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Original article

ANATOMIC OPEN REDUCTION AND INTERNAL FIXATION (ORIF) OF DISPLACED INTRA-ARTICULAR CALCANEAL FRACTURES IN CORRELATION WITH FUNCTIONAL OUTCOMES

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Abstract

Contradictory evidence regarding treatment modalities in displaced intra-articular calcaneal fractures was explored in this paper. Conservative *versus* surgical treatment using open reduction and internal fixation (ORIF) is a widely debated topic in the world literature. In this paper functional outcomes of patients with displaced intra-articular calcaneal fractures treated with open reduction and internal fixation with anatomic locking plate were observed clinically and radiologically.

Fourteen patients diagnosed with intra-articular calcaneal fractures preoperatively evaluated by lateral and axial views roentgenography of the calcaneum and consequent computed tomography were surgically treated within two weeks after injury. Bohler's angle was measured as well as calcaneal width and height. Patients were followed up clinically and radiologically for at least 12 months with functional outcome evaluation using the American Orthopaedic Foot and Ankle Society (AOFAS) scale.

The mean Bohler's angle, calcaneal width and height were 25.47°, 4.32 cm and 3.81cm, respectively at final follow-up. At 1 year following ORIF, the mean AOFAS score was 82.5 ranging from 62 to 95 with 79% having excellent to good outcomes, 11.6% fair and 7.4% poor outcome. Postoperative complications were observed in three patients, one had incision site flap necrosis and two were treated for superficial wound infections.

Open reduction and internal fixation (ORIF) with locking calcaneal plate as a surgical treatment addressing displaced intra-articular calcaneal fractures appreciating well-established AO principles (Arbeitgemeineshaft fur Osteosynthesefragen) leads to satisfactory results appreciated by the patients treated.

Keywords: ORIF, calcaneus, outcomes

Introduction

Calcaneal fractures as the most common fractures of the foot, especially displaced intra-articular fractures representing approximately 80% of all calcaneal fractures pose a treatment perplexity in the everyday orthopaedic trauma world[1,2]. The complex anatomy, calcaneal and fracture morphology and pathophysiology in relation to the treatment modalities is a widely debated topic in the world literature. Already published complications regarding the two main

treatment options being conservative and surgical, amplifies the complexity of the problem[3]. In this paper we review a case series of patients treated at our institution with open reduction and internal fixation (ORIF).

Materials and methods

The series consisted of 14 patients with unilateral closed calcaneal fractures admitted to our institution two to five hours after injury treated by a single attending physician. Following a thorough clinical assessment, they were further radiologically assessed with lateral and axial calcaneal radiographs and computed-tomography (CT) as per standard protocol. Patients diagnosed only with intra-articular fractures treated with ORIF using anatomic locking plate within fourteen days post-injury were included in this study. Awaiting local status resolution patients were immobilized with below knee slab, local cryotherapy was applied as well as limb elevation. Surgery was done under spinal anesthesia using a standard lateral approach to the calcaneus following AO principles (Arbeitgemeineshaft fur Osteosynthesefragen) .. Sutures were removed 10 days postoperatively while immobilization continued for the next 3 weeks, which was followed by physical therapy. Non-weightbearing was advised for the next three months. Calcaneal width, height and Bohler's angle were being radiologically assessed and functional outcome evaluated with the American Orthopaedics Foot and Ankle Society (AOFAS) scale.

Results

Initially, sixteen patients were enrolled in this study, of whom two were excluded due to being unavailable at one year follow-up. The most common mechanism of injury was fall from height followed by motor-vehicle collisions. Two patients had accompanying injures, one had contralateral posterior hip dislocation and the other one bilateral superior pubic rami fractures, all treated conservatively. The mean age of patients was 34.2 years (range 27-54); 13 were males and 1 female. At average, ORIF was done on 8.7 days post-injury (range 6-14) with duration of 82 minutes (range 67-104 minutes). Postoperative complications were observed in three patients, with one patient suffering skin flap necrosis and two patients superficial wound infections. Patients were followed at least 1 year postoperatively (range 12-20 months), average 15.3 months.

Preoperative Bohler's angle was average 3.35° (range -18° to 17°), calcaneal width 3.98 cm (range 3.7 to 4.4 cm) and height 3.3 cm (range 2.9 to 4.0 cm). Postoperative values of the Bohler's angle, calcaneal width and height were as follows: 26.52° (range 19° to 33°), 3.67 cm (range 3.3 to 4.1 cm), 4.2 cm (range 3.9 to 4.6 cm), respectively. At final follow-up, 12 months after ORIF, we observed a decrease in Bohler's angle measuring 25.23° ranging from 18° to 34°, calcaneal width of 3.74 ranging from 3.55 to 4.1 cm and calcaneal height of 4.12 cm. Functional outcome measured by AOFAS scale at one year follow-up was 82.5 ranging from 62 to 95 with 79% having excellent to good outcomes, 11.6% fair and 7.4% poor outcome.

Discussion

Despite the advances that have been made in diagnosing, preoperative planning and operative treatment of displaced intraarticular fractures of the calcaneus, dilemmas still exist, especially in establishing certain radiological parameters that can be measured in order to predict the functional outcome and patient's prognosis in general. Improved imaging modalities such as CT as well as improved intraoperative fluoroscopy have allowed us to better define fracture patterns and improve reduction and fixation techniques. As a result, recent studies have demonstrated improved outcomes with operative treatment of calcaneal fractures[4].

Injuries to the calcaneus can result in severe disability. Sustaining this kind of injury can be a life-altering event for the majority of patients. It is also a socio-economic problem, since working manual labor individuals are most commonly affected, and 20% are unable to return to their previous working place at least 1 year after injury. In our study male predominance was obvious, with an accent on economically active population taking the burden of these injuries[5].

These injuries are almost always associated with a significant soft tissue trauma, represented with massive swelling and quite common fracture blisters. Taken this into consideration, the surgery is delayed until the soft tissues have recovered, especially when using the extended lateral approach. Conflicting literature exists regarding the optimal timing for surgery. Abidi *et al.* suggested that wound complications were higher in patients who had undergone surgery within 5-7 days of the injury[6]. Tennent *et al*. and Koski *et al* demonstrated an increase in wound complication rate if surgery was undertaken earlier than 14 days after trauma[7].

Majority of the surgeons use the "wrinkle sign" as a sign for soft tissue recovery, and if that sign is positive the operative intervention is most likely safe. Despite already published literature, we sought for faster surgical treatment resulting in faster recovery, consecutive physical therapy and better functional outcomes.

As early as 1931, Bohler postulated the principles for operative treatment of intra-articular calcaneus fractures and they have remained the same. The goals are anatomic reduction of the posterior facet, restoration of the calcaneal morphology (height, length and width of the calcaneus), stable internal fixation, and early range of motion[8]. There are several surgical approaches used for operative treatment of intraarticular calcaneal fractures (medial, combined medial and lateral, sinus tarsi approach, extended lateral approach). Disadvantage using the medial approach is that direct reduction and visualization of the subtalar facets is not possible. Several authors have described the advantages of the combined approach. Although, Stephenson reported good results in 17 of 22 patients, 27% developed wound complications[9]. The sinus tarsi approach recently gained an increasing popularity because of the decreased wound complication rates, but the concerning moment is the inability to directly reconstruct the fracture deformity (heel shortening and varus malalignment). Currently, the extensile lateral approach is the most commonly used for ORIF of intraarticular calcaneal fractures. Our familiarity with it, as well as the fact that it allows us to visualize and directly reduce the posterior facet and restore the calcaneal morphology, made this approach the most suitable for this study.

Functional outcomes measured by AOFAS scale at one year follow-up were 82.5 ranging from 62 to 95 with 79% having excellent to good outcomes, 11.6% fair and 7.4% poor outcome. Preoperative Bohler's angle was average 3.35° (range -18° to 17°), calcaneal width 3.98 cm (range 3.7 to 4.4 cm) and height 3.3 cm (range 2.9 to 4.0 cm). Postoperative values of the Bohler's angle, calcaneal width and height were as follows: 26.52° (range 19° to 33°), 3.67 cm (range 3.3 to 4.1 cm), 4.2 cm (range 3.9 to 4.6 cm), respectively. At final follow-up, 12 months after ORIF we observed a decrease in Bohler's angle measuring 25.23° ranging from 18° to 34°, calcaneal width to 3.74 ranging from 3.55 to 4.1 cm and calcaneal height of 4.12 cm.

Our experience regarding ORIF of intra-articular calcaneal fractures is that anatomical reduction of the posterior facet and reconstruction of the normal hindfoot morphology are key steps in the treatment. We have radiographically evaluated this by measuring the Bohler angle on lateral x-ray and calcaneal height and width on lateral and axial x-rays, respectively. We concluded that restoring these three parameters in physiologic values was associated with acceptable functional outcomes. The wound complications are unavoidable and highly present with the extended lateral approach. When present, early range of motion is restricted. Thus, the future lies

in using minimally invasive approaches and percutaneous reduction techniques for obtaining the forementioned values of the radiographic parameters measured.

Conclusion

Although this was a relatively small series of patients, anatomic open reduction and internal fixation with locking plate with restoration of Bohler's angle, calcaneus width and height and adequate patient selection, timing of surgery, satisfactory skin-flap formation and postoperative clinical protocol resulted in early mobilization and satisfactory functional outcomes. As stressed out, giving the circumstances, all of the abovementioned points and the perplexity of this treatment dilemma we suggest studies on large patient samples with extensive analysis of multiple factors that may influence the outcome.

Conflict of interest statement. None declared.

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