

The medial parapatellar approach reports earlier knee recovery than the transpatellar approach for intramedullary nailing of tibial fractures

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Background

A tibial fracture is the most common long bone fracture, and intramedullary nailing is the most widely accepted treatment option for tibial fractures. Several approaches for entry points have been described.

Objective

The study aims to evaluate the knee functional outcome, range of motion, and anterior knee pain after intramedullary nailing for tibial fractures using the medial parapatellar approach (MPA) compared to the transpatellar approach (TPA).

Patients and methods

From January 2021 to December 2022, a prospective case–control study was undertaken on patients presented with diaphyseal tibial fractures treated by intramedullary nailing through MPA or TPA, knee range of motion, anterior knee pain, and functional outcome using Lysholm score was used to evaluate the patients after 12 months follow up.

Results

The study included 80 patients who were allocated into both groups, postoperatively, the mean time for regaining full range of motion was 3.2(±1.2) weeks in the MPA group, and 5.8(±2.2) weeks in the TPA group ($P=0.001$), the anterior knee pain at the end of follow up was present in five (12.5%) cases in the MPA group, and six (15%) cases in the TPA group, The functional outcome of the knee shows the significant difference after 6 weeks and 3 months the follow-up, at the end of the follow-up, the mean Lysholm knee score was 94 in the MPA group in comparison to 91 in the TPA group with no statistically significant difference between both groups.

Conclusion

Using the MPA for intramedullary nailing for tibial fractures leads to earlier regaining of knee range of motion and higher knee scores, but with comparable results after 12 months compared to the TPA.

Keywords:

infrapatellar approaches, intramedullary nailing, knee functional outcomes, medial parapatellar approach, tibial fractures, tibial nailing

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Introduction

Diaphyseal tibial fractures are the most common long bone fracture and one of the most common fractures by far. Tibial fractures account for 6% of all fractures, and the incidence of tibia fractures is about 51.7 per 100 000 per year in low-income and middle-income countries, the incidence seems to be much higher [1–3].

Several treatment options are available for tibial shaft fractures, depending on age, degree of soft tissue damage, location of the fracture, and degree of comminution. However, intramedullary nailing could be considered the standard of care for these fractures [4], even in open fractures where primary nailing has a similar outcome in comparison to external fixation [5,6] or proximal and distal metaphyseal tibial fractures in comparison with plating [7–10].

The most critical step in nailing long bone fractures is the entry point. In tibial fractures, currently, the suprapatellar nailing approach is gaining more popularity and seems to have less incidence of anterior knee pain and malalignment, however the functional outcome and knee scores are similar to the traditional infrapatellar nailing [11,12]; however, the availability of the instruments, and the familiarity of most of the surgeons with the infrapatellar techniques make them still valid options.

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The most popular techniques for intrapatellar approaches for tibial nailing are transpatellar approach (TPA) and medial parapatellar approach (MPA). Recently, the lateral parapatellar extra-articular approach was described, which has special importance in proximal fracture types [13,14]; although both techniques have been used for a long time, there is no data to support the use of TPA or the MPA as regards the restoration of the range of motion of the knee, anterior knee pain, and the early and intermediate functional outcome of the knee.

This study aims to compare the MPA with the TPA for the entry point for intramedullary nailing for diaphyseal tibial fractures as regards the knee range of motion, knee scores, and incidence of anterior knee pain.

Patients and methods

From January 2021 to December 2022, a randomized controlled study was undertaken at Al-Azhar University hospitals (Al-Hussein and Bab Elshaerrya hospitals) in Cairo, Egypt, on patients presented with recent isolated tibial fractures treated by intramedullary nailing through MPA or TPA.

Ethical approval was obtained from the Institutional Ethical Committee, and all procedures performed in this study followed the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all participants included in the study according to the rules of the hospital research ethical committee.

The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cohort studies were followed.

Inclusion and exclusion criteria

Inclusion criteria included a skeletally mature population presented by recent traumatic diaphyseal tibial fractures treated with intramedullary nailing and signed informed consent by themselves or their immediate family members.

Exclusion criteria included patients with previous knee problems, known cases of osteoarthritis knee grade III or IV, cases of ipsilateral femoral fractures, cases with concomitant tibial plateau or patellar fractures, polytrauma patients, patients with initial external fixators due to poor general or soft tissue conditions, old fractures (more than 3 weeks of

immobilization), patients needed combined nail-plate constructs, pathological fractures, and patients deferred participating in this study.

All patients were initially resuscitated according to advanced trauma life support protocol and all first aid measures, radiograph for the whole leg anteroposterior, lateral views showing the ankle and the knee, routine laboratory investigations, and scheduled for surgery.

Surgical technique

All cases were performed on the supine position on a radiolucent table, either spinal or general anesthesia. Prophylactic antibiotic was given (2 g of first-generation cephalosporin unless reported hypersensitivity) at the induction of anesthesia.

Skin incision has been utilized from the lower pole of the patella to the level of tibial tuberosity while the knee in ninety degrees of flexion, dissection of subcutaneous tissue line with the skin, care has been taken to preserve the paratenon as a separate layer for closure, at this time, the incision either done at the middle third of patellar tendon or few millimeters (about 5 mm) medial to it, in some cases the prepatellar pad of fat obscures the proper visualization of the entry point, so partial excision has been made.

Afterwards all the steps of reamed intramedullary nailing are done classically by the same device for all cases. After fixation has been concluded, thorough irrigation of the wound with the closure of the paratenon without any stitches deeper to it in the same position of opening by absorbable interrupted sutures (Vicryl No 0), skin closure by monofilament sutures 2/0, then sterile dressing is applied.

Postoperatively, all patients received anticoagulant therapy for 21 days (enoxaparin 0.4 IU subcutaneously every 24h), and pain relief modalities were given on demand.

The patients have been encouraged to start knee exercises once they recovered from anesthesia as tolerated and emphasized to do knee mobilization with the physiotherapist over the stay in the hospital.

After discharge, all patients were scheduled for weekly visits for the first 6 weeks, then bi-monthly visits for another 6 weeks, then monthly visits for 9 months; hence, the patient completed a year follow-up.

Range of motion was measured every weekly visit by a calibrated goniometer, and the time of regaining full range of motion was recorded. This has been done

alongside other examination parameters, knee pain, wound care, the progress of weight bearing, muscle girth, and any new complains were recorded.

Anterior knee pain was assessed in all visits, and the presence of pain was recorded.

Functional outcome of the knee was assessed using the Lysholm score at 6 weeks, 3 months, 6 months, and at the end of follow-up (12 months).

Statistical analysis

The sample size was calculated as the anterior knee pain in the literature, which was found to be from 10 to 38% [13], with a confidence level of 80%. The appropriate sample size was 22 on each arm, according to Kelsey and Fleiss's measurements, with adding 20% for missed follow-up, the sample size was 27 on each arm.

The randomization was performed on a single-blinded basis; the surgeons were aware of the randomization, and participants were randomly assigned to the MPA or TPA with a 1: 1 allocation as per computer-generated schedule minimizing for age, sex, BMI, and fracture classification according to AO Classification (MinimPy 0.3, Distributed under the GNU GPL v3).

Statistical analysis

The Statistical Package for the Social Sciences (v 25, SPSS Inc., Armonk, New York, USA) was used to

analyze the data. Data for quantitative factors were provided as mean and range, while data for qualitative variables were presented as frequency and percentage. Comparisons between variables at 6 weeks, 3 months, 6 months, and 12 months were made using the Friedman test and the Wilcoxon signed-rank test. Less than 0.05 *P* values were considered statistically significant.

Results

The study included 80 patients (40 patients in each group). The mean age of the participants was 36.8 ± 11.3 years for the MPA group and 37.2 ± 10.9 years in the TPA group, there were 29 males and 11 females in the MPA group, and 31 males and nine females in TPA group, the mean BMI of the MPA group was $28.3 \pm 3.1 \text{ kg/m}^2$ and $27.9 \pm 3.3 \text{ kg/m}^2$ in the TPA group, mechanism of injury was road traffic accident in 31 patients, falling downstairs in four patients, and five cases in other injuries in MPA group, while in TPA group, 30 cases were involved in road traffic accident, falling in five cases, and five cases in other injuries.

Among the MPA group, 28 patients presented with middle third fractures, seven patients presented with distal third, and five patients presented with proximal third fractures, while in the TPA group, 30 patients presented middle third fractures, five cases presented distal third fractures, and five patients presented by proximal third fractures. As regards AO classification, there was no statistically different between both groups (Table 1).

Table 1 Demographic data

Variables	Medial parapatellar group	Transpatellar group	<i>P</i> value
Age (years)			
Mean	36.8	37.2	0.36
SD	11.3	10.9	
Sex [<i>n</i> (%)]			
Males	29 (72.5)	31 (77.5)	0.21
Females	11 (27.5)	9 (22.5)	0.37
BMI (kg/m ²)			
Mean	28.3	27.9	0.27
SD	3.1	3.3	
Mechanism of injury [<i>n</i> (%)]			
RTA	31 (77.5)	30 (75)	0.19
Falling downstairs	4 (10)	5 (12.5)	
Other	5 (12.5)	5 (12.5)	
Location [<i>n</i> (%)]			
Middle 1/3	28 (70)	30 (75)	0.38
Distal 1/3	7 (17.5)	5 (12.5)	
Proximal 1/3	5 (12.5)	5 (12.5)	
AO classification			
Type A	17	16	0.23
Type B	20	19	
Type C	3	5	

RTA, road traffic accident.

Table 2 Postoperative results

Variables	Medial parapatellar group	Transpatellar group	P value
Full ROM (weeks)			
Mean	3.2	5.8	0.001
SD	1.2	2.2	
Anterior knee pain (incidence) [n (%)]			
6 weeks	34 (85)	37 (92.5)	0.24
3 months	27 (67.5)	31 (77.5)	0.17
6 months	14 (35)	16 (40)	0.09
12 months	5 (12.5)	6 (15)	0.12
Lysholm score			
6 weeks	75.8±4.2	62.3±3.7	0.003
3 months	82.1±5.1	71±4.6	0.001
6 months	89.5±3.3	82±3.9	0.15
12 months	94±4	91±5	0.31
Union time (weeks)			
Mean	13.6	14.1	0.32
SD	2.6	2.4	
Nonunion	5	4	0.26
Infection	2	1	0.04
VTE	0	1	0.01

VTE, venous thrombo-embolism events.

Postoperatively, the mean time for regaining full range of motion was 3.2(±1.2) weeks in the MPA group and 5.8(±2.2) weeks in the TPA group ($P=0.001$), the anterior knee pain was initially frequent in both group (Table 2), and dropped with the follow-up, the anterior knee pain at the end of follow up was present in five (12.5%) cases in the MPA group, and six (15%) cases in the TPA group (Table 2).

The functional outcome of the knee shows a significant difference after 6 weeks and 3 months of the follow-up. At the end of the follow-up, the mean Lysholm knee score was 94 in the MPA group compared to 91 in the TPA group, with no statistically significant difference between both groups (Table 2).

The union time, infection rate, nonunion, and venous thrombo-embolism events did not show statistically different results between both groups.

Discussion

The study shows that the utilization of the MPA for the entry point of the intramedullary tibial nail leads to the earlier regaining of the full range of motion of the knee and early knee functional outcome at 6 weeks and 3 months follow-up in comparison to the TPA, while there is no statistically significant difference in the functional knee outcome at 9 and 12 months follow up, anterior knee pain, and the incidence of complications between both groups.

Anterior knee pain is a common complication after intramedullary tibial nailing, regardless of the used

approach, Bakhsh *et al.* [15] compared the anterior knee pain between patellar tendon splitting, medial parapatellar, and the semiextended lateral parapatellar approaches, they found that there are no significant differences between these approaches in knee pain severity, location, or overall function after 12 months follow up.

Comparable results were found by Ozcan *et al.* [16], when they compared the TPA, MPA, and most recently, the suprapatellar approach.

This result was consistent with the earlier reports, which compared the MPA with the TPA as regards knee pain [17,18]; when studying the incidence of anterior knee pain after the MPA, knee pain was found to be moderate to severe in 28% of patients after 22.3 months of follow-up [19].

The anterior knee pain is multifactorial. Nail prominence, infrapatellar fat pad injury, nerve injury, damage to intraarticular structures, and altered biomechanics are involved etiologies and nail removal is a controversial treatment for anterior knee pain [20].

The MPA was first described by Tornetta and Collins [21] to be done in a semiextended position to avoid malalignment in proximal tibial fractures, which was modified later through the smaller incision without lateral patellar subluxation [22] when they found no difference in comparison with standard patellar nailing as regards knee pain but better alignment in

proximal fractures, the MPA carries an advantage that the incision is closer to the anatomical nail entry point [23], such fact meets the experience of the authors in this field. However, there was no data to support that advantage in the literature.

In the last decade, great interest has been shown in the suprapatellar approach as it was first introduced by Sanders *et al.* [24]. This approach seemed to have the potential for several advantages as being done from a small incision, in semiextended position, with a more precise entry point, and decreased operative and fluoroscopy time. However, it needs special instruments for insertion, difficulties in removal, plus there was no significant advantage over infrapatellar approaches [25], on a recent systematic review [26], the suprapatellar approach was preferred than the infrapatellar approaches in angle and distance entrance accuracy of coronal and sagittal planes, fluoroscopy time, Lysholm score, and pain score. There were no significant differences in sagittal angle accuracy, operative time, intraoperative blood loss, and range of motion of the knee.

This study shows that the MPA yields better results than the TPA as regards range of motion and knee scores, which leads to earlier recovery after surgery and facilitates earlier participation in rehabilitation programs, such points which were not covered before in the literature.

However, the study carries some limitations. Being a single-center study, there was no long-term follow-up, especially after implant removal, and the analysis of entry point accuracy was not assessed because the computed tomography parameters were not available for all cases. It seems that the door is still open for further research in this field.

Conclusion

The use of the MPA for intramedullary nailing for tibial fractures leads to earlier regaining of knee range of motion and higher knee scores, but with comparable results after 12 months compared to the TPA.

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Authors' contributions

Mohamed I. Abulsoud: study design, surgical technique follow up of patients, and shared in writing the manuscript. Emad M. Zayed: surgical technique, participation

in writing the manuscript, and statistical analysis. Mohammed Al Nahhas: participation in revising the manuscript, follow-up of patients, and statistical analysis.

Availability of data and material

The datasets used and analyzed during the current study are available from the corresponding author upon request.

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Conflicts of interest

There are no conflicts of interest.

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