Section: Orthopaedic

Original Research Article

COMPARATIVE ANALYSIS OF RETROGRADE INTRAMEDULLARY NAILING VERSUS DISTAL FEMORAL LOCKED PLATING IN THE SURGICAL MANAGEMENT OF DISTAL FEMUR FRACTURES

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ABSTRACT

Background: Fractures involving the distal femur represent severe, complex traumatic injuries exhibiting a bimodal demographic pattern: high-energy motor impacts in young adult males and low-energy osteoporotic insufficiency falls in elderly females. Current internal fixation strategies prioritize biological osteosynthesis, primarily utilizing either retrograde intramedullary nailing (RIN) or distal femoral locked compression plates (LCP). **Aims & Objective:** To systematically assess and compare intraoperative metrics, union timelines, knee joint mobility, functional recovery, and complication profiles between retrograde nailing and locked plating in patients with distal femoral fractures.
Materials and Methods: A prospective comparative clinical study comprising 32 adult patients treated between September 2021 and May 2022 at Muzaffarnagar Medical College and Hospital. Patients were assigned equally into two (n = 16 each): Group A underwent retrograde intramedullary nailing(RIN), and Group B underwent distal femur locked compression plating (LCP). Primary parameters included operative duration, blood loss, radiological union duration, Lower Extremity Functional Scale (LEFS) scores, knee range of motion (ROM), and post-surgical morbidity.
Results: The retrograde nailing cohort demonstrated statistically significant superiority in intraoperative efficiency and healing kinetics: mean operative time was shorter (93.56 ± 18.36 min vs. 107.75 ± 12.56 min; $p = 0.017$), blood loss was substantially reduced (248.13 ± 147.23 cc vs. 434.38 ± 177.41 cc; $p = 0.003$), and bone union occurred significantly faster (11.4 ± 1.92 weeks vs. 15.8 ± 3.37 weeks; $p = 0.001$). Functional outcomes via LEFS ($p = 0.95$), knee flexion range ($p = 0.44$), and overall complication rates showed no statistically significant disparity, although clinical trends favored the RN group.
Conclusion: While both modalities achieve acceptable biomechanical stability, retrograde intramedullary nailing delivers superior surgical ergonomics, reduced perioperative blood loss, and accelerated fracture union compared to open locked plating, predominantly due to the preservation of local biology and periosteal vascularity.
Keywords: Distal femoral fracture, Retrograde intramedullary nail, Locked compression plate, Biological osteosynthesis, Fracture union.

INTRODUCTION

Distal femoral fractures constitute approximately 3% to 6% of all femoral fractures and represent less than 1% of total skeletal injuries. Despite their relatively low overall incidence, they present immense clinical and surgical challenges due to adjacent articular cartilage involvement, severe comminution, and the deforming muscular forces of the gastrocnemius and quadriceps compartments. Epidemiologically, distal femur fractures follow a well-characterized bimodal distribution: High-Energy: Predominantly younger

individuals (under 50 years of age, male predominance) involved in motor vehicle collisions, industrial accidents, or high-impact falls from height, frequently resulting in complex comminuted fractures. Low-Energy Fragility: Elderly patients (above 50 years of age, predominantly osteoporotic females) sustaining low-velocity domestic falls, often characterized by compromised bone stock and metaphyseal bone voids. Historical open reduction and rigid internal fixation with non-locking angle plates or condylar blade plates incurred substantial morbidity, including widespread periosteal devascularization, high non-union rates, implant failure, and deep infection. To overcome these setbacks, the modern management paradigm relies on biological osteosynthesis: Distal Femur Locked Compression Plates (LCP): Provide rigid fixed-angle biomechanical stability without demanding direct plate-to-bone compression, thereby mitigating periosteal strangulation compared to non-locking plates. However, when applied through open approaches, significant soft-tissue dissection is frequently required. Retrograde Intramedullary Nails (RIN): Act as load-sharing, central axis implants with superior mechanical stress distribution, substantially lower bending moments, minimal disruption of fracture hematoma, and limited operative exposure.

MATERIALS AND METHODS

This prospective comparative clinical study was carried out across the Orthopaedic Departments of Muzaffarnagar Medical College and Hospital from September 2021 through May 2022. A total of 32 skeletally mature patients presenting with distal femoral fractures requiring surgical intervention were recruited and allocated into two treatment arms: **Group A (RN Group, n = 16)**: Fixation with retrograde femoral interlocking intramedullary nails. **Group B (LP Group, n = 16)**: Open reduction and internal fixation utilizing distal femoral locked compression plates.

Surgical Protocol & Postoperative Care: Under appropriate general or regional anaesthesia, patients in the **RN Group** were operated on in the supine position via a trans-patellar or medial parapatellar trans-tendinous entry portal. Following distal condylar entry point localization under fluoroscopy, guide wire passage, and reaming, an anatomically contoured retrograde nail was inserted with distal and proximal locking screws. In the **LP Group**, an open lateral approach was performed with anatomically contoured distal locked compression plates placed along the lateral femoral cortex, achieving fixed-angle multiplanar screw purchase. Active and active-assisted knee range of motion exercises were initiated early in the postoperative period based on fixation rigidity. Weight-bearing was progressed incrementally guided by follow-up clinical and radiographic evidence of healing.

Outcome Assessment & Statistical Analysis: Patients were evaluated clinically and radiologically at scheduled intervals (minimum 6 months follow-up). Primary variables encompassed total surgical duration (minutes), estimated blood loss (cc), radiological time to fracture union (weeks), Lower Extremity Functional Scale (LEFS), sagittal knee range of motion (ROM), and postoperative complication rates.

Aims & Objective

To systematically assess and compare intraoperative metrics, union timelines, knee joint mobility, functional recovery, and complication profiles between retrograde nailing and locked plating in patients with distal femoral fractures.

Inclusion Criteria: Skeletally mature patients (≥ 18 years), Distal femur fractures classified under AO/OTA Types 33-A (extra-articular A1–A3) and 33-C (intra-articular C1–C2), Acute fractures amenable to either surgical fixation modality. **Exclusion Criteria:** Skeletally immature individuals with open physis, Open/compound fractures (Gustilo-Anderson grades), Concomitant major neurovascular or ligamentous knee injury, Pathological or periprosthetic fractures, Patients medically unfit for major anaesthesia. Patients were evaluated clinically and radiologically at scheduled intervals (minimum 6 months follow-up). Primary variables encompassed total surgical duration (minutes), estimated blood loss (cc), radiological time to fracture union (weeks), Lower Extremity Functional Scale (LEFS), sagittal knee range of motion (ROM), and postoperative complication rates.

RESULTS

Among the 32 patients enrolled, fracture patterns according to AO/OTA classification showed 15 Type-A (93.75%) and 1 Type-C (6.25%) fractures in the RIN group, compared to 9 Type-A (56.25%) and 7 Type-C (43.75%) fractures in the LCP group.

Table 1: Comparison of Perioperative Parameters and Union Times

Clinical Parameter	Retrograde Nail (RIN) [n=16]	Locked Plate (LCP) [n=16]	Difference / Trend	*P*-Value
Operative Time (min)	93.56 ± 18.36 (range 72–125)	107.75 ± 12.56 (range 94–130)	14.2 min faster in RIN	0.017 (Sig.)
Intraoperative Blood Loss (cc)	248.13 ± 147.23 (range 100–600)	434.38 ± 177.41 (range 100–700)	186.2 cc less in RIN	0.003 (Sig.)

Time to Union (weeks)	11.40 ± 1.92 (range 9–12)	15.80 ± 3.37 (range 9–20)	4.4 weeks quicker in RIN	0.001 (Sig.)
Hospital Stay (days)	2.50 ± 0.65	2.80 ± 0.72	Slightly shorter in RIN	0.390 (NS)

Table 2: Functional Performance & Postoperative Complication Distribution

Outcome Measure / Complication	Retrograde Nail (RIN) [n=16]	Locked Plate (LCP) [n=16]	Statistical Significance
LEFS Score (Mean ± SD)	Higher functional recovery	Good functional recovery	p = 0.95 (Non-significant)
Knee Flexion > 100°	15 cases (93.8%)	14 cases (87.5%)	p = 0.44 (Non-significant)
Superficial Wound Infection	0 cases (0.0%)	1 case (6.25% - resolved via debridement/Abx)	p > 0.05
Knee Joint Stiffness	1 case (Mild - resolved with PT)	2 cases (1 mild, 1 moderate - resolved with PT)	p > 0.05
Healing Disturbances	1 delayed union (united after dynamization)	1 non-union (smoker/diabetic; scheduled for bone graft)	p > 0.05
Hardware Pain / Retinacular Irritation	1 case (screw prominence; removed post-union)	1 case (anterior patellar clicking / tight retinaculum)	p > 0.05
Implant Failure / Breakage	0 cases (0.0%)	0 cases (0.0%)	Identical (0%)

DISCUSSION

The optimal management of distal femoral fractures continues to be an active area of discussion in orthopaedic trauma surgery. The findings of this investigation align closely with biomechanical principles: retrograde intramedullary nails behave as intramedullary, load-sharing load carriers positioned near the mechanical axis of the femur, thereby experiencing lower bending stresses than eccentrically mounted lateral side plates. In our series, the RIN group had a significantly shorter mean operative time (93.56 min vs. 107.75 min, p = 0.017). This contrasts with Gao et al. (87.4 min for RN vs. 79.7 min for LCP; p = 0.106) and Markmiller et al. (142 min for RIN vs. 155 min for LCP). The prolonged operative time observed in our plating cohort is primarily attributable to the utilization of an open anatomic reduction technique rather than closed percutaneous insertion (LISS). Blood loss was markedly lower with retrograde nailing (248.13 cc vs. 434.38 cc; p = 0.003). In contrast, Gao et al. reported lower blood loss in their plate group (200 cc vs. 298 cc for RIN), reflecting their extensive adoption of minimally invasive percutaneous plate osteosynthesis (MIPPO/LISS). Open plating in our cohort necessitated greater muscular and periosteal elevation, resulting in higher intraoperative hemorrhage. Union occurred significantly faster in the RIN group (11.4 weeks vs. 15.8 weeks; p = 0.001). This corroborates the observations of Henderson et al., who demonstrated that locked plates exhibit significantly less periosteal callus formation compared to intramedullary nails due to construct stiffness and periosteal disruption. In studies where plate fixation was performed strictly via closed LISS methods (such as Markmiller et al.: 14.6 weeks RIN vs. 13.8 weeks LCP; Hierholzer et al.), union rates were virtually identical between techniques. Lower Extremity Functional Scale (LEFS) and knee range of motion exhibited no statistically significant differences between groups (p = 0.95 and p = 0.44, respectively). These findings mirror those of Hierholzer et al. (KOOS score), Markmiller et al. (Lysholm-Gillquist score), and Gao et al. (Hospital for Special Surgery score), confirming that both implants provide excellent knee rehabilitation when articular congruity and mechanical alignment are properly restored.

CONCLUSION

Both retrograde intramedullary nailing and distal femoral locked plating represent reliable and effective stabilization methods for distal femur fractures. However, retrograde nailing demonstrates distinct clinical superiority in terms of reduced surgical trauma, diminished blood loss, and accelerated fracture union. Surgical success in distal femoral fracture management is fundamentally dictated by meticulous preoperative planning, soft-tissue preservation, and surgical expertise rather than implant selection alone. For complex intra-articular comminution (AO/ OTA Type C3), locked plating remains indispensable, whereas retrograde nailing is highly advantageous for extra-articular (Type A) and simple intra-articular (Type C1–C2) configurations. Recommendations for Future Work: Large-scale, multicenter randomized controlled trials with extended follow-up durations (> 2 years) are recommended, specifically comparing retrograde nailing directly against minimally invasive percutaneous locked plating (MIPPO/LISS).

REFERENCES

1. Coon MS, Best BJ. Distal Femur Fractures. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2019.
2. Court-Brown CM, Caesar B. Epidemiology of adult fractures: A review. Injury. 2006;37(8):691-697.
3. Walcher F, Frank J, Marzi I. Retrograde nailing of distal femoral fracture—clear and potential indications. Eur J Trauma. 2000;26(4):155-168.

4. Mashru RP, Perez EA. Fractures of the distal femur: current trends in evaluation and management. Curr Opin Orthop. 2007;18(1):41-48.
5. Helfet DL, Lorich DG. Retrograde intramedullary nailing of supracondylar femoral fractures. Clin Orthop Relat Res. 1998;(350):80-84.
6. El-Kawy S, Ansara S, Moftah A, et al. Retrograde femoral nailing in elderly patients with supracondylar fracture femur; is it the answer for a clinical problem? Int Orthop. 2007;31(1):83-86.
7. Binkley JM, Stratford PW, Lott SA, et al. The Lower Extremity Functional Scale (LEFS): scale development, measurement properties, and clinical application. Phys Ther. 1999;79(4):371-383.
8. Hierholzer C, von Rüden C, Pötzel T, et al. Outcome analysis of retrograde nailing and less invasive stabilization system in distal femoral fractures: A retrospective analysis. Indian J Orthop. 2011;45(3):243-250.
9. Henderson CE, Lujan T, Bottlang M, et al. Stabilization of distal femur fractures with intramedullary nails and locking plates: differences in callus formation. Iowa Orthop J. 2010;30:61-68.
10. Gao K, Gao W, Huang J, et al. Retrograde nailing versus locked plating of extra-articular distal femoral fractures: comparison of 36 cases. Med Princ Pract. 2013;22(2):161-166.
11. Markmiller M, Konrad G, Südkamp N. Femur-LISS and distal femoral nail for fixation of distal femoral fractures: are there differences in outcome and complications? Clin Orthop Relat Res. 2004;(426):252-257.