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Antegrade Versus Retrograde Nailing for The Management of Distal Half of Femur Fractures

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Abstract

Distal femur fractures include fractures of the supracondylar and intercondylar region of the distal femur which are relatively common injuries. To avoid the high morbidity and mortality correlating with this fracture, it requires prompt diagnosis and treatment. This study aimed to compare between antegrade and retrograde intramedullary nailing in the treatment of distal half of femur fractures regarding functional outcome, union rate and complications. This prospective clinical trial was carried in Orthopedic Department, at Al-Zahraa University hospital on 20 patients with femoral distal half fractures. Patients were divided into two groups: Group A: 10 patients will be treated by antegrade femoral intramedullary nail, Group B: 10 patients will be treated by retrograde femoral intramedullary nail. There was no statistically significant difference in union between the 2 groups. The union rate was 70 % in antegrade group and 60% in retrograde group. There were 3 patients underwent retrograde group had delayed union fracture. The operation time was longer in antegrade nailing than retrograde nailing. The antegrade nailing was better than retrograde nailing regarding functional outcome in distal half of femur fractures.

Keywords: Distal femur fractures, antegrade and retrograde intramedullary nailing, complications.

1. Introduction

The femur is the skeleton's longest bone and one of the most important load-bearing bones [1]. The distal femur is described as the portion of the femur that extends from the metaphyseal-diaphyseal junction to the articular surface of the knee, roughly 15 cm. Distal femur fractures are very common injuries that involve the supracondylar and intercondylar regions of the distal femur. To reduce the high morbidity and mortality associated with this fracture, it is necessary to diagnose and treat it as soon as possible [2]. In the past, distal femur fractures were treated conservatively with bone traction, cast immobilization, and cast bracing until the fracture healed; however, these methods of therapy were associated with problems such as stiff knee, deformity, and nonunion [3]. After significant improvements in surgical methods and the implants used, surgical treatment has become the conventional treatment, avoiding the risks of conservative treatment [4]. Distal femoral fractures are mostly treated surgically, with the aim of restoring articular congruity, anatomical length, rotation, and axial alignment, as well as

establishing adequate fixation to allow for early unrestricted range of motion and a subjective sense of well-being for the patient. There have been numerous fixing methods described. Open anatomical reduction with plate and screw fixation, bridge plating or submuscular plating, and intramedullary nailing are the three main fixation options [5].
With regard to the future function of the joint serving to insert the nail, the decision between antegrade and retrograde intramedullary nailing continues to be a source of debate [6]. In the therapy of distal femur fractures with osteoporosis, retrograde intramedullary nailing is a promising surgical alternative [7].
Antegrade nailing has been shown to be a superior surgical alternative in supracondylar femur fractures, with clear advantages over retrograde nailing in purpose of offering greater stability and allowing for more satisfactory fracture healing [8].

2. Patients and Methods

2.1 Patients:

This prospective clinical trial was carried in Orthopedic Department, at Al-Zahraa University hospital on 20 patients with femoral distal half fractures. Patients were divided into two groups: **Group A**: 10 patients treated by antegrade femoral intramedullary nail, **Group B**: 10 patients treated by retrograde femoral intramedullary nail. The sample size was calculated according to the following number of patients with distal half of femur fractures coming to Al-Zahraa University Hospital in 3 months expected to be 20 cases, so all cases were included in the study. They were all evaluated both clinically and radiologically. Radiological evaluation included assessment of union, malunion, failure of fixation and implant failure. Subjects that will be included in the study should fulfill the following criteria:

Inclusion criteria: All adult patients with closed femoral distal half fractures and open fractures: Gustilo type 1.

Exclusion criteria: Closed fractures with articular extension, open fractures: Gustilo type 2 and 3, pathological fractures and non-ambulatory patients before injury.

Ethical approval: Approval was obtained from Institutional Review Board (IRB) Al-Azhar University. Written informed consents were obtained from all.

Operational design:

Clinical Evaluation: History: History of the patient was recorded including, name, age, sex, mechanism of injury, time of the injury, previous medical history of associated disease, address and phone number. Examinations: at emergency room; patients examined according to the ATLS protocol.

Radiological evaluation: The following radiographic views were obtained: Anteriopsterior and Lateral views. X ray requested for any other suspected injuries. Routine pelvis x ray to exclude ipsilateral Neck femur fractures.

Preoperative preparation: Preoperative CBC, PT, PTT, INR, liver function and kidney function tests were done. All laboratory investigations were done at Al-Zahraa University Hospital. Preoperative hemoglobin (HB) was at least 10 g/dl in all patients with normal ESR and CRP. Consent had been signed by patient himself. Intravenous Cephalosporin was prescript 2 hours before operation has begun.

Operative Stage: Anesthesia was performed by either general or regional.

2.2 Operative Technique (methods):

2.2.1 Antegrade nailing group:

Patient positioning: The patient was positioned in a lateral position on a radiolucent table with free draping of the injured leg, or a supine position where feet was well padded and placed firmly in fracture table.

Skin disinfecting and draping was occurred as follow: The affected limb was free draped with a single-use U-drape. A stockinette covers the lower leg and was fixed with a tape. The leg was draped to be freely moved.

Skin incision: A 3-5 cm incision was made proximal to the tip of the greater trochanter on the proximal extension of the anatomical femoral bow.

Deep dissection: The fascia was opened with scissors and the gluteus muscle was split along its fibers. Dissection was carried down to bone.

Determination of entry point and guide-wire insertion: A finger was inserted to palpate the greater trochanter. An initial entry was done by a cannulated owl and the 2.8 mm guide wire, inserted under image intensifier control, enters the medullary canal at a slightly oblique angle. Introduction was manual, using the universal chuck with T-handle. The entry point was verified by both AP and lateral views with image intensifier.

Opening the canal: The cannulated drill bit was passed over the guide wire and through the protection sleeve to open the medullary canal.

Reduction: Reduction was performed under image intensification by elevation of the distal fragment by use of a crutch. Lowering of the proximal fragment by external pressure from a mallet. Based on the nature of the fracture, the wrap was placed around the larger fragment. A Schanz screw was inserted into one of the fragments.

Guide wire insertion: A guide wire was advanced into the distal main fragment until it is about 5 mm proximal to the intercondylar notch. The guide wire was centered to prevent eccentric reaming and subsequent malposition of the nail. The maintenance of alignment of the K-wire was ensured throughout the reaming process, it was gently tapped to provide purchase in the cancellous subchondral bone.

Reaming: Reaming was done with a 9 mm medullary reamer. Reaming was performed in sequential steps by increments of 0.5 mm each.

Nail insertion: The insertion handle was connected to the nail by the corresponding connecting screw. It was attached using the hexagonal screwdriver through the hole in the insertion handle. The nail was inserted manually and rotated about 90 degrees from its point of entry to its final orientation. This was assessed by using an additional K-wire that marks the upper end of the nail.

Distal locking: by aiming device of nail system and if aiming device failed, perfect hole technique was used.

Screw insertion technique: The radiolucent drive helps to position the drill bit so that the locking screw can be properly inserted.

Second locking screw: The second locking screw was inserted into the distal locking hole.

Intraoperative radiological assessment: Before positioning the patient, the profile of the lesser trochanter of the intact opposite side was stored in the image intensifier.

Proximal locking: The drill sleeve was in close contact with the bone at all times since it was important for the measurement of the locking screws.

2.2.2 Retrograde intramedullary nailing:

Patient positioning: the patient was positioned supine with roll under the thigh to keep the knee in a 30° flexed position. The image intensifier was positioned on the opposite side of the injury and the surgeon.

Skin disinfecting and draping: The affected limb(s) was draped with a single-use U-drape. Light manual traction was maintained on the limb during preparation.

Skin incision and dissection: A 2 cm skin incision was made longitudinally just distal to the inferior patellar pole, over the midline of the patellar tendon.

Localization of the entry point: The entry point of the nail was in line with the axis of the medullary canal, just below the crest of the intercondylar notch.

Opening the medullary canal: The protection sleeve and drill sleeve were pushed over the guide wire into the notch, and the medullary canal was opened to a depth of approximately 30 mm using the cannulated drill bit. The drill bit, protection sleeve and guide wire were then removed.

Reduction and guide-wire insertion: Direct reduction was operated by a bone hook or with a monocortical Schanz screw.

Determine nail length and diameter:

a- **Determine nail length via guide wire:** The maximal length of the nail was determined by comparing a second identical length guide wire to the one that has been inserted.

b- **Determine nail length via system ruler:** At the proximal pole of patella distally and lesser trochanter proximally.

Poller screw (blocking screw): The poller screw was located according to the direction of the initial fracture displacement. The fracture was displaced medially even after the reduction and poller was placed lateral to the proposed nail track in a medial displacement.

Reaming: The reaming was performed in sequential steps with increments of 0.5 mm each.

Nail insertion: The nail was gently driven manually into the proximal fragment. Gentle hammer taps were used to ensure proper advancement. At distal nail part, we should take care of intra-articular nail protrusion.

Locking sequence and locking type: Distal locking was performed by using the aiming device attached to the insertion handle. Slotted locking holes were used for dynamic locking screws while small circular holes were used for static locking.

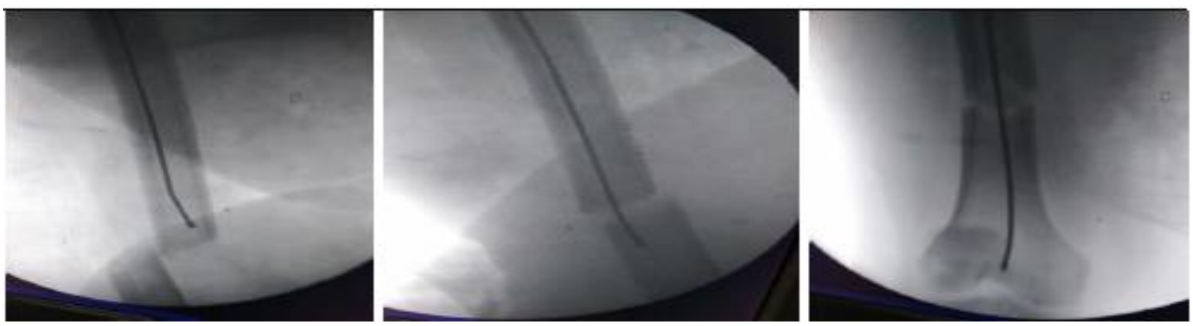

Figure (1): Radiological assessment of guide wire insertion.

Figure (2): Localization of entry point.

Distal locking: After verifying the correct position of the distal end of the nail under the image intensifier, the distal aiming device was attached to the insertion handle.

Intraoperative radiological assessment: The profile of the lesser trochanter was compared with that of the contralateral leg (lesser trochanter shape sign).

Proximal locking: According to the type of proximal locking system anterioposterior screws and lateral screws, each system may be present. The distal aiming device was attached to the insertion handle, while - as same as distal locking - drill sleeve is inserted.

Wound closure and assessment of alignment Assessment of alignment: Before the patient is moved from the fracture table, rotation of the leg is observed clinically and compared to the contralateral leg. With the femur now stable, it is possible to perform a thorough examination of the knee joint to rule out additional ligamentous injuries.

Postoperative assessment: In all cases in which radiological control has not been used during the procedure, a check x-ray to determine the correct placement of the implant and fracture reduction should be taken within 24 hours.

Functional treatment: Unless there are other injuries or complications, mobilization may be started on postoperative day 1.

Weight bearing: Full weight bearing may be performed with crutches or a walker.

Follow-up: Wound healing should be assessed regularly within the first two weeks. Subsequently a 6 and 12 week clinical and radiological follow-up is usually made. A longer period may be required if the fracture healing is delayed.

Implant removal: Implant removal is not mandatory and should be discussed with the patient, if there are implant-related symptoms after consolidated fracture.

Statistical analysis: Statistical analysis will be performed by spss version 28 as follow: Continuous data describe as mean, standard deviation. Nominal data describe as number and frequency. T test will be used for comparing mean. Chi-square used for comparing nominal or ordinal data, Phi test used for comparing 2 dichotomous data. Correlation will be measured by Pearson correlation for continuous data and point biserial for continuous with dichotomous data, phi for 2 binary data and chi-square for multi-nominal data.

Figure (3): Radiological assessment of nail insertion.

3. Results

Operation- injury interval was 8.6 days and 8.85 days in anetgrade and retrograde group respectively. Operation time was 1.85 hours, 1.5 hours in anetgrade and retrograde group respectively. There were no significant differences in operation-injury interval, blood loss, hospitalization time and type of reduction between the 2 groups. There was statistically significant difference in operation time between the 2 groups, **as shown in Table (1)**. There was no statistically significant difference in union between the 2 groups. The union rate was 70 % in antegrade group and 60% in retrograde group. There were 3 patients underwent retrograde group had delayed union fracture. **as shown in Table (2).**

Table (1): Parameters of retrograde and antegrade intramedullary nailing and functional outcome after retrograding and antegrade intramedullary nailing.

	Antegrade nailing (N=10)		Retrograde nailing (N=10)		P-value
Operation-injury interval (days)	8.6±6.4		8.85±7.6		0.510
Operation time (hours)	1.85±.41		1.5±.239		0.018
Blood loss (milliters)	265±81.8		214±67.19		0.165
Hospitalization time (days)	9.9±5.76		7.8±5.55		0.418
	Frequency	Percent	Frequency	Percent	
Type of reduction closed open	6 4	60 40	7 3	70 30	0.639
Full weight bearing time (weeks)	9.3±0.05		11.2±0.33		0.03
Partial weight bearing time (weeks)	6.1±0.02		8.3±.02		0.045
	Frequency	Percent	Frequency	Percent	
Range of motion full ROM limited ROM	9 1	90.0 10.0	5 5	50.0 50.0	0.05

Table (2): Union rate after intramedullary nailing.

Union	Antegrade nailing (N=10)		Retrograde nailing (N=10)		P-value
	Frequency	Percent	Frequency	Percent	
Union	7	70	6	60	0.087
Delayed union	2	20	3	30.0	
Early radiological union features	1	10.0	1	10	

80% of patients in antegrade group was without any intraoperative complications, 10% of patients with Greater tuberosity hairline fracture. While 90% of patients in retrograde group were without any intraoperative complications, 10% of patients with proximal targeting device failure**.** There was no statistically significant difference in intraoperative complications between antegrade and retrograde intramedullary nailing. **as shown in Table (3).** There was no statistically significant difference in the device failure. **as shown in Table (4)**

Table (3): Union rate after intramedullary nailing.

Intra operative complications	Antegrade		Retrograde		
	Frequency	Percent	Frequency	Percent	P-value
Without	8	80.0	9	90.0	0.383
Proximal targeting device failure	0	0	1	10.0	
Lateral entry point	1	10.0	0	0	
Greater tuberosity hairline fracture	1	10.0	0	0	

Table (4): Device failure and complications after intramedullary nailing.

	Antegrade		Retrograde		
	Frequency	Percent	Frequency	Percent	P value
Device failure					0.305
No	10	100	9	90	
Distal screw protrusion	0	0	1	10	

There was statistically significant difference in full and partial weight bearing time and range of motion between the 2 groups. Partial weight bearing was 6. 1 weeks and 8.3 weeks in anetgrade and retrograde group respectively. Full weight bearing was 9. 3weeks and 11.2 weeks in anetgrade and retrograde group respectively. Range of motion was full in 90% of antegrade group and in 50% of retrograde group**, as shown in Table (5)**. Regarding site and causes of fractures, there was no statistically significant difference in distribution of range of motion between both groups, **as shown in Table (6)**. There was no correlation between range of motion and site and causes of fractures of included patients. These were precisely represented in figures. There was no correlation between range of motion and age, operation time, operation-injury interval, hospitalization time, partial weight bearing time, full weight bearing time or blood loss **as shown in Table (7).**

Table (5): Functional outcome after retrograde and antegrade intramedullary nailing.

	Antegrade nailing (N=10)		Retrograde nailing (N=10)		P-value
Full weight bearing time (weeks)	9.3±0.05		11.2±0.33		0.03
Partial weight bearing time (weeks)	6.1±0.02		8.3±.02		0.045
	Frequency	Percent	Frequency	Percent	
Range of motion Full ROM Limited ROM	9 1	90.0 10.0	5 5	50.0 50.0	0.05

Table (6): Distribution of range of motion among site and causes of fracture.

	Antegrade nailing			Retrograde nailing		
	Range of motion		P-value	Range of motion		P-value
	Full ROM	Limited ROM		Full ROM	Limited ROM	
Site of fracture Right Left Bilateral (right and left side)	6 2 1	1 0 0	0.788	3 2 0	2 3 0	0.527
Causes of fractures MVA MCA Pedestrian vs MV Falling on ground Falling from height	6 2 1 0 0	1 0 0 0 0	0.788	3 1 0 1 0	1 1 0 2 1	0.517

Table (7): Correlation between range of motion and some parameters.

	Antegrade nailing		Retrograde nailing	
	Point biserial correlation	P-value	Point biserial correlation	P-value
Age	0.509	0.13	0.245	0.495
Operation time (hours)	0.128	0.724	0.440	0.203
Operation-injury interval	0.350	0.322	0.242	0.501
Hospitalization time (days)	-.177	0.625	-.152	0.675
Partial weight bearing time	-.336	0.343	0.094	0.796
Full weight bearing time	-.228	0.526	-.148	0.683
Blood loss (milliters)	-.064	0.860	0.408	0.242

4. Discussion

Intramedullary (IM) nailing has been shown to be a successful treatment option for femoral shaft fractures [9]. Although antegrade nailing is effective for treating proximal femoral fractures, studies have shown that if the patient is in the supine position on a fracture table, it can damage the hip abductors and sometimes the pudendal nerve. Individuals with multiple injuries, ipsilateral femoral neck and shaft fractures, and obese patients have a better chance of treatment by retrograde nailing [10]. The purpose of this study was to assess the functional outcome, union rate, and complications of antegrade and retrograde nailing for distal half of femur fractures.

Our study revealed that, operation- injury interval was 8.6 days and 8.85 days in anetgrade and retrograde group respectively. Operation time was 1.85 hours, 1.5 hours in anetgrade and retrograde group respectively. There was no significant difference in operation-injury interval, blood loss, hospitalization time and type of reduction between the 2 groups. There was statistically significant difference in operation time between the 2 groups

This result was Compared with Pacheco &Alpuerto [11] who found that the average time between operation and discharge in the retrograde group was 11.25 days, while it was 12.3 days in the antegrade group. The average length of hospital admission was 28.17 days for the retrograde group and 27.71 days for the antegrade group. These differences were not statistically significant in either case. Blood loss and the time between injury and surgery had no statistically significant differences.

The difference in operation time may be explained with Tucker et al., [12]. Who found that; in comparison to retrograde nailing, antegrade nailing required significantly higher operational and radiation exposure time in obese patients. The functional outcome of retrograde and antegrade intramedullary nailing in terms of complete and partial weight bearing time and range of motion, there was a statistically significant difference between the two groups. The anetgrade and retrograde groups took 6.1 and 8.3 weeks, respectively, in partial weight bearing. The anetgrade and retrograde groups, respectively, took 9.3 and 11.2 weeks to reach full weight bearing.

Range of motion was full in 90% of antegrade group and in 50% of retrograde group. There was no statistically significant difference in distribution of range of motion between both groups regarding site of fracture, causes of fractures, union, device failure or different complications or pain. In retrograde nailing, there was a positive correlation between range of motion and type of reduction. This result is in agreement with Murray et al., [13], who found that the retrograde group's knee scores and range of motion (ROM) were even worse. Njoroge et al., [14] revealed that the retrograde group had poorer results than antegrade group ($p<0.001$).

Herrera et al., [8] indicated that anterograde nailing has proved to be a better surgical choice, being an appropriate indication in supracondylar femur fractures, with evident benefits over retrograde nailing, providing significant stabilization and allowing for fracture healing.

In contrast to our results, Hussain et al. [15] operated a meta-analysis study and found no significant differences in functional results.

Knee motion was 120 degrees in all but one knee in each group. The antegrade nailed femurs healed faster than those treated retrograde (A = 14.4, R = 18.1 weeks, p = 0.0496). More patients required dynamization for union in the retrograde insertion group (17 percent versus 5 percent, p = 0.10, NS) [16].

This result may be justified with Herrera et al., [8] who have shown improved biomechanical characteristics for anterograde nails, resulting in higher global stability, less stresses in screws, and Lower stress concentration in cortical bone. In accordance with our result, Yu et al., [17] found that both groups of patients eventually achieved union of the fracture and retrograde nailing group showed significantly earlier union rate (p = 0.032). All fractures in both groups healed and there was no difference in the time taken to achieve union [18].

Our study showed that hip pain occurred in 4 patients (40%) after antegrade nailing. knee pain occurred in 3 patients (30%) after retrograde nailing. there was statistically significant difference in hip and knee pain between the 2 groups. Similar to our result, Njoroge et al., [14] revealed that the incidence of knee pain was higher in the retrograde group (37.5%) as compared to 10% in the Antegrade group.

Hussain et al., [15] revealed that retrograde nailing had a greater risk of postoperative knee pain than antegrade nailing ($p = 0.05$). On the other hand, antegrade nailing had significantly more postoperative hip pain ($p = 0.003$) and heterotopic ossification ($p < 0.001$) than retrograde nailing.

There were more complications related to the knee after retrograde nailing and more complications related to the hip after antegrade nailing [19].

Regarding arthritic pain and pain at fracture site, there was no statistically significant difference in arthritic pain or pain at fracture site between both groups. Murray et al., [13] reported that the knee injury and osteoarthritis Outcome Scores were significantly worse (p = 0.005) in the retrograde group.

Regarding baseline characters of included patients, there was no statistically significant difference in distribution of range of motion. There was no correlation between range of motion and age, operation time, operation-injury interval, hospitalization time, partial weight bearing time, full weight bearing time or blood loss. In contrast to our result, Daglar et al., [20] revealed that Knee function seems to have similar clinical results after either antegrade or retrograde nail insertion for femoral diaphyseal fractures when knee range of motion, Lysholm Scores, and isokinetic knee evaluation are considered as outcome measures. With increasing patient age, a decrease in knee functioning should be anticipated in patients with femoral fractures treated with intramedullary nails regardless of technique. Njoroge et al., [14] revealed that there was a negative correlation between age and the functional outcome in the retrograde group (p < .001).

5. Conclusion

The operation time was longer in antegrade nailing than retrograde nailing. The antegrade nailing was better than retrograde nailing regarding functional outcome in distal half of femur fractures

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