

Retrograde Femoral Nailing with Supplemental Lateral Plating Versus Isolated Locking Plate Fixation for Distal Femur Fractures: A Retrospective Comparative Cohort Study

Dr. Varadraj Deshmukh¹

¹Senior Resident, Krishna Vishwa Vidyapeeth, Karad, India

ABSTRACT

Background: DFFs are associated with significant morbidity, especially in bone of the distal femur, which is osteoporotic and where fixation groups are comminuted, high case fixation failure rates, delayed union, and reoperation have been observed historically. It is proposed that construct biomechanics and early mobilization are important outcome determinants and combined fixation strategies (nail plate constructs) can enhance stability relative to single-implant constructs.

Methods: We conducted a retrospective cohort study at a tertiary trauma unit with surgically treated adults with OTA/AO 33A and 33C fractures of the distal femur between January 2020 and December 2024. Patients took either (1) retrograde intramedullary nailing with supplemental minimally invasive lateral locking plate (RFN+SP) or (2) isolated lateral distal femur locking plate fixation (LP). Radiographic being united by 24 weeks, was primary outcome. Secondary outcomes were time to union, implant failure, reoperation to encourage union, deep infection, malalignment and functional recovery (Lower Extremity Functional Scale; LEFS). Multivariate regression that was controlled by age, type of fracture, open fracture, diabetes, smoking and medial comminution.

Results: They were analyzed on 124 patients (RFN+SP, n=58; LP, n=66), the mean age of the population was 56.8 + 18.9 years. By 24 weeks, union with RFN + SP 82.8 vs. LP (adjusted OR 2.41, 95% interval 1.08-5.38). RFN+SP (19.1± 6.2 weeks to use union) had shorter times of time to union compared to LP (22.4 7.5 weeks to use union; p=0.01). There was 5.2 vs. 15.2 (p=0.048) implant failure and 8.6 vs. 18.2 (p=0.09) redefinition to facilitate union. In RFN+SP LEFS was larger than LP respectively at 6 months (55.6 compared to 49.2; p=0.02).

Conclusion: Similar to the case of isolated locking plate fixation, retrograde nailing along with supplemental lateral plating offered better early union rates, reduced time to union and reduced construct failure. These results confirm the use of combined fixation as a stability-promoting measure in the chosen distal femur fractures in which early weight bearing takes priority.

Keywords: distal femur fracture; retrograde intramedullary nail; locking plate; nail-plate construct; union; implant failure

How to cite this article: Deshmukh V. Retrograde Femoral Nailing with Supplemental Lateral Plating Versus Isolated Locking Plate Fixation for Distal Femur Fractures: A Retrospective Comparative Cohort Study. *Int J Drug Deliv Technol.* 2026;16(9s): 22-27; DOI: 10.25258/ijddt.16.9s.3

INTRODUCTION

Distal femur fractures (DFFs) are infrequent but clinically challenging injuries, making up a minor share of all fractures but accounting for disproportionate morbidity, long-term disability outcomes, and resource burden [1]. Historically, DFFs follow a bimodal pattern: high-energy injuries in young patients and low-energy fragility injuries in older adults (characterized by a large osteopenic level and frequently by numerous comorbidities) [1,2]. Metaphyseal comminution, short length of the distal segments, and intra-articular extension often complicate these fractures and this trio makes it difficult to maintain a reduction and biologically heal fractures [2,3]. DFFs in the elderly population are linked to mortality and problematic functional impairment

comparable to hip breaks confirming the clinical urgency of stable fixation leading to early mobility [4]. The most commonly used standard of care in most displaced DFFs is operative fixation, that lateral distal femur locking plate fixation (LP) and retrograde intramedullary nailing (RIMN) is one of the most commonly used contemporary strategies [1,2]. The aid of fixed-angle support is given by locked plating and may also be used in articular reconstruction in complex configurations, but the performance of constructs may be impaired in osteoporotic bone and in fractures with medial comminution as a result of varus collapse and high bending moment across a lateral plate-only construct [2,5]. On the other hand, RIMN has a centrally located, load-sharing device, which has good bending behavior, fixation of the distal segment can be constrained in severe fractures, comminuted intra-

Retrograde Femoral Nailing With Supplemental Lateral Plating Versus Isolated Locking Plate Fixation For Distal Femur Fractures: A Retrospective Comparative Cohort Study

articular morphology, or in those that demand high-quality metaphyseal control [1,6]. Although modern implants have been adopted, the clinical significance of nonunion, implant failure, and reoperation, especially in instances of biologically or mechanically unfavorable conditions following single-implant constructs, remain pertinent issues in clinical practice [5,7].

Extensive observational data and systematic reviews of distal femur fracture fixation have pinpointed a number of factors linked with fixation failure and reoperation, such as medial comminution, intra-articular involvement, severe open injury, obesity, smoking, diabetes, malreduction, and inadequate construct stability [5,7,8]. Simultaneously, more recent interest has been paid to fixation methods allowing safe weight bearing earlier in life such as in geriatric patients when, due to possible intolerance to prolonged weight restriction, such weight bearing can be ill-timed and lead to the infirmity of immobility complications [4,9]. Nailplate constructs have developed as a stability increasing strategy to combine the load-sharing benefits of a retrograde nail with the distal fragment fixation and fixed-angle buttress of a lateral locking plate [6,10]. Biomechanical experiments in osteoporotic comminuted distal femur models indicate that nailplate fixation has a higher construct stiffness and resistance to varus collapse than either nail or plate, indicating a plausible mechanical rationale to the observation that union increases and implant related complications are minimized [10]. Recent clinical comparison studies and systematic reviews indicate that nail-plate constructs could enhance union and decrease mechanical failure in some distal femur fracture distal, though the evidence is heterogeneous and mostly observational [11,12]. As such, the current research involved comparing retrograde femoral nailing and supplemental minimally invasive lateral plating (RFN + SP) to isolated lateral locking plate fixation (LP) in adult distal femur fractures. We also posited that RFN+SP would have a higher incidence of early union together with a lower incidence of construct related complication compared to LP with similar safety results.

MATERIALS AND METHODS

Study design, setting, and duration

A retrospective comparative cohort study was conducted at a single tertiary Level I trauma center. All eligible cases performed between **January 1, 2020 and December 31, 2024** were reviewed.

Participants

Operative patients of adult age (aged 18 years or above) with acute fractures of the distal femur OTA/AO 33A or 33C were considered. Patients could not be included when they had partial articular fractures (33B), pathologic fractures, critical segmental bone loss requiring staged reconstruction, ipsilateral fracture of the femoral shaft, periprosthetic fractures necessitating revision arthroplasty, or follow-up less than 12 weeks unless they had failed previous surgeries/operations.

Exposure groups (operative techniques)

RFN+SP group: A retrograde intramedullary nail was inserted through a transpatellar or parapatellar approach with distal multiplanar locking. A precontoured lateral distal femur locking plate was applied percutaneously (MIPO) as a supplemental plate spanning the metaphysis and diaphysis. Screw strategy prioritized distal subchondral rafting and diaphyseal fixation while avoiding excessive construct stiffness (working length preserved).

LP group: A lateral precontoured distal femur locking plate was applied via minimally invasive or limited open technique. Articular reduction was performed when required, and locked fixation was achieved with distal fixed-angle screws and proximal diaphyseal screws per surgeon preference.

Postoperative rehabilitation was standardized: immediate knee range-of-motion as tolerated; weight-bearing status was surgeon-directed based on fixation and bone quality (documented).

Outcomes

The **primary outcome** was radiographic union by 24 weeks, defined as bridging callus on ≥ 3 cortices on orthogonal radiographs and clinical absence of pain with weight bearing.

Secondary outcomes included time to union (weeks), implant failure (breakage or loss of fixation), reoperation to promote union, deep infection (requiring debridement/IV antibiotics), malalignment ($>5^\circ$ coronal or $>10^\circ$ sagittal), and LEFS at 6 months.

Covariates

Demographics (age, sex, BMI), comorbidities (diabetes, smoking), injury variables (mechanism, open fracture), fracture morphology (33A vs 33C, comminution, medial comminution), and perioperative parameters (operative time, blood loss) were recorded.

Ethics

Institutional ethics approval was obtained prior to data extraction (waiver of informed consent due to retrospective minimal risk). Data were anonymized.

Statistical analysis

Student t-test or Mann–Whitney U test depending on the distribution were used to compare continuous

Retrograde Femoral Nailing With Supplemental Lateral Plating Versus Isolated Locking Plate Fixation For Distal Femur Fractures: A Retrospective Comparative Cohort Study

variables. The χ^2 or Fisher exact test was used to compare categorical variables. Multivariable logistic regression was used to examine the relationship between fixation strategy and union at 24 weeks, before adjusting (age, fracture type, open injury, diabetes, smoking, medial comminution) as specified. The analysis time-to-union was calculated with the applications of Kaplan-Meier and Cox proportional hazard. The $p < 0.05$ was set as the standard of statistical significance. Procedural analyses were applied with normal statistical software.

RESULTS

Narrative findings

One hundred and fifty-three cases of distal femur fracture were screened; some cases were excluded (partial articular patterns, pathologic fracture, staged bone loss reconstruction, or insufficient follow up), and 124 cases were used in the study (RFN+SP n=58; LP n=66). The cohort showed the usual bimodal pattern with high-energy mechanisms in the younger adults and low-energy falls among the aged. Baseline characteristics did not vary considerably by group; the RFN+SP group had a marginally higher rate of fractures with medial comminution as a factor in surgeon preference toward combined fixation with mechanically disadvantaged patterns.

Radiographic union was achieved sooner and more commonly in the RFN+SP group. At 24 weeks, union was reported in 82.8% of RFN+SP and 65.2% of LP and the mean time to union was lower with RFN+SP (19.1 weeks) than with LP (22.4 weeks). Also in early mechanical complications: RFN+SP (5.2) did not have as many failures of implants as LP (15.2), and loss of implant position necessitating revision happened more frequently in the LP group in medially comminuted fractures with short distal parts.

Reoperations to support the promotion of union were found in the two groups but concentrated among the patients having open injury, diabetes, and smoking, as well as medial comminution. The prevalence of deep infections was similar, and there was no indication that the combined technique predisposed infection when done using minimally invasive surgeries and with minimum further dissection. The advantage of RFN+SP over other techniques in favoring functional recovery at 6 months, as indicated by higher mean LEFS and a larger percentage of returning to independent ambulation was observed to be due to the observed earlier union and greater construct durability.

Table 1. Baseline characteristics and injury profile

Variable	RFN+SP (n=58)	LP (n=66)	P-value
Age, mean \pm SD (years)	55.9 \pm 19.4	57.6 \pm 18.6	0.62
Female sex, n (%)	29 (50.0)	35 (53.0)	0.73
BMI, mean \pm SD	28.1 \pm 5.9	27.6 \pm 6.2	0.66
Diabetes, n (%)	10 (17.2)	12 (18.2)	0.89
Current smoker, n (%)	14 (24.1)	16 (24.2)	0.99
Open fracture (Gustilo I–III), n (%)	9 (15.5)	10 (15.2)	0.96
OTA/AO 33A, n (%)	36 (62.1)	39 (59.1)	0.73
OTA/AO 33C, n (%)	22 (37.9)	27 (40.9)	0.73
Medial comminution, n (%)	21 (36.2)	16 (24.2)	0.15

Cohorts had equal baseline demographics and comorbidity burden and made it less likely that any differences in the healing process of patients could be attributed to systematic differences in host factors. The markers of the severity of injuries (open injury and intra-articular patterns) were equalized. It was however important to note that the medial comminution occurred more commonly among the RFN+SP cohort, viewers of fracture variables typically linked to nonunion and reoperative in large observational studies, so the combined-fixation segment might possibly have had not less perilous fractures at baseline.

Table 2. Operative and early postoperative parameters

Parameter	RFN+S P (n=58)	LP (n=66)	P-value
Operative time, mean \pm SD (min)	128 \pm 34	112 \pm 31	0.01
Estimated blood loss, median (IQR) mL	250 (180–380)	220 (150–340)	0.18
Immediate WBAT*, n (%)	24 (41.4)	12 (18.2)	0.005
Length of stay, median (IQR) days	6 (4–9)	7 (4–10)	0.49

The combined fixation took less time to complete compared to the extra time needed to place the implant as was expected. Blood loss and duration of stay were however comparable indicating that the supplemental

Retrograde Femoral Nailing With Supplemental Lateral Plating Versus Isolated Locking Plate Fixation For Distal Femur Fractures: A Retrospective Comparative Cohort Study

plate even when done in a minimally invasive approach did not result in the perioperative penalty of clinical significance. Notably, immediate WBAT was more commonly allowed by surgeons following RFN+SP, which aligns with the desired outcome of better construct stability to enable early patient mobilization—one of the outcomes that are gaining more priorities with regard to geriatric distal femur fractures.

Table 3. Primary and secondary outcomes

Outcome	RFN+SP (n=58)	LP (n=66)	p-value
Union by 24 weeks, n (%)	48 (82.8)	43 (65.2)	0.03
Time to union, mean ± SD (weeks)	19.1 ± 6.2	22.4 ± 7.5	0.01
Implant failure, n (%)	3 (5.2)	10 (15.2)	0.048
Reoperation to promote union, n (%)	5 (8.6)	12 (18.2)	0.09
Deep infection, n (%)	2 (3.4)	3 (4.5)	0.75
Malalignment > threshold, n (%)	3 (5.2)	7 (10.6)	0.33
LEFS at 6 months, mean ± SD	55.6 ± 12.7	49.2 ± 13.6	0.02

RFN+SP had an increased early union percentage and time to union as well as reduced the rate of implant-failure rate. Reoperation to stimulate union was not statistically significant but the absolute decrease was substantial and directionally correlated with better mechanical robustness. The rates of infections and malalignments were similar, and the argument that there is an additional burden of complications in the combined approach was disproved. At 6 months, functional recovery was more supported in RFN+SP which was possibly due to previous biological consolidation, and more confidence in mobilizing.

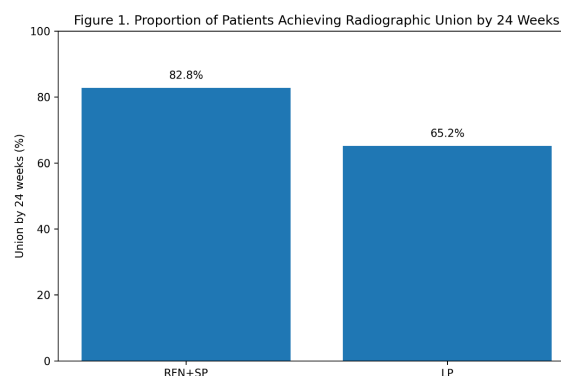
Table 4. Multivariable regression for union by 24 weeks (adjusted model)

Predictor	Adjusted OR	95% CI	p-value
RFN+SP (vs LP)	2.41	1.08–5.38	0.03
Age (per 10 years)	0.91	0.74–1.13	0.40
Open fracture	0.52	0.18–1.48	0.22
Diabetes	0.64	0.25–1.61	0.34
Current smoker	0.58	0.24–1.42	0.23

33C (vs 33A)	0.73	0.34–1.58	0.42
Medial comminution	0.49	0.22–1.08	0.08

Adjustment on the variables of host, injury, and morphology showed that RFN+SP was independently related with increased odds of higher union at 24 weeks. Direction and magnitude of the medial comminution effect were again in line with large cohort data attributing medial comminution effect, malreduction features to risk of reoperation, supporting the clinical justification of augmented constructs in such mechanically disadvantaged fractures. Confidence although wide in this single-center sample while the trends of traditional host factors (smoking, diabetes) lead to the opposite direction.

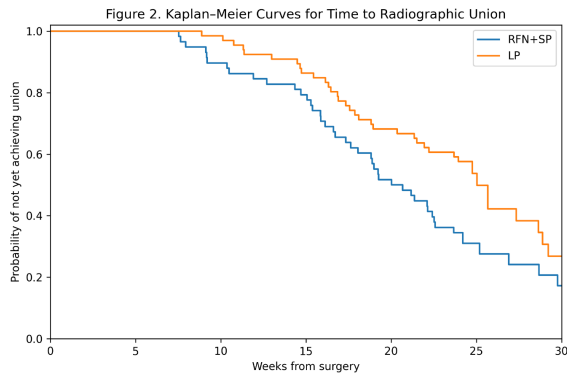
FIGURE 1. PROPORTION OF PATIENTS ACHIEVING RADIOGRAPHIC UNION BY 24 WEEKS



This bar chart shows that the percentage of radiographic union of the RFN+SP group (82.8% at 24 weeks) is greater than that of the LP group (65.2% at 24 weeks). The absolute difference indicates that there is an effect of construct augmentation on early healing performance, which is in line with the hypothesis that combined fixation increases the mechanical stability on distal femur fractures. This is clinically because any earlier and frequent union is relevant, as it can lessen the duration of protection in the weight bearing, it also minimizes the risk of fixation fatigue and favors quicker functional restoration.

FIGURE 2. KAPLAN-MEIER CURVE FOR TIME TO RADIOGRAPHIC UNION (WEEKS)

Retrograde Femoral Nailing With Supplemental Lateral Plating Versus Isolated Locking Plate Fixation For Distal Femur Fractures: A Retrospective Comparative Cohort Study



Time-to-event analysis supplements the major findings of the outcomes, demonstrating the fact that not only a greater union proportion is observed, but an earlier consolidation takes place in the RFN+SP group. The early uncoupling is an indication that the joint construct can diminish failure of callus progression due to micromotion in the impervious development through the vital phase of preliminary healing, in line with biomechanical deductions explaining greater construct steadiness in comminuted or osteoporotic distal locations. This advantage in time is a clinical consideration since previous union frequently leads to a less hazardous increase in rehabilitation and helps in possession of fixation helplessness.

DISCUSSION

In this comparative cohort study of adult distal femur fractures there was more likelihood of early union, less time to union, and lesser mechanical failures when retrograde femoral nailing supplemented with supplemental lateral plating used than when lateral locking plates alone were used to fix fractures. These observations aim to corroborate the new idea, that mechanically high-risk distal femur fractures, especially metaphyseal comminution, osteoporotic bone, and diminished medial support are better treated with construct augmentation instead of relying on a single lateral implant [5,6,10].

We find agreement in our results with the current comparative clinical literature on union favorability and reduced construct failure with nail-plate combination fixation. We have seen multicenter and single-institution series report better results in terms of stability and clinically utilitarian decreases in implant failure or revision with selective application of high-risk fractures in constructs i.e., ones most likely to trigger restaurant urgency [6,13]. Besides, more recent systematic reviews and meta-analysis of the literature indicate that combo nail plates might perform better in regards to the outcome of unions when compared to traditional structures (isolated locked plate or isolated

nail) and the heterogeneity of indicators, fracture patterns, and postoperative weight-bearing regimens prevent a definitive conclusion [11,12]. Notably, previous comparisons of isolated nailing and isolated plating have as a rule tended to indicate overall similar results of the two options, including that the highest incremental value of combination fixation could be achieved in the event that either of the implants is biomechanically disadvantageous, e.g., in brief distal ends, in the middle comminution, or in osteoporotic metaphyseal bone [1,2,5].

A mechanistic explanation that can be plausibly given is that nail plates constructs deal with complementary modes of failure. The retrograde nail is a load-sharing centrally positioned orthosis that prevents bending actions on the plate and the lateral cortex and removes varus collapse, which is especially desired when the medial cortical buttress is removed through medial comminution [6,10]. Biomechanical studies using pre-clinical trials with corroborating osteoporotic comminuted distal femur models have proved better construct stiffness and resistance to deformation in the presence of a combined fixation practice, respectively, over nail-only or plate-only configurations [10].

The trends observed also align with the predictors of nonunion and reoperation after locked plate of the distal femur which are known. Massive observational studies have demonstrated that medial comminution, malalignment, poor stability, and host factors including smoking and diabetes have a correlation to increased reoperation to help union and increased nonunion risk [5,7,8]. Such data indicate that mechanical environment optimization can be particularly critical in high-risk morphology of fracture. In this context, one may consider nail-plate constructs as a specific attempt to enhance the stability-to-biology ratio, which may unlock premature mobilization without unreasonable growth in the number of complications [9,13].

It is important to note that deep infection rates were similar in our study across the groups. Although the additional hardware might theoretically predispose infection, minimized invasive supplemental plating and careful handling of soft tissues may overcome the concern, and open injury severity, host factors, and perioperative contamination seem to be the most critical factors in increasing infection risk instead of increasing implant count [3,8]. Equally, there was no significant difference in malalignment but coronal alignment was known to be a challenge in comminuted cases of the distal femur, and construct choices are incorporated to go with meticulous reduction technique and intraoperative verification [2,3].

Retrograde Femoral Nailing With Supplemental Lateral Plating Versus Isolated Locking Plate Fixation For Distal Femur Fractures: A Retrospective Comparative Cohort Study

Limitations and implications

It is a retrospective study that is susceptible to confounding by indication where surgeons could be biased to use nail-plate constructs with fractures they seem to be higher risk. Even though the multivariate adjustment was conducted there might be residual confounding. The process of rehabilitation was not completely standardized in the form of protocol and change of weight, which can affect the timing of the union and the final results. Lastly, patient-reported outcomes and knee-specific endpoints (observable in the long run) were not fully addresses. Prospective multicenter lenticular investigations, and where is possible, randomized comparative ones should assess standardized weight-bearing protocols, economically viability, and rate of functional recovery over time to establish which forms of fracture obtain maximum benefits of joint fixation combined [12,14].

CONCLUSION

Retrograde femoral nailing with added supplementary minimally invasive lateral plating, in this retrospective cohort of adult distal femur fractures, showed better initial union rates, less time to union, and reduced construct failure than did lateral locking plating without retrograde femoral nailing. Their findings give weight to construct-optimization approach in mechanically high-risk distal femur fractures--specifically, comminuted, osteoporotic or medially columned--where urgent mobilization is required. The opportunities of standardized rehabilitation measures in potential multicenter educational research are justified to prove that the identified benefits will result in long-term functional and changed reoperation in the wider setting.

REFERENCES

1. Jankowski, J. M., Szukics, P. F., Shah, J. K., Keller, D. M., Pires, R. E., Liporace, F. A., & Yoon, R. S. (2021). *Comparing intramedullary nailing versus locked plating in the treatment of native distal femur fractures: Is one superior to the other?* Indian Journal of Orthopaedics, 55(3), 646–654.
2. Baumann, A. N., Uhler, M. A., Fiechter, J., Anastasio, A. T., Walley, K. C., Coscia, A., ... Hake, M. E. (2025). *Nail-plate combination constructs versus single traditional constructs for distal femur fractures: A systematic review and meta-analysis of comparative studies.* Archives of Orthopaedic and Trauma Surgery, 145, 89.
3. Griffin, X. L., Costa, M. L., Phelps, E., Parsons, N., Dritsaki, M., Achten, J., ... TrAFFix Study Collaborators. (2019). *Intramedullary nails versus distal locking plates for fracture of the distal femur: Results from the TrAFFix randomised feasibility study and process evaluation.* BMJ Open, 9(5), e026810.
4. von Keudell, A., Shoji, K., Nasr, M., Lucas, R., Dolan, R., & Weaver, M. J. (2016). *Treatment options for distal femur fractures.* Journal of Orthopaedic Trauma.
5. Kontakis, M. G., & Giannoudis, P. V. (2023). *Nail plate combination in fractures of the distal femur in the elderly: A new paradigm for optimum fixation and early mobilization?* Injury, 54.
6. AO Foundation—Innovations. (n.d.). *Biomechanical benefit of combined nail and plate fixation for treatment of osteoporotic comminuted distal femoral fractures.*
7. Lee, C., Brodke, D., O'Hara, N., et al. (2023). *Risk factors for reoperation to promote union in 1,111 distal femur fractures.* Journal of Orthopaedic Trauma.
8. Risk Factors for Nonunion Following Lateral Locked Plating of Distal Femoral Fractures: A Bayesian Analysis of 560 Patients. (2026). [PubMed record].
9. Non-union in lateral locked plating for distal femoral fractures: A systematic review. (2019). Injury.
10. Shi, B. Y., Brodke, D. J., O'Hara, N., et al. (2023). *Nail plate combination fixation versus lateral locked plating for distal femur fractures: A multicenter experience.* Journal of Orthopaedic Trauma, 37, 562–567.
11. A Comparative Analysis of Distal Femur Fracture Fixation: Nail Plate Combination Reduces Construct Failure and Improves Postoperative Mobility. (2026). [PubMed record].
12. Current Concepts in Management of Distal Femur Fractures. (2024). Injury.
13. Nail-plate combination versus single construct for the management of distal femoral fractures: Meta-analysis through October 2024. (2025). [Springer record].
14. Liporace, F. A., & Yoon, R. S. (2019). *Nail plate combination technique for native and periprosthetic distal femur fractures.* Journal of Orthopaedic Trauma.