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Workshops of the SOO (2013, Tours). Original article

# Internal fixation of the fibula in ankle fractures. A prospective, randomized and comparative study: Plating versus nailing



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## ARTICLE INFO

### Keywords:

Ankle fracture  
 Lateral malleolar fracture  
 Internal fixation  
 Fibular nail

## ABSTRACT

**Aim:** Open reduction and internal plate fixation of the fibula is the gold standard treatment for ankle fractures. The aim of this study was to perform a prospective randomized study to compare bone union, complications and functional results of two types of internal fixation of the fibula (plating and the Epifisa® FH intramedullary nail).

**Materials and methods:** Inclusion criteria were: closed fractures, isolated displaced fractures of the lateral malleolus, inter- and supra-tubercular bimalleolar fractures, and trimalleolar fractures. This study included 71 patients (mean age  $53 \pm 19$ ): plate fixation group ( $n = 35$ ) and intramedullary nail fixation group ( $n = 36$ ). In seven cases, intramedullary nailing was technically impossible and was converted to plate fixation (the analysis of this sub-group was performed independently). Two patients died and two patients were lost to follow-up. The final comparative series included 32 cases of plate fixation and 28 cases of intramedullary nail fixation. Union, postoperative complications and Kitaoka and Olerud-Molander functional scores were analyzed after one year of follow-up.

**Results:** There was no significant difference in the rate of union ( $P = 0.5605$ ) between the two types of fixation. There were significantly fewer complications (7% versus 56%) and better functional scores (96 versus 82 for the Kitaoka score; 97 versus 83 for the Olerud-Molander score) with intramedullary nailing than with plate fixation.

**Conclusion:** Intramedullary nailing of the lateral malleolus in non-comminuted ankle fractures without syndesmotic injury is a reproducible technique with very few complications that provides better functional results than plate fixation.

**Level of evidence:** II (randomized prospective study).

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## 1. Introduction

Ankle fractures are frequent, with an estimated 125/100000/year [1]. Although conservative treatment was used for many years, internal fixation has now become the gold standard treatment for these fractures [1]. Management of these fractures in elderly subjects is still challenging because of a fairly high risk of wound complications, sepsis and hardware failures [2–5]. Plate fixation is the most frequent technique used for stabilization of the fibula [6] but percutaneous techniques (pins, screw fixation) have also been proposed [7–10]. The notion of intramedullary fibular nailing with possible screw fixation has not been extensively developed [11–17]. The goal of this study was to compare the results of internal fixation by a morphologically adapted curved intramedullary

nail that screws into the distal fibula (Epifisa®) to results of open reduction and plate fixation in ankle fractures.

## 2. Materials and methods

We performed a prospective, randomized single blind multi-surgeon (4 senior and 5 junior surgeons) study including 71 patients, hospitalized in our unit for ankle fracture between April 2011 and January 2012. Randomization was performed with a random table of numbers (odd: nailing, even: plating).

Inclusion criteria were the following: closed fractures, isolated displaced fractures of the lateral malleolus, inter- and supra-tubercular bimalleolar fractures and trimalleolar fractures.

Exclusion criteria were the following: open fractures, fractures with a fracture line more than 9 cm from the tip of the fibula, associated tibial pilon fractures, associated talar fractures and pathological fractures.

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Fig. 1. EPIFISA® nail.

All patients received prophylactic antibiotics before surgery. The patient was placed in the supine position with a pillow under the homolateral buttocks with a pneumatic tourniquet on the limb. An associated procedure was performed in bi- or trimalleolar fractures: suturing of the medial collateral ligament, fixation by tension band wiring or screw fixation in fractures of the medial malleolus and anteroposterior screw fixation in posterior malleolar fractures depending on the size of the fragment.

Plate fixation was performed by the lateral approach with Synthes AO® reconstruction locking compression plates. Four millimeters cancellous screws and 3.5 mm cortical screws could be used with these plates.

Nail fixation was obtained with Epifisa® intramedullary nails FH Orthopaedics (Fig. 1). This nail is available in 4 lengths (70, 90, 110 and 130 mm) with one diameter (5 mm). The 9 mm head has a self-tapping thread at the distal end which screws into cancellous bone, locking the bone in place.

The patient was immobilized for 6 weeks in a plastic boot cast with a window. Weight bearing was progressive over a 1-month period. Rehabilitation was begun when the cast was removed.

The preoperative evaluation included: gender, age, cause of trauma and side and type of fracture. The main judgment criterion was bone union 1 year after surgery, evaluated by X-ray (a CT scan was performed to confirm nonunion). Secondary judgment criteria included the development of postoperative complications and functional results (according to the Kitaoka [18] and Olerud-Molander scores [19]).

The results of quantitative variables were presented as means and standard deviations, maximums and medians. Qualitative variables were expressed as frequencies and percentages. The distribution of quantitative variables was compared by the non-parametric Mann and Whitney test for unpaired series. Qualitative variables were compared using the Chi<sup>2</sup> test or the Fischer exact test depending upon the theoretical number of participants, and the number of classes in the variables being considered.  $P < 0.05$  was considered to be significant. SAS 9.2 (SAS Institute, Cary, USA) software was used.



Fig. 2. (a: AP; b: lateral) Postoperative X-ray of intramedullary nail fixation.

### 3. Results

Seventy-one patients were included in the study: 34 women and 37 men, mean age 53 years old  $\pm$  19 (18–90). Thirty-five patients were randomized into the “plate fixation” group and 36 into the “intramedullary nail fixation” group. However, intramedullary nailing was impossible in 7 patients (10%) for technical reasons (severely fragmented fracture, diameter of the proximal fibula too narrow and persistent tibiofibular diastasis) and was converted to plate fixation (Table 1). The 7 converted cases were analyzed independently. At one-year of follow-up two patients were lost to follow-up and two had died. Thus results were based on the analysis of plate fixation in 32 fractures and nailing in 28 fractures (Fig. 2).

There was no significant difference between the two groups for the type of fracture ( $P=0.0941$ ), age ( $P=0.7922$ ), gender ( $P=0.2260$ ), the cause of trauma ( $P=0.2501$ ) or the operated side ( $P=0.3624$ ).

Bone union was obtained in 94% of the cases in the “plate fixation” group and 100% of the cases in the “intramedullary nailing” group (Table 2): the difference was not significant ( $P=0.5605$ ). There were significantly fewer ( $P=0.0014$ ) postoperative complications in the “intramedullary nailing group” than in the “plate fixation group” (7% versus 45% respectively) (Table 3). Functional scores were significantly better in the “intramedullary nailing” than in the “plate fixation” group (Tables 4 and 5).

The conversion sub-group (7 cases) included younger men only (mean 45.6 years  $\pm$  24). There was no significant difference in the rate of union between this group and the “plate fixation group”. There were no postoperative complications. The functional scores were 94 ( $\pm$  4) for the Kitaoka score and 93 ( $\pm$  4) for the Olerud-Molander score.

### 4. Discussion

While epidemiologically, numerous other studies of ankle fractures have identified a majority of older women [20,21], our study included an equivalent number of men and women, mean age 53 years old. Like most other studies in the literature [22,23], we included all closed fractures except supination-adduction fractures (sub-tubercular).

The main goal of this study was to compare the results of bone union with two types of internal fixation: there was no

**Table 1**  
Epidemiologic data.

Epidemiological data	Total	Plate osteosynthesis	Nail osteosynthesis
Age (years)			
<i>n</i>	71	42 (35 ± 7 conversions)	29
Mean	53.30	52.24	54.83
Standard deviation	19.38	20.47	17.92
Median	56.00	54.50	59.00
Min/Max	18/90	18/90	22/81
Gender			
<i>n</i>	71	42 (35 ± 7 conversions)	29
Men	37 (52.11%)	21 (50.00%)	16 (55.17%)
Women	34 (47.89%)	21 (50.00%)	13 (44.83%)
Circumstances			
<i>n</i>	71	42 (35 ± 7 conversions)	29
Domestic acc.	39 (54.93%)	24 (57.14%)	15 (51.72%)
Acc. at work	6 (8.45%)	1 (2.38%)	5 (17.24%)
Sport injury	18 (25.35%)	12 (28.57%)	6 (20.69%)
Road traffic acc.	8 (11.27%)	5 (11.91%)	3 (10.35%)
Side			
<i>n</i>	71	42 (35 ± 7 conversions)	29
Right	39 (54.93%)	20 (47.62%)	19 (65.52%)
Left	32 (47.07%)	22 (52.38%)	10 (34.48%)
Fractures			
<i>n</i>	71	42 (35 ± 7 conversions)	29
Lateral malleolar	18 (25.35%)	6 (14.29%)	12 (41.38%)
Bimalleolar	36 (50.71%)	24 (57.14%)	12 (41.38%)
Trimalleolar	17 (23.94%)	12 (28.57%)	5 (17.24%)

Acc.: accident.

**Table 2**  
Consolidation scope according to the type of osteosynthesis.

Consolidation	Total	Plate osteosynthesis	Nail osteosynthesis	<i>P</i>
<i>n</i>	60	32	28	0.5605
Acquired	58 (95.67%)	30 (93.75%)	28 (100.00%)	
No Acquired	2 (3.33%)	2 (6.25%)	0 (0.00%)	

**Table 3**  
Complications according to the type of osteosynthesis.

Complications	Total	Plate osteosynthesis	Nail osteosynthesis	<i>P</i>
<i>n</i>	60	32	28	0.0014
No	40 (66.67%)	14 (43.75%)	26 (92.86%)	
Skin necrosis	9 (15.00%)	9 (28.13%)	0 (0.00%)	
Sepsis	2 (3.33%)	2 (6.25%)	0 (0.00%)	
Sec. displacement	2 (3.33%)	2 (6.25%)	0 (0.00%)	
Algodystrophy	7 (11.67%)	5 (15.63%)	2 (7.14%)	

Sec.: second.

difference in the rate of union between fibular nailing and plate fixation. There were two cases of lateral malleolar nonunion (3%), which is comparable to rates reported in the literature (1.5–2.2%) [24,25]. However, the rates of nonunion or malunion seem to be higher in older patients (as high as 73% and 48%) [20,26].

In our series, plate fixation resulted in union in 94%, postoperative complications in 56% and good functional scores. These results are comparable to those in the literature [27]. Several authors have reported a higher incidence of complications in older women associated with osteoporosis and precarious cutaneous conditions [20,28–31]. Lateral or posterolateral plating has also been discussed

**Table 4**  
Results by functional Kitaoka score depending on the type of osteosynthesis.

Kitaoka score	Total	Plate osteosynthesis	Nail osteosynthesis	<i>P</i>
<i>n</i>	60	32	28	0.0011
Mean	88.62	82.09	96.07	
Stand. deviation	17.06	21.06	4.31	
Median	94.00	90.00	97.50	
Min/Max	20/100	20/100	85/100	
Excellent	30 (50.00%)	8 (25.00%)	22 (78.57%)	
Good	23 (38.33%)	17 (53.13%)	6 (21.43%)	
Fair	3 (5.00%)	3 (9.38%)	0 (0.00%)	
Poor	4 (6.67%)	4 (12.50%)	0 (0.00%)	

Stand.: standard.

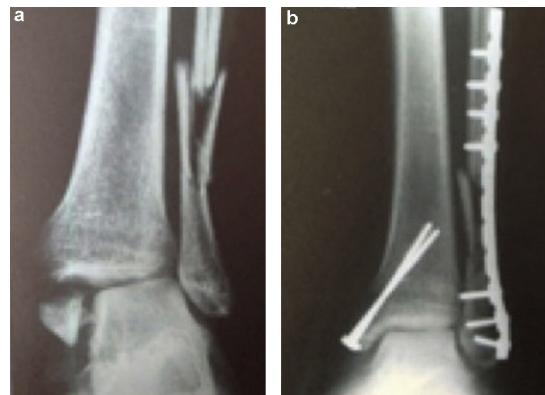
**Table 5**  
Results by Olerud-Molander functional Score depending on the type of osteosynthesis.

Olerud-Molander score	Total	Plate osteosynthesis	Nail osteosynthesis	P
n	60	32	28	<0.0001
Mean	89.50	82.66	97.32	
Stand. deviation	19.52	15.24	3.72	
Median	95.00	85.00	100.00	
Min/Max	40/100	40/100	90/100	
Excellent	40 (66.67%)	12 (37.50%)	28 (100.00%)	
Good	14 (23.33%)	14 (43.75%)	0 (0.00%)	
Fair	2 (3.33%)	2 (6.25%)	0 (0.00%)	
Poor	4 (6.67%)	4 (12.50%)	0 (0.00%)	

[32]. Biomechanical studies have shown that posterolateral fixation of the fibula was as stable as lateral fixation [33,34]. Winkler et al. [35] evaluated posterolateral plating in Weber type B fractures and obtained excellent results in 66.7%; poor results were more frequent in elderly patients (10%). They concluded that the larger the incision, the greater the risk of nerve damage. The posterolateral position also increased the risk of peroneal tendon injury [36]. In the study by Brown et al. [37], 31% of the 126 patients had lateral ankle pain overlying the fracture hardware and 50% of the patients still reported pain after removal of the hardware. Biomechanical studies have shown the theoretical advantages of locking plate fixation in osteoporotic bone [38–40]. In the past few years, this type of plate has been increasingly used but no clinical benefit has been confirmed. A recent study showed a significant increase in the rate of wound complications with locking plates compared to conventional plates (17.5% vs. 5.5% respectively), which is explained by the larger size of the former type of plate [27]. Generally, although wound complications have decreased with the development of mini-invasive techniques, this has not been confirmed for internal fixation of lateral malleolar fractures. A recent study compared conventional open reduction and plating to the percutaneous technique and did not show any difference between the two [41].

In our series, fibular nailing resulted in union in 100%, postoperative complications in 7% and excellent functional scores. There are very few studies on intramedullary fibular nailing. The main criticism of this system is that it is not rigid enough [42]. However, the notion of an interlocking nailing system cannot be compared to simple percutaneous nailing systems. The series evaluating the latter [8–10] report the benefits of the percutaneous approach, but functional results vary. The idea of nailing was first introduced in 1999–2000 with the ANK<sup>®</sup> nail. Kara et al. [11] and Kabukcuoglu et al. [12] used this nailing system for lateral malleolar fractures associated with syndesmotic injury, and they reported good results and no complications. The Biomet SST<sup>®</sup> nail has been evaluated by several authors [13–16]. These studies reported satisfactory functional scores based on the Olerud-Molander score in 88% [13], union in 97% of cases and very few complications (8%: infection, hardware failure) [14]. In a retrospective study of 24 cases (elderly patients) Rajeev et al. [16] reported union in a mean 8.7 weeks, no complications and a mean Olerud-Molander score of 57. Bakar et al. [15] compared both types of fixation (SST<sup>®</sup> Biomet–plates) in a series of 25 patients who were older than 50. At two years of follow-up this study showed that operating time was shorter with intramedullary nail fixation, but did not find any difference between the groups for functional scores (Maryland) or quality of life (EQ-5D et SF-36).

François et al. [17] reported results with the Epifisa<sup>®</sup> nail in 45 lateral malleolar fractures. They obtained union in 100%, no complications and excellent or very good results in 82% according to the Kitaoka score. Seven cases of intramedullary nailing were converted to plate fixation in our study: 2 for a diameter of the proximal fibula that was too narrow, 2 for a comminuted fracture of the fibula that was too severe (Fig. 3) and 3 for persistent tibiofibular diastasis. The Epifisa<sup>®</sup> nail used in our study was 5 mm in diameter and



**Fig. 3.** a (preoperative): fibular comminution that was too excessive; b: (postoperative) conversion to plate fixation.

the maximum length was 130 mm, making it impossible to use a syndesmotic screw. The Acumed<sup>®</sup> nail is based on an interesting technical innovation allowing syndesmotic screws with two diameters (3 and 3.6 mm) and three lengths (110, 145 and 180 mm). In a series of 21 cases after a mean postoperative follow-up of six years, Bugler et al. [43] reported one case of superficial infection with this system, no cases of nonunion, and very good functional results (SF-12, Olerud-Molander and AAOS scores).

## 5. Conclusion

This prospective, randomized study compared the results of intramedullary nailing of the fibula to plate fixation in ankle fractures.

Although there was no difference in the rate of union, there was a fairly high rate of complications with plate fixation compared to intramedullary nailing.

Intramedullary nailing is a percutaneous mini-invasive technique that provides stable fixation and reduces the risk of wound complications. The main limitation is in the treatment of comminuted fractures.

Nevertheless, further randomized comparative studies should be performed to show the non-inferiority or the equivalence of this technique in a larger number of patients to clearly validate this surgical indication.

## Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

## Acknowledgements

Mr François Dalmay, Biostatistics Laboratory, Cebimer. Medical School, Limoges.

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