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Original Research

Clinical and radiological outcomes of double plating in periprosthetic distal femur fractures after total knee arthroplasty

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Abstract

Aim: Periprosthetic distal femur fractures (PDFF) are challenging injuries, particularly in elderly patients with osteoporotic bone. Double plating has emerged as a fixation strategy; however, its clinical value remains incompletely defined. This study aimed to describe the surgical technique and evaluate the clinical outcomes of double plating in PDFF.

Methods: Twelve consecutive patients treated with double plating for PDFF between 2021 and 2025 were retrospectively reviewed. Demographic data, arbeitsgemeinschaft für osteosynthesefragen (AO) and Su classifications, type of secondary plate, follow-up duration, union status, and revision requirements were analyzed. All patients were female, with a mean age of 80.3 years (63–91). According to AO classification, six fractures were 33A2 and six were 33A3. Based on Su's classification, two were Type 1 and ten were Type 2. A lateral distal femur anatomical locking plate was used in all cases, combined with various medial or supplementary plates. The mean follow-up was 10.9 months (3–17).

Results: Union was achieved in 11 patients without additional surgery. One patient developed nonunion with implant failure and underwent revision osteosynthesis, achieving union at final follow-up. Overall, fracture healing was achieved in all patients. One patient required outpatient debridement and oral antibiotics for wound complications. All patients regained independent mobilization postoperatively.

Conclusion: In elderly patients with osteoporotic bone, single-plate fixation may be insufficient for PDFF. Double plating provided stable fixation, high union rates, and acceptable complication rates, representing a reliable treatment option with appropriate patient selection and surgical technique.

Keywords

periprosthetic fractures, distal femur, arthroplasty, osteosynthesis

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Introduction

With the aging global population, the number of patients undergoing arthroplasty due to osteoarthritis is increasing, and consequently, the frequency of complications related to arthroplasty is also increasing. Similarly, distal femur fractures after total knee arthroplasty are becoming more common among orthopedic surgeons. Periprosthetic distal femur fracture (PDFF), similar to hip fractures, has very limited conservative treatment options and is generally treated surgically.[1,2] Suitable surgical treatment options include revision arthroplasty and osteosynthesis with plates. However, debate continues as to which is the gold standard.[3-5]

The high incidence of comorbidities and heterogeneity in the geriatric patient population make the choice of surgical treatment for these fractures difficult. While revision arthroplasty offers advantages such as early postoperative weight-bearing and the absence of complications like nonunion, it also has disadvantages such as reduced bone stock, increased likelihood of a second revision surgery, infection, and the high cost of implants. Osteosynthesis after fracture fixation represents a more natural process compared to arthroplasty. Given the numerous disadvantages present in this patient group, ensuring adequate and reliable stabilization in osteosynthesis procedures is critically important. Stabilization is a fundamental aspect of orthopedics, and research in this area remains current and intensive.[6] Osteosynthesis treatment preserves bone stock, saving the alternative treatment option of revision arthroplasty for later stages, and is also less costly. However, complications such as implant failure, nonunion, and infection are negative aspects of this treatment option.

Osteosynthesis treatment options include intramedullary nails and plates. In cases where the fracture line in the distal femur is distal, or there is a stemmed or solid boxed femoral component, fixation is achieved with a plate instead of an intramedullary nail. Fracture stabilization with a single locking plate from the lateral femur can sometimes lead to fracture non-union. In patients of this age, poor bone quality, extension of the fracture line towards the metaphysis, and varus tendency of the fracture due to comminution in the medial condyle of the distal femur are the main reasons.[7] Dual plating provides stable fixation by converting biomechanically disadvantageous cantilever loading into axial forces; therefore, in selected cases with relevant risk factors, it can be used as a reliable alternative to directly resorting to distal femur replacement.[8] There are a limited number of studies and insufficient patient outcomes in the literature regarding dual plating application in periprosthetic fractures of the distal femur. Therefore, the aim of our study is to contribute to this knowledge gap in the literature by evaluating the clinical and radiological results of this surgical approach.

Materials and Methods

This retrospective study included 12 consecutive patients who underwent double plate osteosynthesis for PDFF at a single tertiary orthopedic trauma center between 2021 and 2025. Patients who had previously undergone total knee arthroplasty (TDA) and were found to have periprosthetic fractures in the distal femur of the affected joint were included in the study. All operations included in the study were performed by orthopedic surgeons with at least 5 years of experience. Exclusion criteria included open fractures, pathological fractures, infected TDA, periprosthetic fractures requiring distal femoral replacement (DFR), and insufficient follow-up (<3 months). Demographic characteristics, fracture classification, medial condyle implant placement options, union status, and complications were collected from medical records and imaging archives.

Fracture Classification

All fractures were classified by two independent orthopedic surgeons using the arbeitsgemeinschaft für osteosynthesefragen (AO)/Orthopaedic Trauma Association (OTA) and Su classification systems. According to the AO/OTA classification, fractures were categorized as 33A1–A3. The Su classification was used to determine the relationship of the fracture to the femoral component.

Preoperative Planning

Due to the equal effect of muscle tone in the knee and thigh on fracture reduction and the high comorbidity rate in the geriatric population, spinal anesthesia was applied to all patients. Patients who underwent general anesthesia were excluded from the study. All patients were provided with necessary intraoperative imaging using radiolucent tables, ensuring visualization of the entire knee joint from the femoral head. A tourniquet was not used to extend the old incision scar from previous knee arthroplasty more proximally and to allow for percutaneous screw fixation of the fracture if necessary. All patients received a standard three-dose antibiotic regimen for perioperative prophylaxis.

Another important point in preoperative planning is plate selection. In all patients, a LISS (Less Invasive Stabilization System) plate was used on the lateral side of the femur, while a medial-distal specific plate was not always available (Figure 1). Therefore, the use of plates suitable for the unique contour of the distal medial condyle of the femur was left to the surgeon's discretion, and the use of a plate bending tool was permitted if necessary.

Due to the limited number of patients in the postoperative period, a standard rehabilitation protocol was not applied; full weight-bearing permission was individualized according to the surgeon's clinical assessment and preference.

Surgical Technique

In all our patients, since a medial parapatellar approach was used in their previous operations, an extended medial parapatellar approach was used for fracture osteosynthesis, extending this approach more proximally. The GMPP approach was preferred because it allows for the use of revision arthroplasty in cases where fracture healing with osteosynthesis is doubtful, and because

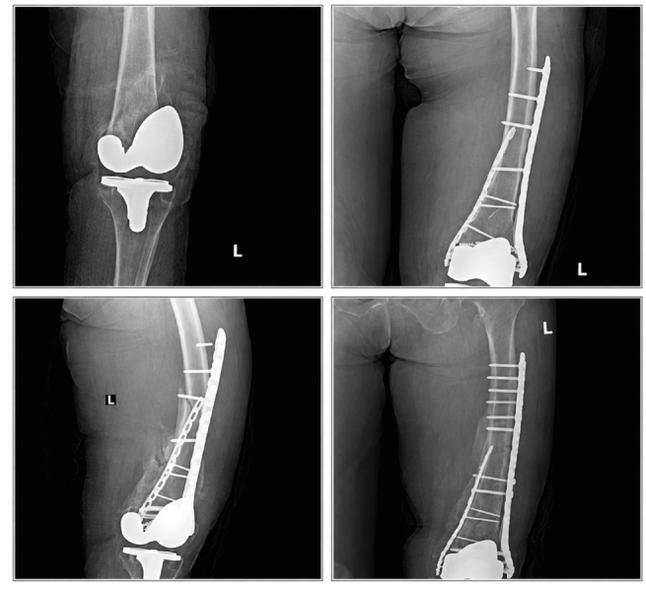


Figure 1. *Representative Radiographs of Double-Plate Fixation For a Periprosthetic Distal Femur Fracture After Total Knee Arthroplasty*

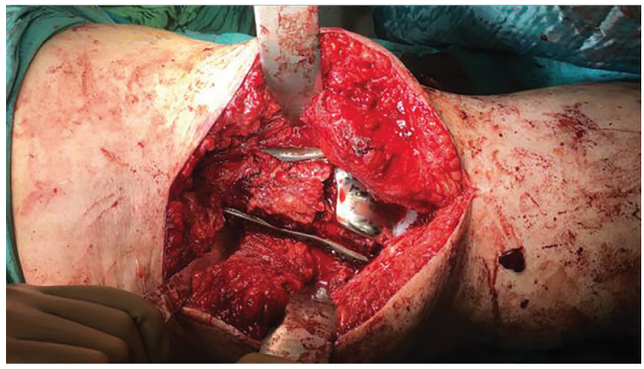


Figure 2. *Intraoperative View of Double-Plate Osteosynthesis for a Periprosthetic Distal Femur Fracture*

the risk of patellar blood flow impairment is lower with the LPP approach in patients who previously underwent the MPP approach.

Due to previous primary arthroplasty, an incision was made through the old midline scar tissue anterior to the knee, and this incision was extended 5 cm proximally if necessary, according to the fracture pattern. A standard capsulotomy was performed using the MPP approach. Proximal to the capsulotomy, the fat strip between the rectus femoris and vastus medialis muscles was identified. This strip was dissected with dissection scissors to reach the aponeurotic fascia over the rectus femoris, and this fascia was elevated and protected. Then, to advance the capsulotomy proximally, the vastus medialis muscle fibers were lifted from where they attach to the rectus femoris. Placing marker sutures here will assist the surgeon during closure. Next, the vastus intermedius muscle fibers under the rectus femoris will be reached, and these fibers will be incised longitudinally to reach the distal femur.

This approach provides good visibility for fracture reduction and facilitates the use of a second plate and cable in the medial condyle, although lateral plate placement presents difficulties due to the patella and exostosis mechanism. Furthermore, in cases where a long lateral plate is required, an intra-incisional window can be created percutaneously in the lateral retinaculum using a plate guide for the proximal screws. After lateral plate placement, the medial plate is chosen based on the specific structure of the distal femoral medial condyle, thereby enhancing fracture stabilization.

Postoperative Follow-up

Postoperative mobilization protocols varied among patients due to advanced age and comorbidities. Weight-bearing was permitted at the surgeon's discretion, without a standard protocol. Clinical and radiographic follow-up assessments were performed at regular intervals (3-6 weeks, 3 months, 6 months, and final follow-up). Radiographic union was defined as bridging callus in at least three of the four cortices in anteroposterior and lateral views.

Outcome Criteria

The primary outcome was radiographic bone union. Secondary outcomes included implant-related complications, wound complications, need for revision surgery, and postoperative outpatient status. Follow-up periods, union times, and revision requirements were systematically recorded.

Ethical Approval

This study was approved by the Ethics Committee of Konya City Hospital (Date: 12.08.2025, Decision No: 2025/241).

Statistical Analysis

Given the retrospective design and small sample size, the study was primarily descriptive in nature. Continuous variables, including age and follow-up duration, were summarized using mean, standard deviation, and range values. Categorical variables, such as fracture classification, union status, and complication rates, were presented as frequencies and percentages.

The primary outcome was radiographic union rate, calculated as the proportion of patients achieving bone union during follow-up. Secondary outcomes, including implant-related complications, wound complications, and revision surgery rate, were also analyzed descriptively.

Due to the limited number of patients and absence of a comparison group, no formal inferential statistical tests were performed. The analysis aimed to provide an observational evaluation of clinical and radiological outcomes in this consecutive case series.

Reporting Guidelines

This study was reported in accordance with the STROBE statement.

Results

A total of 12 patients who underwent double plate osteosynthesis for periprosthetic distal femur fractures were evaluated. The mean age was 80.3 years (range 63-91), and all patients were female. According to the AO/OTA classification, six fractures were classified as 33A2 and six as 33A3. According to the SU classification, 10 patients were classified as Type 2 and two as Type 1; no Type 3 fractures were observed. The mean follow-up period was 10.9 months (range 3-17 months). Radiographic union was achieved in 11 out of 12 patients (91.7%) without the need for additional intervention.

In one patient, implant failure developed due to non-union during follow-up, and revision plate-screw osteosynthesis was performed. Successful union was observed in this patient's subsequent follow-up, and a 100% final union rate was achieved in the cohort. Representative images from the revision case are shown in Figure 2. One patient experienced a superficial wound complication and was successfully treated in an outpatient setting with local debridement and oral antibiotics without requiring surgical revision. No deep infection, thromboembolic events, or implant removal were observed during the follow-up period. Regarding implant structures, all fractures were stabilized laterally with an anatomical lateral distal femur locking plate, while the second (medial or anteromedial) plate varied among reconstruction plates, PHILOS plates, medial plateau plates, distal femur plates, and dynamic compression plate (DCP) plates. No mechanical complications related to the structure were detected except for a single implant failure case. All patients regained unsupported walking postoperatively. Overall, double plating provided stable fixation, allowing fracture healing in all cases, with a low complication profile and no mortality observed during the follow-up period.

Discussion

Our study presents the clinical outcomes of the double plating technique in the treatment of PDFF, offering significant contributions to the literature on this method, which has been reported in limited numbers. Considering advanced age, osteoporotic bone quality, and the biomechanical challenges of fractures occurring after total knee arthroplasty (TKA), unilateral plating often fails to provide sufficient stability and can result in complications such as implant failure, nonunion, or malalignment.[9,10] The double plating approach applied in our study created a more rigid structure by supporting both the medial and lateral columns, and union was achieved in all

patients.

The literature reports that double plating increases load sharing and reduces flexural moment, especially in osteoporotic or multi-fragment fracture cases.[11-13] Several biomechanical studies have highlighted that dual plating reduces the cantilever effect, distributing the load evenly between the two columns and thus minimizing the risk of implant failure.[14,15] In our series, implant failure was observed in only one patient, and union was achieved after revision. This finding indicates the potential for increased union rates in PDFF by providing more biomechanically stable fixation with the dual plating technique.

The fact that all of our patients were female and had a relatively high average age (80.3 years) is consistent with the typical demographic characteristics of this fracture group.[16-18] In particular, the presence of multiple fragments and loss of medial support in 33A2–A3 fractures makes unilateral plating risky. In our study, supporting the medial column with different plate types while preserving vascular structures increased fixation stability and enabled early mobilization. The fact that all patients achieved unsupported mobilization in the postoperative period demonstrates the success of the technique in terms of functional recovery.

Although fracture healing is a multi-stage and biologically highly complex process, and research in this area is still ongoing, the more complex clinical picture of PDFF compared to standard fractures poses significant challenges for orthopedic surgeons.[19-21] There is no consensus in the literature regarding the gold standard treatment for periprostatic fractures after TDA.[22,23] In particular, in cases with comminuted osteoarthritis, impaired medial support, and osteoporosis, retrograde intramedullary nailing does not always provide sufficient stability; unilateral plating, on the other hand, may be prone to varus collapse.[9,24] Therefore, double plaque placement is increasingly preferred in selected cases.[15,25] The low infection rate and the presence of only one superficial wound problem in our study demonstrate that the method offers an acceptable profile in terms of soft tissue.

Limitations

The most important strength of this study is that all cases were treated with a similar technique by the same surgical team, and regular follow-ups were performed. However, the study has some limitations. Firstly, the small number of cases, the retrospective design, and the lack of evaluation of functional scores limit the generalizability of the results. In addition, the use of different types of second plates makes it difficult to make biomechanical comparisons. Prospective studies with larger series will more clearly reveal the standard indications for double plating.

Conclusion

In conclusion, our study shows that the double plating technique is a preferable option in PDFF. Simultaneous support of the medial and lateral columns facilitates union, reduces the risk of implant failure, and enables early mobilization. With appropriate patient selection and correct plate combinations, double plating should be considered a strong alternative in the treatment of PDFF.

Declarations

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.

Informed Consent

Due to the retrospective design of the study and the use of anonymized clinical data, the requirement for written informed consent was waived by the ethics committee.

Data Availability

The datasets used and/or analyzed during the current study are not publicly available due to patient privacy reasons but are available from the corresponding author on reasonable request.

Conflict of Interest

The authors declare that there is no conflict of interest.

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Author Contributions (CRediT Taxonomy)

Conceptualization: N.M.
Methodology: A.F.Ç.
Software: C.E.G.
Validation: V.T.
Formal Analysis: N.M.
Resources: N.M.
Data Curation: N.M. Writing - Orginal Draft: A.Y.
Writing – Review & Editing: A.Y.
Visualization: A.Y.
Supervision: A.Y.
Project Administration: A.Y.
All authors have read and approved the final manuscript.

Abbreviations

AO: Arbeitsgemeinschaft für osteosynthesefragen
DCP: Dynamic compression plate
DFR: Distal femoral replacement
GMPP: Extended medial parapatellar approach
LISS: Less invasive stabilization system
LPP: Lateral parapatellar
MPP: Medial parapatellar
OTA: Orthopaedic trauma association
PDFF: Periprosthetic distal femur fracture
TDA: Total knee arthroplasty
TKA: Total knee arthroplasty

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