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Intramedullary nailing of lateral malleolus in ankle fractures – surgical technique and literature review

Haste intramedular de fíbula nas fraturas maleolares do tornozelo – técnica cirúrgica e revisão da literatura

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ABSTRACT

Our objective is to describe the technique of intramedullary (IM) nailing of lateral malleolus in the surgical management of ankle fractures. Fracture reduction is performed either percutaneously with a small pointed reduction clamp in simple oblique fractures or using longitudinal traction and rotation for comminuted fractures, thus reducing complications related to open reduction and internal fixation with a plate. The technique has been shown to be simple and reproducible. In addition, the technique allows early weight bearing, which accelerates rehabilitation and potentially fasten fracture healing. IM nailing is a viable option for the fixation of the of lateral malleolus in ankle fractures and should be considered in the surgeon's armamentarium.

Keywords: Ankle fracture; Fracture fixation, Intramedullary; Fracture fixation; Fibula.

INTRODUCTION

Intramedullary (IM) nailing of the lateral malleolus has been used with increasing frequency for stabilization of malleolar fractures[1,2]. Relative indications for fibula IM nailing include severe soft-tissue injury on the lateral side of the ankle, osteopenia and osteoporosis, multifragmentary fracture patterns with long comminution of the distal fibula, and patients with severe comorbidities, such as chronic diabetes and vascular insufficiency[1].

Recent studies have shown that fibular nailing allows secure fixation of ankle fractures, with the majority of patients reporting good to excellent outcomes, a mean union rate of 98%, and a significantly lower rate of soft tissue complications compared to open reduction and internal fixation (ORIF)[1,3-5]. Moreover, cadaveric studies have demonstrated that fibular nail is biomechanically comparable to distal fibular locking plate and has greater torque to failure compared to non-locking plate in non-comminuted lateral malleolar fractures[6,7]. Finally, fibular nail is reported to be more cost-effective than ORIF and delayed-staged ORIF, which seems particularly critical in the elderly population[8,9].

Herein, we describe the technique of IM nailing of lateral malleolus in the surgical management of ankle fractures.

DESCRIPTION OF THE TECHNIQUE

Patient positioning depends on the existence or not of a posterior malleolus fracture of the distal tibia and if it is necessary to approach it. When fixation of the posterior malleolus is indicated, patient is positioned in lateral decubitus with uninjured leg resting on the operating table.

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Otherwise, patient is positioned supine with a jelly bump beneath the ipsilateral buttock and hip to promote slight internal rotation of the leg (Figure 1). C-arm is positioned on the opposite side and used to verify fracture reduction either percutaneously with a small pointed reduction clamp in simple oblique fractures or longitudinal traction and rotation for comminuted fractures (Figure 2). A skin incision is made approximately 10 to 15-mm distal to the tip of the lateral malleolus, in line with the longitudinal axis of the fibula. The tip of the distal fibula is identified under fluoroscopy and a 1.6-mm K-wire is manually introduced to confirm the entry point.

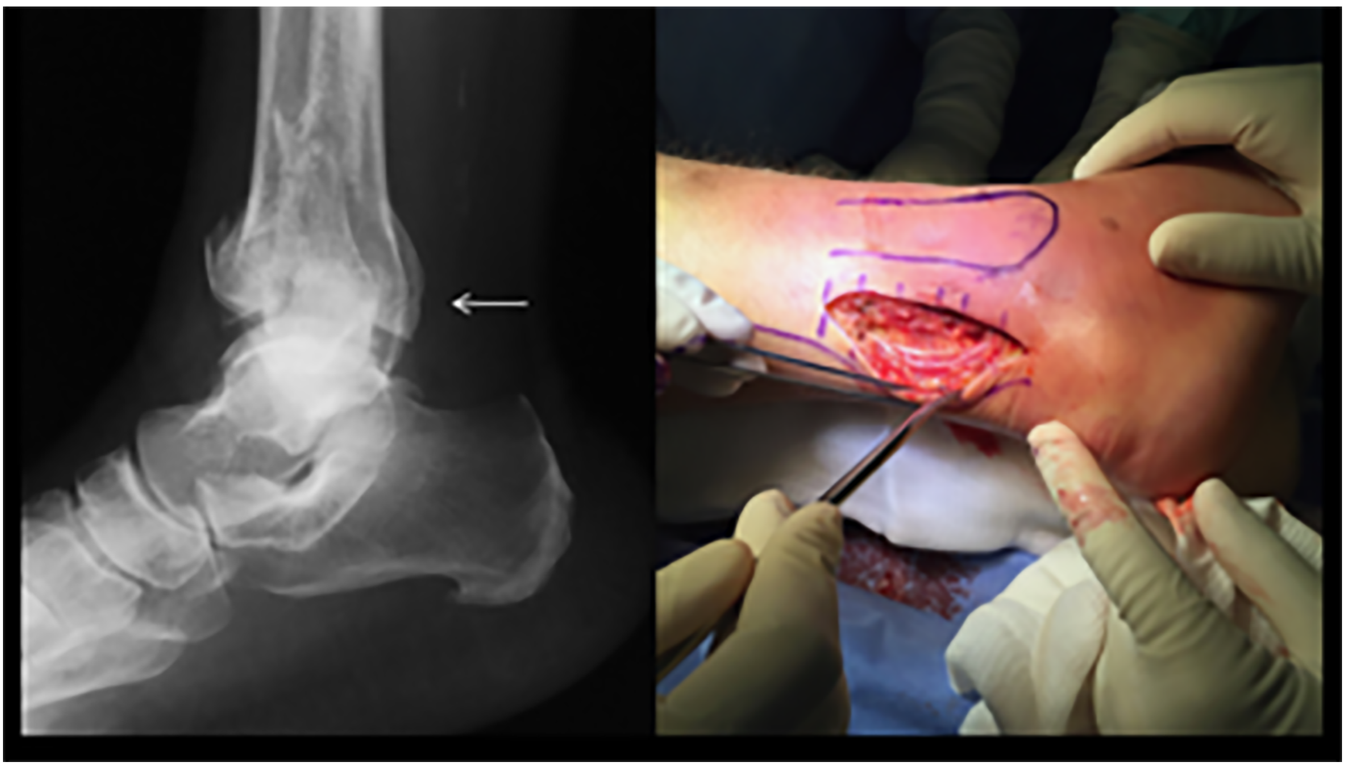

Figure 1. *Positioning of the patient is defined based on the necessity to approach or not the posterior malleolus fracture of the distal tibia. If fixation of the posterior malleolus is indicated, patient is positioned in lateral decubitus with uninjured leg resting on the operating table.*

Figure 2. *In simple fracture patterns, the skin is marked, and a pointed reduction clamp applied to percutaneously reduce the fracture.*

After confirmation of the entry point, a 3.5-mm drill bit is used to prepare the entry point, then a curved awl is advanced into the medullary canal (Figure 3). Awl is removed and IM canal is sequentially reamed with flexible reamers while holding the reduction. Nail is inserted and the final position checked with the C-arm (Figure 4).

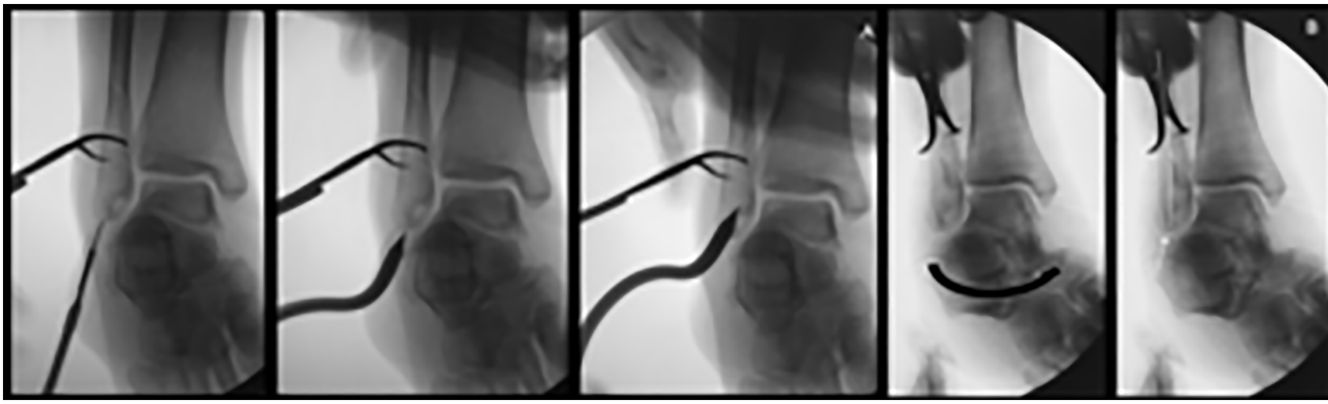

Figure 3. *A, Entry point is marked with a scalpel, then the bone is opened using a curved awl, which is advanced into the medullary canal. B, Slightly invert the subtalar joint to facilitate defining the correct entry point.*

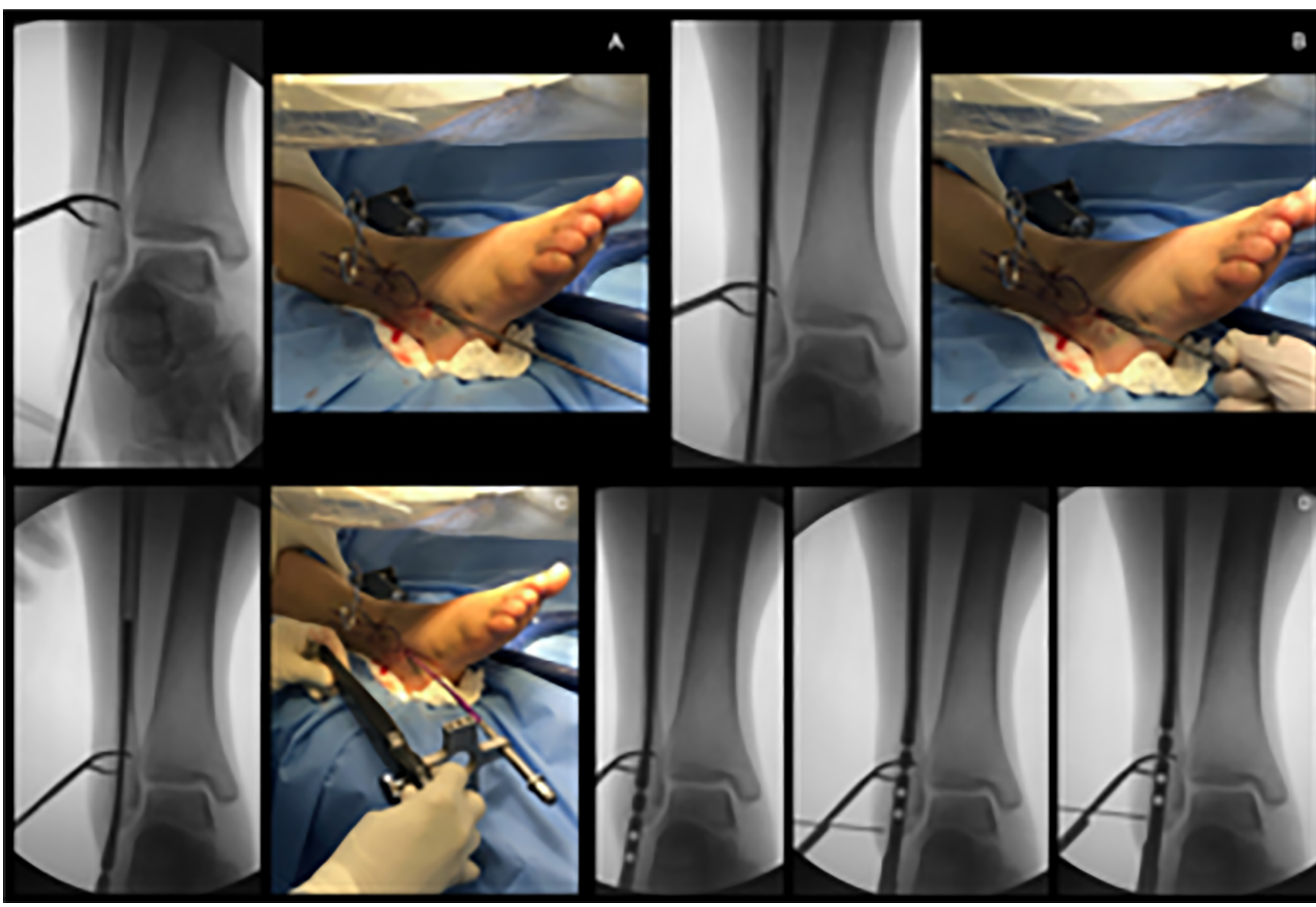

Figure 4. *A and B, IM canal is gradually reamed with sequential flexible reamers while holding the reduction. C, Then the nail is inserted using the targeting guide. D, The final position of the nail is confirmed with a 1.6-mm K-wire introduced through the targeting guide end nail hole using the C-arm. Nail should be completely inside the fibula, thus avoiding local soft tissue irritation.*

The targeting guide should be rotated approximately 25º posteriorly to allow anatomical placement of the lateral screws from the fibula to the center of the tibia, which requires a slight posterior to anterior orientation (Figure 5). Finally, distal locking screws are inserted. In suprasyndesmotic fractures, a screw is inserted just proximal to the tip of the nail using the targeting guide to avoid proximal migration of the nail and consequently fracture collapse. Due to the posterior rotation of the targeting guide it is not infrequent to insert this screw eccentrically anterior to the fibular medullary canal. Thus, adequate positioning of this screw should be confirmed on lateral fluoroscopic imaging (Figure 6).

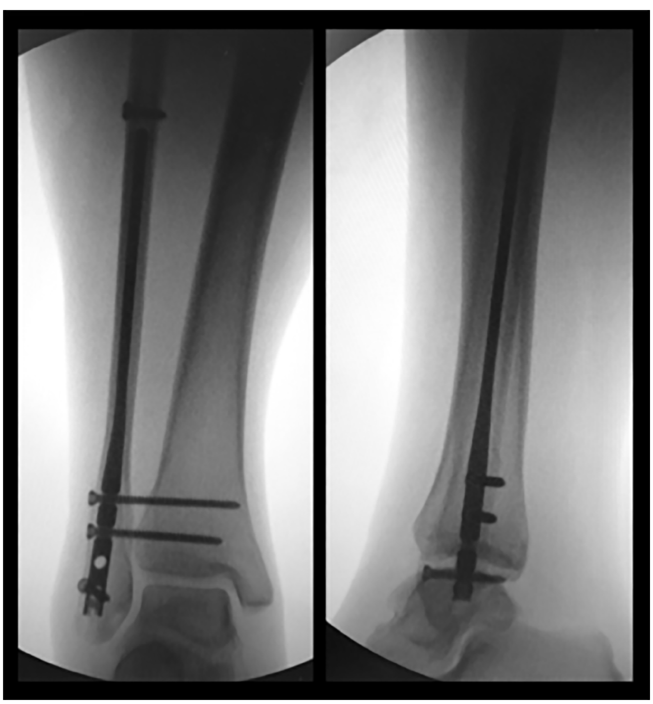

Figure 5. *The targeting guide is rotated approximately 25º posteriorly and both distal locking screws and syndesmotic screws are inserted. A screw just proximal to the tip of the nail should be used in suprasyndesmotic (Weber type C) and some transyndesmotic fractures (Weber type B) to avoid proximal migration of the nail and consequent fracture collapse.*

The study was approved by the Institutional Review Board of Hospital Municipal Miguel Couto.

DISCUSSION

ORIF is the standard of care for fixing displaced fractures of the lateral malleolus[9]. Nevertheless, ORIF is associated with higher rate of complications, mainly in older women with osteoporosis and poor soft-tissue envelope of the distal fibula[3,5]. It has been shown that approximately one fifth of optimally reduced fractures has unsatisfactory results related to wound breakdown, infection, and prominent hardware requiring subsequent removal[5,9].

IM nailing of lateral malleolar fractures is a minimally invasive technique, that reduces potentially devastating wound complications and leads to stable fixation, thus allowing early weight bearing[1-5]. In a systematic review, Jain et al. concluded that IM fixation gives good or excellent results in up to 92% of patients, with a mean rate of union of 98.5%[1]. They found a mean complication rate of 10.3 %, mainly linked to implant-related problems requiring metalwork removal, fibular shortening, and metalwork failure[1].

Several authors compared the results of plating and nailing for internal fixation of the fibula in ankle fractures[3,5]. Asloum et al. used the Kitaoka and the Olerud-Molander functional scores to compare the results of 32 patients treated with a plate versus 28 patients treated with IM after one-year follow-up[3].

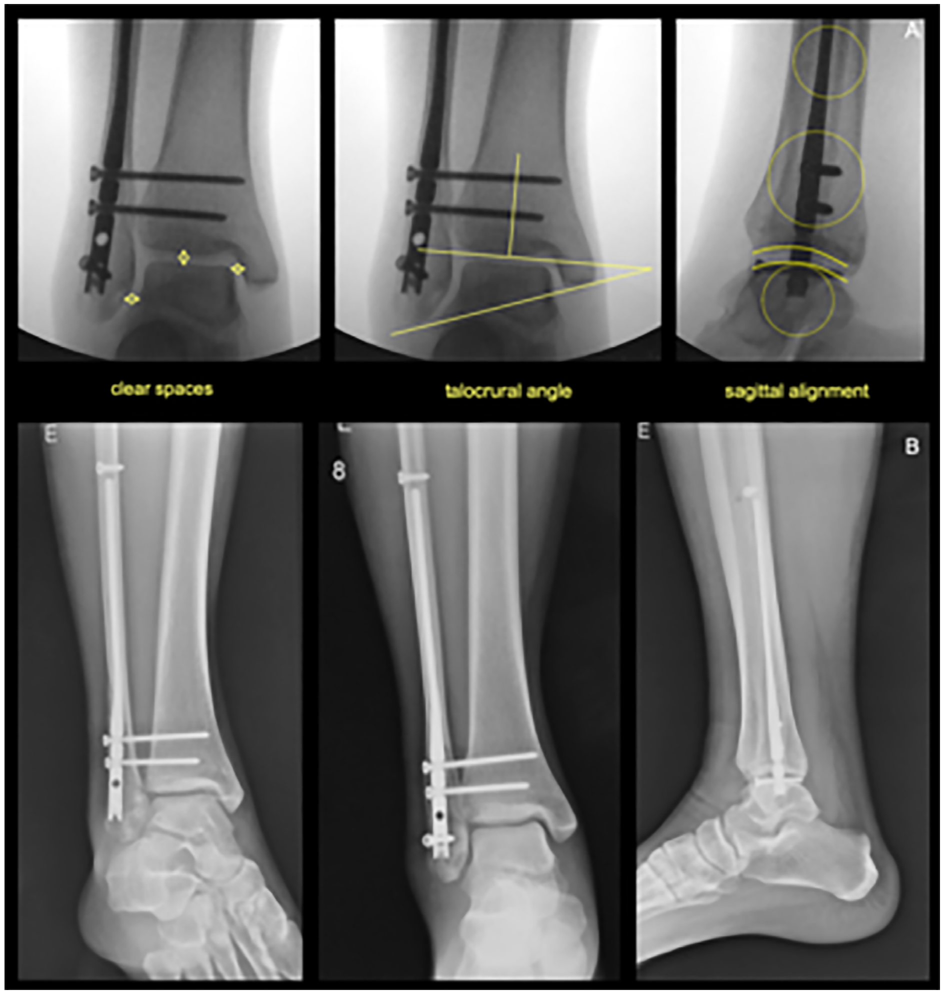

Figure 6. *A, Before closure, anatomical reduction / alignment of the distal fibula and correct position and size of the locking screws are checked with the C-arm. In addition, syndesmosis reduction and tibiotalar joint congruency are confirmed using the existing radiographic parameters. B, Final X-rays are done before patient leaves the OR.*

They reported significantly fewer complications (7% versus 56%) and better functional scores (96 vs 82 for the Kitaoka score and 97 vs 83 for the Olerud-Molander score) with IM nailing than with plate fixation. In a prospective randomized controlled trial, White et al. compared fibular nailing and plating for the fixation of unstable ankle fractures in elderly patients[5]. Fifty patients underwent plating and 50 patients fibular nailing. The primary outcome measure was functional recovery as measured by the Olerud and Molander Ankle Score and secondary outcomes were the incidence and nature of complications, the Short Musculoskeletal Functional Assessment measure and the level of satisfaction with the appearance and comfort of the scar as rated on a visual analogue scale. Also, authors performed an economic evaluation looking for the costs related to the procedures[8,9]. They observed significantly fewer wound infections in the fibular nail group, with no significant difference in mean Olerud and Molander functional score between groups at one-year follow-up.

The overall cost of treatment with a fibular nail was less than with plating, despite the higher initial cost of the IM implant[8]. Smeets et al. also found significantly lower costs for early percutaneous nailing compared to both early and delayed-staged plating in a preliminary exploratory analysis of the health care costs associated with the operative treatment of unstable ankle fractures using nails and plates[9]. They launched a prospective observational study including elderly patients with an AO type 44B fracture treated with a fibular nail, comparing their findings with previous findings of a cohort population treated by ORIF with a one-third tubular plate. Average hospitalization costs were $5,128.00 for patients treated with fibular nail, $7,010.00 for patients treated by ORIF ($p > .05$), and $13,495.00 for patients treated with delayed-staged ORIF ($p < .001$)[8,9].

Biomechanical studies have been performed comparing IM *nail* and plates for comminuted and non-comminuted fractures of the distal fibula[6,7]. Smith et al. compared the strength of a non-locked one-third tubular plate with an IM fibular nail in a cadaveric model of supination external rotation IV (AO 44B-type) ankle fracture[6]. Twenty cadaveric lower limbs (10 fixed with a fibular nail and 10 with a cortical lag screw and neutralization plate) were axially loaded in supination external rotation force to failure. Superior ultimate torque to failure ($p = .28$) was observed in the nail IM fibular nail construct compared to non-locked plating. Switaj et al. compared biomechanically the strength of a distal fibular locking plate with that of an IM fibular nail in a cadaveric model of suprasyndesmotic (AO 44C2-type) ankle fracture[7]. Ten matched cadaveric pairs were randomized, thus for the first matched pairs, the left limb received the nail and the right limb received the plate, and for the last five matched pairs, the left limb received the plate and the right limb received the nail. All specimens were axially loaded and underwent testing for external rotation stiffness, external rotation cyclic loading, and torque to failure. The syndesmotic diastasis, stiffness, torque to failure, angle at failure, and mode of failure were obtained from each specimen. There was no significant difference in syndesmotic diastasis during cyclic loading or at maximal external rotation. Authors found IM nailing to be biomechanically comparable to the locked plating[6,7].

Pitfalls and challenges have been described and include an incorrect entry point, direct damage to the peroneal tendons and superficial peroneal nerve, and fibular malreduction[4,10-12]. It is recommended to anatomically reduce the facture and check all radiographic parameters of the ankle with fluoroscopy before selecting the correct entry point. The tip of the distal fibula has to be adequately seen both on AP and lateral views[4,12]. Protection of all anatomic structures at risk during nail instrumentation and insertion is mandatory[4,11]. Slightly inversion of the subtalar joint greatly facilitates these steps. In addition, a protection sleeve must be used during reaming[4,12]. Finally, reduction can be maintained using a bone clamp during reaming and nailing to avoid perforation or fracture of the cortical bone, as well as fibula shortening. This is more critical when operating patients with reduced bone quality.

R E S U M O

Nosso objetivo é descrever a técnica de fixação intramedular (IM) da fíbula no tratamento cirúrgico das fraturas maleolares do tornozelo. A redução é realizada sempre de forma percutânea: quando o traço de fratura é oblíquo simples, utilizamos uma pinça de redução de pontas e quando a fratura apresenta padrão multifragmentar, usa-se tração longitudinal e rotação. Isso reduz as complicações relacionadas à redução aberta e fixação interna com placa. A técnica demonstrou ser simples e reprodutível. Além disso, essa forma de fixação permite apoio precoce do peso corporal, o que acelera o processo de reabilitação e potencialmente acelera a cicatrização da fratura. A fixação IM da fíbula mostrou-se uma opção viável para a fixação do maléolo lateral nas fraturas do tornozelo, devendo ser considerada no arsenal do cirurgião.

***Descritores:** Fratura do tornozelo; Fixação Intramedular; Fixação de fraturas; Fíbula.*

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