BENHA MEDICAL JOURNAL bmj

Print ISSN 1110-208X.

Online ISSN 2357-0016

Original article

Dual Plate Fixation of Distal Femoral Fracture

Wael A.Kandel, Mohamed G.Ibrahim, Mohamed A. Abd Elbaky

Orthopedic Surgery Department, Faculty of Medicine Benha University, Egypt.

Corresponding to:
Dr. Mohamed G.Ibrahim.
Orthopedic Surgery Department, Faculty of Medicine Benha University, Egypt. Email: netito142000@gmail.com

Received:

Accepted:

Abstract:

Background: Supracondylar femur fractures are commonly associated with severe comminution and significant soft tissue injury. This study aimed to evaluate the clinical results of the dual plate fixation in treatment of distal femoral fractures. **Methods:** This prospective analytic study was conducted on 24 patients suffering from distal femoral fractures admitted at Benha University Hospital and El-Ahrar Teaching Hospital, Orthopedic Surgery Department. Preoperative preparation included full history taking, full examination and full radiological assessment by pelvis AP view, femur AP and lateral views and knee AP and lateral views. Then, the patient was positioned supine on a radiolucent orthopedic table under fluoroscopy imaging and open reduction internal fixation was performed using dual plate. Results: Regarding knee range of movement, it was > 100° in 54.2%, 90 -100° in 37.5%, and < 90° in only 8%. The mean Oxford knee score was 39 ± 5. Regarding complications, only 16.7% had infection. No failure or revision was reported. The Oxford knee score showed significant negative correlations with age and post-operative hospital stay. Also, Oxford knee score was significantly higher in those with high energy trauma than those with low energy trauma. **Conclusion:** Distal femoral fractures are a source of considerable morbidity. MIPO with the dual plate technique can provide rigid fixation for osteoporotic distal femur fractures. This stable and rigid fixation may allow early mobilization and return to pre-fracture activity.

Keywords: Dual Plate; Fixation; Distal Femoral; Fracture

Introduction

Distal femur fractures include fractures of the supracondylar and intercondylar region and are relatively common injuries. The clinical evaluation usually manifests as severe pain about the thigh and knee. Patients typically present with an inability to weight bear on the affected extremity [(1)].

Definitive management of distal femoral fractures requires maintenance or restoration of distal femoral alignment to preserve the function of the extremity. Coronal plane alignment has been shown to be the most difficult factor to control and the most crucial to overall outcome. Posttraumatic arthritis has been reported to develop in fractures that heal with >15° of valgus or any degree of varus at the knee. Surgical fixation has consistently demonstrated better outcomes than has nonsurgical management, including improved alignment, union, knee motion, and functional outcome [(2)].

The application of the dual (medial and lateral) plate augments fixation stability, increases graft impaction, and encourages early rehabilitation without a loss of reduction in the distal femur fracture [(3)]. Lim et al. [(4)] concluded that MIPO with the dual plate technique can provide rigid fixation for osteoporotic distal femur fractures. This stable and rigid fixation may allow early mobilization and return to pre-fracture activity.

The present study aimed to evaluate the clinical results of the dual plate fixation in treatment of distal femoral fractures.

Patients and Methods

This prospective analytic study was conducted on patients admitted at Banha University Hospital and El-Ahrar Teaching Hospital, Orthopedic Surgery Department in which 24 patients were selected of those whom suffering from distal femoral fractures. The study was done over a period of one year from January 2022 to January 2023.

The study was done after being approved by the institutional ethical committee and informed consent was obtained from all participants included.

Sample size: 24 cases (all cases were managed by dual plate fixation of distal femoral fractures; they all were taken as a comprehensive sample.

Inclusion criteria were skeletally mature patients, and type A3, C3 according to AO/OTA classification.

Exclusion criteria were skeletally immature patients, all open fractures, per-prosthetic supracondylar femur fracture and pathological fractures.

Twenty-four patients fitting the inclusion criteria were admitted from the emergency department after the necessary preoperative clinical, radiological and first aid management according to advanced trauma life support protocol for trauma patients. Preoperative preparation included full history taking, full examination and informed consent, besides full radiological assessment by pelvis AP view, femur AP and lateral views and knee AP and lateral views. Preoperative full laboratory examinations were done (CBC, liver function, renal function, bleeding profile, random blood sugar, ECG and echo if needed).

Operative details: All surgeries were accomplished under spinal/epidural or general anesthesia.

Position: The patient was positioned supine on a radiolucent orthopedic table under fluoroscopy imaging and open reduction internal fixation will be performed using dual plate.

Possible risks: 1- Nonunion, 2- Malunion, 3- Infection, 4- Knee pain.

Primary outcome: Function outcome was assessed by using Neers score, Operative time, Union by X ray, Time of union.

Secondary outcome: Intra-operative blood loss, Intra-operative blood transfusion, Infection, and DVT.

Preoperative preparation: Long leg splint was applied, Suitable analgesic to control pain, Low molecular weight heparin (Enoxaparin 40 IU subcutaneous) was allowed at regular interval, stopped 12-24 hours pre-operative then re-managed 12 hours after medical procedure as prophylaxis against DVT.

Position: The patient was positioned supine on a radiolucent orthopedic table under fluoroscopy imaging and open reduction internal fixation was performed using dual plate.

Surgical procedure through median parapatellar approach: All procedures were carried out under combined spinal and epidural anesthesia without the use of tourniquet. With the patient lying supine, the affected knee was flexed to 90° by supporting it inferiorly. A longitudinal straight parapatellar incision was utilized. Superficial dissection was carried out between vastusmedialis (VM) and rectus femoris through the quadriceps tendon leaving a thin tendinous cuff for repair to VM and along medial patella and patellar tendon. The synovium was then incised in line with the capsular incision, and hematoma was washed out. Then, the patella was dislocated laterally and flex knee to 90°. This surgical plane was safely extended between aponeurosis of rectus femoris and vastusintermedius muscles on the lateral side and vastusmedialis muscle on the medial side till full exposure of the fracture segments.

The joint was thoroughly inspected to evaluate the severity of the injury and degree of intra-articular comminution of the femoral condyles. Reduction in small condylar fragments was made with pointed bone reduction clamps. Then, preliminary wires fixation and cannulated interfragmentary screws of 4 mm were recruited to restore the anatomical condylar congruity. Definitive fixation were initiated with countersunk cancellous screws sizes; 4 or 6.5 mm, including those for Hoffa’s fractures or osteochondral fragments, followed by applying a distal femoral locked plate sub-muscularly on the lateral surface of the condyle; being held in 20° internal rotation in the coronal plane to ensure the proper direction of the screws. The intraoperative reduction is preoperatively planned based on preoperative CT scans with 3D reconstruction.

Approach: Lateral approach: This approach allows for visualization, reduction,and fixation of distal femur fractures.

The skin incisions begin in the mid-lateral line of femoral shaft at Gerdys tubercle and curve it proximally over lateral femoral condyle. The proximal starting depends on the most proximal extent of the fracture.

Divide the iliotibial band in line with the skin incision. Distally the fibers slope anteriorly towards the Gerdys tubercle .the incision through the iliotibial band should follow the muscle fiber orientation to facilitate aperfect closure.

Beneath the iliotibial band, the muscle fibers of the vastus lateralis are minimal in the distal 8-10 cm of the femur. Incise the

DOI: 10.21608/bmfj.2023.195060.1763

muscle fascia surrounding the vastus lateralis just anterior to the lateral intermuscular septum and elevate the muscle fibers off the septum, working from distal to proximal. This is most easily accomplished by the use of a large elevator.

Retract the vastus lateralis anteromedially. Several perforating vessels of the profunda femoris artery and vein must be ligated. Failure to do so will result in excessive bleeding. It is important to only remove muscles from the lateral surface of the distal femur and protect as much periosteum surrounding the distal femur as possible for later fracture healing.

Medial approach: A skin incision is made in the line of the tendon of adductor magnus. The adductor tubercle is identified, and the line of the adductor tendon is marked proximally. A straight – line incision is made along the posterior border of the adductor magnus tendon. Identify the anterior edge of the sartorius muscle.in order to aid the dissection, flex the knee.in order to allow anterior border of the sartorius to retracted posteriorly. This allows exposure of tendon of adductor magnus. retract adductor magnus tendon posteriorly and retract the vastusmedialis anteriorly to expose the femur.

Postoperative follow-up protocol: Pain management and prophylaxis against DVT in the form of low molecular weight heparin (clexan – enoxaparin sodium) 40mg daily for 6 weeks. Post-operative broad-spectrum antibiotic. IV analgesics were allowed for 2 days postoperative during their emergency clinic stay. Postoperative non weight bearing for 6 to 8 weeks till union sign appear in x-ray. Follow up for 6 months in the form of serial x-rays at 3 months and 6 months, and clinically using functional score and radiological signs. Postoperative rehabilitation program as soon as possible after the surgery Oxford Knee Score (OKS): The Oxford Knee Score (OKS) is a 12-item patient-reported PRO specifically designed and developed to assess function and pain after around knee surgeries. It is short, reproducible, valid and sensitive to clinically important changes.

Background: The OKS was designed to be completed by the patient thus minimizing potential bias unwittingly introduced by surgeons when assessing the results themselves. The PRO was designed and developed by researchers within Public Health and Primary Health Care at the University of Oxford in association with surgical colleagues at the Nuffield Orthopedic Centre.

Some of the attributes of the Oxford Knee Score: A simple scoring system provides an overall scale for assessing outcomes of knee interventions. The PRO is completed by the patient, independent of the clinical team/surgeon. The PRO can be completed anywhere, can be delivered by post to patients' homes or deployed by various electronic platforms such as web or PDA. This makes follow-up of large study populations much more feasible (and cheaper) than conducting clinical assessments, requiring a return visit to the hospital. It eliminates interobserver error. Users have reported extremely good response rates – 98%. The OKS has been ranked the best disease/site-specific PRO for assessing outcome around knee surgeries.

Statistical analysis

Data management and statistical analysis were done using SPSS version 28 (IBM, Armonk, New York, United States). Quantitative data were summarized as

means and standard deviations. Categorical data were summarized as numbers and percentages. Correlation analysis was done between the oxford knee score and other parameters using Pearson's correlation. Oxford knee score was compared according to different study parameters using independent t-test. All statistical tests were two-sided. P values less than 0.05 were considered significant.

Results

The mean age of the studied patients was 46 ±10 years. About two-thirds were males (66.7%). One-quarter were smokers (25%). The most frequent trauma mode was high energy trauma (75%), while 25% had low energy trauma. Table 1

Operative characteristics: The mean operative time was 162 ±26 minutes. The mean blood loss was 552 ±136 ml. The mean postoperative hospital stay was 3 ±1 day. Table 2

Table 1: General characteristics of the studied patients.

General characteristics	
Age (years)	46 ±10
Gender	
Males	16 (66.7)
Females	8 (33.3)
Smoking	6 (25.0)
Mode of trauma	
High energy trauma	18 (75.0)
Low energy trauma	6 (25.0)

Data were presented as mean ±SD or number (percentage).

Table 2: Operative characteristics of the studied patients

	Mean ±SD
Operative time (minutes)	162 ±26
Blood loss (ml)	552 ±136
Post-operative stay (days)	3 ±1

Data were presented as mean ± SD.

Procedural outcome: The mean time of union was 16±2 weeks. Regarding knee range of movement, it was > 100° in 54.2%, 90 -100° in 37.5%, and < 90° in only 8%. The mean Oxford knee score was 39 ±5. Table 3

Complications: Regarding complications, only 16.7% had infection. No failure or revision was reported. Table 4

Correlation between Oxford knee score and other parameters: The oxford knee score showed significant negative correlations with age ($r = -0.922$, $P < 0.001$) and post-operative hospital stay ($r = -0.654$, $P < 0.001$). Table 5

Oxford knee score according to other parameters: Oxford knee score was significantly higher in those with high energy trauma (40 ±5) than those with low energy trauma (33 ±3) ($P = 0.001$). In contrast, no significant differences were noted in the Oxford knee score regarding gender ($P = 0.672$) and smoking ($P = 0.897$). Figure 1

DOI: 10.21608/bmfj.2023.195060.1763

Table 3: Procedural outcome of the studied patients.

Outcome	
Time of union (weeks)	16±2
Knee range of motion	
< 90°	2 (8.3)
90 - 100°	9 (37.5)
>100°	13 (54.2)
Oxford knee score	39 ±5

Data were presented as mean ± SD or number (percentage).

Table 4: Procedural complications of the studied patients.

	n (%)
Failure	0 (0.0)
Infection	4 (16.7)
Revision	0 (0.0)

Table 5: Correlation between oxford knee score and other parameters.

	Oxford knee score	
	r	**P**
Age (years)	-.922*	<.001
Operative time (min)	0.247	0.244
Blood loss	-0.163	0.447
Post-operative stay (days)	-.654*	<.001
Time of union (weeks)	-0.371	0.074

r: Correlation coefficient, *: Significant

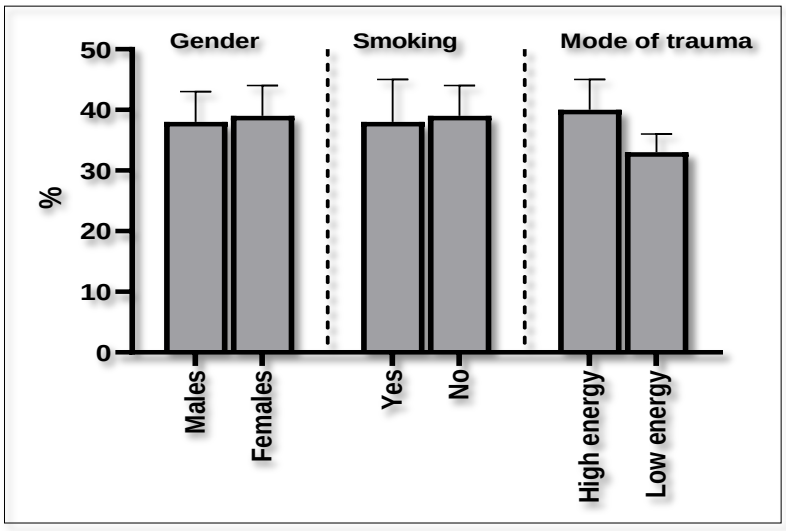


Figure 1: Oxford knee score according to study parameters.

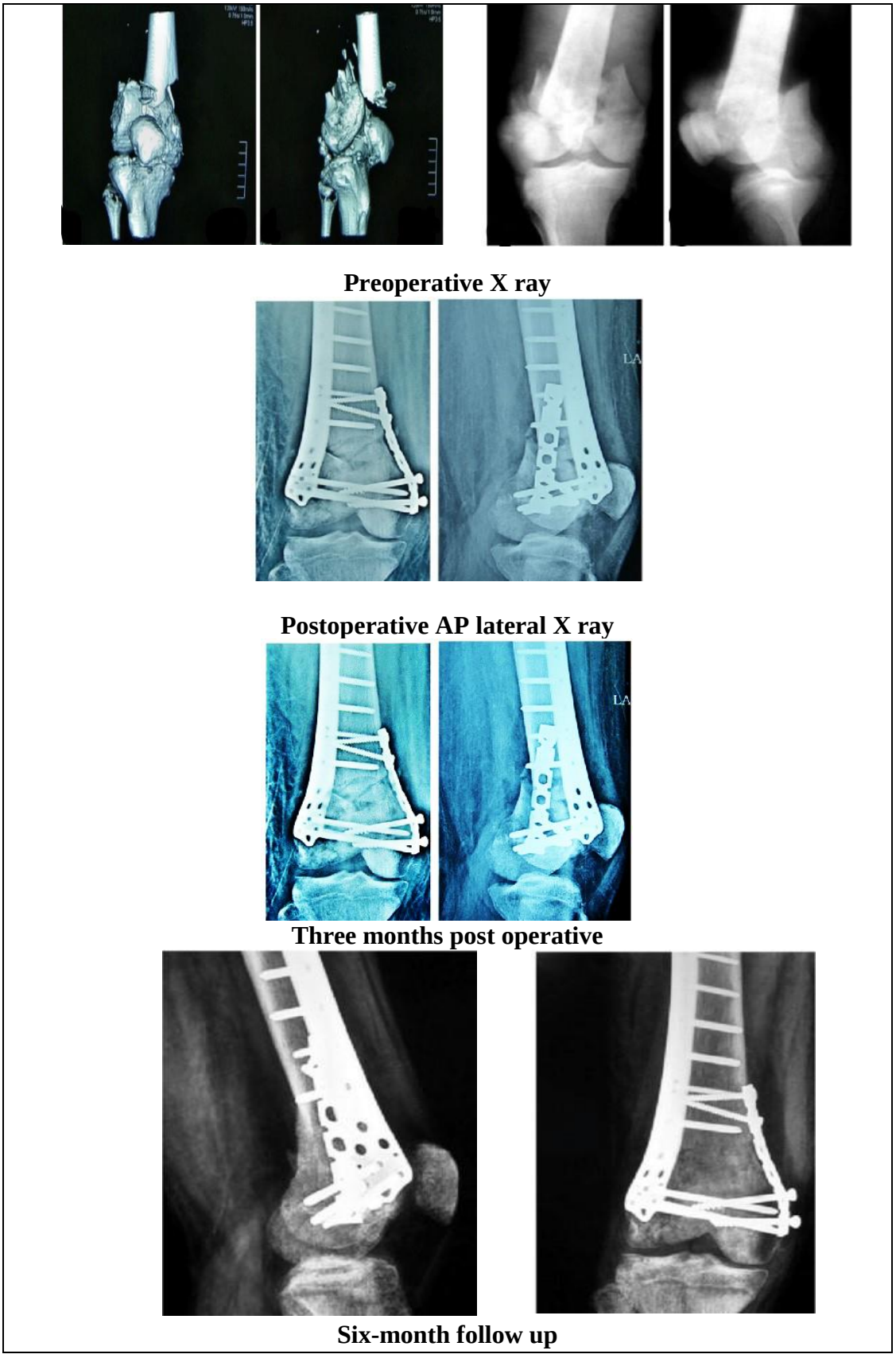
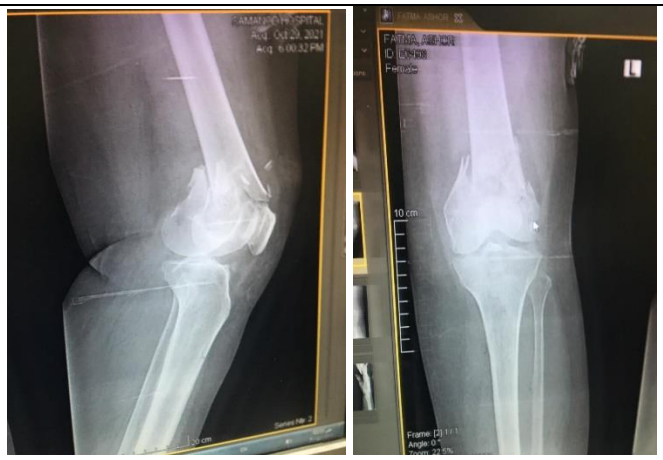
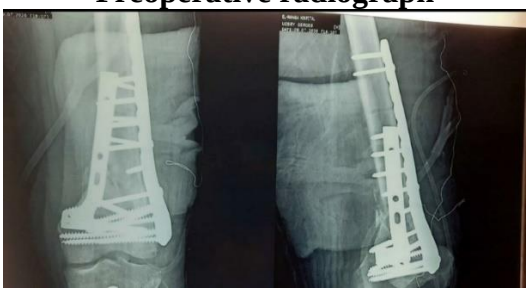


Figure 2: Case 1: A male patient 33 years old had closed right femoral fracture type C3 after RTA. On admission, clinical examination was done plain x rays. He was prepared for surgery next day admission fracture. Follow up: Complete union occurred at 18 weeks, Partial weight bearing started at 10 weeks full weight bearing at 14 weeks, Knee range motion was 0 °130°, Oxford knee score 47.

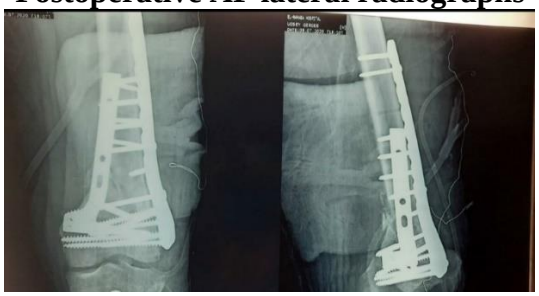
DOI: 10.21608/bmfj.2023.195060.1763



Preoperative radiograph



Postoperative AP lateral radiographs



Postoperative AP lateral radiographs

AP lateral radiographs 3 months postoperatively

AP lateral radiographs 6 months postoperatively

Patient's knee ROM

Figure 3: Case 2: Male patient 51 years closed left femoral fracture type C3 after RTA. On admission, clinical examination was done plain x rays. he was prepared for surgery next day admission. Follow up: Complete union occurred at 20 weeks, Partial weight bearing started at 10 weeks full weight bearing at 3 months, Knee range motion wa

Cases:

Case 1: A male patient 33 years old had closed right femoral fracture type C3 after RTA. On admission, clinical examination was done plain x rays. He was prepared for surgery next day admission fracture. Follow up: Complete union occurred at 18 weeks, Partial weight bearing started at 10 weeks full weight bearing at 14 weeks, Knee range motion was 0 °130°, Oxford knee score 47. Figure 2

Case 2: Male patient 51 years closed left femoral fracture type C3 after RTA. On admission, clinical examination was done plain x rays. he was prepared for surgery next day admission. Follow up: Complete union occurred at 20 weeks, Partial weight bearing started at 10 weeks full weight bearing at 3 months, Knee range motion was 0 °120°, Oxford knee score was 42. Figure 3

Discussion

Osteoporotic fractures have been becoming more common and a challenging clinical entity as the population of old age increases. Surgical treatment with inadequate fixation or prolonged immobilization may result in loss of fixation, mal- or non-union, joint stiffness, and other medical life-threatening

DOI: 10.21608/bmfj.2023.195060.1763

complications, such as thromboembolism or pulmonary complications. Despite bone fragility in osteoporotic fractures, not only rigid fixation but also early rehabilitation is critical for an early return to preoperative ambulatory function and level of daily activity [5].

In our study, the mean age of the studied patients was 46 ±10 years; this young age could be explained by the high rate of road accidents which mainly concerns the youngest subjects. In 2019 [6] some scientists studied the epidemiological, anatomopathological, diagnostic, therapeutic and progressive aspects of patients with distal femur fracture. The average age is 45.6 years,

In our study, about two-thirds were males (66.7%). In the former study [6] it was observed that men have been affected in 76.48% of cases. But Singh et al. [7] showed a female predominance which goes from 63.6% to 87.3%.

In our study, the mean operative time was 162 ±26 minutes. Others, [4] analyzed the clinical and radiologic outcomes of MIPO with the dual plate technique for osteoporotic distal femur fractures. The mean operating time was 114.9 ± 10.5 min (range, 93–147).

In our study, the mean blood loss was 552 ±136 ml. The mean postoperative hospital stay was 3 ± 1 day. The mean time of union was 16±2 weeks. Others [4] reported achieved bone union in all patients at 16.4 ± 4.3 (range, 13–22) weeks.

Regarding knee range of movement, it was > 100° in 54.2%, 90 -100° in 37.5%, and < 90° in only 8%. others [4] found that the final follow-up mean knee ROM was 106.1◦ ± 16.8◦ (range, 80–135).

In our study, the mean Oxford knee score was 39 ± 5. Lim et al. [4] found that mean T score was -3.1 ± 0.8.

Regarding complications, only 16.7% had infection. No failure or revision was reported. Lim et al. [4] found no secondary surgery or revision arthroplasty.

The Oxford knee score showed significant negative correlations with age ($r = -0.922$, $P < 0.001$) and post-operative hospital stay ($r = -0.654$, $P < 0.001$). Also, Oxford knee score was significantly higher in those with high energy trauma (40 ±5) than those with low energy trauma (33 ±3) ($P = 0.001$). In contrast, no significant differences were noted in the Oxford knee score regarding gender ($P = 0.672$) and smoking ($P = 0.897$).

In 2000 [8], it was reported that dual LCP in distal femur fractures provided significantly greater fixation than monolateral LCP plates. The application of medial LCP in MIPO with the dual LCP technique provides a more rigid fixation. Some other scientists [9] also showed more rigid fixation obtained with dual LCP and advantages to postoperative rehabilitation in periprosthetic distal femur fractures after TKA in osteoporotic patients.

Osteoporosis is a systemic skeletal disease characterized by low bone mass and the deterioration of bone microarchitecture leading to bone fragility and a consequent increase in fracture risk. A decrease in cancellous and cortical BMD and an increase in cortical bone porosity can decrease the holding capacity of plates and screws. While adequate internal fixation is necessary in osteoporotic fracture, MIPO with the LCP technique is a good treatment option for distal femur fracture in low BMD patients, compared to conventional nonlocked plates [10].

Because MIPO with the LCP technique depends on indirect bone healing with callus formation, improper fixation that is not stable and firm enough to maintain the

fracture fragments together until the callus formation is likely to result in reduction loss and fixation failure [10].

Kim [10] reported that only lateral LCP is not enough to reliably fix osteoporotic distal femur fractures after TKA. In a biomechanical study,[11] it was reported that dual plating proved stronger than single lateral plate plating in comminuted supracondylar femoral fractures.

Therefore, MIPO with the dual plate technique can provide enough fracture fixation for indirect bone heeling for distal femur fractures in low BMD patients. Previous midline skin incisions and medial parapatella arthrotomy are the other concerns in periprosthetic fractures after TKA. The use of a previous skin incision for periprosthetic fracture may increase the risk for infection and skin necrosis [9].

Moreover, medial parapatellar incisions cause blood supply impairment to the patella, patella maltracking and anterior knee pain. Rather than the previous skin incision, small lateral and medial incisions were made for the MIPO technique in periprosthetic distal femur fracture in order to maintain the periosteal blood supply to bone and to minimize soft-tissue dissection. These factors enhance fracture healing and are associated with early mobilization [12].

It was concluded that the medial and lateral locked plating technique demonstrates a higher union rate, with possible lower rates of revision surgery, compared to a single lateral plate in highly comminuted distal femur fractures [13].

The functional outcomes and complications of dual plating in the distal femur fracture were evaluated and concluded that dual plating leads to a satisfactory union in the comminuted metaphyseal and articular fractures of the distal femur [14]. There is no difference between the single plate and dual plate with regards to nonunion rate, blood loss, functional outcomes and complications. However, dual fixation leads to faster fracture healing at the cost of a longer surgical duration.

The absence of a patient group treated with monolateral LCP for comparing the results of the dual LCP is a major limitation of this study. The follow-up period was not extensive enough to confirm posttraumatic arthritis after surgical treatment, and the small size was also a limitation of this study.

Conclusion

Distal femoral fractures are a source of considerable morbidity. MIPO with the dual plate technique can provide rigid fixation for osteoporotic distal femur fractures. This stable and rigid fixation may allow early mobilization and return to pre-fracture activity. Future large, multi-centered and prospective study are needed.

Sources of funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author contribution

Authors contributed equally in the study**.**

Conflicts of interest

No conflicts of interest

References

1. Coon MS, Best BJ. Distal Femur Fractures. StatPearls. Treasure Island (FL): StatPearls Publishing Copyright © 2022, StatPearls Publishing LLC.; 2022.

2. Lustig S, Khiami F, Boyer P, Catonne Y, Deschamps G, Massin P. Post-traumatic knee osteoarthritis treated by osteotomy only. Orthop Traumatol Surg Res. 2010;96:856-60.

3. Khalil Ael S, Ayoub MA. Highly unstable complex C3-type distal femur fracture: can double plating via a modified Olerud extensile approach be a standby solution? J Orthop Traumatol. 2012;13:179-88.
4. Lim C, Choi S, Choi TH, Kang H. Stable internal fixation with dual plate technique for osteoporotic distal femur fractures. Ann Med Surg (Lond). 2022;75:103374.
5. Chechik O, Amar E, Khashan M, Kadar A, Rosenblatt Y, Maman E. In support of early surgery for hip fractures sustained by elderly patients taking clopidogrel: a retrospective study. Drugs Aging. 2012;29:63-8.
6. Mourafiq O, Boukhriss J, Chefry B, Bencheba D, Bouabid S, Boussouga M. Distal Femur Fractures in Adults. 2019;7:880-3.
7. Singh SK, El-Gendy KA, Chikkamuniyappa C, Houshian S. The retrograde nail for distal femoral fractures in the elderly: high failure rate of the condyle screw and nut. Injury. 2006;37:1004-10.
8. Jazrawi LM, Kummer FJ, Simon JA, Bai B, Hunt SA, Egol KA, et al. New technique for treatment of unstable distal femur fractures by locked double-plating: case report and biomechanical evaluation. J Trauma. 2000;48:87-92.
9. Çiçek H, Tuhanioğlu Ü, Oğur HU, Seyfettinoğlu F, Bozkurt M. An alternative treatment for osteoporotic Su Type III periprosthetic supracondylar femur fractures: Double locking plate fixation. Acta Orthop Traumatol Turc. 2018;52:92-6.
10. Kim K. Usefulness of bilateral plate fixation for periprosthetic distal femur fracture after total knee arthroplasty. Int J Surg Case Rep. 2020;68:43-7.
11. Zhang J, Wei Y, Yin W, Shen Y, Cao S. Biomechanical and clinical comparison of single lateral plate and double plating of comminuted supracondylar femoral fractures. Acta Orthop Belg. 2018;84:141-8.
12. Wu Y, Zeng Y, Bao X, Xiong H, Hu Q, Li M, et al. Comparison of mini-subvastus approach versus medial parapatellar approach in primary total knee arthroplasty. Int J Surg. 2018;57:15-21.
13. Bologna MG, Claudio MG, Shields KJ, Katz C, Salopek T, Westrick ER. Dual plate fixation results in improved union rates in comminuted distal femur fractures compared to single plate fixation. J Orthop. 2020;18:76-9.
14. Tripathy SK, Mishra NP, Varghese P, Panigrahi S, Purudappa PP, Goel A, et al. Dual-Plating in Distal Femur Fracture: A Systematic Review and Limited Meta-analysis. Indian J Orthop. 2022;56:183-207.

To cite this article: Wael A.Kandel, Mohamed G.Ibrahim, Mohamed A. Abd Elbaky. Dual Plate Fixation of Distal Femoral Fracture. BMFJ XXX, DOI: 10.21608/bmfj.2023.195060.1763.