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Research Paper

Evaluation of Results of Displaced Calcaneal Fractures by Open Reduction and Internal Fixation by Calcaneal Plate Fixation (Sinus Tarsi Approach).

Medical Science

KEYWORDS : Intraarticular calcaneal fractures, sinus tarsi approach, Sanders classification.

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ABSTRACT

Background: The operative treatment of displaced intraarticular calcaneal fractures has been a controversial topic. Soft tissue conditions and concomitant disease must be considered in these patients. The minimally invasive sinus tarsi approach is a valid therapeutic solution that guarantees stability, anatomic reduction of the fracture and soft tissue preservation. Objectives: the foremost objectives in such cases are to restore the congruity of the posterior facet and the subtalar joint, to restore the height of the calcaneus, to re-establish the integrity of calcaneocuboid joint and to avoid any deformity. Material and Methods: Twenty closed calcaneal fractures in 20 patients were treated with open reduction and internal fixation using the sinus tarsi approach (including fixation with cannulated screws). All fractures healed by the time of final follow-up at 12 months. Results: The time to union judged both clinically and radiographically, averaged 3 months. Mean Maryland foot scores were: 95 in type II; 91 in type III; and 83 in type IV fractures. Conclusion: Advantages offered by this new approach include a less invasive incision while still permitting good visualization and anatomic reduction of articular surfaces and with few complications.

Introduction:

Fractures of calcaneum make up a large proportion of major fractures of the tarsal bones and have repeatedly been shown to be associated with significant and prolonged disability. Intraarticular calcaneum fractures of calcaneum comprise 60% of all tarsal injuries and 75% of all calcaneal fractures. Displaced intraarticular fractures involving the posterior articular facet, (i.e., the subtalar joint) account for the majority of these fractures. These fractures are uniformly caused by an axial load mechanism such as a fall from height or a motor vehicle accident and may be associated with other axial load injuries, such as lumbar, pelvic and tibial plateau fractures[1].

There has historically been debate over the best approach for treating these fractures.[2-5] The goal of operative treatment of calcaneal fractures is to obtain the best possible reduction of the articular surfaces and restoration of the architecture of the non-articular portions of the bone, and to hold this reduction with stable internal fixation.[6,7] These goals must be balanced with the need to minimize the operative risks, especially the risk of wound healing complications. Operative and non-operative management have both been suggested for the acute treatment of calcaneal fractures, however it is generally accepted that in most cases operative treatment of displaced calcaneal fractures is warranted in order to avoid the negative consequences of malunion.[3,7]

Operative management can consist of reduction through an extensile open incision, limited incision or percutaneous techniques. Both lateral and medial approaches have been described, but the lateral approach allows direct exposure of the articular surface, while the medial approach is limited to reduction of the body. Various internal fixation techniques have been described, but a laterally based plate is commonly accepted to give the most rigid fixation.[8,9] Since displaced calcaneus fractures present with various degrees of comminution and soft tissue trauma, it is advantageous for the calcaneal fracture surgeon to have a variety of methods of treatment to balance minimizing risks of wound complications against obtaining the best reduction possible.[10]

The most common treatment has been open reduction and internal fixation via a lateral extensile approach, but this technique is not without complications. The most frequently used minimally invasive technique for the tongue type fracture was proposed by Westhues in 1935, modified by Gissane, and propagated by Essex-Lopresti.[2] We have used a minimally invasive technique that permits us to treat complex fractures, thereby decreasing complication rates.

Aims and objectives:

The primary objectives in such cases are to restore the congruity of the posterior facet and the subtalar joint, to restore the height of the calcaneus (Bohler's angle), to re-establish the integrity of calcaneocuboid joint, to decompress retro-peroneal space and to avoid varus or valgus deformity.

Material and methods:

This was a prospective study conducted between July 2013 and June 2014, on patients presenting to the outpatient or emergency department of our institution ie. Shri Guru Ram Rai Institute of Medical and Health Sciences (SGRRIM &HS), Dehradun with displaced intra articular fractures of the calcaneum. Patients of either sex between the ages of 15-60-years with closed, displaced intraarticular fractures of the calcaneum were included in the study. Patients with open fracture of the calcaneum, other fractures of ipsilateral on contralateral limb, and/or other conditions that might affect their gait (paraplegia, quadriplegia, cerebrovascular accidents) were excluded from the study. Following application of inclusion and exclusion criteria 20 patients (22 calcaneal fractures) were included in the study. Preoperative assessment included radiographs (lateral, axial and Broden's view)

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of both ankles and computed tomography (CT) imaging of the affected ankle.

Fractures were subdivided based on Sander's classification. After preoperative assessment, patients underwent operative procedures within 5 days; in case of excessive swelling, surgery was delayed for 10-14 days in order to allow soft tissue swelling to resolve. In such cases, the foot was placed in a posterior plaster splint and the limb was elevated. Surgery was undertaken after the oedema had settled completely and the wrinkle sign appeared.

Surgical technique

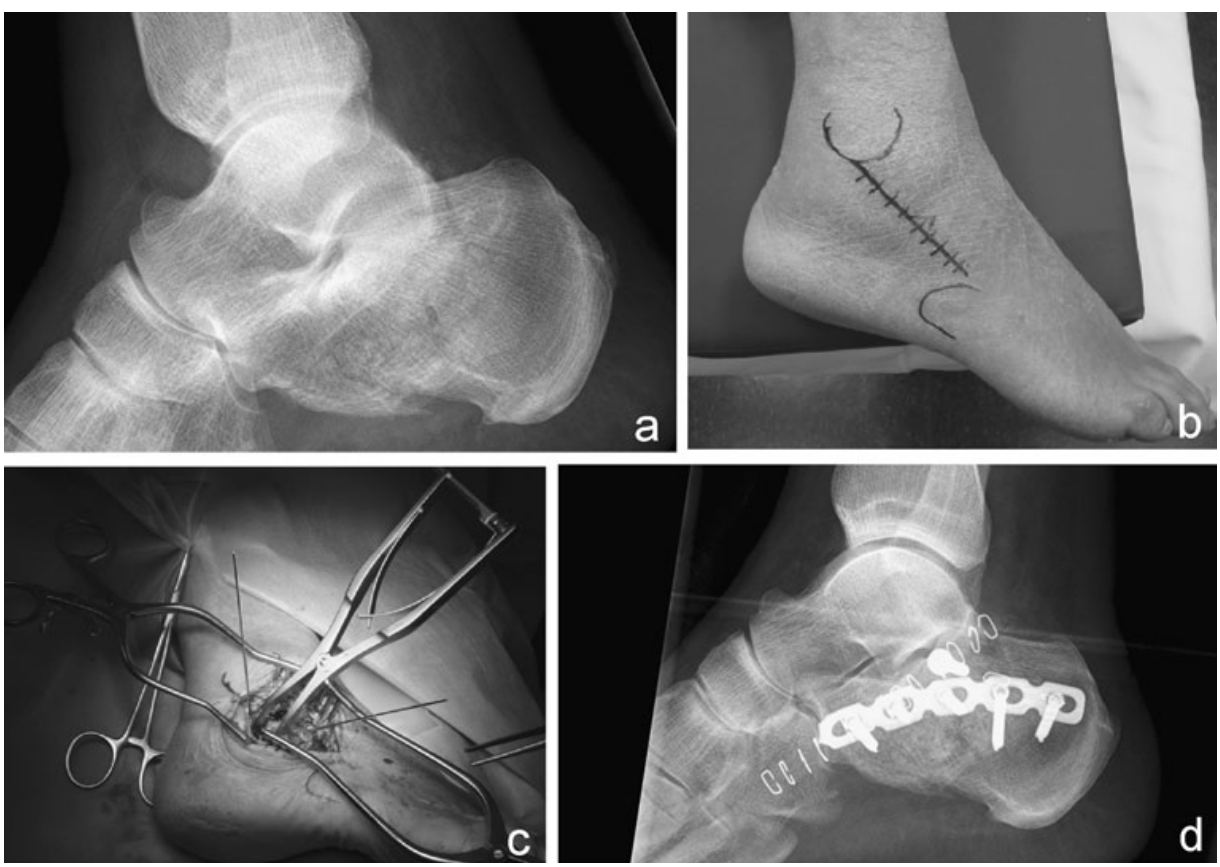
Surgery was performed with tourniquet with surgical time varying from 40 to 90 min; all patients were treated with cefoperazone plus sulbactum for antibiotic prophylaxis. Using the image intensifier and with the patient in lateral position, the fracture was visualized both in lateral and axial view. One Steinmann pin was inserted in the calcaneal tuberosity from the lateral side and then traction toward the bottom was applied to correct the calcaneal valgus. Subsequently, an italic S incision was executed at the sinus tarsi, anteriorly to the lateral malleolus and continued until the calcaneocuboid joint was visible. The posterior facet was reduced using a curved periosteal elevator, which permits elevation from the calcaneal body. Fixation was obtained using 4 mm cannulated screws. The reduction was temporarily stabilized with a K wire and then checked with the intensifier. The anterior facet was reduced and stabilized with 4 mm cannulated screws, and reduction of the medial wall was obtained with a curved periosteal elevator introduced in the sinus tarsi. The sustentaculum tali was reduced with two 4 mm cannulated screws positioned from lateral to medial. Lastly, percutaneous fixation of cannulated screws through the posterior tuberosity directed toward the calcaneocuboid joint was performed with screw lengths 60–70 mm in size.

The wound was irrigated with normal saline and closed in layers. A below knee Plaster of Paris (POP) slab was applied for 2 weeks. Non-weight bearing ambulation was started on the 3rd postoperative day. Sutures were removed at 2 weeks and a new below knee POP cast was applied for an additional 6 weeks. The cast was then removed and ankle physiotherapy was started. Weight bearing was started at 10-12 weeks postoperatively. All patients were followed at

6weeks, 12 weeks, 18 weeks, 24 weeks and then at 3-month intervals up to the final visit.

Figure 1: Displaced intra-articular calcaneal fracture treated via sinus tarsi approach.

- Pre-operative radiograph with Böhler angle of 7.5°.
- Skin marking of sinus tarsi incision.
- Per-operative view with lamina spreader and provisional K-wire fixation.
- Post-operative radiograph with Böhler angle of 22.5°.



Results:

Twenty displaced intraarticular calcaneal fractures in 20 patients were included in the study, 15 patients had unilateral fracture whereas 5 patients had bilateral fracture. 12 patients were male and 08 were females. In 13 patients (85%), the mechanism of injury was fall from height, whereas in 07 patients the injury was due to road traffic accident. All fractures were subdivided according to Sander's classification based on CT scan findings

(Figure 1c). 4 fractures were type 2, 15 fractures were type 3 and one was type 4. Average time delay from injury to surgery was 11 days (range, 4- 14 days). Mean follow up was 12 months (range 6 – 18 months). All fractures healed without any major complication. Time to union, judged both clinically and radiologically, averaged 3 months (range, 2-4 months). Surgery succeeded in restoring various parameters such as Bohler's angle, the angle of Gissane, as well as the height and width of the calcaneum to near normal. Preoperatively, the mean Bohler's angle and angle of Gissane were 5.13° (range, 2° -18°) and 113.57° (range, 95°- 135°) respectively, which improved postoperatively to 20.47° (range, 14° -35°) and 104.95° (range, 95° - 115°).

The mean preoperative calcaneal height was 39.15mm, which improved to 41.15mm postoperatively; the mean preoperative calcaneal width was 37.46mm, which improved to 35.42mm postoperatively.

There were no cases of infection, hardware failure, wound dehiscence or other soft tissue complications. Patients were evaluated using the Maryland foot score - the mean score was 95 in type 2 fractures, 91 in type 3 fractures and 83 in type 4 fractures.

Discussion:

Surgical treatment is the only viable possibility for comminuted extraarticular or intraarticular fractures. Complication rates vary from 10–20%, and include wound dehiscence (14% of cases), deep infection (incidence range, 1.3–8.5%), peroneal tendinitis (incidence, 4%), tarsal tunnel syndrome (incidence, 2%) or compartmental syndrome (incidence, 2%) [11]. Once the fracture is classified and the soft tissue condition is evaluated, appropriate treatment must be considered; possibilities include reduction and stabilization with plate and screws or screws alone, primary arthrodesis, or conservative treatment. Surgical results are dependent upon the timing of surgery; according to Sanders, the correct timing is between 7 and 10 days from 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.

Several surgical techniques have been described [12,13,14]. Medial access permits direct reduction of the body of the sustentaculum tali but not of the posterior facet or the anterolateral fragment; lateral access permits allows direct operative access to the posterior facet and the anterolateral fragment and indirectly to the body of the sustentaculum tali. Combined medial and lateral access enables perfect visualization of the fracture but there is a risk of compromising vascularity; extended lateral access enables avoidance of damage to peroneal tendons and the sural nerve.[15] These treatments enable good results in 50–70% of the cases, but they are burdened by significant complication rates. Minimally invasive treatment of calcaneal fractures was introduced by Westhues[16] in 1934 and allows for percutaneous traction with a K wire introduced in the calcaneal tuberosity and maintenance in a plaster cast. Mini-open techniques are generally used in patients in critical condition (polytraumatised) and in patients in whom open reduction and internal fixation (ORIF) would be contraindicated, as in elderly patients, smokers, and those with decompensated diabetes, immunodeficiency or soft tissue injuries[17,18]. In such cases, these techniques have been shown to be valid and have satisfactory results. Less invasive fixation has the advantage of correcting the alignment of the posterior part of the foot and the articular congruity as well as with classic fixation, but with less damage to soft tissue, thereby decreasing the risks of complications. This fixation is executed with percutaneous cannulated screws, as first described by Essex-Lopresti[19]. Other treatments using external fixation with the Ilizarov technique have been described but are reserved for complex fractures or severely compromised patients.

The minimally invasive technique through a sinus tarsi approach permits rebuilding of the articular surface of the anterior and posterior facet, resulting in decreased risk of infection or hardware failure. With a technique similar to ours, Holmes used an incision from the apex of the peroneal malleolus to the base of the fourth metatarsal, thus allowing access to the sinus tarsi, the subtalar joint and visualization of joint facets. A second mini-incision is executed anteriorly to the calcaneal tuberosity and posteriorly to peroneal tendons on the lateral side. Ebraheim *et al.*[15] reported a technique using small incisions at the sinus tarsi to visualize and reduce the fracture of the posterior facet and of the anterolateral fragment. The tuberosity is then reduced with a Steinmann pin at the primary fracture line. These authors suggest that this type of incision is advantageous because it also allows the surgeon to perform subtalar arthrodesis from the same approach if necessary. Similar to the Holmes report, we have never had any infection using the sinus tarsi technique; Ebraheim reports some experience with infection using this technique. The functional results presented in this study are similar to those reported for open reduction and internal fixation (ORIF) groups in the literature, but appear to be better than those for conservatively treated patients[10,11,12,19]. This study confirms that the function of the calcaneus and subtalar joint can be restored by percutaneous reduction and fixation in patients with a displaced intraarticular calcaneal fracture. The good outcome scores and the preservation of the subtalar range of motion at 3-year follow-up with the minimally invasive procedure indicate little benefit of open procedures, over percutaneous reduction and fixation.

Conclusion:

Sinus tarsi approach is a less invasive method for fixation of calcaneal fractures. It permits good visualization of the fracture, and allows anatomic reduction of articular surfaces and can also be used to perform subtalar arthrodesis when necessary. This is a valid option of treatment for displaced intra-articular calcaneal fractures in young active adults.

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