DOI: https://doi.org/10.30795/jfootankle.2023.v17.1699

Original Article

Suprapatellar nail – the gold standard in the treatment of tibia fractures

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Abstract

Objective: Demonstrate the experience of the team of leg and foot surgeons in tibia instrumentation by the suprapatellar approach for all tibia fractures that meet the indication of an endomedullary nail over three years.

Methods: Forty patients were operated on, and after applying inclusion and exclusion criteria, 14 were excluded, totaling 26 patients. The Olerud & Molander (0–100) and Lower Extremity Functional Scale (LEFS) (80/80, 100%) scores were used. Knee pain was evaluated by subdividing the knee into six quadrants to assess the anatomical location of the discomfort.

Results: The mean Olerud & Molander was 76.92, and the mean LEFS was 72.33. Five patients presented pain in the knee quadrant 3, reproducing this at maximum knee flexion, and one in quadrant 5, the site of the proximal locking nail, which resolved with its removal. None presented pain at the site of nail entry or femoropatellar pain.

Conclusion: Suprapatellar nail instrumentation for tibia fractures has become the gold standard in treating these fractures in the Cirujanos Especialistas en Piena e Pie due to its technical advantages and favorable postoperative evolution.

Level of Evidence IV; Therapeutic Studies; Case Series.

Keywords: Bone nails; Fracture fixation, intramedullary; Tibial fractures.

Introduction

Fractures of the proximal and distal third of the tibia are a challenge for the trauma surgeon, especially when the indication of osteosynthesis is an endomedullary nail given its biological and mechanical advantages[1-3] and for having less incidence of material removal compared to osteosynthesis with plate[4]. To avoid traction of the patellar tendon on the proximal fragment of the tibia, in 1996, Tornetta[5] described the medial parapatellar approach, arthrotomy, and lateral patellar subluxation, with the patient in a semiextended position. In 2006, Dr. Dean Cole described the suprapatellar approach we know today as a modification to the grand approach of Sanders et al.[6]. Over time, the use of this technique gained popularity due to its advantages and its classic indication in extraarticular fractures of the proximal third, extended to the reduction and osteosynthesis of tibia fractures at all levels. The objective of this study was to demonstrate the experience of the Cirujanos Especialistas en Piena e Pie (CEPP) team (Specialist Surgeons in Leg and Foot) in suprapatellar approach for the placement of endomedullary nail to show that this technique is a less demanding and given the semiextended position it helps the reduction and control of the fragments, this being the main indication of endomedullary interlock in the CEPP team, leaving the trans or parapatellar approach with the knee in 90º as the second option.

Methods

The CEPP team operated on 40 patients at the Dupuytren Institute in Buenos Aires from July 2018 to December 2021. The inclusion criteria were patients with tibia fractures with indication of osteosynthesis with endomedullary nail

Study performed at the Instituto Dupuytren, CABA, Buenos Aires, Argentina.

Correspondence: Juan Manuel Gaillard. Estrada 225, Concordia, E3200ELE, Entre Rios, Argentina. **Email:** juanmgaillard@hotmail.com **Conflicts of interest:** none. **Source of funding:** none. **Date received:** April 18, 2023. **Date accepted:** October 24, 2023. **Online:** December 20, 2023.

How to cite this article: Casola L, Iglesias M, Matías-Joannas G, Eslava S, Martinez MJ, Gaillard JM, et al. Suprapatellar nail – the gold standard in the treatment of tibia fractures. J Foot Ankle. 2023;17(3):148-55.

of suprapatellar approach (whether proximal, diaphyseal, or distal fractures) and follow-up greater than six months. All patients were operated on within ten days of the initial trauma. The exclusion criteria were patients with open physis and patients scheduled to have the procedure as a second surgery (review) for some complication. Among the operated patients, 14 were excluded due to not meeting the abovementioned criteria. Twenty-six patients were analyzed, and two patients had bilateral tibia fractures. The main cause of the fractures was a motorcycle accident. The patients were classified according to AO/OTA, and the Gustilo and Anderson classification was used for exposed fractures. A retrospective analysis of the postoperative outcomes of the included patients was performed. The Olerud and Molander Scores (0–100) and the Lower Extremity Functional Scale (LEFS)(80/80, 100%) were used[7,8]. The patient's knees were divided into six equal quadrants to evaluate postoperative pain; the patients were asked to point a finger in which quadrant the pain was located (Figure 1).

Surgical technique

During the physical examination, we recommend verifying the mobility of the patella in laterolateral and avoiding this approach in cases of ankylosis or very rigid patellofemoral space. Osteoarthritis is a relative contraindication; this approach can help remove osteophytes, and with the aid of anesthesia and poor muscle tone of older patients, the patella can be easily dislocated. The patient was placed in a dorsal decubitus position on a radiolucent surgical table, with the healthy contralateral limb unevenly downwards to avoid overlapping images in the profile view. An ipsilateral enhancement below the gluteus may be necessary to place the knee in a neutral position. We operated with a hemostatic cuff and a sterile support below the knee to give 10º–20º flexion (Figure 2). The incision was made from the upper part of the patella towards the proximal end, approximately 3 cm, through the skin, cellular tissue, and quadriceps tendon (Figure 3). We placed the index finger through the joint; if it was not tight and the patella could be easily maneuvered, we slid the protective sheath consisting of the outside inward of the protective handle with the outer sheath, the radiopaque metal protective sheath, and then the cannulated tip (Figure 4). To facilitate the entry, we used a blunt tool to push the patella forward (Figure 5). If the patellofemoral space was tight, we released tension by widening the approach of the quadriceps tendon below the skin; if this is not enough, we can perform a percutaneous release of the lateral facets of the patella and allow its dislocation. We placed the guide pin

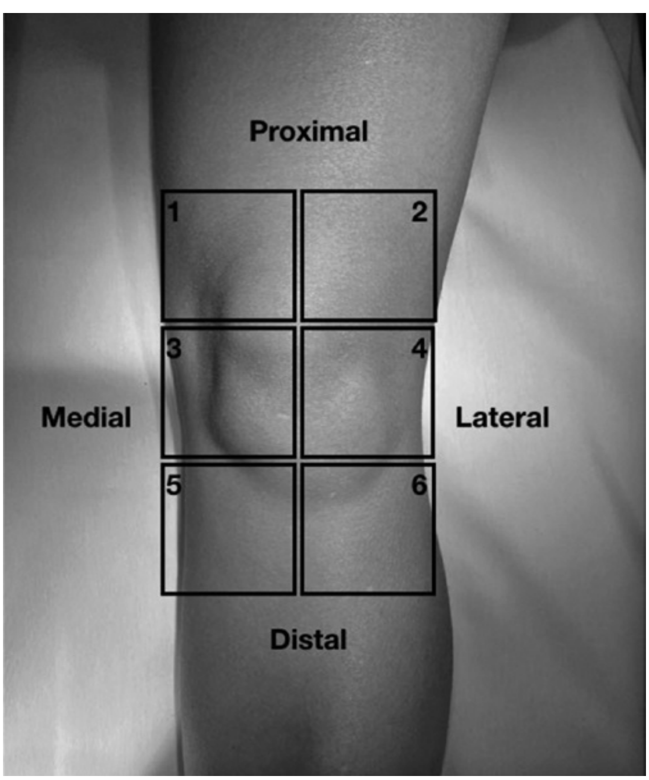

Figure 1. Division of the knee into 6 quadrants to identify areas of postoperative pain.
Source: Sanders et al. (2014)

Figure 2. Patient in dorsal decubitus position with the healthy limb unevenly downward to avoid overlaps in the profile view.

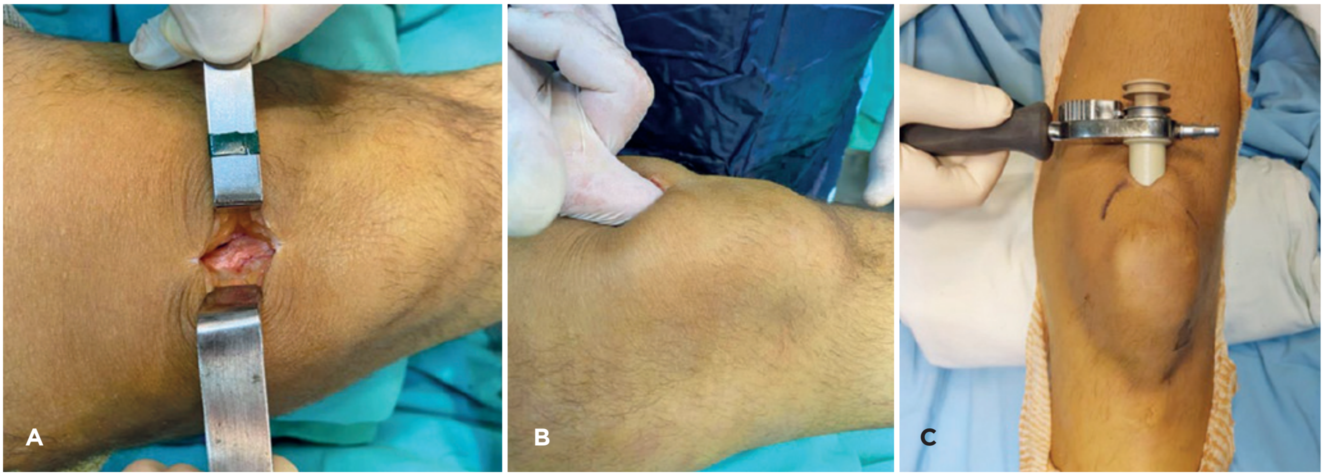

Figure 3. (A) suprapatellar approach; (B) index finger entering the patellofemoral space, indicating that the space may be instrumentable. (C) Instrumentation of the space with the protective sheaths.

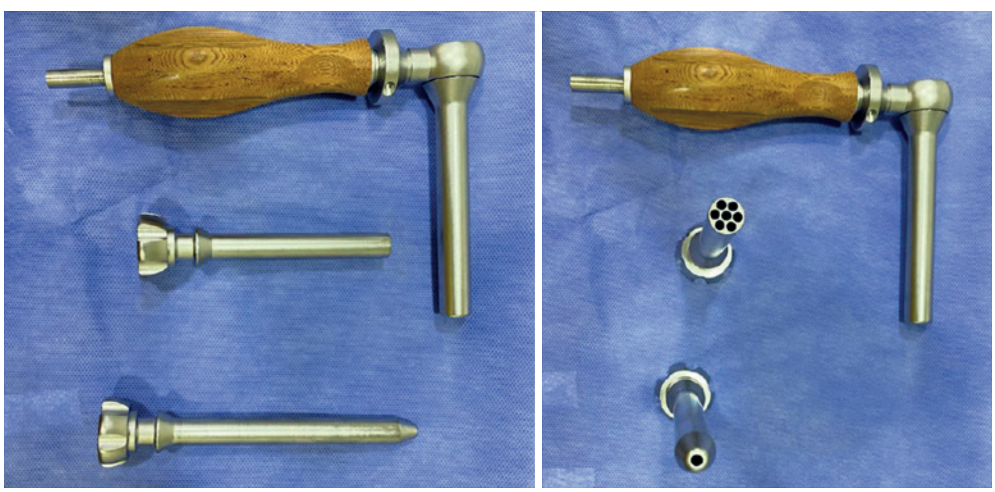

Figure 4. Protective sheaths, from top to bottom, external sheath with handle and adapter for suction; screened sheath for reorientation of the guide pin, and the internal sheath with a blunt cannulated tip.

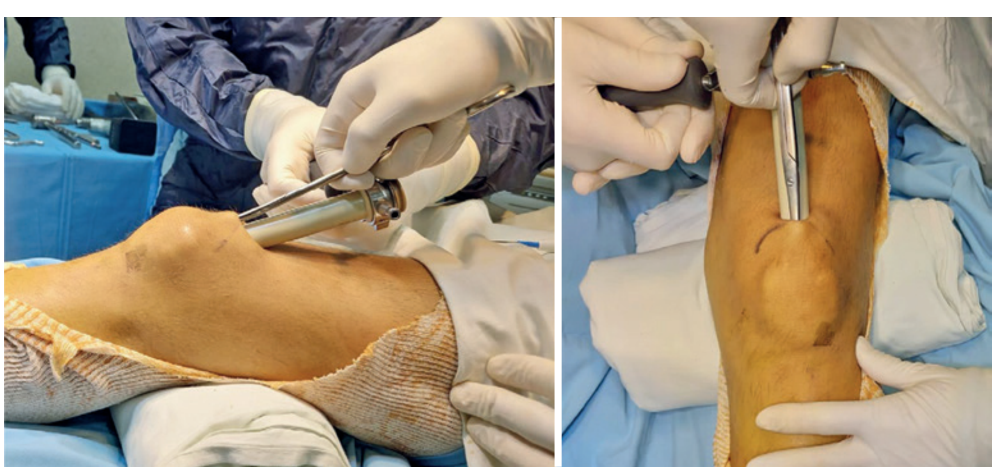

Figure 5. Profile and front view where, with a blunt tool, we pull the patella towards the front, gaining a few millimeters for the placement of the protective sheaths.

through the cannulated or screened tip at the insertion site, 2 mm medial to the lateral spine in line with the axis of the tibia in the front view and adjacent and anterior to the articular surface in profile view[9], controlling the direction of the guide pin from the handle of the protective sheaths, directing the tip of it towards the posterior cortical most parallel to the axis of the tibia. In a strict profile, the femoral condyles must be aligned, and in the front view, the external tibial plateau must cut the head of the fibula in the middle, and we have the spines of the tibia deployed and with good visualization. We advanced with the guide pin, removed the internal tip, and drilled the entry site with the cannulated starter drill (Figure 6). Afterward, we removed the guide pin, passed the olive-shaped endomedullary guide, slightly curved to connect the fragments, and placed the distal pole in the center of the ankle joint. Because the patient was in a semiextended position, the reduction of the fragments and the control of the axes was easily performed, as is the intraoperative radiological examination, since we did not have to flex the hip and knee in the 90º position. The drilling started with the front cutting cutter, which was 1 mm longer than the nail we would place. In case of segmental fractures, we hold the intermediate fragment with a tip clamp to prevent rotation and thus the detachment of soft tissue from it[10] (Figure 7). We measured the length of the nail using a radiopaque ruler under fluoroscopic guidance (from the ankle physis to the anterior edge of the tibial plateau). We must remove the radiopaque sheath before nail placement to avoid jamming. In case of proximal or distal fractures (41 or 43 according to AO/OTA classification), these fragments are first reduced either directly (plates, tip clamps, femoral distractor, or external tutor) (Figure 8) or prepared to be reduced when

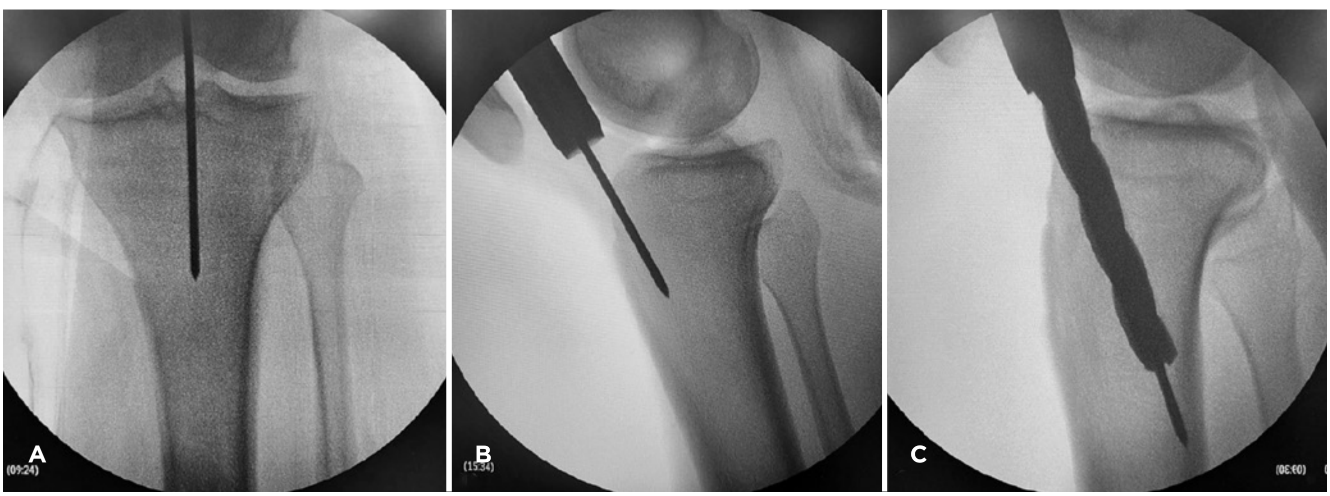

Figure 6. (A) front view where the guide pin is placed medial to the lateral spine. (B) profile view, the pin is positioned adjacent to the articular surface more parallel to the posterior cortex. (C) initial drilling to open the spinal portal.

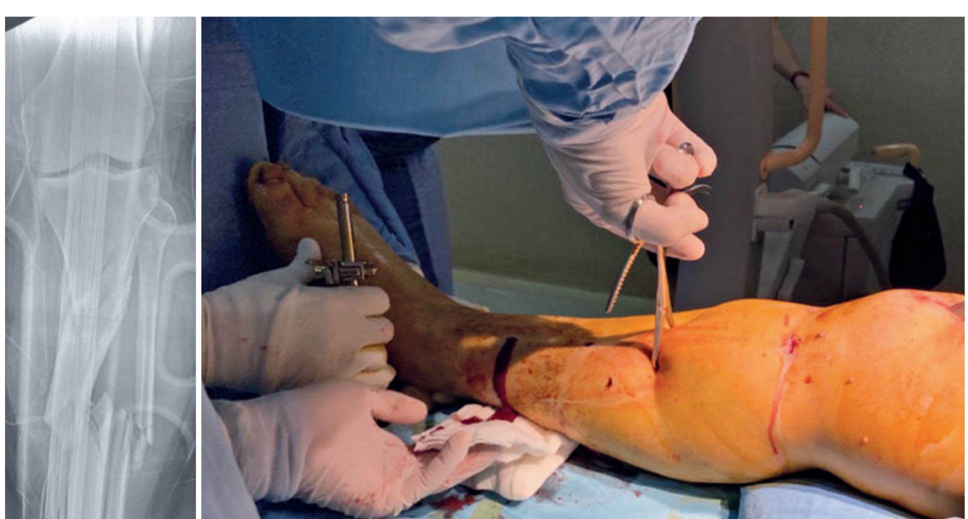

Figure 7. The intermediate fragment is secure during drilling to prevent its rotation.

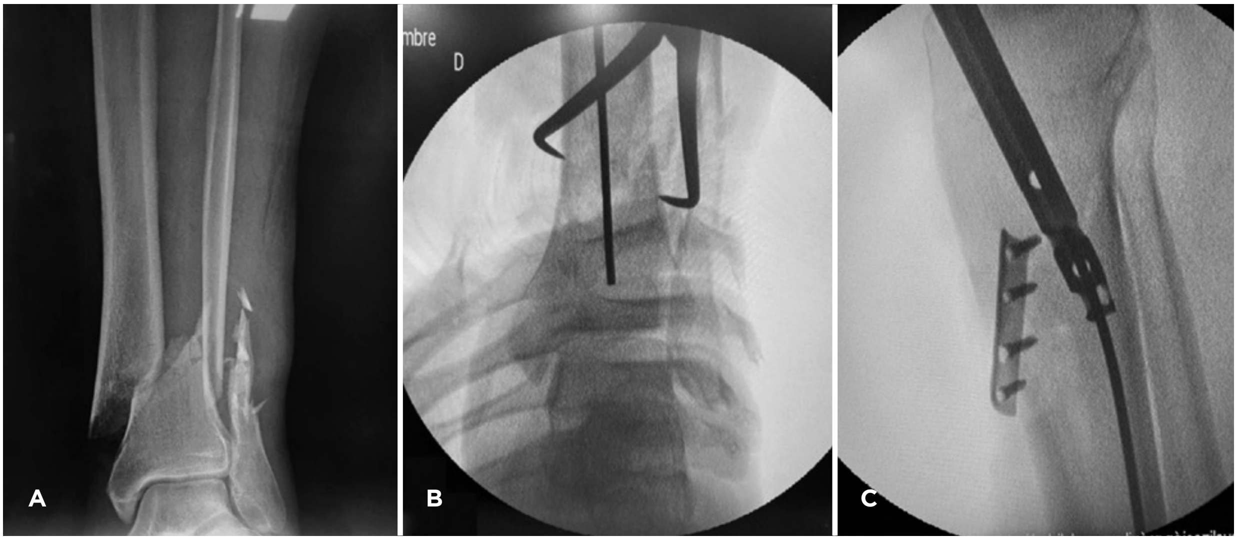

Figure 8. (A) Displaced distal tibia fracture. (B) Reduction with tip clamp and placement of intramedullary guide in the center of the ankle. (C) Reduced proximal third fracture with monocortical tube third plate.

the nail is placed with post screws or Steinmanns (which were then changed by screws when the nail was locked)[11], and one or more can be used (as a palisade method)[12] to mark the path of the nail and avoid misalignment in the different planes (Figure 9). Although the position of the patient helps in the reduction, especially for proximal fractures (since the tension of the patellar tendon is avoided), this does not prevent its displacement after the interlocking, no matter how appropriate the entry site may have been, so we must always start by reducing it (directly or indirectly). Once the tibia had been instrumented, we began by locking the distal end of the nail with a hands-free technique. Then, we finalized the reduction details directly by manipulating the nail using the insertion handle. The nail plug was placed through the patellofemoral space under fluoroscopic guidance.

To avoid injury to the patellofemoral space, we recommended preventing the protective sheaths from moving the place during drilling. Some marks allow the sheath handle to be fixed to the femur with a Steinmann, the external protective sheath should not be removed during nail placement, and the knee joint should not be extended during instrumentation[13]. Once the osteosynthesis is finished, we aspirate the joint with a physiological solution.

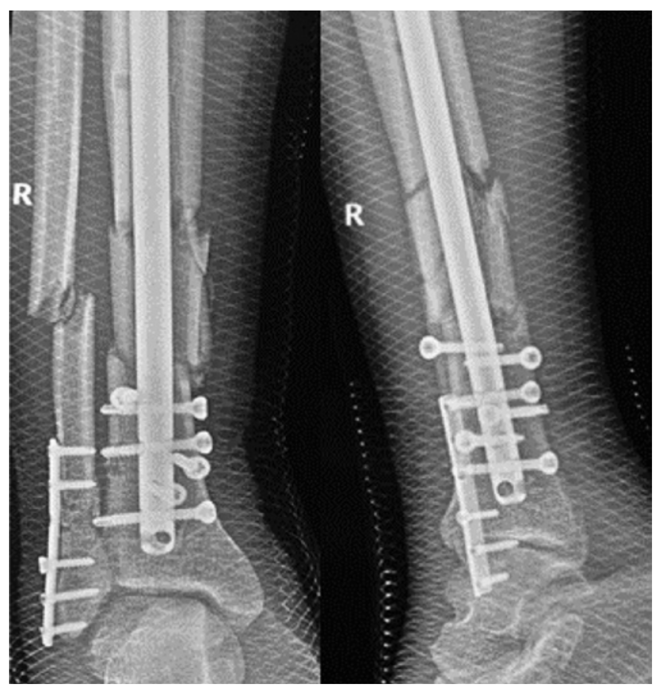

Figure 9. Distal tibia fracture where the post screws are visible in the different planes to avoid the deflection of the distal fragment.

Results

Forty patients were operated on, and 26 were included in the analysis, according to the inclusion criteria, followed by postoperative clinical and radiological assessment in December 2021. Among the patients, nine were women, 17 were men. The mean age was 41.5 (range 22–84). The mean follow-up was 17.69 (6–35 months).

The patients were classified according to AO/OTA tibia fractures, and the Gustilo and Anderson classification was used for exposed fractures. Regarding the distribution of the affected tibia region, three were from the proximal third, 13 from the medial third, and 13 from the distal third. Fourteen had exposed fractures, two Gustillo 1, six Gustillo 2, and six Gustillo 3.

Regarding the cause of the fractures, 14 suffered a motorcycle accident, six fell from their own height, four had car accidents, and two had sports trauma.

The Olerud & Molander mean was 76.92, and the mean LEFS was 72.33.

Five patients (19.23%) presented discomfort in the knee (quadrant 3) at the maximum flexion, a condition that did not generate limping, and one (3.84%) patient presented discomfort in the knee (quadrant 5), locking site, which resolved with its removal. None presented pain at the site of nail entry or femoropatellar pain.

Immediate postoperative complications: one (3.84%) patient to whom we released the lateral facets of the patella suffered postoperative hemarthrosis, and we had to perform arthroscopic debridement and due to lack of adherence to kinesiology evolved with knee stiffness that after mobilization under anesthesia and rehabilitation regain normal mobility. One (3.84%) patient had wound dehiscence, and another (3.84%) had skin necrosis at exposure sites, which was resolved by plastic surgery-total immediate complications 11.52%, which resolved without sequelae.

Isolated complications: two (7.69%) nail replacements, one due to lack of consolidation in a proximal tibia fracture (hypertrophic pseudoarthrosis) due to the lack of locks that stabilize the nail (it only had the dynamic lock) and the other patient due to chronic osteomyelitis (Table 1).

Discussion

Many studies have been published to compare the suprapatellar vs. infrapatellar approaches[14-16], demonstrating some advantages the former has over the latter (anterior knee pain, better fragments reduction, less radiation exposure time), even greater precision at the insertion site in the coronal plane[15,17]. Soft tissue would appear less exposed to trauma with the semiextended position[18]. No differences were found in the learning curve between these two techniques[19]. With the infrapatellar approach, whether transtendon or paratendon, anterior knee pain may exceed 70% of cases, affecting more the young population[16,20-22] This condition may cause scarring of the patellar tendon, posterior shortening, or the iatrogenic incision of the infrapatellar branches of the internal saphenous nerve among others[23,24]. The percentage of misalignment in proximal fractures by the infrapatellar approach may reach 58%[25]. Although the patellofemoral instrumentation appeared aggressive, Sanders et al.[6] performed pre- and postoperative arthroscopy in 26 patients with 12-month follow-up, and only two presented with grade 2 chondromalacia but no anterior knee pain, there was no evidence of heterotopic ossifications around the debris of the intramedullary drilling. Fifteen cadaveric limbs

Table 1. Evaluation of patient

Patient	Age	Cause	AO + G&A	Follow-up (Months)	Olerud	Pain Status	LEFS
1	28	Motorbike	42B2 + GIIIB	23	100	No pain	93.8
2	34	Car	42B3B + GI	12	80	No pain	76.3
3	30	Car	43B2 + GII	8	80	3	66.3
4	53	Motorbike	423C + GI	30	75	No pain	76.3
5	42	Sports trauma	43B2	8	85	No pain	77.5
6	51	Motorbike	42C2	34	90	No pain	81.3
7	32	Motorbike	L – 43A2 + D – 43B2 GIIIB	9	80	No pain	76.3
8	49	Motorbike	L – 42A2 + D – 43C1	20	80	No pain	76.3
9	53	Car	42C3 GIIIB	23	75	No pain	72.5
10	23	Motorbike	43B2 + GIIIB	35	85	No pain	77.5
11	32	Fall from the own height	43A3	12	85	No pain	77.5
12	33	Motorbike	42C2 GIIIA	20	80	No pain	76.3
13	84	Fall from the own height	42A2	17	75	No pain	72.5
14	29	Sports trauma	42B2	33	85	No pain	77.5
15	29	Motorbike	42A2 + GII	15	85	No pain	81.3
16	43	Fall from the own height	43A1	12	85	No pain	72.5
17	34	Motorbike	42A2a + GII	24	80	No pain	76.3
18	25	Motorbike	42B2 + GII	19	100	3	86.3
19	84	Fall from the own height	41A2	15	20	No pain	28.7
20	34	Motorbike	42A2	7	55	6	53.8
21	43	Motorbike	43A1	10	90	No pain	81.3
22	49	Fall from the own height	43A2	8	60	No pain	63.7
23	42	Motorbike	42A3 + GI	24	100	3	93.8
24	22	Motorbike	42A3	6	60	3	56.3
25	79	Fall from the own height	42A1	20	35	3	26.3
26	27	Motorbike	41A2 GIIIB	15	75	No pain	72.5

were instrumented with a suprapatellar nail with a medial arthrotomy and lateral patella dislocation, finding injury to the internal meniscus in 6.7%, injury to the medial articular edge in 13% (damage of 1 mm to 2 mm), damage to the intermeniscal ligament in 20%, and abrasion of the patellar fat. These results cannot be clinically applied, and it is believed that medial arthrotomy leads to initiating the portal a little more medial than it should[26]. The pressure exerted by the protective sheaths on the patellofemoral space is 3.83 MPa compared to 1.26 (3 times more) exerted by the 90º position when we instrument the tibia in an infrapatellar approach[27], but for apoptosis to occur on the cartilage cells, a pressure of 4.5 MPa is needed as demonstrated in bovine cartilage[28].

The risk of knee sepsis after the suprapatellar approach, especially in exposed fractures, may be a consideration, but multicenter studies have shown that this is not the case[29,30].

In case of facet release, caution is advised regarding hemarthrosis. We believe this may be due to the arrangement of the vessels of the peripatellar ring around the patella susceptible to being injured with the incision. In our series, we had a patient who then underwent arthroscopic debridement and knee mobilization under anesthesia to regain mobility.

Due to lack of consolidation, two nails were removed, one due to lack of proximal stability in an unstable fracture since it only had the dynamic lock placed, and the other patient due to osteomyelitis after osteosynthesis in an exposed fracture. The same was removed conventionally from the transtendon and knee in 90º flexion without complications at the approach site. In our series, five patients presented residual pain at maximum knee flexion in quadrant 3 but without limping, and one in quadrant 5. Sperone et al.[31], in a series of six patients with proximal tibia fracture treated with suprapatellar placement endomedullary nail, divided the knee into three thirds (extraarticular proximal, purely articular, and extraarticular distal), and each of these thirds was subdivided into internal, middle and external. One patient had pain in the internal extraarticular distal third related to the proximal locking nail, and two patients in the middle distal extraarticular related to the fracture focus, the remaining quadrants reported no pain.

Conclusion

The semiextended position in which the patient is placed helps reduce fractured fragments and better control of the axes, whether in proximal, half-diaphyseal, or distal fractures. The advantages of suprapatellar vs. infrapatellar instrumentation have been demonstrated in different studies. In our series, no disadvantages were found except the possibility of hemarthrosis when we released the facet, and five patients had pain in quadrant 3 at maximum knee flexion. We had no residual pain in the suprapatellar incision because it is far from the infrapatellar nerve branches, it does not address the tendon, and the scar does not produce ailments either. There were no complications with the quadriceps tendon, with the placement of the endomedullary nail by the suprapatellar approach, the gold standard adopted by our team. This study is the first group of patients that we were able to evaluate, and we are committed to continuing incorporating patients to have a larger study population and not only compare it with the infrapatellar approach but with the medial and lateral parapatellar also to find answers to residual pain in quadrant 3.

Authors' contributions: Each author contributed individually and significantly to the development of this article: LC *(https://orcid.org/0000-0003-1187-0864), and MI *(https://orcid.org/0000-0002-6336-6080), and GMJ *(https://orcid.org/0000-0001-9998-190X), SL *(https://orcid.org/0009-0007-6508-8487) and MJM *(Orcid), and JMG *(https://orcid.org/0000-0002-8669-0852), and GMA *(https://orcid.org/0000-0003-4767-5489). All authors read and approved the final manuscript.*ORCID (Open Researcher and Contributor ID) iD.

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