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Original article

When is indicated fibular fixation in extra-articular fractures of the distal tibia?

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Summary. *Background and aim of the work:* There is no consensus about indications for fibular osteosynthesis in extra-articular fractures of the distal tibia (DTF). This study analyses patients affected by DTF associated to fibular fracture and has the aim to define whether the level of fibular fracture has an influence on bone healing and consequently when its fixation is indicated. *Methods:* Eighty-seven patients were operated from January 2005 to December 2016. Inclusion criteria were: the presence of skeletal maturity, the absence of physical limitations before trauma and a type 43-A AO closed fracture. Clinical outcomes were evaluated using Olerud–Molander Ankle Score (OMAS) and the Disability Rating Index (DRI). Malrotation was also assessed as well as incidence of nonunion and malalignment through x-rays. *Results:* No differences in clinical scores were reported at follow-up between patients in which fibular fixation was performed (Group 1) in comparison with those in which this procedure was not executed (Group 2). Nonunions were registered in 8 cases: four in Group 1 and four in Group 2. A statistically significant difference in incidence of external malrotation and valgus malalignment between the groups was documented, with a higher risk in patients of the second group. *Conclusions:* The level of fibular fracture is important to determine when the fixation of this bone is indicated. In supra-syndesmotic fractures osteosynthesis leads to a higher incidence of nonunions. Fibular osteosynthesis could prevent malrotation and malalignment and is advisable in distal metaphyseal fracture of this bone (trans- or infrasyndesmotic lesion) with syndesmotic injury. (www.actabiomedica.it)

Key words: distal tibia, fibula, fracture, fixation, osteosynthesis, syndesmosis

Introduction

The role of fibular fixation in the treatment of ankle and tibial pilon fractures has been well defined (1-6). However, there is no consensus in the literature about indications for fibular osteosynthesis in extra-articular DTF and this regardless of the surgical technique used [open reduction and internal fixation (ORIF), external fixation, minimally invasive percutaneous plate osteosynthesis (MIPO) and intramedullary nailing (IMN)]. This is mainly related to the results of many biomechanical studies that have underscored the role of fibular stabilization when the tibial fracture was already internally fixed (7, 8) and of previous reports that have provided unclear informations about the potential role of the fibula in tibial healing (9-11). Surgeons who are in favor of fixation of the fibula claim that it provides a stiffer construct and aids in achieving a more anatomical reduction of the tibia, thus preventing lower leg malalignment (varus/valgus and rotational). Furthermore, other studies have suggested that this bone contributes significantly to lower-leg weight-bearing and could act as a strut, relieving stress from the tibia and allowing earlier healing (12). On the contrary, other traumatologists have reported that the intact fibula contributes little to the support of the lower leg, provides no additional stability to synthesis of a fractured tibia and even creates abnormal strain and complicates compression and fixation of tibial fractures (13,14).

The current study is an analysis of a cohort of patients affected by DTF associated to fibular fracture and has the aim to define whether the level of fibular fracture has an influence on bone healing and consequently when its reduction and fixation is indicated.

Materials and Methods

Patients with extra-articular fracture of the distal tibia associated with fibular lesion were included in the present study (January 2005-December 2016). Further inclusion criteria were: the presence of skeletal maturity, the absence of limitation in physical activity before trauma and closed pattern of fracture. According to the AO classification all lesions were type 43A.

Informed consent relating to the surgical and anesthetic procedures were always obtained. Patients also gave their signed consent for the use of their personal data and clinical/instrumental outcomes for scientific researches.

In all cases tibial osteosynthesis with locked IMN [2 screws proximally (1 static and 1 dynamic) and 2/3 distally] or ORIF was performed (Figure 1). In those cases in which the fixation of the fibula was executed a 1/3rd tubular plate was used and was inserted before tibial management. Surgery was done under general or peripheral anesthesia. All patients had thromboprophylaxis and antibiotic prophylaxis with first generation cephalosporins. Both IMN and ORIF are part of routine clinical practice of the traumatologists involved in this study and all surgeons were familiar with these surgical techniques. Nail insertion was at the proximal end of the tibia and passed down the hollow center (medullary canal) of the bone in order to hold the fracture in the correct anatomical position. The reduction technique, the surgical approach, the type and size of the nail, the configuration of the proximal and distal interlocking screws and any supplementary device or technique depended on the pattern of the lesion in accordance to standard clinical practice. For ORIF the plate was inserted at the distal end of the tibia and passed under the skin on the surface of the bone.

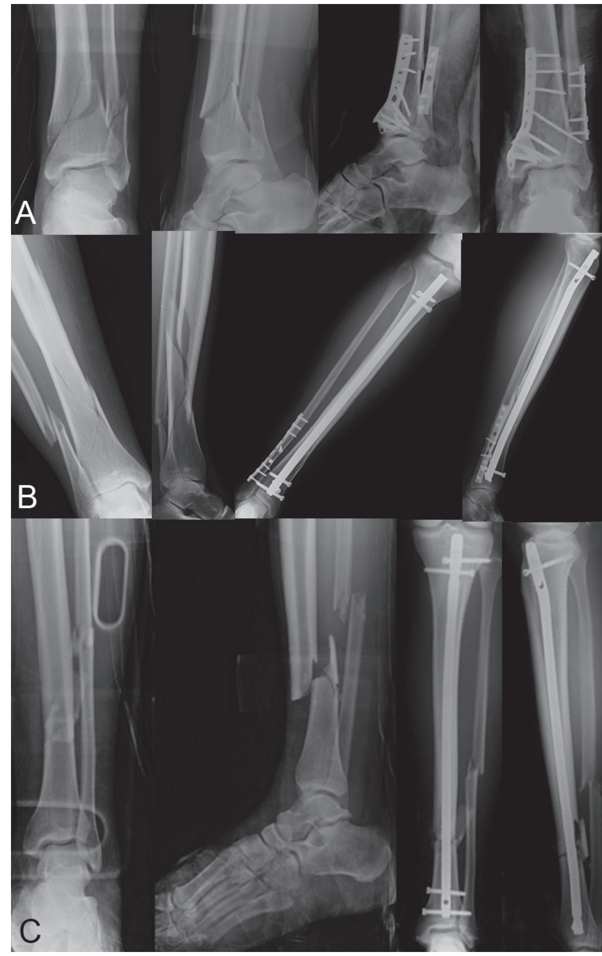

Figure 1. Different surgical strategies. A: ORIF with fibular fixation. B: IMN with fibular osteosynthesis. C: IMN without fibular fixation

Again, the details of the reduction technique, the surgical approach, the type and position of the plate, the number and configuration of fixed-angle screws, and any supplementary device or technique was conducted in accordance to standard clinical practice (specifically fixed-angle screws must be used in at least some of the distal screw holes). Postoperatively, all patients received the same rehabilitation protocol. Mobilization of the knee and ankle was started in the immediate postoperative period. Sutures were removed on the 14th postoperative day. Weight-bearing protected by crutches was generally permitted 30 days after surgery, following an X-ray of the involved leg, including both knee and ankle joints in the same film.

Patients were checked clinically and radiographically at 1, 2, 6, 9, 12 and 18 months. If no radiological signs of bone healing were detected 12 weeks after IMN, proximal nail controlled dynamization was performed to enhance healing.

The research group was divided in two parts in order to reach the goals of the study:

- Group 1: patients who had fibular fixation
- Group 2: patients without fibular fixation.

Data were collected by verbal communication, clinical examination and radiographs.

Clinical outcomes were evaluated using OMAS and the DRI. All cases were also clinically assessed for malrotation, which was defined as an internal/external rotation deformity >10° in comparison with the normal contralateral limb. The subjects were made to lie down supine. By standing at the foot end of the patient, the rotation of the ankle was determined by measuring the angle subtended by a plumb line with a line passing through the mid-point of the knee, the line joining the mid-point of the ankle (intermalleolar distance) and the second toe. As reported by Prasad et al (15) the grade of rotation was classified as: excellent (0-5°), good (5-10°), fair (10-15°), poor: (>15°).

X-rays views studied consolidation and varus-valgus deformity. Nonunion was defined as the absence of radiological signs of bone union and pain in the fracture site during weight-bearing 6 months after the osteosynthesis procedure. The degree of tibial angulation (varus or valgus) was measured on the antero-posterior projections by determining the angle formed by the intersection between the perpendicular lines drawn from the tibial plateau and the tibial plafond (16). As reported By Pravad et al. the grade of varus deformity were classified as: excellent (0-1°), good (2-5°), fair (6-10°) and poor (>10°) (15). The fibular fracture was classified according to the AO and related to the level of the tibial fracture.

Statistical analysis was performed comparing Group I and Group II for clinical and radiological results, and comparing IMN and ORIF group of treatment. The Mann-Whitney test was used to evaluate linear variables and the Chi-Square test was used for categorical variables. The cut-off value of significance was determined at p<0.05.

Results

Ninety-six patients were operated for DTF associated to fibular fracture between January 2005 and December 2016. Nine patients were lost at follow-up, thus finally 87 were included in the cohort of analysis of this study. In Group I were allocated 49 patients and in Group II 38. Details about demographic characteristics, classification of the fractures, and type of tibial osteosynthesis for both groups are shown in Table 1. Most cases were consequent to road traffic accidents (80%). Other causes were simple fall or sport-related injuries, which constituted 20% of the cases.

Clinical and radiographic outcomes are reported in Table 2. No differences in clinical scores were reported comparing group 1 and 2 for OMAS and DRI at 18 months of follow-up. Twelve cases out of 39 underwent proximal controlled dynamization of the nail. Malrotation was always external and was higher in group 2; this difference was statistically significant at univariate analysis (p=0.021). Nonunion was registered in a total of 8 cases (4 in Group I and 4 in Group II). In the four cases of Group I the fibular fracture was

Table 1. Demographic characteristics, classification of fractures and type of surgery

Variable	Group I Mean (SD)	Group II Mean (SD)
Number of patients	49	38
Age	56.4 (±11.6)	59.8 (±13.3)
Gender	M 30/F 19	M 22/F 15
BMI	27.3 (±6.9)	26.6 (±6.5)
ASA score (1/2/3)	12/29/8	8/24/6
Side of fracture	R 23/L 26	R 22/L 16
Time fracture/surgery (days)	3.2 (±0.9)	2.7 (±0.7)
Operation time (minutes)	74 (±15.9)	58 (±11.5)
Type of fracture		
43 A1	15	10
43 A2	23	19
43 A3	11	9
Side of fibular fracture		
Supra-syndesmotic	9	26
Trans-syndesmotic	24	5
Infra-syndesmotic	16	7
Type of surgery		
IMN	22	17
Plate and screws	27	11

Table 2. Results of group 1 and 2

Variable	Group I Mean (SD)	Group II Mean (SD)	p
OMAS	80.2 (±72-88)	82.6 (±71-92)	0.618
DRI	19.7 (±11.6)	22.8 (±13.3)	0.539
Nonunion	4	4	0.782
Rotational alignment			
Excellent	4	1	
Good	38	21	
Fair	7	16	
Poor	0	0	
Mean ± SD	7.7° (±2.4°)	12.2° (±2,8)	0.021
Varus/valgus alignment			
Excellent	0	0	
Good	35	5	
Fair	14	33	
Poor	0	0	
Mean ± SD	5.2° (±1,2°)	9.7° (±1.6°)	0.036

always supra-syndesmotic. In the four cases of Group II the fractures were trans-syndesmotic type in three cases and infra-syndesmotic in one. Thus, performing a sub-analysis of Group I, we documented respectively an incidence of nonunion of 44% in supra-syndesmotic fractures and of 0% in trans-syndesmotic and infra-syndesmotic fractures. Valgus tibial malalignment was observed more frequently in group 2 with a statistically significant difference at univariate analysis (p=0.036).

Discussion and conclusions

The surgical management of DTF and fibula fractures has significantly evolved over the past several decades. Nevertheless, the role of concomitant fibular fixation during treatment of closed extra-articular DTF remains controversial. From an anatomical point of view, the fibula has shown to shear between 3% and 16% of the axial loads of the leg (17-20) and to have a tension band effect against the medial bending forces on a fractured tibia (21, 22). In 1971 Lambert first described the weight-bearing function of the fibula, which absorbs approximately 1/6 of the load applied to the knee; these forces increase if syndesmosis disruption is associated (23, 24).

Cadaveric biomechanical studies tried to define the role of adjunctive fibular fixation to tibial stabilization. In comparing intramedullary nail fixation to locked plating in the treatment of 43-A tibia fractures with concurrent same level fibula fractures, Strauss et al (6) established that locked plates produced greater stability than intramedullary nails in vertical loading but less effective stabilization in cantilever bending. Furthermore, construct displacements significantly increased with cyclical loading after simulated fibular fracture was achieved through osteotomy. Therefore, the authors concluded that a distal tibia fracture with intact fibula improved fracture fixation stability in both fixation constructs. Bonnevialle et al (25) stated that fibular and tibial fractures should be considered as a single biomechanical and pathological entity, and confirmed the value of double surgical synthesis as a complement to stability and an aid to tibial reduction. Kumar et al (26) performed a cadaveric study investigating the effect of fibular plate fixation on same level simulated distal fractures of the tibia and fibula. They demonstrated that fibular plate stabilization increased the rotational stability by decreasing axial rotation of distal metaphyseal fractures treated with IMN in comparison with that of tibia fractures treated with IMN alone when torque was applied to the tibial tubercle. They concluded that fibular plate fixation increased rotational stability in patients with distal tibia fractures with ipsilateral fibula fracture and may reduce the risk of malunion with valgus deformity. Comparable findings of increased rotational stability, but without improved stability with axial or angular loading, were reported by Morin et al (27). Furthermore, other reports have determined that fibular fixation in the treatment of acute 43-A distal tibial fractures facilitated reduction of the tibia and promoted mechanical stability, especially in comminuted fractures and bone loss (28-34).

However, some studies have demonstrated that fibular fixation may prevent tibial fracture reduction and render the fixation too rigid, thus facilitating higher rates of delayed union and nonunion (35, 36). Kruppa et al (37) reported increased rates of nonunions associated with fibular ORIF in distal tibia fractures treated with IMN. Twenty nonunions were recorded and of them, 13 (65%) had undergone fibular fixation.

This nonunion rate is similar to that of Teitz et al (9), as previously discussed. Similarly, Attal et al (38) multicenter case series reported a negative effect of fibular plating on tibial fractures treated with an IMN, citing an 8-fold increase risk of delayed union. Vallier et al (36) prospective study of 104 43-A fractures, of which 28 had associated fibular fractures (27%), were randomized to IMN versus medial plate fixation. In particular they found 4 patients (7.1%) with nonunion after nailing versus 2 (4.2%) after plating (P=0.25) with a trend for nonunion in patients who had distal fibula fixation (12% vs. 4.1%, P=0.09). Eighty-five percent of patients with malalignment after nailing did not have fibula fixation. Based on their data, they concluded that fibular fixation aids in tibial fracture reduction at the time of surgery, but ultimately may contribute to nonunion. Finally, Varsalona and Liu (7) concluded in their clinical review on distal tibial fractures that the case for using fibular fixation has not yet been established when the fracture does not involve the syndesmosis or ankle mortise. Moreover, the reduction and fixation of the fibula may lead to additional soft tissue damage, and an improper reduction and fixation of the fibula may be associated with a higher risk of late malunion.

In the present study no differences in clinical outcomes, comparing procedures which included osteosynthesis of the fibula and procedures which did not, are reported. However, statistically significant differences are documented in terms of malalignment with a higher incidence of external malrotation and valgus deformity in patients in which synthesis of the fibula was not performed. Furthermore, results suggest that, in cases of supra-syndesmotic fibular fracture, fixation could lead to a higher risk of nonunion.

This study has several limitations. First of all the absence of randomization and the small number of subjects included. Furthermore, results may also be influenced by the experience and personal bias of senior surgeons and they may be less reflective of the procedure or sequence itself.

In conclusion, the level of fibular fracture is important to determine when the fixation of this bone is indicated. In supra-syndesmotic fractures osteosynthesis leads to a higher incidence of nonunions. Fibular synthesis may improve the ability to obtain and maintain tibial reduction and could prevent malrotation and malalignment. On the basis of the results observed, authors sustain that fibular fixation in extra-articular DTF is advisable in distal metaphyseal fracture of this bone (trans- or infrasyndesmotic lesion) with syndesmotic injury and should be performed before tibial osteosynthesis.

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