

# Suprapatellar nail removal after suprapatellar nailing of the tibia: it could work!

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**Abstract.** *Background and aim of the work:* Intramedullary nailing is a fundamental tool for the treatment of meta-diaphyseal tibia fractures. While, in the past, the infrapatellar approach was the only one available, over the last few years, an alternative approach has been developed: the suprapatellar tibial nailing. This technique has shown some advantages over the other one. However, as the most recent method has become increasingly more common, concerns have been put forward about the possibility to remove the nail using only the infrapatellar approach, thus incising the previously unviolated patellar tendon. The aim of our study is to describe the technique and the results of a suprapatellar approach to remove the nail. *Methods:* We describe the surgical technique used to remove the tibial nail via the suprapatellar approach. We analyze a small case series of 12 patients who underwent the operation of nail removal, analyzing operation time, intraoperative and/or postoperative complications and clinical outcomes. *Results:* The mean duration of the operation was 39.8 minutes. The difference between the two values of the Lysholm score (pre- and postoperative) in each patient was not statistically significant, ranging between -2 to +4 points. We did not observe any intraoperative or postoperative complications. *Conclusions:* After suprapatellar nailing of the tibia, it is possible to remove the nail using the same suprapatellar approach with a safe, easy and reproducible technique. The clinical results observed in our case series show excellent outcomes in terms of absence of complications and good functional knee score.

**Key words:** suprapatellar nailing, infrapatellar nailing, nail removal, hardware removal

## Introduction

Intramedullary nailing (IMN) is the standard of care for the treatment of fractures of the tibial shaft, even with extension to the proximal or distal meta-epiphysis, and good results have been well-documented in the literature (1-4). The advantages of tibial IMN include good fracture alignment, immediate mobilization, early weight-bearing, predictable union rates and excellent functional outcomes (5, 6). Other techniques available for fixation of these fractures are external fixators, plate and screws, or a cast (Sarmiento brace) (7, 8).

Historically, the only approach used to insert the nail was an infrapatellar approach, with the splitting of the patellar tendon. With infrapatellar nailing (IPN)

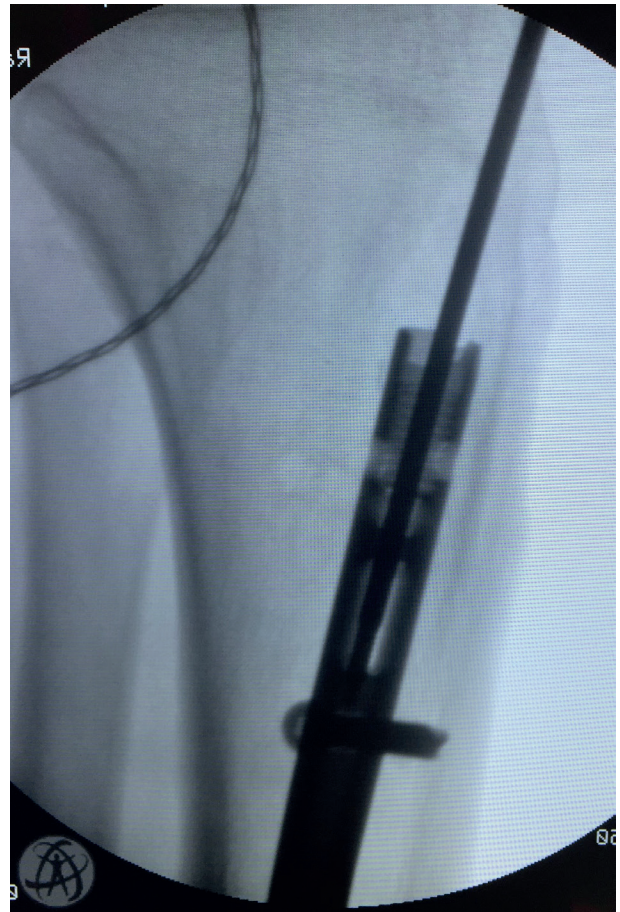
the patient is positioned supine, with the leg free or in traction and with the knee flexed at 90 degrees or more for the proper insertion of the nail (to avoid impingement with the patella). Although this technique is widely used today, its limits and disadvantages include the difficulties in visualizing the fracture with the C-arm, the possibility of residual anterior knee pain (due to the incision of the patellar tendon), the possibility of malreduction in apex anterior angulation (especially in fractures of the proximal third of the shaft), and the difficult evaluation of rotational malalignment (5, 9, 10).

These disadvantages have led to the development of new techniques for nailing tibia fractures. Recent reviews and meta-analyses show that nailing a tibia in a semiextended position, with the knee flexed at about

15°-20°, can overcome the problem of apex anterior deformity, it allows for better visualization with the C-arm, it reduces the incidence of knee pain and the average malalignment of the fracture, it reduces the operation and fluoroscopy time, and it significantly reduces total blood loss compared to infrapatellar IMN (9, 11, 12). Many approaches for the insertion of the nail have been studied: Tornetta and Collins, who employed a medial parapatellar approach with lateral subluxation of the patella in 25 patients with proximal tibial fractures (13); Kubiak (14) described a similar technique, with a lateral parapatellar approach, an easy and reproducible procedure with good results and outcomes (9, 15). With these techniques, some problems can be experienced due to the difficult mobilization of the patella, which can lead to an eccentric insertion of the initial guidewire. Tibial nailing with the knee semiextended through a suprapatellar entry has become more widespread (16); the improvement in surgical techniques and the development of new instruments have made this technique simple, safe and reproducible.

The surgical technique of suprapatellar nailing (SPN) of the tibia is well-documented in the literature and it is beyond the scope of this paper. With SPN, it has become simpler to treat all tibia fractures, from the proximal third to the foremost distal part. Some concerns have been raised over the use of SPN: high pressure within the patella-femoral joint, entry through a healthy knee joint with the risk of damage to the cartilage, risk of articular infection, especially when nailing an open fracture, and residual knee pain (6, 9, 11, 12). The literature on this topic has clearly shown that these are unfounded concerns. Peak pressures within the patella-femoral joint are below the thresholds considered detrimental to the joint cartilage both for supra- and infrapatellar tibial nailing (17). Several manufacturers have developed equipment for SPN in which a polyethylene or elastic sleeve protects against intraarticular damage. Some authors (18) performed arthroscopy before and after SPN, showing no cartilage changes. Cadaver studies have shown similar results between IPN and SPN in terms of injuries to the intermeniscal ligament and medial meniscus; conversely, no violations to the articular surface, lateral meniscus, or anterior cruciate ligament were observed with SPN (19, 20). Anterior knee pain after IPN has an average incidence of

47% after two years; the reasons for anterior knee pain remain unknown, but it is reasonable to assume that the surgical entry point, through the patellar tendon,



**Figure 1.** Tip-threaded guide wire inserted into tibial nail



**Figure 2.** The extractor threaded into the nail over the guide wire

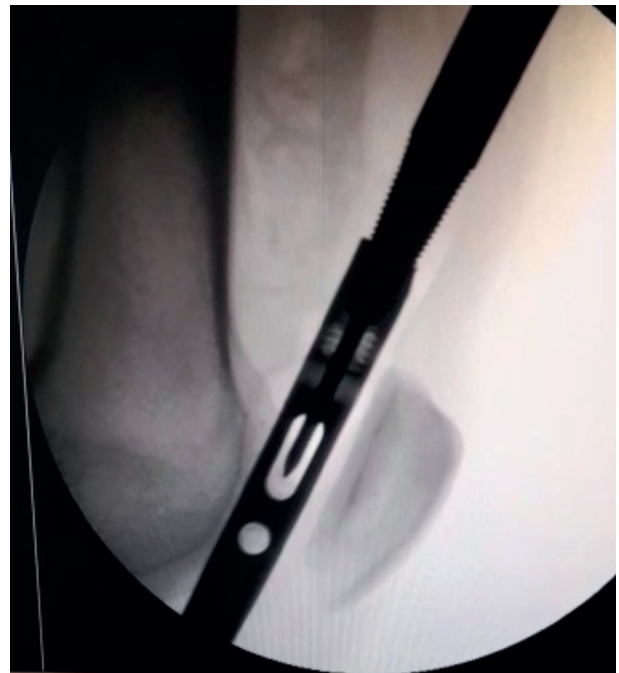


**Figure 3.** Truncated conical-threaded head of the extractor

may play a role (12). A retrospective study comparing SPN with IPN did not find any differences in terms of pain, while another paper reports that none out of 37 patients operated with SPN experienced anterior knee pain at the one-year follow-up (21, 22, 23).

Hardware removal is not performed routinely and many differences exist in different countries. Of all orthopedic procedures done in the United States, 5% consists of hardware removal; in Finland, nearly all implants inserted for fracture fixation (81%) are removed after fracture healing (24, 25).

Nail removal should not be considered an easy procedure; too often it receives careless preoperative planning and is carried out without the necessary operative expertise and staff support. The reasons for removing a nail are non-union, mechanic complications (hardware breakage), infection, prevention of future bacterial colonization, potential difficult surgery in case of re-fracture or in case of articular replacement, implant-related pain or patient request (26, 27). Litigation is another reason for hardware removal; Rohling and colleagues demonstrated that, in these cases, an injury was associated with poorer outcomes and reduced treatment efficacy; this may lead the pa-



**Figure 4.** Extraction of the nail through the suprapatellar approach

tient to request IMN removal because of an unspecified persistent pain around the device (28).

Routine removal of implants is not supported by the literature and exposes the patient to unnecessary costs and complications (infection, refracture, nerve damage and worsening pain), even in patients reporting implant-related pain. Additionally, some patients (or some surgeons) may recommend device removal on unproven grounds, such as protection from neoplasm or reduction of stress shielding (26, 27). Before proposing this operation, it is especially important to understand the expected benefits as well as to know (and communicate to the patient) the inherent risks of the procedure.

The clinical results after IMN tibial nail removal are controversial and not uniform. Sidky et al. (29) analyzed 130 patients (134 fractures) that had had their implant removed: 72.2% of patients had an improvement in their symptoms, with better results related to gender (female) and litigation. Court-Brown et al. (30) reported on 62 patients who had had their nails removed for anterior knee pain: 96.7% experienced complete resolution of their symptoms, while 3.3% said that their symptoms had worsened. Other authors report complete relief of symptoms in 45% of cases and partial relief in 35%, but no improvements of symptoms in 20% of patients (31, 32). In the paper by Boerger et al. (26), persistent anterior knee pain developed in 4 out of 34 previously asymptomatic patients (12%) after tibial nail removal. Moreover, following nail removal, their patients were unable to work for an average of 11 days and had to use crutches to alleviate leg pain. After tibia intramedullary nailing, bony overgrowth and scarring around the insertion site can interfere with device removal; large incisions with extensive dissection of soft tissues and bone can cause significant bleeding and damage to soft tissues, cartilage and the bone itself (6).

Some arguments supporting tibial nail removal can be that up to 35% of patients show a decrease in bone mineral density in the nailed tibia; this occurs distant to the fracture site when the tibia has healed. However, the clinical implications of these data remain unclear (6).

In spite of the superiority in many clinical and mechanical features of titanium tibial nails over stain-

less steel devices, titanium nail removal is more difficult, thus resulting in longer surgery and more intraoperative bleeding (33).

Once the patient and the healed fracture have been carefully analyzed, and after discussing the pros and cons, a patient can finally be scheduled for intramedullary tibial nail removal.

Nowadays, the main criticism and worry about SPN is the issue regarding tibial nail removal (27, 33). A specific disadvantage of the suprapatellar nail has been the perceived need for a second incision for nail removal, which is cosmetically undesirable and has the potential to cause more scarring and, therefore, more pain (especially anterior knee pain). Noia et al. (7) reported their experience with infrapatellar removal of a tibial nail previously inserted with suprapatellar access: they found no complications and showed good clinical results. For other authors (26, 27) nail removal by the infrapatellar approach can lead to cosmetic problems and, as reported for insertion, to anterior knee pain. Leary et al. (34) described the technique used to remove a nail via the suprapatellar approach on a cadaver specimen. With the knee in a semiextended position, they removed the nail, under a fluoroscopic intensifier, using some basic instruments: a 2.8 mm terminally threaded guidewire, a 7.3 mm cannulated drill, a reamer 0.5 mm greater than the diameter of the nail and a tapered conical extraction bolt. After the procedure, they dissected the knee and examined the articular cartilage, menisci and intermeniscal ligament, finding no evidence of damage to any structures within the knee.

To our knowledge, this is the first paper which analyzes the suprapatellar removal of a tibial nail in a cohort of patients. We analyze a case series of patients with a tibial nail (previously inserted with the suprapatellar approach) who underwent hardware removal through the same suprapatellar approach, accurately describing the surgical technique.

## Methods

Our study is a retrospective analysis of 12 patients who underwent removal of an intramedullary tibial nail (12 nails) (Trigen Meta Nail, Smith & Nephew,

Memphis, TN, USA), previously inserted with a suprapatellar approach. All participants provided written informed consent to participate in this study. This study was conducted under the principles of the Declaration of Helsinki. All the nails were removed with the same approach used for the insertion; all the procedures were done or supervised by an experienced trauma surgeon in one of two hospitals (Infermi hospital in Rimini -RN- and Bufalini hospital in Cesena -FC-). Nail removal procedures were performed from April 2019 to March 2021. We analyzed age, gender, side and type of fracture according to the AO classification, time interval between insertion and removal of the nail, duration of the operation, pre- and postoperative Lysholm Knee Score at three months (referred to removal operation). We analyzed if any complications had occurred and the necessity of blood transfusion. Then, we accurately describe, step by step, the surgical technique used for nail removal, suggesting tips and tricks to avoid problems and complications.

## Results

The mean age of the patients who underwent nail removal was 30.5 (range 18-44), including eight males and four females. Six patients had the right side involved and six patients had the left side; there were

no bilateral procedures. According to the AO classification there were six 42-A1, one 42-A3, three 42-B2 and two 42-C3. The mean interval between implant and removal of the nail was 18.25 months (range 13-29): the main reason for nail removal was intolerance of hardware along with strong and persistent requests by the patients. The mean duration of the operation was 39.8 minutes (range 32-60). The mean pre-operative Lysholm score was 96.6, while the mean post-operative score at the three-month follow-up was 97.75. The difference between the two values in each patient was not statistically significant, with a small range of variation between -2 to +4 points (table 1).

## Surgical technique

Skin incision is made on the previous suprapatellar scar, and the quadriceps tendon is exposed, incised and split longitudinally. Palpation of the femoro-patellar joint is done to rule out any articular scars that could hinder the instruments for nail removal. If adhesences are found, they are broken with the finger or with blunt instruments.

Proximal locking screws of the nail are removed; the distal screws are not removed to prevent the nail from rotating during extractor insertion. A 3.2-mm-tip threaded guide wire (Smith and Nephew, Mem-

**Table 1:** Case series of patients who underwent nail removal

Patient	Age	Gender	Side	AO classification	Interval in months between operations (insertion and removal)	Duration in minutes of the operation (removal)	Pre-op Lysholm Knee Score	Post-op Lysholm Knee Score
S.T.	44	M	SX	42-A1	23	44	96	98
G.L.	22	M	SX	42-B2	13	32	97	99
F.E.	32	F	DX	42-A1	16	56	97	95
D.S.	33	M	DX	42-C3	14	33	97	96
P.R.	21	F	SX	42-B2	15	27	97	100
E.A.	18	F	DX	42-A1	15	35	99	99
J.H.	26	M	SX	42-A1	15	42	98	100
A.D.	42	M	SX	42-C3	15	38	98	98
F.Z.	31	F	DX	42-B2	18	44	93	96
R.O.	34	M	SX	42-A1	19	27	95	99
R.M.	37	M	Dx	42-A1	27	60	95	96
B.I.	23	M	DX	42-A3	29	40	97	97

phis, TN, USA) is inserted into the proximal part of the tibial nail (Fig. 1). A fluoroscopy guide is necessary to drive the wire in the center of the nail as precisely as possible. It is obviously necessary that no end cap of the nail was inserted during the previous nailing operation.

After assembling the long cannulated impactor with the disposable nail extractor (Smith and Nephew, Memphis, TN, USA), the latter is threaded into the top of the nail over the guide wire (Fig. 2). The disposable nail extractor has a truncated conical head with a long thread and some grooves (Fig. 3). This peculiarity allows the extractor to thread firmly into the thread of the top of the nail, thus permitting proximal migration of ingrown bone along the grooves. If any difficulties are encountered during the insertion of the extractor, there are two options: gentle hammering of the extractor to create space within the ingrown bone or reaming the bone on the top of the nail with the 12.5 entry reamer (Smith and Nephew, Memphis, TN, USA) or with any smaller diameter ream. It is necessary to check with fluoroscopy that the extractor is coaxial with the nail when the extractor is gently rotated clockwise to engage the thread of the top of the nail. After the extractor has been finally engaged, before proceeding with nail extraction, the distal locking screws must be removed. Finally, through hammering the extractor backwards, the nail is removed (Fig. 4). The knee can be extended and the patella elevated with a retractor to allow for a safe passage of the nail outside the knee, without scratching the patello-femoral joint. If available, one can use a protection cannula large enough to allow the nail to pass through.

Sometimes, especially in younger patients with good bone quality, the nail can be firmly seated into the tibia, because of strong osteointegration. In this case, since there is strong resistance to extraction, it is advisable to hit forward and backward alternatively to disengage the nail. This procedure will be carried out several times until it is possible to overcome the bone resistance.

At the end of the procedure, fluoroscopy images of the entire tibia are obtained to rule out any iatrogenic fractures. The knee is then thoroughly washed with a saline solution to remove bone fragments and clots. An articular drain is positioned for 24 hours and

the wound is closed in layers.

The patient is discharged from the hospital the day after surgery, allowing weight-bearing as tolerated on the operated limb with the aid of two sticks for two weeks to alleviate the pain. The patient is encouraged to move the knee immediately after drain removal. Dressing is scheduled at seven days and stitch removal at 14 days. An outpatient clinic check-up is programmed after 30 days.

## Conclusions

Suprapatellar nailing of tibial fractures is a procedure that is gaining more and more popularity, due to its simplicity, reproducibility, together with the good results and outcomes that the literature is demonstrating (10, 15, 22). The perplexities and concerns of the early years regarding the possibility of articular damage during suprapatellar nailing have been excluded by arthroscopic and magnetic resonance demonstration of the absence of any iatrogenic lesions after the procedure (18). For the past few years, the main unresolved question has been the issue of hardware removal. It had always been postulated that it is necessary to remove the nail with a standard infrapatellar approach. Leary et al. (34) described the suprapatellar approach to remove a nail in a cadaver specimen.

To our knowledge, this is the first paper about a case series of patients who underwent suprapatellar removal of a tibial nail previously inserted through the same approach.

We believe that an intramedullary nail should only be removed in the presence of a convincing indication. The patients in our series have strong motivation to remove the nail, as they are young, active and sporty people. The real discomfort that can be caused directly by the presence of the nail remains an issue to discuss.

Our technique of nail removal is safe, reproducible and easy; the overall time of operation is in line with other similar operations of hardware removal described in the literature. Furthermore, we did not observe any complications during or after the procedure.

The instruments used for nail extraction are the standard ones used for nail removal. The only peculi-

arity of the nail extractor that we use is the truncated conical head with a long thread and some grooves. In our opinion, the shape of the head of this extractor should be preferred to simple cylindrical head extractors when performing this operation.

The Lysholm score measured before and three months after the procedure clearly shows that removal of a tibial nail through a suprapatellar approach has no clinical consequences on the knee joint; indeed, the difference between the two values is extremely small. In some cases, the postoperative value was lower, while in other cases it was higher. None of our patients shows a significant worsening of the score.

In conclusion, when proposing nail removal after suprapatellar nailing, the actual possibility of using the suprapatellar approach for hardware removal should be discussed with the patient. Only in difficult cases, if the surgeon is experiencing problems with the suprapatellar approach, the standard infrapatellar approach should be performed, thus avoiding prolonged surgical procedure with high rates of potential complications.

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