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Fibular-Lengthening Osteotomy in Patient with Progressive Valgus Deformity After an Ankle Fracture

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Data Interpretation D
Manuscript Preparation E
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Conflict of interest: None declared

Patient: Male, 23-year-old
Final Diagnosis: Malunion fracture of the fibula
Symptoms: Pain and limited movement in the right ankle
Medication: —
Clinical Procedure: Fibular-lengthening osteotomy
Specialty: Orthopedics and Traumatology

Objective: Unusual setting of medical care

Background: The fibular fracture requires an anatomical reduction. When a malunion occurs, it can lead to a valgus deformity with an opening of the ankle mortise.

Case Report: This case deals with a 23-year-old patient with pain and limited movement in the right ankle, caused by a fracture healed in an incorrect position, with shortening of the fibula and progressive displacement of the valgus, after surgery 12 months earlier for an ankle fracture. The patient underwent a corrective procedure consisting of extemporaneous lengthening of the fibula, with interposition of autologous bone graft and fixation using a compression plate. Six months after surgery, the patient did not present pain or limited movement, and was able to return to his habitual sporting activity.

Conclusions: Fibular-lengthening osteotomy is a procedure indicated for patients with malunion fracture of the distal fibula, with shortening and progressive valgus deformity. This surgery allows the restoration of the joint surface, reduces stress on the cartilage and prevents the development of arthropathy of the ankle.

MeSH Keywords: Ankle Fractures • Bone Lengthening • Fractures, Malunited

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Background

Insufficient reduction of a fibular fracture causes malunion, resulting in fibular shortening and/or rotation. This usually presents alongside progressive valgus deformity and instability of the ankle. Patients with an incorrectly healed fracture to the distal fibula tend to present pain, inflammation, rigidity and occasional instability due to abnormal joint contact, resulting in increased stress on the cartilage. Consequently, these patients are susceptible to developing secondary arthropathy. A number of techniques have been developed for the reconstruction of the fibula, via the correction of the valgus deformity and restoration of the ankle mortise to its correct anatomical shape, which can help to prevent progression to osteoarthritis. The procedures available to correct possible shortening and/or rotation of the fibula include fibular-lengthening osteotomy [1]. In fibular-lengthening osteotomy, if there is a malrotation of more than 10°, the classic horizontal Weber and Simpson osteotomy is indicated, while if the rotation is less than 10°, an oblique or Z-shaped osteotomy can be performed [2]. These procedures have been linked to satisfactory results, managing to slow down or even halt the progression to osteoarthritis in a majority of cases. However, the careful selection of candidates for this surgery is often a challenge for orthopedic surgeons. A range of factors must be taken into account prior to performing this procedure, including the presence of chondral or osteochondral lesions, or restricted ankle movement.

Case Report

The patient was a 23-year-old athlete referred to the orthopedic consultant with pain and swelling in the right ankle. The patient had undergone surgery 12 months previously for a Pott's fracture to the right ankle, involving open reduction and internal fixation using 2 partially threaded cancellous screws in the internal malleolus, and 2 cortex screws at the supra-syndesmotic level due to damage to the tibiofibular syndesmosis. These screws were removed 2 months after the procedure. In addition to the aforementioned surgery, the patient did not have any personal or family medical history of interest, or toxic habits.

The physical examination revealed the presence of pain, swelling, and valgus deformity in the operative ankle. These signs had increased in recent months. Conventional x-ray imaging showed a malunion of the supra-syndesmotic fracture, with shortening of the fibula and medial opening of the ankle mortise (Figure 1). It was observed that the Shenton line was partially interrupted. The amount of fibular shortening was assessed using the talocrural and bimalleolar angles; the bone length was reduced by approximately 10 mm. A computed tomography (CT) scan ruled out the presence of an accompanying angular or rotational alteration. Regarding pre-operative planning, malrotation of the fibula can be difficult to detect on simple x-rays, making it advisable to perform a CT scan as this is essential to assess the extent of the fibular shortening, as well as any rotational and/or angular defects [3]. Given these findings, it was decided to perform an extemporaneous lengthening of the fibula, with a provisional bone distraction with the aid of an external fixator, interposition of autologous

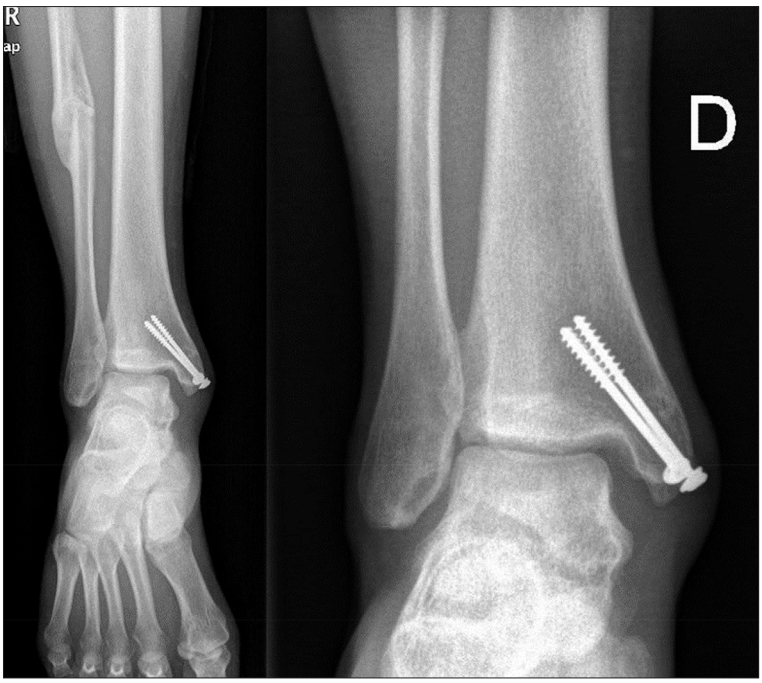

Figure 1. Anteroposterior radiographs demonstrating the medial opening of the ankle mortise.

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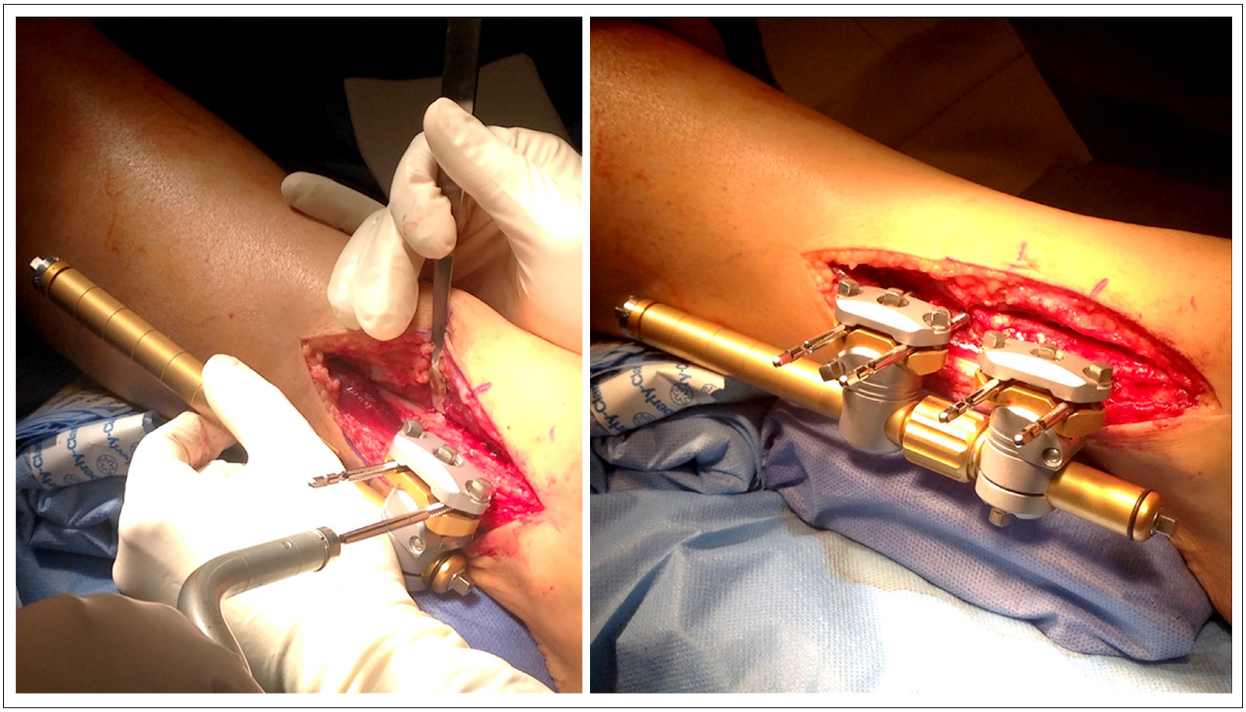

Figure 2. Intraoperative images. External fixation placement.

Figure 3. Intraoperative images. Progressive bone distraction.

bone graft taken from the iliac crest, and finally, an internal fixation using a compressive osteosynthesis plate.

Before starting the procedure, a popliteal nerve block was administered, which helped to control postoperative pain. The surgery was completed under general anesthesia and in supine decubitus. Intraoperative ischemia was used, as well as fluoroscopy to obtain intraoperative x-ray imaging. A lateral approach to the distal fibula was carried out, making an incision over the existing scar, allowing access to this point and having a direct view of the amount of shortening. A supra-syndesmotic transverse osteotomy was performed, distal to the point of malunion, with the aid of a sagittal saw.

The present of possible syndesmotic instability was ruled out via an assessment of the patient's symptoms, together with a pre-operative MRI, which revealed the integrity of both the deltoid ligament and the syndesmotic ligament complex. Magnetic resonance imaging (MRI) is a highly sensitive, specific and precise diagnostic tool for preoperative assessment of syndesmotic injuries [4]. Fluoroscopy intraoperative tests were also performed, allowing the assessment of syndesmosis, such as the bone hook stress test and the external rotation stress test [5]. Syndesmotic injury was consequently ruled out, and no screw fixation was necessary. However, the scar tissue present in the joint was carefully debrided. With the aid of external fixation, progressive bone distraction was performed until

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Figure 4. Intraoperative images. Cortico-cancellous bone graft placement into the gap.

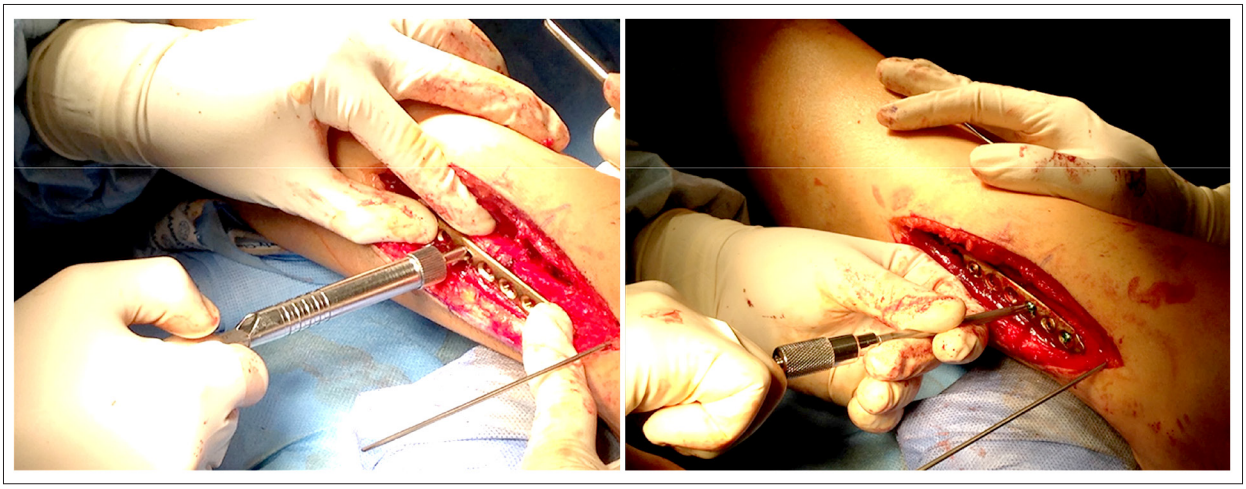

Figure 5. Intraoperative images. Definitive fixation with a compression plate.

x-rays revealed the correction of valgus deformity, and the medial closure of the ankle mortise (Figures 2, 3). The necessary lengthening of the fibula was assessed intraoperatively by measuring the talocrural and bimalleolar angles, taking the contralateral ankle as reference. The suitability of lengthening was confirmed intraoperatively using intraoperative x-ray imaging.

The lengthening planned and subsequently performed was around 10 mm. A cortico-cancellous bone graft, harvested from the iliac crest, was then inserted into the gap created by the distraction (Figure 4). The stability achieved from bone graft and the provisional fixation using Kirschner wires allowed the removal of the external fixation. Definitive fixation was then performed with a compression plate and 2.5 mm cortex screws (Figure 5). The procedure lasted approximately 60 minutes.

After surgery, the patient did not put weight on the limb in question for 6 weeks and underwent a personalized physical therapy program. His evolution was satisfactory, with a gradual reduction in pain and joint limitation. X-ray imaging confirmed correction of the valgus deformity, closure of the ankle mortise, restoration of Shenton line and normalization of the talocrural and bimalleolar angles (Figures 6, 7). Six months post-surgery, the patient no longer reported pain or limited movement, with an American Orthopedic Foot & Ankle Society (AOFAS) score of 94/100. After 12 months, the patient had returned to the same level of sporting activity as prior to his injury. After 3 years of monitoring, the patient remained asymptomatic, with completely normal sporting performance, and x-ray imaging showed no evidence of any progression to arthropathy.

Discussion

Inadequate reduction of a distal fibular fracture can result in the fibula healing in a rotated and shortened position. The lateral malleolus plays a significant role in the lateral reinforcement of the talus and the transmission of loads through the ankle. When there is shortening of the fibula, with or without rotation, pressure on the cartilage of the joint increases. This can lead to a progressive deformity of the valgus and the development of early onset osteoarthritis [6]. The increased strain on the cartilage tissue becomes more evident where

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Figure 6. Anteroposterior radiography immediately after surgery showing the correction of the valgus deformity and closure of the ankle mortise.

is shortening of 2 mm or more, or rotation of 5° or more [7]. In these cases, as described in our article, lengthening and correction of the distal fibula as a relief procedure enables the restoration of the alignment and surface of the joint, reducing ankle instability and stress on the cartilage, which can be prevent the development of arthropathy [8,9].

Proper preoperative planning is essential. The radiographic assessment of the mortise must show an intact Shenton line and a continuous curve between the lateral edge of the talus and the fibular groove of the distal fibula. Several radiographic measurements have been put forward to assess the degree of shortening present in the distal fibula. Sarkisian et al. (1976) described the talocrural angle [10], the average of which was 78.5° (within a range of 75° to 86°), meaning that a difference of 3° or more with respect to the contralateral would represent a shortening of the fibula. A few years later, Rolfe et al. (1989) noted that the talocrural angle had a greater variability than that previously described. For this reason, they proposed using a new index to assess fibular length, the bimalleolar angle [11]. This angle has an average of 77.8° (with a range of 72° to 86°), meaning that a difference of 2.5° or more with respect to the contralateral ankle is indicative of a shortening of the fibula. In the case of this patient, these measurements were taken several times, preoperatively and intraoperatively, which meant that the length of the fibula could be re-established accurately.

With regards to the surgical technique, several different types of osteotomy have been described to correct the shortening and possible rotation of the distal fibula, including transverse, oblique and Z-shaped osteotomy. The transverse osteotomy is a simple way of correcting rotation and achieve significant lengthening [1]. As described in our case, this required transitory distraction using an AO distractor or external fixation. This makes it possible to restore the correct length of the fibula, and then fit permanent fixation using an osteosynthesis plate. Weber et al. (1985) describe the fibular lengthening in 23 patients using transverse osteotomy and insertion of an autologous bone graft, with satisfactory results in up to 76% of cases [12]. Similarly, Yablon et al. (1989) present the results obtained for 26 patients, reporting that in up to 77% of cases patients were able to return to the same level of activity as prior to their injury [13].

Some authors have popularized fibular lengthening by performing osteotomies that do not require the use of a bone graft. In this respect, Chao et al. (2004) promoted the use of a long oblique osteotomy on the sagittal plane [14]. They reported that none of the patients who underwent this procedure presented progression towards arthropathy under x-ray after 34 months' monitoring. Thangarajah et al. (2012), however, list the advantages of supra-syndesmotic Z-shaped osteotomy, performed in 4 patients with excellent results [15]. In 1998, Weber et al. (1998) published a paper comparing the results obtained for a standard transverse osteotomy with a coronal plane Z-shaped osteotomy [6]. After an average of 4.3 years of monitoring, no significant differences we observed. However, they noted that a Z-shaped osteotomy avoids the need for an autologous bone graft.

As we have already mentioned, although some osteotomy methods do not require a bone graft for lengthening, in our case it was used. Thus, authors such as Sinha et al. (2008) encourage the use of an autologous cortico-cancellous graft harvested from

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Figure 7. 18 months post-operative x-ray showing the complete bone graft healing. Anteroposterior and lateral planes.

the iliac crest [16], which provides an excellent osteoconductive, osteo-inductive and osteogenic material [17]. The article published by Visser et al. (2017) describes the completion of a fibular lengthening using a frozen allogeneic graft taken from the femoral head, which avoids the morbidity of the donor area itself [18]. In this respect, the paper by Brin et al. (2013) [19] is also of interest; it presents the advantage of using cervical spine cage type devices, with excellent results as an alternative to the bone graft habitually used until now.

It is essential to assess the syndesmosis. In the case of our patient, the syndesmosis was unaffected, and it was therefore not necessary to perform fixation using syndesmotic screws. However, despite not requiring fixation, we did need to perform careful debridement of the surrounding scar tissue to achieve the desired lengthening and correction [20]. In the same way, on occasion, the lengthening and correction of the deformity may necessitate a medial approach.

The benefits of fibular lengthening using provisional distraction with a monolateral external fixator and subsequent fitting of a fixation plate include the correction of shortening in a single procedure, in comparison with the gradual fibular lengthening technique put forward by Talusan et al. [21] through the progressive distraction using an external fixator, where further surgery is needed to remove the fixator. Furthermore,

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our technique avoids the risk of infection associated with the fitting of an osteosynthesis plate in the area where an external fixator has been positions for several months for gradual lengthening, in addition to the inherent complications of external fixators, which include infection along the path of the pins, disuse osteoporosis or soft tissue atrophy.

Despite mostly being used as a relief procedure for malunion, as was the case of our patient or the case resented in the paper by Brosky et al. [22], fibular lengthening has also been considered an appropriate alternative in patients with shortening of the lateral malleolus after premature closure of the epiphysial plate in the distal fibula [23].

In our patient's case, no angular/rotational fibular deformity was observed. While in cases where a preoperative CT scan may reveal this type of deformity, correction therefore must be assessed in detail using intraoperative x-ray imaging. After completion of the procedure, the level of correction must be assessed using a further CT scan.

Conclusions

We can therefore conclude that fibular-lengthening osteotomy is an appropriate relief procedure for patients with insufficiently reduced ankle fractures. It allows valgus deformity correction and minimizes the risk of secondary arthropathy, reducing the chances of requiring arthroplasty or arthrodesis of the ankle. In short, the above procedure is simple, easily performed, low-cost, and also avoids the complications arising from progressive distraction using an external fixator.

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