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Outcomes of Retrograde Intramedullary Nailing Versus Locking Plate Fixation in Distal Femur Fractures: A Systematic Review

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Abstract

Background: Surgical treatment of distal femur fractures has progressed over the years, with decisions guided by factors such as fracture type, pattern, presence of metaphyseal comminution, intra-articular extension, and bone quality. Retrograde intramedullary nails (RIMN) and locking plates (LP) are both commonly used fixation methods for these fractures. However, the question of which approach yields better outcomes remains open, as no consensus has been reached on the optimal treatment. **Objective:** This systematic review aimed to compare the effectiveness of RIMN versus LP in managing distal femur fractures. **Methods**: An electronic search was conducted in Medline (PubMed), Embase, and Google Scholar to identify relevant studies published up to July 24, 2024. Studies were included if they compared outcomes of RIMN and LP fixation for acute supracondylar or distal femur fractures (AO/OTA type-33A, B, and C) and reported at least one primary outcome (mean fracture union time, overall complications, implant-related complications, and reoperation rate) or secondary outcome (duration of surgery, intra-operative blood loss, and knee range of motion). **Results**: Three randomized controlled trials, Three prospective studies, three retrospective studies and one prospective study involving a total of 767 patients (343 treated with RIMN, 424 with LP) were analyzed. This analysis compares locked plating and retrograde intramedullary nailing (rIMN) for distal femur fractures and reveals several key findings. Both methods demonstrate comparable functional outcomes across various scoring systems, with no significant differences in range of motion or recovery; however, rIMN shows advantages in early weight-bearing and quicker union, particularly in less complex fractures. Union rates favor rIMN, with lower nonunion rates (4% to 11.8%) compared to plating (up to 27.5%), though rIMN is associated with more anterior knee pain, while plating has higher infection rates. Operative parameters indicate rIMN involves shorter surgical times and less blood loss, whereas plating provides better stability for complex fractures. rIMN is effective for extra-articular fractures in younger patients, while locked plating is preferable for comminuted and intra-articular fractures in older patients. Overall, both techniques are viable, influenced by fracture type and patient demographics, but the strength of evidence is low due to a lack of randomized controlled trials, underscoring the need for larger studies to bolster these findings. **Conclusion**: Both retrograde intramedullary nailing and distal femur plating have their respective strengths and limitations. Retrograde nailing may be more advantageous for extra-articular fractures, offering faster recovery and lower nonunion rates, while distal femoral plating is beneficial for complex, intra-articular fractures requiring robust fixation. Further high-quality, prospective studies are recommended to refine indications and optimize outcomes for both techniques in different patient and fracture profilesare viable options depending on patient-specific needs and surgeon preferences.

Keywords: Distal femur fracture; Locking plate; Retrograde intramedullary nail; Surgical outcomes; Supracondylar femur fracture fixation.

INTRODUCTION

Distal femoral fractures comprise approximately 5% of all femoral fractures [1]. Non-operative management of these fractures is largely outdated due to the high risk of complications, including malunion, non-union, and joint stiffness [2]. With advancements in surgical techniques and implant design, operative fixation has become the preferred approach, though debate remains regarding the most effective implant choice. The use of implants like the condylar blade plate in distal femoral fractures has been associated with a high complication rate, while the introduction of locking plates has provided enhanced stability and improved clinical outcomes [3]. However, placing the condylar blade plate is technically challenging, requiring precise three-dimensional alignment; improper positioning of the chisel or plate can result in condylar malalignment [4].Locking plate technology allows for stable fixation with minimal soft tissue disruption, preserving blood supply around the fracture site. Unlike unlocked plates, locked plates do not rely on the screw-bone interface alone, which reduces the likelihood of construct failure, especially in osteoporotic or comminuted fractures [5].

The retrograde intramedullary nail (RIMN) has also demonstrated favorable outcomes, particularly for extra-articular distal femur fractures, due to reduced soft tissue trauma and preservation of the fracture hematoma [6,7]. Evidence supports using RIMN even in certain intra-articular fractures. For example, Heiney et al. achieved positive outcomes with nailing in AO type C1 intra-articular fractures [8], while Neubauer et al. also showed favorable results with this approach [9]. Studies by Saumya et al. and Garnavos et al. suggest that retrograde nailing with supplemental compression screws facilitates early weight-bearing and minimizes complications [10,11]. Warner et al. highlighted that retrograde nailing in intra-articular fractures, although effective, can present challenges such as iatrogenic fracture combination, inadequate articular fracture stabilization, and insufficient fixation, sometimes necessitating supplemental plate fixation [12].In femoral peri-prosthetic fractures, retrograde nailing is often preferred, although its use is limited by prosthetic design and the risk of extension deformities due to the posterior nail entry point [13].Despite extensive use of both implants for distal femoral fractures, there is no consensus on which is superior. The few comparative studies available have yielded inconsistent results. Consequently, this meta-analysis was conducted to evaluate the relative outcomes of locked plating versus retrograde intramedullary nailing in managing distal femoral fractures.

METHODS

Search strategy

This study was designed and executed in alignment with PRISMA guidelines [14]. A comprehensive search was conducted across electronic databases, including PubMed, Embase, Scopus, and Ovid Medline, from each database's inception through 2019-2023. The search was limited to articles published in English and used keywords such as “distal,” “femur,” “fracture,” “intramedullary fixation or plate or plating,” and “nail or nailing.” Additionally, the reference lists of included studies, original articles, and previous reviews were manually examined to identify further relevant studies for inclusion.

InclusionCriteria

- The study design was either a randomized controlled trial (RCT) or a comparative study (Level 1, 2, 3, or 4).
- Participants were adult patients with distal femoral fractures, whether open or closed.
- The study included at least two groups, one of which involved fixation with a locked plate and another with a retrograde nail for distal femoral fractures.
- Outcome measures included one or more of the following: anterior knee pain, malunion, non-union, duration of surgery, implant failure, and infection.

Exclusion Criteria

- Included only elderly patients or focused exclusively on periprosthetic distal femoral fractures.
- Employed condylar blade plates or angle blade plates.
- Had incomplete data, limiting statistical analysis.
- Were reviews, letters, or commentary articles.
- Represented duplicated literature.
- Were cadaveric studies or case reports.
- Included fractures of other femoral regions.

Study Selection

The initial database search yielded 1920 studies, from which 603 duplicates were removed. The remaining 444 articles were screened, leading to the exclusion of 1476 studies based on title and abstract review. An additional three studies were excluded for not exclusively using locked plates or for lacking specific mention of their use [15,16,17]. One study focused solely on osteoporotic elderly patients, and another was a feasibility trial, both of which were excluded (18,19). Following a detailed review of titles, abstracts, and full texts of the shortlisted studies, six studies were deemed suitable for inclusion (8,10,20-23) [Tables 1 and 2].

Table 1: Search Methodology

Database	Search Date	Search Query	Results
Google Scholar	14 July 2024	((distal [All Fields] AND ("femur"[MeSH Terms] OR "femur"[All Fields]) AND ("fractures, bone"[MeSH Terms] OR ("fractures"[All Fields] AND "bone"[All Fields]) OR "bone fractures"[All Fields] OR "fracture"[All Fields])) AND English[lang])	1680
PUBMED	14 July 2024	(distal[All Fields] AND ("femur"[MeSH Terms] OR "femur"[All Fields]) AND ("fractures, bone"[MeSH Terms] OR ("fractures"[All Fields] AND "bone"[All Fields]) OR "bone fractures"[All Fields] OR "fracture"[All Fields]) AND ("intramedullary fixation"[All Fields] OR ("nails"[MeSH Terms] OR "nails"[All Fields] OR "nail"[All Fields]) OR ("fracture fixation, intramedullary"[MeSH Terms] OR ("fracture"[All Fields] AND "fixation"[All Fields] AND "intramedullary"[All Fields]) OR "intramedullary fracture fixation"[All Fields] OR "nailing"[All Fields])) AND English[lang]	129
EMBASE	14 July 2024	distal AND femur AND fracture AND ('intramedullary fixation' OR nail OR 'intramedullary nailing') AND (plate OR plating) AND [english]/lim	111

Data Collection and Analysis

Two independent reviewers conducted the screening of studies. The title of the current study served as a guide to assess articles that seemed suitable for inclusion, followed by a review of their abstracts. In cases where uncertainty arose during abstract screening, full-text articles were retrieved for further evaluation. Articles relevant to the research question were identified, and these shortlisted studies were included in the final review for analysis. Any selection disagreements between the two reviewers were resolved through discussions with additional co-authors to reach a consensus. Data extraction was recorded in a structured form, categorizing studies into two groups: Group 1—Retrograde Medullary Nail (RLN) and Group 2—Distal Locked Plating (DLP). The extracted data included information such as authors' names, publication year, demographic details (age, sex, number of patients), and complications (e.g., infection, malunion, anterior knee pain). For studies with missing information, the authors were contacted directly for clarification.

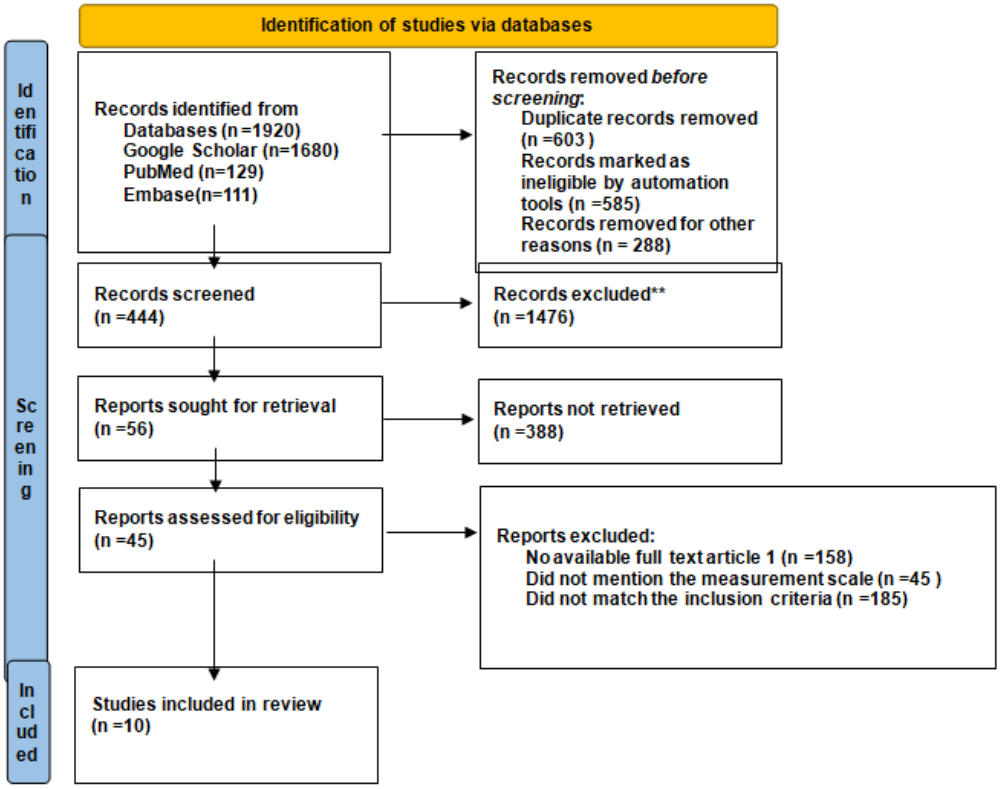

Fig 1: PRISMA Flowchart of the studies selected for the current study

Quality Assessment

Two independent reviewers evaluated the methodological quality of all included clinical trials following Cochrane Collaboration guidelines. Key aspects assessed included random sequence generation, allocation concealment, blinding of outcome assessment, completeness of outcome data, selective reporting, and potential sources of other biases.

RESULTS

Study Characteristics

All studies included in this analysis provide a direct comparison between intramedullary nailing and plating for treating distal femoral fractures, covering both intra-articular and extra-articular cases. Among the ten studies reviewed, three were retrospective, three were prospective, three were randomized controlled trials and one wasa cross-sectional study, each published within the past decades. The studies varied in sample sizes, with the smallest group comprising 13 patients for nailing and 15 for plating, and the largest study including up to 115 patients [18]. Each study also ensured that preoperative parameters such as age, sex, and fracture type were comparable between groups**.**

Table 2: Summary of Studies on Retrograde Intramedullary Nailing vs. Locking Plate Fixation for Distal Femur Fractures

Author	Methods	Sample Size	Main Outcome Measurements	Results	Conclusions
(Dunbar, Robert P., *et.al*, 2023) USA	Randomized controlled trial.	160 patients with distal femur fractures enrolled; 126 followed for 12 months	Functional scoring (Short Musculoskeletal Functional Assessment, Bother Index, EQ Health, EQ Index)	-No significant difference in functional outcomes between the two groups - Both groups affected by fractures 12 months post-injury -More coronal plane valgus in the plating group (approaching statistical significance) - Similar range of motion, walking ability, and stair management between groups - Rate and type of adverse events were not statistically different	- Both lateral locked plating and retrograde intramedullary nailing are viable surgical options - Patients continue to improve over the year after injury but remain impaired for 1 year postoperatively
K. Chandra Vemulapalli, et. al (2021) USA	Retrospective Study	106 distal femur fractures in 106 patients (50 underwent retrograde intramedullary nailing (rIMN), 56 underwent lateral locked plating (LLP))	Age, gender, body mass index, sagittal and coronal plane alignment on immediate postoperative radiographs, time to union, incidence of nonunio	rIMN group: Average coronal alignment: 83.7° aLDFA; sagittal alignment: <1° apex anterior angulation - LLP group: Average coronal	- Higher nonunion rate and coronal plane malalignment with LLP compared to rIMN - rIMN appears to be an appropriate treatment for complete articular distal femur fractures with a

				alignment: 87.9° aLDFA; sagittal alignment: 1.9° apex anterior angulation (p = 0.005 for coronal alignment, p = 0.36 for sagittal alignment) **Time to Union** - rIMN group: 6 months; LLP group: 6.6 months (p = 0.52) **Incidence of Nonunion** - rIMN group: 11.8%; LLP group: 27.5% (p = 0.008) **Secondary Procedures for Nonunion** -rIMN group: 8 procedures; LLP group: 18 procedures (p = 0.43)	potentially decreased rate of nonunion - Further prospective data is required to confirm findings
Chandra Bhusan Yadav, et.al, (2020) Nepal	Randomized controlled trial.	30 patients with isolated traumatic closed extra-articular fractures of the distal femurfollowed for 6 months	Functional outcome measured by Hospital for Special Surgery (HSS) Knee Score, union, complications, fracture alignment, range of motion (knee and hip)	- No significant difference in functional outcome (HSS score) between plating and nailing - No significant difference in union rates or complications between the two techniques - Similar fracture alignment and range of motion for knee and hip joint	- No significant difference in functional outcomes, union, complications, or other measures between plating and nailing for distal femoral fractures in adults - Further studies are required to draw firmer conclusions
Dr. Gaurav Parikh, et.al, (2020) India	Randomized controlled trial.	24 patients with distal one-third femur fractures (12 treated with retrograde nailing, 12 treated with distal femur plating)	Functional outcome measured by Hospital for Special Surgery (HSS) Knee Score, union, complications, fracture alignment, range of motion (knee and hip)	- Retrograde nailing group: 1 patient developed non-union; 1 patient had a fracture at the proximal end of the nail following	- Main disadvantage of retrograde nailing: cannot be used in type C fractures - Distal femur locking plate can be used in any type of distal

				trauma - Plating group: 2 patients developed superficial infections; 1 patient had restriction in knee range of motion	femur fracture - Distal femur plating is a better modality for treating distal femur fractures than retrograde nailing
Dr. A Senthilnathan, et.al (2022) India	Prospective randomized study	30 patients with extra-articular distal femur fractures (15 treated with retrograde nailing, 15 treated with distal femur locking compression plate)	Functional outcome measured by Neer's Scoring System	- Patients assessed up to 1 year post-treatment - **Neer's score**: Nailing group (54%); Plating group (46%)	- Retrograde nailing demonstrated better functional outcomes in terms of early weight-bearing, knee flexion, and shorter union time compared to plating - Both nailing and plating techniques yielded excellent results with proper preoperative planning
Amit Yadav et. al, (2021) India	Prospective study	86 patients with distal femur extra-articular fractures (44 treated with intramedullary nailing, 42 treated with locking plate) followed for 12 months	Clinical and radiological outcomes, intraoperative timing, blood loss, visual analogue scale, Neer score, knee range of motion, radiological union	- Mean operative time and blood loss were less in the intramedullary nailing group - Intraoperative blood loss was less in the plating group - Surgical site infections: 6 patients in the plating group - Mean time to radiological union was significantly better in the intramedullary nailing group - Union issues in plating group: 7 patients (5 non-union, 2 delayed union); 1 non-union in IMN group - 93% of IMN cases were able to bear full weight at 12 weeks	- Intramedullary nailing (IMN) proved to be a better fixation modality for distal femur fractures in terms of operative time, union rates, infection rates, and overall patient outcomes when performed with proper techniques - Emphasis on the importance of proper principles and techniques of intramedullary fixation

				compared to 66% in the plating group - Knee pain at 6 months was reported more in the intramedullary nailing group	
Anthony Howard, et. al, (2024) Englad	Retrospective Study	193 patients with distalfemur fractures(93 treated with intramedullary nailing, 100 treated with locking plate) followed for 12 months-120 months	Fracture type, procedures performed, time to union, complications, and functional scores (Oxford Knee Score).	- Oxford Knee Score: LP group mean: 37.3 (6–48, SD 7.3) vs. IMN group mean: 28.4 (3–48, SD 14.4), $p < 0.02$. - Non-union rate: LP group: 8.6% vs. IMN group: 4%, $p < 0.01$.	The LP group had a higher rate of non-union but superior functional results compared to the IMN group.
Shailendra Singh, et.al, (2018) India	Prospective randomized study.	32 patients with extra-articular distal femur fractures 193 patients with distal femur fractures(14 treated with intramedullary nailing, 18 treated with locking plate) followed for 12 months-120 months	Functional scoring (Short Musculoskeletal Functional Assessment, bother index, EQ Health, EQ Index)	- Time to full weight-bearing was significantly less in the nailing group ($p = 0.004$). - Bone union occurred earlier in Group II (DFN), statistically significant ($p = 0.0006$). - Knee pain was present in 42.86% of patients in Group II, statistically significant ($p < 0.001$). - Flexion score was significantly better in Group II ($p = 0.029$).	- Functional results trended toward better outcomes in the distal femoral nailing group compared to the plating group in terms of knee flexion, early weight-bearing, and union time. - However, the incidence of knee pain was significantly higher in the nailing group compared to the plating group.
Ahmed, Arshad, et.al (2024) India	Cross-sectional comparative study.	46 patients with distal femur fractures (6 lost to follow-up). - Groups: 20 patients underwent distal femoral nailing; 20 were treated with locking plates. Followed	Functional outcomes assessed using the NEER Score, aiming for restoration of the articular surface, stable fixation, full knee range of motion, and good functional results.	- Mean time for radiological union: Nailing group: 14.05 weeks; Plating group: 16 weeks (significantly shorter in nailing). - Mean range of	- Both retrograde intramedullary nailing and locking compression plates are suitable treatment options. - Early weight-bearing can be initiated with retrograde nailing.

		for 6 months		knee flexion: Nailing group: 111°; Plating group: 114.5°. - Average NEER score: Plating group: 84.10; Nailing group: 83.30 (no statistically significant difference).	- No significant difference in outcomes, fracture healing, or NEER score between the two techniques. - Time for radiological union was comparable for both techniques. - Proper operative planning, execution, and strict rehabilitation protocols are crucial for patient outcomes.
Dr. Ajay Kurahatti, *et,al.* (2019)	Retrospective study.	60 patients with displaced distal femur fractures - Groups: 30 patients underwent distal femoral nailing; 30 were treated with locking plates. Followed for 6 months	Functional outcomes were assessed using the NEER Score, aiming for restoration of the articular surface, stable fixation, full knee range of motion, and good functional results.	- Union achieved in all patients. - Mean time to radiological union: 20 weeks (nailing) vs. 24 weeks (plating). - Neer scores: Excellent in 51.7% of nailing patients and 56.6% of plating patients. - Mean range of motion: 115° in nailing patients vs. 114° in plating patients at the end of follow-up.	- No statistically significant differences in functional outcomes between the two surgical methods. - Locking compression plates are better for comminuted intra-articular fractures, especially in elderly patients with osteoporotic bone. - Retrograde intramedullary nailing is effective for extra-articular distal third femoral fractures. - Both techniques require sufficient surgical experience and appropriate preoperative planning.

Demographic variables

The studies included in this analysis assessed patients ranging in age from 17 to 89 years, with all participants being skeletally mature. None of the studies exclusively targeted elderly osteoporotic patients; a retrospective study focusing solely on osteoporotic fractures in elderly patients was excluded to prevent potential bias [19]. The studies consistently indicate that distal femoral fractures are more prevalent among males than females, a trend largely attributed to the predominance of high-energy trauma, such as road traffic accidents, which more frequently involve males. Both groups in most studies were gender-comparable, maintaining a similar male-to-female ratio except for one study, which reported a male-dominant nailing group and a female-dominant plating group [20].Regarding fracture type, three studies exclusively examined extra-articular supracondylar femur fractures [21,22], while three studies included both intra-articular and extra-articular fractures with comparable distributions in the nailing and plating groups. In cases of intra-articular fractures, retrograde intramedullary nailing (RMN) was performed using an intramedullary nail with a widened distal end and at least two interlocking bolts. Plating fixation utilized a lateral distal femur-locked plate (DLP). Only locking plates were included in the studies; those that used condylar blades or angular blade plates were excluded.

Additionally, studies exclusively focusing on periprosthetic distal femur fractures were not included.
The analysis of findings from the various studies on surgical treatments for distal femur fractures reveals a comprehensive comparison between retrograde intramedullary nailing (rIMN) and distal femoral plating (DFP or LLP). Here is an overall analysis based on the study data provided:

Functional Outcomes:
- Both retrograde nailing and distal femoral plating generally showed similar functional outcomes when evaluated by different scoring systems (Short Musculoskeletal Functional Assessment, Oxford Knee Score, Neer Score, and Hospital for Special Surgery Knee Score). Studies found no significant differences in the range of motion, knee flexion, and functional recovery across both methods.
- However, some studies suggested a slight edge in early weight-bearing and faster union times for the retrograde nailing group compared to plating, particularly in less complex fracture types. Intramedullary nailing seemed to favor better outcomes for extra-articular fractures due to its minimally invasive approach and reduced soft-tissue disruption.

Union and Complications:
- Union rates and complications varied across studies but generally showed trends. Retrograde nailing exhibited a shorter time to union in several studies, especially in extra-articular fractures. Nonunion rates were often lower with retrograde nailing (ranging from 4% to 11.8%) compared to plating (up to 27.5% in some cases), and retrograde nailing required fewer secondary procedures for nonunion correction.
- Complications differed, with intramedullary nailing associated with increased anterior knee pain and occasional difficulties in knee range of motion. Plating, while suitable for complex fractures, particularly intra-articular fractures, had higher infection rates and coronal plane malalignment in some cases.

Operative Parameters:
- In terms of operative time and intraoperative blood loss, intramedullary nailing generally performed better, showing shorter surgery durations and lower blood loss compared to distal femoral plating. This finding aligns with the minimally invasive nature of retrograde nailing.
- Plating, while associated with slightly longer operative times, provided more stability for complex fractures, which is advantageous in cases with osteoporotic bone or multi-fragmentary fractures.

Study Findings Based on Fracture Types:
- The findings suggested that retrograde nailing is more appropriate for extra-articular distal femur fractures, especially in younger patients with good bone quality, due to its favorable outcomes in terms of weight-bearing and reduced nonunion rates.
- Locking plates were shown to be beneficial for comminuted and intra-articular fractures, particularly in older patients with osteoporotic bones, where stability is crucial for effective healing. However, they require a careful balance as increased surgical site infections and coronal malalignment were noted in some studies.

Consensus on Surgical Technique:
- Across studies, both retrograde nailing and plating are viable treatment options for distal femur fractures, with the choice largely dependent on fracture characteristics, patient demographics, and surgeon expertise.
- Optimal patient outcomes across both techniques were highly associated with proper preoperative planning, surgical precision, and adherence to postoperative rehabilitation protocols. Retrograde nailing offers advantages in terms of reduced operative burden, quicker union, and functional recovery in simpler fracture types, while plating remains a reliable approach for complex and osteoporotic fractures, despite a slightly higher complication profile.

Table 3: Comparative Analysis of Retrograde Intramedullary Nailing and Distal Femoral Plating for Distal Femur Fractures

Category	Retrograde Intramedullary Nailing (rIMN)	Distal Femoral Plating (DFP or LLP)
Functional Outcomes	- Similar functional outcomes to plating overall - Better for early weight-bearing and union in extra-articular fractures - Minimally invasive with less soft tissue disruption	- Similar functional outcomes overall - Effective for complex fractures, especially intra-articular

Union and Complications	- Faster union times, especially in extra-articular fractures - Lower nonunion rates (4%-11.8%) - Increased anterior knee pain in some cases	- Longer time to union, higher nonunion rates (up to 27.5%) - Higher infection rates - Occasional coronal plane malalignment
Operative Parameters	- Shorter operative times and lower blood loss due to the minimally invasive nature	- Longer operative times - Provides stability in osteoporotic and multi-fragmentary fractures
Fracture Type Suitability	- Ideal for extra-articular fractures, especially in younger patients with good bone quality	- Preferable for comminuted, intra-articular fractures, particularly in elderly with osteoporotic bones
Consensus on Technique	- Suitable for simpler fractures; offers quicker recovery and fewer complications with precise technique	- Reliable for complex fractures; higher complication risk but beneficial for stability

DISCUSSION

The treatment of distal femur fractures has progressed from the traditional use of condylar screws and angled blade plates to more advanced techniques, such as the Less Invasive Stabilization System and retrograde intramedullary nailing [23]. While several biomechanical studies have compared locked plating and intramedullary implants for distal femur fractures, there is a notable scarcity of comparative clinical studies directly involving patients [24-29]. Both locked plating and distal femoral nailing offer fixation with minimal soft tissue dissection, aligning with the principles of biological osteosynthesis.Gao et al. and Gill et al. reported comparable outcomes in patients with extra-articular distal femur fractures, noting significant differences in blood loss and surgical duration, with the plating group showing advantages in these parameters. The nailing cohort required sequential reaming, which contributed to increased blood loss and extended surgical time. However, these differences did not lead to any long-term implications, as there were no significant variations between the groups regarding deep infections, implant failures, knee pain, or range of motion. Notably, Gao et al. did identify a higher incidence of union disturbances, including both non-union and delayed union, in the plating group compared to the nailing group. Similarly, Demirtas et al. found no significant differences in implant failure, malunion, non-union, knee pain, or union times in extra-articular distal femur fractures. Hierholzer et al. and Markmiller et al. also reported no significant differences in non-union or infection rates between the fixation methods for both extra- and intra-articular fractures [30].

In a comprehensive analysis of the data, patients treated with plating exhibited less blood loss and shorter surgical durations compared to those in the nailing group, with these findings being statistically significant. While malunion rates were somewhat lower in the plating group, this result was not statistically significant. Conversely, the nailing group demonstrated a slightly lower risk of implant failure, infection, and non-union, although these differences were insignificant, potentially due to the limited number of studies available. Other outcome parameters, including knee range of motion, anterior knee pain, and time to union, appeared similar between the two fixation techniques. Subgroup analysis based on fracture types was not feasible due to the lack of data on outcomes across various age groups and fracture classifications. El-Kawy et al. conducted a study on retrograde nailing in elderly patients with distal femur fractures without intra-articular extensions, concluding that it is a surgically limited yet reliable procedure for this demographic [31,32].

In summary, both locked plating and retrograde intramedullary nailing are effective methods for managing distal femur fractures, demonstrating comparable outcomes concerning malunion, non-union, implant failure, infection rates, knee range of motion, anterior knee pain, and time to union. Plating offers advantages in terms of reduced blood loss and shorter surgical duration, which are statistically significant. These findings are applicable to patients with intra-articular fractures of the distal femur, given the similar distribution of AO type C fractures in both nailing and plating groups, albeit with some reservations. Additionally, retrograde nailing remains a viable alternative, even for comminuted fractures, allowing for early weight-bearing and mobilization.

This study's limitations include a low certainty of evidence based on grading scores, attributed to the scarcity of randomized controlled trials in literature. Furthermore, individual studies often lacked comprehensive outcome parameters, and the inclusion of retrospective studies may weaken the overall strength of the evidence. Conducting larger, well-designed prospective randomized controlled trials could enhance the robustness of these findings.

CONCLUSION

Both retrograde intramedullary nailing and distal femur plating have their respective strengths and limitations. Retrograde nailing may be more advantageous for extra-articular fractures, offering faster recovery and lower nonunion rates, while distal femoral plating is beneficial for complex, intra-articular fractures requiring robust fixation. Further high-quality, prospective studies are recommended to refine indications and optimize outcomes for both techniques in different patient and fracture profiles.

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