



## Arthroscopic tibiototalcalcaneal arthrodesis in neurological pathologies : outcomes after at least one year of follow up

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The main complications of open tibiototalcalcaneal arthrodesis are wound healing disorders and nonunion. Our hypothesis was that arthroscopy and interlocking intramedullary nailing decrease these complications.

We retrospectively reviewed six patients (mean age : 58 years ; mean preoperative Kitaoka score : 51/100) having undergone arthroscopic tibiototalcalcaneal arthrodesis with retrograde intramedullary nailing between January and November 2011 for equinus deformity of the hindfoot and subtalar instability of neurological origin.

Postoperative pain disappeared completely in four cases, one patient presented some pain associated with projection of the proximal locking screw head under the skin and the remaining patient presented fibular tendinitis that resolved after infiltration of anti-inflammatory drugs. The mean postoperative Kitaoka score was 64/100. None of the patients presented any wound healing complications or nonunion. The observed incidence of wound complications and bone consolidation disorders after tibiototalcalcaneal arthrodesis was lower than the ones reported for open tibiototalcalcaneal arthrodesis.

Level of clinical evidence IV : retrospective case series.

**Keywords :** arthroscopy ; tibiototalcalcaneal arthrodesis ; intramedullary nailing ; ankle.

### INTRODUCTION

Indications of tibiototalcalcaneal arthrodesis include osteoarthritis (usually as a result of trauma), osteonecrosis of the talus, chronic inflammatory diseases, diabetic neuropathic arthropathy, chronic ankle instability, failure of talocrural Arthroplasty or arthrodesis and deformities of the hindfoot of neurological origin that made plantigrade position and stable walking impossible. This procedure remains a challenge for the surgeon because of the non-negligible risk of postoperative complications. The two most frequent complications risks are nonunion (at one or both levels) and wound healing disorders up to 20% in some series (18). These complications are more common with certain risk factors, such as : arterial occlusive disease of the lower limbs, peripheral neuropathy (often as a result of

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diabetes, inflammatory disease, chronic alcohol intoxication, etc.), trauma or damage to the central nervous system (stroke, multiple sclerosis, etc.), old age, immunosuppression, previous surgery or poor compliance. Many techniques for tibiotalocalcaneal arthrodesis have been described since Merle d'Aubigné's initial report in 1948. Most recently, Devos-Bevernage (3) described the performance of arthroscopic arthrodesis via a posterior approach.

To investigate the value of arthroscopy in dual arthrodesis of the hindfoot fixed by intramedullary nailing, we reviewed a series of patients operated on in our institution.

### MATERIALS AND METHODS

This was a retrospective, single-centre study of six patients (three men and three women) having undergone arthroscopic tibiotalocalcaneal arthrodesis between January and November 2011 in our department. All operations were performed by the same surgeon. Prior to surgery, all the patients presented neurological painful equinus deformity and subtalar instability that resisted to medical treatment (analgesic drugs, local care and orthopaedic shoes), making stable plantigrade position impossible. The extensor and evertor/invertor muscles of the ankle were paralyzed or very deficient in all cases. Two non-walking patients had a chronic impingement with the outside edge of the foot. This hypersupination induced recurrent wounds and could not be corrected by use of an orthopaedic shoe. One patient had Charcot-Marie-Tooth disease and the other five were hemiplegic. The study population's mean age was 58 years (range : 40 to 74) at the time of surgery. The operation concerned three left ankles and three right ankles. The mean preoperative Kitaoka score (10) was 51 out of 100 (range : 43 to 59) (Table I). All patients had multiple cardiovascular risk factors such as : smoking (4/6), arterial hypertension (2/6), hypercholesterolaemia (2/6) and two patients had these three factors combined. Two patients had antecedent of deep vein thrombosis and three had venous insufficiency of the lower limbs (one varicose veins and two postphlebotic diseases). Anteroposterior and lateral X-rays was performed preoperatively in order to analyse the bone quality and the articular deformation (Fig. 1).

The surgical technique was the same for all patients. The patient lay in the prone position, with the foot protruding over the edge of the operating table. First, percutaneous Achilles tendon lengthening was performed. Next, optics and instruments were introduced via two

posterior, arthroscopic approaches (one lateral and one medial). In order to visualize the posterior tibiotalar and talocalcaneal interlines correctly, a workspace was created with a radiofrequency system (VAPR™, Depuy Orthopaedics, Inc., Warsaw, IN, USA) and a bone shaver. The tendon of the flexor hallucis longus was identified because it determined the boundary of posteromedial debridement. This tendon was cut in a case of interphalangeal joint flexion contracture of the hallux. Joints were heightened with a shaver and curettes, in order to expose subchondral bone. All ankles were fixed by intramedullary nailing with the T2™ system (Stryker Orthopaedics, Kalamazoo, MI, USA). Next, a plantar approach was made along the axis of the fourth metatarsal, just in front of the heel-ground contact point. A guide wire was placed into the tibial shaft under X-ray guidance and the bone was reamed progressively. Next, the nail was introduced and locked dynamically. Distractors were not used in our surgical procedure. The mean length of postoperative hospital stay was 8 days (range : 5 to 10).

All patients were reviewed clinically and radiologically at least 12 months after surgery. The Kitaoka score was established. Anteroposterior and lateral X-rays and a weight-bearing Méary-Tomeno view X-ray were performed (Fig. 2), in order to check the bone's consolidation and the hindfoot axis. Weight-bearing X-rays was only realized for four patients because the other two were not able to stand up (due to poor balance).

### RESULTS

The patients were reviewed after a mean follow-up period of 17 months (range : 12 to 22). No skin or infectious complications were observed. Four patients were completely pain-free. One patient presented pain related to projection of the head of the proximal locking screw into the anteromedial aspect of the leg. The remaining patient presented pain on the side of the ankle while walking as a result of fibular tendonitis, which resolved after infiltration of anti-inflammatory drugs. Arthrodesis enabled all the patients to achieve upright stance with a clinically well-aligned hindfoot and an ankle in a neutral flexion/extension position. All patients left their orthopaedic shoe. Four patients were able to walk with a cane and a stable hindfoot. The other two patients succeeded in doing their transfers supporting in full weight-bearing on the operated foot without recurrence of their bedsores. The mean

Table I. — Preoperative and postoperative data on the study population

	Age	Gender	Side	Preop. Kitaoka score	Diagnosis	Postop. Kitaoka score	Time to consolidation	Postop. hindfoot axis
Patient 1	61	F	R	43	Hemiplegia/stroke	72	3 months	Valgus
Patient 2	70	F	L	53	Charcot-Marie-Tooth	67	2.5 months	Valgus
Patient 3	40	M	L	59	Hemiplegia/stroke	74	3 months	Valgus
Patient 4	74	M	L	50	Hemiplegia/stroke	60	3 months	Valgus
Patient 5	58	M	R	56	Hemiplegia/stroke	48	3 months	Valgus
Patient 6	45	F	R	45	Hemiplegia/stroke	60	3 months	Valgus

Legend : F : female ; M : male ; R : right ; L : left ; Preop. : preoperative ; Postop. : postoperative.



**Fig. 1.** — Preoperative radiographs of the ankle : weight-bearing (for measurement of Méary's angle).

postoperative Kitaoka score was 64 (range : 48 to 74) (Table I). Full consolidation of the arthrodesis was obtained in all cases. The mean consolidation time was 2.9 months (range : 2.5 to 3). Control X-

rays did not evidence any osteolysis or secondary displacement of the material. In the four hindfeet evaluated with a weight-bearing X-ray, the hindfoot was normally aligned (according to Méary's angle).

An intraoperative complication (a short, oblique fracture of the tibial shaft) was observed during the introduction of the nail. The problem was treated orthopaedically, with the use of a resin boot. The patient's time to discharge was not significantly modified.

## DISCUSSION

Our present results were in agreement with the literature data in favour of arthroscopic technique. Risk factors for poor wound healing were established by DeVries *et al* (4) as diabetes, revision surgery, age and preoperative ulcer. Authors also insisted on the risk of wound complication in case of : smoking, neuropathy, diabetes and others. Gordon *et al* (7) reviewed 82 consecutive primary open ankle fusions and found a complication rate of 57% in a group of smokers compared with 21% in their whole group. In our series, all patients had neuropathy, four patients were smokers and three patients had venous insufficiency. Despite these risk factors, we did not have wound healing complication or delayed union.

This study presented some limits : the functional score used could be a subjective score as the Foot Function Index (FFI). It would improve the analysis of the quality of life of patients but it was impossible to realize it preoperatively through a retrospective cases review. We used the Méary-Thomeno



**Fig. 2.** — Postoperative radiographs of the ankle : lateral (a) and weight-bearing (for measurement of Méary's angle) (b).

view to measure the axis of the hind-foot of the patients because it was usual in our department and we realized the same views at last follow up to obtain comparable values preoperatively and postoperatively. At last, the small number of patients did not allow us to conclude but gave preliminary results.

Many reports on isolated arthroscopic talocrural or subtalar arthrodesis have been published. The latter researchers found that these techniques were associated with a relatively low postoperative compli-

cation rate, reduced use of analgesics and shorter hospital stays. Zvijac *et al* (20) demonstrated that the preservation of peri-articular soft tissue decreased bone devascularization and the risk of nonunion. Furthermore, Myerson *et al* (12) showed that the shape of the joint line could be followed more easily with an arthroscopic technique, resulting in optimal contact between the bone surfaces.

We observed an intraoperative complication in one patient (a short, oblique fracture of the tibial

shaft during introduction of the intramedullary nail). This fracture did not significantly modify the subsequent surgical procedures and care.

Devos-Bevernage (3) did not observe any complications in a small group of patients (n = 3) who underwent tibiotalar fusions with conventional arthroscopic approaches. All fusions were consolidated at both levels within 12 weeks and all patients showed a postoperative improvement in the American Orthopaedic Foot and Ankle Society score. They described an accessory-fluoroscopically-guided lateral incision, performed in order to distract the subtalar joint with a trocar in order to facilitate the debridement but this procedure was not required in our series.

Sekiya *et al* (16,17) studied a series of nine arthrodeses (in eight patients) after a mean follow-up period of 41 months. The patients underwent arthroscopic talocrural arthrodesis with an anterior approach and subtalar fusion via a one cm mini-open lateral approach through the sinus tarsi, in the absence of arthroscopic control. This technique is associated with a risk of talar devascularization because it damages the arterial branch near the roof of the sinus tarsi that supplies blood to the posterior two thirds of the talus (15). Fixation was performed with a screw-locked intramedullary nail with fins. The only complication described in this series is a case of subtalar non-union.

For simultaneous talocrural and subtalar arthrodesis, intramedullary nailing appears to be biomechanically superior to other means of fixation (11), especially in terms of rotation control. The technique has been improved by the development of specific implants and the optimization of distal, posterior-to-anterior calcaneal locking. In a series of 55 patients, Chou *et al* (2) recorded a consolidation rate of 86% and a complication rate of 30%, with nonunion (n = 8), superficial infection (n = 5), deep infection (n = 1), skin necrosis (n = 1), scar granuloma (n = 1), neuroma of the sural nerve (n = 1) and stress fracture (n = 1). Similarly, Hammett *et al* (8) reported a consolidation rate of 88% and a major complication rate of 25%, with nonunion of the subtalar joint (n = 4), nonunion of the tibiotalar joint (n = 2), postoperative tibial fracture near the extremity of the nail (n = 3), deep infection

(n = 1), implant fracture (n = 1) and amputations (n = 2). Niinimäki *et al* (13) observed a consolidation rate of 76% (85% for the tibiotalar line and 88% for the subtalar line) and a complication rate (excluding nonunions) of 15%, with 4 cases of deep infection and one case of deep vein thrombosis. In a series of 33 operations (on 32 patients) with a dynamic locking nail, Pelton *et al* (14) reported cortical hypertrophy near the extremity of the nail (due to the movement of the locking screw) in 13 cases (39%). We did not observe this phenomenon in the present series. Although we do not have any experience of the nail with fins developed by Fujimori (6), this appears to be another means of controlling rotation.

In the five series mentioned above, a total of 184 patients underwent open, tibiotalar arthrodesis with a lateral, transmalleolar approach and intramedullary nailing. The fixation was static in 55 cases (30%), static with compression in 81 cases (44%) and dynamic in 48 cases (26%). The nonunion rates in these groups were 15%, 17% and 8%, respectively (Table 2). There were no significant intergroup differences in the nonunion rate (p = 0.23). In our series (using dynamic fixation), we did not observe any nonunions of the tibiotalar or talocalcaneal lines. Dynamic fixation may thus favour consolidation.

Open arthrodesis consolidation rates have been improved by the use of autologous cancellous or tricortical bone taken from the iliac crest and frozen or freeze-dried allograft, cortical allograft and corticocancellous, cancellous and demineralized bone matrix. The techniques stimulate bone growth and thus consolidation when a large quantity of bone has been lost during the correction of extensive deformities (1,3,5). Another advantage of nailing relates to medullary reaming, which provides a source of bone material for the arthrodesis. Arthroscopy enables preservation of the joint capsule and the reaming product is kept within the site of arthrodesis level (3). In the present series, we did not need to use bone material to facilitate consolidation.

So far, Devos-Bevernage (3) is the only author to have used a strictly arthroscopic technique. We share his view that open arthrodesis is more effective

Table II. — Incidence of nonunion in five series of tibiotalocalcaneal arthrodeses, as a function of the type of locking

Series	Type of locking	Cases number	Nonunions number
Chou <i>et al</i> (31)	Static	55	8 (15%)
Hammett <i>et al</i> (32)	Static with compression	47	6 (13%)
Niinimäki <i>et al</i> (33)	Static with compression	34	8 (24%)
Pelton <i>et al</i> (34)	Dynamic	33	4 (12%)
Fujimori <i>et al</i> (35)	Dynamic	15	0

than arthroscopic arthrodesis in the correction of extensive deformities.

### CONCLUSION

Tibiotalocalcaneal arthrodesis with intramedullary nailing is indicated for many diseases of the hindfoot and can restore upright stance in patients with deformities of neurological origin. According to the literature, arthroscopy improves immediate and late postoperative outcomes. It decreases postoperative pain, reduces the incidence of wound healing disorders and (when combined with retrograde intramedullary nailing) improves the consolidation rate at both levels of the arthrodesis. The results of our present series were in line with the literature. However, open arthrodesis appears to be preferable for extensive deformities.

### REFERENCES

- Boer R, Mader K, Pennig D, Verheyen CCPM.** Tibiotalocalcaneal arthrodesis using a reamed retrograde locking nail. *Clin Orthop Relat Res* 2007 ; 463 : 151-156.
- Chou LB, Mann RA, Yaszay B *et al*.** Tibiotalocalcaneal arthrodesis. *Foot Ankle Int* 2000 ; 21 : 804-808.
- Devos-Bevernage B, Deleu PA, Maldague P, Leemrijse T.** Technique and early experience with posterior arthroscopic tibiotalocalcaneal arthrodesis. *Orthop Traumatol Surg Res* 2010 ; 96 : 469-475.
- Devries JG, Berlet GC, Hyer CF.** Predictive Risk Assessment for Major Amputation After Tibiotalocalcaneal Arthrodesis. *Foot Ankle Int* 2013 ; 34 : 846-850.
- Ebraheim NA, Elgafy H, Stefancin JJ.** Intramedullary fibular graft for tibiotalocalcaneal arthrodesis. *Clin Orthop Relat Res* 2001 ; 385 : 165-169.
- Fujimori J, Yoshino S, Koiwa M *et al*.** Ankle arthrodesis in rheumatoid arthritis using an intramedullary nail with fins. *Foot Ankle Int* 1999 ; 20 : 485-490.
- Gordon D, Zicker R, Cullen N, Singh D.** Open Ankle Arthrodeses via an Anterior Approach. *Foot Ankle Int* 2013 ; 34 : 386-391.
- Hammett R, Hepple S, Forster B, Winson I.** Tibiotalocalcaneal (hindfoot) arthrodesis by retrograde intramedullary nailing using a curved locking nail. The results of 52 procedures. *Foot Ankle Int* 2005 ; 26 : 810-815.
- Lafenetre O., Solofomalala D., Villet L., Chauveaux D.** Arthrodesè tibio-talocalcanéenne par clou rétrograde. *Chirurgie de la cheville et du pied*. Elsevier-Masson, Paris, 2009, pp 379-87.
- Kitaoka HB, Romness DW.** Arthrodesis for failed ankle arthroplasty. *J Arthroplasty* 1992 ; 7 : 277-284.
- Mann MR, Parks BG, Pak SS, Miller SD.** Tibiotalocalcaneal arthrodesis : a biomechanical analysis of the rotational stability of the Biomet Ankle Arthrodesis Nail. *Foot Ankle Int* 2001 ; 22 : 731-733.
- Myerson MS, Quill G.** Ankle arthrodesis. A comparison of an arthroscopic and an open method of treatment. *Clin Orthop Relat Res* 1991 ; 268 : 84-95.
- Niinimäki TT, Klemola T-M, Leppilahti JI.** Tibiotalocalcaneal arthrodesis with a compressive retrograde intramedullary nail : a report of 34 consecutive patients. *Foot Ankle Int* 2007 ; 28 : 431-434.
- Pelton K, Hofer JK, Thordarson DB.** Tibiotalocalcaneal arthrodesis using a dynamically locked retrograde intramedullary nail. *Foot Ankle Int* 2006 ; 27 : 759-763.
- Rammelt S, Zwipp H.** Talar neck and body fractures. *Injury* 2008 ; 40 : 120-135.
- Sekiya H, Horii T, Kariya Y, Hoshino Y.** Arthroscopic-assisted tibiotalocalcaneal arthrodesis using an intramedullary nail with fins : a case report. *J Foot Ankle Surg* 2006 ; 45 : 266-270.
- Sekiya H, Horii T, Sugimoto N, Hoshino Y.** Arthroscopic tibiotalocalcaneal arthrodesis with intramedullary nail with fins : a case series. *J Foot Ankle Surg* 2011 ; 50(5) : 589-592.
- Trombert D., Hammel E.** Arthrodesè tibio-talocalcanéenne par enclouage transplantaire : complications vasculaires et neurologiques. A propos de 11 cas. *Médecine et chirurgie du pied* 2010 ; 26 : 24-32.
- Van Dijk CN.** Hindfoot endoscopy. *Foot Ankle Clin* 2006 ; 11 : 391-414.
- Zvijac JE, Lemak L, Schurhoff MR *et al*.** Analysis of arthroscopically assisted ankle arthrodesis. *Arthroscopy* 2002 ; 18 : 70-75.