International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

Retrograde Intramedullary Nailing Versus Plating for Distal Femur Fractures: A Prospective Comparative Study

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Received: 07-02-2026
Accepted: 10-03-2026
Available online: 12-03-2026

ABSTRACT

Background: Distal femur fractures are technically demanding injuries because they occur near the knee, are often associated with high-energy trauma in younger adults, and require stable fixation that permits early mobilization.
Objectives: To compare operative characteristics, time to union, postoperative complications, and functional outcomes between retrograde intramedullary nailing and plating in adult distal femur fractures.
Methods: This hospital-based prospective comparative study was conducted in the Department of Orthopaedics, Maharajah's Institute of Medical Sciences, over 18 months. Sixty adults with distal femur fractures were treated with either retrograde intramedullary nailing or plate fixation, with 30 patients in each group. Demographic details, fracture subtype, operative duration, time to union, complications, and knee function were recorded. Functional outcome was assessed using the Lysholm and Gillquist knee scoring scale.
Results: Patients were predominantly aged 31-40 years, male, and injured in road traffic accidents. Müller A1 fractures were the most common subtype. Mean operative time was shorter with retrograde nailing than with plating (82.5 vs 107.5 minutes). Mean time to union was also lower in the retrograde nailing group (13.07 ± 2.91 vs 14.93 ± 2.49 weeks). Infection and knee pain/restricted range of motion occurred only in the plating group. Excellent functional outcome was achieved in 60.0% of the retrograde nailing group and 53.33% of the plating group, with no statistically significant difference in overall functional outcome.
Conclusion: Retrograde intramedullary nailing demonstrated shorter operative time and earlier fracture union, while both techniques provided broadly comparable complication profiles and functional recovery. Retrograde nailing appears to be an effective option for extra-articular distal femur fractures when fracture configuration permits its use.

Keywords*: Distal femur fracture; retrograde intramedullary nailing; plating; fracture union; functional outcome.*

INTRODUCTION

Distal femur fractures account for a relatively small proportion of all fractures, yet they present a disproportionate surgical challenge because they involve the metaphyseal region close to the knee, where restoration of alignment, rotation, length, and joint mechanics is essential for good function [1-3]. Epidemiological studies have shown a characteristic bimodal distribution. Younger patients, especially men, typically sustain these injuries after high-energy mechanisms such as road

traffic collisions, whereas older patients, particularly women, often present after low-energy falls in the setting of osteopenia or osteoporosis [1,2]. This dual pattern explains the wide clinical spectrum of distal femur fractures, ranging from simple extra-articular supracondylar injuries to highly comminuted patterns with substantial soft-tissue compromise [2,3].

The objectives of treatment are stable fixation, preservation of biology at the fracture site, restoration of mechanical axis, and early mobilization of the knee [3]. Over time, operative management has evolved from conventional open plating to biologically friendly fixation strategies that aim to minimize soft-tissue stripping and preserve periosteal blood supply. The development of minimally invasive locked plating systems expanded the indications for plate osteosynthesis and improved fixation in metaphyseal bone [4,5]. In parallel, retrograde intramedullary nails became an attractive option for many extra-articular and selected intra-articular distal femur fractures because they are load-sharing devices inserted through a less extensive exposure and can facilitate shorter operative time and earlier rehabilitation in appropriate fracture patterns [3].

Despite these advances, the optimal implant for distal femur fractures remains debated. Contemporary evidence suggests that both locking plates and retrograde nails can achieve satisfactory union, but differences have been reported in infection, nonunion, operative duration, knee motion, and implant-related complications [6-9]. A recent Cochrane review emphasized that the available comparative evidence is still limited by heterogeneity and study quality, while meta-analytic data have suggested potential advantages of retrograde nailing in union-related outcomes and infection profiles in selected settings [6,8,9]. Because implant choice is influenced by fracture configuration, bone quality, soft-tissue condition, and surgeon experience, prospective institutional data remain clinically relevant, particularly for extra-articular distal femur fractures managed in routine practice [3,7].

Against this background, the present study was undertaken to compare retrograde intramedullary nailing and plating in adult distal femur fractures treated at a tertiary care center. The specific objectives were to describe the demographic and injury profile of the study population, compare operative time and fracture union between the two fixation methods, evaluate postoperative complications, and assess functional outcome using the Lysholm and Gillquist knee scoring scale.

MATERIALS AND METHODS

STUDY DESIGN AND SETTING

This was a hospital-based, prospective, comparative study conducted in the Department of Orthopaedics, Maharajah's Institute of Medical Sciences, Vizianagaram, over a period of 18 months. The study included adult patients presenting to the outpatient and inpatient services with newly diagnosed distal femur fractures considered suitable for operative fixation. A total of 60 patients were enrolled, and definitive fixation was performed with either retrograde intramedullary nailing or plating, with 30 patients in each group.

PARTICIPANTS AND SELECTION CRITERIA

Patients aged more than 20 years with distal femur fractures involving the supracondylar region and extra-articular Müller type A1, A2, or A3 patterns were considered eligible for inclusion. Compound fractures up to Gustilo-Anderson grade IIIA were included when soft-tissue condition permitted definitive fixation [10]. Patients aged less than 20 years, those with more severe open injuries, pathological fractures, or major comorbid ailments that could substantially influence perioperative recovery were excluded from the study.

PREOPERATIVE EVALUATION AND OPERATIVE MANAGEMENT

After admission, all patients underwent detailed clinical assessment, routine laboratory investigations, and standard radiographic evaluation of the affected femur and knee. Fracture morphology was assessed on anteroposterior and lateral radiographs, and classification was recorded according to the Müller system for distal femur fractures [2,3]. Computed tomography was obtained when radiographs suggested complex metaphyseal configuration or possible articular extension. The injured limb was immobilized before surgery. In compound injuries, initial wound assessment, debridement, irrigation, and stabilization were undertaken on an emergency basis according to open-fracture principles [10]. Definitive fixation was then carried out using either retrograde intramedullary nailing or plate osteosynthesis, depending on fracture characteristics and intraoperative decision-making.

POSTOPERATIVE REHABILITATION AND FOLLOW-UP

Standard postoperative rehabilitation was followed in both groups. Static quadriceps exercises were started on the first postoperative day. Knee range-of-motion exercises were initiated after the early dressing change, and non-weight-bearing ambulation with walker support and supervised gait training were begun as tolerated. Patients were typically discharged after wound review and suture removal. Follow-up visits were scheduled at 6, 12, and 20 weeks after surgery and then at three-month intervals until radiological union. At each visit, patients underwent clinical examination, assessment of knee movement, and radiographic evaluation for progression of fracture healing.

OUTCOME MEASURES AND STATISTICAL ANALYSIS

The main study outcomes were operative time, time to union, postoperative complications, and functional outcome. Union time was recorded in weeks based on combined clinical and radiological evidence of healing. Postoperative complications assessed included infection, rotational deformity, limb length discrepancy, and knee pain or restricted range of motion. Functional assessment was performed using the Lysholm and Gillquist knee scoring scale, classifying results as excellent, good, fair, or poor [11]. Categorical variables were summarized as frequency and percentage, whereas continuous variables were described using mean and standard deviation. Group comparisons were interpreted using the reported p-values, and a p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 60 patients with distal femur fractures were included in the study, with 30 patients in the retrograde nailing group and 30 patients in the plating group. The age of the patients ranged from 20 to 65 years. Most patients were aged 31-40 years. Males were affected more frequently than females, with a male-to-female ratio of 1.31:1. Road traffic accident was the predominant mechanism of injury. Among the Müller fracture subtypes, A1 fractures were the most common.
The baseline demographic and injury profile of the study population is presented in Table 1.

Table 1. Baseline demographic and injury characteristics of the study population (N = 60)

Variable	Category	n	%
Age group (years)	20-30	12	20.00
	31-40	24	40.00
	41-50	16	26.67
	>50	8	13.33
Sex	Male	34	56.67
	Female	26	43.33
Side of injury	Right	38	63.33
	Left	22	36.67
Mechanism of injury	Road traffic accident	46	76.67
	Accidental fall	14	23.33
Müller fracture subtype	A1	32	53.33
	A2	18	30.00
	A3	10	16.67

The baseline demographic and injury profile of the study population is presented in Table 1. Most fractures occurred in the 31-40 years age group (40.0%), followed by the 41-50 years group (26.67%). Males accounted for 56.67% of cases. The right side was more commonly involved than the left. Road traffic accidents (76.67%) were the leading cause of injury. With respect to fracture morphology, A1 subtype fractures (53.33%) were the most frequent.
Operative and radiological outcomes in the two treatment groups are summarized in Table 2.

Table 2. Operative and radiological outcomes in the two study groups

Outcome	Retrograde nailing group (n = 30)	Plating group (n = 30)
Mean operative time (minutes)	82.5	107.5
Mean time to union (weeks)	13.07 ± 2.91	14.93 ± 2.49

Operative and radiological outcomes in the two treatment groups are summarized in Table 2. The mean operative time was shorter in the retrograde nailing group (82.5 minutes) than in the plating group (107.5 minutes).

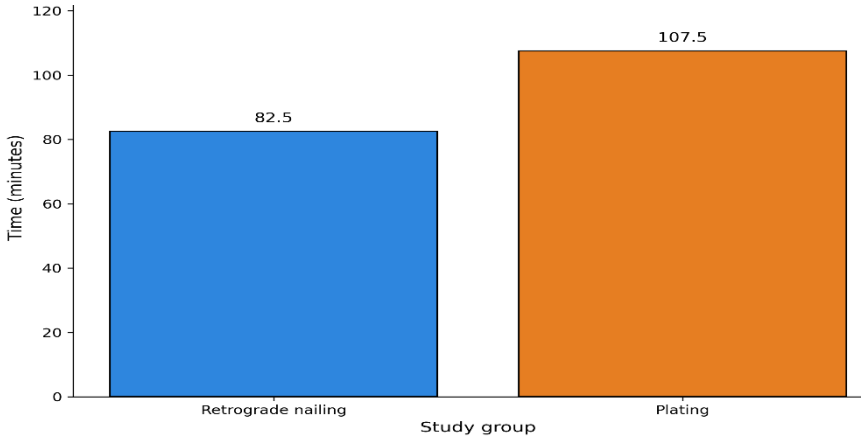

Figure 1: Mean Operative Time in the Two Study Groups

Similarly, the mean time to fracture union was lower in the retrograde nailing group (13.07 ± 2.91 weeks) compared with the plating group (14.93 ± 2.49 weeks).

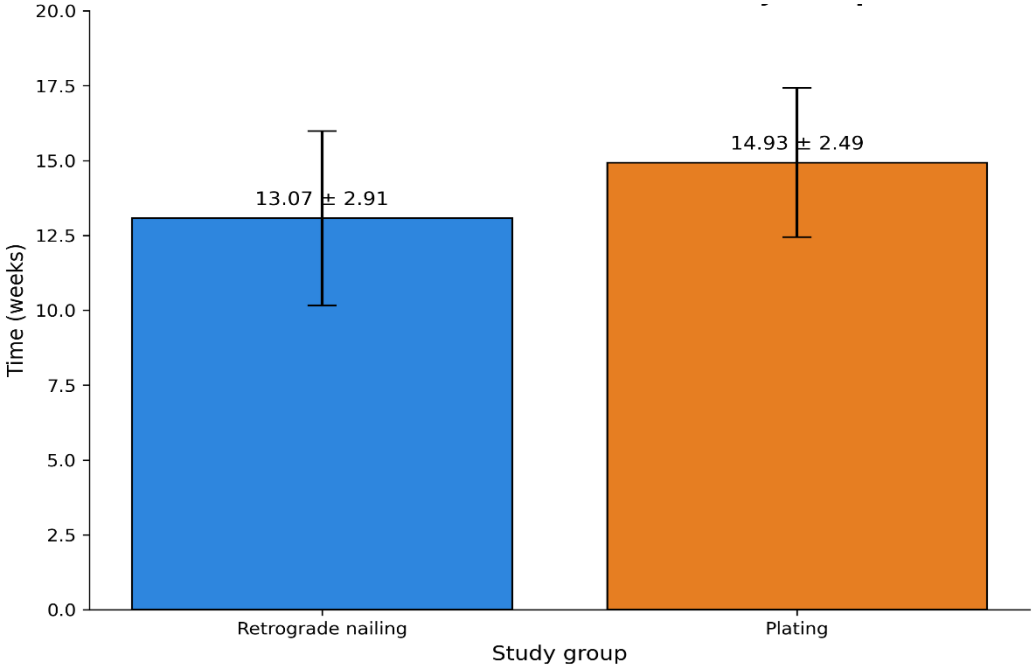

Figure 2: Mean time to Union in the two study Groups

Postoperative complications are shown in Table 3.

Table 3. Postoperative complications in the two study groups

Complication	Retrograde nailing (n = 30) n (%)	Plating group (n = 30) n (%)	p-value
Infection	0 (0.00)	2 (6.67)	0.174
Rotational deformity	2 (6.67)	1 (3.33)	1.000
Limb length discrepancy	1 (3.33)	2 (6.67)	0.686
Knee pain/restricted ROM	0 (0.00)	3 (10.00)	0.082

Postoperative complications are shown in Table 3. Complications were relatively infrequent in both groups. Infection was observed only in the plating group (6.67%), whereas rotational deformity was slightly more common in the retrograde nailing group (6.67%). Knee pain or reduced range of motion was reported only in the plating group (10.0%). None of the recorded complications showed a statistically significant difference between the groups.

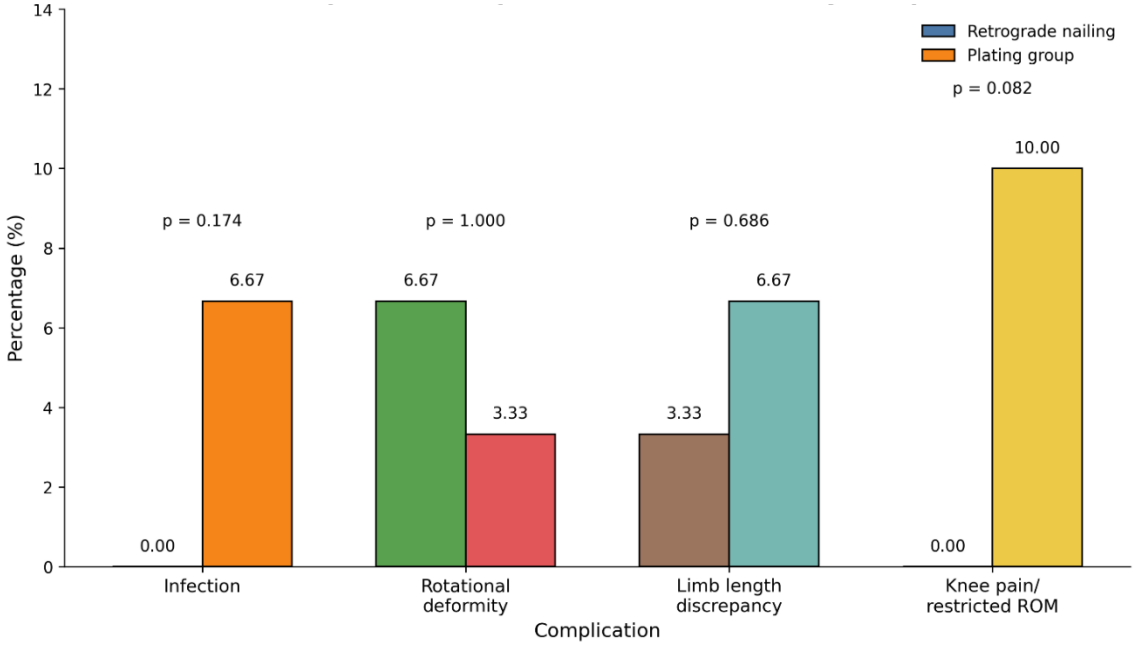

Figure 3: Postoperative Complications in the Two Study Groups

Functional outcome according to the Lysholm and Gillquist knee scoring scale is presented in Table 4.

Table 4. Functional outcome according to the Lysholm and Gillquist knee scoring scale

Functional outcome	Retrograde nailing (n = 30) n (%)	Plating group (n = 30) n (%)
Excellent	18 (60.00)	16 (53.33)
Good	6 (20.00)	6 (20.00)
Fair	4 (13.33)	6 (20.00)
Poor	2 (6.67)	2 (6.67)

Lysholm and Gillquist grading was interpreted as follows: excellent, >90; good, 84-90; fair, 65-83; and poor, <65. The p-value for comparison of functional outcome between groups was 0.490.

Functional outcome according to the Lysholm and Gillquist knee scoring scale is presented in Table 4. Functional recovery was comparable between the two groups. In the retrograde nailing group, 60.0% of patients had an excellent outcome compared with 53.33% in the plating group. Poor outcome was seen in 6.67% of patients in each group. The difference in overall functional outcome between the two groups was not statistically significant (p = 0.490).

DISCUSSION

The present prospective comparative study evaluated retrograde intramedullary nailing and plating in distal femur fractures and found a cohort dominated by younger adults, male patients, and high-energy road traffic trauma. This pattern is consistent with classic epidemiological descriptions showing that distal femur fractures in younger adults are commonly associated with severe trauma and male predominance [1,2]. The predominance of Müller type A fractures in the present series also reflects the extra-articular fracture profile for which both retrograde nailing and plate fixation are established treatment options [3].

A key finding of this study was the shorter mean operative time in the retrograde nailing group. Reduced surgical duration can limit anesthesia exposure, blood loss, and soft-tissue handling. The finding aligns with the biological and technical rationale for retrograde nailing, which generally requires a smaller exposure and functions as a load-sharing construct [3]. The earlier mean time to union in the retrograde nailing group also supports the mechanical advantage of intramedullary fixation in selected extra-articular fractures. Similar trends have been noted in comparative and pooled analyses. Demirtaş et al. reported a shorter mean union duration in the nail group than in the plating group, although the overall difference was not statistically significant [12]. More recent syntheses by Aggarwal et al. and Kim et al. also identified favorable union-related outcomes and lower infection rates with retrograde nailing in several study settings [8,9].

In the present study, infection and knee pain/restricted range of motion were encountered only in the plating group, whereas rotational deformity was slightly more frequent after retrograde nailing. Although these differences were not statistically significant, the pattern is clinically plausible. Plating requires a lateral approach and greater soft-tissue manipulation than intramedullary fixation, which can influence wound-related events, whereas nailing demands careful intraoperative attention to rotational alignment and distal locking [3,4]. The low complication burden in both groups also suggests that satisfactory outcomes can be achieved when fracture selection and operative execution are appropriate. This is consistent with prospective experience reported with biologically oriented locked plating techniques [4,5] and with the meta-analysis by Yoon et al., which found low nonunion rates with contemporary devices [7].

Functional outcome was similar between the two groups, with excellent or good results in most patients. This finding agrees with Demirtaş et al., who found no significant difference in functional outcome between bridge plating and retrograde nailing for extra-articular distal femur fractures [12]. Howard et al., in a larger comparative series, also showed that both implants can provide acceptable outcomes, although complication and union profiles differed across subgroups [13]. In more complex intra-articular settings, Yoon et al. highlighted that implant performance is influenced by metaphyseal comminution and articular extension [14]. Taken together, the current findings suggest that for extra-articular distal femur fractures, retrograde nailing offers the advantages of shorter operative time and earlier union, while plating remains an alternative when fracture anatomy, distal bone stock, or surgeon preference favors extramedullary fixation.

LIMITATIONS

This study was conducted at a single center with a modest sample size, limiting statistical power. Baseline variables were summarized for the overall cohort rather than separately for each treatment arm. Fracture-specific details such as open versus closed injury distribution, metaphyseal comminution severity, intraoperative blood loss, and exact knee motion values were not independently analyzed. Follow-up emphasized union and short-term functional recovery rather than late outcomes.

CONCLUSION

In this prospective comparative study of adult distal femur fractures, retrograde intramedullary nailing showed a shorter operative time and earlier fracture union than plating. Postoperative complications were infrequent in both groups, and no statistically significant differences were observed in complication rates or final functional outcome. Excellent or good knee function was achieved in most patients irrespective of implant. These findings indicate that both retrograde nailing and plating are valid fixation options for distal femur fractures, particularly extra-articular patterns. However, when fracture anatomy is suitable, retrograde intramedullary nailing offers practical advantages in operative efficiency and union profile, supporting its use as an effective treatment strategy in routine orthopedic practice.

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