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Comparison of retrograde intramedullary nailing and bridge plating in the treatment of extra-articular fractures of the distal femur

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Objective: The aim of this study was to compare retrograde intramedullary nailing (RIMN) and bridge plating for the treatment of extra-articular distal femur fractures.

Methods: The study retrospectively examined 15 patients (13 males and 2 females; mean age: 36 years, range: 17 to 55 years) who underwent bridge plating and 13 patients (11 males and 2 females; mean age: 31.1 years, range: 17 to 49 years) who underwent RIMN for the treatment of extra-articular distal femur fractures between 2007 and 2012. Functional results were evaluated using the Sanders criteria. The mean follow-up time was 31.3 (range: 20 to 46) months and 26.7 (range: 18 to 62) months in the plate and the nail groups, respectively.

Results: Mean duration until union was 25.7 (range: 12 to 72) weeks in the plate group and 22.3 (range: 12 to 52) weeks in the nail group. Nonunion was observed in 2 patients in the plate group and in 1 in the nail group, delayed union in 3 patients in the plate and 2 in the nail groups, malalignment (>10°) in 2 patients in the plate group and 1 in the nail group and implant failure in 1 patient in the plate group. Excellent/good functional results were obtained in 12 and 10 patients in the plate and the nail groups, respectively. No significant difference was found between the groups in terms of duration of union, complications and functional results ($p>0.05$).

Conclusion: Bridge plating and RIMN have similar results in the treatment of extra-articular distal femur fractures. Both methods can be applied to all fractures, with the exception of Gustilo-Anderson Type 3B and C open fractures.

Key words: Bridge plating; extra-articular distal femur fracture; retrograde intramedullary nailing.

Increased incidences of traffic accidents have led to a greater number of distal femur fracture cases.[1] However, the debate continues concerning the most appropriate treatment approach for these fractures.

Union and infection problems encountered with traditional open reduction and plating methods in the treatment of distal femur fractures have encouraged the development of biological fixation methods. Retrograde intramedullary nailing (RIMN) and bridge plating are frequently applied biological fixation methods.[2-9] Due

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to its low complication rates and satisfactory results, RIMN is used in extra-articular distal femur fractures in particular.[1,7] The advantages of RIMN include the allowance of load sharing by its intramedullary localization and resultant early loading.[5] On the other hand, some of the disadvantages of RIMN include the potential development of arthrosis due to knee joint damage during the retrograde application of the nail, observation of pain in the anterior part of the knee, insufficient effectiveness in comminuted metaphyseal fractures and systemic complications such as embolism during reaming, especially in patients with concomitant thorax trauma.[1,10-12] Bridge plating, which has become more popular in recent years, together with locked plate manufacturing, causes external callus formation by allowing limited fracture movement against physiological loading and provides good fixation, especially in osteoporotic and comminuted metaphyseal fractures.[1,6,13-16] As fixation is provided from the lateral side with this technique, knee problems that might develop due to the opening of the joint and embolism risk decreases; however, weight-bearing might be delayed. Furthermore, problems such as implant failure, delay in union and nonunion have also been reported.[17,18] As far as we are aware, few studies have compared these two methods in groups that involve intra/extra-articular distal femur fractures and only one has reported extra-articular distal femur fractures.[5,8,9,14]

The aim of the current study was to compare RIMN and locked bridge plating methods for the treatment of extra-articular distal femur fractures and to determine the most appropriate method.

Patients and methods

Fifteen patients (13 males and 2 females; mean age: 36 years, range: 17 to 55 years) who underwent locked bridge plating and 13 patients (11 males and 2 females; mean age: 31.1 years, range: 17 to 49 years) who underwent RIMN for the treatment of extra-articular distal femur fractures between 2007 and 2012 were retrospectively evaluated. The study was approved by the local ethics committee. Patients with acute supracondylar and distal diaphyseometaphyseal fractures that had no extension to the knee joint and no walking disturbance before the fracture were included in the study. Those with pathological fractures, periprosthetic fractures, ipsilateral tibia fractures and ligament and neurovascular injuries related to the fracture were excluded from the study. Mean follow-up time was 31.3 months (range: 20 to 46 months) in the plate group and 26.7 months (range: 18 to 62 months) in the nail group.

Distal femur fractures were classified according to the AO/OTA classification.[19] The demographic characteristics of the patients are presented in Table 1. In cases with open fractures, antibiotic prophylaxis was administered as the initial treatment and the wound was closed with sterile dressing after irrigation and debridement.

Table 1. Demographical characteristics of the patients.

	Plate group (n=15)	Nail group (n=13)
Mean age (year)	36	31.1
Gender		
Male	13	11
Female	2	2
Side		
Right	11	6
Left	4	7
Trauma mechanism		
EVTA	3	5
IVTA	3	1
FAI	7	5
FH	1	1
CI	1	1
SF	1	-
Closed fracture	8	7
Open fracture	7	6
Gustilo-Anderson Type 1	-	-
Gustilo-Anderson Type 2	-	1
Gustilo-Anderson Type 3A	7	5
AO/OTA Type		
33-A1	3	4
33-A2	5	5
33-A3	7	4

HSCI: Crush injury; EVTA: Extra-vehicle traffic accident; FAI: Firearm injury; FH: Falling from a height; IVTA: In-vehicle traffic accident; SF: Simple fall.

Mean time to surgery was 2.8 (range: 1 to 5) days in the plate group and 3.2 (range: 1 to 4) days in the nail group. Operations were performed within the first 24 hours in 5 of the 7 open fracture patients in the plate group and 4 out of 6 in the nail group. Prophylactic antibiotherapy was administered to all patients 30 minutes to 1 hour before surgery.

All patients were operated in the supine position. In the plate group, an incision was made approximately 5 to 6 cm to the lateral part of the distal thigh, corresponding to the distal region of the fracture line. The locked distal femur plate (Tıpmed, Izmir, Turkey and Ortopro, Izmir, Turkey) was then submuscularly inserted to the proximal part of the fracture line. The plate was accessed through an incision of approximately 5 to 6 cm to the lateral part of the proximal thigh in the proximal region of the fracture line. The distal part of the plate was fixed

Fig. 1. Radiological images of a 24-year-old patient in which retrograde intramedullary nail was applied. Preoperative **(a)** anteroposterior **(b)** lateral radiograph. 20 months after surgery **(c)** anteroposterior and **(d)** lateral radiographs.

to the bone with a Kirschner wire (K-wire). After adequate extremity length and alignment was ensured by means of manual traction, the fracture was reduced and the proximal part of the plate was fixed to the bone with an additional K-wire. Osteosynthesis was completed by locking the proximal and distal parts of the plate with locking screws after radiological control of the reduction.

In the nail group, the joint was accessed using a medial parapatellar approach of approximately 3 to 4 cm in length. The fracture was reduced and length and alignment was obtained with manual traction. After radiological control of the reduction, a K-wire was directed in a retrograde manner towards the trochanter minor level of the femur, just anterior to the insertion point of the posterior cruciate ligament to the medial condyle. After drilling the femoral medulla over the K-wire, a RIMN (Tıpmed, Izmir, Turkey and Biomet UK Ltd., Bridgend, South Wales, UK) was inserted. In all patients except one, osteosynthesis was completed by locking the nail with at least two locking screws at the distal part and at least one locking screw at the proximal end.

Antibiotherapy was administered 24 to 48 hours postoperatively for infection prophylaxis and low-molecular-weight heparin was administered for deep vein thrombosis until the patient was mobilized. Isometric quadriceps strengthening and knee-hip-ankle exercises were initiated at the end of the 1st postoperative day. On the 2nd day, patients were mobilized with double crutches without weight-bearing on the affected extremity. In the follow-up, according to the stability of the fracture, partial weight-bearing was allowed in the nail group within 3 weeks in cases with AO/OTA Type A1 fractures and within 6 weeks in AO/OTA Type A2 and A3 fractures and all fractures in the plate group. Full weight-bearing was allowed after observation of radiological union in both groups.

In the postoperative follow-up, patients were evaluated in terms of duration of union, complications and functional results. Functional results were evaluated according to the criteria determined by Sanders et al.[20] The Sanders criteria consists of five parameters that assess the knee range of motion, pain, deformity, walking capacity, and return to work. Results were classified as excellent, good, intermediate or poor.

SPSS v.19.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. The Fischer's exact test was used for the comparison of paired categorical variables and the Mann-Whitney U test for the comparison of paired numerical variables. P values of less than 0.05 were accepted as statistically significant.

Results

Radiological union was detected in the final follow-up in all patients (Figs. 1 and 2). Mean duration until union was 25.7 (range: 12 to 72) weeks in the plate group and 22.3 (range: 12 to 52) weeks in the nail group. The difference between the two groups in terms of mean duration of union was not significant (p=0.821). Complications are presented in Table 2. Although more complications were observed in the plate group, the difference was not statistically significant (p=1.000).

Fig. 2. Radiological images of a 24-year-old patient in which indirect reduction with bridge plating was applied. **(a)** Preoperative anteroposterior radiograph. 31 months after surgery **(b)** anteroposterior and **(c)** lateral radiographs.

According to the Sanders criteria, 12 (80%) patients in the plate group (8 excellent and 4 good) and 10 (76.9%) patients in the nail group (7 excellent and 3 good) had excellent or good functional results. Intermediate or poor results were observed in 3 (%20) patients in the plate group (2 intermediate and 1 poor) and 3 (%23.1) patients in the nail group (1 intermediate and 2 poor). No statistically significant difference was found between the two groups in terms of functional results (p=1.000).

Discussion

Biological fixation methods such as RIMN and bridge plating decrease union and infection problems by preventing soft tissue injury and have been frequently used in the treatment of distal femur fractures in recent years.[4-9,14]

Different results have been reported in a limited number of studies that compare biologically applied RIMN and bridge plating in distal femur fractures.[5,14] In retrospective studies of AO/OTA Type 33-A and C1 distal femur fractures, Hierholzer et al. reported that 90% of fractures in both groups healed within 6 months and there was no significant difference between the two groups in terms of fracture healing.[5] On the other hand, in their retrospective study, Henderson et al. reported that the amount of callus measured at the 12th week in the LISS plate group was significantly lower than in the RIMN group.[14] In the present study, which included AO/OTA Type 33-A type distal femur fractures, the mean healing time in the RIMN and plate groups were 22.3 weeks and 25.7 weeks, respectively, and the difference between the two groups was not significant. Healing time in the present study supports the results of Hierholzer et al.[5] We believe that many factors can affect healing times in heterogeneous groups in which intra/extra-articular fractures are present together and these may be less reliable when compared to studies with homogenous groups. On the other hand, the similar outcomes obtained in these studies suggest that both methods can be used in the treatment of extra-articular distal femur fractures when applied using the correct technique.

Studies comparing the RIMN and bridge plating methods in distal femur fractures have reported similar complications in both groups.[5,8,9,14] Hierholzer et al.[5] reported that the small RIMN incision protects soft tissues and results in less blood loss. On the other hand, the authors reported no significant difference between both fixation methods in terms of nonunion or infection rates. In their prospective study of intra/extra-articular distal femur fractures, Markmiller et al. found no significant differences between the two groups in terms of infection, malalignment or nonunion.[8] As far as we are aware, only one study by Gao et al.[9] has compared extra-articular distal femur fractures. The authors evaluated patients with a mean age of over 50 excluding Gustilo-Anderson Type 3 fractures and found no significant differences between the two groups in terms of malalignment, deep infection, implant failure, knee pain or knee range of motion. Gao et al.[9] also reported significantly higher blood loss in the RIMN group and significantly

Table 2. Complications encountered in the plate and nail groups.

	Plate group (n=15)	Nail group (n=13)	p
Union disturbance	5 (33.3%)	3 (23.1%)	0.686
Nonunion	2 (13.3%)	1 (7.7%)	1.000
Delayed union	3 (20%)	2 (15.4%)	1.000
Malalignment			
(>10°)	2 (13.3%)	1 (7.7%)	1.000
(5-10°)	2 (13.3%)	2 (15.4%)	1.000
Motion restriction of knee joint			
Flexion restriction			
(ROM: 100°-124°)	3 (20%)	3 (23.1%)	1.000
Extension restriction			
(6°-10°)	1 (6.6%)	1 (7.7%)	1.000
(1°-5°)	5 (33.3%)	4 (30.8%)	1.000
Anterior knee pain	3 (20%)	3 (23.1%)	1.000
Shortness			
(<1.5cm)	3 (20%)	2 (15.4%)	1.000
Implant failure	1 (6.6%)	–	1.000

ROM: Range of motion.

more union disturbances (nonunion+delayed union) in the locked plate group; however, when nonunion and delayed union were separately compared, there was no significant difference between the two groups.

In the current study, mean age was 33.7 years and there was a relatively high ratio of open fractures. The inclusion of both closed and open fractures might affect the complications, such as infection and union disturbances, and make the intergroup comparisons difficult. However, in the literature, it was reported that Gustilo-Anderson Type 1, 2 and 3A open distal femur fractures can be treated as closed fractures with early internal fixation with locked plate or RIMN if the wound can be cleaned with early debridement.[21] In another study, Poyanli et al.[22] reported that osteomyelitis or septic arthritis were not observed in any patient after the application of RIMN by biological methods in 15 patients in which open supracondylar femur fractures developed following firearm injury. Furthermore, the authors reported that RIMN could be applied within 7 days following trauma in cases with no skin defect. In addition, as the number and rate of open fractures were similar in both groups in the current study (7 patients in the plate group [46.7%] and 6 in the nail group [46.2%]) and most (7 patients in the plate group and 5 in the nail group) were Gustilo-Anderson Type 3A fractures caused by firearm injury, comparability was increased and partial homogenization in regard to open/closed fractures was enabled; therefore, we did not exclude open fracture cases from the study. In our study, we observed no significant differences between the two groups in terms of complications (including infection and union disturbances). The results of the current study were consistent with those of Gao et al.[9] and other similar studies in the literature.[5,8,13]

Studies comparing RIMN and bridge plating methods in distal femur fractures reported similar results in both groups despite the use of different functional scoring systems.[5,8,9,14] Using the Knee and Osteoarthritis Outcome scoring system in Type A fractures, Hierholzer et al. reported no significant differences between the two groups in terms of functional results at the end of a 14-month follow-up and that both methods are sufficient treatment options for distal femur fractures.[5] Using the Lysholm-Gillquist score, Markmiller et al. reported that there was no significant difference between the two groups in terms of functional outcomes after a mean follow-up of one year and that both methods were suitable for the treatment of distal femur fractures.[8] In addition, Gao et al. used the Hospital for Special Surgery knee score and reported no significant difference in functional outcomes at the 23rd and 26th month follow-up of the plate and RIMN groups, respectively.[9] Similarly, the present study used the Sanders criteria and found no significant difference in the functional outcomes of the two groups. Bridge plating and RIMN methods appear to both be suitable methods for the treatment of extra-articular distal femur fractures.

The retrospective design and low patient number of

the current study may be considered as its limitations. A different aspect of the current study from Gao et al.'s[9] study was that all patients were young or middle-aged and the cases with open fractures were at a relatively high ratio in both groups.

In conclusion, the outcomes of the bridge plating and RIMN methods for the treatment of extra-articular distal femur fractures were similar. Both methods can be applied in all fractures, with the exception of Gustilo-Anderson Type 3B and C open fractures. Further prospective studies involving a greater number of patients are necessary to make a more accurate conclusion.

Conflics of Interest: No conflicts declared.

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