the conservatively treated patients underwent arthrodesis procedure. Poorer health and social prognosis is related to males, heavy workers, patients with B-angle smaller than 0° and bilateral fractures.⁽⁹⁾ Conclusions of Bajammal who analysed 20 publications dealing with operative vs. 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.⁽¹⁰⁾ Buckley⁽¹¹⁾ (analysis of 559 calcaneal fractures) and Tufescu⁽¹²⁾ reported similar findings and both definitely recommended operative treatment. Her scoviciet⁽¹³⁾ al proved that there were no significant risks of wound healing for patients older than 65.

In 2004, Zwippet al⁽¹⁴⁾ 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 primary fusion in 0.3%). He used intra-operative open arthroscopy to control articular joint reduction. In this study the implanting of 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 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.⁽¹⁵⁾ Louckset al⁽¹⁶⁾ in a prospective randomized study pointed out that initial negative size of Bohler's angle negatively influences postoperative results irrespective of therapy choice. In accordance with other⁽¹⁷⁾ authors, by intra-articular calcaneal fracture⁽¹⁸⁾ treatment, we emphasize right operation timing, knowledge in anatomy & articulations of calcaneum, no-touch technique, perfect posterior facet fragment reduction in subtalar joint, restoration of calcaneal height, width, and length with calcaneal-cuboid joint revision. Most of them use AOFAS score & Allmarcher grade as clinical criteria and postoperative Bohler angle as radiological criteria.^(19,20)

T. Tomesen, MD and Daniel C. Farber,⁽²¹⁾ Interstudy, on treating calcaneus fracture by closed reduction minimally invasive surgery over an eight-year period of thirty-seven patients suggests that this technique can be successful but that it has limitations. Anatomically, their method successfully restored calcaneal height and partially restored calcaneal width and Bohler angle (average, 20.1°). Range of motion was 78% of normal in the sagittal ankle plane and 55% of normal through the subtalar joint. AOFAS, MFS, and SF-36 scores were uniformly improved in most patients. Restoration of the Bohler angle

did not correlate with functional outcome, nor did fracture type. Most patients (70%) returned to their previous level of work, but it is not clear how strenuous the work environments were. Just 57% were able to return to previous levels of physical activity. Most concerning was an infection rate of 13%, which is not an improvement over the results of many of the studies cited in the Discussion section of their paper. Three of these five infections were deep, which is concerning in a technique designed, in part, to minimize wound and infection complications. In addition, there was very high rate of screw removal (46%), which, while not a failure of treatment, does obligate the patient to a second procedure.

J.C.Coetze and S.Resig (1996-2002)⁽²²⁾ with 56 patient shows the ankle hind foot scale (AOFAS) improved from 34 preoperatively to 85 at the most recent follow up and visual analogue pain scale improved from 9.1 preoperatively to 2.2 at 3 years. The satisfaction rate was 86%. Functional results depended on the quality of the reduction of the posterior facet and severity of initial injury. Complications included a) 5% sural nerve injury b) 3% peroneal tendinopathy. The mean time to union was 10.2 weeks (8-14 weeks), which is comparable to our study. There was no wound complication like us.

In a similar study of 60 cases operated in Al razi orthopaedic hospital in Kuwait by Sherif Mohamed Abdelgaid MBBS, MSc, MD (2007-2009)⁽²³⁾ shows American orthopaedic foot and ankle society hind foot score, 22 cases (38.3%) had excellent result, 25 cases (41%) good result, 9 cases (15%) fair and 4 cases (5%) poor result. The overall satisfactory result (excellent to good) in 79.3% cases.

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 and articulation of calcaneum and principles of ligamentotaxis and restoration of Bohler's angle under fluoroscopic guidance and most importantly post op 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. So, 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 specialised department of orthopaedics or traumatology.

PICTURES:



Picture 1: Operative procedure showing close reduction technique of depressed calcaneum fracture



Picture 2: 6 months post operative clinical picture

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

	EXCELLENT	GOOD	FAIR	POOR
PRE OP BOHLER ANGLE $\geq 20^\circ$	3	0	0	0
PRE OP BOHLER ANGLE $<20^\circ$	25	7	0	0

Table 2: Comparison of Allmacher grade in respect of preoperative Bohler's angle

	0	1	2	3	4
PRE OP BOHLER ANGLE $\geq 20^\circ$	3	0	0	0	0
PRE OP BOHLER ANGLE $<20^\circ$	15	10	4	3	0

Table 3: Comparison of patients according to pre-operative and post-operative Bohler's angle:

	Post-operative Bohler's angle 20° to 24°	Post-operative Bohler's angle 25° to 29°
PRE OP BOHLER ANGLE $\geq 20^\circ$	0	3
PRE OP BOHLER ANGLE $<20^\circ$	8	24

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