Foot and Ankle Surgery 21 (2015) 182–186

Contents lists available at ScienceDirect

Foot and Ankle Surgery

journal homepage: www.elsevier.com/locate/fas

Open surgical management of high energy ipsilateral fractures of the fibula and calcaneus

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A R T I C L E I N F O

Article history:
Received 13 October 2014
Received in revised form 15 November 2014
Accepted 22 November 2014

Keywords:
Fibula
Calcaneus
Peroneal artery
Angiosomes

A B S T R A C T

Background: Simultaneous ipsilateral fractures of the calcaneus and fibula are the result of high-energy injuries. Open surgical treatment of both fractures can be performed with incisions based on the described blood supply of the lower extremity.
Methods: A retrospective review for all patients with ipsilateral fractures of the calcaneus and fibula was performed over an eight-year period. Thirty-eight patients were identified. Eleven patients (28.9%) were treated with open reduction and internal fixation through two separate incisions. Average follow-up was 48.8 weeks.
Results: Two patients (18.1%) required a secondary procedure. Three patients (27.2%) developed incisional cellulitis that resolved with oral antibiotics and one patient required local wound care. All fractures united.
Conclusions: Ipsilateral fractures of the calcaneus and fibula require open reduction and internal fixation when closed or percutaneous treatment is not appropriate. We describe an operative approach based on the angiosomes of the lower extremity that allows for treatment of these complex injuries and report the associated complications.

1. Introduction

Concurrent ipsilateral fractures of the calcaneus and distal fibula occur infrequently and are the result of high-energy injuries. Associated fractures of the medial malleolus, tibial diaphysis or plafond can also be present [1]. Lower extremity soft tissue is severely traumatized following injury and frequently dictates fracture management. Soft-tissue complications have been associated with isolated fractures of the calcaneus, ankle and tibia [2–5]. The simultaneous presence of these injuries is uncommon, places the patient at increased risk of complication following management and is a clinical challenge.

In the setting of complex lower extremity trauma, restoration of limb length, alignment and rotation is essential to soft tissue management. Minimally invasive or percutaneous techniques are utilized for some fractures, when appropriate [6–8]. In some instances, displaced calcaneal and fibular fractures require open operative reduction and stabilization. Successful management requires an understanding of the ankle and hindfoot vascular anatomy. This allows for well-planned operative incisions that provide adequate operative access and do not devascularize skin and soft tissue bridges between incisions.

The purpose of this study is to provide a strategy for the staged management of patients with concurrent displaced calcaneal and fibular injuries. We present an operative approach focused on preservation of the peroneal artery and vascular anastomosis of the lower extremity. Multiple incisions for fixation of the fibula, calcaneus, and tibia can be safely performed, if necessary, for operative fixation. In addition, we describe the use of provisional external fixation in these injuries to provide temporary limb stability and soft tissue protection. We have utilized this approach successfully in the management of patients with these rare but severe injuries.

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http://dx.doi.org/10.1016/j.fas.2014.11.006
1268-7731/

2. Materials and methods

This study was performed with the approval of the Institutional Review Board. A retrospective review of a prospectively collected orthopedic trauma database at a single Level I academic institution was performed over an eight-year period between 2001 and 2008. Trained clinical fellows maintain the database; all fractures are classified by the AO-OTA fracture classification system [9]. A search was performed for all patients who sustained an ipsilateral fracture of the calcaneus (AO-OTA Type 83) as well as fracture of the distal tibia or ankle (AO-OTA Type 43 and 44). Patients were selected for inclusion in our study if they were treated with open reduction and internal fixation of both their calcaneal and fibular fractures. Patients were excluded if calcaneal fixation was not performed through a lateral extensile incision. Patients were also excluded if any component of the lower extremity injury was treated nonoperatively or if fixation of the fibula or calcaneus was performed in a percutaneous or limited open manner.

Patient demographics collected were age, sex and tobacco use. Injury details included mechanism of injury, laterality, AO-OTA fracture type and whether the fracture was open or closed. Operative details including timing of treatment, procedure performed and form of operative fixation was collected. Duration of follow up, complications, fracture union and any additional treatments or secondary procedures were also recorded.

3. Operative technique

Patients were initially evaluated and managed according to Advanced Trauma Life Support protocols. Following stabilization and resuscitation, plain radiographs were used to diagnose skeletal injuries. Initial management of calcaneal fractures associated with a fracture of the fibula and/or tibia, was similar. The limb was realigned and stabilized in a well-padded splint. If an open fracture is present, appropriate antibiotic and tetanus prophylaxis was administered immediately and the patient was taken to the operating room when medically stable for debridement and irrigation. Stabilization of skeletal injuries with internal or external fixation was dictated by the overall condition of the soft tissues. Computed tomographic (CT) scans were obtained of the lower extremity except when a pilon injury was present in which case the study was commonly deferred until after provisional reduction and stabilization. The soft tissues dictated definitive fixation in the stable patient.

Open reduction and internal fixation of the fibula was typically performed first. The patient was positioned supine with a bump under the ipsilateral ischium and prepped and draped using sterile technique. A Doppler was commonly used to identify and mark the course of the peroneal artery (Fig. 1). Using the information from the Doppler examination, a sterile marker was then used to mark the anticipated operative incision for fixation of the fibula, calcaneus and if necessary, pilon. The fibular incision was positioned along the posterior border of the fibula. The lateral extensile calcaneal incision does not overlap the fibular incision (Fig. 2); the interval between the two incisions contained the peroneal artery and its terminal branches. The peroneal artery is the primary blood supply for the lateral calcaneal flap and must be carefully protected [10,11]. Reduction and fixation of the fibula was achieved using minimal soft tissue stripping and without sustained retraction on the skin edges. Our preference for skin closure was the Allgöwer modification of the Donati vertical mattress suture with an unbraided monofilament. If a medial malleolar fracture was present, percutaneous screw placement or open reduction and internal fixation can be performed during the initial procedure.

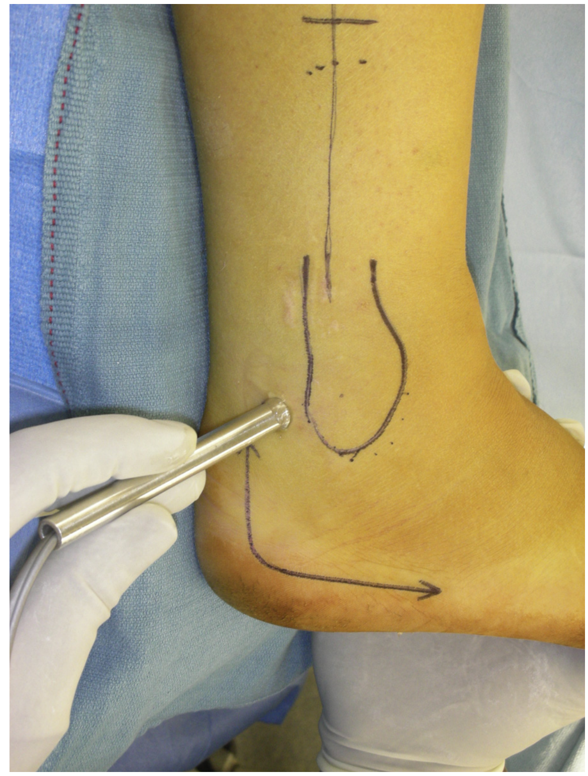

Fig. 1. Clinical photo demonstrating use of sterile doppler to identify course of peroneal artery between intended operative incisions for distal fibula and calcaneus.

If lower extremity axial instability was present or there was significant displacement of the calcaneal fracture, a medially based external fixator could be placed at the time of fibular fixation. A spanning fixator was also considered when the overall medical condition of the patient, or the condition of the soft tissues, could potentially delay definitive operative fixation. In the setting of a calcaneal fracture, the use of a trans-calcaneal pin was avoided, to avoid violating the lateral calcaneal flap and future incision. To do this, a 4.0 or 5.0 mm threaded half-pin was placed from the medial side into the calcaneus. The calcaneal tuberosity is a relatively constant fragment in joint depression calcaneus fractures. In tongue type calcaneal fractures, the medial pin was placed in a more plantar and posterior location. Supplemental reduction and temporary percutaneous fixation techniques were used to protect the posterior skin when needed [12,13]. A second 4.0 mm Schanz pin was placed in the cuneiforms. One or two medially based 5.0 mm Schanz pins were placed in the tibia away from any planned operative incisions or hardware. A triangular frame was then constructed that spans the ankle. Reduction of the talus under the tibial diaphysis in the coronal and sagittal planes was confirmed with biplanar fluoroscopy (Figs. 2 and 3).

If operative fixation of a pilon fracture was required, this was frequently performed in a staged fashion between fibular and calcaneal fixation. The anterolateral or anteromedial approach could be safely used when the condition of the soft tissues allowed. The anterolateral incision was placed just lateral to the peroneus tertius proximally and in line with the fourth metatarsal ray distally. This non-extensile approach could be safely used based on the arterial supply provided by branches of the anterior tibial artery, communicating vessels between the peroneal artery and anterior tibial arteries and the anterior perforating branch of the peroneal artery [10,14,15].

Open reduction and internal fixation of the calcaneus was performed once the condition of the soft tissues and the patient