



Original Article

Functional Outcomes of Retrograde Nailing vs Plating in Distal Femur Fractures: A Prospective Study

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ABSTRACT

Background: Distal femoral fractures are debilitating injuries that impair knee function and mobility, typically resulting from high-energy trauma in younger adults and low-energy falls in the elderly. Surgical fixation has largely replaced conservative management to permit early mobilisation, with retrograde intramedullary nailing (IMN) and open reduction and internal fixation (ORIF) with plating being the two most widely used options. IMN provides stable fixation with minimal soft-tissue disruption, whereas plating allows accurate anatomical reduction in complex fracture patterns. This study compares the clinical and radiological outcomes of these two techniques.

Materials and Methods: A prospective observational study was conducted over 18 months at AIMS & RC Hospital, Rajasthan, including 54 adult patients (≥ 18 years) with distal femur fractures requiring surgery. Patients were randomly allocated into two equal groups: Group 1 (nailing) and Group 2 (plating), with 27 patients in each. Standard IMN or ORIF with plating was performed, and patients were followed up at 2 and 6 weeks post-operatively. Outcome measures included operative time, postoperative pain assessed using the Visual Analog Scale (VAS), time to partial mobilisation, time to radiological union, complications, and functional outcome using Neer's score. Statistical analysis was performed with significance set at $p < 0.05$.

Results: Baseline demographic and injury characteristics were comparable between groups. Operative time and early postoperative pain did not differ significantly. However, patients treated with plating achieved earlier mobilisation and faster fracture union than those treated with nailing. Overall complication rates were similar, with pattern-specific issues such as nail impingement in the nailing group and joint stiffness in the plating group, while infection occurred in both. Functional outcomes measured by Neer's score were comparable, with a similar proportion of excellent results in each group.

Conclusion: Both retrograde IMN and ORIF with plating are effective, reliable options for distal femur fractures when appropriately selected according to fracture morphology. Plating offers a modest advantage in terms of earlier mobilisation and faster union, while overall functional outcomes and complication rates remain comparable between the two methods.

Keywords: Distal femur fracture; Retrograde intramedullary nailing; Open reduction and internal fixation; Plating

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INTRODUCTION

A distal femoral fracture is defined as any fracture occurring within 15 cm of the distal articular surface of the femur [1]. Distal femur fractures make up less than 1% of all fractures and approximately 3% to 6% of all femoral fractures and typically occur due to high-energy trauma, such as motor vehicle accidents in younger adults or low-energy falls in the

elderly population [2]. The distal femur plays a vital role in weight-bearing and knee joint stability [3], and fractures in this region pose significant challenges because of the complex anatomy and proximity to the knee joint [4]. These injuries often involve the articular surface and are commonly associated with severe comminution, soft tissue damage, and metaphyseal bone loss, which can complicate management and delay rehabilitation [5]. Additionally, complications such as malunion, nonunion, knee stiffness, and infection are relatively frequent, further affecting long-term function [6]. Over the years, the management of distal femur fractures has shifted from conservative methods such as skeletal traction and cast immobilisation to surgical fixation techniques that allow early mobilisation and anatomical restoration [7,8]. Currently, internal fixation methods like retrograde intramedullary nailing (IMN) and open reduction and internal fixation (ORIF) using locking compression plates (LCP) are the most widely used approaches [8]. The primary goals of surgical management include restoring limb alignment, achieving stable fixation, preserving the biological environment for healing, and enabling early rehabilitation [9].

Retrograde intramedullary nailing has gained wide acceptance due to its minimally invasive nature, limited soft tissue disruption, good mechanical stability and load sharing, and preservation of the fracture hematoma, which facilitates biological healing [10,11]. The intramedullary location of the nail provides good mechanical stability and load sharing. However, concerns persist regarding anterior knee pain and difficulty in distal locking in comminuted fractures [10,12].

In contrast, open reduction and internal fixation with locking compression plates offers superior control over fracture fragments, enabling accurate anatomical reduction and stable fixation, especially in complex, intra-articular, or osteoporotic fractures [9,13]. The locking plate system allows for fixed-angle stability, minimising the risk of secondary displacement and providing better outcomes in patients with poor bone quality [5,13]. However, plating is associated with higher risks of soft tissue injury, infection, and delayed healing due to its more extensive surgical exposure [4].

Although both techniques are widely practised, there is still no clear consensus regarding the superiority of one method over the other. Therefore, the present study was conducted to compare the functional outcomes of retrograde intramedullary nailing and plating in patients with distal femur fractures. The comparison includes evaluation of demographic parameters, operative details, postoperative complications, union time, and overall functional recovery using Neer's scoring system to determine which method provides superior clinical and radiological outcomes.

MATERIALS AND METHODS

Study Design: This study was a **prospective observational study** conducted to compare retrograde nailing versus plating in the management of distal femur fractures.

Study Duration: The study was carried out over a period of **18 months**, wherein **6 weeks** of treatments were provided, with patient follow-up visits at **week 2 and week 6** post-surgery.

Study Area: The study was carried out at **AIMS & RC hospital, Rajasthan**, where patients with distal femur fractures admitted to the **Orthopaedic ward and undergoing surgical intervention** were included.

Study Population: The study population comprised patients presenting with a **fracture of the distal femur** to the **inpatient department (IPD)** of the **Department of Orthopaedics** at the study centre.

Inclusion Criteria:

- Adults aged 18 years and above of both sexes.
- Patients diagnosed with distal femur fractures requiring surgical intervention.

Exclusion Criteria:

- Pathological fractures of the femur were excluded.

Sample Size: A total of **54 patients** were enrolled and randomly divided into two groups (**27 in each group**) based on the surgical intervention they received. **Group 1 (Retrograde Nailing Group)** and **Group 2 (Plating Group)** consisted of patients who underwent retrograde intramedullary nailing (IMN) and open reduction and internal fixation (ORIF), respectively, for the treatment of distal femur fractures.

Sampling Methodology: A **purposive sampling technique** was employed, where all eligible patients meeting the inclusion criteria during the study period were enrolled.

Data Collection and Procedure:

- All patients underwent a detailed clinical and demographic evaluation (age, gender, residence, education, socio-economic background, religion, fracture laterality and cause), including history-taking and routine preoperative investigations.

- Radiographic investigations (X-rays or CT scans) were performed for fracture classification, preoperative planning and postoperative inspection.
- Patients underwent retrograde intramedullary nailing (IMN) or open reduction and internal fixation (ORIF) with locking compression plating, as per their respective groups, performed by orthopaedic surgeons following standard surgical protocols.
- Postoperative care and rehabilitation were initiated based on standardised physiotherapy protocols.
- Clinical and operative outcomes were evaluated. Postoperative pain assessment using the Visual Analog Scale (VAS), partial weight-bearing mobilisation time, operative time and union time were recorded.
- Functional outcomes were assessed using Neer's Score (Annexure 1) at follow-up visits.

Data Analysis:

- Data were recorded systematically and analysed using SPSS software (version 26.0).
- Continuous variables were expressed as mean \pm standard deviation (SD), and categorical variables were presented as frequencies and percentages.
- Comparative analysis between the two groups was performed using the independent t-test or Mann-Whitney U test for continuous variables and the chi-square test for categorical data.
- A p-value of <0.05 was considered statistically significant.

Ethical Considerations:

- Ethical approval was obtained from the Institutional Ethics Committee before the commencement of the study, which followed the Declaration of Helsinki.
- Patient confidentiality was strictly maintained by anonymising personal data and securely storing medical information.
- Written informed consent was obtained from all patients before inclusion in the study.
- All surgical interventions followed standard safety protocols, with anaesthesia coverage and post-surgical monitoring provided as per institutional guidelines.

RESULTS

The study population had a mean age of 41.96 ± 10.50 years in the nailing group and 44.15 ± 7.75 years in the plating group ($p = 0.325$). Gender distribution showed 55.56% males and 44.44% females in the nailing group, and 70.37% males and 29.63% females in the plating group, with no significant difference ($\chi^2 = 0.715$, $p = 0.398$).

The nailing and plating groups were similar in terms of baseline socio-demographic characteristics (Table 1). The distribution of participants across areas of residence, educational level, socio-economic status, and religion was comparable between the two groups, with no statistically significant differences observed. The distribution of participants according to the side of fracture and cause of fracture was similar between the two groups, with no statistically significant differences observed (Table 2).

The nailing and plating groups showed comparable pain levels as measured by the Visual Analog Scale, with no statistically significant difference (Table 3). However, the plating group achieved earlier partial weight-bearing mobilisation and faster fracture union, both of which were statistically significant. Operative time was slightly longer in the plating group, but this difference was not statistically significant. The majority of patients in both groups experienced no complications (Table 4). The nailing group had a few cases of nail impingement and delayed union, whereas the plating group showed a small incidence of stiffness and delayed union. Surgical site infections occurred equally in both groups.

The overall Neer's scores and functional grading were comparable between the nailing and plating groups (Table 5). There were no statistically significant differences in mean Neer's scores or in the distribution of patients across the Neer's grade categories (poor, fair, good, excellent).

Table 1: Socio-demographic profile of study participants

Characteristic	Category	Nailing Group (n, %)	Plating Group (n, %)	Statistical Analysis
Area of residence	Urban	15 (55.56)	14 (51.85)	$\chi^2 = 0.00$, $p = 1.00$
	Rural	12 (44.44)	13 (48.15)	
Education	Primary	4 (14.81)	2 (7.41)	$p = 0.576$
	Secondary	5 (18.52)	9 (33.33)	
	Higher Secondary	6 (22.22)	4 (14.81)	
	Graduate	6 (22.22)	8 (29.63)	
	Post Graduate	6 (22.22)	4 (14.81)	
Socio-economic status	Lower	8 (29.63)	7 (25.93)	$\chi^2 = 3.24$, $p = 0.356$

	Lower Middle	5 (18.52)	7 (25.93)	
	Upper Middle	9 (33.33)	5 (18.52)	
	Upper	5 (18.52)	8 (29.63)	
Religion	Hindu	15 (55.56)	15 (55.56)	$\chi^2 = 0.381, p = 0.827$
	Muslim	11 (40.74)	10 (37.04)	
	Others	1 (3.70)	2 (7.41)	

Table 2: Distribution of laterality and cause among study participants

Characteristic	Category	Nailing Group (n, %)	Plating Group (n, %)	Statistical Analysis
Side of fracture	Left	14 (51.85)	15 (55.56)	$\chi^2 = 0.00, p = 1.00$
	Right	13 (48.15)	12 (44.44)	
Cause of fracture	Accidental fall	15 (55.56)	9 (33.33)	p = 0.17
	Road traffic accident	11 (40.74)	15 (55.56)	
	Assault	0 (0.00)	0 (0.00)	
	Fall from height	0 (0.00)	2 (7.41)	
	Others	1 (3.70)	1 (3.70)	

Table 3: Comparison of clinical and operative outcomes between nailing and plating groups

Parameter	Nailing Group (Mean ± SD)	Plating Group (Mean ± SD)	p-value
Visual Analog Scale (VAS)	4.89 ± 1.91	4.19 ± 2.11	0.205
Partial weight-bearing mobilisation time (days)	6.96 ± 1.87	4.85 ± 2.10	0.003
Operative time (minutes)	81.47 ± 9.40	87.34 ± 12.28	0.058
Union time (weeks)	15.48 ± 2.34	11.89 ± 2.06	<0.001

Table 4: Postoperative complications in nailing and plating groups

Complication	Nailing Group (n, %)	Plating Group (n, %)
None	19 (70.37)	20 (74.07)
Delayed union	2 (7.41)	1 (3.70)
Nail impingement	3 (11.11)	0 (0.00)
Surgical site infection	3 (11.11)	3 (11.11)
Stiffness	0 (0.00)	3 (11.11)

Table 5: Postoperative Neer's score and functional outcomes in study groups

Parameter	Nailing Group	Plating Group	p-value	
Neer's Score (Mean ± SD)	83.11 ± 11.35	82.59 ± 11.58	0.856	
Neer's Grade (n, %)	Poor	4 (14.81)	5 (18.52)	0.726
	Fair	6 (22.22)	4 (14.81)	
	Good	6 (22.22)	9 (33.33)	
	Excellent	11 (40.74)	9 (33.33)	

DISCUSSION

The present study assessed the functional outcome of distal femur fractures using Neer's Score, which were treated with retrograde interlocked nailing compared with locked compression plating. The mean ages were similar between the retrograde nailing group (41.96 ± 10.50 years) and the plating group (44.15 ± 7.75 years; p = 0.325), consistent with previous studies showing distal femur fractures are common in young to middle-aged adults. Comparable age ranges were reported by **Kumar et al. (2014)** [14] and **Aterkar (2020)** [15] (mean 52.6 years). Both groups showed a higher proportion of males (55.56% in the nailing group, 70.37% in the plating group), but this difference was not significant (p = 0.398). Other studies reported similar trends, wherein, **Vikranth et al. (2019)** [16] found 66.6% male patients with locking compression plates, while **Aterkar (2020)** [15] observed a 17:3 male-to-female ratio, attributing it to males' greater involvement in road accidents and high-energy injuries.

Among patients, 55.56% in the nailing group and 51.85% in the plating group were from urban areas, with the remainder from rural regions; this difference was not statistically significant (p = 1.0), indicating residence did not impact surgical choice. Educational status was similar between the two groups (p = 0.576). The nailing group included more patients with postgraduate or higher secondary education, while the plating group had more with secondary-level education. Although educational background does not directly determine fixation method choice, it may impact postoperative outcomes through treatment adherence and rehabilitation participation. Prior research by **Prakash et al. (2025)** [17] and **Aterkar (2020)** [15] highlighted early mobilisation and rehabilitation as crucial for recovery, which may be affected by patient awareness linked to education.

Socio-economic status was distributed evenly between groups, with no significant difference ($p = 0.356$). Both nailing and plating were used across economic classes, suggesting accessibility was similar regardless of income. While socio-economic factors can affect healthcare access and outcomes, the study's standardized protocols and support at a tertiary centre likely minimized such disparities, allowing an equitable comparison between interventions. Both groups had similar proportions of Hindu and Muslim patients (55.56% Hindu in each; 40.74% and 37.04% Muslim in nailing and plating groups, respectively), with no significant difference ($p = 0.827$). While religious affiliation might affect cultural practices related to care, it did not influence clinical outcomes in either group.

Fracture laterality was nearly even between groups, with no significant difference ($p = 1.0$). This matches findings by **Konuganti et al. (2018)** [18] and **Prasad and Sandhu (2020)** [1], who also found no side predominance in distal femur fractures. The data suggest trauma mechanism, not limb dominance, drives fracture occurrence. Road traffic accidents (RTAs) were the leading cause in the plating group (55.56%), while falls predominated in the nailing group (55.56%). Although not statistically significant ($p = 0.17$), this trend suggests treatment selection may relate to injury mechanism. High-energy trauma like RTAs often leads to complex fractures (AO Type C), where plating is preferred for better anatomical reduction, as reported by **Kumar et al. (2014)** [14]. **Prakash et al. (2025)** [17] also found that 90% of distal femur fractures resulted from RTAs, highlighting a shift toward younger patients with high-energy injuries. Conversely, low-velocity trauma such as falls tends to cause simpler fractures, making retrograde nailing suitable, especially for younger patients with good bone quality.

Postoperative pain, assessed via the Visual Analog Scale (VAS), showed no significant difference between nailing (mean 4.89 ± 1.91) and plating (mean 4.19 ± 2.11) groups ($p = 0.205$), indicating similar pain control with standardized analgesia. **Kale et al. (2025)** [19] found comparable results; at six months, VAS scores dropped to 2.8 ± 1.02 , confirming effective pain reduction through appropriate fixation and rehabilitation. The mean time to mobilisation was longer with retrograde nailing (6.96 ± 1.87 days) than plating (4.85 ± 2.10 days) ($p = 0.003$). This delay may be due to cautious weight bearing in less stable fractures or alignment issues during intramedullary fixation. Locking compression plating improves stability and anatomical restoration, enabling earlier mobilisation [17]. However, **Ahmed et al. (2024)** [20] and **Agarwal et al. (2018)** [21] report earlier partial or full weight bearing with nailing versus plating, possibly reflecting differences in fracture types, fixation stability, and rehabilitation protocols.

The mean operative time was shorter for the nailing group (81.47 ± 9.40 minutes) than for the plating group (87.34 ± 12.28 minutes), though this difference was not statistically significant ($p = 0.058$). This likely stems from the streamlined procedure of retrograde intramedullary nailing, which is less invasive and involves fewer steps. **Yadav et al. (2021)** [22] similarly found that nailing had a mean operative time of 77 ± 4 minutes compared to 87.5 ± 5 minutes for plating, concluding that nailing offers reduced duration, smaller incisions, and better cosmetic results. Fracture union took significantly longer in the nailing group (15.48 ± 2.34 weeks) than in the plating group (11.89 ± 2.06 weeks, $p < 0.001$). The extended healing time in the nailing group may be due to a higher percentage of unstable metaphyseal fractures, which are more difficult to fix securely with nails. This aligns with **Ankadava and Nazim (2025)** [4], who reported a similar union time for distal femur fractures treated with nailing. In contrast, **Lal et al. (2018)** [23] and **Kumar et al. (2014)** [14] found most LCP-treated cases united within 10–12 weeks, matching our plating group's results. These differences underscore the impact of fracture type and fixation method on healing.

Postoperative complications were low and similar between groups (complication-free: nailing 70.37%, plating 74.07%). Delayed union was more common with nailing (7.41%) than plating (3.70%), often due to metaphyseal instability and nail impingement (11.11% in nailing group). Joint stiffness occurred only with plating (11.11%), likely due to greater soft-tissue dissection, consistent with **Aterkar (2020)** [15]. Surgical site infection rates were identical (11.11%), indicating that standard aseptic procedures control infection risk for both methods.

The mean Neer's scores were similar for nailing (83.11 ± 11.35) and plating (82.59 ± 11.58) groups ($p = 0.856$), both indicating good outcomes. Excellent results occurred in 40.74% of the nailing group and 33.33% of the plating group, with poor outcomes in 14.81% and 18.52%, respectively ($p = 0.726$). These results align with **Ahmed et al. (2024)** [20] confirming no significant difference in functional efficacy between distal femoral nailing and plating.

Overall, retrograde intramedullary nailing and locking compression plating are effective treatments for distal femur fractures with similar functional outcomes. Plating allows for slightly faster healing and earlier mobilisation, while nailing offers a shorter operation and less tissue disruption. Complication rates are alike, so the choice should be based on fracture type, bone quality, and surgeon experience, as both methods can achieve good results.

CONCLUSION

Both retrograde intramedullary nailing and open reduction and internal fixation with plating proved to be effective fixation methods for distal femur fractures, with comparable demographic characteristics, operative duration, pain (VAS), and functional outcomes (Neer's scores). However, plating demonstrated clear advantages in terms of earlier mobilisation and faster fracture union. The overall complication rates were similar between groups, though nail

impingement occurred exclusively with nailing and joint stiffness was noted only with plating. These findings indicate that both fixation techniques are effective and reliable when appropriately selected based on fracture characteristics, with plating offering a modest advantage in terms of recovery and union time. Further large-scale, long-term studies are warranted to validate these observations and refine fixation strategies for optimal patient outcomes.

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Representative Images:

Case 1 – A 29-year-old male who suffered a distal femur fracture due to a road traffic accident and underwent retrograde intramedullary nailing (IMN).

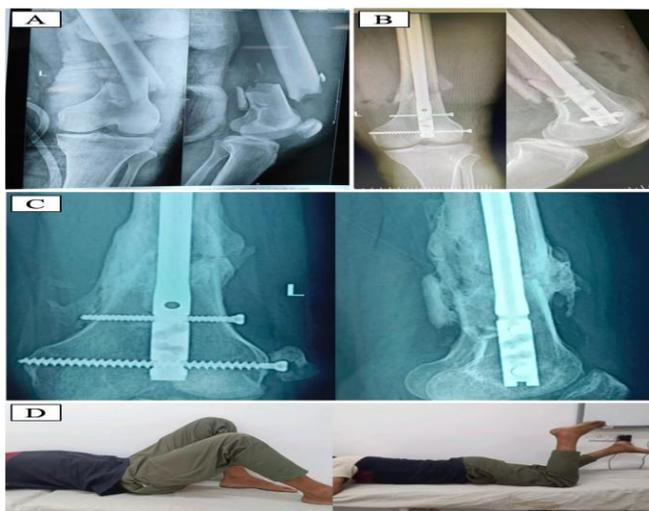


Fig. 1: (A) Preoperative radiograph showing an AO A1 type fracture. (B) Postoperative radiograph showing proper fixation and alignment of the fracture using IMN. (C) Follow-up radiograph indicates maintained alignment and healing. (D) Clinical photographs at follow-up displayed full, pain-free knee movements in multiple planes, signifying excellent functional recovery and restoration of knee range of motion.

Case 2 – A 39-year-old male who suffered a distal femur fracture due to a road traffic accident and underwent open reduction and internal fixation (ORIF).



Fig. 2: (A) Preoperative radiograph showing an AO C2 type fracture. (B) Postoperative radiograph showing proper fixation and alignment of the fracture using ORIF. (C) Follow-up radiograph indicates maintained alignment and healing. (D) Clinical photographs at follow-up displayed full, pain-free knee movements in multiple planes, signifying excellent functional recovery and restoration of knee range of motion.

Annexure 1: Scoring System

- The Neer's Scoring System consists of functional and anatomical components that aid in quantifying the functional outcome of distal femur fractures, with points allocated as follows:

Functional (70 points)		
A.	Pain	20 points
B.	Walking Capacity	20 points
C.	Joint Movement	20 points
D.	Work Capacity	10 points
Anatomical (30 points)		
A.	Gross Anatomy	15 points
B.	Roentgenogram	15 points

- A higher score indicates a better functional outcome, with results typically graded as:

Excellent	>85
Good	70-85
Fair	56-69
Poor	<55