



# Isolated distal fibula fractures can be treated with locking screw plates with an immediate postoperative weight-bearing

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## Abstract

**Background** Isolated distal fibula fractures (DFF) are usually treated with open reduction and internal fixation (ORIF) and non-weight-bearing protocols. The study assessed the outcomes of immediate weight-bearing on DFF healing and stability after lateral locking plating.

**Materials and methods** For this study, 49 patients affected by isolated DFF were enrolled. They underwent ORIF with a lateral polyaxial locking plate and were allowed immediate weight-bearing with crutches postoperatively. Clinical and radiographic evaluations were performed at 2, 6, and 12 weeks using the AOFAS (American Orthopedic Foot and Ankle Society) score and X-rays evaluations..

**Results** Immediate weight-bearing yielded positive outcomes, with a significant increase of the AOFAS score during the clinical re-evaluations. All patients tolerated early and progressive full weight-bearing without complications. Radiographic findings at 12 weeks showed complete bone healing in all cases.

**Conclusions** The immediate weight-bearing protocol combined with lateral locking plating resulted in favorable clinical outcomes, accelerated recovery, and successful bone healing for stable DFF cases.

**Keywords** Peroneal malleolus · Orthopedic surgery · Traumatology · Ankle fracture · ORIF

## Abbreviations

ORIF	Open reduction and internal fixation
DFF	Distal fibula fractures
AOFAS	American Orthopedic Foot and Ankle Society score for ankle and hindfoot

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## Introduction

Ankle fractures are among the most common fractures in the adult population, accounting for 9% of all fractures of the human skeleton [1, 2]. Men and women are both characterized by an almost equal bimodal incidence distribution: A peak between 20 and 40 years of age (predominantly men after high-energy trauma) and a second peak between 50 and 70 years of age (females, linked to low-energy trauma) are described [3]. Isolated distal fibula fractures (DFF) represent the most common ankle fracture accounting for 56% to 65% of all cases [4, 5].

According to the Danis–Weber classification, isolated DFF can be classified as follows: type B trans-syndesmotic fractures (52%), type A infra-syndesmotic fractures (38%)

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and type C supra-syndesmotic fractures (10%) [6, 7]. Despite its simplicity and reproducibility, this classification does not consistently predict the extent of the tibiofibular syndesmosis injury, as several studies have already demonstrated [8]. This classification also commonly disregards the state of the structures on the medial side, and it is not possible to compare prognosis, treatments or evolution of the pathology [9].

The AO-OTA group expanded the Danis–Weber classification, developing a classification based on the fracture line localization and on the degree of comminution [10]. This can be used to describe the severity and to define the degree of instability associated with a specific fracture pattern.

Many authors suggest conservative treatment for isolated DFF if there are no signs of ankle instability, with good clinical results described in most cases [6]. However, surgical management of unstable isolated lateral malleolar ankle fractures is recommended through open reduction and internal fixation (ORIF), with advantages in terms of anatomic restoration and earlier recovery [5].

Traditional postoperative non-weight-bearing management for ankle fracture lasts approximately 4–6 weeks and is intended to prevent fracture displacement, osteosynthesis implant failure, or an overall increase of complications. However, many studies challenge this protocol showing that early weight-bearing could be able to restore a full range of motion, prevent osteoporosis, and reduce swelling and skin atrophy, reducing the return-to-work time [11–14].

The main purpose of the study was to investigate the effects of immediate weight-bearing on the stability and healing of DFF after lateral plating. Secondarily early clinical outcomes and wound complications were evaluated.

## Materials and methods

The study was conducted in accordance with the Declaration of Helsinki and was approved by the IRB following the ethical recommendations of National Law Guidelines for Clinical Studies. The study was approved by the local ethics committee, ensuring compliance with all established regulations and ethical guidelines for clinical research. All patients signed an informed consent, and an individual ID was assigned to each patient. Data were prospectively collected and retrospectively analyzed.

Inclusion criteria were: isolated DFF classified as 44B1.1, 44B1.2, 44C1.1 according to AO classification [10], age of more than 18 and less than 65 years old at the time of surgery. Exclusion criteria were: open fracture, ankle fracture-dislocation, ankle unstable fracture, pediatric fractures (physeal injuries), and pathological fracture. In particular, unstable fracture were defined as bimalleolar, bimalleolar-like,

trimalleolar fractures and syndesmosis injuries. Moreover, demographic data, BMI, ASA score, time from fracture to surgery and surgical time were recorded.

X-rays including anteroposterior, mortise and lateral views were obtained preoperatively, and at 6 and 12 weeks after surgery. Two authors independently classified the preoperative X-rays according to the AO classification.

Clinical evaluation was performed at 2, 6 and 12 weeks after surgery. For clinical assessment, the AOFAS score (American Orthopedic Foot and Ankle Society score for ankle and hindfoot) was used [15, 16] after 6 and 12 weeks, while the local wound condition was assessed after 2 weeks. The AOFAS questionnaire consisted of 9 items over 3 categories: pain (40 points), function (50 points) and alignment (10 points), with a total maximum of 100 points.

Overall, 49 patients met inclusion criteria and were involved in the study.

All selected patients were treated surgically by ORIF using a lateral polyaxial fixation plate (Initial A™—Fibula kit, Newclip Technics, Haute Goulaine, France), with a single-use disposable instrumentation.

All procedures were performed by the same surgeon to reduce internal bias, under general or spinal anesthesia. A single prophylactic dose of Cefazolin 2 g was administered 30 min prior to surgery. Patients were placed in a supine position on a radiolucent table without the use of tourniquet [17]. Standard lateral approach to the distal fibula, anatomical fracture reduction temporarily stabilized using a Kirschner wire or a bone holding forceps and internal fixation with the fibular locking plate were performed. Three distal, three/two proximal locking and one non-locking screws were applied. Anatomical reduction was defined as an intraoperative fracture displacement after fixation of  $\leq 1$  mm, ensuring the anatomical continuity of the peroneal cortical bone interrupted by the fracture. After fibular fixation, the fluoroscopic “hook test” was performed to assess a syndesmosis instability. In this test, the fibula is grabbed with a bone hook and a lateral force is applied, while the tibia is hand stabilized. The test is considered positive if more than 2 mm of lateral movement of the fibula is observed [18]. None of the studied DFF showed a positive test. Finally, a subcutaneous suture was performed using 4–0 or 3–0 absorbable sutures and the skin was closed using a stapler to reduce the risk of surgical site complication [19, 20].

Postoperative care was characterized by tolerable weight-bearing up to full body weight allowed with crutches since the first postoperative day in all patients. All patients were advised to use comfortable, hard-soled shoes with medial vault support.

No casts or braces were applied, and crutches progressively abandoned after 3 weeks; sutures were removed 2 weeks postoperatively and the wound assessed. During

radiographic follow-ups, bone consolidation was represented by the neo-apposition of bone tissue at the fracture area.

Statistical analysis was performed using R v3.6.3 (<https://www.r-project.org>). Data are presented with value  $\pm$  standard deviation. The t-Student test for paired data was used. The level of significance was set at  $p < 0.05$ .

## Results

Demographic data related to patients included in the study are reported in Table 1.

Forty-one (83,6%) fractures were preoperatively classified as type 44B1.1, and 8 (16,4%) as type 44C1.1. The fractures classified as 44C1.1 (AO) enrolled for the study occurred in patients with stable ankles on valgus stress maneuvers, thus with likely partial deltoid ligament injury such that mortise stability was not precluded. The fractures were classified uniformly by the two authors, without contrasts (no internal bias). The mean fracture-to-surgery time was 4.6 days  $\pm$  3.0 (range 1–14). The mean surgical time was 36.1 min  $\pm$  16.6 (range 15–75).

**Table 1** Demographic data related to patients enrolled in the study

Variable	Mean $\pm$ SD	Range
Age	39.3 $\pm$ 7.9	18–65
Gender	M 30 (61%) / F 19 (29%)	–
BMI	23.8 $\pm$ 2.2	19–26
ASA score (1/2/3)	35/13/1	–
Side of fracture (R:L)	25: 24	–

The mean AOFAS score at 6 weeks was 86.5  $\pm$  6.4 (range 79–96), and it significantly increased up to 94.2  $\pm$  4.3 (range 81–100) at final follow-up at 12 weeks ( $p < 0.05$ ).

All patients were able to tolerate an early and progressive full weight-bearing without any cast or brace. At follow-up at 2 weeks after surgery, all patients enrolled for the study were able to ambulate at full weight-bearing with the aid of crutches. At follow-up at 6 weeks, all patients were ambulating at full body weight without crutches. Neither infection of surgical site nor wound trouble were observed.

In 2 patients, the plate was removed after 1 year, due to high-demanding sport activities.

In all patients, radiographical findings at 12 weeks after surgery showed complete bone healing. No complications as non-unions or radiographical signs of screw loosening were reported during the prospective evaluations (Fig. 1).

## Discussion

Ankle fractures are one of the most common fractures of the lower limb, and there is no consensus upon the best postoperative rehabilitative protocol [2, 21, 22]. Typically, patients affected by ankle fracture 44B1.1, 44B1.2, 44C1.1 according to AO classification are allowed to start weight-bearing after the fourth postoperative week. In particular, the rehabilitation process begins with the use of two crutches, bearing from 30 to 50% of body weight [21, 22]. Afterward, full weight-bearing is achieved at seventh to eighth postoperative week. Nevertheless, current fracture rehabilitation protocols tend to shorten recovery times to achieve an early return to activities [1].



**Fig. 1** Clinical case. a: 46-year-old man with an isolated fracture of right DFF (44.B1). b. 12-week postoperatively follow-up: good alignment of the osteosynthesis and fracture healing

In our knowledge, this is the first study on the effects of immediate weight-bearing after ORIF of DFF with a new-generation lateral polyaxial locking plate with single-use disposable instrumentation, analyzing fracture healing, development of early or late complications, and short-term outcomes.

Herrera-Perez et al. [23] compared the use of titanium, one-third, conventional low profile tubular non-locking plate (Group A) and titanium, one-third, tubular locking plate (Group B), always without immediate weight-bearing. The study showed higher AOFAS scores for the locking plate group, with a mean AOFAS Score of  $88.41 \pm 11.33$  at 6 months. In this cohort, no patient required revision surgery. The immediate full weight-bearing protocol adopted in our study provided even higher scores, with a mean AOFAS score at final follow-up at 3 months of  $94.2 \pm 4.3$  (range 81–100). As reported by Nightingale et al. [24], an immediate weight-bearing reduces the risk of muscle loss and joint stiffness that inevitably arises after surgical fixation associated with ankle immobilization.

During the follow-up period, no case of non-union complications or delayed union was detected in our study. This evidence suggested that such fixation device could be a very reliable tool in the treatment of DFF, providing a reliable fracture stabilization even with an immediate weight-bearing.

A recent study [1] showed that the use of anatomically preformed polyaxial plates in the treatment of DFF allows early rehabilitation protocol with full weight-bearing after 3 weeks with the aid of a walking boot. The interval of three weeks between the surgical procedure and the beginning of weight-bearing was adopted to ensure a complete wound healing. This early rehabilitation protocol led to excellent clinical results with a very low incidence of deep wound infection and implant removal.

Another study [25] compared the use of one-third tubular non-locking plate (TP) with anatomical distal lateral fibular locking plate (FLP) for the treatment of AO/OTA 44B DFF in 72 patients (34 treated with FLP; 38 with TP). No weight-bearing was allowed until 2 weeks after surgery, while full weight-bearing was introduced after 8 weeks or with radiological evidence of union. They did not find differences between the two groups in terms of wound healing and deep infection (both groups had two cases of delayed wound healing and one superficial infection); however, the implant removal rate was higher in the TP group. These findings suggest that a delayed weight-bearing could frustrate the potential advantages of a stable fixation combined with an early weight-bearing.

In our study, no surgical site superficial or deep infection and no wound trouble were observed; the use of disposable

instrumentations, in fact, could have contributed to reduce the risk of local superinfection.

It is reported in the literature that in total knee arthroplasty the use of tourniquet is associated with wound hypoxia during and after surgery [26]. Furthermore, the use of the pneumatic tourniquet is associated with an increased risk of venous thrombosis [27]. In our series, although no tourniquet was employed, the mean surgical time was relatively short, reaching nonetheless a satisfactory fracture reduction.

Literature disagrees about the use of staples for wound closure in orthopedic surgery [28, 29]. One of the main advantages of use of staple closure is the rapidity of the procedure, that is approximately seven times faster than suture closure [30]. In our experience, we progressively shifted from suture to staple in order to minimize surgical time and surgical site complications [19, 20].

Considering the thinness and the width of the plate (10 mm), we observed an extremely low rate of implant removal. Moreover, patients of this study did not report discomfort when wearing high shoes or boots. The implant was removed in only two patients, who were high demanding athletes characterized by a high mechanical stress of the ankle joint.

The limits of this study were the lack of a control group and absence of different postoperative protocols comparison. The short follow-up period relates to the main objective of the study, concerning the healing of peroneal malleolar fractures with early complete weight-bearing protocol rather than a long-term assessment of functional impact. Further studies will be aimed at evaluating long-term functional outcomes.

The use of new-generation lateral polyaxial locking plate represents a trustworthy tool in the treatment of AO 44B1.1, 44B1.2, 44B2.1, 44C1.1, 44C2.1 DFF, providing optimal fracture stabilization and allowing immediate weight-bearing.

Further studies will be needed to investigate the role of immediate post-operative rehabilitation following internal fixation of DFF even comparing the outcomes of the use of lateral polyaxial locking plate with those of other available devices.

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## Declarations

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** This retrospective chart review study involving human participants was in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The Human Investigation Committee (IRB) of Local University approved this study.

**Consent to participate** Informed consent was obtained from all individual participants included in the study.

**Consent to publish** The authors affirm that human research participants provided informed consent for publication of the image.

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