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ORIF Assisted by Open Subtalar Small Joint Arthroscopy for Intra-articular Displaced Calcaneus Fractures

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Introduction

Fractures of the calcaneus are severe and complex injuries that result from high-energy injuries. Approximately two-thirds of them involve the articular surface. Displaced intra-articular fractures are generally associated with poor health-related quality of life.[8] Nonanatomic reduction of the subtalar joint may result in incongruent articular contact, which accelerates joint degeneration. In addition, it may restrict the inversion/eversion range of motion, leading to difficulty in normal gait. Therefore, anatomic reduction of the posterior facet of the calcaneus is considered a major determinant of outcome.[4,8]

Subtalar arthroscopy is a useful additional tool to assist the osteosynthesis procedure.[3,11] It aims to provide a real-time direct and thorough vision of the posterior facet to assess the quality of articular reduction and guide reduction maneuvers. The narrow space and the irregular and tridimensional shape of the subtalar joint makes congruency difficult to evaluate visually or through fluoroscopy.

However, some problems related to the traditional subtalar arthroscopy can be encountered.[9] First, more equipment is required with a significant amount of apparatus and connecting cables, which could burden the operating room. Furthermore, the proper use of these devices may be associated with a steep learning curve. Third, in closed arthroscopy it may be a higher risk of rare but potentially devastating complications, such as neurovascular injury, tendon injury, or compartment syndrome due to fluid extravasation. Last, it is difficult to insert the traditional larger arthroscope into the narrow subtalar joint space without iatrogenic chondral injury.

We present a surgical technique for intra-articular displaced calcaneus fractures based on open reduction and internal fixation (ORIF) assisted by open subtalar arthroscopy using a 1.9-mm arthroscopic device (Nanoscope, Arthrex, Naples, USA).

Surgical Technique

ORIF for intra-articular displaced calcaneus fractures should be performed as early as soft tissue swelling has dissipated adequately (positive wrinkle test). Patient is placed in the lateral decubitus position. Under thigh tourniquet, the lateral extensile approach is performed with gentle soft tissue handling. A full-thickness subperiosteal flap is raised and Kirschner wires are placed in the fibula, talar neck, and

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Figure 1. Intraoperative photography showing the use of open subtalar small joint arthroscopy assisting an ORIF procedure for an intra-articular displaced calcaneus fracture. This novel 1.9-mm arthroscope consists of a unique handpiece device and a tabletlike screen, requiring just 1 connecting cable.

cuboid for retraction. The expanded lateral wall is mobilized carefully, and fractures lines are identified.

Then, open reduction maneuvers are performed to obtain proper calcaneus height, width, and coronal alignment and to achieve a precise anatomic reduction of the posterior facet. When reduction seems to be correct under direct visualization, temporary Kirschner wires are placed to maintain it. Then, articular congruency is checked using open subtalar small joint arthroscopy (Figure 1). The scope can be held by the surgeon or the assistant. The screen is placed 1 m directly in front of the surgeon, inclined to the surgeon eyes. The connecting cable is placed together with the other cables of the surgical field. The scope is not limited by arthroscopic portals; it is inserted in the surgical wound and it can be moved through the joint (Figure 2). The dimensions of this arthroscope (1.9 mm) and its wide view field allow to insert the scope deep and smoothly into the narrow subtalar joint, obtaining a complete vision of the articular surface. If step-off is detected arthroscopically in the posterior facet, reduction is repeated subsequently under arthroscopic vision and assistance (Figure 3). Then, fluoroscopy is used to assess calcaneal width and height and calcaneocuboid joint congruity. When reduction is deemed satisfactory, internal fixation is performed using a low-profile lateral calcaneal plate. Simultaneously, small joint arthroscopy can be used to check that anatomic reduction is maintained and to detect joint penetration by screws. After lavage, the full-thickness flap is closed over a deep drain.

Splint immobilization is maintained until soft tissue is not compromised and sutures can be removed, typically at 3-4 weeks. Then, patients are converted into a rigid ankle brace. Ankle and subtalar range of motion exercises are begun early. However, weightbearing is not initiated until 10-12 weeks postoperatively.

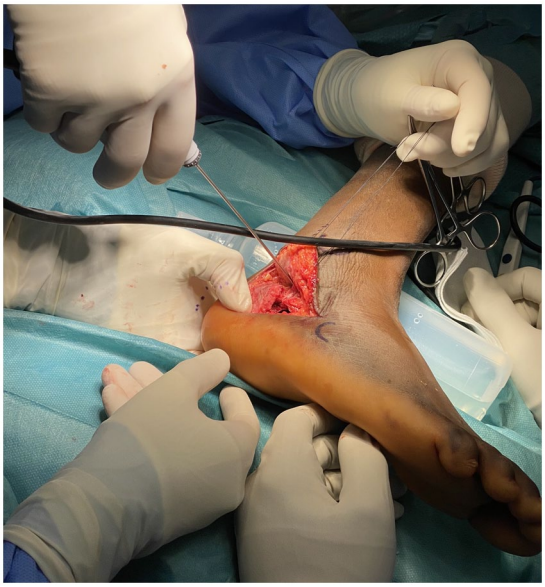

Figure 2. Intraoperative photography showing the arthroscope placement. The scope is not limited by arthroscopic portals; it is inserted in the surgical wound and it can be moved through the joint.

Discussion

A review of the current literature suggests that the role of subtalar arthroscopy in the management of intra-articular calcaneus fractures is still evolving. Gavlik et al[3] demonstrated that percutaneous, arthroscopically assisted osteosynthesis allows minimally invasive surgery without risking inadequate reduction of the subtalar joint in selected moderately displaced Sanders type II fractures. Similarly, Law et al[7] combined arthroscopy and fluoroscopy in percutaneous fixation of simple Sanders type II fractures and showed excellent long-term functional outcomes. However, percutaneous techniques should be carefully indicated in complex and comminuted fracture patterns because of the technical difficulty of reduction.[3,7] The minimally invasive sinus tarsi approach has gained popularity because of the lower risk of soft tissue complications and sural nerve injury. However, it is difficult to restore calcaneal width through this approach, and articular reduction can be restricted by the limited surgical view.[9] Therefore, subtalar arthroscopy can be especially useful to enhance posterior facet reduction when using a sinus tarsi approach.[10]

Rammelt et al[11] used open subtalar arthroscopy to evaluate the congruency of the posterior facet after seemingly exact open reduction as judged visually and fluoroscopically. They reported that minor steps may be overlooked even with the time-consuming Brodén views in about one-quarter of all cases because of the posterior facet irregular

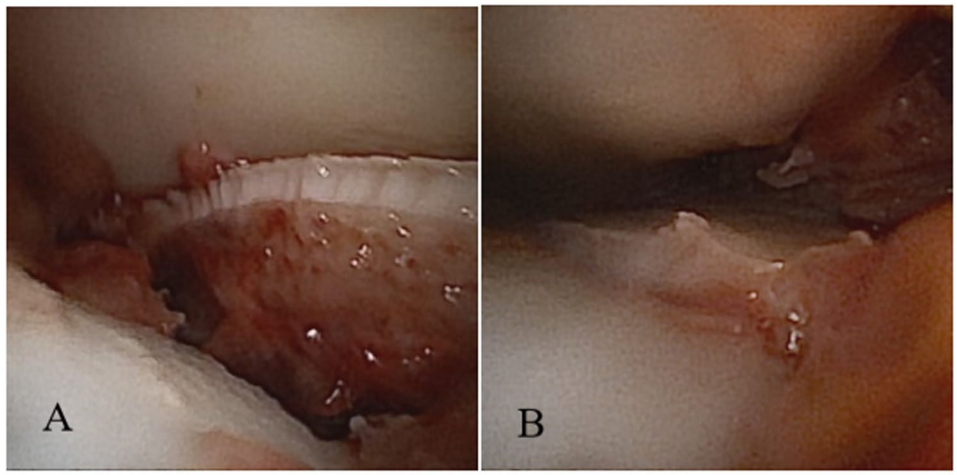

Figure 3. Intraoperative nanoscopic images. (A) Intra-articular displaced calcaneus fracture. (B) Anatomically reduced fracture. The small joint arthroscopy allows to obtain a thorough vision of the subtalar joint to assess the quality of the reduction. Moreover, it can assist during reduction maneuvers.

Table 1. List of Advantages and Disadvantages of Using Open Subtalar Nanoscopy to Assist ORIF for Intra-articular Displaced Calcaneus Fractures.

Advantages	Disadvantages
Easy to use and intuitive	It should be used in conjunction with fluoroscopy
Avoid an increased equipment	Increase surgical time
Ideal to thoroughly explore the narrow subtalar joint	Increase cost
Assist during reduction maneuvers	
Allow to remove small fragments lodged in the medial portion of the subtalar joint	
Detect joint penetration by screws	
Avoid complications associated with closed arthroscopy	
Reduce the exposure to fluoroscopy	

Abbreviation: ORIF, open reduction internal fixation.

shape. Park and Yoon[10] stated that a combined approach using fluoroscopy and open arthroscopy showed better reduction on CT than fluoroscopy alone. Advantages of open subtalar arthroscopy are that the arthroscope is not restricted to the standard portals and that it does not carry the risk of neurovascular or tendon damage.

The use of this novel 1.9-mm arthroscope may overtake some of the limitations encountered in the traditional subtalar arthroscopy (Table 1). This system consists of a unique handpiece device and a tabletlike screen, requiring just 1 connecting cable (Figure 1). An LED light source, an illumination system, and a detection system are all included in the handpiece.[12] Therefore, it avoids the increased equipment required in the traditional arthroscopic system. Although subtalar arthroscopy may be associated with a steep learning curve, the simplicity of use of this apparatus makes it very intuitive.[12]

The handpiece tube is 9.5 cm long, semirigid, and has a 1.9-mm outer diameter. It carries the detection system at its distal end (chip-on-tip technology), with a pixel number of 400×400. The scope direction of view is 0°, with a 120° field of view. The dimensions of this arthroscope and its wide view field allow to insert the scope deep and smoothly into the narrow subtalar joint, obtaining a thorough vision without iatrogenic chondral injury.

The system comes with tailored arthroscopic instruments for interventional purposes. They may help to assist during reduction maneuvers (Figure 3) and also to remove small fragments lodged in the medial portion of the subtalar joint that are otherwise difficult to reach. Furthermore, images and videos can be recorded as in conventional arthroscopy.

Colasanti et al[2] treated 31 patients with anterior ankle impingement using a small joint arthroscopy technique. This

procedure was found to be safe, leading to good clinical results and high patient satisfaction. Labib and Slone[6] used small joint arthroscopy in patients with ankle fractures to diagnose syndesmotic injuries or small chondral lesions, and to verify joint reduction. Alvarez et al[1] used this tool to extract retained intra-articular ballistics in the ankle. Moreover, small joint arthroscopy has shown to be useful in smaller joints of the foot. Kaplan et al[5] reported a surgical technique performing nanoscopic cheilectomy for hallux rigidus.

Despite the evident advantages of the use of small joint arthroscopy, it is not without limitations (Table 1). Fluoroscopy has better roles in the evaluation of the calcaneal width and height, determination of the screw length, and restoration of the calcaneocuboid joint congruity. Therefore, in our opinion, intraoperative small joint arthroscopy should be used in conjunction with fluoroscopy. Furthermore, adding the use of small joint arthroscopy may increase overall surgical time and cost.

In conclusion, ORIF assisted by open subtalar small joint arthroscopy may be a useful surgical technique for intra-articular displaced calcaneus fractures. This novel 1.9-mm arthroscope provides the advantages of the traditional arthroscopy while overtaking some of its limitations. The increased equipment is avoided when using this intuitive system. The very small dimensions of this arthroscope makes it ideal to explore the narrow subtalar joint. On the other hand, its use may increase surgical time and cost.

Ethical Approval

The study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki.

Declaration of Conflicting Interests

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