

Original Article

Acute retrograde tibiototalcalcaneal nailing in osteoporotic periarticular ankle fractures

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Abstract

Objective: This study aimed to report the short-term results of retrograde tibiototalcalcaneal (TTC) nailing in a selected series of patients with fragility ankle fractures.

Methods: This study included 17 patients who underwent primary retrograde TTC nailing from January 2016 to April 2019. The Olerud-Mo-lander ankle score (OMAS) was recorded preoperatively and at the final follow-up.

Results: Mean patient age was 81.5 years (range, 67-91 years), and mean follow-up duration was 20.9 months (range, 8-50 months). No patient was lost to follow-up. Eleven patients had diabetes. Thirteen patients were able to walk with an assistive device, and 4 with help from another person. Two patients died at 8 and 9 months after treatment. Radiographic healing was observed in 100% of the fractures. No deep infection or scarring problems were recorded. Two patients were wheelchair bound after treatment, whereas 15 recovered their previous autonomy. The mean OMAS score changed from 64.1 (range, 55-75) preoperatively to 55.3 (range, 45-65) postoperatively.

Conclusion: Our results suggest that primary retrograde TTC nailing is a valid option in selected patients with fragility ankle fractures, multiple comorbidities, poor soft tissue condition, and difficulty in walking before the fracture.

Level of Evidence IV; Therapeutic Studies; Case Series.

Keywords: Ankle fractures; Osteoporotic fractures; Aged; Fracture fixation, intramedullary/methods; Tibial fractures/surgery.

Introduction

Osteoporotic fractures are becoming more frequent due to increasing life expectancy in the developed world, and ankle fractures are no exception. In older adults, ankle fracture is the third most common fracture type, after hip and wrist fracture, with an incidence of 184 cases per 100 000 population⁽¹⁾. Difficulties in managing these fractures in older patients are associated with osteoporosis, which produces more complex fracture patterns with greater inherent instability⁽²⁻⁴⁾.

Multiple treatment options are available for ankle fractures, but open reduction and internal fixation (ORIF), aiming to achieve absolute stability, remains the gold standard. However, conventional ORIF is contraindicated in older patients due to injury-related factors (e.g., swelling, dislocation, and skin damage) or patient-related factors (e.g., advanced age, pre-

existing poor skin condition, systemic disorders, and impaired mobility).

Conservative treatments are often not well tolerated by older people⁽⁵⁻⁸⁾. Desirable goals in the older population with periarticular ankle fracture include stable fixation of usually unstable fractures, minimally invasive technique to protect soft tissue coverage, the least aggressive surgical procedure (only one surgery, only one anesthesia), and early weight bearing and mobilization to avoid the effects of prolonged immobilization (e.g., deep vein thrombosis, pneumonia, and bed sores).

Tibiototalcalcaneal (TTC) nailing has been a valid treatment option for osteoporotic ankle fractures in the acute phase. Several studies have been published since 2005 with satisfactory functional results in selected patients, with a low rate of complications⁽⁹⁻¹⁸⁾.

Study performed at Hospital Universitario de Canarias, Tenerife, Spain.

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The objective of this study was to report the short-term functional results of the treatment of osteoporotic periarticular ankle fractures with TTC nailing and to provide an update of the available literature addressing this topic.

Methods

After approval by the Local Ethics Committee, we conducted a retrospective study of a series of 17 consecutive patients treated with a retrograde TTC nail for fragility fractures of the ankle or distal tibia from January 2016 to April 2019. The inclusion criteria were age >65 years, periarticular fragility fracture of the ankle (defined as injury secondary to a low-energy mechanism, such as a simple twist or a fall from one's own height, or any fracture in a patient previously diagnosed with osteoporosis), and surgical treatment with TTC nailing at the surgeon's discretion, with a follow-up of at least 6 months.

Epidemiological variables were recorded, including walking ability (Table 1), intraoperative and postoperative complications, mean hospital stay, and patient outcome. Patients were followed up with regular appointments at 2 weeks postoperatively for wound check, and at 6 weeks and 3, 6, and 12 months postoperatively for clinical and radiographic evaluation. The Olerud-Molander ankle score (OMAS) was used for clinical assessment (Table 2)⁽¹⁹⁾.

Table 1. Demographic characteristics

Population	17
Female	16 (94.1%)
Male	1 (5.9%)
Age (years)	81.5 (67-91)
Female	81.3 (67-91)
Male	84 (84)
ASA score	2.1 (1-3)
Diabetes mellitus	
No	6 (35.3%)
Yes	11 (64.7%)
Type of fracture	
Bimalleolar fracture	5 (29.4%)
Trimalleolar fracture	6 (35.3%)
Fracture-dislocation	5 (29.4%)
Tibial pilon	1 (5.9%)
Preoperative OMAS	64.1 (55-75)
Open/closed fracture	
Closed	12 (70.6%)
Open Gustilo-Anderson I	1 (5.9%)
Open Gustilo-Anderson II	3 (17.6%)
Open Gustilo-Anderson III	1 (5.9%)
Walking ability	
Walks independently	0
Alone with an assistive device	13 (76.5%)
With help from another person	4 (23.5%)

ASA: American Society of Anesthesiology. OMAS: Olerud-Molander ankle score.

Table 2. Olerud-Molander ankle score (OMAS)

Parameter	Degree	Score
Pain	None	25
	While walking on uneven surface	20
	While walking on even surface outdoors	10
	While walking indoors	5
	Constant and severe	0
Stiffness	None	10
	Stiffness	0
Swelling	None	10
	Only evenings	5
	Constant	0
Stair climbing	No problems	10
	Impaired	5
	Impossible	0
Running	Possible	5
	Impossible	0
Jumping	Possible	5
	Impossible	0
Squatting	No problems	5
	Impossible	0
Supports	None	10
	Taping, wrapping	5
	Stick or crutch	0
Work, activities of daily life	Same as before injury	20
	Loss of tempo	15
	Change to a simpler job/part-time work	10
	Severely impaired work capacity	0

Our results were compared with those reported in the literature by searching PubMed electronic database with the following keywords: "fragility ankle fractures and nail", "fragility ankle fractures and retrograde nailing". Articles were included if they treated fractures of the ankle or tibial pilon with retrograde solid nailing. Cadaveric studies, biomechanical studies, and studies using fixation methods other than a nail were excluded.

Surgical technique

Patients received a single dose of antibiotic prophylaxis (cefazolin 2 g). The procedure was performed with the patient in supine position under general or spinal anesthesia at the anesthesiologist's discretion (sciatic nerve block was performed in 3 patients at high anesthetic risk). No tourniquet was applied in any case (Figure 1). The nail entry point was determined in the external plantar region at the center of the lateral column of the calcaneus. The fracture was reduced under radioscopic control. A guide wire was inserted, followed

by progressive reaming to 11 mm and insertion of an angled retrograde titanium nail (Expert-HAN, Synthes) of 10 mm in diameter and 18 cm in length (Figure 2). Neither the subtalar joint nor the tibiotalar joint was addressed in any case because the procedure did not pursue the arthrodesis of these joints. The wound was closed, and a compression bandage was applied. The mean operative time was 48 minutes (range, 35-93 minutes). There were no intraoperative complications.

Postoperative protocol

At 48 hours after admission, the wound was checked and the patient was discharged if there were no complications. Full weight bearing was allowed as tolerated and protected by the use of a CAM walker boot for 6 weeks. The stitches were removed after 3 weeks.



Figure 1. Patient in position. Note the poor condition of soft tissues.



Figure 2. Immediate postoperative result.

Results

The sample consisted of 16 women and 1 man, with a mean age of 81.5 years (range, 67-91 years). Mean follow-up duration was 20.9 months (range, 8-50 months). No patient was lost to follow-up, but 2 patients died at 8 and 9 months after treatment (Table 3).

Radiographic healing was observed in 100% of the fractures. In 5 cases, a complete arthrodesis of the ankle joint was achieved with a simple reamed nail (Figure 3).

Complications included 1 superficial infection, 1 symptomatic nonunion of the subtalar joint, and 1 distal screw loosening. No deep infection, scarring problems, peri-implant fracture, or nail failure were recorded. The mean OMAS changed from 64.1 (range, 55-75) preoperatively to 55.3 (range, 45-65) postoperatively.

None of the patients could walk independently before surgery. After treatment, 2 patients could no longer walk and were wheelchair bound, whereas 15 recovered their previous autonomy (Figure 4).

Table 3. Results

Follow-up (months)	20.9 (8-50)
Complications	4 (23.5%)
Deaths	2 (11.8%)
Postoperative OMAS	55.3 (45-65)
Walking ability	
Alone with an assistive device	10 (58.8%)
With help from another person	5 (29.4%)
Wheelchair bound	2 (11.8%)
Radiographic union	17 (100%)
Spontaneous ankle fusion	5 (29.4%)

OMAS: Olerud-Molander ankle score.



Figure 3. An 86-year-old woman who sustained an ankle fracture-dislocation (A). Note the poor condition of soft tissues (B). Spontaneous fusion of the tibiotalar joint without cartilage removal (C).



Figure 4. Good outcome at 3 months.

Discussion

Osteoporotic fractures of the ankle in frail older people present a serious therapeutic challenge for the orthopedic surgeon for multiple reasons: poor bone quality secondary to osteoporosis, poor condition of soft tissue coverage, instability patterns and comminuted fracture, in addition to the high comorbidity in this population^(1,4). These particularly frail patients are poor candidates for conservative treatment, especially in cases of unstable ankle fractures, because long immobilization and non-weight bearing periods can lead to local complications (pressure ulcers, deep vein thrombosis) and medical problems (pneumonia, pulmonary thromboembolism)^(2,3,13).

Although ORIF remains the gold standard treatment, it has been associated with a high complication rate in the older population, leading to the use of other methods^(5,6). A surgical technique that meets the requirements of sufficient primary stability and minimal soft tissue aggression and that allows early mobilization and weight bearing in these frail patients would therefore be desirable.

TTC nailing has been used as a salvage procedure after failed osteosynthesis or failure of conservative treatment^(7,14,15). However, over the past 10 years, interest has grown in the use of TTC nailing as a treatment option for unstable fractures in selected patients. Based on data from the literature and our own experience, retrograde TTC nailing as a method of osteosynthesis in unstable osteoporotic periarticular ankle fractures in frail patients with difficulty in walking without assistance is a highly satisfactory technique⁽⁹⁻¹²⁾.

Since 2005, 10 studies have been published on the treatment of these fractures with retrograde TTC nailing (Table 4). Most of these studies reported satisfactory functional results and low complication rates⁽⁹⁻¹⁸⁾. In 2005, Lemon et al.⁽⁹⁾ published the first article on this technique: a case series of

12 patients (mean age, 84 years; follow-up, 67 weeks), achieving good functional results and early full weight bearing in all patients. However, although the patients' medical history was reported, the authors failed to report the inclusion criteria that led to treatment with a TTC nail. In 2008, Amirfeyz et al.⁽¹⁰⁾ published a retrospective study of 13 patients (mean age, 79 years; follow-up, 11 months) and reported early hospital discharge, functional outcome comparable to the preoperative status, fracture healing, and no complications; however, the inclusion criteria were not well defined. In 2010, O'Daly et al.⁽¹¹⁾ published a series of 9 cases treated with TTC nailing after failure of conservative treatment with closed manipulation. Fracture union was observed in 89%, and 70% of patients returned to their previous functional status without any complication. In 2013, Jonas et al.⁽¹²⁾ published a series of 31 cases of unstable ankle fractures treated with TTC nailing. Although the inclusion criteria were not well defined, the authors assessed preoperative mobility, preexisting morbidity, soft tissue condition, and level of patient compliance with non-weight bearing. Despite the good functional results, the rate of complications was high (38.7%), including 3 peri-implant fractures and 2 broken nails, drawing attention to the fact that more active patients could have a higher failure rate when treated with this method. In 2014, Al-Nammari et al.⁽¹³⁾ published a retrospective study of 48 frail patients (mean age, 82 years) treated with retrograde nailing using a long femoral nail. The inclusion criteria were an American Society of Anesthesiology (ASA) score ≥ 3 , multiple preoperative comorbidities, and inability to walk independently for more than 200 m. The authors recommended the use of long nails that passed the isthmus of the tibia to avoid peri-implant fractures. At 6 months, 90% of patients had returned to their preoperative functional status, but the rate of complications was high, including deep infection (2%) and broken distal screws (6%), valgus malunion (4%), medical complications (29%), and 1 below-knee amputation. In 2016, Taylor et al.⁽¹⁴⁾ published a retrospective study of 31 patients (mean age, 63 years; follow-up, 13.6 months) and reported the occurrence of 2 superficial infections (6.5%) and 3 deep infections (9.7%). The fracture healed in 90.3% of cases, with satisfactory functional results. The authors did not clearly define the inclusion criteria, but they highlighted obesity and diabetes as risk factors. In 2017, Georgiannos et al.⁽¹⁵⁾ published the only prospective randomized controlled study of ORIF vs TTC nailing. The inclusion criteria for both treatments were age > 70 years, closed bimalleolar or trimalleolar fractures, and ankle fracture-dislocations; 37 patients (mean age, 78 years) were recruited. Functional outcome did not differ between the groups (TTC nailing vs ORIF), but the rates of complications, hospital stay, and mortality were lower in the nailing group. In 2018, Baker et al.⁽¹⁶⁾ published a retrospective study of 16 patients with 3 or more comorbidities and unstable ankle fractures. Overall, the results were good, especially the low rate of wound complications and early recovery. In the same year, Persigant et al.⁽¹⁷⁾ published the results of a series of 14 patients treated with a retrograde femoral nail and immediate weight bearing, with a mean follow-up of 12 months.

Table 4. Review of the literature on retrograde intramedullary TTC nailing for fragility ankle fractures

Study	Design	Evidence level	Sample	Age (yrs)	Nail	Postop WB	Follow-up (months)	Complications
Lemon 2005 ⁽⁹⁾	RT	IV	12	84	Long expandable humeral nail	Full	16	8.3%: 3 DVT.
Amirfeyz 2008 ⁽¹⁰⁾	RT	IV	13	78.9	Short humeral nail and short TTC nail	Partial	11	7.7%: 1 minor wound breakdown, 1 delayed union.
O'Daly 2010 ⁽¹¹⁾	RT	IV	9	81	Long humeral nail	Full	34	None.
Jonas 2013 ⁽¹²⁾	RT	IV	31	77	Short TTC nail	Full	18	38.7%: 2 peri-implant fractures, 2 broken nails.
Al-Nammari 2014 ⁽¹³⁾	RT	IV	48	82	Long retrograde femoral nail	Full	6	47%: 2 superficial infections, 1 deep infection, 3 broken distal screws, 2 valgus malunion, 1 BKA.
Taylor 2014 ⁽¹⁴⁾	RT	IV	31	63	Short TTC nail	*Full/Partial	13.6	29.1%: 3 implant failures, 2 superficial infections, 3 deep infections, 1 BKA.
Georgiannos 2016 ⁽¹⁵⁾	PT	II	37	78	Short TTC nail	Full	12	8.1%: 1 superficial infection, 1 DVT, 1 protrusion of the nail.
Baker 2018 ⁽¹⁶⁾	RT	IV	16	73	Long retrograde femoral nail	No WB 7-10 days (then full WB)	21	N/R
Persigant 2018 ⁽¹⁷⁾	RT	IV	14	79.6	Long retrograde femoral nail	Full	12	20%: 1 deep infection, 1 distal screw loosening.
Ebaugh 2019 ⁽¹⁸⁾	RT	IV	27	66	Short TTC nail	No WB until healing of plantar wound (then full WB)	29.6	18.5%: 1 superficial infection, 3 deep infections, 1 nail failure, 1 AKA.
Present series 2020	RT	IV	17	81.5	Short TTC nail	Full	20.9	23.5%: 1 distal screw loosening, 1 painful subtalar nonunion, 1 superficial infection.

TTC: tibiototalcalcaneal; RT: retrospective; PT: prospective; N/R: not reported; WB: weight bearing; DVT: deep vein thrombosis; BKA: below-knee amputation; AKA: above-knee amputation.
* At the surgeon's discretion.

The authors reported satisfactory functional results, fracture union, and only 1 major complication (deep infection requiring nail removal). Finally, in 2019, Ebaugh et al.⁽¹⁸⁾ published a retrospective study of 27 patients with complicated diabetes treated with TTC nailing and reported high functional and limb salvage rates, few complications, and maintenance of the previous level of autonomy.

The present study included 17 patients (mean age, 81.5 years; follow-up, 20.9 months) and found satisfactory functional results, in accordance with the existing literature. Despite the high prevalence of diabetes (11 of 17 patients were diabetic), there was only 1 superficial infection and no deep infection. Consistent with the published literature, the most common complication was loosening of the locking screws, which led to their removal. There were no cases of peri-implant fracture

despite using an intermediate-length nail (18 cm). As previously reported in the literature, except for 1 patient requiring subtalar arthrodesis, patients did not report pain due to limited mobility at level of the subtalar and tibiotalar joint. Finally, a remarkable outcome of this study was the rate of spontaneous fusion of the tibiotalar joint, which occurred in 5 cases, despite not being the objective of the technique.

In sum, the published articles have included in their series frail older patients with difficulty in walking independently and unstable fractures. Despite the short follow-up duration (1 year on average), all of them have reported satisfactory functional results, shorter mean hospital stay, and earlier full weight bearing with TTC nailing than with ORIF, in addition to fewer complications, which is of vital importance to these particularly frail patients.

Study limitations

Our study has some limitations. The first is related to the study design, as all data were collected retrospectively, and there was no control group for comparison. Other potential weaknesses are the relatively small sample size and short follow-up.

Conclusion

Our results suggest retrograde TTC nailing as a valid treatment option for fragility ankle fractures in selected patients in whom both conservative treatment and conventional osteosynthesis are contraindicated. Prospective studies with a larger sample size are needed to confirm our promising results.

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