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Original Research Article

FUNCTIONAL AND RADIOLOGICAL OUTCOMES OF DISTAL FEMUR FRACTURES TREATED WITH PRE-CONTOURED DISTAL FEMORAL LOCKING COMPRESSION PLATE: A PROSPECTIVE STUDY

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ABSTRACT

Background: Distal femur fractures are complex injuries requiring stable fixation to achieve early mobilization and satisfactory functional recovery. This study evaluated the functional and radiological outcomes of pre-contoured distal femoral locking compression plate (DF-LCP) fixation.
Materials and Methods: A prospective observational study was conducted on 40 adult patients with distal femur fractures treated with DF-LCP between January 2020 and January 2022. Functional outcomes were assessed using the Oxford Knee Score (OKS) and Neer Functional Score (NFS), while radiological union and postoperative complications were evaluated during serial follow-up.
Results: Mean OKS improved significantly from 9.15 ± 3.17 preoperatively to 40.10 ± 4.54 at 20 weeks, and mean NFS increased from 10.88 ± 5.81 to 83.15 ± 11.94 (both $p < 0.001$). Radiological union occurred at a mean of 20.58 ± 4.52 weeks, with 45% of fractures uniting between 15–19 weeks. At final follow-up, 65% achieved satisfactory OKS and 62.5% had excellent NFS. Most patients (82.5%) experienced no postoperative complications, and earlier fracture union was significantly associated with superior functional outcomes ($p < 0.001$).
Conclusion: Pre-contoured DF-LCP provides reliable fixation for distal femur fractures, resulting in excellent functional recovery, satisfactory radiological union, and a low complication rate, supporting its effectiveness as a preferred treatment option.
Keywords: Distal femur fracture; Distal femoral locking compression plate (DF-LCP); Locking compression plate (LCP); Functional outcome.

INTRODUCTION

Distal femur fractures are relatively uncommon injuries, accounting for approximately 3–6% of all femoral fractures in adults. They are associated with substantial morbidity because of their proximity to the knee joint and the complexity of the distal femoral anatomy.[1] The incidence of distal femur fractures demonstrates a bimodal age distribution. Young adults typically sustain these injuries following high-energy trauma, particularly road traffic accidents, whereas elderly individuals are more likely to experience these fractures after low-energy falls due to osteoporosis.[2]

The distal femur comprises the supracondylar region and the femoral condyles, forming the articular surface of the knee joint. Because of its complex anatomy and the frequent involvement of the metaphysis and articular surface, restoration of normal alignment and joint congruity remains a major surgical challenge.[3] Management of distal femur fractures requires a thorough understanding of the regional anatomy, fracture configuration, and associated soft-tissue injuries to achieve satisfactory functional outcomes.[4]
Operative management has become the standard treatment for most displaced distal femur fractures because conservative treatment is associated with

prolonged immobilization, malunion, knee stiffness, and delayed rehabilitation. Systematic reviews have demonstrated improved functional outcomes with surgical fixation when stable reduction is achieved.[5]

The primary objectives of surgical treatment include anatomical reduction of the articular surface, restoration of limb alignment and length, stable fixation, and early mobilization of the knee joint to minimize complications and facilitate functional recovery.[6]

Various fixation methods have been described for distal femur fractures, including condylar blade plates, dynamic condylar screws, retrograde intramedullary nails, locking plates, and external fixation. The choice of implant depends on fracture morphology, bone quality, and the extent of metaphyseal comminution.[7]

Locking plate technology represents a major advancement in fracture fixation by providing angular stability through a fixed-angle screw–plate construct. Unlike conventional plating systems, locking plates do not depend on compression between the plate and bone, thereby preserving periosteal blood supply and promoting biological fracture healing.[8]

Biomechanical studies have demonstrated that locking compression plates provide superior construct stability, particularly in osteoporotic bone and highly comminuted metaphyseal fractures where conventional screw fixation may be inadequate.[9] The evolution of biological internal fixation has emphasized preservation of fracture biology while maintaining sufficient mechanical stability for fracture healing. Modern fixation techniques therefore advocate minimal disruption of periosteal circulation and fracture hematoma whenever possible.[10]

The concept of biological osteosynthesis has significantly improved fracture management by combining minimally invasive surgical techniques with stable fixation, thereby reducing soft-tissue damage and promoting early fracture union.[11] Clinical guidelines for the Locking Compression Plate (LCP) recommend its use in distal femur fractures because the anatomically pre-contoured design, combined with locking screw technology, provides stable fixation even in osteoporotic bone and fractures with metaphyseal comminution.[12]

Several investigators have reported that minimally invasive plate osteosynthesis using locking compression plates decreases soft-tissue trauma, preserves vascularity, and improves fracture healing while reducing the need for primary bone grafting.[13] Successful management of distal femur fractures ultimately depends on achieving stable fixation that permits early knee mobilization and weight bearing without compromising fracture biology. Anatomical reduction and rigid fixation remain the cornerstones for obtaining favourable radiological union and satisfactory functional outcomes.[14]

Despite recent advances in implant technology and surgical techniques, distal femur fractures continue to present considerable therapeutic challenges because of fracture complexity, osteoporosis, and associated complications. Therefore, continued evaluation of the functional and radiological outcomes following fixation with a pre-contoured distal femoral locking compression plate is essential to establish its effectiveness in contemporary orthopaedic practice.

Aim: To evaluate the functional and radiological outcomes of distal femur fractures treated with a pre-contoured distal femoral locking compression plate.

Objectives:

1. To evaluate the functional outcome of distal femur fractures treated with a pre-contoured distal femoral locking compression plate using an appropriate functional scoring system.
2. To assess the radiological outcome, including fracture union and postoperative complications, and correlate radiological healing with functional outcome.

MATERIALS AND METHODS

Study Design and Setting: This prospective observational study was conducted in the Department of Orthopaedics, Rani Durgavati Medical College, Banda between January to December 2025.

Study Population: A total of 40 consecutive adult patients with distal femur fractures who underwent surgical fixation using a pre-contoured distal femoral locking compression plate (DF-LCP) were included in the study.

Inclusion Criteria:

- Patients aged 18 years or older.
- Closed distal femur fractures and Gustilo-Anderson Grade I and II open fractures.
- Distal femur fractures suitable for fixation with a distal femoral locking compression plate.
- Patients willing to participate and provide written informed consent.

Exclusion Criteria

- Gustilo-Anderson Grade III open fractures.
- Pathological fractures.
- Skeletally immature patients.
- Undisplaced fractures managed conservatively.
- Patients medically unfit for surgery or unwilling to participate.

Preoperative Assessment: All patients underwent detailed clinical evaluation, including assessment of injury mechanism, associated injuries, neurovascular status, and soft tissue condition. Standard anteroposterior and lateral radiographs of the entire femur, including the hip and knee joints, were obtained. Computed tomography was performed in patients with suspected intra-articular extension. Fractures were classified according to the AO/OTA (Müller) classification. Routine preoperative investigations included complete blood count, renal function tests, blood grouping, viral markers, electrocardiography, and chest radiography where indicated. Patients received preoperative antibiotic prophylaxis according to institutional protocol.

Surgical Technique: All procedures were performed under spinal or general anaesthesia with the patient in the supine position on a radiolucent operating table. Fracture reduction was achieved by open reduction through a standard lateral approach or minimally invasive techniques whenever appropriate. Anatomical reduction of the articular surface was obtained under fluoroscopic guidance, followed by fixation using a pre-contoured distal femoral locking compression plate. Reduction, alignment, screw placement, and implant position were confirmed intraoperatively using an image intensifier.

Postoperative Management: Intravenous antibiotics were administered for the first 48 hours, followed by oral antibiotics as indicated. Early knee range-of-motion exercises and quadriceps strengthening were initiated as tolerated. Partial weight-bearing was permitted after evidence of early radiological healing, while full weight-bearing was allowed only after satisfactory radiological union.

Follow-up and Outcome Assessment: Patients were followed at 4, 8, 12, 16, and 20 weeks, with subsequent follow-up up to 12 months when feasible. At each visit, clinical examination and radiographic evaluation were performed.The primary outcome was functional recovery assessed using the Neer Functional Score (NFS). The secondary outcome was radiological union, defined by bridging callus formation across at least three cortices on standard radiographs with painless full weight-bearing. Complications including delayed union, non-union, malunion, superficial or deep infection, implant failure, knee stiffness, and loss of reduction were documented throughout the follow-up period.

Statistical Analysis: Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version XX (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were presented as frequencies and percentages. The association between functional and radiological outcomes was evaluated using appropriate statistical tests. A p-value <0.05 was considered statistically significant.

RESULTS

[Table 1] The mean Oxford Knee Score improved significantly from 9.15 ± 3.17 preoperatively to 40.10 ± 4.54 at 20 weeks ($p < 0.001$). Similarly, the mean Neer Functional Score increased from 10.88 ± 5.81 to 83.15 ± 11.94 during follow-up ($p < 0.001$). At final assessment, 65% of patients achieved a satisfactory Oxford Knee Score, while 62.5% demonstrated an excellent Neer Functional Score.

[Table 2] Radiological union was achieved at a mean of 20.58 ± 4.52 weeks, with 45% of fractures uniting between 15 and 19 weeks. AO type A1 and B1 fractures united earliest (17 weeks), whereas AO type C3 fractures required the longest time (30 weeks). Most patients (82.5%) experienced no postoperative complications; knee stiffness (7.5%), superficial infection (5.0%), non-union (2.5%), and vascular injury (2.5%) were infrequent.

[Table 3] A significant association was observed between radiological healing and functional recovery. Earlier fracture union was associated with significantly better Oxford Knee Score and Neer Functional Score outcomes (both $p < 0.001$). Furthermore, Oxford Knee Score and Neer Functional Score demonstrated a significant positive correlation ($p < 0.001$).

Table 1: Functional Outcome Following Pre-Contoured Distal Femoral Locking Compression Plate Fixation (n = 40)

Outcome Measure	Result
Oxford Knee Score (OKS)	
Preoperative (Mean ± SD)	9.15 ± 3.17
4 weeks	17.88 ± 3.60
8 weeks	24.80 ± 3.48
12 weeks	30.70 ± 3.49
16 weeks	34.92 ± 4.38
20 weeks	40.10 ± 4.54
Repeated Measures ANOVA	p < 0.001
Neer Functional Score (NFS)	
Preoperative (Mean ± SD)	10.88 ± 5.81
4 weeks	30.78 ± 10.72
8 weeks	43.18 ± 13.30
12 weeks	64.40 ± 8.77
16 weeks	73.95 ± 11.40
20 weeks	83.15 ± 11.94
Repeated Measures ANOVA	p < 0.001
Final Functional Outcome at 20 weeks	
OKS Satisfactory (40–48)	26 (65.0%)
OKS Mild Unsatisfactory (30–39)	14 (35.0%)
Moderate/Severe Unsatisfactory	0
NFS Excellent (>85)	25 (62.5%)
NFS Satisfactory (70–85)	8 (20.0%)

NFS Unsatisfactory (55–69)	6 (15.0%)
NFS Failure (<55)	1 (2.5%)

Table 2: Radiological Outcome and Postoperative Complications Following Distal Femoral Locking Compression Plate Fixation (n = 40)

Parameter	Category	n (%) / Mean ± SD
Radiological Union	Mean union time (weeks)	20.58 ± 4.52
	Range (weeks)	12–32
	Union in 10–14 weeks	2 (5.0)
	Union in 15–19 weeks	18 (45.0)
	Union in 20–24 weeks	13 (32.5)
	Union in 25–29 weeks	5 (12.5)
	Union in 30–34 weeks	2 (5.0)
Mean Time to Radiological Union According to AO Fracture Type	Type A1	17.0 weeks
	Type A2	20.4 weeks
	Type A3	22.8 weeks
	Type B1	17.0 weeks
	Type C1	17.6 weeks
	Type C2	23.0 weeks
	Type C3	30.0 weeks
Postoperative Complications	None	33 (82.5)
	Knee stiffness	3 (7.5)
	Surgical site infection	2 (5.0)
	Non-union	1 (2.5)
	Vascular injury	1 (2.5)

Table 3: Association Between Functional Outcome and Radiological Healing

Variable	Statistical Test	Result
Change in Oxford Knee Score over follow-up	Repeated Measures ANOVA	$p < 0.001$
Change in Neer Functional Score over follow-up	Repeated Measures ANOVA	$p < 0.001$
Association between OKS and NFS outcomes	Fisher's Exact Test	$p < 0.001$
Association between Union Time and OKS	Fisher's Exact Test	$p < 0.001$
Association between Union Time and NFS	Fisher's Exact Test	$p < 0.001$

DISCUSSION

The present prospective study evaluated the functional and radiological outcomes of distal femur fractures treated with a pre-contoured distal femoral locking compression plate (DF-LCP). The findings demonstrated significant improvement in functional scores, satisfactory fracture union, and a low rate of postoperative complications, indicating that DF-LCP is an effective treatment modality for distal femur fractures. The angular stability provided by locking plate technology facilitates stable fixation, particularly in osteoporotic bone and comminuted fractures, while preserving the biological environment necessary for fracture healing.[7-12]

Functional recovery was one of the major strengths of the present study. The mean Oxford Knee Score improved significantly from 9.15 ± 3.17 preoperatively to 40.10 ± 4.54 at 20 weeks, while the mean Neer Functional Score increased from 10.88 ± 5.81 to 83.15 ± 11.94 ($p < 0.001$). Moreover, 65.0% of patients achieved satisfactory Oxford Knee Scores, and 62.5% had excellent Neer Functional Scores. These findings are consistent with those reported by Yeap and Deepak, who observed satisfactory functional outcomes following DF-LCP fixation in distal femur fractures.49 Similar results have also been reported by Virk et al., Girisha et al., and Khajotia et al., who concluded that locking compression plates provide stable fixation with favourable functional recovery and early mobilization.[18-20]

Radiological union was achieved at a mean duration of 20.58 ± 4.52 weeks, with most fractures (45%) uniting between 15 and 19 weeks. Simpler fracture patterns (AO type A1 and B1) united earlier than complex intra-articular fractures (AO type C3), reflecting the influence of fracture severity on healing time. Comparable union times have been reported by Zlowodzki et al., Yeap and Deepak, and Kadam et al., who demonstrated high union rates following DF-LCP fixation when anatomical reduction and stable fixation were achieved.[5,17,23]

The biomechanical superiority of locking plates, combined with preservation of periosteal blood supply, contributes to reliable fracture healing and maintenance of alignment.[9,10]

The incidence of postoperative complications in the present study was low. A total of 82.5% of patients experienced no complications, while knee stiffness (7.5%), superficial surgical-site infection (5.0%), non-union (2.5%), and vascular injury (2.5%) were uncommon. These findings compare favourably with previous reports by Sommer et al. and Vallier et al., who highlighted that although locking plates provide excellent stability, improper surgical technique or excessive construct stiffness may predispose to implant-related complications and delayed healing.[15,16] Therefore, meticulous surgical technique, preservation of soft tissues, and adherence to biological fixation principles remain essential for successful outcomes.

An important finding of the present study was the significant association between radiological healing and functional recovery. Patients with earlier fracture union achieved significantly better Oxford Knee Scores and Neer Functional Scores ($p < 0.001$), emphasizing the importance of timely fracture healing in restoring knee function. Similar observations have been reported by Medhi and Mote and Rajpal and Bansal, who demonstrated that successful radiological union is closely associated with improved functional outcomes following locking plate fixation.[21,22]

CONCLUSION

The present study concluded that fixation of distal femur fractures using a pre-contoured distal femoral locking compression plate achieved excellent functional and radiological outcomes. The mean Oxford Knee Score improved from 9.15 to 40.10, while the mean Neer Functional Score increased from 10.88 to 83.15 ($p<0.001$). Radiological union occurred at a mean of 20.58 ± 4.52 weeks, with 82.5% of patients experiencing no postoperative complications. Earlier fracture union was significantly associated with better functional outcomes, supporting DF-LCP as a reliable and effective treatment option for distal femur fractures.

REFERENCES

1. Martinet O, Cordey J, Harder Y, Maier A, Bühler M, Barraud GE. The epidemiology of fractures of the distal femur. Injury. 2000;31(Suppl 3):C62-C63.
2. Court-Brown CM, Caesar B. Epidemiology of adult fractures: A review. Injury. 2006;37(8):691-697.
3. O'Brien PJ, Meek RN, Blachut PA. Fractures of the distal femur. In: Rockwood CA Jr, Green DP, Bucholz RW, editors. Rockwood and Green's Fractures in Adults. 6th ed. Philadelphia: Lippincott Williams & Wilkins; p.1916-1967.
4. Whittle AP, Wood GW II. Fractures of the lower extremity. In: Canale ST, editor. Campbell's Operative Orthopaedics. 10th ed. Philadelphia: Mosby; p.2805-2825.
5. Zlowodzki M, Bhandari M, Marek DJ, Cole PA, Kregor PJ. Operative treatment of acute distal femur fractures: Systematic review of two comparative studies and 45 case series. J Orthop Trauma. 2006;20(5):366-371.
6. Crist BD, Della Rocca GJ, Murtha YM. Treatment of acute distal femur fractures. Orthopedics. 2008;31(7):681-690.
7. Greiwe RM, Archdeacon MT. Locking plate technology: Current concepts. J Knee Surg. 2007;20(1):50-55.
8. Cantu RV, Koval KJ. The use of locking plates in fracture care. J Am AcadOrthop Surg. 2006;14(3):183-190.
9. Egol KA, Kubiak EN, Fulkerson E, Kummer FJ, Koval KJ. Biomechanics of locked plates and screws. J Orthop Trauma. 2004;18(8):488-493.
10. Perren SM. Evolution of the internal fixation of long bone fractures: The scientific basis of biological internal fixation. J Bone Joint Surg Br. 2002;84(8):1093-1110.
11. Broos PL, Sermon A. From unstable internal fixation to biological osteosynthesis: A historical overview of operative fracture treatment. Acta Chir Belg. 2004;104(4):396-400.
12. Gautier E, Sommer C. Guidelines for the clinical application of the Locking Compression Plate (LCP). Injury. 2003;34(Suppl 2):B63-B76.
13. Mize RD, Bucholz RW, Grogan DP. Surgical treatment of displaced comminuted fractures of the distal end of the femur. J Bone Joint Surg Am. 1982;64(6):871-879.
14. Siliski JM, Mahring M, Hofer HP. Supracondylar-intercondylar fractures of the femur: Treatment by internal fixation. J Bone Joint Surg Am. 1989;71(1):95-104.
15. Sommer C, Babst R, Müller M, Hanson B. Locking compression plate loosening and plate breakage: A report of four cases. J Orthop Trauma. 2004;18(9):571-577.
16. Vallier HA, Hennessey TA, Sontich JK, Patterson BM. Failure of LCP condylar plate fixation in the distal part of the femur: A report of six cases. J Bone Joint Surg Am. 2006;88(4):846-853.
17. Yeap EJ, Deepak AS. Distal femoral locking compression plate fixation in distal femoral fractures: Early results. Malays Orthop J. 2007;1(1):12-17.
18. Virk JS, Garg SK, Gupta P, Jangira V, Singh J, Rana S. Distal Femur Locking Plate: The Answer to All Distal Femoral Fractures. J ClinDiagn Res. 2016;10(10):RC01-RC05.
19. Saini RA, Shah N, Sharma D. Functional outcome of distal femoral fractures treated with distal femur locking compression plate. Int J Orthop Sci. 2018;4(1):439-444.
20. Khajotia BL, Shekhawat V, Chauhan S, Bhatiwal S. Clinical and radiological outcome of distal femoral fractures treated by distal femoral locking compression plate. Int J Res Orthop. 2019; 5:1083-1088.
21. Medhi M, Mote G. Competency of distal femur locking plate as an answer for fixation of all varieties of distal femur fractures. Int J Res Orthop. 2019;5.
22. Rajpal K, Bansal D. Minimally invasive plate osteosynthesis of distal end femur using locking compression plate. Int J Orthop Sci. 2019;5(3):90-93.
23. Kadam AM, Mahadik SK, Rampure S, Jiwani RB. Management of distal femoral fractures with Locking Compression Plate: A prospective study. Asian J Med Sci. 2021;12(1):61-68.