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Comparison of antegrade locked intramedullary nails and retrograde expandable intramedullary nails in distal femur diaphysis fractures

Antegrade vs retrograde nailing in distal femur fractures

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Abstract

Aim: In this study, we aimed to compare antegrade locked and retrograde expandable intramedullary nails, which are common methods in the treatment of distal femur diaphysis fractures.

Material and Methods: Twenty three femurs of 23 patients (12 males, 11 females) who underwent REN and 78 femurs of 71 patients (49 males, 22 females) who underwent ALN between January 2010 and December 2013 were included in the study. Functional outcomes were compared with HSS (Hospital for Special Surgery) and Neer scores for postoperative assesments at 24 and 48 week [1, 2].

Results: The mean duration of bone union was evaluated as 49.7 (range 21-140) weeks in patients with ALN and 32.9 (range 13-74) weeks as the mean duration of bone union in the REN group.

In the ALN group with 71 patients, 50 patients had excellent and good functional results according to Neer evaluation and 47 patients according to HSS evaluation at 48th week. In the REN group for 23 patients, excellent and good results were obtained in 14 patients for the Neer evaluation and 16 patients for HSS evaluation at the 48th week. There was no significant difference between Neer and HSS functional evaluations at 24th and 48th week between the two groups ($p > 0,5$); it was seen that REN application in terms of union time was significantly better than ALN ($p < 0,5$).

Discussion: ALN and REN applications are treatment options that can be used safely for distal femur fractures, and the REN option should be considered to have a significant positive effect on the duration of bone union for non-contraindicated situations.

Keywords

Distal femur; Antegrade locked nail; Retrograde expandable nail; HSS; Neer

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Introduction

As a result of the rapid increase of industrial and traffic activities and personal arming, related accidents and gunshot injuries have become an important cause of general orthopedic trauma.

Fractures of the distal femur diaphysis have a relatively small proportion in the general trauma, it is considered important because of the complexity of surgical intervention in this anatomical region. Due to the high morbidity, prolonged hospitalization and postoperative complications due to plate-screw osteosynthesis, more biologic and less invasive intramedullary fixation options have become preferred. RENs have such advantages over ALNs due to being less invasive, requiring smaller incisions, causing less bleeding, and more comfortable for obesity. In addition, REN application is a good choice for distal femoral diaphysis fractures because of the need for less scopy.

However, REN application has potential disadvantages, such as causing arthritic changes in the knee, causing knee pain, and creating septic arthritis compared with ALN application.

REN and ALN applications both provide mechanically optimal load distribution and are ideal for fixation to allow early loading, as well as difficulties with distal locking in locked nails and doubts about the reliability of rotational stability in expandable nails especially in osteoporotic patients makes both of them technically problematic.

In this study, we aimed to compare ALN and REN within distal femoral diaphysis fractures that are not joint-related, and also, we aimed to determine which treatment and fixation method is more appropriate.

Material and Methods

Twenty-three femurs in 23 patients (12 males,11 females) who underwent REN, and 78 femurs in 71 patients (49 males, 22 females) who underwent ALN between January 2010 and December 2013 were evaluated retrospectively. The mean ages of REN patients and ALN patients were 38.59 (range 15-86) and 45.09 (range 15-88), respectively. Patients with an acute distal femur diaphysis fracture who had no knee joint deformity before the trauma, and had no walking problems were included. Patients with a periprosthetic fracture, patients with a pathological fracture, and children with open physis line were excluded from our study. The mean follow-up time in the ALN group was 28.4 (range 10-48) weeks, while in the REN group, 20.3 (range 12-32) weeks. The fracture pattern of the patients was evaluated according to the AO-OTA and Winquest-Hansen fracture classification. The demographic characteristics of the patients are shown in Table 1.

In our study, open fracture cases were evaluated in the emergency service, and debridements and tetanus prophylaxis were first performed under sedoanalgesia, and then debridement was re-made in the operating room pre-surgery.

In open fracture cases, allergic conditions were investigated, and prophylactic antibiothics with double (Penicillin G-Genta) or triple (Penicillin G-Gentamycin-Metronidazole) antibiotherapy was started in patients with dirty wounds, according to wound status.

As a general principle, unless there is a very serious soft-tissue defect, we plan to do surgery for our patients as soon as possible. In the patient group with ALN, the time to the surgery was 2.8 (range 0-16) days, and the REN group, 3.3 (range 0-14) days because of the relatively longer duration of fixation material supply. Cefazolin sodium (1 gram) was given prophylactically 1 hour before the operation, and the dose was repeated if the operation lasted longer than 2 hours.

All patients underwent surgery in the supine position over the radiolucent surgery table. Patients treated with ALN were locked with proximal and distal locking with an appropriate locked intramedullary nail by getting into the medulla from the trochanter major, or in cases where the fracture site was opened, the nail performing and reaming was done retrogradely from the fracture site to the trochanter major. Perop ALN application was shown in Figure 1.

In patients treated with REN, a 5 cm longitudinal incision was performed over the patellar tendon. The patellar tendon was cut longitudinally in the middle line and retracted. The posterior cruciate ligament was palpated and the attaching fascia of PCL on the femur was seen, and then the Kirschner wire was drilled into the femur medulla from 5 mm anterior of PCL, and the centralization of the AP and the lateral view were controlled with a scope. If the intramedullary centralization of the Kirschner wire was determined appropriately, the Kirschner wire was used as a guide for reaming the medulla. During all these procedures, patella articular cartilage was kept using deep retractors. The REN, which was expanded intramedullary with an appropriate length, was applied to the trochanter minor level. Perop REN application method is shown in Figures 2 and 3.

All patients received prophylaxis with lmwh (low molecule weight heparin) 0,4 cc single dose until mobilization and were given prophylactic antibiotherapy as cefazolin 1 gr 2*1 for 2 or 3 days post-op. The quadriceps exercises were started the postop first day, as much as the patient tolerated the pain. Mobilization was started on the 2nd postoperative day without weight-bearing with the crutch. The group of patients who underwent REN were allowed partial loading 3 to 6 weeks postop according to the state of the patient and the fracture pattern; The ALN group was allowed loading with fragmented fractures late term and non-fragmented fractures postop 2ndday. Full loading was allowed after the radiological callus formation in all patients.

Patients' postoperative follow-up was evaluated according to the duration of the bone union, early and late complications, and functional outcomes. Functional results were assessed and compared using the HSS and Neer scoring systems at 24th and 48th weeks postoperatively. Pain, function, range of motion of the knee joint, muscle strength, flexion deformity, and instability were assessed in the HSS score system and the results were classified as excellent, good, medium and bad. Pain, function, knee joint motion, working capacity, anatomic structure of the fracture site, and x-ray findings are evaluated using Neer's score system, and results were classified as excellent, good, medium and bad.

Analysis of the data obtained as a result of the evaluations was performed using the "Statistical Package for Social Sciences" (SPSS 20) program. Student's t-test was used when all numerical data were evaluated in two independent groups. When the histogram was used, the non-parametric variant of

the Student's t-test and the Mann-Whitney-U test were used for the data with no normal distribution. Pearson's correlation test was used to evaluate the relationship between 2 numerical values.

Anova test was used for numerical data with more than 2 independent groups. However, the Kruskal-Wallis test, which is a non-parametric alternative to ANOVA, was used for non-normal distribution data. P<0.05 was considered statistically significant.

Results

All of these patients who underwent ALN and REN had bone union after surgery. Patients with ALN were followed for an average of 28.4 (range 10-48) months. The mean duration of union was 44.64 (range 21-140) weeks in these patients. The mean follow-up period was 20.4 (range 12-32) months for patients with REN. The mean duration of union was found about 32.9 (range 13-74) weeks in these patients. Compared to the ALN and REN patients according to the union duration; it was observed that the union time was significantly better in the REN group (p = 0,0002).

According to the HSS scoring at 48 weeks in the patient group with REN; 11 (47.8%) patients were excellent, 5 (21.7%) were good, 3 (13.04%) were moderate, and 4 (17.4%) patients were evaluated as poor. According to the Neer scoring, 8 (34.7%) patients were excellent, 6 (26.0%) patients were good, 5 (21.7%) patients were moderate, and 4 were evaluated as bad. According to the HSS scoring at 48 weeks in the patient group with ALN; 25 patients (35,2%) were excellent, 22 (31%) were good, 11 (15,5%) were moderate and 13 (18,3%) patients were evaluated as poor. According to the Neer scoring, 25 patients (35.2%) were excellent, 25 patients (35.2%) were good, 14 patients (19.7%) were moderate and 7 (9.8%) patients were evaluated as bad. No significant statistical difference was found except for the 48th week of the Neer evaluation of the patients who had REN in these evaluations.

Four patients who underwent ALN developed an antibiotic-responsive superficial infection. They all had proper antibotherapy, and implant removal was not required for these patients. Pseudoarthrosis developed in six patients, and one patient had nonunion. All six patients underwent pseudoarthrosis surgery and the nonunion patient underwent REN and iliac bone grafting after replacing the antegrade nail. After these operations, all of the patients had a bone union. In one patient, implant failure developed at the postoperative 5th month and the nail was replaced with a thicker one. A 66-year-old patient had a collum femoris fracture after union of the fracture line. The patient underwent implant removal and partial prosthesis. In one patient, a collum femoris fracture occurred during nail application. Treatment was adjusted by performing a long proximal femur nail.

Patellofemoral crepitation was detected in 13 patients (19.7%) who underwent REN, and in 1 patient who had ALN, and knee effusion occurred in 6 patients (26.0%) who underwent REN. Nothing was done to these patients and complaints disappeared spontanously.

No patient had varus, valgus deformity or rotation.

Table 1. Demographic characteristics of patients

	Antegrade locked nail (n=71)	Retrograde expandable nail (n=23)
Mean age (years)	38,59	45,09
Gender		
Male	49	12
Female	22	11
Side		
Right	33	13
Left	24	10
Bilaterally	7	
Etiological cause		
In vehicle traffic accident	12	4
Extra vehicle traffic accident	25	2
Gunshot wound	6	3
Falling from height	20	8
Simple fall	6	4
Earthquake	2	2
Closed fracture	60	20
Open fracture		
Gustilo Anderson type 1		
Gustilo Anderson type 2	3	1
Gustilo Anderson type 3a	7	2
Gustilo Anderson type 3b	1	
AO-OTA Classification		
33A1	44	15
33A2	1	1
33A3		
33B1	9	1
33B2	5	
33B3	2	
33C1	4	5
33C2	3	
33C3	3	1



Figure 1. Perop clinical and scope view of antegrade nailing



Figure 2. Perop clinical and scope view of retrograde nailing



Figure 3. Ap and lateral positioning of retrograde nailing

Discussion

In this study, we aimed to compare ALN and REN, which are common methods in the treatment of distal femur diaphysis fractures. In this case, we evaluated and compared the results of 71 patients who underwent ALN and 23 patients who underwent REN.

We found REN to be better than ALN for distal femur fractures in general. Duration of surgery, less bleeding, union time are significant advantages of retrograde nailing.

The previously reported mean age of patients was between 24 and 36 years. In a thesis study similar to ours, the reported mean age of patients was 45.9 years. In our series, the average age of 40.1 years was slightly higher than reported in the literature. Since our hospital is a university hospital, and the general patient age is higher than in state hospitals because of the increasing potential morbidity risk with age [3-6].

More active involvement of males in social and industrial life is responsible for the higher rates of distal diaphyseal femur fractures among men. While in the other studies, the ratio of male patients is between 61.2% and 88%; in our study, 65% of patients are males. Since there is no industrial potential in Erzurum that may cause more trauma to the male population, so there is not a big difference between males and females as in other studies cited below [3,5,6].

REN application offers several practical and theoretical advantages in the treatment of distal femoral fractures. It represents a rapid, practical, and less invasive approach with a reduced risk of bleeding that minimizes the soft tissue and periosteal dissection and that facilitates fusion by preserving the circulation at the fracture site. In our series, 71 of 94 patients (75.5%) with distal femoral fractures underwent ALN, and 23 (24.5%) patients underwent REN. The average volume of the perioperative bleeding and the average duration of surgery in patients undergoing ALN were 202 ml (range 100-420 ml) and 89.5 minutes (range 45-180 min), respectively, while the corresponding values in the REN group were 131.3 ml (range 50-300) and 66 (range 35-120) minutes, with a significant difference in favor of the REN group in terms of perioperative bleeding volume and duration of surgery ($p<0.05$) [7-18].

The union of femoral fractures is defined as the absence of pain in fracture line on physical examination, the demonstration of solid callus tissue on radiographs, and the ability of the patient to walk without symptoms and crutches. For femoral diaphysis fractures, the union process is considered normal if it is completed in less than 6 months, delayed if the union occurs without intervention between 6 and 9 months, and non-union if no callus is formed. The mean time to the union after fixation of the femoral diaphysis fractures by ALN was18 weeks in different two studies. In our patient group, patients treated with ALN were followed up for a mean duration of 28.4 months (range 10-48 months), with a mean union time of 49.7 weeks (range 21-140). Similarly, patients in the REN group were followed up for 20.3 months (range 12-32) on average, and their mean time to union was 32.9 weeks (range 13-74). Although significantly better union time was found in the REN group, the time to union was significantly longer in both of our study groups compared to previously reported studies because we accepted all the parameters we defined below to be completed as to say full bone union. In other studies they accepted only callus formation in radiographs as to say full bone union ($p< 0.05$) [15,20].

The Neer, Shelbourne, and the Hospital for Special Surgery (HSS) scoring systems are the most commonly used tests for assessing distal femoral fractures. Similarly, we also used the Neer and HSS scoring systems in our study. The reason for using two different evaluation systems is that one evaluation system may not be adequate for all patients. For example, while the Neer classification system appears to be inadequate for patients with ligament instability after distal femoral fractures, the HSS scoring system does not consider radiological findings, functional capacity, and the anatomical characteristics of the fracture site. The HSS and Neer classification systems are used at variable times during the course of management, and we believe that optimal standardization with regard to the duration of postoperative rehabilitation may allow clinicians to obtain more objective and Standard assessments. Contrastly with similar previous studies, we assessed the ALN and REN groups both separately and combined at 24 and 48 weeks using the Neer and HSS criteria. In a similar thesis study by Erkan Tan, MD, carried out in 2006, the mean Neer and HSS scores were 88.5 and 88.3, respectively, without the use of standardized timepoints [1,2,12].

In our study, the average Neer and HSS scores in the overall study population were 76.11 and 76.06 at the 24th week, and 79.47 and 79.33 at the 48th week, respectively. Another study found 88,5(range 67-100) and 88,3(range 69-100)Neer and HSS scores, respectively. According to the Neer score at 24

weeks for all patients, the outcomes were rated as excellent, good, moderate, and poor in 29 (30.8%), 27 (28.7%), 16 (17%), and 23 (24.4%), respectively. At 24 weeks according to HSS score, it was rated as excellent, good, moderate, and poor in 29 (30.8%), 31 (33%), 13 (13.8%), and 21 (22.3%), respectively. According to the Neer score at 48 weeks, excellent, good, moderate, and poor results were obtained in 33 (35.1%), 31 (33%), 19 (20.2%), and 11 (11.7%) patients, respectively. It was rated at 48 weeks according to HSS score as excellent, good, moderate, and poor in 36 (38.2%), 27 (28.7%), 14 (14.8%), and 17 (18%)patients, respectively. The mean Neer and HSS scores at 24 weeks in 71 patients undergoing ALN were 76.51 and 76.67, respectively; the same scores at 48 weeks were 80.45 and 79.67, respectively. The mean Neer and HSS scores at 24 weeks in 23 patients undergoing REN were 75.26 and 74.74, respectively; the same scores at 48 weeks were 77.39 and 78.61, respectively.

The difference in the number of cases between the ALN and REN groups is a limitation of our study. We compared a locked fixation system with an unlocked retrograde fixation system; that may be assessed as a limitation. Our retrograde locked case number was not enough to obtain a significant result for our study, so we did not include locked retrograde cases.

Conclusion

According to our study we decided that the REN system is a better fixation system for distal femur fractures because of less bleeding, shorter surgery time and early bone union according to antegrade locked system nailing.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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