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ORIGINAL ARTICLE

Comparative Study of Locking Compression Plate versus Intramedullary Nail in Distal Femur Fracture

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ABSTRACT

Introduction: *Distal femur fractures are complex injuries that can occur from high-energy trauma in young adults or low-energy falls in the elderly. Surgical fixation is the standard approach to restoring alignment, allowing early mobilisation, and achieving good functional outcomes. The two most common methods are Locking Compression Plate (LCP) and Intramedullary Nailing (IMN). This study aimed to compare the clinical, radiological, and functional outcomes of Locking Compression Plate versus Intramedullary Nailing in patients with distal femur fractures.* ***Methods & Materials:*** *This comparative observational study was conducted in the Department of Orthopedics, Satkhira Sadar Hospital, Satkhira, Bangladesh from January 2024 to January 2025. A total of 68 patients diagnosed with distal femur fractures (AO/OTA type 33) were enrolled based on predefined inclusion and exclusion criteria. Data were analysed using SPSS software version 25.0.* ***Result:*** *In our study of 68 distal femur fracture patients (34 treated with Locking Compression Plate (LCP) and 34 with Intramedullary Nailing (IMN)), IMN resulted in significantly shorter operative time, less intraoperative blood loss, and faster radiological union (mean 15.9 vs. 18.7 weeks, p = 0.004). Functional outcomes (knee motion, pain, walking ability) at 6 months were slightly better in the IMN group, though not statistically significant. Complication rates— including infection, implant failure, non-union, and knee stiffness — were roughly similar between groups.* ***Conclusion:*** *IMN was associated with shorter operative time, less blood loss, and faster union, while LCP offered better stability for comminuted or intra-articular fractures with slightly superior early functional outcomes.*

Keywords: *Locking Compression Plate, Intramedullary Nail, Distal Femur Fracture*

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INTRODUCTION

Distal femur fractures represent approximately 0.4% of all fractures and 3–6% of femoral fractures, occurring predominantly in elderly individuals following low-energy falls and in young adults following high-energy trauma [1]. These fractures are challenging to manage due to their anatomical complexity, proximity to the knee joint, comminution, and frequent association with osteoporosis in the elderly population [2]. Non-operative treatment is rarely preferred today, as it is associated with malunion, nonunion, joint stiffness, prolonged immobilisation, and poor functional outcomes. Therefore, operative fixation has become the standard of care, with the two most commonly utilised methods being the locking compression plate (LCP) and the retrograde intramedullary nail (IMN). The development of locking plates has greatly improved fixation stability, particularly in osteoporotic or metaphyseal comminuted fractures. LCPs provide angular stability, allow for biologic fixation using minimally invasive plate osteosynthesis techniques, and maintain alignment even in poor-quality bone [3]. Several studies have demonstrated that LCPs offer good control of axial and rotational stability and facilitate early mobilisation, although implant-related complications such as screw pull-out, plate breakage, and delayed union remain concerns, especially when construct stiffness is excessive [4]. Retrograde intramedullary nailing, on the other hand, offers a load-sharing fixation that respects the biology of fracture healing by minimising soft-tissue disruption. IMN fixation has been shown to require smaller incisions, reduced operative time, less blood loss, and earlier knee motion in many cases [5]. Additionally, IMNs are biomechanically advantageous due to their central location, which allows effective transmission of axial loads [6]. However, complications such as malalignment, knee pain, and technical challenges in intra-articular fractures have been reported [7]. Several comparative studies and meta-analyses have evaluated outcomes of LCP versus IMN for distal femur fractures, but the findings remain inconsistent. Some studies report no major difference in union rates or functional outcomes between the two techniques, while others suggest that IMN may result in faster union and fewer mechanical failures in extra-articular fractures [8,9]. Conversely, plating has been favoured in fractures with severe metaphyseal comminution or intra-articular extension due to its superior ability to achieve anatomical reduction [4,5]. Despite these advances, the optimal fixation method remains debated, as both implants have distinct strengths and limitations depending on fracture morphology, bone quality, and patient factors.

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METHODS & MATERIALS

This comparative observational study was conducted in the Department of Orthopedics, Satkhira Sadar Hospital, Satkhira, Bangladesh from January 2024 to January 2025. A total of 68 patients diagnosed with distal femur fractures (AO/OTA type 33) were enrolled based on predefined inclusion and exclusion criteria. Eligible participants were adults aged ≥18 years who presented with closed distal femur fractures suitable for surgical fixation using either Locking Compression Plate (LCP) or Intramedullary Nail (IMN). Patients with pathological fractures, open fractures (Gustilo-Anderson grade II and III), polytrauma requiring staged procedures, neurovascular compromise, or those unfit for anesthesia were excluded. After obtaining informed consent, patients were allocated into two groups based on the fixation method selected according to fracture pattern and surgeon preference: Group A (LCP, n = 34) and Group B (IMN, n = 34). Baseline demographic and clinical data—including age, sex, mechanism of injury, comorbidities, and fracture classification—were recorded. Preoperative assessments included radiographic evaluation with anteroposterior and lateral views, a CT scan when needed, and standard laboratory investigations. All surgeries were performed under spinal or general anesthesia by experienced orthopedic surgeons following standardised protocols. In the LCP group, open reduction and internal fixation were done using anatomical distal femur locking plates with indirect reduction techniques. In the IMN group, retrograde intramedullary nails were inserted with closed or minimally open reduction as required. Operative time, intraoperative blood loss, and surgical complications were documented. Patients were followed at 6 weeks, 3 months, 6 months, and 1 year. Outcome measures included time to radiological union, knee range of motion (ROM), functional outcome assessed by the Lysholm score, and complications such as infection, malalignment, implant failure, or nonunion. Radiological union was defined as the presence of bridging callus in at least three cortices on orthogonal views. Malalignment was considered significant if varus/valgus angulation exceeded 5° or if sagittal plane deformity exceeded 10°. Functional outcomes were categorised as excellent, good, fair, or poor based on standard scoring systems. Data were analysed using SPSS software version 25.0. Continuous variables were expressed as mean ± standard deviation and compared using the Student's t-test, while categorical variables were analysed using the chi-square test. A p-value <0.05 was considered statistically significant. Ethical clearance was taken from the institutional Review Board.

RESULTS

The average ages of the LCP and IMN groups were 49.8 ± 15.1 years and 47.4 ± 13.2 years, respectively, with no significant difference (p = 0.48). Males constituted 64.7% in the LCP group and 67.6% in the IMN group (p = 0.80). Road-traffic accidents were the most common cause (61.8% vs. 55.9%). AO Type C fractures were slightly more frequent in the LCP group (44.1%) compared to the IMN group (38.2%), but again, not statistically significant. [Table I]

Table – I: Baseline Demographic and Clinical Characteristics (*n* = 68)

Variables	LCP (n = 34)	IMN (n = 34)	p-value
Age (years), mean ± SD	49.8 ± 15.1	47.4 ± 13.2	0.48
Sex (Male), n (%)	22 (64.7%)	23 (67.6%)	0.80
Mechanism of Injury			
– Road-traffic accident	21 (61.8%)	19 (55.9%)	0.61
– Fall from height	9 (26.5%)	10 (29.4%)	0.78
– Others	4 (11.7%)	5 (14.7%)	0.72
Fracture Type (AO Classification)			
– Type A	12 (35.3%)	15 (44.1%)	0.45
– Type B	7 (20.6%)	6 (17.6%)	0.76
– Type C	15 (44.1%)	13 (38.2%)	0.62

The LCP group had a significantly longer mean operative time (108.3 minutes vs. 82.6 minutes, p < 0.001), higher mean blood loss (411.2 mL vs. 267.3 mL, p < 0.001), and longer incision (9.4 cm vs. 5.7 cm, p < 0.001). Open reduction was required in 76.5% of LCP cases compared with only 20.6% in the IMN group. [Table II].

Table – II: Intraoperative Parameters Between LCP and IMN Groups

Variables	LCP (n = 34)	IMN (n = 34)	p-value
Operative time (minutes), mean ± SD	108.3 ± 22.5	82.6 ± 18.7	<0.001
Intraoperative blood loss (mL), mean ± SD	411.2 ± 136.4	267.3 ± 112.5	<0.001
Incision length (cm), mean ± SD	9.4 ± 2.1	5.7 ± 1.3	<0.001
Need for open reduction, n (%)	26 (76.5%)	7 (20.6%)	<0.001

The IMN group showed a significantly faster mean union time (15.9 weeks) compared to the LCP group (18.7 weeks, p = 0.004). Delayed union occurred in 17.6% (LCP) vs. 8.8% (IMN), while nonunion was reported in 5.9% vs. 2.9%, respectively. Malalignment (>5°) occurred in 3 cases (8.8%) for LCP and 5 cases (14.7%) for IMN. [Table III].

Table – III: Radiological Outcomes and Time to Union

Variables	LCP (n = 34)	IMN (n = 34)	p-value
Radiological union (weeks), mean ± SD	18.7 ± 4.3	15.9 ± 3.8	0.004
Delayed union, n (%)	6 (17.6%)	3 (8.8%)	0.28
Non-union, n (%)	2 (5.9%)	1 (2.9%)	0.55
Malalignment (>5°), n (%)	3 (8.8%)	5 (14.7%)	0.45

At 6 months, mean knee flexion was slightly higher in the IMN group (118.3°) compared to the LCP group (112.4°), but not statistically significant (p = 0.08). Pain scores were 2.6 (LCP) vs. 2.1 (IMN). Good/excellent walking ability was achieved in 76.5% (LCP) vs. 85.3% (IMN). The overall functional score was marginally higher in the IMN group (28.1) compared to LCP (26.7). [Table IV].

Table – IV: Postoperative Functional Outcome

Functional Parameter (at 6 months)	LCP (n = 34)	IMN (n = 34)	p-value
Mean knee flexion (°), mean ± SD	112.4 ± 15.2	118.3 ± 12.7	0.08
Pain score (0–10), mean ± SD	2.6 ± 1.8	2.1 ± 1.5	0.27
Walking ability (Good/Excellent), n (%)	26 (76.5%)	29 (85.3%)	0.36
Overall functional score, mean ± SD	26.7 ± 3.9	28.1 ± 3.4	0.07

Superficial infections occurred in 11.7% of LCP cases vs. 5.9% of IMN cases. Deep infection was noted in 1 LCP patient. Knee pain/stiffness was slightly higher in the IMN group (26.5%) compared to LCP (20.6%). Reoperation rates were 8.8% for LCP and 5.9% for IMN, with no significant statistical difference. [Table V]

Table – V: Postoperative Complications

Complications	LCP (n = 34)	IMN (n = 34)	p-value
Superficial infection	4 (11.7%)	2 (5.9%)	0.39
Deep infection	1 (2.9%)	0 (0%)	0.31
Implant failure	2 (5.9%)	1 (2.9%)	0.55
Knee pain/stiffness	7 (20.6%)	9 (26.5%)	0.56
Reoperation rate	3 (8.8%)	2 (5.9%)	0.64

DISCUSSION

In our cohort of 68 patients (34 treated with LCP and 34 with IMN), we observed that the IMN group achieved a significantly shorter time to radiological union (15.9 ± 3.8 weeks) compared with the LCP group (18.7 ± 4.3 weeks; p = 0.004), while overall union rates, nonunion, malalignment and complication rates were similar between groups. These findings are in broad agreement with a recent meta-analysis of 936 patients from 16 studies, which reported no statistically significant difference between retrograde intramedullary nailing (RIMN) and locked plate (LP) fixation in terms of mean fracture union time, overall complications, implant-related complications, re-operation rates, and duration of surgeries [10]. In that meta-analysis, although LP showed somewhat better knee range of motion, RIMN had fewer nonunions and infections compared to LP [10]. Our study echoes that trend: although the functional outcomes (knee flexion, pain score, walking ability, and overall functional score) at 6 months were slightly better in the IMN group, the differences did not reach statistical significance - suggesting comparable overall performance by both modalities in terms of function and safety. Looking at a large systematic review specific to "native" distal femur fractures, the authors reported a union rate of 93.9% with IMN versus 90.2% with LP; mean time to union was 19.2 weeks for IMN and 20.5 weeks for LP; mean knee arc of motion was 105.1° and 104°, respectively; and malalignment averaged 14.4° for IMN vs. 12.6° for LP [11]. In our study, the mean union times (15.9 vs 18.7 weeks) are shorter than those pooled averages, which may reflect modern surgical techniques, optimised perioperative care, or stricter inclusion criteria. Our union rates are consistent with high union likelihood regardless of method; the slightly better (but statistically nonsignificant) functional results in IMN also mirror the negligible differences in knee arc or malalignment described by that review [11]. A retrospective comparative study by Amit Yadav et al., including 86 patients (44 IMN, 42 LP), noted significantly less operative time and blood loss in the IMN group, and a faster time until radiological union; they reported 5 non-unions and 2 delayed unions in the LP group versus only 1 non-union in the IMN group; full weight-bearing at 12 weeks was achieved in 93% of IMN patients compared with 66% in LP — though knee pain at 6 months was more frequent in the IMN group [12]. These results are similar to ours: we observed significantly shorter operative time (82.6 vs 108.3 min), less blood loss (267.3 vs 411.2 mL), and shorter time to union in the IMN group; nonunion was rare in both groups (2 in LCP, 1 in IMN), and functional outcomes favoured IMN, even if not statistically significant. That Yadav et al. found more knee pain in the IMN group at 6 months, whereas our study did not show a significant difference (pain score 2.1 vs 2.6), might reflect differences in postoperative rehabilitation, patient population, or implant design. In a retrospective series of 60 patients (30 LCP, 30 distal femoral nail), Ajay Kurahatti et al. reported a mean time to radiological union of 24 weeks for LCP versus 20 weeks for IMN; Neer scores (functional outcome) were similar: 56.6% excellent in plating vs 51.7% excellent in nailing; knee range of motion at follow-up was also comparable (114° for LCP vs 115° for IMN) [13]. Our union times are shorter than both, possibly due to different fracture patterns or surgical protocols. The similar functional outcomes between groups in their study align with our findings, supporting that both LCP and IMN remain valid options depending on fracture characteristics. On the other hand, in the systematic review focusing on periprosthetic distal femur fractures after total knee arthroplasty, no differences were found between LCP and IMN in mean time to union, nonunion rate, or revision surgery requirement; sometimes IMN had slightly shorter operative time and marginally higher functional scores, but differences were not statistically significant [14]. Although periprosthetic fractures differ in biology and bone quality from native fractures, their conclusion reinforces the concept that both constructs can yield acceptable results when properly applied — as did our study in a non-arthroplasty context.

Limitations of The Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

In this study of 68 distal femur fracture patients, both Locking Compression Plate (LCP) and Intramedullary Nailing (IMN) proved effective, but with different strengths. IMN was

associated with shorter operative time, less blood loss, and faster union, while LCP offered better stability for comminuted or intra-articular fractures with slightly superior early functional outcomes.

RECOMMENDATION

Based on the findings of this study, Intramedullary Nailing (IMN) is recommended for extra-articular or simple distal femur fractures where rapid surgery, minimal blood loss, and faster bone healing are priorities. Locking Compression Plate (LCP) is recommended for comminuted or intra-articular fractures requiring precise anatomical reduction and stable fixation.

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