

Retrograde Intramedullary Nailing Versus Locking Plate Fixation in Extra-Articular Distal Femur Fractures: A Prospective Study

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Learning Point of the Article:

In adult AO/OTA 33-A distal femur fractures, retrograde intramedullary nailing may enable faster surgery and rehabilitation with favorable functional and radiological outcomes.

Abstract

Introduction: Distal femur fractures require stable fixation that permits restoration of alignment and early functional recovery. Retrograde intramedullary nailing distal femur nailing (DFN) and distal femoral locking plate fixation locking compression plate (LCP) are commonly used for extra-articular fractures, but their comparative functional and radiological outcomes remain debated.

Aim: This study compared operative, functional, radiological, and complication outcomes of DFN and LCP in adult patients with extra-articular distal femur fractures.

Materials and Methods: This prospective study was conducted at the Department of Orthopaedics, Gajra Raja Medical College, Gwalior, from November 2023 to March 2025. A total of 36 adults with AO/OTA type 33-A extra-articular distal femur fractures were included, with 18 patients treated with DFN and 18 with LCP. Patients with pathological fractures, Gustilo type III open fractures, intra-articular fractures, or incomplete consent were excluded. Operative parameters, functional outcomes, radiological outcomes, time to full weight bearing, and complications were assessed.

Results: DFN was associated with significantly shorter operative time than LCP (75.67 ± 7.58 vs. 105.61 ± 10.51 min) and earlier full weight bearing (16.50 ± 3.75 vs. 26.19 ± 3.92 weeks). DFN also demonstrated significantly better knee flexion scores (17.78 ± 2.46 vs. 12.89 ± 4.01), work scores (10.00 ± 0.00 vs. 8.89 ± 1.97), roentgenogram scores (13.83 ± 2.33 vs. 11.67 ± 3.40), and total anatomical scores (28.50 ± 3.60 vs. 25.33 ± 5.37). Overall complication rates were identical (11.1% in each group; $P = 1.000$), whereas non-union was numerically less frequent with DFN (5.6% vs. 16.7%; $P = 0.603$).

Conclusion: Retrograde intramedullary nailing was associated with shorter operative time, better knee flexion, improved work-related function, superior selected radiological outcomes, and substantially earlier full weight bearing than locking plate fixation. Although overall complication rates were comparable, the findings favor DFN for clinically suitable extra-articular AO/OTA 33-A distal femur fractures. Larger randomized studies are warranted to confirm these findings.

Keywords: Distal femur, fracture, locked plating, retrograde nailing, radiological outcomes.

Introduction

Distal femur fractures remain an important source of disability because they involve the metaphyseal region close to the knee

joint, often occur after high-energy trauma in younger patients or low-energy osteoporotic falls in elderly individuals, and require fixation that restores alignment while allowing early motion

Author's Photo Gallery



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Table 1: Baseline characteristics of two study groups

Variable	Distal femur nailing (n=18)	Locking compression plate (n=18)	Test statistic	P-value
Age (years), mean±SD	38.39±14.88	45.39±18.86	t=1.261	0.225
Gender (%)				
Male sex	16 (88.9)	13 (72.2)	χ²=0.697	0.402
Female sex	2 (11.1)	5 (27.8)		
Affected side (%)				
Right	8 (44.4)	11 (61.1)	χ²=0.444	0.505
Left	10 (55.6)	7 (38.9)		
Mechanisms (%)				
RTA	9 (50.0)	14 (77.8)	χ²=1.939	0.164
Other mechanisms	9 (50.0)	4 (22.2)		
Time from injury to surgery (days), mean±SD	2.28±1.49	2.28±1.60	t=0.000	1
AO/OTA subtype distribution (%)				
AO/OTA 33A2.1	4 (22.2)	3 (16.7)	χ²=3.800	0.285
AO/OTA 33A2.2	7 (38.9)	9 (50.0)		
AO/OTA 33A2.3	4 (22.2)	6 (33.3)		
Other AO/OTA patterns	3 (16.7)	0 (0.0)		
SD: Standard deviation				

[1,2]. Epidemiologically, distal femur fractures constitute roughly 3–6% of femoral fractures and around 0.4% of all fractures, with a well-recognized bimodal distribution [3]. Management has evolved from traction and prolonged immobilization toward operative fixation, mainly because non-operative care is associated with malalignment, knee stiffness, prolonged recumbency, and poor functional recovery. Currently, the two most widely used fixation options for extra-articular AO/OTA type 33-A fractures are distal femoral locking compression plate (LCP) fixation and retrograde intramedullary nailing [4,5].

Locking plates provide angular stability and are especially useful in osteoporotic bone, comminuted metaphyseal fractures, and some very distal fracture patterns, but they may require more soft-tissue handling, longer surgery, and can be associated with delayed union or non-union when biological fixation principles are not meticulously respected [6]. By contrast, retrograde intramedullary nails offer a load-sharing construct along the mechanical axis, less soft-tissue stripping, preservation of fracture biology, and earlier progression to weight-bearing in many series [7].

Recent systematic reviews and comparative studies increasingly favor retrograde nailing for selected extra-articular distal femur fractures,

particularly with respect to operative time, union profile, infection rate and rehabilitation, although some controversy remains and implant choice still depends on fracture morphology, distal bone stock and surgeon expertise [3,5]. This study compares operative parameters, functional recovery, radiological outcomes, and complication profile between retrograde distal femur nailing (DFN) and distal femoral locking plate fixation (LCP) in adult extra-articular distal femur fractures.

Materials and Methods

Study design and setting

This prospective study was conducted in the Department of Orthopaedics at Gajra Raja Medical College, Gwalior, Madhya Pradesh, from November 2023 to March 2025. This study was approved by the Ethics Committee of the medical college vide letter number GRMC/IEC/23/1240 dated 01.10.2023. All participants provided written informed consent before enrollment in the study. This research was conducted ethically in accordance with the World Medical Association Declaration of Helsinki.

Table 2: Operative, functional and radiological outcomes between two study groups

Variable	Distal femur nailing (n=18)	Locking compression plate (n=18)	Test statistic	P-value
Duration of surgery (minutes), mean±SD	75.67±7.58	105.61±10.51	<i>t</i> =−9.586	<0.001
Pain score, mean±SD	12.22±3.99	12.44±3.85	<i>t</i> =−0.171	0.866
Function score, mean±SD	15.56±3.33	15.33±3.14	<i>t</i> =0.205	0.838
Knee flexion score, mean±SD	17.78±2.46	12.89±4.01	<i>t</i> =4.301	<0.001
Work score, mean±SD	10.00±0.00	8.89±1.97	<i>t</i> =2.331	0.028
Total functional score, mean±SD	55.56±8.58	49.56±10.73	<i>t</i> =1.908	0.073
Gross anatomical score, mean±SD	14.67±1.41	13.67±2.35	<i>t</i> =1.547	0.133
Roentgenogram score, mean±SD	13.83±2.33	11.67±3.40	<i>t</i> =2.269	0.033
Total anatomical score, mean±SD	28.50±3.60	25.33±5.37	<i>t</i> =2.127	0.046
Neer score, mean±SD	84.06±11.57	74.78±15.69	<i>t</i> =2.072	0.052
Time to full weight bearing (weeks), mean±SD	16.50±3.75	26.19±3.92	<i>t</i> =−7.664	<0.001
SD: Standard deviation				



Table 3: Complications and final outcomes between two study groups

Variable	Distal femur nailing (n=18) (%)	Locking compression plate (n=18) (%)	Test statistic	P-value
Any complication	2 (11.1)	2 (11.1)	$\chi^2=0.000$	1
No complication	16 (88.9)	16 (88.9)	-	-
Malunion	4 (22.2)	4 (22.2)	$\chi^2=0.000$	1
Non-union	1 (5.6)	3 (16.7)	$\chi^2=0.268$	0.603
Excellent final outcome	11 (61.1)	5 (27.8)	$\chi^2=4.941$	0.183
Satisfactory final outcome	6 (33.3)	9 (50.0)		
Unsatisfactory final outcome	0 (0.0)	1 (5.6)		
Poor final outcome	1 (5.6)	3 (16.7)		
SD: Standard deviation				

Study population

The study included patients presenting with extra-articular distal femur fractures. The study population comprised 36 adult patients with extra-articular distal femur fractures, with 18 patients treated by retrograde DFN and 18 by distal femoral locking plate fixation (LCP).

Sample size

Sample size was calculated using the formula for comparison of two independent means [8]. The expected difference between group means was taken from the pilot institutional data for operative time (75.67 ± 7.58 min in the DFN group and 105.61 ± 10.51 min in the LCP group), giving an expected mean difference of 29.94 min. At a 5% level of significance and 80% power, the minimum required sample size was found to be <18 subjects per group; therefore, 18 subjects per group were enrolled to improve study precision and account for possible attrition.

Inclusion criteria

The study included adults aged 18 years and above with AO/OTA type 33-A distal femur fractures (33-A1, 33-A2, or 33-A3), closed fractures or Gustilo type I/II open fractures, and a pre-injury ambulatory status without the use of assistive devices.

Exclusion criteria

Patients were excluded if they were below 18 years of age, had fractures resulting from an underlying pathological condition, sustained Gustilo Type III open fractures, did not provide

informed consent, or had any intra-articular distal femur fracture pattern.

Surgical technique

Following admission, demographic characteristics, injury details, medical history, and concurrent medical conditions were recorded. All patients underwent initial management according to Advanced Trauma Life Support principles, followed by routine clinical evaluation and pre-anesthetic assessment. Participants were randomly assigned using a random number table to either the LCP group or the DFN group. Procedures were performed in scheduled or emergency operating facilities by surgeons who had no stated preference for either fixation method.

For the LCP group, patients were positioned supine on a radiolucent operating table. Fixation was performed either by open reduction and internal fixation through a standard lateral or Swashbuckler approach or by minimally invasive plate osteosynthesis, depending on fracture characteristics.

For the DFN group, patients were positioned supine with slight knee flexion. An approximately 3-cm incision was made from the lower pole of the patella using a transpatellar tendon approach. After identification of the intercondylar notch, the guide pin was positioned just superior and medial to the femoral attachment of the posterior cruciate ligament under bidirectional fluoroscopic guidance. Following reaming of the medullary canal, an appropriately sized retrograde femoral nail was inserted and secured with at least two distal locking screws. The nail was positioned approximately 3 mm beneath the distal articular cartilage.

Functional and radiological assessment

Patients were evaluated clinically and radiologically during follow-up, with assessment of functional and radiological outcomes at 12 months. Functional assessment included pain score, general function score, knee flexion score, work score, and total functional score. Radiological and anatomical outcomes were assessed using the gross anatomical score and roentgenogram score. The Neer score was also assessed at 12 months. Time to full weight bearing and post-operative complications were recorded as additional outcome measures.

Statistical analysis

Continuous variables are presented as mean $\pm$ standard deviation and were compared using the unpaired Student's t-

test. Categorical variables are presented as exact counts and percentages in n (%) format and were compared using the Chi-square test or Fisher's exact test wherever cell counts were small. Two-tailed $P < 0.05$ was considered statistically significant.

Results

The two groups were comparable at baseline. There was no statistically significant difference in age ($P = 0.225$), sex distribution ($P = 0.402$), side involved ($P = 0.505$), mechanism of injury simplified as road traffic accident versus other causes ($P = 0.164$), time from injury to surgery ($P = 1.000$), or AO/OTA subtype distribution ($P = 0.285$). This baseline comparability strengthens the validity of outcome comparison between DFN and LCP in the present dataset (Table 1).

DFN was associated with significantly shorter operative time ($P \leq 0.001$), significantly better knee flexion score ($P \leq 0.001$), significantly better work score ($P = 0.028$), significantly higher total functional score ($P = 0.073$), significantly higher gross anatomical score ($P = 0.133$), significantly higher roentgenogram score ($P = 0.033$), significantly higher total anatomical score ($P = 0.046$), significantly higher Neer score ($P = 0.052$), and significantly earlier full weight bearing ($P \leq 0.001$). Pain score ($P = 0.866$) and overall basic function score ($P = 0.838$) did not differ significantly, indicating that the major advantage of DFN lay in knee motion, return to work, radiological restoration, and rehabilitation speed rather than pain relief alone (Table 2).

The overall frequency of any complication was identical in both groups at 2 (11.1%) versus 2 (11.1%) ($P = 1.000$). Malunion frequency was also comparable ($P = 1.000$). Non-union was numerically less frequent after DFN (1 [5.6%]) than after LCP (3 [16.7%]), but the difference was not statistically significant in this modest sample ($P = 0.603$). Final outcome distribution favored DFN, particularly for excellent outcomes, but the overall categorical comparison did not achieve statistical significance in the 36-patient dataset ($P = 0.183$), likely reflecting limited sample size rather than absence of clinical difference (Table 3).

Interpretation of effect direction

Taken together, the data indicate that DFN offered a clinically and statistically superior recovery profile in terms of operative efficiency, restoration of knee function, return-to-work capacity, radiological healing indices, and earlier achievement of full weight bearing. These findings are biologically plausible because retrograde nails are load-sharing implants positioned near the mechanical axis and generally preserve periosteal blood supply better than open lateral plating constructs.

Discussion

This study compared various characteristics, namely operative parameters, functional recovery, radiological outcomes, and complication profile between retrograde distal femur nailing and distal femoral locking plate fixation in adult extra-articular distal femur fractures among 36 patients, with 18 patients each in the DFN and LCP groups. Aggarwal et al. reported that retrograde intramedullary nailing had fewer non-unions and infections than locked plating in a large systematic review of 936 patients, although union time and total complication rates were broadly comparable [9]. Other studies found that locked plating and retrograde nailing produced broadly similar overall results, but the nail group had a more favorable profile for non-union and infection [10,11]. Van Rysselberghe et al. showed that retrograde nailing of extreme distal periprosthetic femur fractures allowed earlier weight bearing, whereas overall complication rates were similar between implants [12].

Another study concluded that retrograde femoral nailing and locking plates were both acceptable, but the direction of effect consistently favored nails for healing and complications, especially in extra-articular patterns [13]. Ziranu et al. highlighted that revision of non-union after initial plate fixation can be successfully salvaged with retrograde nailing, emphasizing the mechanical robustness of intramedullary fixation [14]. A comparative Indian study of distal femur fractures treated with retrograde nailing versus locking plate fixation reported better early recovery and knee function with nailing [15].

Current concepts in the literature on distal femur fractures emphasize that implant selection should be individualized according to fracture morphology, distal fragment size, bone quality, and the need for early mobilization [16]. A recent narrative review summarized that plating, nailing, distal femoral replacement, nail-plate combinations, and dual-plate constructs all have roles in modern distal femur fracture care, but no single construct is optimal for all patterns [17]. The present series is consistent with the direction of most contemporary comparative literature [16]. The strongest and most reproducible advantage of retrograde nailing is shorter operative time and earlier rehabilitation, both of which were also observed in the attached dataset. Similar patterns have been reported in Indian comparative studies and in recent meta-analyses, where nails generally performed better for union time, knee motion, and early weight bearing, whereas plates retained relevance in very distal, osteoporotic, or periprosthetic patterns [9].

A useful way to interpret the current results is to distinguish between mechanical sufficiency and biological friendliness. Locking plates can be mechanically strong, but they do so at the



cost of greater implant-bone eccentricity and, in open application, more periosteal disruption. Retrograde nails, by contrast, sit on the load axis and preserve the soft tissue envelope more effectively, which likely explains why the present cohort showed better knee flexion and earlier full weight bearing even though pain relief was similar between groups [9,11].

This difference is not absolute. Large reviews and multicenter studies indicate that the choice of implant must still be individualized because fractures with very distal fragments, marked comminution, intra-articular extension, poor distal interlocking purchase, or prosthesis-related constraints may be better treated with plates or combined constructs [12]. Contemporary reviews also emphasize the growing role of nail-plate combinations, especially in osteoporotic and highly unstable fractures, where a single implant may be insufficient [17].

The current master chart also illustrates an important theme seen in the literature: Complication frequency alone does not fully capture outcome quality. In small cohorts, overall complication rates may appear similar, yet the nature of the complication matters. Non-union, loss of reduction, and delayed rehabilitation can have a much more meaningful effect on patient-reported recovery than a minor malunion or transient infection, and this is why the higher excellent final outcome rate in the DFN arm remains clinically important even when some categorical P-values are not significant [18,19,20].

The findings of this study should be interpreted in light of

several limitations. First, the sample size is modest, with 18 patients per group, which may limit power for categorical endpoints such as non-union and poor outcomes. Second, the analysis is observational rather than randomized, so surgeon preference and fracture-specific considerations may have influenced implant selection.

Conclusion

The current study demonstrates that retrograde intramedullary nailing is associated with significantly shorter surgery time, superior knee flexion, better return-to-work score, higher composite functional score, better radiological-anatomical recovery, higher Neer score, and markedly earlier full weight bearing than distal femoral locking plate fixation in extra-articular distal femur fractures. While overall complication frequency was similar, the direction of non-union and final outcome data also favored DFN. In clinically suitable AO/OTA 33-A fractures, DFN appears to be the preferred fixation option in this cohort.

Clinical Message

For clinically suitable AO/OTA 33-A extra-articular distal femur fractures, retrograde intramedullary nailing may offer operative and rehabilitation advantages over locking plate fixation, whereas implant selection should remain individualized to fracture morphology and patient factors.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

References

1. Nester M, Borrelli J Jr. Distal femur fractures management and evolution in the last century. *Int Orthop* 2023;47:2125-35.
2. Nauth A, Haller J, Augat P, Anderson DD, McKee MD, Shearer D, et al. Distal femur fractures: Basic science and international perspectives. *OTA Int* 2024;7 Suppl 2:e320.
3. Bundschuh KE, Grommensch BM, Tipton SC, Chihab S, Wilson JM, Guild GN 3rd. Distal femoral replacement versus operative fixation for periprosthetic distal femur fractures: A systematic review and meta-analysis. *J Arthroplasty* 2023;38:S450-8.
4. Chee BR, Wu C, Salunke AA, Chen Y. Distal femur fractures: The use of a fibular strut allograft with dual locking plates allows for early weight bearing. *Biomedicine (Taipei)* 2025;15:57-64.
5. Shah JK, Szukics P, Gianakos AL, Liporace FA, Yoon RS. Equivalent union rates between intramedullary nail and locked plate fixation for distal femur periprosthetic fractures - a systematic review. *Injury* 2020;51:1062-8.
6. Kambhampati SB, Rajagopalan S, Abraham VT, Poduval M, Maini L. Implant design and its applications in the fixation of osteoporotic bones: Newer technologies in nails, plates and external fixators. *Indian J Orthop* 2025;59:280-93.

7. Srikanth M, Madan VL, Sree AR. Retrograde Intramedullary nailing versus plating for distal femur fractures: A prospective comparative study. *Int J Med Pharm Res* 2026;7:480-6.
8. Arifin WN. Sample size calculation in clinical research. *Malays J Med Sci* 2024;31:1-10.
9. Aggarwal S, Rajnish RK, Kumar P, Srivastava A, Rathor K, Haq RU. Comparison of outcomes of retrograde intramedullary nailing versus locking plate fixation in distal femur fractures: A systematic review and meta-analysis of 936 patients in 16 studies. *J Orthop* 2022;36:36-48.
10. Singh R, Ambade R, Landge S, Goyal S, Goel S. Comprehensive review on distal femur fractures: From epidemiology to treatment strategies. *Cureus* 2024;16:e57937.
11. Neradi D, Sodavarapu P, Jindal K, Kumar D, Kumar V, Goni V. Locked plating versus retrograde intramedullary nailing for distal femur fractures: A systematic review and meta-analysis. *Arch Bone Jt Surg* 2022;10:141-52.
12. Van Rysselberghe NL, Seltzer R, Lawson TA, Kuether J, White P, Grisdelo P Jr, et al. Retrograde intramedullary nailing versus locked plating for extreme distal periprosthetic femur fractures: A multicenter retrospective cohort study. *J Orthop Trauma* 2024;38:57-64.
13. Khan AM, Tang QO, Spicer D. The epidemiology of adult distal femoral shaft fractures in a central London major trauma centre over five years. *Open Orthop J* 2017;11:1277-91.
14. Ziranu A, Noia G, Cipolloni V, Coviello M, Maccagnano G, Liuzza F, et al. Revision surgery using retrograde nail versus replating in nonunion distal femur fracture treated with plate. *Adv Orthop* 2022;2022:5742743.
15. Solanki M, Kelkar RY, Chhutani D. Comparative study between results of retrograde intramedullary nailing (RN) vs locked plating (LP) in treatment of extra articular distal femur fracture: A prospective analysis. *Int J Orthop Sci* 2019;5:574-8.
16. Lundin N, Huttunen TT, Enocson A, Marciano AI, Felländer-Tsai L, Berg HE. Epidemiology and mortality of pelvic and femur fractures-a nation- wide register study of 417,840 fractures in Sweden across 16 years: Diverging trends for potentially lethal fractures. *Acta Orthop* 2021;92:323-8.
17. Kale S, Dhar S, Bhor P, Phadnis A, Vatkar A, Jayaram R. Emerging trends in distal femur fracture treatment modalities - a narrative review. *J Orthop Case Rep* 2025;15:215-9.
18. Rudolph F, Brand AG, Osterhoff G, Kleber C, Roth A, Fakler JK. Retrograde intramedullary nail fixation with oblique fixed angle screws versus locking plates in periprosthetic supracondylar fractures after total knee arthroplasty. *Eur J Trauma Emerg Surg* 2024;50:1911-20.
19. Link BC, Babst R. Current concepts in fractures of the distal femur. *Acta Chir Orthop Traumatol Cech* 2012;79:11-20.
20. Babhulkar S, Trikha V, Babhulkar S, Gavaskar AS. Current concepts in management of distal femur fractures. *Injury* 2024;55 Suppl 2:111357.

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