Fibular Intra-articular Resection During Arthroscopic Ankle Arthrodesis: The Surgical Technique

Alessio Bernasconi, M.D., Nazim Mehdi, M.D., and François Lintz, M.D., F.E.B.O.T.

Abstract: Ankle arthrodesis is still considered the gold standard in the treatment of advanced painful ankle osteoarthritis. More than 3 decades ago, it was performed under arthroscopy; thereafter, many authors have reported excellent results and a low complication rate. Despite the significant improvements in surgical techniques, nonunion remains a problematic and relatively frequent event. This is one of the reasons the research is constantly active in this field. Ten years ago, a fibular resection during ankle arthrodesis was, for the first time, described in the literature as a means to correct malalignment in varus cases. Nowadays, we perform a similar technique during all arthroscopic ankle arthrodeses, regardless of the kind of preoperative deformity (varus, valgus, or normal alignment). In this article, we describe the arthroscopic technique to perform a fibular intra-articular resection during arthroscopic ankle arthrodesis, joining the benefits of arthroscopic minimal invasiveness to the full joint contact gained after such a fibular osteotomy. In our opinion, this would be the only way through which full contact between the talar and tibial surfaces may be achieved.

The first description of arthroscopic ankle arthrodesis (AAA) was reported in 1983 by Schneider[1]; since then, many authors have reported satisfactory results and fewer complications with this technique compared with the traditional open approaches. However, a certain percentage of nonunions is still documented in the literature, which is not always justified by the classic risk factors for pseudarthrosis. In 2007 Smith and Wood[2] described performing a fibular resection during open ankle arthrodesis (AA) in a few patients with ankle arthritis with severe varus ankle malalignment and reported good results. Nevertheless, surgeons have never really included this artifice in surgical daily practice.

If we look at the literature, fibular resection is generally carried out in orthopaedic surgery to use the fibula as bone graft, whereas in the foot and ankle literature, it has usually been discussed in a laterally approached AA or in association with supramalleolar tibial osteotomy carried out as joint-preserving ankle osteoarthritis treatment. Concerning the arthrodeses, a resection of the fibula is part of the transfibular approach for traditional (open) AA, being known for allowing an excellent exposure of the ankle.[3] It was particularly valorized in 1948 by Adams,[4] who documented the resection of the distal fibula and its subsequent fixation through screws to the lateral aspect of the tibiotalar joint, with the fibula finally used as an onlay graft bridge. It is interesting that, in a very recent publication, Mehdi et al.[5] have described a detailed technique of fibular shortening osteotomy during open AA, performing it in varus, valgus, and normal ankles and reporting a 97.6% fusion rate in a series of 42 arthrodeses. Regardless of the surgical approach, adequate contact of the bony surfaces has been largely proved to be a crucial prerequisite for a successful fusion,[6] and the presence of the fibula might be a mechanical obstacle to the required full contact.

Our goal is to report the fibular intra-articular resection (FIRE) surgical technique during AAA as a means to gain a better reduction and coaptation of the joint surfaces to further reduce the incidence of pseudarthrosis. This approach is indicated in patients with a diagnosis of primary or secondary tibiotalar arthritis, complaining of ankle pain exacerbated by weight bearing and walking on uneven ground, and presenting (not systematically) with swelling and stiffness of the

From the Department of Public Health, Orthopaedic and Traumatology Unit, "Federico II" Naples University School of Medicine and Surgery (A.B.), Naples, Italy; and Clinique de l'Union, Ankle and Foot Surgery Center (N.M., F.L.), Saint-Jean, France.

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Address correspondence to François Lintz, M.D., F.E.B.O.T., Clinique de l'Union, Ankle and Foot Surgery Center, Boulevard de Ratalens, 31240 Saint-Jean, France. E-mail: dr.f.lintz@gmail.com

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tibiotalar joint on physical examination. Weight-bearing plain radiographs or computed tomography scans (pedCAT; Curvebeam, Warrington, PA) are usually obtained to confirm the diagnosis and to characterize the stage of arthritis. As for other kinds of AAA, this procedure is rarely contraindicated; however, contraindications include important bone defects, active infection, and revision of previous nonunion or arthroplasty requiring autologous grafting.

Surgical Technique

Patient Positioning

The patient is placed in the supine position on the operating table under general or locoregional anesthesia. A well-padded high-thigh 300−mm Hg tourniquet is inflated, and a circumferential adhesive-backed plastic drape is applied to the upper leg. The knee is slightly flexed (around 20°) by applying a support under the popliteal cavus (Video 1).

Arthroscopic Technique

The skin projection of the joint line is determined by repetitive flexion-extension movements of the ankle. The main skin landmarks, such as the medial malleolus, tibialis anterior tendon, extensor digitorum longus tendon, and lateral malleolus, are identified (Fig 1). At this level, a needle is placed medially to the tibialis anterior tendon, and 5 to 10 mL of 0.9% saline solution is injected to verify the needle position as the elastic refilling of the syringe corresponds to the passive capsular retensioning, confirming the correct needle

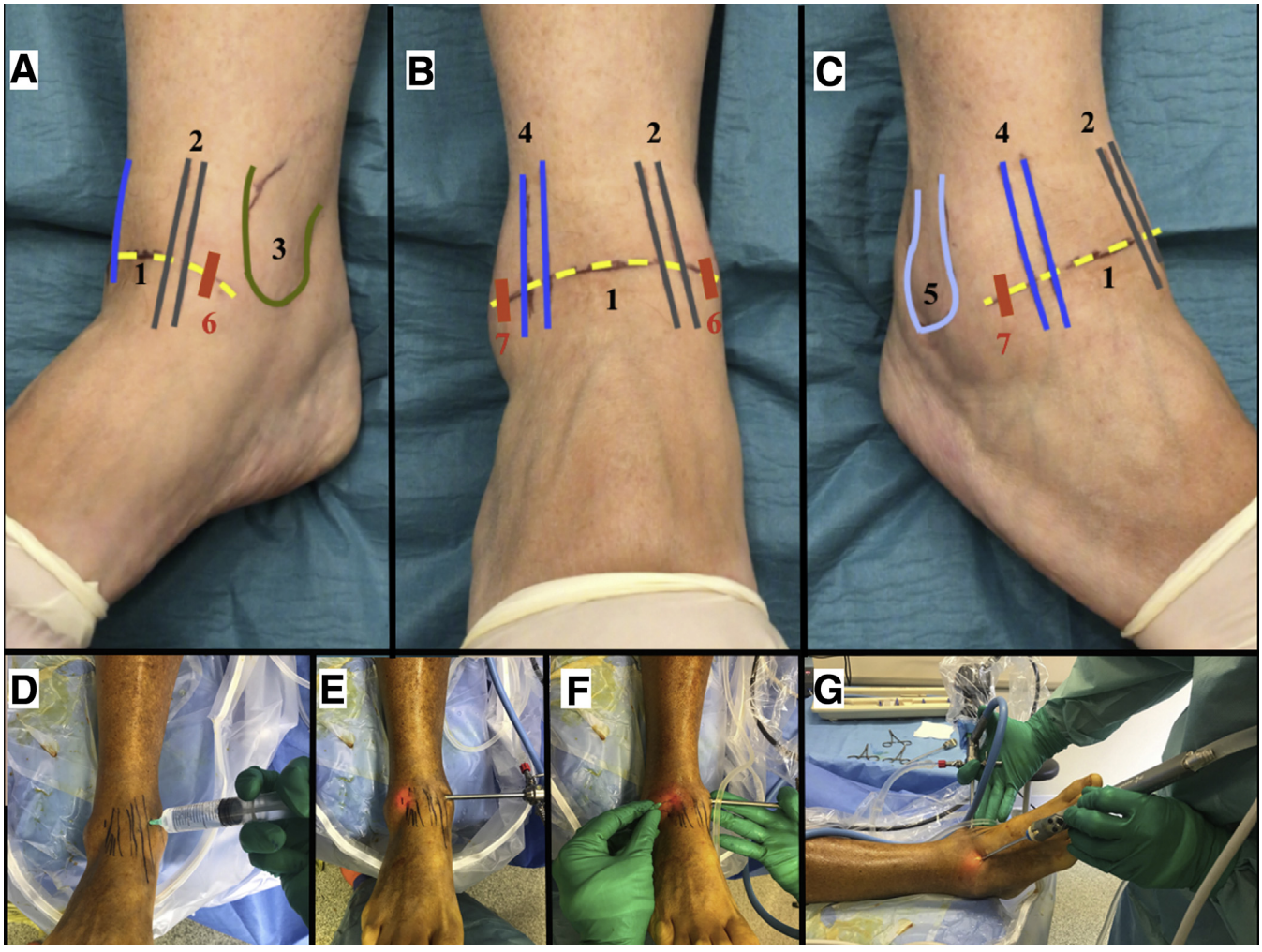

Fig 1. Main skin landmarks and steps to introduce instruments in the 2 portals during arthroscopic ankle arthrodesis in a right ankle, showing the external anatomy of portal placement. The patient is placed in the dorsal position. The anteromedial view (A), frontal view (B), and anterolateral view (C) of the ankle are shown. The main landmarks, such as the joint line (1), tibialis anterior tendon (2), medial malleolus (3), extensor digitorum longus tendon (4), and fibular malleolus (5), are identified. The anatomic location of the tibiotalar arthroscopy portals (6 and 7) is marked. (D) Five to ten milliliters of 0.9% saline solution is injected medially to the tibialis anterior tendon, where the anteromedial portal will be placed. With the arthroscope inserted in this portal, transillumination (E) and a needle (F) help to identify the anterolateral portal, through which a shaver (G) and other instruments will be inserted.

position. If possible, the fibular superficial nerve should also be marked on the skin and avoided (in some thin patients, it is visible with the foot inverted and toes flexed). Even if the transversal landmark for both incisions is represented by the joint line, in our opinion, both portals should be slightly distal to this line to take into account the curvature of the talus and to avoid being ill exposed for freshening the anterior part of the tibial plafond.

A 5-mm incision corresponding to the anteromedial portal (AMP) is placed where the needle was, blunt dissection is performed, and an arthroscope sheath with a blunt obturator is introduced. The obturator is then removed, and a 4.0-mm 30° arthroscope (Dyonics; Smith & Nephew, Andover, MA) is positioned (hydraulic pump at 50 mm Hg of pressure). By means of transillumination (outside-in technique), the anterolateral portal (ALP) is placed through a 5-mm incision at a location medial to the lateral malleolus and lateral to the extensor digitorum longus tendon (Fig 1). A careful synovectomy and debridement of the anterior fibrous scar tissue are performed with a synovial resector (Dyonics); thereafter, the inner part of the joint is well visualized and examined. The introduction of a probe in the ALP allows the surgeon to realize a tactile examination to gain supplementary information about the residual cartilage and subchondral bone conditions. A third portal is never required, and an external distraction device is seldom used in our experience and is not usually needed for the procedure (although it could be useful to have it in the room in case of difficulties). The synovial resection is essential to gain a good view of the whole joint (Video 1).

A 4-mm burr is inserted to freshen the joint surfaces of the tibia, the talus, and both gutters, moving from anterior to posterior and vice versa (Fig 2). Because the arthroscope is in the AMP at the beginning, the lateral gutter is usually addressed before the medial gutter. It is noteworthy that too much bone on the anterior part of the joint may prevent adequate positioning of the instruments (crucial to freshen the posterior part of the joint); thus, when progression in the posterior joint is difficult, it is likely that some anterior osteophytes have been missed and their excision is required to carry out the procedure correctly. A curved curette or a microfracturing tool can be used to better expose the subchondral bone. Once the articular surfaces appear to have been completely freshened (Fig 2), exchanging instruments in the portals may be useful to freshen the zones not reachable with the burr in the ALP.

Arthroscopic FIRE

With the arthroscope being kept in the AMP, the burr is inserted in the ALP and directed toward the fibula;

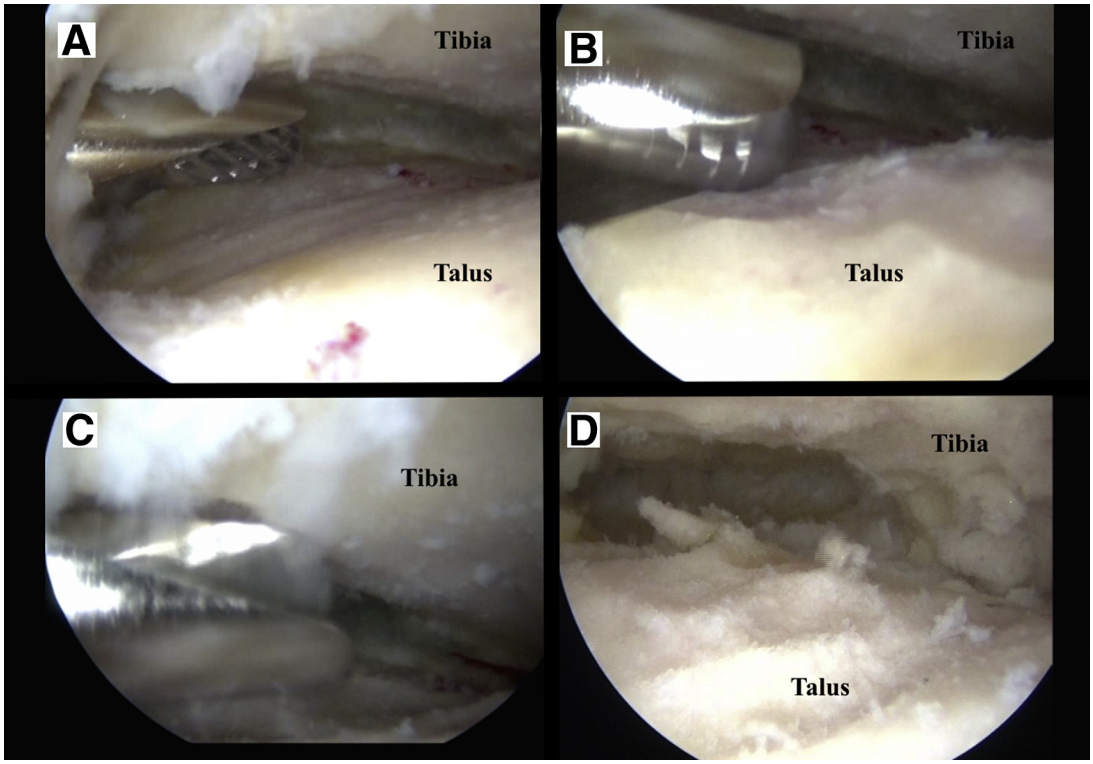

Fig 2. Arthroscopic arthrodesis in a right ankle in a patient with severe idiopathic tibiotalar arthritis. The patient is placed in the dorsal position. The difference in joint surfaces before (A) versus after (B) cartilage debridement is shown. A burr is used to remove cartilage from the talar (C) and tibial (D) surfaces. Small bone irregularities (B) should be left in place.

then, a linear superficial cut on the articular aspect of the fibula from anterior to posterior is drawn, corresponding to the joint line, so that the width of this mark will be equal to the width of the burr (Fig 3). Thereafter, the burr is positioned at the anterior extremity of this line (which serves as a guideline) and is moved from front to back and back to front to cut the fibula's full thickness. In this fashion, FIRE is performed (Fig 3). When this occurs, manual pressure on the sole of the foot will move the talus upward in complete contact with the tibia (Video 1). This aspect is characteristic of this technique and could never be obtained without this technical artifice.[5]

At the end of the procedure, the tourniquet is deflated to appreciate consistent trabecular bone bleeding and to exclude vascular lesions. Bone grafting is never used. The skin portals are sutured by 2 absorbable sutures.

Fixation of Arthrodesis

To stabilize the arthrodesis, while the foot is kept in neutral dorsiflexion, 5° of valgus, and 10° of external rotation, 2 K-wires are introduced in a parallel (or almost parallel) configuration on the medial-distal aspect of the tibia (with the second wire entry point placed 1 cm inferiorly and 0-1 cm posteriorly to the first). Their direction is from medial to lateral, from proximal to distal, and from posterior to anterior (Fig 4). Two cannulated interfragmental compression percutaneous screws (AutoFix 6.5-mm Compression Screws; Stryker, Mahwah, NJ) are used to fix the arthrodesis, with care taken to completely insert the distal threads into the talus (Video 1). The K-wire placement, drilling, and screw insertion are all performed and checked under fluoroscopy. The contact between the articular surfaces is also checked arthroscopically. The skin portals are closed by 2 absorbable sutures.

Postoperative Protocol

The patient is immobilized in a non−weight-bearing cast for 3 weeks; walking using crutches is allowed. Discharge is usually authorized the day after surgery. At 3 weeks, progressive weight bearing is allowed, first in a swimming pool and then on land. Full weight bearing (according to the patient's ability) is allowed after this period, and a weight-bearing cone beam computed tomography assessment (pedCAT) is performed to verify the bone healing. Full activity recovery generally occurs between 3 and 6 months, depending on the patient's tolerance.

Discussion

FIRE performed during AAA allows us to obtain both the advantage of full intra-articular contact and the classic benefits of an arthroscopic approach, including

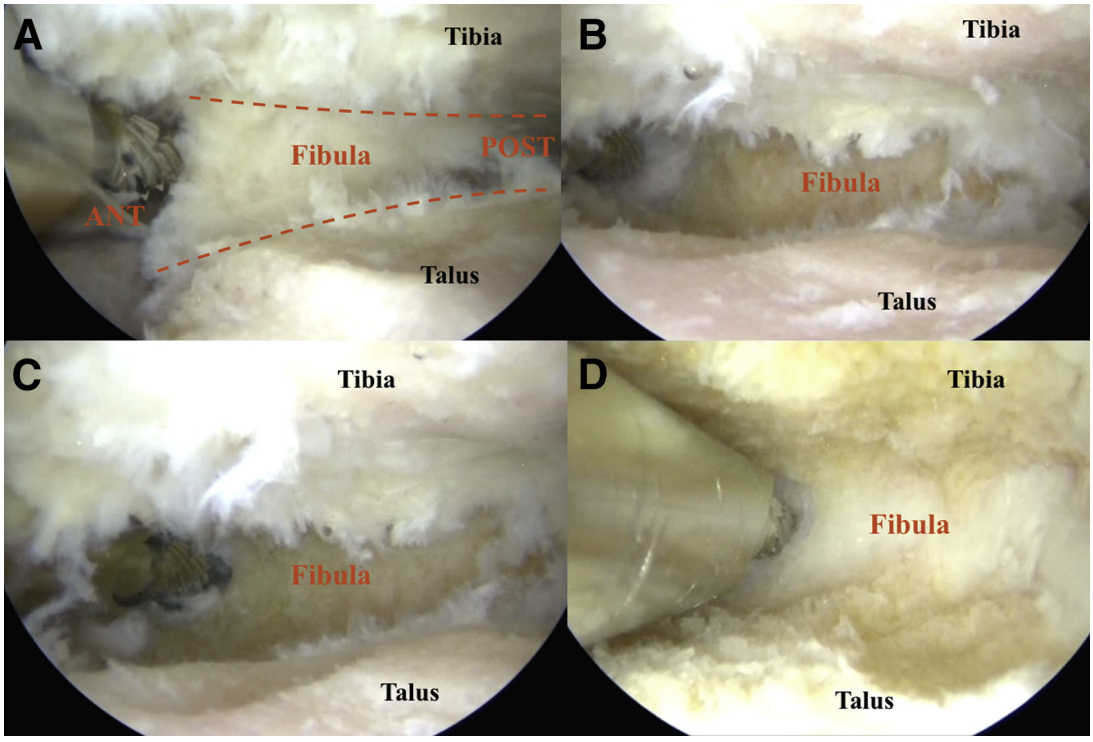

Fig 3. Arthroscopic arthrodesis in a right ankle in a patient with severe idiopathic tibiotalar arthritis. The patient is placed in the dorsal position. To perform fibular intra-articular resection, the burr is initially placed just anterior to the fibula that is covered by fibrous tissue (A); then, a linear superficial cut on the articular aspect of the fibula from anterior to posterior is drawn, corresponding to the joint line (B). Therefore, the osteotomy is realized, starting anteriorly (C) and progressing toward the posterior limit of the fibula (D). (ANT, anterior; POST, posterior.)

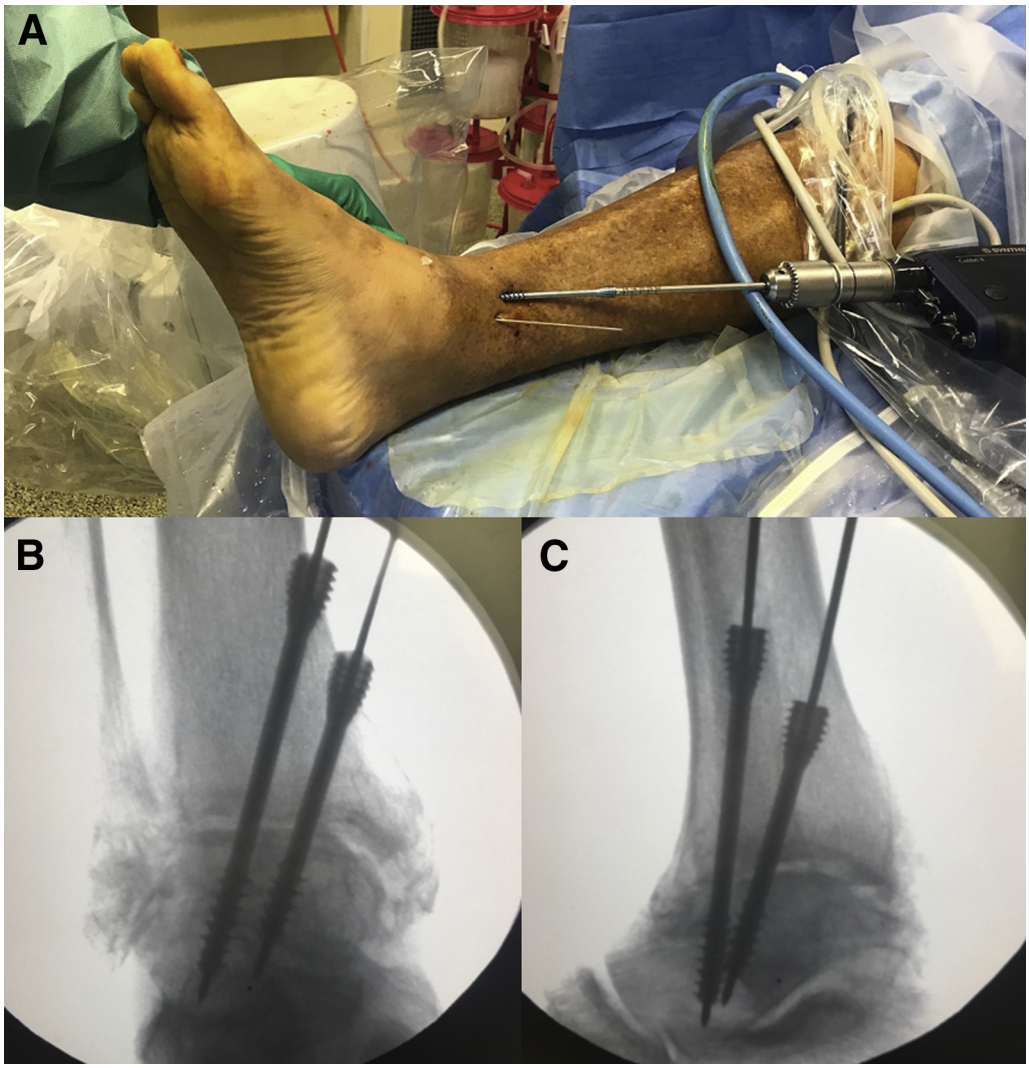

Fig 4. Arthroscopic arthrodesis in a right ankle in a patient with severe idiopathic tibiotalar arthritis. The patient is placed in the dorsal position. (A) At the end of cartilage debridement and fibular intra-articular resection, fixation of the arthrodesis is achieved by introducing 2 K-wires in a parallel configuration on the medial-distal aspect of the tibia (with the second wire entry point placed 1 cm inferiorly and 0-1 cm posteriorly to the first). Their direction is from medial to lateral, from proximal to distal, and from posterior to anterior. Two cannulated interfragmental compression percutaneous screws (AutoFix 6.5-mm Compression Screws) are used to fix the arthrodesis, with care taken to completely insert the distal threads into the talus. (B, C) The K-wire placement, drilling, and screw insertion are all performed and checked under fluoroscopy (anteroposterior view in B and lateral view in C).

mini-incisions, a faster recovery time, and fewer wound-related complications (Tables 1-3). AAA is widely considered a safe procedure presenting long-term highly satisfactory success rates.[7-9] Despite this, in a recent systematic review, Abicht and Roukis[10] have reported a global nonunion rate of approximately 9% independently from the type of arthroscopic approach (various fixation methods), with patients being symptomatic and requiring further intervention in two-thirds of cases.

If we look at the literature, some authors have investigated nonunion risk factors, reporting a fusion rate of 87% to 92% and highlighting that neuromuscular

Table 1. Indications and Contraindications of AAA With FIRE

Indications
Idiopathic ankle arthritis
Secondary ankle arthritis
Post-traumatic
Related to arthritic systemic conditions
Ankle instability
Neurologic conditions
Contraindications
Large bone defects
Active infection
Revision of previous nonunion or arthroplasty requiring autologous grafting

AAA, arthroscopic ankle arthrodesis; FIRE, fibular intra-articular resection.

Table 2. Advantages and Disadvantages of AAA With FIRE

Advantages
Arthroscopy vs open
Decreased postoperative pain and edema
Shorter hospital stay
Fewer complications
Reduced time to union
FIRE vs no FIRE
Full tibiotalar contact
Disadvantages
Arthroscopic skills required
Grafting not allowed

AAA, arthroscopic ankle arthrodesis; FIRE, fibular intra-articular resection.

imbalance and obesity are often commonly associated with a greater risk of this complication.[11-13] On the other hand, the weight of the fibula on the result of an arthrodesis has only recently been stressed. The restricting role played by the fibula in the ankle fusion had been previously discussed by Winson et al.,[6] but its clinical impact in a series of patients has been documented only recently, in 2017, by Mehdi et al.[5] FIRE definitely addresses this issue; thus, its diffusion potentially represents the step forward to prevent nonunion and avoid some reinterventions. It allows removal of a mechanical obstacle to complete tibiotalar contact without a significant lengthening of the surgical time (usually taking around 10 minutes). Unlike the fibular resection already described in some open arthrodeses, in FIRE the fibula is tackled from inside the joint, leaving the perifibular tissues uninvolved so that the peroneal vascular groove may be preserved.

Indications, as well as contraindications, for performing FIRE and those for traditional AAA usually overlap. The only absolute contraindications are important bone defects requiring grafting and active infections.[13] Over the years, bone deformity has been considered an official contraindication to AAA,[14,15] but recently, it has been shown that good results are achievable even in more marked deformities.[7] In this context, FIRE during AAA might usefully contribute to facilitate tibiotalar realignment in addition to gaining the best possible coaptation between the 2 deformed surfaces. However, our belief is that important deformations (congenital or post-traumatic), malunions, or failure of a previous arthrodesis requiring a more extensive debridement might be better addressed by means of open surgery.

Table 3. Pearls and Pitfalls of AAA With FIRE

Pearls
The use of transillumination helps place the anterolateral portal.
Traditional portals are placed on the joint line; despite this, the incisions should be slightly distal to this line because this helps to visualize and debride the articular surfaces.
Interchanging the instrumental and arthroscopic portals enables the surgeon to debride a greater surface area.
At the beginning of FIRE, a line should be drawn by means of a burr on the fibular articular surface to have a guide during the osteotomy.
Cartilage debridement may be completed just after FIRE because it makes it easier to obtain access to the posterior zones.
Bone grafting is never used.
Pitfalls
There is a risk of a lesion of the fibular superficial nerve when placing the anterolateral portal; if possible (as in thinner patients), it should be identified under the skin.
Because of the subtalar joint curvature, a curette must be used to complete debridement; a preoperative CT scan enables the surgeon to anticipate this because it is possible to see to which degree the surface is curved depending on individual and post-traumatic variations.

AAA, arthroscopic ankle arthrodesis; CT, computed tomography; FIRE, fibular intra-articular resection.

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