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Injuries associated with calcaneal fractures—An MRI assessment

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Abstract

Twenty one consecutive isolated calcaneal fractures (mean age 46; range 19–75) were treated by open reduction and internal fixation. In 19 patients, MRI scans were undertaken at (mean) 7.5 weeks to assess the technical aspects of reduction and fixation, and identify associated soft tissue and tarsal injuries. Clinical outcome was assessed with a validated scoring system, and compared with the demonstrable injuries.

Assessment of the intra-articular fracture reduction and screw position was obscured in a proportion of cases and for this reason MRI is not the technique of choice for to assessing the post-operative reduction.

However, MRI did reveal pathology which other imaging could not assess including abscess formation, non-viable bone, osteochondritis and plantar muscle changes. The lateral wall fragment of the calcaneum was found to be viable in all uncomplicated cases.

This study also documented signal changes in the talus in 11 cases (58%) consistent with persisting bone marrow oedema, and in 5 cases (26%) persisting subcutaneous oedema of the heel pad was demonstrated. These findings may indicate a cause for the patients' symptoms in the recovery period; however, they did not correlate with clinical outcome scores at 2 years, and we consider that these lesions are likely to resolve completely.

Keywords: Calcaneal fracture; MRI (magnetic resonance imaging); Talus; Heel pad; Lateral wall

1. Introduction

The management of displaced intra-articular fractures of the calcaneum has historically included conservative and operative approaches, and remains controversial. Open anatomical reduction and internal fixation (ORIF) is gaining acceptance as the treatment of choice.

Pain after fractures of the calcaneum is common and multifactorial. It has been shown to correlate with incongruence and cartilage damage [1,2], causing post-traumatic arthritis of the sub-talar joint [3,4], and reduction of Boehler's angle [3]. A higher incidence of symptoms has been associated with more comminuted fracture patterns [5] and disrupted heel biomechanics. Pain has also been attributed to fibulo-calcaneal impingement [6] and peroneal tendon involvement [2,7,8]. Suggested neurological pain sources include entrapment of branches of the tibial nerve (tarsal tunnel syndrome) [9–12] and reflex sympathetic dystrophy [5]. The soft tissues of the heel pad transmit the force of injury and have also been studied as potential sources of residual pain [13].

Anatomical operative reduction potentially decreases the morbidity from these causes, and pre-operative three-dimensional imaging is mandatory to define the complex fracture anatomy and plan treatment. Post-operative computed tomography has been recommended to confirm reduction and fixation position [14]. In the study centre, we investigated whether magnetic resonance imaging (MRI) could fulfil this goal, whilst offering superior assessment of the soft tissues and bone marrow.

MRI is the investigation of choice in many foot and ankle pathologies. In relation to calcaneal fractures, MR imaging of the ankle has be reported specifically for the assessment of peroneal tendon involvement [6,15,16], collateral ligaments

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[17,18], sural nerve and posterior tibial artery involvement [7,19,20], plantar fasciitis [21,22] and Sudek's atrophy [23]. It has a proven role in other pathologies: post-traumatic osteo-arthritis [6,23], sinus tarsi syndrome [17], and osteochondral lesions [4,24]. Furthermore, the MRI findings of tarsal osteonecrosis [25–28], and osteomyelitis [29,30–32] are well described and it has been proposed for the assessment of osteo-arthritis of adjacent tarsal joints [6].

MRI is superior to CT and plain radiographs for the imaging of subtle bone oedema [17,18], which has not previously been described in the context of intra-articular fractures of the calcaneus.

MRI is limited by degradation of image quality due to susceptibility artefact around surgical metalwork. This can in some circumstances render imaging non-diagnostic. However its effect can be reduced by the use of non-ferrous implants such as titanium.

The objectives of this retrospective study were to

(1) assess the associated injuries around the foot and ankle seen on MRI after operatively treated calcaneal fracture, and correlate them with the clinical outcome;
(2) assess the suitability of MRI in reviewing fracture reduction and the position of titanium metalwork.

2. Materials and methods

Between April 2000 and June 2003, 27 unilateral isolated closed intra-articular fractures of the calcaneum were treated at the study centre (20 male, 7 female, mean age 45, range 7–75). After plain X-ray series and CT scanning, six with minimal displacement were managed conservatively (mean age 40, range 7–68).

Once the soft tissue swelling had settled, the remainder (mean age 46, range 19–75) were treated with ORIF using titanium alloy calcaneal plates and screws (Stratec Medical, Switzerland). One patient was excluded because the use of a stainless steel plate prevented adequate MR imaging. Of the remaining 20, 18 were operated on by the senior author. The mean interval between injury and operation was 11.2 days (range 3–24).

An extended lateral approach described by Atkins and co-workers [33,34] was used to expose the fracture and sub-talar joint. Prior to closure, the peroneal tendons were checked for entrapment. Routine postoperative care included elevation and early active movements from 48 h post-operatively. Patients were non-weight bearing for 8 weeks and had routine follow up for 2 years.

A MRI scan was performed around the time of return to full weight bearing in 19 patients (mean 7.5 weeks post-operatively), in order to assess the intra-articular reduction, reduction of the height and width of the calcaneum, position of metalwork, bone viability, signal changes in the adjacent soft tissues and adjacent tarsal bones.

MRI was undertaken on a 1.5 T Phillips Intera MR, using T1 and STIR sequences in the sagittal and coronal planes. Slice thickness was 3 mm sagittally and 4 mm coronally using a 15 cm field of view. In one case, due to the concern about infection, gadolinium DTPA was administered intravenously. MR scans were assessed in raw data form by a single consultant musculo-skeletal radiologist (PC).

Between October and December 2003 (F/U 23.5 months), 19 of the 21 patients completed a Kerr and Atkins calcaneal fracture questionnaire [35] by telephone. Patient's total score and combined pain score were separately plotted against the quantifiable radiological features to assess the prognostic value of the MRI findings.

3. Results

Despite the short post-injury interval, the quality of MR images in this series was acceptable for assessment of both bone anatomy and soft tissue injury.

3.1. Talus

Evidence of bone oedema of the talar body and neck was found in 11 patients (58%): in 9 cases sagittal section of the

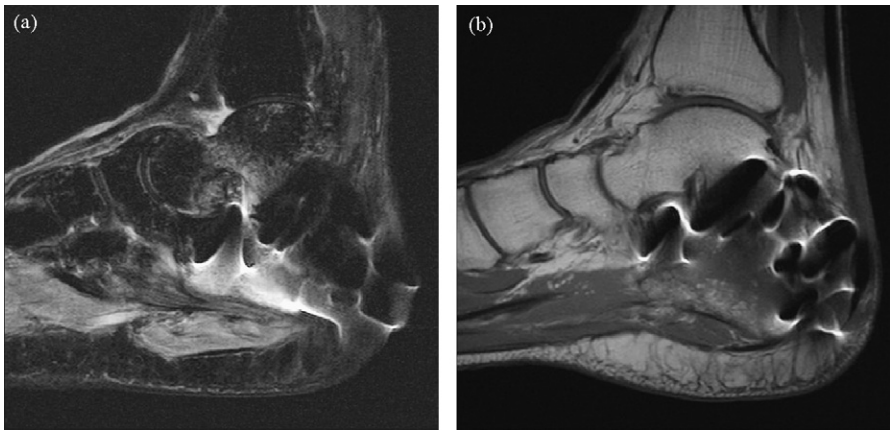

Fig. 1. Increased signal of talar neck on STIR (a), while T1 remains normal (b). Consistent with bone oedema.