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Functional outcomes of periprosthetic and non-periprosthetic distal femur fractures: a comparative study

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ABSTRACT

Aim: The purpose of this study was to compare the outcomes of locked plating in closed distal femur periprosthetic, and non-periprosthetic fractures. We hypothesized that the outcomes would be superior in the non-periprosthetic distal femur fracture group.

Material and Method: Patients who underwent surgery for distal femur fractures between January 2019 and January 2022 were retrospectively reviewed. Patients aged under 18 years, who had multiple fractures, pathological fractures, follow-up less than 6 months, previous history of revision knee arthroplasty, interprosthetic fractures between hip and knee arthroplasties, fixation performed other than distal locking femoral plate and intra-operative periprosthetic fractures were excluded. Patients' age, gender, laterality, length of hospital stay, and follow-up duration were obtained from hospital registry notes. Fractures were classified using the AO classification system. At the last follow-up, visual analogue scale (VAS), Tegner activity score, Lysholm knee score, and short form 36 (SF-36) scores were noted.

Results: A total of 30 patients met the inclusion criteria and were included in the study. There were 14 patients in the non-periprosthetic fracture group and 16 patients in the periprosthetic fracture group. The periprosthetic group had significantly lower mean VAS score (p=0.047), Tegner activity score (p=0.015), and Lysholm knee score (p=0.034) than the non-periprosthetic group. The periprosthetic fracture group had significantly inferior quality of life scores compared to non-periprosthetic groups based on SF-36 sub-parameters.

Conclusion: Periprosthetic distal femoral fractures have inferior clinical outcomes and quality of life than non-periprosthetic fractures despite having similar fracture healing rate. Orthopaedic surgeons should be aware of the frailty of the patients caused by prior total knee arthroplasty surgery.

Keywords: Distal femur fracture, periprosthetic fracture, total knee arthroplasty, locking plate fixation, non-union

INTRODUCTION

Distal femur fractures account for less than 1% of all fractures. These fractures commonly occur secondary to high-energy trauma in young adults or low-energy trauma in the elderly. In addition, distal femur fractures in patients aged above 35 years of age are associated with generalized osteopenia or localized osteopenia around fracture (1,2). The number of periprosthetic distal femur fractures is increasing due to the high volume of primary knee arthroplasty performed. The reported incidence of these fractures ranges between 0.3% and 5.5% (3). The patient population of periprosthetic fractures and non-periprosthetic fractures after low-energy trauma generally have similar demographic characteristics (4,5).

Locking plates have become the primary treatment choice in both non-periprosthetic and periprosthetic distal femur fractures, with contemporary improvements in locking plate designs allowing minimally invasive fixation options. Locking plates designed in accordance with distal femur anatomy, brought the advantage of indirect reduction of the fracture during surgery, in addition to the improved bone-implant surface congruity. As these locking plates have anatomical design and are not suitable for bending, in the instances of femoral deformity, locking plates may not match the surface anatomy(6, 7).

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Although non-periprosthetic and low energy periprosthetic fractures have similar patient demographics, only a limited number of comparative analyses of functional healing and quality of life are available on either fracture type. In this study, we aimed to compare the clinical and radiographic outcomes of patients with non-periprosthetic, and periprosthetic distal femur fractures treated with locking plates.

MATERIAL AND METHOD

The study was carried out with the permission of Karabük University Clinical Researches Ethics Committee (Date: 13.12.2022, Decision No: 2022/1203). 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 who underwent surgery for distal femur fractures between January 2019 and January 2022 were retrospectively reviewed after local ethics committee approval. Patients aged under 18 years, who had multiple fractures, pathological fractures, follow-up less than 6 months, previous history of revision knee arthroplasty, interprosthetic fractures between hip and knee arthroplasties, fixation performed other than distal locking femoral plate and intra-operative periprosthetic fractures were excluded. Patents with a periprosthetic fracture and requiring revision knee arthroplasty due to implant loosening were also excluded. Patients with periprosthetic fractures after primary total knee arthroplasty and primary distal femur fractures were included in the study (**Figure 1**).

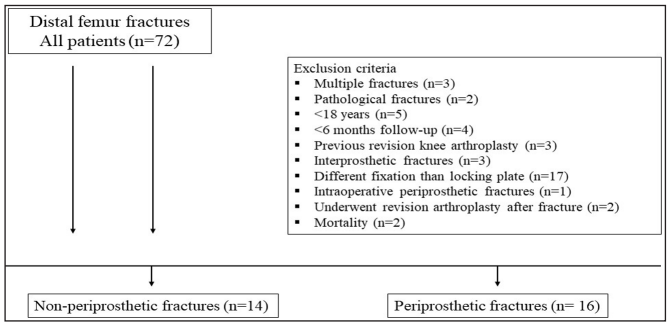

Figure 1. Flowchart of the included patients

Patients' age, gender, laterality, length of hospital stay, and follow-up duration were obtained from hospital registry notes. Fractures were classified using the AO classification system. At the latest follow-up, visual analogue scale (VAS), Tegner activity score, Lysholm knee score, and short form 36 (SF-36) scores were noted. Three bridging cortices in anteroposterior and lateral radiographs are considered as a bony union. Fractures that do not demonstrate three bony bridging cortices in AP and lateral radiograph at 6 months are considered as non-union. Complications were recorded. Patients were divided into two groups: the non-periprosthetic group (**Figure 2**) and the periprosthetic group (**Figure 3**). Groups were compared based on demographics, functional outcomes, quality of life parameters, and complication rates.

Figure 2. Anteroposterior (A) and lateral (B) radiographs of a 45-year-old male patient with a distal femur fracture treated with less invasive stabilization system plate (C). Anteroposterior (D) and lateral (E) radiographs demonstrating fracture healing.

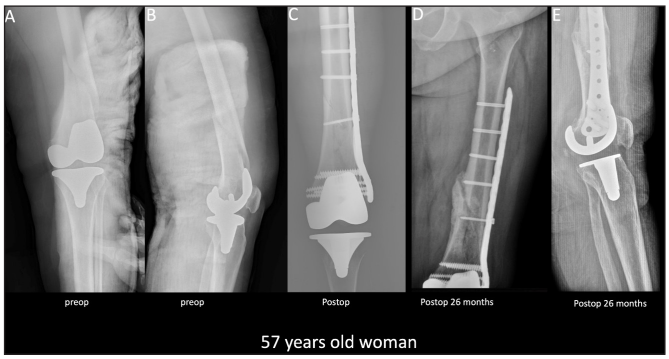

Figure 3. Anteroposterior (A) and lateral (B) radiographs of a 57-year-old female patient with a periprosthetic distal femur fracture treated with less invasive stabilization system plate (C). Anteroposterior (D) and lateral (E) radiographs demonstrating fracture healing.

Descriptive statistics were expressed as mean±standard deviation for continuous numerical variables, categorical variables were expressed as the number of patients and percentage. Distribution of variables was measured with the Kolmogorov-Smirnov test. Statistical analysis was performed for continuous variables with student t-test and Mann Whitney-U test when appropriate. Categorical variables were compared with Pearson Chi-square test. Analyses of the data were performed using the IBM SPSS Statistics 23.0 (IBM Corporation, Armonk, NY, USA) program. The results were considered statistically significant when the p-value was <0.05.

RESULTS

A total of 30 patients met the inclusion criteria and were included in the study. There were 14 patients in the non-periprosthetic group and 16 patients in the periprosthetic group. Other than periprosthetic group having more female patients (p=0.010), there were no statistically significant differences in demographic parameters between the groups (**Table 1**). Of the 14 non-periprosthetic fractures, 4 were AO 33A2, 2 were AO 33A3, 4 were AO 33B1, 1 was AO33B2, and 3 were AO 33C2 fractures. Of the 16 periprosthetic fractures, 13 were AO 33A2 and 3 were AO 33A3 fractures.

Table 1. Demographics of the patients.

	Non-periprosthetic group (n=14)	Periprosthetic group (n=16)	P value
Age	65.8±13.4	71.0±8.7	0.294
Gender (M/F)	8/6	2/14	0.010
Side (R/L)	7/7	6/10	0.491
Mean length of stay (days)	3.0±1.9	5.4±5.1	0.257
Mean time to union (months)	5.3±0.6	5.6±0.4	0.316
Mean follow-up (months)	21.0±8.6	21.3±13.3	0.984

(M: male, F: female, R: right, L: left)

The mean time to union and length of stay was similar between the groups (**Table 1**). The periprosthetic group had significantly lower mean VAS score (p=0.047), Tegner activity score (p=0.015), and Lysholm knee score (p=0.034) than the non-periprosthetic group. The periprosthetic group had significantly inferior quality of life scores compared to non-periprosthetic groups based on SF-36 sub-parameters (**Table 2**).

Table 2. Comparison of non-periprosthetic group and periprosthetic group on clinical parameters

	Non-periprosthetic group (n=14)	Periprosthetic group (n=16)	P value
Mean VAS score	1.4±1.3	3.3±2.6	0.047
Mean Tegner activity score	2.7±1.6	1.3±1.4	0.015
Mean Lysholm knee score	74.2±22.4	63.9±16.9	0.034
Mean SF-36 scores			
Physical functioning	58.5±35.5	15.6±24.4	0.001
Role limitation due to physical health	62.5±48.7	13.7±31.2	0.013
Role limitation due to emotional problems	61.9±48.6	13.7±32.2	0.022
Energy/fatigue	58.5±25.4	42.5±23.8	0.047
Emotional well-being	64.8±23.9	57.5±12.8	0.224
Social functioning	61.6±31.9	30.4±26.6	0.017
Pain	70.8±21.6	46.8±24.4	0.009
General health	63.5±22.3	34.0±15.8	<0.001

There was one non-union in the non-periprosthetic group. This patient was treated with retrograde intramedullary nailing and an augmentation plate. There was one non-union in the periprosthetic group who underwent surgery with dual plating and iliac crest grafting.

DISCUSSION

Distal femur fractures are challenging injuries due to high non-union rates and relatively unfavourable functional outcomes. There is paucity in the literature in regard to the quality-of-life changes after periprosthetic and non-periprosthetic distal femur fractures. In this study, we compared the clinical outcomes of patients underwent surgery due to both periprosthetic and non-periprosthetic distal femur fractures. We showed that the periprosthetic group had inferior functional outcomes and lower quality of life despite being treated with the same surgical approach utilizing locking plates.

Distal femur fractures are more common in female patients. In the present study, periprosthetic fractures were observed more in female patients, in line with the literature, however non-periprosthetic group had a more even gender distribution. We suspect this difference between the groups may have been caused by the low number of patients. In addition, the mean age of both groups were above 65, consistent with previous literature (8).

Poor bone quality at distal femoral region is one of the obstacles in the treatment of distal femur fractures. Although it is known that, locking plates are biomechanically advantageous to non-locking plates on osteoporotic bone, there are several studies pointing at the poor outcomes related to their use (9). These unfavorable outcomes can be attributed to wide facture gap and increased stiffness leading to delayed union or non-union (10). Furthermore, implant related complications has also been reported with use of locking plates (11). A meta-analysis done by Hendersen et al. (12) showed complication rates can reach up to 32% with locking plates including nonunion, delayed union, or implant failure. In a comparative study assessing the outcomes of locking versus non-locking plates in the treatment of periprosthetic fractures, non-locking plates showed inferior clinical outcomes, higher incidence of varus collapse, and earlier micromotion at the fracture (13-15). In current study, locking plates were used with minimally invasive percutaneous plate osteosynthesis (MIPPO) technique with locking and non-locking screws, given the theoretical advantages. Both periprosthetic and non-periprosthetic groups had comparable union rates (93.75% and 92.9%, respectively). There were no implant failure or reduction loss, and only one nonunion occurred in either groups. The high union, low complication rates could be attributed to the MIPPO technique preserving the soft tissues, maintaining the fracture gap below 1 mm, and establishment of dynamic osteosynthesis with locking plates.

There is controversy in the literature regarding the outcomes following the treatment of periprosthetic and non-periprosthetic fractures. Patients with periprosthetic fractures are believed to be frailer than with non-periprosthetic fractures. Therefore, periprosthetic fractures can be expected to have inferior outcomes than non-periprosthetic fractures. On the other hand, fixation of both periprosthetic and non-periprosthetic fractures are reported to have similar outcomes (4, 16). Our results show that, although

union rates and mean time to union were similar, periprosthetic group had significantly lower functional outcomes. It can be speculated that previous total knee arthroplasty is associated with frailty in patients, despite having similar fracture healing rates.

Arthroplasty is an option in the setting of a distal femur fracture. Relatively higher dissatisfaction and complication rate of fixation of these fractures influence the choice of arthroplasty. The advantages of the use of arthroplasty include immediate weight bearing and lack of non-union problem after surgery. However, the risk of infection and high cost are also disadvantages that should be considered (19, 20). Due to the possible lower functional outcomes after treatment with osteosynthesis of periprosthetic fractures, distal femoral arthroplasty may be a promising alternative option in these fractures (21).

Hintedra et al. (22) showed satisfactory functional outcomes in 24 elderly patients undergoing fixation with distal locking plates secondary to distal femur fractures, supported by our results for the non-periprosthetic group. However, there are several studies showing unfavorable outcomes with internal fixation in the treatment of elderly distal femur fractures (23,24). Hoffman et al. (25) stated that successful bone healing was achieved with locking plates in 36 patients with periprosthetic fractures but two thirds of the patients needed an ambulatory aid device in long term. In another study, results of distal femur fractures treated with locking plates by MIPPO technique was evaluated and age groups was compared. Patients younger than 35 years had excellent outcomes, while good results in between 35 and 50 year old group and only moderate and poor results in the patients aged above 50 group were reported (26). In contrast, study by Schütz et al. (27) evaluating the effect of fracture type, age, mechanism of injury, reduction technique and soft tissue injury on the outcomes of distal femur fractures failed to reveal any correlation. In the present study, periprosthetic group had lower functional outcomes parallel to the study done by Hoffman et al. (25) Older age, comorbidities, a secondary major surgery after total knee arthroplasty could be the factors compromising the mobility and functional capacity of the patients thereby decreasing the functional outcomes.

There are several limitations of this study. It has the disadvantage of its retrospective design and limited patient population. Moreover, it is a single centre study therefore the outcomes may not be generalized to the entire population. A study with a longer follow-up would be beneficial.

CONCLUSION

The results of this study suggest that periprosthetic distal femoral fractures have inferior clinical outcomes and quality of life than non-periprosthetic fractures despite having similar fracture healing rate. Orthopaedic surgeons should be aware of the frailty of the patients caused by prior total knee arthroplasty surgery.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Karabük University Clinical Researches Ethics Committee (Date: 13.12.2022, Decision No: 2022/1203).

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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