



Minimally Invasive Percutaneous Screw Osteosynthesis (Mipso) For Displaced Intra-Articular Calcaneal Fractures

KEYWORDS

calcaneus, intra-articular fractures, minimally invasive, percutaneous fixation, wound complication.

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ABSTRACT *Introduction: Minimally invasive treatment of calcaneal fractures intends to reduce soft tissue complications. We evaluated time to union, function and complications in intraarticular calcaneal fractures treated with percutaneous screw fixation.*

Methods: This is a retrospective review of 27 calcaneal fractures in 25 patients who were treated with Minimally Invasive Percutaneous Screw Osteosynthesis (MIPSO) from January 2012 to January 2014. All patients had a closed reduction under radiographic control followed by percutaneous screw fixation.

Results: All of the 27 calcaneal fractures in 25 patients, all were available for follow up. We did not observe any wound complications or deep infections. There was one case with superficial wound infection that resolved with oral antibiotics. At the end of one year follow-up, the average AOFAS score was 96. One patient required screw removal after 5 months because of impingement.

Conclusion: MIPSO is a reasonable alternative to displaced, intra-articular calcaneal fractures.

Introduction:

The fracture of the calcaneum and its complications are very disabling. The intraarticular fractures, which constitute 75% of calcaneal fractures, increase the morbidity of the injury due to the articular surface injury in addition to severe soft tissue trauma. The mechanism of injury is almost always fall from height and especially young males are affected. The axial load that causes a displaced intra-articular calcaneal fracture leads to crushing and shearing injury of the bone. The problems caused by this include intra-articular incongruity with the development of arthritis of the subtalar and/or calcaneocuboid joint. In many cases the lateral wall blowout leads to peroneal tendon impingement and/or calcaneofibular impingement. The heel alignment goes into varus and the heel is widened due to the lateral bulge. Shorter heel height leads to the malleoli being close to the ground reducing the ground clearance. [1, 2] The ankle dorsiflexion also reduces due to a relatively dorsiflexed position of the talus within the crushed calcaneus. The elevated achilles tendon insertion leads to weakening of the gastrocnemius-soleus complex. Shortened calcaneus results in a decreased lever arm upon which the gastrocnemius-soleus complex cannot work efficiently. Thus, non-operative management if administered

to intraarticular calcaneal fractures results in multiple structural abnormalities leading to complications.[3]

The treatment options therefore, till now, are almost always open reduction and internal fixation using the principles of intrarticular fracture treatment namely articular surface reduction followed by buttress or raft screws using wide exposure, plate fixation and sometimes bone graft/ bone graft substitutes.[4,5] This treatment has its own complications, if operated before associated soft tissue injury reduces, like deep infection, flap necrosis and wound dehiscence with exposed implants. This can also lead to calcaneal osteomyelitis. Wound complications are so disastrous as to discourage surgeons from opening fractures which need reduction and fixation. Awaiting soft tissue homeostasis may lead to non operative treatment in certain cases and hence leading to painful malunions with associated comorbidities.[6,7] A recently published randomized controlled trial has shown that the risks of complications was higher after surgical treatment.[8]

Considering the risks of open reduction a middle pathway in the form of minimally invasive percutaneous screw osteosynthesis using C arm image guidance can be used. It

involves only few stab incisions causing minimal soft tissue trauma thus avoiding the complications associated with plating but addresses the joint line restoration and maintaining the reduction with multiple cancellous screws and the heel length and width by another set of screws.

We report results using minimally invasive screw osteosynthesis for displaced, intraarticular calcaneal fractures. Our aim was to determine the time to union, rate of complications and to determine the functional outcomes.

Materials and Method:

After obtaining ethics committee approval, a retrospective review of 25 patients who had MIPSO for displaced intra-articular fracture of calcaneus between January 2012 and January 2014 was done. Two patients had bilateral fracture of the calcaneum so we had 27 calcaneum fractures.

All intra-articular fractures of the calcaneum were included in the study excluding severe comminuted (Sanders IV) fractures. Open fractures were excluded.

Pre-operatively all patients had a CT scan in addition to the standard lateral and axial radiographs of the calcaneum. In addition, antero-posterior view of the foot and the ankle were done to exclude associated fractures. The Broden's view was taken intra operatively to assess the reduction of posterior facet of calcaneus and the posterior subtalar joint.

Clinical outcomes including length of hospital stay, complications, ability to return to work, and AOFAS hindfoot score were noted in each case.

On admission all patients were treated in below knee slab and leg elevation. The average duration from admission to surgery was 7 days (range 3 to 10 days). We did wait for atleast two days for the edema to settle in every case but were not particularly worried as we were not going to open the lateral side and raise a flap.

Operative Technique:

All patients were operated under spinal anaesthesia. Single-dose antibiotic prophylaxis (Cefuroxime) was administered in the operation theatre before starting the surgery.

Patient was placed in lateral position with the fractured leg extended on a pillow and the other leg flexed 90 degrees below it. The C arm was at the foot end so as to have a lateral and axial view of the calcaneus intra-operatively. A tourniquet was applied to the thigh but was not inflated in any of the cases. It was minimally invasive surgery through small incisions and blood loss was not anticipated hence tourniquet was not inflated. The initial incision was done 5 mm anterior to the tendo Achilles insertion on the calcaneus on the lateral side with an 11 no blade. A Steinmann pin was passed from the calcaneal tuberosity under C arm image guidance below the depressed fracture fragment and levered down to elevate it in case of joint depression fractures. In case of tongue type fractures, an Essex-Lopresti type manipulation with Steinmann pin was done. Reduction was confirmed on axial view and maintained with a 2 mm K wire passed from lateral wall of calcaneum to the sustentacular tali fragment. After confirmation of reduction, a 6.5mm cannulated cancellous screw was passed from lateral to medial side close to the articular surface of the posterior facet of calcaneum to support the elevated fragment. If needed another 4mm cannulated cancellous screw was added. The Steinman pin was removed during the

screw insertion and a 6.5mm cannulated cancellous screw with washer was passed from the calcaneal tuberosity to the inferior and central part of calcaneum to maintain the length and further support the reduction and fill the void created due to fragment elevation until fracture healing. In patients with excessive heel widening, a bone

compress the primary fracture, and the fracture was subsequently fixed with one to two transverse cannulated screws. This screw can only be effective in compressing if there is no comminution of the lateral wall. Care was to be taken not to include the peroneal tendons in the lateral incision and the sural nerve in the anterolateral incision. In few cases, for impacted fragments, another Denhman pin was inserted in the calcaneal posteriorly, from lateral to medial and pulled posteroinferiorly for disimpaction. This pin also helps to control the heel varus/valgus. In two cases a thick 3mm K wire was used from lateral wall in addition to elevate the depressed fragment.

Post-operative protocol: None of the patients were given a plaster slab. We used a bulky dressing using gamgee roll and crepe bandage for all patients. Active range of movement exercises of the ankle and foot were commenced on post-operative Day 1. Patients were mobilised non weight bearing on walker/crutches. Patient with unilateral calcaneal fractures without any spine injury were mobilized as soon as tolerated. Two patients with bilateral calcaneal fractures were ambulated after 2.5 months. Patients with associated spine fracture were mobilized as tolerated with a spinal brace as advised by spine surgeon. Full weight-bearing walking was initiated at 8-12 weeks depending on the progress of bone healing. Patients had first follow-up at 2 weeks for wound assessment; second follow-up at 8 weeks for plain radiographic evaluation of fracture healing and to see if weight-bearing walking could be initiated; and subsequent follow-ups at 3 months, 6 months, and 1 year. Radiographic parameters used to assess bony union were trabecular continuity across the fracture site, congruity of the articular surface in axial and lateral views and, Gissane and Bohler's angles of the calcaneum.

Results:

There were 27 calcaneal fractures in 25 patients. All patients were available for follow-up. The average age of the patients was 29 years, ranging from 18 years to 52 years. All patients were males. Mechanism of injury was fall from height in 20 patients and road traffic accidents in 5 patients. Three patients had associated lumbar spine fracture of which one needed fixation and remaining were treated non-operatively.

Bone grafting was done in any of the cases and none required open reduction because of unacceptable reduction. The average length of stay was 8 days (ranging from 3 days to 13 days). At the final follow up bony union was present in all 27 fractures. The average length of follow up was one year. There were no cases of deep infection. One patient had superficial wound infection that settled after oral antibiotics. There were no wound or skin problems. One patient had pain in the tendo Achilles insertion area due to impingement from screw washer which needed removal at 5 months. There were no neurovascular complications. Ankle and subtalar movements were evaluated using the McMaster technique with comparison to the opposite limb. We used the American Orthopaedic Foot and Ankle Society (AOFAS) ankle hindfoot scale to quantify functional outcome. This score assigns a maximum of 40 points for

pain, 45 for function, and 15 for alignment resulting in a maximum of 100 points. The average AOAFS score was 96/100. Of the 25 calcaneal fractures, 21 patients had excellent scores and function. One patient having screw impingement had a poor score at 3 months of 67/100. After screw removal at 5 months eventually his score and function increased to 87/100. Five patients had occasional pain initially and the scores were 90/100 but at end of one year the scores improved and they were painless. At the end of one year follow up none of the 27 patients requires a walking aid or corrective shoes.



Figure 1: Preoperative lateral radiograph showing displaced intra-articular calcaneal fracture



Figure 2: Pre-operative axial radiograph showing varus position



Figure 3: Intra-operative clinical photograph showing a stab incision for screw placement



Figure 4: Intra-operative lateral view showing restoration of subtalar joint



Figure 5: Intra-operative axial view showing restoration of normal anatomy



Figure 6: Radiographs at followup showing healed fracture with restoration of articular congruity



Figure 7: Axial radiograph at follow-up showing healed fracture

Discussion:

Although there is no consensus on the best treatment for calcaneal fractures, in general, it is well accepted that treatment should aim at anatomical restoration of the joint articular surface, width, height and length of the heel to achieve functional recovery. There is evidence from previous studies by Tornetta in 2000, Zwipp in 1993 and Sanders in 2000, that restoration of joint congruity, shape can translate into higher functional score [2,6,9]. The balance between the percentage of anatomical reduction and the amount of soft tissue damage should be carefully weighted in the management of fracture calcaneus especially the severely comminuted types. The choice lies between trail of full reduction with extensive soft tissue damage or reasonable reduction with minimal soft tissue insult. Diabetics, smokers, patients with vascular impairment, compound fractures or fractures with extensive blisters and persistent swelling are not the best choice of extensile open reduction [1,2,10]. Moreover, the extensile approach should be carried only when swelling subsides.

Various percutaneous modalities have been used in the treatment of calcaneal fractures. [11-15] These modalities include, use of smooth or threaded wires, screws, external fixator systems.

In a study by Rammelt et al. arthroscopy assisted percutaneous screw fixation was carried out for less severe intra-articular fractures of the calcaneum. Authors found that imaging modality or arthroscopy can help in ascertaining adequacy of articular congruity [13].

In a prospective, randomised study comparing minimally invasive screw fixation versus open surgery, 30% patients had wound healing problems compared to 0% in the minimally invasive group. Time to return to work was earlier in the minimally invasive group so were the functional scores [15].

In a systematic review of clinical outcomes following percutaneous fixation techniques it was found that the complication rates were lower than the open procedures. However the article sites lack of statistical power and lack of uniformity in documentation in the existing literature and hence superiority of one treatment over the other cannot be determined. [12] Stulik et al in their large series of 287 displaced intra-articular calcaneal fractures reported 86.2% satisfactory result using mini invasive technique [16]. Tornetta in his series of 41 patients treated with percutaneous fixation for tongue type fractures used Kwires and protruding Steinmann pins. These are prone to superficial pin track infections. [2] Percutaneous mini open approaches (sinus tarsi approach) are now been used to access the reduction and slide the plate to reduce the soft tissue trauma and yet have the advantage of being able to see the reduction. [17]

Fixation by screws allows early mobilisation and avoids prolonged bracing. Percutaneous method reduces scarring and hastens the recovery of the injured limb. It also obviates the need for any bone grafting procedures and its associated co-morbidities. This operative technique is soft tissue friendly and allows the patient to be operated early. Early surgery helps in better elevation and mobilization of the displaced fracture fragments.

The hospital stay is short with early return to normal life and so is the cost of the surgery. Lack of protruding pins and wires explained the low infection rate in this series.

Percutaneous nature of the surgery reduced the post operative scarring and hence reduced the chances of subtalar stiffness and peroneal tendon impingement. In our study we did not encounter any complications except for one case of superficial infection and one case of hardware prominence which required its removal. There are some potential disadvantages with this closed percutaneous technique like indirect reduction of subtalar joint with the image intensifier which may not result in an exact anatomic reduction. Also percutaneous screw fixation is less rigid than plate osteosynthesis. Thought in this case series, at one year follow up, there were no cases with loss of reduction, there is always a possibility of loss of Bohlers angle with a late collapse. In this series patients similar to patients with open reduction and internal fixation, are not allowed to bear weight for 8 to 12 weeks but are free to do ankle and subtalar movements from post operative day 1. Our study has certain limitations such as small sample size, retrospective nature and lack of control group.

Conclusions:

Results of our study show that for the treatment of displaced intra-articular calcaneal fractures minimally invasive screw osteosynthesis remains a viable option. Use of minimally invasive approach reduces the wound healing problems and yields good functional outcomes.

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