



Functional and Radiological outcome of Distal Femur Fracture Treated with Locking Compression Plate.

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Abstract

Introduction: Distal femur fractures are complex peri-articular injuries that can result in knee stiffness, malalignment, limb length discrepancy, and impaired function. Locking compression plates provide stable angular fixation and facilitate early mobilization. This study evaluated the functional and radiological outcomes of distal femur fractures treated with locking compression plates. **Materials and Methods:** This hospital-based observational study was conducted in the Department of Orthopaedics at Geetanjali Medical College and Hospital, Udaipur, from June 2024 to December 2025. Twenty-five adult patients with distal femur fractures who underwent locking compression plate fixation were included. Patients with Gustilo-Anderson type IIIB/IIIC fractures, pathological or periprosthetic fractures, previous knee surgery or trauma, neurological deficits, or other ipsilateral limb injuries were excluded. Patients underwent clinical and radiological assessment, operative fixation, postoperative rehabilitation, and serial follow-up. Functional outcome was assessed using Neer's Knee Score, while radiological union and complications were recorded. **Results:** Males constituted 84% of the patients, and the 31–40-year age group was predominant. Road traffic accidents accounted for 80% of injuries, while 72% were closed fractures and 64% were Müller type A1. Mean intraoperative blood loss was 144.80 ± 29.95 mL, and 68% of procedures lasted less than 90 minutes. Partial weight bearing was achieved within 2–3 months in 92% of patients. Radiological union occurred within 18 weeks in 88%, while the overall union rate was 96%. Complications were absent in 88% of patients. At one year, 60% achieved excellent and 28% good Neer's scores. **Conclusion:** Locking compression plate fixation provided reliable fracture union, low complication rates, and favorable functional recovery in distal femur fractures. Appropriate fixation combined with early rehabilitation appears to be an effective treatment approach.

Keywords: Distal femur fracture; Locking compression plate; Neer's Knee Score; Radiological union; Functional outcome.



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INTRODUCTION

Distal femur fractures are complex peri-articular injuries accounting for less than 1% of all fractures and approximately 4–6% of all femoral fractures [1,2]. They represent a challenging subset of lower-limb trauma because of their proximity to the knee joint and the frequent involvement of the articular surface [3]. These fractures demonstrate a bimodal age distribution, with high-energy mechanisms such as road traffic accidents being more common among younger individuals, while low-energy falls are frequently encountered in elderly patients with osteoporosis [4]. Inadequate management may result in substantial functional morbidity, including knee stiffness, malalignment, limb length discrepancy, and post-traumatic osteoarthritis [5-7]. Restoration of articular congruity, maintenance of axial alignment, stable fixation, and early mobilization are therefore important goals in the management of these injuries.

Historically, distal femur fractures were managed conservatively using skeletal traction and cast bracing; however, prolonged immobilization was associated with joint stiffness, malunion, and unsatisfactory functional recovery [8,9]. With advances in orthopaedic trauma surgery, operative fixation has become the preferred treatment for most displaced and unstable fractures, facilitating anatomical reduction and stable fixation with earlier rehabilitation [10]. Various fixation methods, including angled blade plates, dynamic condylar screws, condylar buttress plates, retrograde intramedullary nails, and external fixation, have been used with varying outcomes [11]. However, limitations such as inadequate angular stability, varus collapse, and extensive soft-tissue disruption led to the development and increasing adoption of locking plate technology [12].

The distal femoral locking compression plate (DF-LCP) provides a fixed-angle construct in which locking screws engage the plate to create a stable beam, thereby distributing forces across multiple screw–bone interfaces [13]. This configuration provides enhanced stability in comminuted metaphyseal fractures and osteoporotic bone while minimizing disruption of the periosteal blood supply [14]. The angular stability of the construct helps maintain alignment and reduces the risk of varus collapse, while minimally invasive application can further preserve soft-tissue integrity and promote biological fixation [15,16]. Several studies have reported favorable radiological union and functional outcomes following DF-LCP fixation. Rathod et al. reported a mean radiological union time of approximately 14 weeks, with 68% of patients achieving excellent Neer's scores [3]. Saini et al. reported excellent functional outcomes in more than 60% of patients with reliable fracture union [15]. Singh et al. observed union in the majority of patients within six months, accompanied by predominantly excellent functional outcomes and satisfactory knee motion [11]. Solanki et al. and Sundar et al. also reported favorable functional outcomes and consistent radiological union following DF-LCP fixation [17,18].

Despite these encouraging results, distal femur fractures remain technically demanding, and outcomes may be influenced by fracture configuration, bone quality, timing of surgery, plate selection, adequacy of fixation, reduction quality, and postoperative rehabilitation. Evaluation of both functional recovery and radiological healing is therefore important for determining the effectiveness of locking compression plating. The present study aimed to evaluate the functional and radiological outcomes of distal end femur fractures treated with locking compression plating, with primary objectives of assessing functional outcome using Neer's Knee Score and determining the time required for radiological union, and a secondary objective of evaluating complications associated with the treatment.

MATERIALS AND METHODS

This hospital-based observational study was conducted in the Department of Orthopaedics at the tertiary care teaching hospital attached to Geetanjali Medical College and Hospital, Udaipur, over a period of 18 months from June 2024 to December 2025. The study included patients aged >18 years presenting with distal femur fractures who fulfilled the eligibility criteria, were considered fit for surgery and anaesthesia, and provided written informed consent. A minimum of 25 patients undergoing surgical management during the study period were enrolled. Patients with Gustilo-Anderson type IIIB and IIIC open fractures, pathological or periprosthetic fractures, previous knee trauma or surgery, associated spinal injury or neurological deficits, or other injuries involving the ipsilateral limb were excluded.

Institutional Ethics Committee approval was obtained before commencement of the study, and written informed consent was obtained from all participants. A detailed history was obtained regarding demographic characteristics, mechanism of injury, comorbidities, and the interval between trauma and hospital presentation. All patients underwent thorough general, systemic, and local examination. Standard anteroposterior and lateral radiographs of the knee were obtained for diagnosis and fracture classification according to the AO/OTA system. Associated bony and soft-tissue injuries were assessed clinically and radiologically. Until definitive fixation, temporary immobilization was provided using a plaster slab or knee brace. Patients were positioned supine on a radiolucent table with the knee maintained in slight flexion. An extensile lateral approach was commonly used, particularly for intra-articular fractures, with preservation of the medial soft tissues. Articular fragments were anatomically reduced and provisionally stabilized with Kirschner wires, followed by application of an appropriately sized distal femoral locking compression plate. At least five screws, including lag and locking head screws, were placed in the distal fragment, while a minimum of four screws engaging eight cortices were inserted into the proximal femoral diaphysis.

Postoperatively, patients received intravenous antibiotics, analgesics, limb elevation, and routine wound care. Sutures were removed between the 12th and 14th postoperative days. Quadriceps strengthening and knee mobilization were initiated during the immediate postoperative period. Weight-bearing progression was individualized according to fracture stability and radiological progress, with partial and full weight bearing advanced progressively. Patients were followed up at 2 weeks for suture removal and subsequently at 6 weeks, 3 months, and 6 months. Radiographs were obtained during follow-up to assess callus formation and progression to complete union. Functional outcome was assessed using the Neer's Knee Score, while radiological outcome was evaluated based on the time required for complete radiological union. Intraoperative and postoperative complications, including surgical-site infection, neurovascular injury, delayed union, malunion, non-union, implant failure, and knee stiffness, were recorded.

Data were collected using a predesigned proforma and entered into Microsoft Excel 2021 for analysis. Statistical analysis was performed using SPSS version 26.0. Categorical variables were expressed as frequency and percentage, whereas continuous variables were summarized using mean $\pm$ standard deviation and median with interquartile range, as appropriate. Results were presented using tables and appropriate graphical representations.

RESULTS

The study included 25 patients with distal femur fractures treated with locking compression plates. The mean age distribution showed the highest proportion of patients in the 31–40-year age group, comprising 7 (28.00%) patients, followed by 21–30 years with 6 (24.00%) patients. Males predominated, accounting for 21 (84.00%) patients, while females constituted 4 (16.00%) patients. (Table 1)

Table 1: Demographic Characteristics of Study Participants

Variable	Category	N (%)
Age group (years)	<20	2 (8.00%)
	21–30	6 (24.00%)
	31–40	7 (28.00%)
	41–50	5 (20.00%)
	51–60	5 (20.00%)
Gender	Male	21 (84.00%)
	Female	4 (16.00%)

Closed injuries were predominant, occurring in 18 (72.00%) patients, while open type II and open type I injuries accounted for 5 (20.00%) and 2 (8.00%) patients, respectively. According to Müller's classification, type A1 fractures were most frequent, observed in 16 (64.00%) patients, followed by A3 in 6 (24.00%) and A2 in 3 (12.00%) patients. Road traffic accidents were the most common mechanism of injury, accounting for 20 (80.00%) cases, followed by falls in 4 (16.00%) and assault in 1 (4.00%) case. (Table 2)

Table 2: Injury Characteristics

Variable	Category	N (%)
Type of injury	Closed	18 (72.00%)
	Open type I	2 (8.00%)
	Open type II	5 (20.00%)
Müller's classification	A1	16 (64.00%)
	A2	3 (12.00%)
	A3	6 (24.00%)
Mode of injury	Road traffic accident	20 (80.00%)
	Fall	4 (16.00%)
	Assault	1 (4.00%)

Surgery was performed more than 7 days after trauma in 15 (60.00%) patients, while 6 (24.00%) underwent surgery within 4–7 days and 4 (16.00%) within 1–3 days. Operative duration was less than 90 minutes in 17 (68.00%) patients, 91–120 minutes in 7 (28.00%), and more than 120 minutes in 1 (4.00%) patient. (Table 3)

Table 3: Duration Between Trauma and Surgery and Operative Duration

Variable	Category	N (%)
Duration between trauma and surgery	1–3 days	4 (16.00%)
	4–7 days	6 (24.00%)
	>7 days	15 (60.00%)
Duration of surgery	<90 minutes	17 (68.00%)
	91–120 minutes	7 (28.00%)
	>120 minutes	1 (4.00%)

The mean intraoperative blood loss was 144.80 ± 29.95 mL. An 8–9-hole locking compression plate was used most frequently, in 16 (64.00%) patients, while 5–7-hole, 10–12-hole, and >12-hole plates were each used in 3 (12.00%) patients. (Table 4)

Table 4: Intraoperative Parameters

Parameter	Category/Measure	N (%) / Mean $\pm$ SD
Intraoperative blood loss	Blood loss (mL)	144.80 $\pm$ 29.95
Plate size	5–7 holes	3 (12.00%)
	8–9 holes	16 (64.00%)
	10–12 holes	3 (12.00%)
	>12 holes	3 (12.00%)

Knee-bending exercises were initiated before the 7th postoperative day in 16 (64.00%) patients and after the 7th postoperative day in 9 (36.00%) patients. Partial weight bearing was achieved within 2–3 months in 23 (92.00%) patients and within 4–5 months in 2 (8.00%) patients. Full weight bearing was achieved within 4–5 months in 22 (88.00%) patients, while 1 (4.00%) patient achieved it within 2–3 months and 2 (8.00%) required up to 6 months. (Table 5)

Table 5: Postoperative Rehabilitation

Variable	Category	N (%)
Initiation of knee-bending exercises	<7th postoperative day	16 (64.00%)
	>7th postoperative day	9 (36.00%)
Partial weight bearing	2–3 months	23 (92.00%)
	4–5 months	2 (8.00%)
	6 months	0 (0.00%)
Full weight bearing	2–3 months	1 (4.00%)
	4–5 months	22 (88.00%)
	6 months	2 (8.00%)

Radiological union was achieved within 18 weeks in 22 (88.00%) patients, including 7 (28.00%) patients who united before 16 weeks and 15 (60.00%) between 16–18 weeks. Two (8.00%) patients achieved union at 19–20 weeks, while 1 (4.00%) patient developed non-union. No patient demonstrated union during the 21–22-week interval. (Table 6)

Table 6: Radiological Time to Union

Radiological outcome	N (%)
<16 weeks	7 (28.00%)
16–18 weeks	15 (60.00%)
19–20 weeks	2 (8.00%)
21–22 weeks	0 (0.00%)
Non-union	1 (4.00%)

Postoperative complications were absent in 22 (88.00%) patients. Limb shortening of 1 cm and 2 cm occurred in 1 (4.00%) patient each, while non-union was observed in 1 (4.00%) patient, indicating a low overall complication rate following fixation with a locking compression plate. (Table 7)

Table 7: Postoperative Complications

Complication	N (%)
None	22 (88.00%)
Limb shortening by 1 cm	1 (4.00%)
Limb shortening by 2 cm	1 (4.00%)
Non-union	1 (4.00%)

At one-year follow-up, the functional outcome assessed using Neer's score was excellent in 15 (60.00%) patients and good in 7 (28.00%) patients, giving an excellent or good functional outcome in 22 (88.00%) patients. Fair and poor outcomes were observed in 2 (8.00%) and 1 (4.00%) patients, respectively. (Table 8)

Table 8: Functional Outcome According to Neer's Score at 1 Year

Neer's score	N (%)
Excellent	15 (60.00%)
Good	7 (28.00%)
Fair	2 (8.00%)
Poor	1 (4.00%)

DISCUSSION

The present study demonstrated a predominance of distal femur fractures among young to middle-aged adults, with the 31–40-year age group being the most frequently represented and males comprising 84% of the cohort. This demographic pattern is consistent with previous studies. Singh et al. reported a mean age of 45.3 years with a range of 18–62 years, while Khajotia et al. reported a mean age of 40.56 years [11,19]. Similarly, Prakash et al. found that nearly half of their patients were aged 21–40 years, and Saini et al. reported a mean age of 45.9 years with the largest proportion between 20–40 years [15,20]. Male predominance was also reported by Singh et al., Khajotia et al., Prakash et al., and Saini et al. [11,15,19,20].

The predominance of road traffic accidents in the present study, accounting for 80% of cases, further supports the association of distal femur fractures with high-energy trauma in younger and middle-aged adults. Khajotia et al. reported RTA in 68.8% of cases, while Hiremath et al. reported 70%, demonstrating a similar etiological pattern [19,21].

The fracture characteristics in the present study showed a predominance of closed injuries (72%) and Müller type A1 fractures (64%). The proportion of closed injuries was comparable to that reported by Hiremath et al., who observed 80% closed fractures, and Patil et al., who reported 84% closed injuries [21,22]. However, the fracture pattern differed from some published series. Prakash et al. predominantly included complex intra-articular AO type C fractures, with C2 fractures accounting for 73.5%, whereas Saini et al. reported a more heterogeneous distribution of A and C fracture types [15,20]. Patil et al. reported A3 fractures as the most common pattern [22]. These differences are likely related to variations in inclusion criteria, trauma severity, referral patterns, and study populations. The predominance of relatively simpler extra-articular fractures in the present cohort may have contributed to the favorable fixation and healing outcomes observed.

The present study demonstrated favorable operative and radiological outcomes following locking compression plate fixation. Most procedures were completed within 90 minutes, with a mean intraoperative blood loss of 144.80 ± 29.95 mL. This blood loss was lower than the 200 mL reported by Bhimani et al. and slightly lower than the 157.5 mL reported by Hiremath et al. [21,23]. Radiological union was achieved in 96% of patients, with 60% achieving union within 16–18 weeks and only one patient developing non-union. These findings compare favourably with Khajotia et al., who reported a 100% union rate with a mean union time of 14.3 weeks, and Saini et al., who reported union in all patients [15,19]. Singh et al. documented union in the majority of patients within six months, while Hiremath et al. reported a mean union time of 18.15 weeks with a 90% union rate [11,21]. Thus, the present findings support the ability of locking compression plates to provide stable fixation and predictable fracture healing.

Functional recovery was also favourable, with 60% of patients achieving an excellent Neer's score and 28% achieving a good score at one year, resulting in 88% excellent-to-good outcomes. This compares favourably with Singh et al., who reported predominantly excellent and satisfactory outcomes, Hiremath et al., who documented 75% excellent-to-good results, and Khajotia et al., who reported 84.4% excellent-to-good outcomes [11,19,21]. The present study also demonstrated a low complication burden, with 88% of patients experiencing no complications and only one case of non-union. Singh et al. and Hiremath et al. reported higher rates of infection, delayed union, stiffness, and non-union, while Saini et al. reported only one superficial infection, broadly comparable to the favorable complication profile of the present study [11,15,21]. Early knee mobilization, achieved within the first postoperative week in 64% of patients, together with progressive weight bearing, may have contributed to the favourable functional recovery. Overall, the findings support locking compression plating as an effective treatment option for distal femur fractures, providing reliable union, low complication rates, and satisfactory long-term knee function when appropriate fixation and rehabilitation principles are followed.

CONCLUSION

The present study demonstrates that distal femur fractures treated with Locking Compression Plate predominantly affected middle-aged males and were most commonly caused by high-energy road traffic accidents, with closed extra-articular (Müller type A1) patterns being the most frequent. Although a majority underwent surgery after one week of trauma, operative time was generally under 90 minutes with minimal intraoperative blood loss. Early knee mobilization was initiated in most patients, partial weight bearing was achieved within three months in nearly all cases, and full weight bearing was attained by five months in the majority. Radiological union occurred within 18 weeks in most patients, with a very low incidence of non-union. Complications were infrequent and largely minor, and functional assessment at one year revealed predominantly excellent to good outcomes. Overall, Locking Compression Plate fixation provided stable fracture control, reliable healing, early rehabilitation, and satisfactory functional recovery with minimal morbidity.

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