

## Original Article

# Suprapatellar intramedullary nailing of the tibia

Enzo Sperone<sup>1</sup> , Matías Iglesias<sup>1</sup> , Andrés Bigatti<sup>1</sup> , Iván Torterola<sup>1</sup> , Yanser Atilmis<sup>1</sup> , Alberto Macklin-Vadell<sup>1</sup> 

1. Sanatorio Finochietto, Ciudad Autónoma de Buenos Aires, Buenos Aires, Argentina.

## Abstract

**Objective:** To report our experience with intramedullary fixation and osteosynthesis of the tibia with suprapatellar approach and semiextended positioning.

**Methods:** This study retrospectively assessed 6 patients with tibial fracture treated with suprapatellar intramedullary nail fixation and osteosynthesis from September 2015 to September 2018.

**Results:** There was acceptable bone fixation. Mean healing time was 6 months (range: 4-10 months). Postoperative pain was assessed using a visual analog scale, and the knee was divided into 9 quadrants to help locate the specific site of pain; all participants reported that pain was located at distal quadrants. Knee function was completely restored.

**Conclusion:** Suprapatellar approach with the knee in the semiextended position is a good surgical technique for extra-articular proximal tibial fractures or those associated with soft tissue involvement at the conventional infrapatellar entry site. Thus, this analysis led us to believe that the technique should also be applicable to middle diaphyseal fractures or fractures in general, regardless of their location.

**Level of Evidence IV, Therapeutic Studies; Case Series.**

**Keywords:** Patellofemoral joint/surgery; Tibial fractures/surgery; Fracture fixation, intramedullary; Treatment outcome.

## Introduction

Tibial fractures are the most common long bone fractures, and extra-articular proximal tibial fractures account for 5-11% of all tibial shaft fractures. They are usually caused by high-energy trauma and often associated with soft tissue injuries<sup>(1)</sup>.

The treatment of choice for extra-articular tibial fractures, regardless of their location (epiphysis, metaphysis, or diaphysis), is fixation and osteosynthesis with intramedullary nails<sup>(2)</sup>, which are inserted through an infrapatellar portal with the knee in the maximum flexion position<sup>(3)</sup>. There are two problems with this approach. First, it requires maximum flexion of the knee, meaning that fixation of proximal fractures is affected by the patellar tendon, which shows antecurvatum deformity; second, the nail entry site is often compromised by soft tissue injuries resulting from these fractures. Therefore, a new technique emerged to treat these fractures using a suprapatellar approach and semiextended positioning<sup>(1)</sup>.

The aim of this study was to report our experience with intramedullary fixation and osteosynthesis of the tibia with a suprapatellar approach and semiextended positioning.

## Methods

This study was approved by the Institutional Review Board.

The present study retrospectively assessed 6 patients with tibial fracture treated with suprapatellar intramedullary nail fixation and osteosynthesis from September 2015 to September 2018.

Inclusion criteria were patients aged 18 years or over with extra-articular proximal tibial fractures or with fractures associated with soft tissue injuries at the conventional infrapatellar entry site, regardless of their location, who were followed up for at least 12 months.

Study performed at the Sanatorio Finochietto, Ciudad Autónoma de Buenos Aires, Buenos Aires, Argentina.

**Correspondence:** Matías Iglesias. 1555 Haedo St., Vicente López, Buenos Aires, Argentina, Zip Code: 1605. **E-mail:** [mfiglesias6@gmail.com](mailto:mfiglesias6@gmail.com). **Conflicts of interest:** none. **Source of funding:** none. **Date received:** May 31, 2020. **Date accepted:** July 03, 2020. **Online:** August 30, 2020

How to cite this article: Sperone E, Iglesias M, Bigatti A, Torterola I, Atilmis Y, Macklin-Vadell A. J Foot Ankle. 2020;14(2):153-7.



Patient assessment included clinical history, imaging scans, and functional testing of the knee. The following variables were investigated: type of fracture according to AO classification, quality of fracture fixation according to acceptable angle values (angle deviations below 6° at any plane)<sup>(4)</sup>, radiographic bone healing (bridging of two or more cortices)<sup>(5)</sup>, postoperative pain intensity according to a visual analog scale, site of pain, and knee function (Table 1).

## Surgical technique

Patients were placed in the supine position on a radiolucent table with the knee semiextended at an angle from 15° to 30°. No hemostatic tourniquet was applied (Figure 1). First, a 2-3cm longitudinal incision was made along the midline at 2 cm proximal to the upper portion of the patella. After dissection through the quadriceps tendon, a guide pin was inserted into the tibia under radioscopic control, using the following landmarks: a line medial to the lateral intercondylar tubercle of the tibia in the coronal plane, and ventral edge of the joint surface in the sagittal plane (Figure 2). Subsequently, we placed a patellofemoral protection sleeve, whose internal and external parts were made of metal and thermoplastic material, respectively. Afterwards, surgery proceeded with the usual procedures of the infrapatellar technique.

## Results

Mean age at the time of surgery was 48 years (range: 22 to 82 years); all patients were male. Five fractures affected the left leg and one affected the right leg. Five fractures were located at the proximal third of the diaphysis and one was located at its distal third (Figure 3).

Two fractures were open, both classified as Gustilo-Ander-son 3A, and four were closed. Four fractures were caused by high-energy trauma, of which two were caused by a motor vehicle collision, one by fall from height, and another by a high-risk sport. Two fractures were associated with contrala-

teral leg fracture, one with homolateral patellar fracture, and one with severe multiple trauma.

Mean time elapsed from fracture to surgery was 10 days (range: 3 to 25 days). Of note, the longest times were found for the two cases of open fracture, which required surgical cleaning and temporary external stabilization. Mean follow-up duration was 22 months (range: 12 to 48 months).

Acceptable bone fixation was achieved in all cases, as shown by adequate alignment (mean frontal axis of 1° and mean lateral axis of 4.36°), length, and rotation in control panoramic frontal and lateral radiographs of the leg.

Mean time for bone healing was 6 months (range: 4 to 10 months) (Figure 4).

Three patients reported postoperative pain, of whom two had moderate pain and one had mild pain according to the visual analog scale.

To enable the assessment of site of pain, the knee was divided into three thirds (purely articular third, extra-articular proximal third, and extra-articular distal third), and each of these thirds was further divided into another three thirds (internal, middle, and external) (Figure 5).

All cases of pain were located at the distal third, i.e., the lower extra-articular third. One of these cases, which was located at the internal distal third and was related to the proximal locking nail used in osteosynthesis, resolved soon after nail removal. The other two, which were located at the middle distal third and were related to fracture focus or bone exposure area and soft tissue injury, did not require any other procedure. There were no reports of pain at the proximal middle third (surgical site) or at the articular middle third (patellofemoral compartment).

Knee function was completely restored in all patients, and maximum knee extension and flexion angles were restored to those reported prior to the fracture or to those found in the healthy contralateral knee (Figure 6). There were no soft tissue complications at the surgical site.

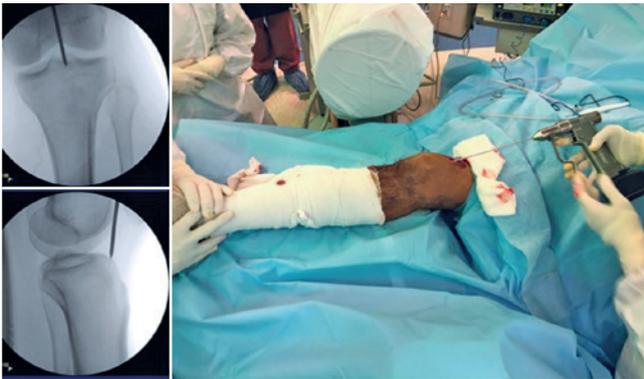
**Table 1.** Patients

	1	2	3	4	5	6
<b>Age</b>	65	36	22	44	82	40
<b>Sex</b>	M	M	M	M	M	M
<b>Type of fx</b>	42-A2 P	42-A1 P	42-A2 P	42-B2 D	42-A2 P	42-A3 P
<b>Affected side</b>	L	L	L	L	L	R
<b>Associated events</b>	Patellar fx	Contralateral tibial fx	Open fx	Open fx	Contralateral tibial fx	-
<b>Days from fx to sx</b>	3	6	25	15	6	7
<b>Fixation</b>	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Satisfactory
<b>Healing time</b>	6 m	4 m	10 m	4 m	6 m	5 m
<b>Follow-up duration</b>	48 m	18m	18 m	15 m	12 m	12 m
<b>Postoperative pain</b>	6	0	5	0	2	0
<b>Site of pain</b>	7	-	8	-	7	-
<b>Function</b>	Complete	Complete	Complete	Complete	Complete	Complete

Fx: fracture; Sx: surgery.



**Figure 1.** Patient positioning.



**Figure 2.** Placement of guide pin and radioscopic control.



**Figure 3.** Frontal and lateral radiograph of a typical proximal tibial fracture.

## Discussion

According to the literature, proximal tibial fractures are difficult to manage using the infrapatellar approach. Traction of patellar and hamstring tendons usually leads to malalignment and more complex fixation<sup>(4)</sup>. Malalignment is reported to range from 58 to 84%<sup>(5)</sup>.



**Figure 4.** Frontal and lateral radiographs showing bone healing.



**Figure 5.** Quadrants to assess sites of pain.



**Figure 6.** Complete flexion and extension of the knee, asymptomatic.

Therapeutic alternatives include plates that allow for direct visualization and anatomic fixation. However, they have some disadvantages, such as poor axial fixation and poor varus stability, in addition to greater risk of infection and dehiscence in cases requiring large dissections for the placement of these plates<sup>(1)</sup>.

The two main indications for suprapatellar approach are extra-articular proximal tibial fractures and those associated with soft tissue involvement at the infrapatellar entry site. Secondary indications may include patients with knee flexion deficit, *patella baja*, or patellar tendon calcification<sup>(1)</sup>.

In 1996, Tornetta and Collins<sup>(6)</sup> were the first to treat proximal tibial fractures with the knee in the semiextended position and using a suprapatellar approach by performing a subluxation of the middle patella. However, Cole was the author who proposed, in 1998<sup>(7)</sup>, a minimally invasive suprapatellar insertion technique that approaches the midline of the quadriceps. In 2018, Wang et al.<sup>(8)</sup> conducted a review that showed advantages of the suprapatellar approach with regard to shorter radioscopies duration. We agree that semiextended positioning facilitates the operation of the radioscopies equipment.

We believe that the semiextended knee position makes surgical management easier in patients with multiple trauma

and in those with soft tissue involvement at the infrapatellar entry site. Compared to findings from the literature, we did not observe anterior knee pain related to nail insertion using the suprapatellar approach. Higher levels of knee pain after infrapatellar nailing may result from knee flexion during nail insertion or from the transpatellar tendon approach<sup>(3,7,8)</sup>.

Suprapatellar approach is questioned due to possible patellofemoral joint damage. Gelbke et al.<sup>(9)</sup> compared patellofemoral contact pressure of infrapatellar and suprapatellar nailing of the tibia in human cadaver specimens and found that was the maximum pressure recorded during the suprapatellar procedure was 3.83 MPa, which was three times higher than that recorded during the infrapatellar procedure (1.26 MPa). However, the suprapatellar value is still below the 4.5 MPa at which apoptosis of chondrocytes occurs and, therefore, suprapatellar nailing did not pose significant risks to patellofemoral joint integrity.

Sanders et al.<sup>(3)</sup> assessed a series of 26 cases undergoing arthroscopies before and after nail insertion to investigate the presence of osteochondral lesions and found no such lesions in these patients. Similarly, our analysis did not find any patient with symptoms suggesting patellofemoral involvement.

The limitations of our study include its small sample size (6 patients) and lack of accurate angle measurements with weight-bearing panoramic radiographs, which would help to diagnose arthroscopically damage to the patellofemoral cartilage.

## Conclusion

Suprapatellar approach with the knee in the semiextended position is a good surgical technique for extra-articular proximal tibial fractures or those associated with soft tissue involvement at the conventional infrapatellar entry site. Thus, this analysis led us to believe that the technique should also be applicable to middle diaphyseal fractures or fractures in general, regardless of their location.

**Authors' contributions:** Each author contributed individually and significantly to the development of this article: AMV \*(<https://orcid.org/0000-0002-0384-4044>) conceived and planned the activities that led to the study, interpreted the results of the study, performed the surgeries, approved the final version; ES \*(<https://orcid.org/0000-0001-5028-9584>) conceived and planned the activities that led to the study, interpreted the results of the study, performed the surgeries; YA \*(<https://orcid.org/0000-0001-8926-5088>) data collection, bibliographic review; AB \*(<https://orcid.org/0000-0003-1690-025X>) data collection, clinical examination; MI \*(<https://orcid.org/0000-0002-6336-6080>) wrote the article, bibliographic review; IT \*(<https://orcid.org/0000-0001-9210-9051>) data collection, clinical examination. \*ORCID (Open Researcher and Contributor ID) 

## References

1. Franke J, Hohendorff B, Alt V, Thormann U, Schnettler R. Suprapatellar nailing of tibial fractures-Indications and technique. *Injury*. 2016;47(2):495-501.
2. Githens M, Bishop J. Complex tibial fractures: tips and tricks for intramedullary nail fixation. *Clinical Medicine Insights: Trauma Intensive Med*. 2014;5:19-25.
3. Sanders RW, DiPasquale TG, Jordan CJ, Arrington JA, Sagi HC. Semiextended intramedullary nailing of the tibia using a suprapatellar approach: radiographic results and clinical outcomes at a minimum of 12 months follow-up. *J Orthop Trauma* 2014;28(suppl 8):S29-S39.
4. Rothberg DL, Holt DC, Horwitz DS, Kubiak EN. Tibial nailing with the knee semi-extended: review of techniques and indications: AAOS exhibit selection. *J Bone Joint Surg Am*. 2013;95(16):e116.

5. Nork SE, Barei DP, Schildhauer TA, Agel J, Holt SK, Schrick JL, et al. Intramedullary nailing of proximal quarter tibial fractures. *J Orthop Trauma*. 2006;20(8):523-8.
6. Tornetta P 3rd, Collins E. Semiextended position of intramedullary nailing of the proximal tibia. *Clin Orthop Relat Res*. 1996;(328):185-9.
7. Cole JD. Intramedullary fixation of proximal tibia fractures. *Tech Orthop*. 1998;13(1):27-37.
8. Wang C, Chen E, Ye C, Pan Z. Suprapatellar versus infrapatellar approach for tibia intramedullary nailing: a meta-analysis. *Int J Surg*. 2018;51:133-9.
9. Gelbke MK, Coombs D, Powell S, DiPasquale TG. Suprapatellar versus infra-patellar intramedullary nail insertion of the tibia: a cadaveric model for comparison of patellofemoral contact pressures and forces. *J Orthop Trauma*. 2010;24(11):665-71.