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# Evaluation of Results of Closed Reduction and Percutaneous Fixation by Multiple K-Wires in Closed Intra-articular Calcaneal Fracture

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**Abstract** **Original Research Article**

***Background:*** Goals common to all types of treatment of calcaneal fractures are restoration of congruency of the posterior facet of the subtalar joint, restoration of the height of the calcaneus (Böhler's angle), reduction of the width of the calcaneus, realignment of the tuberosity into a valgus position, rehabilitation of the extremity and maximizing overall function of the limb and return the patients to their previous occupation as early as possible. ***Objectives:*** To evaluate the outcome of closed reduction and percutaneous fixation by multiple K-wires in closed intra-articular calcaneal fractures. ***Methods:*** This prospective Quasi experimental study was conducted in all patients attending at emergency and out-patient department in National Institute of Traumatology & Orthopedic Rehabilitation (NITOR), Dhaka, Bangladesh during July 2010 to June 2012. A total of 15 patients with intra-articular calcaneal fractures managed by close reduction and multiple k wires fixation. Postoperative followed up for an average period of 12 months. ***Result:*** According to Maryland foot score, out of 15 patients 2 patients had excellent, 6 patients had good, 1 patient had fair and 6 patients had poor result. ***Conclusion:*** Close reduction and minimal internal fixation through percutaneous k- wires is an effective treatment for the carefully selected cases for displaced intra-articular calcaneal fractures.

**Keywords:** K-wires, Percutaneous Fixation, Calcaneal Fracture.



## INTRODUCTION

Calcaneal fractures comprise 2% of all fractures & 60% of all major tarsal injuries of the foot. A large percentage of its fractures (60 to 70%) result in displaced intra-articular fracture leading to significant disabilities [1]. 10% of calcaneal fractures are associated with thoracic & lumber spine compression fracture & more than 20% are associated with long bone injuries of the lower extremities [2]. The calcaneus acts as a weight-bearing base of the foot as well as a lever arm for the muscles that allow the push-off which occurs with forceful gait [3]. The calcaneus articulates with the talus through three facets: posterior, middle & anterior. The largest of this is the posterior which transmit a significant portion of the body weight concentrated to small area, creating large forces over the small domelike articular surface. The mechanism of injury is usually through axial loading of the calcaneus causing a blowout of the lateral wall of the calcaneus & fracture through the posterior facet with various degrees of comminution. Calcaneus fractures are the result of high energy impact, with mechanism of injury including fall from height & motor vehicle accidents. As such they tend to be the more common in young laborers who work on scaffolding, bridges & ladders [4]. Calcaneal fractures have characteristic appearances based on the mechanism of injury and are divided into two major groups, intra-articular and extra-articular. Most calcaneal fractures (70%-75%) are intra-articular [5] and extra-articular fractures account for about 25% - 30% [6]. 90% of calcaneal fractures occur in males between 41 and 45 years of age, with most occurring in industrial workers. The economic importance of this injury is highly significant in that 20% of patients may be totally incapacitated for up to 3 years and partially impaired for up to 5 years after injury [7]. The management of calcaneal fractures was first described

by Essex-Lopresti, and since then their conservative or surgical approaches have been recommended. A fracture of the calcaneus allowed to heal in improper anatomical position leads to static and dynamic malfunctions of the whole foot with consequent limited load bearing capacity and walking ability. The goal of therapy for calcaneal fractures is the elimination of pain and restoration of walking ability for patients with normal foot shape and the ability to wear normal footwear. It's common to all types of treatment of calcaneal fractures are restoration of congruency of the posterior facet of the subtalar joint, restoration of the height of the calcaneus (Böhler's angle), reduction of the width of the calcaneus, decompression of the sub-fibular space available for the peroneal tendons, realignment of the tuberosity into a valgus position, reduction of the calcaneocuboid joint if fractured, rehabilitation of the extremity and maximizing overall function of the limb and return the patients to their previous occupation as early as possible [8]. Surgical treatment of displaced intra-articular fractures of the calcaneus is a standard procedure in many institutions. The outcome after displaced intra-articular calcaneal fractures is influenced by the condition of the surrounding soft tissues. To avoid secondary soft tissue complications after surgical treatment, several less invasive procedures for reduction and fixation have been introduced. The percutaneous technique according to Tim Alexander Walde, B.Sauer, J.Degreif, H.J.Walde is suitable for all types of displaced intra-articular calcaneal fractures and therefore introduced in our hospital. The aim of this study was to evaluate the outcome of percutaneous treatment according to Tim Alexander et al in patients with displaced intra-articular calcaneal fractures [9]. Several types of surgical treatment have been proposed: percutaneous Kirschner's wires fixation, open reduction and internal fixation by plates of different shapes and thickness, e.g. 2 mm and 3.5 mm reconstruction plates, H cervical plate, Galveston plates, Y calcaneal plates [10]. A possible complication of an open procedure is the disturbance of wound healing with skin and soft tissue necrosis. Clinical & technical problems can occur due to thickness & the stiffness of the plates that may cause ischemic problems to the skin & impingement of the peroneal tendons. Moreover, most plates have a limited number of holes & do not allow significant molding because of their thickness. In addition to post-traumatic arthritis in the lower ankle and adjoining joints, there are reports of osteitis of the calcaneus. In an effort to reduce the complications that can occur with an open procedure, we can use closed reduction and percutaneous fixation techniques. Some patients with fractures are obvious surgical candidates. Others present with medical contraindications to open surgery, or local soft-tissue contraindications to open surgery. Patients who have significant co-morbidities, aged or having risk factors (smoking) are considered to be too high a risk for a formal open reduction and internal fixation. It is in this patient group that minimally invasive techniques are most useful. During percutaneous Kirschner's wires fixation sural nerve injury, peroneal tendon injury may occur. When a fracture changes foot morphology, normal gait would be compromised, thereby reduction is indicated in order to restore normal anatomy and normal biomechanical relationships. Such restoration leads to normal gait. If the fracture is extra-articular, absolutely anatomical reduction is not necessary. In these situations, indirect reduction techniques minimally invasive surgical stabilization methods can be used.

## OBJECTIVES

**General Objective:**

- To evaluate the outcome of closed reduction and percutaneous fixation by multiple K-wires in closed intra-articular calcaneal fractures.

**Specific objectives:**

- To assess the status of pain after surgical treatment of closed intra- articular calcaneal fractures during active day life.
- To find out any limping, use of support during walking, and walking distance after treatment.
- To evaluate any deformity and range of movement of ankle, subtalar and mid-tarsal joint after treatment.

## MATERIALS & METHODS

This prospective Quasi experimental study was conducted in all patients attending at emergency and out-patient department in National Institute of Traumatology & Orthopedic Rehabilitation (NITOR), Dhaka, Bangladesh during July 2010 to June 2012. On a total of 15 patients with intra-articular calcaneal fractures managed by close reduction and multiple k wires fixation. Postoperative followed up for an average period of 12 months. Purposive sampling (nonrandom sampling) was followed considering the inclusion and exclusion criteria. Closed and displaced intra-articular calcaneal fractures and less than 3 weeks old fracture irrespective of sex, occupation and socioeconomic status of the patients were included. More than 3 weeks fracture, severely comminuted fracture, open fracture, pathological fracture & patients with peripheral vascular diseases were excluded. Data and result were presented in the form of tables, figures and charts. After collection of data, all data were checked and cleaned. After cleaning, the data were entered into computer and statistical analysis of the results being obtained by using windows-based computer software devised with MS Excel-2016.

## RESULTS

All the relevant findings obtained from data analysis. Results were evaluated according to Maryland Foot Score. Total 15 patients included in the study.

Among them 11(73.33%) were male and 4(26.7%) were female (Figure-1). The age range was 14–70 years both in male and female. Most of the patients 9(60.00%) were in 30-60 range then 4(26.67%) had less than 30 years and 2(13.33%) were found in more than 60 age group. Out of 15 patients, 5 patients were day-laborer which includes 33.33% of total patients and 4 patients were house wives which includes 26.7% of total patients. 2 patients were students (13.33%), One garments worker (6.67%), one construction worker (6.66%), one electrician (6.67%) and one retired service holder (6.67%). Among 15 patients, 13(86.67%) patients were affected by fall from height and 2(13.33%) patients by RTA [Table-1]. Out of 15 patients, 2 (13.33%) patients were Sanders type II, 7(46.67%) patients were type III and 6(40%) patients were type IV [Table-2]. About 3(20%) patients were operated within 1 week, 9(60%) patients within 1 to 2 weeks and 3(20%) patients within 2 to 3 weeks after injury [Table-3]. In term of complication, 1 (6.66%) of the patients noticed bleeding from pin tract through which Steinmann pin was introduced for reduction and 3 patients (20%) developed subtalar arthritis [Table-4]. From the study patients 4(26.67%) returned to routine pre-injury activities, 6(40 %) patients to pre-injury activities with mild limitation, 2(13.33%) to pre-injury activities with moderate limitation and 3(20 %) patients were unable to perform routine activities [Table-5]. Final clinical outcome of patients was based on Maryland Foot Score. In2(13.33%) patients, result was excellent, 6(40%) patient showed good result, in one (6.67%) patient, fair and in 6(40%) patients result was poor. Satisfactory = Excellent + Good = 13.33% +40% = 53.33%. Unsatisfactory = Fair + Poor = 6.67% + 40% = 46.67% (Table-6).

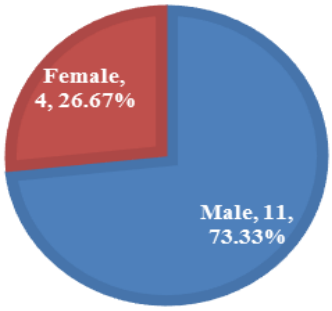


**Fig-1: Distribute the study people according to gender (N=15)**

**Table-1: Distribute the study people according to demographic characteristics (N=15)**

| Characteristics | | n | % |
|---|---|---|---|
| Age | <30 | 4 | 26.67 |
| | 30-60 | 9 | 60.00 |
| | >60 | 2 | 13.33 |
| Occupation | Day Labor | 5 | 33.33 |
| | Housewives | 4 | 26.67 |
| | Students | 2 | 13.33 |
| | Garment worker | 1 | 6.67 |
| | Construction Worker | 1 | 6.67 |
| | Electrician | 1 | 6.67 |
| | Retired Service Holder | 1 | 6.67 |
| Cause | Fall from height | 13 | 86.67 |
| | RTA | 2 | 13.33 |

**Table-2: Distribute the study people according to Sanders type (N=15%)**

| Sanders type | n | % |
|---|---|---|
| Type-II | 2 | 13.33 |
| Type-III | 7 | 46.67 |
| Type-IV | 6 | 40 |

**Table-3: Study people distributed according to the duration before operation (N=15)**

| Duration before operation | n | % |
|---|---|---|
| 1 week | 3 | 20 |
| 1-2 weeks | 9 | 60 |
| 2-3 weeks | 3 | 20 |

**Table-4: Complications identified in the study people (N=15)**

| Complications | n | % |
|---|---|---|
| Bleeding from pin tract | 1 | 6.66 |
| Subtalar arthritis | 3 | 20 |

**Table-5: Type of injury of the study people (N=15)**

| Injury type | n | % |
|---|---|---|
| Pre- injury | 4 | 26.67 |
| Pre-injury mild | 2 | 13.33 |
| Pre-injury moderate | 3 | 30 |

**Table-6: Distribute the study people according to the clinical outcome (N=15)**

| Clinical Outcome | n | % |
|---|---|---|
| Excellent | 2 | 13.33 |
| Good | 6 | 40 |
| Fair | 1 | 6.67 |
| Poor | 6 | 40 |

## DISCUSSION

Conservative treatment of the displaced intra-articular fracture is unlikely to result in normal function because of secondary arthritis and mal-union of the calcaneum. Crosby and Fitzgibbon originally treated all fractures of the calcaneum non-operatively. Because the results were poor, they began to treat patients with displaced fractures surgically and found that the results improved significantly [11]. In a meta-analysis by Randle et al comparing operative and non-operative treatment of intra-articular fractures of the calcaneum, patients treated operatively fared better in terms of reduced pain, earlier return to work, reduced heel width, improved gait and better radiological outcomes [**12**].

The lateral extensile approach is the most widely used. Surgeons employing this approach including Sanders, Benirschke and Sangeorzan, Zwipp et al and Eastwood et al stress the importance of anatomical reduction of the posterior and middle facets. The lateral surface of the calcaneum is better suited to the application of plates and rigid fixation [13]. Serious complications are associated with this approach, the most common being wound dehiscence, which may occur as much as four weeks after surgery. Folk, Starr and Early reported that in 190 fractures, four patients required amputation, there was a 25% wound complication rate, 22 patient's required early removal of their implants and 11 needed flap cover[14]. Sanders noted three amputations and five free flaps in 120 patients. To prevent these potentially disastrous complications, careful patient selection is necessary. Diabetics, smokers, patients with vascular impairment, compound fractures or fractures with blisters and persistent swelling should be excluded. Surgery should be undertaken only when the swelling subsides, usually seven to ten days after the initial injury. By contrast, minimally-invasive technique has very few contraindications and excludes only patients with infected blisters and those who are too unwell for surgery. The overall reduction of the calcaneum, as judged by restoration of length, height, width and correction of varus deformity, is very good. Patients treated using percutaneous technique should be operated on as soon as possible after injury, while for open reduction, using the extensile lateral approach an interval of five to nine days between the trauma and surgery has been advised to prevent complications with wound healing. Attempts to reduce hospital stay by pre-operative outpatient management of patients to be treated by open reduction has proved unsuccessful. This technique requires manipulation of the posterior facet without full exposure. This permits the Essex-Lopresti manoeuvre and relatively easy manipulation. Tornetta reported 46 patients treated with percutaneous fixation, of whom 39 had a Sanders type-IIC fracture and seven a type-IIB. He believes that Sanders type-IIC fractures, where the entire posterior facet is in continuity with the tuberosity fragment and the facet itself is intact, are best suited for percutaneous fixation. He reported 85% excellent or good results, and concluded that for selected fracture types the method gives comparable or possibly better results than open fixation [15]. Levine and Helfet in their series of intra-articular fractures of the calcaneum treated with a minimally-invasive technique, were surprised that subtalar movement was almost completely preserved despite an articular surface reconstruction described as 'nearly anatomical'. They believe that minimal dissection results in less post-operative swelling, less peri-articular scarring and an improved range of movement than formal open reduction, despite imperfect restoration of the joint surface [16]. Thermann et al advised minimally-invasive fixation for cases with severe soft-tissue contusion, compound and Sanders type-IV fractures, and in multiply-injured patients [17]. Rammelt et al advocated percutaneous reduction of fractures of the calcaneum with severe soft-tissue compromise, and in patients in whom there are systemic contraindications to open surgery. He believes that it is suitable for Sanders type-IIC fractures and that, if used for Sanders type-IIA or IIB fractures, should be performed under arthroscopic control of reduction of the articular fragment [18]. In my series, both joint-depression and tongue-type fractures of all grades of severity (Sanders type II, III, IV) were treated using the same protocol. Both the extra-articular anatomy and joint congruity were restored in most of my patients, resulting in 80% good to excellent long-term results. Carefully performed semi-open reduction and percutaneous fixation is an effective treatment for displaced intra-articular fractures of the calcaneum, especially in patients where formal open reduction is considered to constitute a significant risk. In our study from the total 15 patients 11(73.33%) were male and 4(26.7%) were female. That mean most of the patients found male. The age of the patient was between 14-70 years. Mean age was being 30 ± 11.18 years. Total number of patients were 15. In the study of Stulik in 2005 total number of patients were 247 and 88 respectively and number of intra-articular fractures were 287 and 92 respectively and age range and mean age were 13-67 years and 44.3 years respectively[19]. Regarding configuration of fractures, in this study Sanders type II, III and IV fractures were 2(13.33%), 6(40%) and 7(46.67%) respectively. In the study of Stulik in 2005 [19], Sanders type II, III and IV fractures were 175, 86 and 26 respectively. There were 183 joint-depression fractures, 72 tongue-type fractures and 32 comminuted fractures. In this study 3(20%) of the patients were operated within 7 days of injury and 9(60%) within 7 to 14 days. Height, length and width of the fractured calcaneus were almost within normal limit. Böhler's angle was corrected in 8 patients. In this study, pin track infection was detected in one case (6.66%) and sub-talar arthritis in 3 cases (20%). Pin track infection was managed by immobilization and antibiotic. In the study of Stulik, 13 cases (4.5%) lost reduction due to inadequate fixation with K-wires, 20 cases (7%) developed superficial pin-track infection. Considering the range of movement of subtalar joint at the final follow-up the researcher observed normal range of movement in 6 patients (40%), mild restriction of the movement on 2 patients (13.33%), moderate restriction of the range of movement in 2 patients (13.33%) and severe restriction in 5 patients (33.33%). In this study, 3 patients (20%) developed subtalar joint arthritis. The pain was relieved by walking aids and non-steriodal anti-inflammatory drugs. These patients may require subtalar arthrodesis later on. From the study patients 4(26.67%) returned to routine pre-injury activities, 6(40 %) patients to pre-injury activities with mild limitation, 2(13.33%) to pre-injury activities with moderate limitation and 3(20 %) patients were unable to perform routine activities. In the final follow -up, according to Maryland Foot Score criteria, the final result (good to

excellent) was 53.33%, of which 13.33% was excellent and 40% was good. In the study of Stulik (2005) results were excellent in 29 patients (16.5%) and good in 98 (55.7%) [19].

## CONCLUSION

Tongue-type fractures (Sanders IIB, IIC), can be successfully treated using a minimally-invasive technique. All Sanders type-IV fractures should be treated with a minimally-invasive technique, as many are accompanied by severe soft-tissue trauma. All displaced intra-articular fractures in patients at increased risk from a formal open reduction can be treated safely with a minimally-invasive technique. In this study, it is established that closed reduction and percutaneous fixation by multiple K-wires can lead to satisfactory results in the management of displaced intra-articular fractures of the calcaneus.

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## REFERENCES

1. Sanders R. Displaced intra-articular fractures of the calcaneus. J Bone Joint Surg Am. 2000, vol. 82, no.2, pp.225–250.
2. Rogers LF. Rogers LF (ed) Radiology of skeletal trauma, 2nd edn. New York: Churchill Livingstone, 1992, pp.1429-1521.
3. Lowery RBW. Fractures of the talus and calcaneus. Curr Opin Orthop ; 1994, vol.5, pp. 24-32.
4. Essex-Lopresti, P. The mechanism, reduction technique and results in fractures of the os calcis. Clin Orthop, **1993,** vol.290, pp.3 -16.
5. Carr. J. B. Mechanism and pathoanatomy of the intra-articular calcaneal fracture. Clin. Orthop, 1993, vol.290, pp.36-40.
6. Sanders R, Fortin P, DiPasquale T, Walling A. Operative treatment in 120 displaced intraarticular calcaneal fractures. Clin Orthop. 1993 ,vol. 290,pp.87–95.
7. Kitaoka HB, Schaap EJ, Chao EY, An KN. Displaced intra-articular fractures of the calcaneus treated non-operatively. J Bone and Joint Surg AM. 1994, vol.76, pp.1531 – 1540.
8. Sanders R , and Gregory, P. Operative treatment of intra-articular fractures of the calcaneus. Orthop. Clin. North America.1995, vol.26, pp203 – 214.
9. Tim Alexander Walde, B. Sauer, J. Degreif, and H.-J. Walde. Closed reduction and percutaneus Kirschner wire fixation for the treatment of dislocated calcaneal fractures: surgical technique, complications, clinical and radiological results after 2–10 years.Arch Orthop trauma Surg, 2008, vol.128, pp585 – 591.
10. Bernischke FR, and Sangeorzan B J. Extensive intra – articular fractures of the foot. Surgical management of the calcaneal fractures. Clin Orthop. 1993, vol.292, pp.128 – 134.
11. Crosby LA, Fitzgibbons T. Intraarticular calcaneal fractures: results of closed treatment. Clin Orthop. 1993, vol.290, pp.47–54.
12. Randle JA, Kredler HJ, Stephen D, et al. Should calcaneal fractures be treated surgically? Clin Orthop. 2000, vol.377, pp.217–27.
13. Eastwood DM, Langkamer VG, Atkins RM. Intra-articular fractures of the calcaneum. Part II:.open reduction and internal fixation by the extended lateral transcalcaneal approach. J Bone Joint Surg [Br]. 1993, vol.75-B, pp. 189–95.
14. Folk JW, Starr AJ, Early JS. Early wound complications of operative treatment of calcaneus fractures: analysis of 190 fractures. J Orthop Trauma.1999 ,vol.13no.5, pp.369–372
15. Tornetta P 3rd. Percutaneous treatment of calcaneal fractures. Clin Orthop. 2000, vol.375, pp.91–6.
16. Levine DS, Helfet DL. An introduction to the minimally invasive osteosynthesis of intra-articular calcaneal fractures. Injury. 2001, vol.32, pp.51–4.
17. Thermann H, Hufner T, Schratt HE, Albrecht K, Tscherne H. Treatment of intraarticular calcaneal fractures in adults. A treatment algorithm. Unfallchirurg. 1999, vol. 102,no.3, pp.152–166.
18. Rammelt S, Barthel S, Biewener A, Gavlik JM, Zwipp H. Calcaneus fractures. Open reduction and internal fixation. Zentralbl Chir.2003, vol.128,no.6, pp.517–528
19. Stulik J, Stehlik J, Rysavy M, Wozniak A Minimally-invasive treatment of intra-articular fractures of the calcaneum. J Bone Joint Surg Br.2005, vol. 88, no.12, pp.1634–1641.