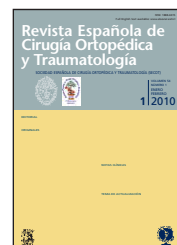


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## ORIGINAL PAPERS

### Tibiototalcaneal arthrodesis with a retrograde intramedullary nail

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#### KEYWORDS

Tibiototalcaneal  
arthrodesis;  
Nail;  
Retrograde

#### Abstract

**Introduction:** The purpose of this study is to assess the results of patients subjected to a tibiototalcaneal arthrodesis with a retrograde intramedullary nail.

**Materials and methods:** We studied 8 patients of a mean age of 60 years that showed involvement of the tibiotalar and subtalar joints with significant gait alterations and acute pain, secondary to either primary or post-traumatic arthritis or pseudoarthrosis of a previous arthrodesis. There was also one case of a severe deformity secondary to acute stroke. Patients were treated by means of tibiototalcaneal arthrodesis with a retrograde intramedullary nail. The AOFAS scale was used to assess functional results before and after surgery.

**Results:** Mean follow-up was 32 months (range: 7-61). Overall results were highly satisfactory, with a mean score of 88.6 points.

Healing occurred after a mean of 18.3 weeks. The most frequent complications were an instance of mild skin necrosis at the edges of the wound, a plantar ulcer that resolved with conservative treatment and a leg length discrepancy of 2 cm.

**Conclusion:** Tibiototalcaneal arthrodesis with a retrograde nail can be an excellent technique for patients with severe involvement of the tibiotalar and subtalar joints who are unresponsive to conservative treatment. It can also be used as salvage surgery in previously failed arthrodesis procedures.

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#### PALABRAS CLAVE

Artrodesis  
tibioastragalocalcánea;  
Clavo;  
Retrógrado

#### Artrodesis tibioastragalocalcánea con clavo intramedular retrógrado

#### Resumen

**Introducción:** El objetivo es valorar los resultados de los pacientes intervenidos de artrodesis tibioastragalocalcánea con clavo intramedular retrógrado.

**Material y métodos:** Se presentan 8 pacientes con una edad media de 60 años con afectación de las articulaciones tibioastragalina y subastragalina con alteración importante de la marcha y dolor intenso, secundarias a artrosis primaria o postraumáticas, pseudoarthrosis de una artrodesis previa o deformidad grave secundaria a accidente cerebrovascu-

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lar. Se trató a los pacientes mediante artrodesis tibioastragalocalcánea con clavo intramedular retrógrado, con valoración de los resultados funcionales antes y después de la cirugía, según los criterios de la AOFAS (American Orthopaedic Foot and Ankle Society). **Resultados:** El seguimiento medio fue de 32 meses (rango: 7 a 61), y los resultados fueron muy satisfactorios, con una puntuación media de 88,6 puntos.

El tiempo medio de consolidación fue de 18,3 semanas. Las complicaciones más frecuentes fueron una leve necrosis cutánea de los bordes de la herida, una úlcera plantar resuelta con tratamiento conservador y una discrepancia de longitud de 2 cm.

**Conclusión:** La artrodesis tibiotalocalcánea con clavo retrógrado puede ser una técnica excelente en pacientes con afectación grave de las articulaciones tibioastragalina y subastragalina que no respondan al tratamiento conservador y como cirugía de rescate en aquellas técnicas de artrodesis que hayan fracasado previamente.

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## Introduction

Lesions of the tibiotalar and subtalar joints can be secondary to primary arthritic processes (infrequent) or secondary to fractures of the tibial pilon, ankle, and talus, or to rheumatic processes (rheumatoid arthritis, haemophilia, etc.), necrosis of the talus, failed arthroplasties and tibiotalar arthrodeses, tumour diseases, or neuropathic arthropathy (diabetes mellitus, mielomeningocele, siringomielia, etc.).<sup>1-4</sup> Clinically, they manifest as complex tibiotalocalcaneal deformities, intense pain while walking and even at rest, limited movement, and secondary pain in the inferior extremities and vertebral column due to poor support.<sup>3,4</sup> Various treatments are available, including analgesics and anti-inflammatories, rest and orthosis, and surgical treatments when these measures fail.

Arthrodesis of the foot must be understood from a functional aspect rather than an anatomical one, as a

procedure designed to normalise support and reduce pain.<sup>5</sup>

Surgical treatment by tibiotalocalcaneal arthrodesis was initially referenced by Russotti et al in 1988<sup>3</sup> with the objective of reducing pain, facilitating plantigrade support, and providing functional independence to the patient. Since then, numerous articles have arisen in the medical literature that display good results using this technique, making it into one of the most often used for treatment of this difficult group of patients. There are various types of fixation materials used, including large fragment screws, plates, external fixators, and intramedullary nails.<sup>5</sup>

Tibiotalocalcaneal arthrodesis with a retrograde intramedullary nail was first described as a technique by Adams<sup>6</sup> in a case of pseudoarthrosis following a failed attempt at arthrodesis of the ankle. Other authors rapidly adopted this method,<sup>1,7-11</sup> and there are also documented

**Table 1** Cases treated by tibiotalocalcaneal arthrodesis with a retrograde intramedullary nail

Case	Sex	Age at fracture	Follow-up months	Side	Initial diagnosis	Complications	Initial score according to the AOFAS scale	Final score according to the AOFAS Scale
1	M	59	52	Left	Posttraumatic osteoarthritis	Length discrepancies	20	100
2	M	59	30	Right	Failed arthrodesis		20	97
3	F	65	61	Right	Posttraumatic osteoarthritis	Protruded nail	12	82
4	F	71	53	Left	Primary osteoarthritis		31	84
5	M	69	24	Left	Failed arthrodesis		20	94
6	F	62	7	Left	Primary osteoarthritis		38	97
7	F	62	9	Right	Primary osteoarthritis		8	88
8	M	32	16	Left	Neuropathic foot	Wound necrosis	20	62

AOFAS: American Orthopaedic Foot and Ankle Society; F: female; M: male.



**Figure 1** Biomet® retrograde intramedullary nail for tibiototalcanal arthrodesis.

cases from the medical literature of anteroposterior arthrodeses, although these show poorer results.<sup>12</sup>

The purpose of this study is to evaluate patients following intervention by tibiototalcanal arthrodesis with a retrograde intramedullary nail to treat damage to the tibiototal and subtalar joints.

## Material and methods

Between 2003 and 2007, 8 patients with lesions of the tibiototal and subtalar joints were treated by tibiototalcanal arthrodesis: 4 women and 4 men, with a mean age of 60 years (range: 32 to 71 years), with damage to the left side in 5 cases (62.5%) and to the right side in 3 cases (37.5%). Surgical indications were advanced primary osteoarthritis of both joints with varus deformity of the hindfoot in 3 cases (37.5%), post-traumatic osteoarthritis in 2 cases (25%), failed primary arthrodesis of the ankle in 2 cases (25%), and one case (12%) of a neuropathic cavus varus foot due to a cerebrovascular accident with a spastic hemiplegia sequela (table 1).

Of the 3 patients who were operated on for primary osteoarthritis, one presented with an arthrodesis of the ankle and a triple contralateral arthrodesis with screws for the same condition.

Of the two patients treated for secondary osteoarthritis, one had sequela of a bimalleolar ankle fracture from 30 years prior, and the other had a pseudoarthrosis from fractures of the tibial pilon and fibula that had received orthopaedic treatment, and had received a contralateral infratuberosity amputation.

Of the 2 cases of pseudoarthrosis with a previous arthrodesis, one case had been performed with screws for a primary osteoarthritis, and the other with an external fixator following osteoarthritis secondary to fracture of the ankle.

In all cases that had received previous non-surgical treatments, these had failed to correct the issue.

Clinically, all of the patients presented with intense pain while walking and in repose, 4 cases of difficulty of ambulation more than 500m, and severe deformity of the tibiototalcanal axis in 6 cases. The diagnosis was based on anamnesis, radiological assessment (weight bearing anteroposterior and lateral views of the ankle and foot and oblique views of the ankle) and CT scans to evaluate the level of damage to both joints. The intervention was performed at a mean time of evolution of the symptoms of

16.6 months (range: 4 to 25). The mean follow-up time was 32 months (range: 7 to 61). All patients were evaluated using the Ankle-Hind Foot Clinical Rating System of the AOFAS (American Orthopaedic Foot and Ankle Society) before the intervention and at the end of the follow-up period, measuring pain (40 points out of 100), function (28 points out of 100), mobility (22 points out of 100), and alignment (10 points out of 100)<sup>13</sup> (table 2).

In all of the 8 cases we used a Biomet®<sup>14</sup> retrograde ankle arthrodesis nail, which served as a distal posteroanterior block that improves resistance to lateromedial torsion of the implant with respect to the block by 40% and offers the possibility of an *in situ* compression (fig. 1).

Following the standard preoperative exam, we performed the surgical procedure (fig. 2) under general anaesthesia (3 cases) or spinal anaesthesia (5 cases), and one of the 8 patients (with pseudoarthrosis from a previous attempt at arthrodesis with an external fixator following an ankle fracture) received an autogenous bone graft from the iliac crest due to the serious loss of bone.

In the post-operative period, a posterior splint was placed for 4 to 6 weeks, and following the sixth week, partial weight-bearing assisted by crutches was permitted, with restrictions on full weight-bearing until consolidation was confirmed by radiological tests. In some cases, a walking boot was prescribed between the fourth and eighth weeks.

## Results

The results were evaluated using objective and subjective (level of satisfaction of the patient) criteria. As objective criteria, we established the existence or lack of bone consolidation, both clinically and radiologically, as well as the AOFAS scale evaluation.

Radiological consolidation was achieved in all 8 patients with a mean time of 18 weeks (range: 16 to 20 weeks) (fig. 3). One patient had consolidation with a 2cm long discrepancy (the patient with the previous ankle fracture from 30 years prior), which was treated with ipsilateral lengthening.

Gait improved considerably in all cases, except in the patient with a length discrepancy, who required more time for rehabilitation of the gait.

The patient's quality of life improved in all cases by a reduction or complete disappearance of pain, the ability to walk longer distances without symptoms, and improvement of gait functionality without the need for crutches or canes (fig. 4).

The subjective opinion of the patients was good in all cases, but above all in those with more chronic conditions and those who had more progressive incapacities.

The mean preoperative score according to the AOFAS scale was 21.1 points (range: 8 to 38) and the final mean score at the end of the follow-up period was 88 points (range: 62 to 100). The increased AOFAS score was essentially due to cessation of pain, which raised from a mean of 5 points before the intervention (severe pain always present) to 35 points at the end of the follow-up period (mild or absent pain in all patients).

Regarding complications, it should be noted that in addition to the previously mentioned length discrepancy,

**Table 2** Evaluation scale of the American Orthopaedic Foot and Ankle Society

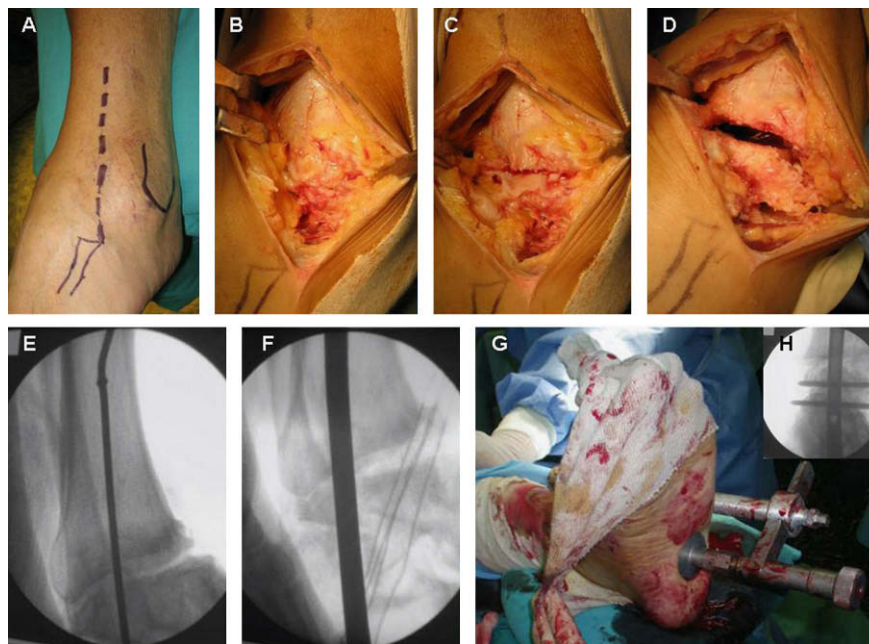
Pre-surgery Date:	Ankle-Hindfoot scale (total: 100 points) (Kitaoka et al)	Twelve months Date:
<b>Pain (40 points)</b>		
None		40
Mild, occasional		30
Moderate, daily		20
Severe, always present		0
<b>Function (50 points) (Activity limitations/ support requirements)</b>		
No limitation, no support needed		10
No limitation of daily activities, limitation of recreational activities, no support needed		7
Limited daily activities, support		4
Severe limitation of daily and recreational activities, walker, crutches, wheelchair, brace, etc.		0
<b>Maximum walking distance in blocks (equivalence in m)</b>		
> 6		5
4-6		4
1-3		2
< 1		0
<b>Walking surfaces</b>		
No difficulty on any surface.		5
Some difficulty on some surfaces, stairs, etc.		3
Severe difficulty on some surfaces, stairs, etc.		0
<b>Gait abnormality</b>		
None, slight		8
Obvious		4
Marked		0
<b>Sagittal plane motion (F/ E)</b>		
Normal or mild restriction (> 30°)		8
Moderate restriction (15 to 29°)		4
Severe restriction (< 15°)		0
<b>Motion inversion/ eversion</b>		
Normal/ mild restriction (75 to 100°)		6
Moderate restriction (25 to 74°)		3
Marked restriction (< 25°)		0
<b>Hindfoot instability</b>		
Stable		8
Unstable		0
<b>Alignment</b>		
Good, plantigrade foot, ankle-hindfoot well aligned		10
Fair, plantigrade foot, some degree of ankle-hindfoot malalignment observed, no symptoms		5
Poor, non-plantigrade foot, severe malalignment, symptomatic		0
<b>Total points</b>		<b>100</b>

F/E: flexion-extension.

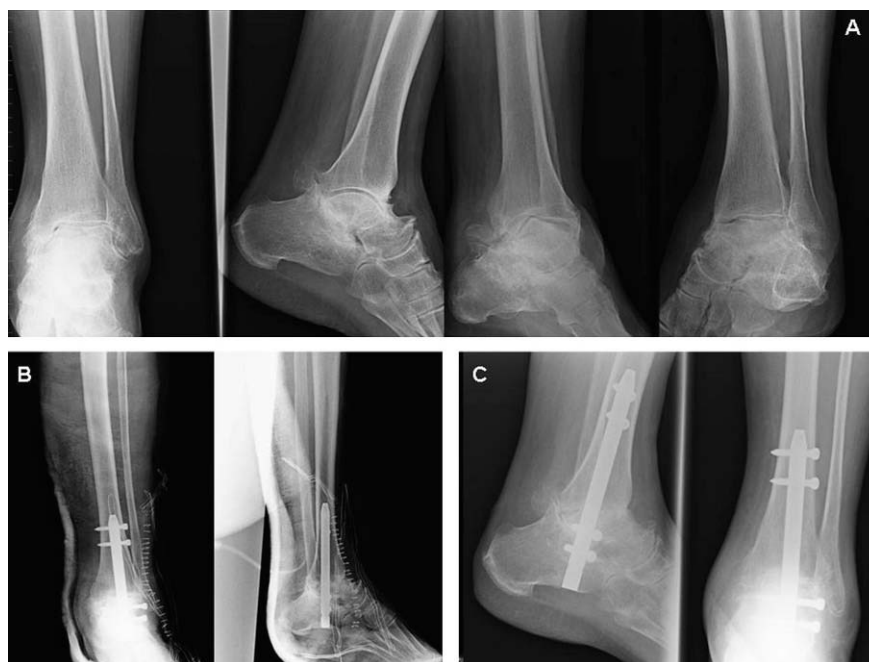
one case of a slight necrosis along the borders of the wound occurred, although it healed without problems, and another patient had a protrusion of the nail in the plantar zone, which was treated with a silicone heel cup after the patient refused extraction of the nail (fig. 5).

## Discussion

Injuries with simultaneous clinical symptoms of the tibiotalar and subtalar joints is one of the most difficult conditions that an orthopaedic surgeon of the foot and



**Figure 2** Surgical technique. A) Anterolateral incision approximately 6cm proximal and anterior to the tip of the fibular malleolus, then incurved in this zone until the base of the fourth metatarsal. B and C) Osteotomies were not performed on the 3cm distal to the fibula, allowing easy access to both joints. D) The articular surfaces were prepared along with a resection of the articular cartilage. E) The nail guide with a threaded point is inserted under radioscopic control. F) Progressive drilling through the guide. G and H) Once the desired nail is inserted, the alignment is tested and the external guider is put into place for insertion of the transversal screws at the proximal height of the tibia and distal height of the calcaneus.

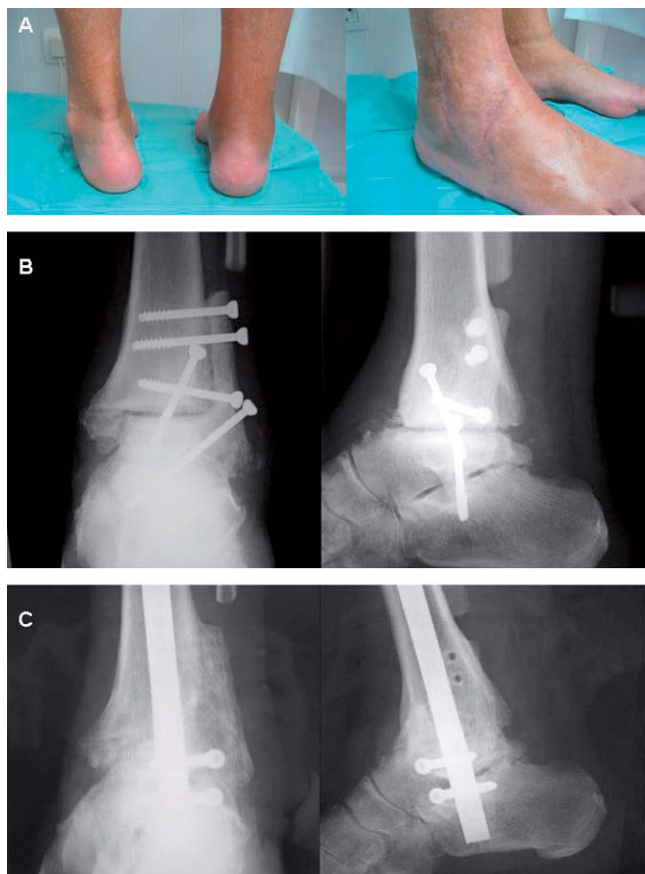


**Figure 3** Case No. 6. A) Initial anteroposterior, lateral, and oblique radiographic images. B) Postoperative radiographic images. C) Radiographic images at the end of the follow-up period.

ankle has to face, since these patients present with moderate to intense pain, major functional alterations, and in many cases, severe deformities that can have repercussions along the entire inferior limb.<sup>1-3</sup> The number of cases

published on the use of tibiototalcaneal arthrodesis with endomedullary nails has grown in recent years, although these are still the minority compared to other osteosynthesis techniques.<sup>4,18-27</sup>





**Figure 4** Case No. 2. A) Clinical images of the patient showing varus hindfoot and scarring from previous procedures. B) Initial radiographic images showing pseudoarthrosis following a previous attempt at arthrodesis. C) Initial radiographic images showing the pseudoarthrosis at the end of the follow-up period.

Tibiototalcaneal arthrodesis has classically been considered as a rescue or salvage surgery indicated in patients with moderate or intense pain, severe functional alterations, and important hindfoot deformities, as long as the tibiotalar and subtalar joints are both affected.<sup>1-4</sup> There are various methods that have been employed for fixation in tibiototalcaneal arthrodeses, including Steinmann nails<sup>3</sup> and screws, compression,<sup>28-30</sup> plates with screws,<sup>30</sup> 95° sheet plates,<sup>31-33</sup> external fixation,<sup>3,13,30</sup> endomedullary nails<sup>18-27,34</sup> and, more recently, intramedullary fibular grafts,<sup>35,36</sup> which are placed as a retrograde nail that provides a bone graft and fixation. The biomechanical studies available in the literature show superior results using endomedullary nails as opposed to the various constructions performed with cannulated screws on large fragments or external fixators, and similar to 95° sheet plates, with the advantage of having a lower rate of infection and injury to soft tissues.<sup>37-40</sup>

Retrograde locking nails provide a solid union, with a high rate of union and few complications, resulting in a high level of satisfaction in the patient.<sup>5</sup>

The approach can be lateral with an osteotomy of the 3cm distal to the fibula or not, above all when attempting

corrective osteotomies for malalignment of the hindfoot. McGarvey et al<sup>15</sup> recommend adding a medial approach to the lateral one with osteotomy of the tibial malleolus in order to mobilise the talocalcaneal complex 1cm medially with respect to the tibia, in order to avoid lesions of the plantar neurovascular bundle and so that the nail remains centred on the tibial diaphysis.<sup>15</sup> Other authors defend the trans-achilles posterior approach with the patient lying down prone, due to its advantages of greater accessibility to both articular surfaces and greater ease in placing the foot in the ideal position for arthrodesis.<sup>2,3</sup> The authors of this article prefer the lateral approach without osteotomy of the fibular malleolus because this allows excellent access to the tibiotalar and subtalar surfaces and because it allows corrective osteotomies for malalignments of the hindfoot with ease, and even medial translations of the talocalcaneal complex (as recommended by McGarvey et al),<sup>15</sup> so that the nail is centred on the tibial diaphysis. In cases with normal axes, access can be obtained through anterolateral and subtalar arthrotomies.

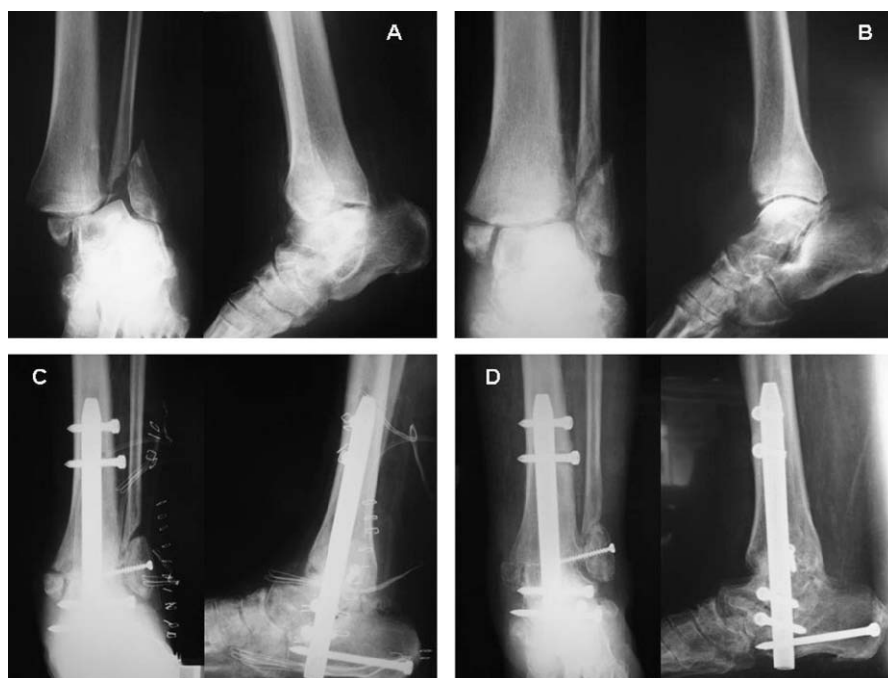
Other methods for arthrodesis are arthroscopic and MIS (minimal incision surgery) drill techniques.<sup>5</sup> Arthroscopy provides a great many advantages over open techniques, such as diminished time of immobilisation, higher rates of consolidation, lower rates of complication in the soft tissues and from infections, and reduced hospitalisation time. However, bad alignment of the sagittal plane or a marked anteroposterior translation of the tibiotalar joint are difficult to correct using arthroscopic techniques, as are cases of avascular necrosis, in which a bone graft is required and open surgical techniques must be used.<sup>5,41</sup>

Some authors, such as Boer et al,<sup>18</sup> recommend not performing a debridement of the subtalar joint from good results produced in a study of 50 patients.

Therefore, one could opt for an arthroscopic arthrodesis when there is no varus or valgus ankle deformity greater than 15° and with a minimum joint space for inserting the optics and the motor. In cases where there is no varus or valgus deformity, but neither is there a joint space, as in rheumatoid arthritis, an MIS technique could be used. If there is a severe deformity, a transmalleolar lateral approach is called for. The skin status must also be evaluated prior to surgery, since patients frequently have received previous interventions, and often have scarring or cutaneous/musculocutaneous skin grafts. As a general rule, incisions in areas that previously have presented with problems are unadvisable, and it is in these cases that a trans-achilles posterior approach could be used.<sup>5</sup>

The final objective is to get the foot into plantigrade position, where the hindfoot should be at 0 to 5° valgus, in neutral flexion, and with an external rotation similar to the contralateral foot.<sup>5</sup>

The most involved technique in using an endomedullary nail is the exact placement of the entry point, which is located at the intersection of the sagittal plane line, which goes from the second metatarsal to the centre of the heel, and the coronal plane line in the transition between the middle and distal third of the heel.<sup>2,16,17,42</sup> Flock et al<sup>16</sup> recommend performing this procedure with a transversal line slightly posterior to the middle line of the tibia, which avoids damaging the abductor digiti quinti nerve during dissection, as well as the lateral plantar nerve and artery.



**Figure 5** Case No. 3. A) Initial radiographic images following the fracture. B) Radiographic images at consultation. C) Postoperative radiographic images. D) Radiographic images at the end of the follow-up period. Note the light distal protrusion of the nail.

The use of endomedullary nails has the advantage over other fixation systems in tibiotalocalcaneal arthrodesis (screws and external fixation), in that it requires a shorter immobilisation period, provides greater multiplanar stability to the fixation, avoids the complications that arise in external fixation, provides greater control in rotational deformities, allows earlier weight bearing, and results in lower rates of nonunions and malunions.<sup>2,15-17,29,30,43</sup>

The mean time for fusion of the arthrodesis in this study was 18 weeks, similar to the time of 19 weeks presented by Chou et al.<sup>1</sup> All cases had fusion of the arthrodesis, with no delays in consolidation or material withdrawal. The indices of fusion oscillate in most reports between 93<sup>2</sup> and 100%.<sup>43</sup> AOFAS scores improved considerably in all studies (66 points Chou et al,<sup>1</sup> 74 points Mann et al,<sup>44</sup> and 67 points in the present study).

The principle complications associated with this technique are superficial and deep infections, sural neuromas, protuberance of the nail in the sole of the foot, stress reactions in the proximal area of the nail or the proximal locking screws, breaking of the distal screws, pseudoarthrosis, malpositioned consolidation, and shortening.<sup>1-3,29,43,45</sup> In this study there was one case of shortening greater than 1.5cm in which the gait was improved with lengthening, one protruding nail in the heel that was solved by a heel brace, and one slight necrosis of the edges of the wound that healed without further problems.

The use of endomedullary nails has been modified since the first constructions using non-specific retrograde nails (distal femoral nail, distal femoral T2, Marchetti-Vicenzi, etc.), finally arriving at the current specially designed nails. These have evolved since the first static designs to dynamic ones, with compression as the focus of arthrodesis,

anatomical nails, and the latest generation of nails with blocking/locking screws.<sup>46-49</sup> Modifications have also been implemented in the location of locking screws.<sup>50</sup> In distal locking, the most distal screw always penetrates the calcaneus (whether lateral or anteroposterior placement, depending on the type of nail used), but the most proximal tends to present problems, since the talus is often collapsed or necrotic, which means that either good fixation is not achieved or the subtalar or tibiotalar joint is pierced.

As a result, current locking procedure tends to go distally from posterior to anterior, increasing the bone fixation, since the screws press against the entire calcaneus and at least the neck and head of the talus, which increases stability and contributes to neutralise the sagittal forces that act on the zone of fusion.<sup>5</sup>

In summary, tibiotalocalcaneal arthrodesis is a technique indicated in patients with moderate or intense pain and an important functional incapacity caused by damage to the tibiotalar and subtalar joints, and as a salvage surgical procedure for failed arthrodeses and other techniques and arthroplasties; this is the technique of choice for these last cases. Broader studies with a longer follow-up period are needed in order to confirm these positive initial results.

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