

Treatment of distal femur fractures with retrograde intramedullary nailing utilizing a tibial nail

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ABSTRACT

Aim: Retrograde intramedullary nailing for the treatment of femur fractures is a sound option due to its advantages including ease of implant placement and better control of the distal segment, especially in distal femur fractures. Unfortunately, retrograde femoral nails are not available in most developing countries or rural areas. The primary aim of the study is to investigate the outcomes of an alternative treatment of distal femur fracture with retrograde intramedullary nailing using a tibial nail.

Material and Method: Patients who had distal femur fractures and underwent retrograde intramedullary nailing with a tibial nail between January 2020–March 2022 are retrospectively evaluated. Patients who were treated other than a tibial nail, aged below 18, had follow-up less than 6 months, multiple fractures, and open fractures were excluded. Patients' demographics, time to union, and complications were recorded. Functional outcomes included visual analogue pain score (VAS), Lysholm score, Tegner activity scale, Knee Society Score (KSS), and Short Form-36 (SF36) on the latest follow-up.

Results: A total of 15 patients (11 male, 4 female) met the inclusion criteria and included in the study. The mean age of the patients was 42.9 ± 17.3 (range, 18 to 72) months. The mean follow-up period was 10.1 ± 5.2 months (range, 6 to 18). There was no reduction loss and implant failure during follow-ups. One patient had nonunion. No intraoperative fracture occurred. Persistent knee pain was seen in a patient due to an intraarticular screw and removed arthroscopically. In the latest follow-up, the mean VAS was 0.73 ± 0.70 (range, 0 to 2), the mean Tegner score was 5.0 ± 1.5 (range, 3 to 7), the mean Lysholm score was 90.9 ± 9.9 (range, 64 to 100), the mean KSS was 86.6 ± 8.6 (range, 70 to 97), and the mean SF-36 score was 96.5 ± 4.7 (range, 87 to 100).

Conclusion: The results of this study suggest that a tibial nail with retrograde intramedullary nailing has good functional outcomes in the treatment of distal femur fractures. The tibial nail should be considered as an alternative treatment option where retrograde femoral nails are not available.

Keywords: Femur, tibia, nail, plate, fixation, retrograde nail

INTRODUCTION

Distal femur fractures have a reported incidence of 8.7/100.000 and have bimodal age distribution including younger patients with high-energy traumas and older patients after low-energy traumas (1). In the surgical treatment of distal femur fractures; open reduction and internal fixation with a locking plate, minimally invasive plating, and intramedullary nailing after closed or open reduction are defined treatment options (2). Nonunion can occur due to distal femur fractures' inherent location at metaphyseal and metaphyso-diaphyseal regions (3).

Intramedullary nailing can be performed antegrade or retrograde in distal femur fractures. In the surgical treatment of distal femur fractures, the retrograde

intramedullary nailing (RIMN) technique is preferred more often than the antegrade nailing technique due to the ease of fracture reduction and its stability with multiple distal screws in varying angles (4). If the distal femur fracture does not extend to the knee joint, distal femoral retrograde nailing and locking plate fixation have similar union and complication rates but nailing provides better patient satisfaction (5, 6). However, in intra-articular comminuted fractures, a locking plate is preferred over nails, particularly in patients with low bone mineral density.

Due to the sagittal inclination of the femur, fixation cannot be performed with straight nails in the RIMN technique. For this reason, retrograde femoral nails

suitable for the anatomical inclination of the femur were introduced into the market. However, in developing countries, there may be difficulties in obtaining these retrograde nails produced for distal femur fractures. Despite being not manufactured for the treatment of distal femur fractures, the use of a tibial nail to benefit from the advantages of retrograde intramedullary nailing has been reported in these fractures with a limited patient population (7, 8). The aim of the study is to investigate the outcomes of an alternative treatment of distal femur fracture with retrograde intramedullary nailing using a tibial nail to take advantage of the intramedullary nailing technique.

MATERIAL AND METHOD

The study was carried out with the permission of Karabük University Non-interventional Clinical Researches Ethics Committee (Date: 23/09/2022, Decision No: 2022/1060). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants who participated in this study.

Patients treated with the RIMN technique using a tibial nail for distal femur fracture in our institution between January 2020 and March 2022 were retrospectively analyzed. Patients who were treated with other than a tibial nail, aged below 18, had follow-up less than 6 months, multiple fractures, and open fractures were excluded. Patients' demographics, time to union, fracture type according to AO classification, length of stay at the hospital, and complications were recorded. Functional outcomes included visual analog pain score (VAS), Lysholm score, Tegner activity scale, Knee Society Score (KSS), and Short Form-36 (SF36) on the latest follow-up. Absence of callus or bony bridge on at least three cortices at anteroposterior and lateral radiographs at six months follow-up was considered to be nonunion.

Surgical Technique

The patients were operated in supine position after standard skin preparation from the iliac crest to the foot and with a bump under the knee to position the 30 degrees of flexion of the knee joint. Articular reduction was achieved by performing medial paratendinous arthrotomy in fractures involving the joint. The patellar tendon split approach was preferred for fractures not extending the knee joint. The entry point of the nail was determined using the apex of the Blumensaat line on lateral imaging, and the femoral shaft axis in the middle or slightly medial of the trochlear groove in anterior-posterior imaging. Subsequently, after the determination of the entry point, the entrance hole was enlarged with a cannulated reamer over a guide wire. The ball tip guide wire was then passed through the fracture under fluoroscopy control and advanced to the level of the trochanter minor. The nail length was determined with an equal length ball tip guide wire. Nail thickness was determined by evaluating the reamer thickness at the isthmus by fluoroscopy during reamerization. The tibial nail was introduced into the intramedullary canal so that the Herzog angle of the tibial nail was in line with the sagittal inclination of the femur. Care was taken to ensure that the proximal end of the nail was proximal to the trochanter minor, and the distal end was a few millimeters above the joint level. Due to the short and wide metaphyseal region, two parallel and at least one divergent distal locking screws were placed over the guide. The nail was locked proximally with at least one bicortical screw using freehand technique (**Figure 1**).

Patients were allowed to bear full weight with double crutches immediately after the surgery, then with single crutches between 6-8 weeks, and without support after the 8th week. Knee and hip joint range of motion exercises were started immediately.



Figure 1. Anteroposterior (A) and lateral (B) radiographs of a 52-year-old male patient with a distal femur fracture treated with retrograde intramedullary nailing with a tibial nail (C). Anteroposterior (D) and lateral (E) radiographs demonstrating fracture healing

Descriptive statistics were expressed as mean±standard deviation for continuous numerical variables, categorical variables were expressed as the number of patients and percentage. Analyses of the data were performed using the IBM SPSS Statistics 23.0 (IBM Corporation, Armonk, NY, USA) program.

RESULTS

Of the 19 patients who were treated RIMN technique using a tibial nail for distal femur fracture, 15 patients met the inclusion criteria and were included in the study. The demographics of the patients are presented in **Table**. The mean follow-up period was 10.1±5.2 months (range, 6 to 18). Mean length of stay at hospital was 5.4±3.4 (range, 2 to 15) days. Mean time to union was 3.0±1.2 months (range, 2 to 6). No intraoperative fracture and neurovascular injury occurred. There was no reduction loss or implant failure during follow-up. One superficial wound infection was observed and treated with oral antibiotics. One patient had persistent knee pain after surgery which was due to an intraarticular screw and was treated with arthroscopic screw removal (**Figure 2**).

Table. Demographics of the patients.	
Mean age (years)	42.9±17.3 (range, 18 to 72)
Gender (M/F)	11/4
Side (R/L)	9/6
Mechanism of injury	
	Traffic accident (n=4)
	Blount trauma (n=5)
	Simple fall (n=6)
Fracture type (AO classification)	
	A1 (n=6)
	A2 (n=6)
	A3 (n=2)
	C2 (n=1)

M: male, F: female, R: right, L: Left

In the latest follow-up, the mean VAS was 0.73±0.70 (range, 0 to 2), the mean Tegner score was 5.0±1.5 (range, 3 to 7), the mean Lysholm score was 90.9±9.9 (range, 64 to 100), the mean KSS was 86.6±8.6 (range, 70 to 97), and the mean SF-36 score was 96.5±4.7 (range, 87 to 100).

DISCUSSION

RIMN technique with a tibial nail allowed patients to give full weight immediately after surgery without any implant failure during follow-ups. Complication rates including nonunion, wound healing problems, neurovascular injuries seemed low in our series. RIMN with a tibial nail provided good functional outcomes as patients' pain levels were low, knee functions are quite good, and they can easily perform their daily activities.

The incidence of distal femur fractures has a bi-modal distribution, peaking in young men after high-energy trauma and in elderly women after low-energy trauma (9). The demographic data of the cases included in our study are consistent with the literature posing older women after energized trauma.

Orthopedic surgeons may have concerns regarding possible intraoperative fractures due to anatomical mismatch and possible implant failures after surgery as tibial nails are not designed for distal femur fractures. There were no intraoperative fractures or implant failures in our series. We believe that the Herzog angle of the tibial nail is in line with the sagittal alignment of the femur thus reduced potential anatomical mismatch. In addition, tibial nails have solid biomechanical compatibility and strength as well as anatomical retrograde femoral nails in the treatment of distal femoral fractures (7). One implant-related complication occurred in our series due to an intraarticular screw. The divergent screws have 90 degrees of angle in between. This narrow angle can cause

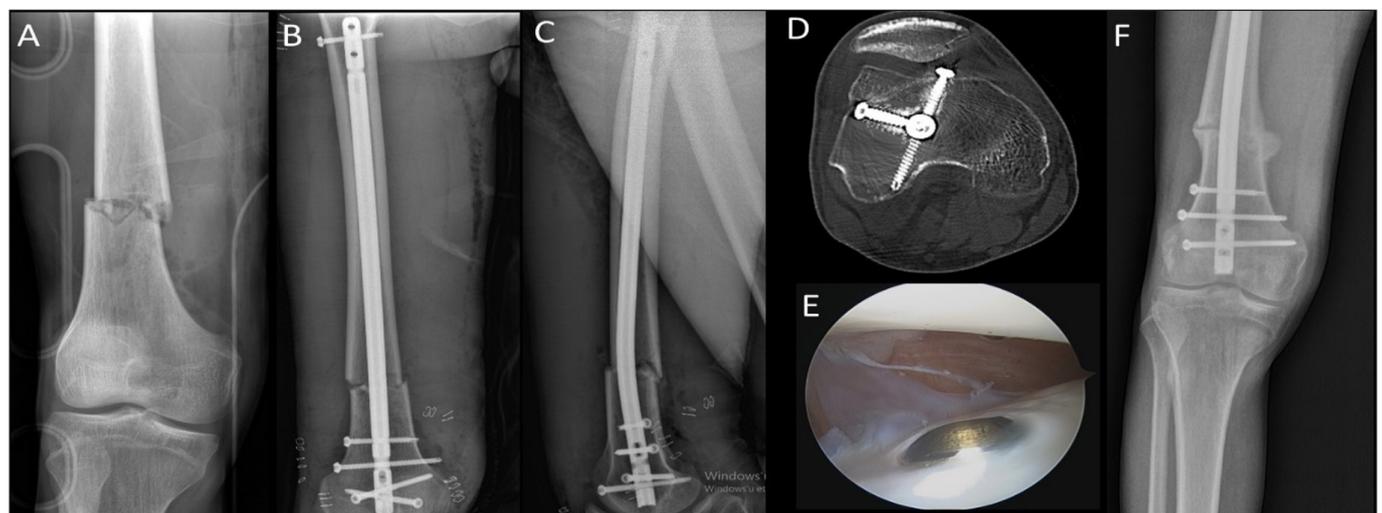


Figure 2. Anteroposterior (A) radiographs of a 30-year-old male patient with a distal femur fracture treated with retrograde intramedullary nailing with a tibial nail (B-C). The patient had persistent knee pain at four-week follow-up. Computed tomography showed an intra-articular screw (D). The patient underwent arthroscopic screw removal (E) and showed fracture healing at six months follow-up (F).

screw malposition in the RIMN technique with a tibial nail. We recommend that if a second divergent screw is necessary for distal stabilization, it should be placed with direct visualization utilizing an arthrotomy.

The union rate of distal femoral fractures treated with an anatomical retrograde femoral nail has been reported as 84-92% (10). In this study, there was nonunion in one of the 15 patients with distal femur fractures who were operated RIMN technique with a tibial nail. This result is in line with the nonunion rates of previous literature.

RIMN technique interferes with the knee joint and may affect knee functions. However, it has been reported that locking plate fixation has no superiority over RIMN in the treatment of distal femur fractures in terms of knee scores (11). The KSS scores of the patients after RIMN with a femoral nail for distal femur fractures range between 70 to 80. The mean KSS score in this study was consistent with the previous literature (12) and the use of a tibial nail did not end up with an inferior outcome.

There are some limitations of our study. The generalizability of the study is limited as it is a retrospective and single-center study. The current study lacked a control group, but we were able to discuss our outcomes with existing literature.

CONCLUSION

The finding of this study suggests that the RIMN technique with a tibial nail in the treatment of distal femur fractures can provide good functional and radiographic outcomes. If a retrograde femoral nail cannot be accessed, the tibial nail can be used as an alternative fixation method in order to benefit from the advantages of intramedullary nailing.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Karabük University Non-interventional Clinical Researches Ethics Committee (Date: 23/09/2022, Decision No: 2022/1060).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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