Treatment of intra articular fracture calcaneus using sinus tarsi approach, bone block substitute, and screws

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Received: 02 January 2023
Revised: 21 May 2023
Accepted: 23 May 2023
Published: 07 September 2023

The Egyptian Orthopaedic Journal 2023, 58:128–132

Objective
To evaluate the results of fixation of intra articular calcaneus fracture using Sinus Tarsi Approach, bone block substitute, and screws fixation.
Background
Minimal invasive techniques for treatment calcaneus fractures have developed to overcome soft tissue complications associated with the traditional lateral approach. Sinus Tarsi approach has the advantage of visualization of posterior part of subtalar joint.
Methods
All patients underwent preoperative calcaneal lateral and axial radiographs and CT scan of the injured foot. The injured type was graded according to the Sanders classification on the basis of the CT scan findings.
Bohler and Gissane angles were measured as anatomical parameters before surgery. Sinus Tarsi Approach was done for all patients, in addition to use of percutaneous screws fixation and bone block graft substitute.
Results
A total of 17 patients were included in our study. The mean age was 37.8 years. At the end of follow-up, radiological evaluation was done by measuring the Bohler angle and the angle of Gissan. The American Orthopaedic Foot and Ankle Society (AOFAS) ankle/hindfoot score was calculated at the end of the follow-up for all cases. Excellent results were found in7 patients, good results in 8 patients and fair results in only 2 patients. There was a statistically significant improvement of Bohler angle at the end of the follow-up.
Conclusion
Treatment of intra articular calcaneal fractures using Sinus Tarsi Approach with a bone block substitute and screws can provide satisfactory clinical outcomes.

Keywords
bone block substitute, calcaneus fracture, sinus tarsi approach

Egypt Orthop J 2023, 58:128–132

1110-1148

Introduction

Based on the computed tomography Scan(CT), Sanders *et al*. [1], classified intra articular calcaneal fractures as 4 types, based on the fracture location at the posterior articular facet. Type I fracture is nondisplaced fracture with fracture displacement less than 2 mm. Type II–IV fractures are displaced intraarticular calcaneal fracture which are divided by different articular pieces [1].

The optimal operative approach for the treatment of displaced intra articular calcaneal fractures continues to be controversial [2], but the anatomical reduction of the posterior facet of the subtalar joint is crucial for successful outcomes [3–6].

The extended lateral L-shaped approach is commonly used for the treatment of calcaneal fractures. This approach accurately reduces the subtalar joint, fully exposes, and addresses the intra articular calcaneal fragments and conveniently places the plate to achieve a stable fixation. However, the wound complication rate was reported to be as high as 30% [7]. Deep bone infection or osteomyelitis rate of 2.5% has been reported [8,9].

Minimally invasive techniques have been developed, and Sinus Tarsi Approach being the most commonly used [10–12]. This approach protects the blood supply by avoiding wide dissection and can still provide direct visibility of the subtalar joint [13]. Whether or not to use bone graft in the operative treatment of displaced intra articular calcaneus fracture is still controversial [14]. The aim of our study was to evaluate the results of the treatment of intra articular calcaneus fractures using Sinus Tarsi Approach, bone block substitute,and screws.

Patients and methods

A total of 17 patients were included in our study from February 2018 to march 2020. Exclusion criteria included: open fracture,bilateral calcaneal fractures, any other fracture in the same foot or bilateral cases.

All patients underwent preoperative calcaneal lateral and axial radiographs and CT scan of the injured foot. The injury type was graded according to the Sanders classification on the basis of the CT scan findings. Bohler and Gissane angles were measured as anatomical parameters before surgery. The average time between injury and surgery was 7.4 days, (ranged from 6 to 11). Written informed consent was taken from all patients before enrollment in the study.

Operative procedure

Surgery was performed under general or spinal anesthesia and with antibiotic prophylaxis. The patient was placed in a lateral position with a tourniquet on the thigh. The incision was made approximately 1 cm distal and posterior to the fibula and extended towards the base of the fourth metatarsal bone. Incision length ranged from 3–5 cm.

The anterior process of the calcaneus was in the distal aspect of the wound. The peroneal tendon was identified and pulled gently in a cephalic direction. The fracture segments of the lateral wall were taken down to clearly expose the subtalar joint and the initial fracture line. Reduction techniques were done under image intensifier; included the use of distraction with a Schanz pin or K-wire size 4 mm transversely through the tuberosity segments.

The traction was directed in a backward, downward, and external-oblique motion, aiming to recover the original fracture line by aligning the interior wall, correcting the varus, shortening deformity, and restoring the Böhler angle. Temporary fixation was performed with K-wires ranging in size from 1.5 to 2 mm according to the size of the displaced fragment. One or two bone block substitutes were placed to fill the gap inside and to make support to the underneath the posterior facet (Fig. 1).

External segments of the subtalar joint were relocated to reconstruct the joint, and the lateral wall was realigned. Percutaneous fixation with three fully serrated cannulated screws was done. Finally, irrigation and closure of the wound. A removable splint was applied to keep the foot in a plantigrade position (90°).

Poatoperative care

Prophylactic antibiotics were given(24–48 h) to prevent operative site infections. On the 3rd day postoperatively, the patients began to perform ankle dorsal flexion function exercise. Full weight bearing was not allowed until the signs of bone union were observed on the radiographs.

Figure 1

Intraoperative impaction of bone block substitute.

Outcome measurements

At the end of the follow-up, radiological evaluation was done by measuring Bohler angle, and the angle of Gissan.The American Orthopaedic Foot and Ankle Society (AOFAS) ankle/hindfoot score was calculated at the end of follow-up for all the cases [15].

Statistical analysis

Statistical analysis was carried out using SPSS18.0 software (SPSS, Chicago, Illinois, USA). Data were presented as means + standard deviation (SD). The preoperative, and the last follow-up variables were compared using Student's paired *t* test ($P<0.05$) was considered to be a statistically significant difference.

Results

17 patients had mean age of 37.8 years, (range from 23 to 52), there were 13 males and 4 females, 4 patients were diabetic. The average follow-up period of the 17 patients was 14.8 (range, 13–29) months.

All the patients had full weight bearing at mean of 12.5 weeks (range,11–15) weeks, and all of them had returned to their work at mean of 4.7 (range, 4–6) months. Superficial wound infection was reported in 2 patients and healed spontaneously without any secondary procedure. No deep infection was reported.

The AOFAS hind/foot score at the end of follow-up was 86.52 ± 9.5(range 70–100) points. Excellent results were found in7 patients, good results in 8 patients and fair results in only 2 patients. There was a statistically significant improvement of Bohler angle at the end of follow-up (Table 1), (Fig. 2).

Table 1 Radiological assessment

Radiological measure	Mean	Range	Paired sample *T* test (sig if *P*<0.05)
Bohler angle			
Preoperative	13.76	-6–23	*P*=0.000 significant
End follow-up	26.94	13–35	
Angle of Gissane			
Preoperative	125.1	105–140	*P*=0.445 Non significant
End follow-up	124.7	109–140	

Figure 2

A and B preoperative, C (lateral view) D (axial view) postoperative showing screws fixation and the use of 2 bone block substitute. and F end follow-up radiography G photograph of the patient with good healing of the wound.

Discussion

The selection of operative approach to calcaneal fractures is controversial. The extended lateral approach has been considered the gold standard treatment for intraarticular calcaneal fractures. However, soft tissue complications remain a major concern, ranging from 2 to 30% with the extended lateral approach [7,16,17].

Many minimally invasive approaches have been developed to decrease the wound related complication rates. Among them, the Sinus Tarsi Approach has become one of the most popular minimally invasive methods as it can provide direct visualization of the posterior articular facet and has fewer soft tissue related complications [18,19].

According to Sanders, the correct timing for surgery is between 7 and 10 days after trauma, because if treated earlier there is risk of compartmental syndrome or soft tissue damage, and if treated later the results could be otherwise unsatisfactory [1].

In our study, the duration between injury and surgical interference was 7.4 days (range 6to11). Sinus Tarsi Approach was used in all 17 patients and only 2 patients (11.8%) got superficial wound problem which resolved without any secondary procedure. Schepers reported an average wound complication rate of 4.8% (range 0% to 15.4%) for patients treated with use of the Sinus Tarsi Approach [18].

In our study good visualization and open reduction of posterior articular facet through Sinus Tarsi Approach were achieved in all our patients. Bone block substitute was placed into the void of the calcaneal body to support and maintain the already elevated and fixed construct of the intraarticular calcaneal fracture. Percutaneous cannulated screwing from the posterior calcaneal tuberosity was performed in all patients.

As it was believed that screwing alone can not guarantee maintenance of reduction of the intra articular calcaneal fractures and facilitate rehabilitation, a bone block substitute was added in all cases to prevent the collapse of reduction and facilitate weight bearing. Our concept of using bone graft was supported by some authors [20].

Nevertheless, others believe that the need for bone grafting needs to be proved in the future as there has been a little report of need for bone grafting in the treatment of calcaneal fractures [21]. Some researchers believe that bone grafts are not generally needed because the cancellous calcaneal bone has a strong regenerative ability [22,23].

Now, there are several radiographic parameters used for the description of the calcaneal fractures. The Böhler's angle is a well-established tool to quantify fracture displacement with a prognostic value in predicting morbidity associated with calcaneal fractures [24]. One of the main surgical goals is to restore the Böhler's angle back to normal range of 25 to 40 degrees to yield satisfactory results [25].

In our study there was a significant improvement of Bohler angle at the end of the follow-up, with mean of 26.94° (range 13to 35). Böhler's angle has a significant positive role in predicting the functional recovery.

Restoration of Böhler's angle should be an important reduction index during repair of the displaced intraarticular calcaneal fractures, and should be ≥9 degrees to achieve satisfactory functional outcomes [26].

The mean AOFAS ankle/hindfoot score at the final follow-up was 86.5 ± 9.5 (range, 70–100) points. The overall satisfactory (excellent and good) results were obtained in 15 patients (88.2%).

Our results were compared with the results achieved using other minimally invasive techniques [27,28]. Zhan J *et al.* [29] reported close score to our results, their mean AOFAS ankle/hindfoot score was 90.2 + 17.7 (range70–98), with good and excellent rates of 89.7%.

Conclusion

Treatment of intra articular calcaneal fractures using Sinus Tarsi Approach with a bone block substitute and screws can provide excellent or good clinical outcomes with few soft tissue complications. The recommendation for routine use bone graft still needs further evaluation.

Acknowledgements

Nil.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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