Joint Diseases and Related Surgery

Jt Dis Relat Surg
2023;34(3):679-686

ORIGINAL ARTICLE

Comparison of clinical and radiological results after a minimum one-year follow-up of tibial fractures operated via suprapatellar or infrapatellar intramedullary nailing: A retrospective study

Serdar Kamil Cepni, MD, Bahattin Kemah, MD, Muhammed Enes Karataş, MD, Mehmet Mete Oruç, MD, Suat Batar, MD, Mehmet Salih Söylemez, MD

Department of Orthopedics and Traumatology, Ümraniye Training and Research Hospital, Istanbul, Türkiye

ABSTRACT

Objectives: In this study, we aimed to evaluate the clinical and radiological results after a minimum one-year follow-up of suprapatellar (SP) and infrapatellar (IP) nail applications for the treatment of tibial fractures.

Patients and methods: Between September 2019 and September 2021, a total of 80 patients treated for tibial fractures were retrospectively analyzed. The patients were divided into two equal groups including 40 patients in each group. The first group (32 males, 8 females; mean age: 36.4±13.2 years; range, 19 to 64 years) consisted of those who were operated using intramedullary nailing (IMN) through the SP approach (SP Group). The second group (25 males, 15 females; mean age: 34.4±13.6 years; range, 15 to 64 years) consisted of patients operated with IMN using an IP approach (IP Group). Data including the location of the fracture, duration of surgery, need for additional interventions for fracture reduction, union time, duration of follow-up, delayed union, nonunion, malunion, and infection rates were recorded. During the final follow-up, we evaluated the results for range of motion (ROM), Visual Analog Scale (VAS), score, Lysholm score, and Knee Society Score (KSS) postoperative functional outcome measure.

Results: The mean duration of follow-up in the SP and IP groups were 17.6±2.3 (range, 13 to 21) and 19.9±1.3 (range, 15 to 41) months, respectively (p=0.236). The mean duration of surgery was significantly shorter in the SP group than in the IP group (73.2±19.9 [45 to 160] min in the SP group and 152.0±28.5 [100 to 240] min in the IP group) (p=0.0001). There was no significant difference between the groups regarding duration of postoperative hospital stay, union time, and decrease in hemoglobin levels. There was no significant difference between the groups regarding Lysholm scores, KSS functional outcome scores, VAS, ROM, and thigh and calf diameter difference measured at the final follow-up. A Poller screw or provisional Kirschner wire was used for 14 (35%) of 16 diametaphyseal fractures in the IP group. No additional technique was used for any patient in SP group (p=0.001).

Conclusion: The SP application of an IMN for diaphyseal tibial fractures yields an easy and practical application, having easy reduction with shorter operative time and no need for additional techniques to achieve reduction. However, the clinical and radiological outcomes of both techniques are similar after a one-year follow-up.

Keywords: Anterior knee pain, infrapatellar, nail, suprapatellar, tibial fracture.

Tibia shaft fractures are frequently treated with intramedullary nails (IMNs). However, there is an ongoing debate regarding the most optimal surgical technique to use during nail application. There are several techniques for nail placement, including suprapatellar (SP), transarticular, and infrapatellar (IP) techniques.[1] Traditionally, the midline transtendinous IP technique is the most commonly used technique. However, high rates of reported permanent anterior knee pain after surgery have led surgeons to use the medial or lateral parapatellar technique.[2] In the IP technique, the nail is inserted while the knee is positioned at a flexion angle of 90 to 100°. However, for proximal third fractures, flexion beyond 30° degrees tends to extend the fracture line, which causes an apex anterior malalignment of the fracture. Additionally, in medial and lateral IP techniques, adjustment of the precise entry point for the nail was reported to be challenging.[1]

Received: June 14, 2023
Accepted: July 24, 2023
Published online: August 21, 2023

Correspondence: Muhammed Enes Karataş, MD. Ümraniye Eğitim ve Araştırma Hastanesi, Ortopedi ve Travmatoloji Kliniği, 34764 Ümraniye, İstanbul, Türkiye.

E-mail: menskrts@hotmail.com

Doi: 10.52312/jdrs.2023.1153

Citation: Cepni SK, Kemah B, Karataş ME, Oruç MM, Batar S, Söylemez MS. Comparison of clinical and radiological results after a minimum one-year follow-up of tibial fractures operated via suprapatellar or infrapatellar intramedullary nailing: A retrospective study. Jt Dis Relat Surg 2023;34(3):679-686. doi: 10.52312/jdrs.2023.1153.

These additional reduction techniques, including the use of Poller screws and/or provisional Kirschner wires (K-wires) to reduce canal diameter, have been recommended for use in conjunction with the IP nail placement for proximal and distal diametaphyseal tibial fractures.[3] Currently, SP transarticular nail application for proximal third fractures are strongly recommended as precise adjustment of the nail entrance point is easier and the semi-extended position of the knee brings the fracture in reduction without further intervention.[4] The SP approach has been shown to have a very low risk for chondral damage; however, this potential risk is still a major drawback to this technique, as damage to intra-articular structures, particularly chondral surfaces, may result in anterior knee pain and osteoarthritis.[5,6]

In the present study, we hypothesized that clinical and radiological results of both techniques should be similar after one year of follow-up, as acceptable reduction limits were the same for both techniques to finalize the procedure regardless of the techniques used to obtain reduction. Additionally, surgeries were performed using transtendinous dissections in both groups, and adequate soft tissue healing and restored muscle strength could be expected after a one-year follow-up.[7] We, therefore, aimed to evaluate the clinical and radiological results of IP and SP techniques after a minimum of a one-year follow-up.

PATIENTS AND METHODS

This single-center, retrospective study was conducted at Ümraniye Training and Research Hospital, Department of Orthopedics and Traumatology between September 2019 and September 2021. Medical records of a total of patients treated for tibial fractures were reviewed. A total of 127 patients were operated via IMN for tibial fractures. Of these patients, 72 were operated via the SP approach, and 55 were operated using the IP technique. Thirty-two patients in the SP group and 15 patients in the IP group were excluded from the study, as they did not fulfill the inclusion criteria. Finally, a total of 80 patients were divided into two equal groups including 40 patients in each group. The first group (32 males, 8 females; mean age: 36.4±13.2 years; range, 19 to 64 years) consisted of those who were operated using IMN through the SP approach (SP Group) (Trigen, Metanail, semi-extended, Smith & Nephew, London, UK). The second group (25 males, 15 females; mean age: 34.4±13.6 years; range, 15 to 64 years) consisted of patients operated with IMN using an IP approach (IP Group) (Trigen, Metanail, Smith & Nephew, London, UK). Inclusion criteria were as follows: undergoing surgery with IMN, being over 15 and under 70 years of age, having type 1, 2, or 3 open fractures, Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association (AO/OTA) 42 type A-B-C fractures, and undergoing surgery within two weeks after hospitalization. Patients with previous knee injuries, previous knee surgeries, bilateral fractures needing bilateral IMN for either femur or tibia, pathological fractures, fragility fractures, proximal intra-articular extended fractures, patients who did not complete at least a one-year follow-up, and patients with extensive patellofemoral osteoarthritis were excluded from the study.

Health Information Systems (HIS V5) was used to evaluate the follow-up data of the patients. X-rays were evaluated by two authors for angular measurements and union time, using the digital Picture Archive and Communication System (PACS). Any conflict was resolved by consensus after discussion between the two authors.

Age, sex, injured side, dominant side, trauma pattern, existence of open fracture, existence of accompanying fractures at the same extremity, type of fracture, location of fracture (proximal 1/3, middle 1/3, and distal 1/3), pre, and postoperative duration of hospitalization, decrease in hemoglobin (HB) levels after surgery, duration of surgery, additional interventions for fracture reduction (Poller screw, provisional K-wire), range of motion (ROM) at the final follow-up, union time, duration of follow-up, delayed union, nonunion, malunion, infection and all related complications were recorded.

Fractures were classified through the AO/OTA system.[8] The Gustilo-Anderson classification was used to define open fractures.[9] Union was defined as the appearance of a callus on three cortices on anteroposterior (AP) and lateral X-rays with pain-free full weight-bearing.[10] Delayed union was defined as slow progression of fracture healing that extended beyond four months (>18 weeks). Fractures without any progression of healing after six months were defined as nonunion.[11] Angulation ≥5° in any plane or 10-mm shortening was defined as malunion.[12]

Clinical results were evaluated using patient-related outcome measures (PROMs) at the final follow-up. The Visual Analog Scale (VAS) scores, Lysholm scores, and Knee Society Score (KSS) postoperative functional outcome measures were used as PROMs.[13,14] The KSS postoperative functional outcome measure was used to evaluate the whole strength of the injured extremity. The

Lysholm scores and VAS were used to evaluate the anterior knee pain. All patients were asked to define their knee pain, if any, from 0 to 10 (0 meaning no pain and 10 meaning the worst pain ever) after a 1-min squat to measure VAS scores. Non-injured and injured thigh and calf diameters were evaluated at the final follow-up to evaluate persisting muscular atrophy. Thigh diameters were measured from 15 cm proximal to the upper pole of the patella, and calf diameters were measured 10 cm distal to the lower pole of the patella using the same tape for both legs.[7]

All patients underwent operations at the same institution following the same pre- and postoperative antibiotic, anticoagulant, and rehabilitation regimen. The surgical technique used for IMN was at the discretion of the operating surgeon. All operations were performed by 11 experienced orthopedic surgeons or by six senior residents under the supervision of these surgeons. During the enrollment period, IMNs were not the sole surgical option for tibial fractures. We also employed external fixators, Ilizarov frames, and even IMNs after utilizing other techniques in certain cases. In cases where the debridement of an open wound was performed within 2 h in the emergency room for type 1, 2, and gunshot type 3C open fractures, or within 6 h for type 3A and 3B open fractures, and if no skin graft was required, the wounds were initially closed after debridement, and nails were subsequently used either immediately or during the following week, depending on the skin's condition. However, if the skin was deemed unsuitable or unhealthy, an alternative surgical option other than nailing was chosen. Nonetheless, if the skin was suitable and healthy after appropriate debridement, IMN was performed.

Surgical technique

Suprapatellar entrance

The patient was placed in a supine position on a radiolucent table with the affected limb semi-extended in 20 to 30° of flexion with a pre-adjusted foam wedge under the knee. No tourniquet was used.

A 2 to 3-cm midline incision was made over the quadriceps tendon, 2 to 3-cm proximal to the superior pole of the patella. The quadriceps tendon was split to open the knee capsule. After sharp dissection of the capsule, the sleeve was introduced from patella-femoral sulcus with great care to prevent chondral damage. The entry point for the nail entrance was just medial to the lateral tibial eminence in the AP view, and right at the edge of the anterior cortex and in line with the intramedullary canal in the lateral view. A maximum width of an 11.5-mm nail was used with SP approach (minimum 8.5-mm width). Reduction was only performed with manipulation. Distal locking was performed using a magnetic locking device. Nails were locked proximally and distally with at least two screws of appropriate length in two different planes. However, the number of the proximal or distal locking screws varied depending on the location and type of fracture.

Infrapatellar entrance

The patient was placed in a supine position on a radiolucent table. No tourniquet was used. The patient's knee was flexed at 90° free at the end of the table. A 2-3 cm incision was made over the patellar tendon and further dissection was performed via patellar splitting fashion. The entry point for the nail entrance was the same as the SP entrance. A suitable size of nail (minimum 8.5-mm and maximum 13-mm width) was inserted after reaming. Reduction was performed with manipulation and use of provisional Poller/K-wires. Nails were locked in the same manner using an SP entrance technique.

Knee and ankle ROM exercises were started on the first day postoperatively, and weight-bearing was allowed if patients were pain-free during the activity at follow-up visits. Clinical and radiographic progress of the healing and complications were assessed in all visits. Follow-up visits were conducted at three and six weeks, and at three, four, six, and 12 months. The patients with complications were visited earlier and more frequently than those following a regular schedule.

Statistical analysis

Statistical analysis was performed using the SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). Continuous data were expressed in mean±standard deviation (SD) or median (min-max), while categorical data were expressed in number and frequency. The normality of the data distribution was evaluated by Levene's test and the Shapiro-Wilk test. The Student t-test and one-way analysis of variance (ANOVA) tests were used to compare quantitative data of the independent groups. Categorical variables were compared using the Pearson chi-square test and Monte Carlo simulations with the Fisher exact test. The Pearson correlation coefficient (rho) was calculated with the associations between categorical variables. (1=perfect positive correlation and -1=perfect negative correlation; rho <0.3 indicates none; 0.3-0.5 indicates weak; 0.5-0.7 indicates moderate, and >0.7 indicates a strong correlation). The study power was calculated as ranging between 0.82 and 0.95. A p value of <0.05 was considered statistically significant with 95% confidence interval (CI).

RESULTS

The mean duration of follow-up in the SP and IP groups were 17.6±2.3 (range, 13 to 21) and 19.9±1.3 (range, 15 to 41) months, respectively (p=0.236). There was no significant difference between the groups regarding age, sex, trauma mechanism, dominant side, fracture site, fracture location, AO/OTA class, and existence of an open fracture (Tables I and II). There was no significant correlation between the seniority and the choice of surgical method between operating surgeons (r=0.084, 95% CI, p<0.05).

The main trauma mechanism for fracture was high-energy trauma (motorcycle accident, crushed by a motor vehicle, gun-shot injury, industrial injury, fall from height) in 23 (57.5%) patients in the SP group and in 24 (40%) patients in the IP group. Low-energy trauma (pedestrian fall, sports injury, fall from bicycle) was the main mechanism of injury in 17 (42.5%) patients in the SP group and in 16 (40%) patients in the IP group.

There was an accompanying fracture of the same extremity in 31 (77.5%) patients in both groups. The most common accompanying fracture was fibula fracture (n=21, 52.5% and n=20, 50% in the SP and IP groups, respectively). There was no significant difference between the groups in terms of accompanying fractures (p=0.788). The fibula fracture was fixed with a plate in the lateral malleolus fractures in three (7.5%) and four (10%) patients in the SP and IP nailing groups, respectively.

The mean duration of surgery was significantly shorter in the SP group (73.2±19.9 [45 to 160] min in the SP group and 152.0±28.5 [100 to 240] min in the IP group) (p=0.0001). There was no significant difference between the groups regarding pre- and postoperative hospital stays, union time, and decrease in HB levels (Table II). Moreover, there was no significant difference between the groups in terms of the Lysholm scores, KSS functional outcome measure, VAS, ROM, and thigh and calf diameter difference measured at the final follow-up (Table II). Clinical and radiological results and rate of complications were also similar between open fractures operated with IP or SP technique.

A 5 to 10° extension loss was detected in five (12.5%) patients in the SP group and 11 (27.5%) patients in the IP group. However, there was no significant difference between the groups (p=0.094). In addition, there was no significant difference in delayed union, malunion, nonunion, and infection rates between the groups (Table III).

Of the nine (22.5%) cases that sustained malunion in the SP group, six had a valgus, two had a shortening, and one had a recurvatum deformity. There were also six (15%) cases that sustained malunion in the IP group. Of these cases, four had valgus, one had varus,

TABLE I
Preoperative patient demographics

	Suprapatellar nail (n=40)		Infrapatellar nail (n=40)		
	n	%	n	%	*p*
Sex					0.084*
Female	8	20	15	37.5	
Male	32	80	25	62.5	
Injured side					0.361*
Right	26	65	22	55	
Left	14	35	18	45	
Dominant side					0.066*
Right	27	67.5	34	85	
Left	13	32.5	6	15	
AO/OTA class					0.541*
42A1, A2, A3	25	62.5	30	75.0	
42B1, B2, B3	6	15.0	4	10.0	
42C1, C2, C3	9	22.5	6	15.0	
Fracture location					0.034**
Proximal 1/3	2	5.0	1	2.5	
Middle 1/3	13	32.5	24	60.0	
Distal 1/3	25	62.5	15	37.5	
Gustillo-Anderson class					0.580*
Type 1 and 2	6	15.0	4	10.0	
Type 3A, B, C	5	12.5	3	7.5	

AO: Arbeitsgemeinschaft für Osteosynthesefragen; OTA: Orthopaedic Trauma Association; * Chi-square test; ** Fisher exact test.

TABLE II
Perioperative patient characteristics

	Suprapatellar nail (n=40)		Infrapatellar nail (n=40)		
	Mean±SD	Min-Max	Mean±SD	Min-Max	*p*
Age (year)	36.4±13.2	19-64	34.4±13.6	15-64	0.491
Preoperative stay in hospital (day)	2.8±1.1	1-5	5.6±3.1	1-14	**0.000**
Postoperative stay in hospital (day)	2.9±3.4	1-20	2.4±1.2	1-6	0.329
Follow-up duration (month)	17.6±2.3	13-21	19.9±1.3	15-41	0.236
Time to union (week)	16.7±5.2	11-44	20.1±13.4	10-57	0.142
Decrease in hemoglobin levels (IU)	0.75±0.96	-1.00-3.30	0.31±1.13	3.70-2.50	0.065
Duration of surgery (min)	73.2±19.9	45-160	152.0±28.5	100-240	**0.000**
KSS functional outcome measure tool	78.05±9.06	45-85	77.87±5.75	65-85	0.918
Lysholm score	83.3±12.3	50-97	84.2±6.20	62-95	0.682
Visual Analog Scale	0.67±1.09	0.0-5	0.97±1.02	0.0-4	0.210
Tigh diameter difference (cm)	0.65±1.369	-2-3	0.45±1.810	-3-4	0.579
Calf diameter difference (cm)	0.77±1.624	-2-4	0.42±1.906	-3-7	0.380
Range of motion (°)	121.7±9.3	100-135	118.8±10.2	100-130	0.194

SD: Standard deviation; KSS: Knee Society Score; P: Student's t- test.

and one had a recurvatum deformity. There was no statistically significant difference in the malunion rates between the groups (p=0.521) (Figure 1).

There were more statistically significantly higher distal (diametaphyseal) fractures in the SP nail group than in the IP group (p=0.034). However, no positive or negative correlations were found between the types of malunion (varus, valgus, recurvatum, antecurvatum and shortening) and fracture locations (r=0.131).

A Poller screw or provisional K-wire was used for 14 (35%) of 16 diametaphyseal fractures in the IP group (one proximal and 13 distal part fractures). However, no additional techniques were used for any patient in the SP group (p=0.001). The mean duration of surgery was 150.3±26.1 (range, 100 to 180) min for surgeries that needed additional reduction techniques and 153.7±28.5 (range, 161 to 100) min for the remaining surgeries in the IP group (p=0.726). This finding indicated that the IP technique, itself, had already a long surgery duration, let alone the additional methods used for fracture reduction.

We also evaluated the duration of surgery between diametaphyseal fractures and middle shaft

TABLE III
Complication rates among groups

	Suprapatellar nail (n=40)		Infrapatellar nail (n=40)		
	n	%	n	%	*p*
Extension lag					0.094*
None	35	87.5	29	72.5	
Exists	5	12.5	11	27.5	
Delayed union					0.892*
None	30	75.0	29	76.3	
Exists	10	25.0	9	23.7	
Malunion					0.521**
None	31	77.5	34	85.0	
Exists	9	22.5	6	15	
Nonunion					0.1**
None	39	97.5	38	95.0	
Exists	1	2.5	2	5.0	
Infection					0.494**
None	38	95.0	40	100.0	
Exists	2	5.0	0	0.0	

* Chi-square test; ** Fisher exact test.

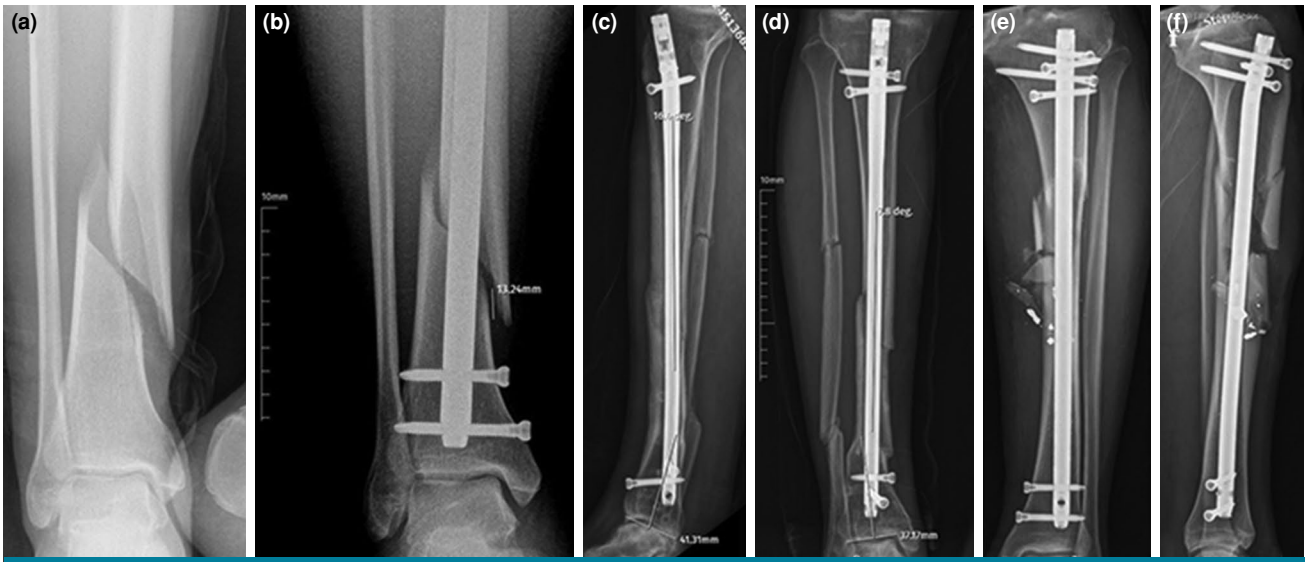

FIGURE 1. (a, b) A 31-year-old male with a distal fracture classified as AO 42A2, treated with SP nailing. The patient achieved reduction with 13 mm shortening, resulting in malunion. **(c, d)** A 51-year-old female with a segmented distal tibia fracture classified as AO 42C2, treated with IP nailing. The patient achieved union with 16 degrees of recurvatum and 8 degrees of varus, leading to malunion. **(e, f)** A 28-year-old male with a midshaft fracture classified as AO 42C3 and Type 3C open fracture, treated with IP nailing. Due to medial comminution and a potentially inappropriate entrance point, the fracture line was fixed in a 15-degree varus position.
AO: Arbeitsgemeinschaft für Osteosynthesefragen; IP: Infrapatellar.

fractures in the SP group. There were 27 (67.5%) meta-diaphyseal fractures in the SP group (two proximal and 25 distal). However, there was no significant difference between the fractures within this group (p=0.169). The mean surgery duration for middle shaft fractures was 66.9±11.8 (range, 45 to 90) min, and the mean surgery duration for proximal and distal diametaphyseal fractures was 76.2±22.4 (range, 55 to 160) min.

DISCUSSION

In the present study, we evaluated the patients who underwent surgery for tibial fractures with IP or SP nail application techniques during a minimum of one year of follow-up. We hypothesized that there should be no significant difference between the groups after one year as the acceptable reduction limits are clearly outlined, and minimum acceptable reduction limits must be achieved before finalizing the surgery, regardless of the surgical technique. Additionally, both surgeries were performed using transtendinous dissections and adequate soft tissue recovery, and restored muscle strength could be expected after one year. This is because of the fact that PROMs tend to improve and become similar by the extended duration of follow-up, particularly in mid-term follow-up visits.[7,15,16]

In line with our hypothesis, radiological results (i.e., union time, delayed union, nonunion, malunion) were similar after one-year follow-up. Also, no statistically significant difference between the groups was observed regarding clinical results (i.e., infection, ROM, VAS, Lysholm score, and change in thigh and calf muscle diameters). However, the SP application of IMNs for tibial fractures presented an easy and practical application with easy reduction. Moreover, surgeons tended to use the SP technique, particularly for diametaphyseal fractures.

Although tibia diaphyseal fractures can be treated by several techniques, IMN is the most popular one, as locked IMN enables compression of the fracture with certain benefits, such as good anatomic reduction, increased union rates, decreased union time, early return to daily activities, and decreased surgical site infections.[17] However, anterior knee pain after IMN using the IP technique urged surgeons to find another method for IMN application.[18] From this point of view, SP IMN for tibial fractures has become more common, as previous studies have reported an easier nail application, better fracture reduction for diametaphyseal fractures, and less anterior knee pain after a relative time.[19,20] Although there is insufficient evidence to support the superiority of the IMN with SP approach over IMN with an IP approach, it has

become more common in the last decade. This is due to the fact that the semi-extended SP approach allows easier nail application and fracture reduction, particularly in proximal and distal tibial shaft fractures.[16] Moreover, using the IP approach, the patient's leg in a drooping position creates difficulties in terms of both nail application and reduction in proximal and distal shaft fractures.[16]

To prevent malreduction in proximal and distal diametaphyseal fractures of the tibia, percutaneous clamps, Poller screws, K-wires, external fixators, and unicortical reduction plates are widely used.[15] However, in our study, no additional reduction maneuver was used in the SP group, but was used in 14 (35%) of 16 diametaphyseal fractures (one proximal and 13 distal fractures) in the IP group. However, alignments were similar in both groups. Baker et al.[15] previously reported a similar alignment between SP and IP nail application techniques. As, expected, the use of additional reduction techniques in the IP group may have increased the duration of surgery compared to the SP group. However, the similar duration of surgeries that needed additional reduction techniques and the time for the remaining surgeries in the IP group implied that the IP technique, itself, requires longer time to terminate the procedure apart from the additional methods used for fracture reduction. Accordingly, there were more distal diametaphyseal fractures in the SP group, as surgeons primarily preferred using the SP technique in diametaphyseal fractures to achieve an easier reduction. Proximal and distal 1/3 tibial fractures (diametaphyseal) needed specific levels of expertise in tibial fracture nailing, as medullary discrepancy at this level required extra technical applications to achieve acceptable reduction.[3] Base don our study results, a semi-extension position during SP IMN possesses an easy anatomic reduction, as well as convenient fluoroscopic imaging during the procedure, as our study revealed a similarity regarding the duration of surgery for diametaphyseal and middle diaphyseal fractures for the SP group.[21] Çiçekli et al.[20] reported similar results in terms of alignment, healing, and anterior knee pain for proximal, middle, and distal 1/3 tibial fracture operated using the SP IMN technique.

Anterior knee pain is a common complication and drawback associated with tibial IMN, particularly in the case of the interpatellar approach. The reported incidence of anterior knee pain ranges from 10 to 73%.[18] Several factors, such as the location of the skin incision, injuries to Hoffa's fat pad and saphenous nerve interpatellar branch, can contribute to the development of anterior knee pain.[7] On the other hand, the SP nailing technique has its own disadvantages, including the intra-articular route, which is a major concern. Despite the use of protective cannulas and sheaths during SP nailing, there is a potential risk of disrupting the muscle-tendon junction and causing chondral injury. Moreover, arthrotomy during SP nailing exposes the joint to the risk of septic arthritis.[6] Previous studies have compared SP and IP tibial nailing regarding various clinical outcomes.[16-20,22] Chan et al.[23] conducted a prospective, randomized study in 42 patients, followed the patients for 12 months, and reported no significant differences in terms of Lysholm knee scores, VAS pain scores, and ROM between the SP and IP groups. Similar results were reported by Courtney et al.[24] who evaluated patients undergoing SP and IP IMN in terms of the Oxford Knee Score, VAS, and ROM. Conversely, Sun et al.[19] reported higher Lysholm knee scores in the SP IMN group compared to the IP IMN group in their prospective, randomized study including 162 patients with an average follow-up of two years, although VAS and ROM were comparable between the two groups. A recent meta-analysis by Packer et al.[25] included 16 randomized-controlled trials involving 1,750 patients and reported that the SP approach had better Lysholm knee scores with an equivalent risk of complications and blood loss compared to the IP approach. Of note, in our study, there was no significant difference between the two groups in terms of blood loss, postoperative hospital stays, union time, anterior knee pain, Lysholm scores, KSS functional outcome measure, VAS, ROM, or thigh and calf diameter at the final follow-up visit; however, we did not include postoperative magnetic resonance imaging (MRI) to assess the rate of chondral damage or its clinical implications after SP nailing.

Nonetheless, there are several limitations to this study, the first of which is its single-center, retrospective design. Second, despite the fact that all patients underwent the same surgical technique in both groups, were operated by or under the supervision of 11 surgeons may have affected the results. In addition, the fluoroscopy duration was not recorded for each patient. Thus, the amount of radiation exposure in both groups could not be evaluated in our study. No arthroscopy examinations or MRI examinations were performed to evaluate cartilage changes preoperatively or at the final follow-up visit.

In conclusion, SP application of an IMN for diaphyseal tibial fractures yields an easy and practical

application, having easy reduction with shorter operative time and no need for additional techniques to achieve reduction. However, the clinical and radiological outcomes of both techniques are similar after a one-year follow-up. Further well-designed studies are warranted to draw more reliable conclusions on this subject.

Ethics Committee Approval: The study protocol was approved by the Ümraniye Training and Research Hospital Clinical Research Ethics Committee (date: 17.06.2021, no: B10.1.TKH.4.34.H.GP.0,01/206). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Design of the study, statistical analysis, development of checklists, interpretation of data, writing of the article, drafting and revision of the article: M.S.S.; Took charge in follow-up of the patients, contributed to the acquisition the data: M.E.K., M.M.O.; Contributed to the acquisition and analysis of the data: B.K.; Contributed to the interpretation of the data and design of the research, co-writing of the article: S.K.Ç.; Contributed to the interpretation and acquisition of data. All authors critically revised the manuscript, agree to be fully accountable for ensuring the integrity and accuracy of the work, and read and approved the final manuscript: S.B.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Hessmann MH, Buhl M, Finkemeier C, Khoury A, Mosheiff R, Blauth M. Suprapatellar nailing of fractures of the tibia. Oper Orthop Traumatol 2020;32:440-54. doi: 10.1007/s00064-020-00649-9.
2. Zelle BA, Boni G, Hak DJ, Stahel PF. Advances in intramedullary nailing: Suprapatellar nailing of tibial shaft fractures in the semiextended position. Orthopedics 2015;38:751-5. doi: 10.3928/01477447-20151119-06.
3. Poyanlı OS, Soylemez MS, Ozkut AT, Esenkaya I, Unal OK, Kılıncoglu V. Use of provisional K wires instead of Poller screws for treatment of diametaphyseal fractures of the distal femur and proximal and distal tibia. Acta Orthop Belg 2016;82:579-85.
4. Kulkarni MS, Tummala M, Aroor MN, Vijayan S, Rao SK. Suprapatellar nailing in proximal third tibial fractures - Clinicoradiological outcome. Injury 2020;51:1879-86. doi: 10.1016/j.injury.2020.05.008.
5. Serbest S, Tiftikçi U, Çoban M, Çirpar M, Dağlar B. Knee pain and functional scores after intramedullary nailing of tibial shaft fractures using a suprapatellar approach. J Orthop Trauma 2019;33:37-41. doi: 10.1097/BOT.0000000000001337.
6. 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;24:665-71. doi: 10.1097/BOT.0b013e3181f6c001.
7. Väistö O, Toivanen J, Kannus P, Järvinen M. Anterior knee pain and thigh muscle strength after intramedullary nailing of a tibial shaft fracture: An 8-year follow-up of 28 consecutive cases. J Orthop Trauma 2007;21:165-71. doi: 10.1097/BOT.0b013e31803773cd.
8. Meinberg EG, Agel J, Roberts CS, Karam MD, Kellam JF. Fracture and dislocation classification compendium-2018. J Orthop Trauma 2018;32 Suppl 1:S1-170. doi: 10.1097/BOT.0000000000001063.
9. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: Retrospective and prospective analyses. J Bone Joint Surg [Am] 1976;58:453-8.
10. Barcak E, Collinge CA. Metaphyseal distal tibia fractures: A cohort, single-surgeon study comparing outcomes of patients treated with minimally invasive plating versus intramedullary nailing. J Orthop Trauma 2016;30:e169-74. doi: 10.1097/BOT.0000000000000530.
11. Kruppa CG, Hoffmann MF, Sietsema DL, Mulder MB, Jones CB. Outcomes after intramedullary nailing of distal tibial fractures. J Orthop Trauma 2015;29:e309-15. doi: 10.1097/BOT.0000000000000323.
12. De Giacomo AF, Tornetta P 3rd. Alignment after intramedullary nailing of distal tibia fractures without fibula fixation. J Orthop Trauma 2016;30:561-7. doi: 10.1097/BOT.0000000000000637.
13. Tegner Y, Lysholm J. Rating systems in the evaluation of knee ligament injuries. Clin Orthop Relat Res 1985;(198):43-9.
14. Noble PC, Scuderi GR, Brekke AC, Sikorskii A, Benjamin JB, Lonner JH, et al. Development of a new Knee Society scoring system. Clin Orthop Relat Res 2012;470:20-32. doi: 10.1007/s11999-011-2152-z.
15. Baker HP, Strelzow J, Dillman D. Tibial alignment following intramedullary nailing via three approaches. Eur J Orthop Surg Traumatol 2022;32:1247-55. doi: 10.1007/s00590-021-03101-1.
16. Bleeker NJ, Reininga IHF, van de Wall BJM, Hendrickx LAM, Beeres FJP, Duis KT, et al. Difference in pain, complication rates, and clinical outcomes after suprapatellar versus infrapatellar nailing for tibia fractures? A systematic review of 1447 patients. J Orthop Trauma 2021;35:391-400. doi: 10.1097/BOT.0000000000002043.
17. Duygun F, Aldemir C. Effect of intramedullary nail compression amount on the union process of tibial shaft fracture and the evaluation of this effect with a different parameter. Eklem Hastalik Cerrahisi 2018;29:87-92. doi: 10.5606/ehc.2018.60331.
18. Katsoulis E, Court-Brown C, Giannoudis PV. Incidence and aetiology of anterior knee pain after intramedullary nailing of the femur and tibia. J Bone Joint Surg [Br] 2006;88:576-80. doi: 10.1302/0301-620X.88B5.16875.
19. Sun Q, Nie X, Gong J, Wu J, Li R, Ge W, et al. The outcome comparison of the suprapatellar approach and infrapatellar approach for tibia intramedullary nailing. Int Orthop 2016;40:2611-7. doi: 10.1007/s00264-016-3187-2.
20. Çiçekli Ö, Kochai A, Şükür E, Başak AM, Kurtoğlu A, Türker M. Suprapatellar approach for fractures of the tibia: Does the fracture level matter? Eklem Hastalik Cerrahisi 2019;30:10-6. doi: 10.5606/ehc.2019.63487.
21. Atik OŞ. Which articles do the editors prefer to publish? Jt Dis Relat Surg 2022;33:1-2. doi: 10.52312/jdrs.2022.57903.
22. Lu K, Gao YJ, Wang HZ, Li C, Qian RX, Dong QR. Comparison between infrapatellar and suprapatellar approaches for intramedullary nailing for the fractures of the tibial shaft. Eur J Trauma Emerg Surg 2022;48:3651-7. doi: 10.1007/s00068-020-01531-w.
23. Chan DS, Serrano-Riera R, Griffing R, Steverson B, Infante A, Watson D, et al. Suprapatellar versus infrapatellar tibial nail insertion: A prospective randomized control pilot study. J Orthop Trauma 2016;30:130-4. doi: 10.1097/BOT.0000000000000499.
24. Courtney PM, Boniello A, Donegan D, Ahn J, Mehta S. Functional knee outcomes in infrapatellar and suprapatellar tibial nailing: Does approach matter? Am J Orthop (Belle Mead NJ) 2015;44:E513-6.
25. Packer TW, Naqvi AZ, Edwards TC. Intramedullary tibial nailing using infrapatellar and suprapatellar approaches: A systematic review and meta-analysis. Injury 2021;52:307-15. doi: 10.1016/j.injury.2020.09.047.