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Technical note

External fixation of the thalamic portion of a fractured calcaneus: A new surgical technique



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ABSTRACT

The optimal treatment for intra-articular calcaneus fractures remains controversial, despite internal fixation techniques providing good results. The major point of contention is the need to reconstruct the overall morphology *versus* to restore the anatomy of the subtalar joint perfectly. We will describe a two-stage technique for treating intra-articular calcaneus fractures in which the primary fracture line goes through the thalamic fragment. The first procedure focuses on the overall morphology by restoring the height and length with osteotaxis being accomplished with a medial external fixator. The second procedure consists of internal fixation through a minimally invasive lateral approach to restore the anatomy of the articular facets. Any defects are filled with injectable bone substitute. This novel technique is compared to the complication rates and radiology and anatomy outcomes in published studies. This two-stage surgical technique reduces the length of hospital stays and the number of complications.

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1. Introduction

When treating intra-articular calcaneal fractures, the intra-articular surface of the thalamic fragment and the bone morphology must be restored, preferably using dedicated internal fixation [1–3]. The congruence of the subtalar joint must be restored [2], as does the overall shape of the calcaneus to ensure good outcomes [4]. These dual treatment objectives are difficult to achieve because of surgery-related complications [5–8]. The spatial and morphological reduction of calcaneus length, height and width can be performed immediately by applying the principles of ligamentotaxis and osteotaxis [5,9]. The shape of the posterior talar articular facet of the calcaneus can be restored in a later, minimally-invasive procedure.

We have developed a two-stage surgical technique to treat intra-articular calcaneal fractures. In the first phase, the calcaneus is reduced in an emergency setting. In the second phase, secondary fixation of the posterior talar articular facet of the calcaneus is performed. This treatment concept is consistent with the damage control approach used when treating complex fractures in the arms and legs.

2. Surgical technique

The first surgical stage is performed on an emergency basis using ligamentotaxis and osteotaxis principles with a Hoffmann external fixation system (Stryker, Lyon, France). Two 4-mm diameter pins are inserted into the calcaneal tuberosity based on information from the preoperative CT scan (Fig. 1). These parallel pins are placed in the most posterior part of the tuberosity in a non-fractured area and are always located behind the depressed thalamic fragment. If the posterior part of this tuberosity is massively comminuted, the pins cannot be implanted reliably. They are inserted inside-out and perpendicular to the major longitudinal axis of the calcaneus, while making sure to avoid the inferior calcaneal nerve [10]. The plane is selected based on the separation line between the calcaneal tuberosity and thalamic fragment. It must allow for complete visualisation of the subtalar joint in lateral X-rays after the fixator rods and clamps have been inserted. The rear foot varus can be corrected and the calcaneal height and length restored by moving the pin-jaw unit. Two other 4-mm pins are inserted into the anteromedial side of the tibia along the long axis of the bone. The last two 3-mm pins are implanted in an anteromedial position in the distal metaphysis region of the first metatarsal along the major axis of the bone. The jaws are joined together to create a triangular construct on the medial side of the foot (Fig. 2). Osteotaxis principles are applied to restore the height, length and valgus of

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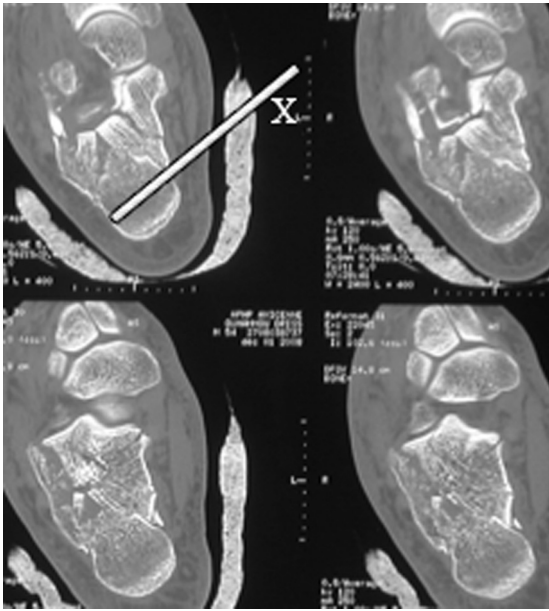


Fig. 1. Immediate pre-operative CT scan with fracture classification; this case is a Sanders type III AC fracture. (X): projection of the position of the fixator pins to allow for distraction without interfering with the secondary procedure at the subtalar joint.

the calcaneus, which are verified by fluoroscopy. The surgeon must be careful not to over-correct into valgus. This surgical procedure must be performed on an emergency basis, while the fragments can still be moved. The sole goal of this surgical phase is to move the

entirety of the calcaneus around the thalamic fragment. Intramuscular pressures are systematically measured with a suitable device (CompassTM, Eaubonne, France).

X-rays (Fig. 3) and a new CT scan are performed to determine if another surgery will be needed to raise and fix the thalamic fragment. The Sanders classification is used for this purpose [11]. If an articular step-off remains, a second surgical procedure through a lateral approach is indicated. The second stage can be performed fairly soon after the first one (2–3 days) because unfolding the soft tissues and restoring the overall morphology of the calcaneus through osteotaxis allow the oedema to resolve.

By placing the external fixator completely on the medial side, the lateral side of the calcaneus is freed up for additional fixation. An extensive surgical approach is not necessary. Instead, a small lateral incision is made under fluoroscopy guidance that provides access to the thalamic region. With simple fractures (Sanders type II), anatomical percutaneous reduction is performed and any defects filled with injectable bone substitute (Fig. 4). With type III fractures, the subtalar joint is opened to reconstruct the thalamic surface of the calcaneus and stabilize the fragment with a transverse screw. With type IV fractures, this additional surgical procedure is only performed if the fragment is large enough to be fixed.

The external fixator is left in place for two months. Weight bearing is not allowed during this period and movement is only allowed in the toes. Once the fixator has been removed, gradual weight bearing is allowed over a 30-day period, along with active rehabilitation of joints in the feet.

Later on after bone union, if there is persistent pain because of post-traumatic degradation of the subtalar joint, fusion can be easily performed because the calcaneus is in the correct anatomical position. Subtalar joint fusion has been shown to provide good outcomes [2,8].

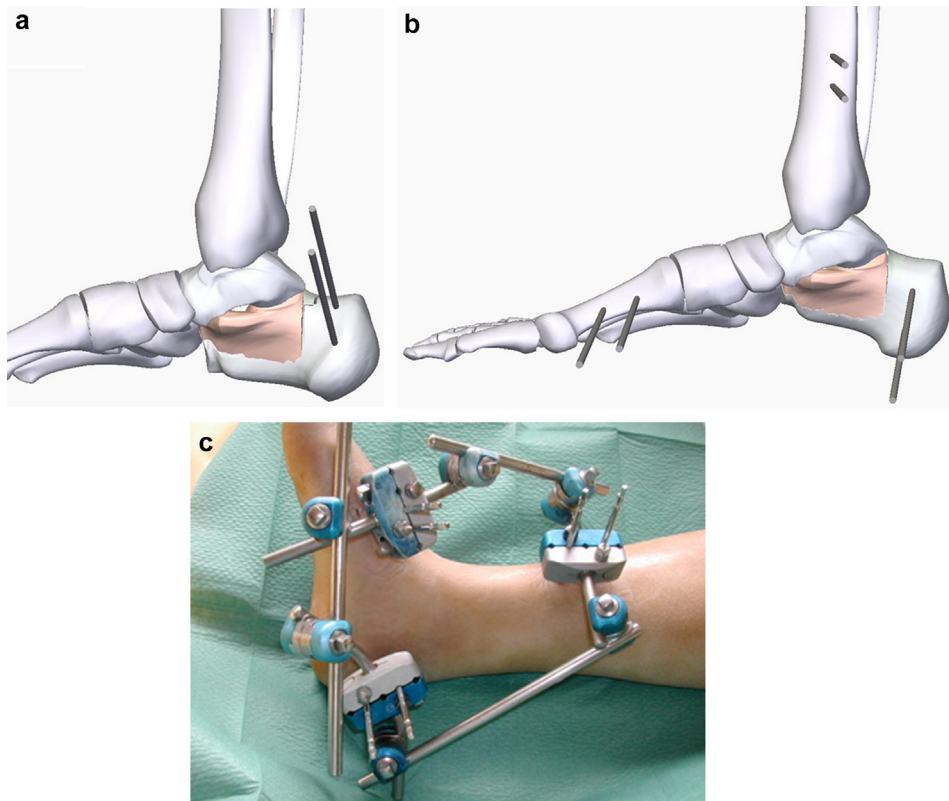


Fig. 2. a: position of the pins in the calcaneal tuberosity; b: medial triangular construct, position of pins; c: clinical appearance of fixator in medial position with triangular distraction.

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