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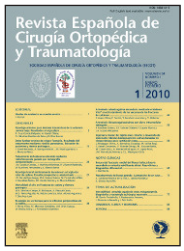

ORIGINAL ARTICLE

Evaluation of tibiotalocalcaneal arthrodesis using a retrograde nail as a rescue technique in 15 cases

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KEYWORDS
Retrograde nail;
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Abstract
Objective: To evaluate the usefulness of tibiotalocalcaneal arthrodesis using a retrograde nail as a rescue technique in patients with deformity and pain in the tibia-astragalus and sub-astragalus joints.
Material and method: A retrospective study of 15 consecutive cases (9 men, 5 women), with a mean age of 46 years, in whom a tibiotalocalcaneal arthrodesis using a retrograde nail was performed. Other measures had failed in all the patients. An anamnesis, physical and radiographic examination, details of previous treatments were carried out, as well as functional assessment using the American Orthopedic Foot and Ankle Society (AOFAS) scale and the degree of fusion after surgery with x-rays and CT.
Results: The most common indication was post-traumatic arthrosis 8 of the 15 cases, followed in frequency by primary arthrosis in 4 cases. Consolidation was achieved in 93% of cases (14 of the 15 patients) in a mean time of approximately 20 weeks and a mean follow up of 20 months. Complications were observed in 73%of patients, with delayed consolidation and pseudoarthrosis being the most important. The mean improvement on the AOFAS scale was 43.8 points, mainly due to the improvement in pain.
Conclusion: We agree with that published in the literature in considering this a useful rescue technique in patients where previous surgery has failed, and as a procedure of choice in patients with inflammatory arthritic disease. However, it is a demanding technique, with a high percentage of complications, and requires careful selection of the cases and a detailed dialogue on the expectations of the patients.

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PALABRAS CLAVE
Clavo retrógrado;
Artrodesis tibiotalocalcánea;
Escala AOFAS

Evaluación de los resultados de la artrodesis tibiotalocalcánea con enclavado retrógrado como técnica de rescate en 15 casos

Resumen
Objetivo: Evaluar la utilidad de la artrodesis tibiotalocalcánea mediante clavo retrógrado como técnica de rescate en pacientes con deformidad y dolor de las articulaciones tibioastragalina y subastragalina.
Material y método: Estudio retrospectivo de 15 casos consecutivos (9 hombres, 5 mujeres), edad media de 46 años, en los que se realizó una artrodesis tibiotalocalcánea con clavo retrógrado. En todos los pacientes habían fracasado otras medidas. Se realizó una anamnesis, exploración y estudio radiográfico detallados previa intervención, valoración funcional mediante la escala AOFAS y el grado de fusión tras la cirugía mediante estudio radiográfico y TC.
Resultados: La indicación más frecuente fue la artrosis postraumática en 8 de los 15 casos, seguida en frecuencia por artrosis primaria en 4 casos. Se obtuvo la consolidación en el 93% de los casos (14 de los 15 pacientes) en un tiempo medio aproximado de 20 semanas y un seguimiento medio de 20 meses. El 73% de los pacientes presentaron complicaciones siendo el retardo de consolidación y la pseudoartrosis las más importantes. La mejoría media en la escala AOFAS fue de 43,8 puntos, a expensas fundamentalmente de la mejoría del dolor.
Conclusión: Coincidimos con la literatura publicada en considerarla una técnica de rescate útil en pacientes en los que han fracaso cirugías previas y como procedimiento de elección en pacientes con artropatia inflamatoria. Sin embargo, es una técnica exigente, con un alto porcentaje de complicaciones, por lo que requiere una selección cuidadosa de los casos y un diálogo detallado sobre las expectativas de los pacientes.

Introduction

Tibiotalocalcaneal arthrodesis is a surgical rescue technique for patients whose ankle and subtalar joint surfaces are damaged, whether it is a primary condition, due to osteoarthritis, or secondary to inflammatory, rheumatic, or traumatic pathology,[1,2] who present with pain, functional limitation, and/or deformity that has not been controlled with conservative measures.[1] Although multiple arthrodesis methods have been described, tibiotalocalcaneal arthrodesis with retrograde nail offers the advantages of a minimally invasive technique that provides biomechanical stability and torsional rigidity superior to other arthrodesis methods[4-8] and a high degree of patient satisfaction, for it results in a non-painful, plantigrade foot, maintains alignment and length of the surgically treated extremity, and permits controlled early weight-bearing by virtue of the fact that it is a dynamic system.[3,9]

However, it is a demanding surgical technique associated with a high incidence of complications, which means that patient selection is important.[7,10,11] It is not indicated in patients with severe peripheral vasculopathy, active infection, subtalar joint integrity, or significant tibiotalar angular deformity, which complicates coaxial reduction.

The choice of surgical technique depends upon clinical factors, such as bone quality and condition of the soft tissue, as well as the surgeon's preference. In non-osteoporotic bone, fusion rates are similar whether intramedullary nailing or screws are used for the arthrodesis, and either of the two techniques may be employed.[12,13] However, when there is osteoporotic bone or poor bone quality, such as in patients with rheumatoid arthritis, intramedullary nails are preferable because they give better results; nailing is also recommended for patients with neuropathy because the intramedullary nail would hold the alignment firmly, and patients would have no sensory problems post-operatively due to the plantar insertion of the nail.[14] Nailing is also recommended when soft tissues are in poor condition because, in these cases, closure of the wound over a screw plate could be compromised. Arthrodesis with screw plate would be advisable in post-traumatic patients who have normal sensitivity and previous scars with good condition of the soft tissues.

This study attempts to evaluate tibiotalocalcaneal arthrodesis with retrograde nail as a rescue technique in patients in whom previous surgeries have failed, as well as to convey our impressions of the efficacy of this technique.

Materials and Methods

This is a descriptive, retrospective study of 15 cases of tibiotalocalcaneal arthrodesis with retrograde intramedullary nail performed on 14 patients (one case of bilateral arthrodesis) who were seen between 2000 and 2008 in the Foot and Ankle Surgery Unit at Hospital Universitario la Fe (Valencia) (table 1).

When the original manuscript was edited, one of the editors suggested eliminating the following paragraph: "The first 10 patients underwent surgery between 2004 and 2008 by the same surgeon, representing the continuation of the

Table 1 Summary of patients enrolled in the study

No.	Sex	Age	Side	DX	An	Appr	Implant	Size	Graft	Complication	Fusion	Satisfac.	Disability	Would undergo again	AOFAS pre-	AOFAS post-	F/U
1	Male	60	R	PT	SA	Double	DePuy + Orthomed	10×150	Fibula	Pseudarthrosis w/ re-arthrodesis + graft	17	Total	3 to 6	Yes	20	67	26
2	Female	54	L	IA	GA + PX	Double	DePuy	10×150	Fibula	No	21	Total	6 to 12	Yes	5	55	24
3	Male	45	R	PT	SA	Double	DePuy	10×150	Fibula	No	29	Total	< 3	Yes	0	65	15
4	Male	59	L	PO	SA	Double	DePuy	10×150	Iliac crest + fibula	Asymptomatic pseudarthrosis	21	Not satis	> 12	No	19	31	39
5	Female	61	L	PT	GA	Double	DePuy + Orthomed	10×150	Fibula	No	13	Partial	> 12	—	20	54	26
6	Female	20	R	PT	GA	Double	DePuy	10×150	Iliac crest + fibula	Delayed fusion	17	Total	3 to 6	Yes	—	73	29
7	Male	70	L	PO	SA	Double	DePuy	10×150	Fibula	Extrusion of distal screw	29	Total	< 3	Yes	20	62	24
8	Male	73	R	PO	SA	Double	DePuy	10×150	Fibula	Delayed fusion	No	Partial	6 to 12	Yes	35	60	12
9	Male	40	R	PT	SA	Double	DePuy + Orthomed	10×250	Iliac crest + fibula	Delayed fusion	46	Total	6 to 12	Yes	42	61	12
10	Female	54	L	PT	GA + PX	Double	DePuy + Orthomed	10×150	Fibula	Infection, delayed fusion	12.6	Partial	< 3	Yes	5	77	9
11	Female	28	—	N	3 GA, 2 SA	Lateral	Smith & Nephew	—	Fibula	Leg length discrepancy	20 (14-70)	—	—	—	18	83	12
12	Male	62	—	PO					Fibula	Infection					9	67	14
13	Male	55	—	IA					Fibula	No					18	64	18
14	Male	25	—	PO					Fibula	No					50	77	21
15	Male	24	—	PT					Iliac crest + fibula	Leg length discrepancy					Not eval.	63	24

DX: diagnosis (PT, post-traumatic osteoarthritis; IA, inflammatory arthropathy; PO, primary osteoarthritis; N, avascular necrosis). An: anaesthesia (SA, spinal anaesthesia; GA, general anaesthesia; PX, plexus). Appr: approach. Fusion: evaluated in weeks. Satisfac: patient satisfaction. Disability: evaluated in months. F/U: patient follow-up (in months).

study published by another of the authors[15] that reported on five consecutive cases operated on between 2000 and 2001 (table 1).

Of the 15 cases, the distribution by sex was 9 males (one patient with bilateral arthrodesis) and 5 females, with a mean age of 46 years (range of 20 to 70 years). Post-traumatic osteoarthritis and/or fracture sequelae were the most common surgical indications—in 8 of the 15 cases, representing 53% of the total (due to tibial pilon fracture, mainly, with or without associated calcaneus and talus fractures)—followed in frequency by primary osteoarthritis in 4 cases (27% of the total), 2 cases of inflammatory arthropathy (13% of the total), and 1 case of avascular necrosis of the talus (7%). Other treatments had failed in all these patients.

Pre-operative assessment

A detailed history was obtained on all patients with regard to aetiology, severity of the pain, and functional deficit. The clinical examination recorded painful points, range of motion, and ankle alignment using a goniometer. The radiological examination included an anterior-posterior x-ray of both feet in standing position and lateral x-rays. The workup was completed with oblique x-rays and computerized tomography in cases where there was doubt as to the involvement of the subtalar joint.[3] The AOFAS score[16,17] (Ankle-Hindfoot Scale, clinical rating system of the American Orthopaedic Foot and Ankle Society) was used pre-operatively and post-operatively as a functional assessment tool, together with a satisfaction survey.

Surgical technique

The anaesthetic technique most commonly employed was spinal anaesthesia (8 cases), followed in frequency by general anaesthesia alone (5 cases) and general anaesthesia combined with popliteal plexus block (2 cases).

Patients were placed in supine decubitus position on a radiotransparent table with a surgical drape pack under the ipsilateral buttock. The surgery was performed in a bloodless field through placement of a cuff at the proximal root of the ipsilateral thigh at a pressure of 100 mm Hg above the patient's systolic blood pressure.

As for surgical approach, a lateral transfibular approach alone was used in 5 cases, with resection of the last 3 centimetres of fibular malleolus (used as spongy graft), and a combined lateral and small medial approach was used in the remaining 10 cases. In 73% of cases (11/15 procedures), only an autologous graft from the resected fibular malleolus was used, while in the other 27% (4 procedures), the autologous fibular graft was combined with iliac crest graft because these were patients with severe post-traumatic bone defects (n=3) and previous failed arthrodesis with cannulated screws (n=1).

The nail insertion point was the intersection between the line joining the second metatarsal in the sagittal plane with the centre of the heel and another line joining the middle third and posterior third of the heel in the coronal plane. Through a 3-centimetre longitudinal incision, carefully making a blunt dissection so as not to damage neurovascular structures (lateral plantar artery and nerve and the abductor nerve for the fifth toe), the intramedullary guide was inserted under image intensifier control, keeping the foot in 5° valgus, neutral dorsiflexion, and 5-10° external rotation.

Sequential reaming was performed through a soft tissue protector, increasing the diameter in 1-mm increments via the guide, usually up to a diameter of 1 mm more than the desired nail. The nail was inserted, checking foot alignment, and the extracted graft was placed at the fusion point; the nail was tapped gently to promote compression of the arthrodesis area. Then, distal locking bolts were inserted in the talus and calcaneus in a lateral-medial transverse direction; the nail was again tapped lightly and locked in position proximally with transverse bolts in a medial-lateral direction.

In our review, the 10x150 mm VersaNail (DePuy®) retrograde intramedullary nail was used in the first 10 cases, supplemented with 1-2 Orthomed anteromedial staples in 4 of these 10 cases where, intraoperatively, torsional rigidity was found to be insufficient. In the remaining 5 patients, a retrograde nail for reconstruction (Smith & Nephew®) was used; its dimensions were not recorded.

Post-operative regimen

Antibiotic prophylaxis with a second-generation cephalosporin was initiated in the operating room and continued until the drains were removed at 24-48 hours. Likewise, antithrombotic prophylaxis was instituted, using low-molecular-weight heparin, and continued until the patient began weight-bearing with crutches. The wound was examined upon discharge from the hospital and thereafter at 1 and 2 weeks for staple removal. Patients were kept in a posterior splint for 6-8 weeks post-operatively; partial weight-bearing was then allowed using an orthotic system for unweighting the heel (CAM Walker®), and full weight-bearing was not permitted until there was x-ray evidence of fusion.

Results

Fusion was obtained in 93% of cases (14 of the 15 ankles) in a mean time of 20 weeks (shortest 12 weeks, longest 70 weeks) (fig. 1), with a mean follow-up time of 20 months (range of 9-39 months). The mean length of hospitalisation was 5.6 days (range of 3-9 days).

In 11 of the 15 cases (73% of the total number of patients), there were post-operative incidents: 2 cases of delayed fusion, resolved with dynamization of the nail at a mean interval of 4 months; 2 cases of pseudarthrosis (1 case of symptomatic tibiotalar pseudarthrosis, which was resolved by re-arthrodesis using a new, larger nail with a crest and BMP graft, and 1 case of clinically asymptomatic subtalar pseudarthrosis); 3 cases of leg length discrepancy, of which only 1 case required a shoe lift for a discrepancy of >1.5 cm; 2 cases of infection with good response to local treatments and antibiotic therapy; 1 dysaesthesia on the dorsal surface of the ankle that resolved spontaneously;

Figure 1 Mean time to fusion after surgery. Subject #8 developed a symptomatic tibiotalar pseudarthrosis that required another surgical procedure.

Figure 2 a) No incidents. b) Delayed fusion. c) Pseudarthrosis. d) Leg length discrepancy. e) Infection. f) Nerve lesion. g) Extrusion.

and, finally, 1 case of extrusion of the distal bolt, which was removed under local anaesthesia (fig. 2).

The mean improvement in AOFAS score was 43.8 points, from a mean pre-operative score of 19.8 to a mean post-operative score of 63.6, due primarily to pain reduction (fig. 3). The degree of patient satisfaction was evaluated: 7 patients (46% of the total) were completely satisfied; 4 patients (27%) were partially satisfied; and 4 patients (27%) were dissatisfied with the results, these being the youngest individuals in the study. Of the 15 patients, 9 patients (60%) responded affirmatively to the question of whether they would undergo the procedure again, 3 patients (20%) responded negatively, and the remaining 3 patients (20%) gave no response.

Figure 3 AOFAS scores, showing a significant improvement for all patients. There was no pre-operative score for subjects #6 and #15.

Discussion

With advancements in nailing technology, indications for the technique have steadily expanded; in some cases, it is no longer considered rescue surgery but rather the surgical technique of choice—especially in patients with osteoporotic bone and inflammatory arthropathies, where arthrodesis with retrograde intramedullary nail appears to achieve higher fusion rates than conventional arthrodesis methods.[14]

The most common surgical approach is the single transfibular approach with the patient in supine decubitus; a small medial approach may be added with osteotomy of the tibial malleolus, which enables the talo-calcaneal complex to be shifted medially so that the nail can be positioned more precisely in the centre of the tibia.[18,19] Other authors recommend the trans-Achilles approach with the patient in prone decubitus, which allows the surgeon to avoid old scars and achieves good exposure of the tibiotalar joint. However, because it complicates patient monitoring, this approach is not widely used by surgeons.

This surgical technique frequently requires use of the image intensifier, and many authors[20-23] have described anatomical landmarks that are helpful in locating the ideal point for inserting the nail into the calcaneus, thereby preventing needlessly prolonged exposure.

The fusion rates in our study (93%, 14 of 15 cases) and the mean time to fusion (20 weeks) are consistent with the data published by other authors. Fusion rates reported in the medical literature have been from 76% in 25 weeks (22 of 29 patients in the Goebel study[24]) to 95% in 20 weeks (19 of 20 patients in the Mendicino study[10]). The literature cautions that the rate of non-fusion is significantly higher for patients who smoke than for those who do not smoke;[25] in our study, patients' smoking habits could not be evaluated.

Some authors[26] warn that there are inferior results in patients with inflammatory arthropathies—lower fusion rates and more frequent complications. In our series, there were only 2 patients who had an inflammatory aetiology, and no differences were found between this subgroup and patients who had a non-inflammatory aetiology.

Although there were post-operative incidents in a high percentage of patients in our study (73%, 11 of the 15 cases), the only significant complications were 2 cases of pseudarthrosis, only 1 of which required intervention. It may be possible to achieve higher fusion rates with systematic dynamization of the nail at 6 weeks to 3 months in all patients. Extrusion of the distal locking screws (1 case in our series), which is also described in the literature[26] as a common complication, could be lessened with the distal lock placed in a posterior-anterior direction rather than a lateral-medial direction, since the former would secure it more firmly to the bony framework of the calcaneus.

Figure 4 Upper: preoperative clinical and x-ray images for study subject #7 (case of bilateral arthrodesis), in whom marked bilateral primary osteoarthritis is seen with obvious clinical deformity. Lower: post-operative clinical and x-ray images of the same subject, showing fusion of the arthrodesis performed on the left side and removal of the proximal block on the right side to promote arthrodesis of the tibiotalar surface.

We found no cases of deep infection or pandiaphysitis requiring, as a last resort, amputation of the operated extremity—a much-feared and not insignificant complication: 2 cases of amputation reported in the Kile study,[18] 2 cases of amputation in the Tavakkolizadeh study,[26] and 1 case of amputation in the Mendicino study.[10] The rate of complications was similar to that in our series: complications in 30 of 43 patients in the Fazal series,[27] of which 7 were delayed fusion and 4 were pseudarthrosis, and in 19 of 26 patients in the Tavakkolizadeh study,[26] with 2 cases of non-displaced fracture.

Some authors[18,28] have identified non-displaced stress fractures at the proximal locking screws and/or at the nail point—with both steel and titanium implants—that were resolved with immobilization. There was evidence of cortical hypertrophy as these fractures were healing but not prior to their appearance. The authors[18,28] also observed asymptomatic cortical hypertrophy at the nail tip in some patients and suggested that this could result from stress forces being concentrated at the nail tip. Because none of these patients subsequently developed a symptomatic stress fracture, it is not known whether this proximal cortical hypertrophy reaction represents the healing process of a subclinical stress fracture or a protective adaptive mechanism in response to symptomatic stress fractures. There were no cases of stress fracture in our study; however, a proximal cortical reaction was identified in 4 patients, all of them asymptomatic.

Performing open abrasion on the subtalar joint is of questionable benefit; it might improve the degree of fusion, but subtalar pseudarthrosis does not translate to pain, apparently. Only 1 patient in our series developed a subtalar pseudarthrosis; even though it was clinically asymptomatic, we cannot draw from it any conclusions on this matter. We believe that, in patients who have no subtalar joint involvement, it is important that this joint not be sacrificed; retrograde nailing should be rejected, and the surgeon should opt for another tibiotalar arthrodesis technique that respects the subtalar joint, thereby preserving foot inversion and eversion capabilities.

Clinical improvement in the patients in our study, as assessed by the AOFAS score, was basically due to pain reduction; scores changed from a mean of 19.8, pre-operatively, to a mean of 63.6, post-operatively—similar to the degree of improvement achieved in other studies.[3,14,24,26,29] The lowest scores on the AOFAS scale corresponded to the youngest patients, who had great expectations in terms of functional demands following surgery; therefore, it is very important to make it clear to patients that the primary objective of this procedure is to eliminate or reduce pain and that they will continue to have functional limitations (fig. 4).

We may conclude that 1) tibiotalocalcaneal arthrodesis with retrograde intramedullary nail is an effective surgical technique in patients with involvement of the tibiotalar and subtalar joint surfaces who have uncontrolled pain and for whom other surgical techniques have failed, and 2) it is the technique of choice in patients with inflammatory arthropathy because it is associated with fewer complications and a higher fusion rate than classical arthrodesis techniques using plates and screws. It is a demanding surgical technique, however, with a high percentage of complications, which requires that patients be carefully selected and informed in detail as to expectations for the procedure.

Level of evidence

Level of evidence IV.

Conflict of interest

The authors declare that they have no conflict of interest.

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