

Intramedullary nailing of tibial shaft fractures in the semi-extended position using a suprapatellar approach: A retrospective case series

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ARTICLE INFO

Article history:

Received 27 June 2018

Received in revised form 3 October 2018

Accepted 4 October 2018

Keywords:

Tibial shaft fracture

Tibial nailing

Suprapatellar approach

Semi-extended position

Anterior knee pain

ABSTRACT

Tibial shaft fractures are extremely common injuries. High rate of union, acceptable alignment in all planes, and a low complication rate have been reported when diaphyseal fractures are treated by intramedullary nailing. However, knee pain after tibial nailing has historically been problematic. While the exact aetiology of the knee pain is still unknown, surgical approach relative to the patellar tendon, nerve transection, violation of the fat pad or joint capsule as well as nail diameter and implant prominence have been claimed as possible causes. Therefore, establishing an appropriate starting point remains a crucial step in the surgical procedure. Recently, suprapatellar nailing in the semi-extended position has been suggested as a safe and effective surgical technique. Literature is lacking on this topic, therefore the present article discusses clinical outcomes of 25 patients treated by suprapatellar nailing at 2 years follow up and a literature review.

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Introduction

Tibial shaft fractures represent the most common long-bone fractures in the adult population [1]. Intramedullary nail fixation remains the treatment of choice for unstable and displaced shaft fractures [2]. The goals of surgical treatment are to achieve osseous union and to restore length, alignment, and rotation of the fractured tibia. Advantages of intramedullary nailing relies first on minimal surgical dissection which minimizes risk of wound complications; and second, on appropriate biomechanical stabilization which allows early postoperative mobilization and high union rates [3,4]. Therefore, recent advances in nail design and reduction techniques have expanded the indications for intramedullary nail fixation to proximal and distal third tibial fractures. However, proximal third tibial shaft fractures have been reported to be associated with an increased risk of valgus and procurvatum deformities due to the hyperflexion of the knee during the nailing procedure by using the infrapatellar approach [5,6]. The infrapatellar approach has long been considered the standard procedure for tibial intramedullary nailing. However, high incidence of anterior knee pain, ranging from 10 to 80% [7,8], has been reported by using an infrapatellar approach. Although

the aetiology has not been clarified yet, several factors related to the surgical approach have been claimed: damage to intra-articular structures, injuries to infrapatellar nerve injury, nail prominence and the insertion point of the nail [9,10]. Based on this assumption, recently, the focus has been shifted to establishing an appropriate starting point. A suprapatellar approach with knee in semi-extended position has been developed to overcome disadvantages of infrapatellar nailing. This new approach facilitates fracture reduction, simplifies radiographic imaging and overcomes the problems of hyperflexion with subsequent malalignment of the fragments [11,12].

Literature is still lacking on this topic, therefore the aim of the following article is to present the clinical outcomes of 25 patients affected by tibial shaft fractures treated by suprapatellar nailing at 2 years follow up. Moreover, the current available literature has been reviewed.

Materials and methods

The present study is a retrospective case series.

Patients affected by a tibial shaft fracture (AO as 42-A, 42-B, 42-C), associated with other fractures involving the same or the contralateral limb as well as the pelvis were included. Open as well as closed fractures were considered eligible.

Exclusion criteria were: age under 18 years, isolated tibia fractures, severe knee osteoarthritis, history of previous surgeries on the same limb or knee infection, neurologic diseases.

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All patients underwent an intramedullary tibial nailing by using a suprapatellar approach in a semi-extended position of the knee. A suprapatellar incision, 3 cm proximal to the superior pole of the patella was performed (Fig. 1). The knee was positioned in 20°–30° of flexion. After dissection of quadriceps tendon and articular capsule, a specialized suprapatellar insertion cannula was placed through the skin incision, under the surface of the patella, and on the desired start point for tibial nailing. Fluoroscopy was used to ensure the position of the entry point (Fig. 2). Then the fracture was reduced and after a bore of the medullar canal the nail was inserted through the cannula-sleeve device and fixed with proximal and distal locking screws. Postoperative x-rays were routinely performed (Fig. 3a, b)

All patients underwent a standard postoperative rehabilitation protocol with clinical evaluation at 1, 3 and 6 months after surgery.

All patients were then recalled at a minimum of 24 months after surgery for a clinical and radiological follow up. Clinical exam was composed of evaluation of passive and active range of motion as well as administration of five questionnaires: SF-36 [13], IKCD [14], Kujala [15], Lysholm and Oxford knee score [14]. The first is a self-administered questionnaire, which evaluate general health status and quality of life; the latter are joint-specific forms and assess knee pain and function. Active and passive range of motion was also recorded at last follow up.

A further x-rays evaluation in two standard views was also performed at 24 months follow up.

The Radiographic Union Scale of Tibial Fractures (RUST) was used to evaluate the healing process [16]. Sagittal and coronal alignment were evaluated by measuring the anatomical axis of the tibia on standard views.

Infection rate and hardware removal for any reason were also recorded at any follow up visit.

Results

Twenty-five patients (18 men and 7 women) with diaphyseal tibia fractures were included in the present study between April 2014 and March 2016. Patients' age ranged between 27 and 70 years old (mean age 46.4). The tibia fracture was always associated to other fractures involving the same or the contralateral limb and/or the pelvis (Table 1). The mean follow-up duration was 28.76 months (range 24–48 months).



Fig. 1. Right knee, suprapatellar skin incision, 3 cm proximal to the superior pole of the patella.



Fig. 2. Left knee. Entry point position.

Neither wound complications, nor postoperative infections were reported.

At the last follow up, all patient showed full passive and active range of motion. Functional outcome scores also showed very good results (Table 2).

X-rays showed complete healing in all cases (RUST = 4). Only in one case the dynamization of the nail was necessary at 8 months after surgery. Excellent alignment in both planes was observed in all cases.

Six patients underwent hardware removal, but only one of them complained of anterior knee pain due to nail prominence.

Discussion and literature review

The most important finding of the present article was that suprapatellar approach showed favorable clinical and radiographic outcomes at 2 years of follow-up in a selected group of patients. Only one patient underwent nail removal because of anterior knee pain, probably due to nail prominence.

A recent meta-analysis compared suprapatellar versus infrapatellar approach for tibia intramedullary nailing. The review included eight studies (two randomized controlled trials and six retrospective cohort trials) and showed that suprapatellar approach led to a significant shorter fluoroscopy time, less VAS pain score, better knee functional score, better sagittal plane alignment and lower incidence of angular malalignment without increasing risk of postoperative complications [17].

Accordingly, Avilucea et al, after comparing alignment obtained with intramedullary nailing using the suprapatellar approach versus the infrapatellar one, confirmed that the malalignment was significantly lower in patients operated by using the suprapatellar approach. [18]. Sun et al showed superior clinical results and reduced fluoroscopy time by using a suprapatellar approach. Therefore, the authors recommended the suprapatellar technique in all tibial shaft fractures amenable to tibial nailing [19].

The present study included only patients affected by multiple fractures because we want to highlight that suprapatellar approach

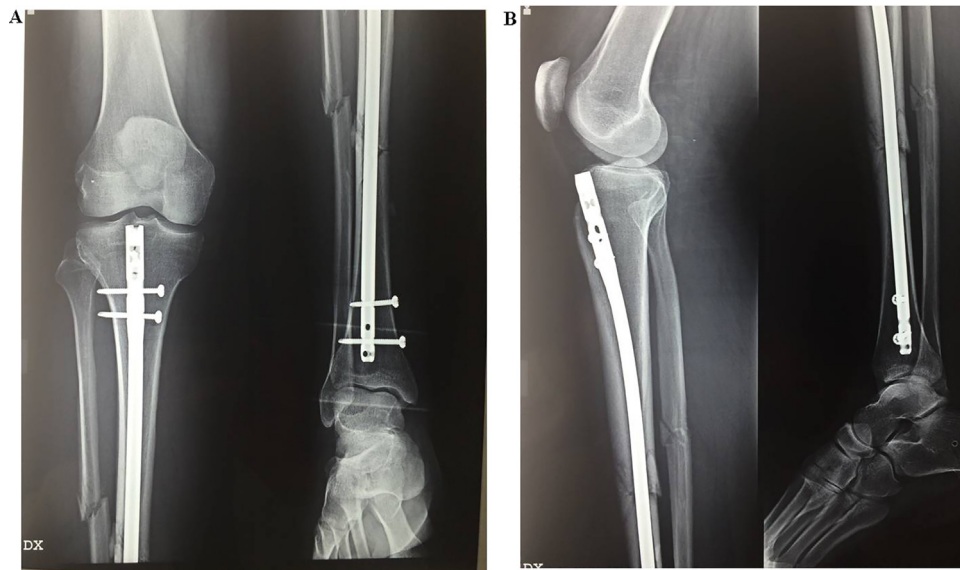


Fig. 3. Right knee, postoperative x-ray. A) AP view: excellent alignment and reduction; B) Lateral view: excellent alignment and reduction.

is very useful in polytraumatic patients for several reasons. As a matter of fact, the suprapatellar approach is always associated to the semi-extended position. Therefore, shorter fluoroscopy time as well as better sagittal plane alignment and lower incidence of angular malalignment are related both to the semi-extended position and to the suprapatellar approach. The semi-extended position for intramedullary nailing of the tibia was originally described by Tornetta et al. [20,21] and is particularly useful when treating difficult metaphyseal and metadiaphyseal proximal and distal tibia fractures, where the amount of knee flexion required in traditional infrapatellar approach causes much difficulty in obtaining and maintaining an acceptable reduction. The use of a suprapatellar approach added a new component to the semi-extended position. Beside simplifying the fracture reduction maneuvers, the semi-extended position also facilitates the positioning of the C arm, thus reducing the intraoperative fluoroscopy time. A recent cadaveric study showed that the suprapatellar approach in the semi-extended allows a more direct and less angulated route of nail insertion into the medullary canal compared to the standard infrapatellar insertion therefore allowing a better alignment of the fractured leg [22]. Moreover, in the present study, the semi-extended position has been chosen in order to avoid flexion or hyperflexion of the knee in patients affected by multiple fractures.

Table 1
Associated fractures in polytraumatic patients.

	Ipsilateral	Controlateral
Femur	5	10
Leg	–	6
Pelvis	9	

Table 2
Functional outcome scores at 24 months after surgery.

Outcomes	Mean $\pm$ SD
SF-36	79.25 $\pm$ 5.7
IKCD	77 $\pm$ 6.35
Oxford knee	42.22 $\pm$ 5.8
Kujala	85.44 $\pm$ 3.6
Lysholm	97.7 $\pm$ 7.3

However, the main concerns regarding the suprapatellar approach still remain potential damage to the patello-femoral joint during nail insertion as well as intra-articular structures injuries due to inability to achieve an accurate entry point for nail insertion, and a permanent quadriceps strength deficit. That being said, it must be noticed that nowadays retrograde femoral nailing as well as knee arthroscopies are common procedures usually performed without the same concerns. Moreover, in the present study, no clinical or radiographic signs of chondral damage were reported. The use of a specific cannula system likely reduced the risk of iatrogenic damage to the surrounding articular cartilage and allowed for a safe nail insertion. Moreover, a cadaveric study quantified the peak pressures within the patella-femoral joint, comparing suprapatellar and infrapatellar approach [23]. The authors showed that the patellofemoral contact pressures were higher with suprapatellar nail insertion. However, for both techniques, the peak pressures were below the thresholds that have been reported to be detrimental to joint cartilage. Subsequent clinical studies confirmed that chondral damage can be rarely found on immediate arthroscopy after nail insertion or at 1-year of follow-up by MRI evaluation [24,25]. However, even when signs of chondral damage are present, patients are rarely symptomatic [24].

Recent cadaveric studies focusing on soft tissue and cartilage damage, showed that suprapatellar and parapatellar techniques have similar rates of knee structures damage [26,27].

Regarding accuracy of the entry point, cadaveric studies [28,29] showed that the correct anatomic entry point is in a safe zone, where the center is located 9 mm $\pm$ 5 mm lateral to midline of the tibial plateau and 3 mm lateral to the center of the tibial tubercle, as described by Tornetta et al. [21].

To the best of our knowledge no studies up to now focused on evaluation of permanent postoperative quadriceps weakness. However, no complaints of strength deficit could be found in the present study. Further studies with larger sample size are needed to clarify this issue.

The present study has some limitations. First, the absence of a control group. Secondly, the small sample size. However, it must be noticed that only polytraumatic patients were included.

Strengths of the study are the length of the follow up and the use of multiple subjective and objective functional scores, which added an important clue in the current literature.

Conclusions

Based on the current literature and on the results of the present study suprapatellar nailing in the semi-extended position is a safe and easy technique. Clinical and radiographic outcomes are very good. However, although current results are promising, larger randomized clinical trials with longer follow up remain necessary.

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