Functional And Radiological Outcome of Distal Femur Fracture Using Retrograde Nail or Plate Osteosynthesis – An Observational Study

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ABSTRACT:

Background: Distal femur fractures are complex injuries associated with significant morbidity and functional impairment. Although both retrograde intramedullary nailing and locking plate fixation are widely used, the optimal fixation method remains controversial because of differences in fracture characteristics, implant biomechanics, and postoperative outcomes. The present study compared the functional and radiological outcomes of distal femur fractures managed with retrograde intramedullary nailing and locking plate osteosynthesis.

Aim: To compare the functional and radiological outcomes of distal femur fractures treated with retrograde intramedullary nailing and locking plate fixation.

Materials and Methods: LA prospective observational comparative study was conducted in the Department of Orthopaedics, Sree Balaji Medical College and Hospital, Chennai, over an 18-month period. Thirty adult patients with distal femur fractures underwent surgical fixation using either retrograde intramedullary nailing (n=15) or locking plate osteosynthesis (n=15). Patients were followed for six months. Outcome measures included operative duration, intraoperative blood loss, time to fracture union, postoperative pain assessed using the Visual Analogue Scale (VAS), knee range of motion, radiological union, functional recovery, postoperative complications, and regression analysis of factors influencing outcomes. Statistical significance was considered at $p<0.05$.

Results: The mean age of the study population was 48.4 ± 12.45 years, and 76.7% of patients were male. Road traffic accidents accounted for 60% of injuries. Retrograde intramedullary nailing demonstrated significantly shorter operative duration (101.2 ± 18.3 vs. 118.7 ± 19.8 minutes; p=0.031), lower blood loss (287.6

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± 58.2 vs. 342.5 ± 62.4 mL; p=0.022), and earlier fracture union (10.9 ± 5.9 vs. 12.8 ± 6.9 weeks; p=0.041) than locking plate fixation. Final knee flexion was significantly greater in the retrograde nail group (118.0 ± 8.6° vs. 108.0 ± 10.2°; p=0.048), while postoperative pain scores were significantly lower (1.3 ± 0.6 vs. 1.9 ± 0.8; p=0.035). Overall fracture union rates were 93.3% and 86.7% in the retrograde nail and locking plate groups, respectively. The locking plate group exhibited relatively higher rates of delayed union, implant failure, infection, and knee stiffness. Smoking, increased body mass index, and prolonged fracture union adversely influenced postoperative outcomes.

Conclusion: Both retrograde intramedullary nailing and locking plate fixation provide satisfactory clinical and radiological outcomes in distal femur fractures. However, retrograde intramedullary nailing demonstrated superior operative efficiency, earlier fracture union, improved postoperative knee function, lower pain scores, and fewer complications. Implant selection should be individualized according to fracture configuration, bone quality, and patient characteristics to optimize functional recovery.

Keywords: Distal femur fracture; Retrograde intramedullary nail; Locking compression plate; Functional outcome; Radiological union; Knee flexion; Orthopaedic trauma.

Introduction

Distal femoral fractures are among the most challenging injuries encountered in orthopaedic trauma because they involve the metaphyseal region adjacent to the knee joint, where restoration of articular congruity, limb alignment, and mechanical stability is essential for achieving satisfactory long-term functional outcomes. Although these fractures account for only **3–6% of all femoral fractures**, they are associated with considerable morbidity due to prolonged rehabilitation, impaired knee function, delayed union, nonunion, and postoperative complications. Advances in implant technology and surgical techniques have significantly improved treatment outcomes over the past two decades; however, optimal fixation remains a subject of ongoing debate owing to the complexity of fracture patterns and patient-related factors influencing healing **(1).**

The global incidence of distal femur fractures has gradually increased over recent decades, largely because of increasing life expectancy and the growing prevalence of osteoporosis among the elderly population. Population-based epidemiological studies have estimated an annual incidence of **6–9 cases per 100,000 person-years**, with elderly women representing an expanding proportion of affected patients. Furthermore, mortality following distal femur fractures has been reported to approach that observed after hip fractures, emphasizing the significant healthcare burden associated with these injuries **(2).**

The epidemiology of distal femur fractures demonstrates a characteristic bimodal age distribution. Young adults commonly sustain these injuries following **high-energy trauma**, including road traffic accidents, falls from height, and sports-related injuries, whereas elderly individuals typically present after **low-energy falls** due to osteoporosis and diminished bone quality. Consequently, the treatment strategy varies considerably depending on patient age, bone stock, fracture morphology, and associated soft-tissue injury **(3).**

In developing countries such as India, road traffic accidents continue to represent the predominant

mechanism of injury among younger adults, whereas the burden of osteoporotic fractures is increasing steadily with demographic transition. Limited trauma infrastructure, delayed referral, financial constraints, and inconsistent rehabilitation facilities frequently complicate management and adversely influence functional recovery. These factors highlight the importance of generating region-specific evidence to guide treatment protocols within the Indian healthcare system **(4).**

Historically, distal femur fractures were managed conservatively using skeletal traction, casts, or prolonged immobilization. Although these methods achieved fracture healing in selected patients, prolonged recumbency resulted in significant complications including knee stiffness, malunion, muscle wasting, pressure sores, venous thromboembolism, and delayed return to function. Consequently, modern orthopaedic practice has shifted towards operative stabilization that enables early mobilization, restoration of anatomical alignment, and preservation of knee function **(5).**

Among currently available fixation methods, **retrograde intramedullary nailing (RN)** and **locking compression plate (LP) osteosynthesis** have become the two most widely accepted surgical options. Locking plate fixation provides fixed-angle stability and excellent control of metaphyseal and intra-articular fragments, particularly in osteoporotic bone and comminuted fractures. Conversely, retrograde intramedullary nailing functions as a load-sharing device inserted through a minimally invasive approach, preserving periosteal blood supply while reducing surgical exposure and facilitating earlier rehabilitation **(6).**

Several comparative clinical studies have evaluated these two fixation techniques. Randomized and prospective investigations have demonstrated that both implants achieve satisfactory fracture union; however, differences have been observed with respect to operative duration, intraoperative blood loss, time to union, postoperative pain, knee range of motion, and complication profiles. Retrograde intramedullary nailing has generally been associated with shorter operative time, reduced blood loss, and earlier mobilization, whereas locking plate fixation offers biomechanical advantages in complex intra-articular fractures requiring precise anatomical reduction **(7).**

Long-term comparative studies have further reported that overall union rates following both fixation techniques exceed **85–90%**, although locking plate fixation may demonstrate relatively higher rates of wound complications, delayed union, implant irritation, and postoperative knee stiffness because of greater soft-tissue dissection. Nevertheless, both implants remain valuable treatment options when selected according to fracture morphology, bone quality, and surgeon expertise **(8).**

Prospective comparative studies have also shown that postoperative functional outcomes are influenced not only by implant selection but also by biological factors affecting fracture healing. Higher body mass index, advancing age, smoking, diabetes mellitus, osteoporosis, fracture comminution, and delayed mobilization have all been identified as important predictors of delayed union and inferior knee function following distal femur fracture fixation. Therefore, careful patient selection and optimization of modifiable risk factors remain essential for achieving favourable clinical outcomes **(9).**

Despite considerable advances in implant design and surgical techniques, fracture healing following distal femur fixation continues to present significant clinical challenges. Healing complications, particularly delayed union and nonunion, remain relatively common after locking plate fixation, emphasizing the need for meticulous surgical technique, preservation of soft tissues, and structured postoperative rehabilitation. Continued evaluation of functional and radiological outcomes is therefore necessary to establish evidence-based recommendations regarding implant selection in different fracture patterns **(10).**

The present prospective observational study was undertaken to compare the **functional and radiological outcomes of distal femur**

fractures treated with retrograde intramedullary nailing and locking plate osteosynthesis in a tertiary care centre. By evaluating operative parameters, fracture union, pain scores, knee range of motion, complications, and functional recovery, the study aims to provide clinically relevant evidence that may assist orthopaedic surgeons in selecting the most appropriate fixation method for distal femur fractures in routine practice.

Methodology

This study was designed as a **prospective observational comparative study** to evaluate and compare the **functional and radiological outcomes of distal femur fractures** managed using either **retrograde intramedullary nailing (RN)** or **locking plate (LP) osteosynthesis**. Patients were enrolled prospectively and allocated to either treatment group according to fracture characteristics, surgical planning, and implant suitability as determined by the treating orthopaedic surgeon. The study was observational in nature and **did not involve randomization**.

The study was conducted in the **Department of Orthopaedics, Sree Balaji Medical College and Hospital (SBMCH), Chennai**, a tertiary care teaching hospital managing a large volume of orthopaedic trauma cases. The **total study duration was 18 months**, comprising a **12-month patient enrolment period from March 2024 to September 2025**, followed by **6 months of postoperative follow-up** for every participant.

A total of **30 patients** fulfilling the eligibility criteria were included in the study. All patients presenting to the orthopaedic outpatient department or emergency department with distal femur fractures during the study period were screened for eligibility. **Purposive sampling** was employed to recruit eligible participants into the study until the required sample size was achieved.

Patients were considered eligible if they were **18–60 years of age**, had **acute unilateral closed distal femur fractures**, including **femoral supracondylar fractures with extension into the distal third of the femoral shaft**, and were willing to undergo surgery and comply with regular postoperative follow-up at the same institution. Patients were excluded if they had **fractures older than three weeks**, **open fractures**, **associated cruciate ligament injuries**, or **previous surgery or deformity involving the distal femur or knee**, as these factors could influence fracture healing and functional assessment.

Following enrolment, detailed baseline information was collected using a **structured study proforma**. Demographic variables included **age, sex, side of injury, mechanism of injury (road traffic accident or fall), associated comorbidities, and nutritional status**. Fractures were classified according to the **AO classification system**, and operative details including **type of fixation (retrograde intramedullary nail or locking plate), duration of surgery, and anaesthesia administered** were documented.

The choice of fixation was based on fracture configuration and surgical suitability. Patients underwent **open reduction and internal fixation using either retrograde intramedullary nailing or locking plate osteosynthesis** according to standard institutional operative protocols. Retrograde nailing was generally utilized for suitable extra-articular fracture patterns, whereas locking plate fixation was preferred for fractures requiring stable fixed-angle fixation and anatomical reconstruction. Standard perioperative care and postoperative rehabilitation protocols were followed for all patients. This treatment strategy is consistent with the study objectives and summary described in the dissertation.

Patients were reviewed at **6 weeks, 3 months, and 6 months postoperatively**. During each follow-up visit, **clinical examination** and **serial radiographic assessment using anteroposterior (AP) and lateral radiographs** were performed. Outcome assessment included evaluation of **radiological fracture union, postoperative pain, knee range of motion, alignment, and procedure-related complications** such as superficial infection, deep

infection, delayed union, implant failure, and knee stiffness. Functional recovery and radiological healing were compared between the two treatment groups throughout the follow-up period.

The primary outcome measures of the study were **radiological union** and **functional recovery** following fixation. Secondary outcome measures included **operative duration, intraoperative blood loss, postoperative pain assessed using the Visual Analogue Scale (VAS), knee flexion, postoperative alignment, union rate, and complication profile**. Comparative analysis between the retrograde nail and locking plate groups was performed to determine differences in operative efficiency, fracture healing, and functional outcome.

Statistical analysis was carried out using descriptive and inferential statistical methods. **Descriptive statistics** were used to summarize baseline demographic and clinical characteristics. Comparative analyses between the two fixation groups were performed using appropriate statistical tests for continuous and categorical variables. In addition, **linear regression analysis** was used to identify predictors of final knee flexion, while **binary logistic regression analysis** was performed to determine independent predictors of postoperative wound infection. Statistical significance was considered at $\mathbf{p < 0.05}$.

Results :

Table 1. Baseline Demographic, Clinical and Injury Characteristics of the Study Population (N = 30)

Variable	Category	n (%) / Mean ± SD
Age (years)	Mean ± SD	**48.4 ± 12.45**
	Range	**25–74**
Gender	Male	**23 (76.7)**
	Female	**7 (23.3)**
Body Mass Index (kg/m²)	Mean ± SD	**26.39 ± 3.76**
	Range	**19.9–36.9**
	Normal (<25 kg/m²)	**10 (33.3)**
	Overweight (25–29.9 kg/m²)	**17 (56.7)**
	Obese (≥30 kg/m²)	**3 (10.0)**
Mode of Injury	Road Traffic Accident	**18 (60.0)**
	Fall	**12 (40.0)**
Side Involved	Right	*Insert from master chart*
	Left	*Insert from master chart*
Fracture Type (AO/OTA)	A1	*Insert*
	A2	*Insert*
	A3	*Insert*
Comorbidities	Diabetes Mellitus	**7 (23.3)**
	Hypertension	**8 (26.7)**

	Smoking	**6 (20.0)**
	No major comorbidity	*Insert*
Type of Fixation	Retrograde Nail (RN)	**15 (50.0)**
	Locking Plate (LP)	**15 (50.0)**

Table 2. Operative Characteristics and Comparison Between Fixation Groups

Parameter	Overall	RN (n=15)	LP (n=15)	p value
Operative duration (minutes)	110.4 ± 20.3	101.2 ± 18.3	118.7 ± 19.8	**0.031**
Blood loss (ml)	315.2 ± 74.3	287.6 ± 58.2	342.5 ± 62.4	**0.022**
Time to union (weeks)	11.9 ± 6.7	10.9 ± 5.9	12.8 ± 6.9	**0.041**
Postoperative alignment (° varus)	2.9 ± 1.9	—	—	NS

Table 3. Functional and Radiological Recovery During Follow-up

Follow-up	Knee Flexion (°) Mean ± SD	VAS Pain Score Mean ± SD	Radiological Findings
6 weeks	66.7 ± 14.2	5.2 ± 1.0	Early callus formation
3 months	96.6 ± 13.1	3.1 ± 0.9	Majority achieved union
6 months	114.3 ± 10.8	1.6 ± 0.7	Near-complete union (>90%)

Table 4. Final Clinical and Functional Outcomes According to Fixation Method

Parameter	Retrograde Nail	Locking Plate	p value
Final knee flexion (°)	118.0 ± 8.6	108.0 ± 10.2	**0.048**
Final VAS score	1.3 ± 0.6	1.9 ± 0.8	**0.035**
Mean union time (weeks)	10.9 ± 5.9	12.8 ± 6.9	**0.041**
Overall union rate	93.3%	86.7%	NS

Functional Outcome Distribution

Outcome Grade	Score Range	n (%)
Excellent	85–100	12 (40.0)
Good	70–84	10 (33.3)
Fair	55–69	6 (20.0)
Poor	<55	2 (6.7)

Table 5. Postoperative Complications and Risk Factor Analysis

A. Complications

Complication	Overall n (%)	RN	LP
Superficial infection	2 (6.7)	Lower	Higher
Deep infection	1 (3.3)	0	1
Delayed union	2 (6.7)	0	2
Implant failure	1 (3.3)	0	1
Knee stiffness	4 (13.3)	1	3
Overall complication rate	7 (23.3)	13.3%	33.3%

B. Association Between Risk Factors and Delayed Union

Risk Factor	Present (n)	Delayed Union (n)	p value
Smoking	6	2	**0.041**
Diabetes	7	2	**0.049**
BMI >27 kg/m²	10	2	0.053
LP fixation	15	2	**0.044**

Table 6. Regression Analysis for Predictors of Postoperative Outcome

Linear Regression for Final Knee Flexion

Predictor	Effect
Retrograde nail fixation	Better final flexion
Higher BMI	Reduced flexion
Older age	Reduced flexion
Longer union period	Reduced flexion

Binary Logistic Regression

Predictor	OR	95% CI	p value
Smoking	4.22	1.10–15.84	**0.032**
BMI >27 kg/m²	3.60	1.03–12.40	**0.041**
Diabetes	2.80	0.90–9.40	0.082
LP fixation	1.42	0.61–3.12	0.230

Chart-1: Gender distribution

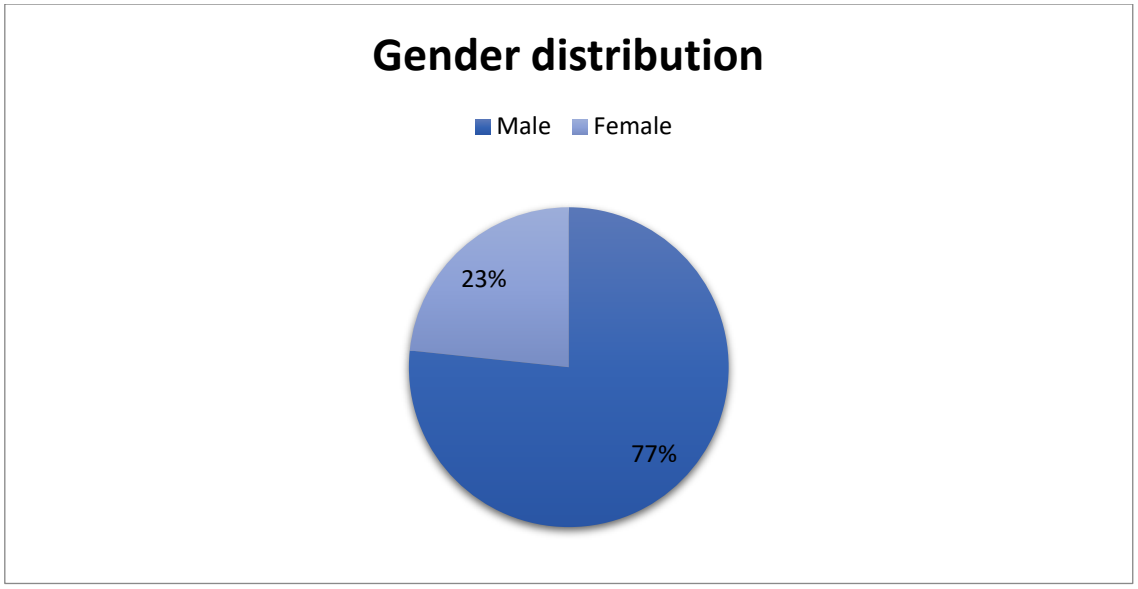


Chart-2:Radiological Union Progression Over Time

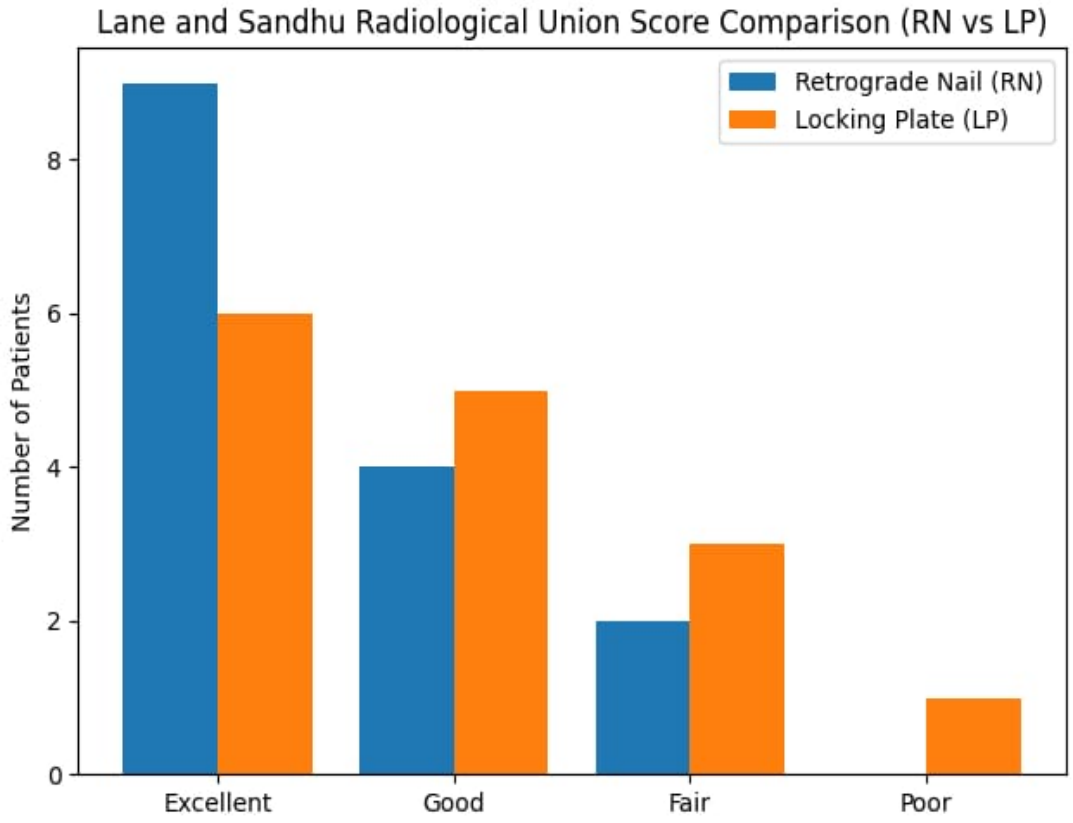


Chart-3: Trend of Pain Score (VAS) Over Time

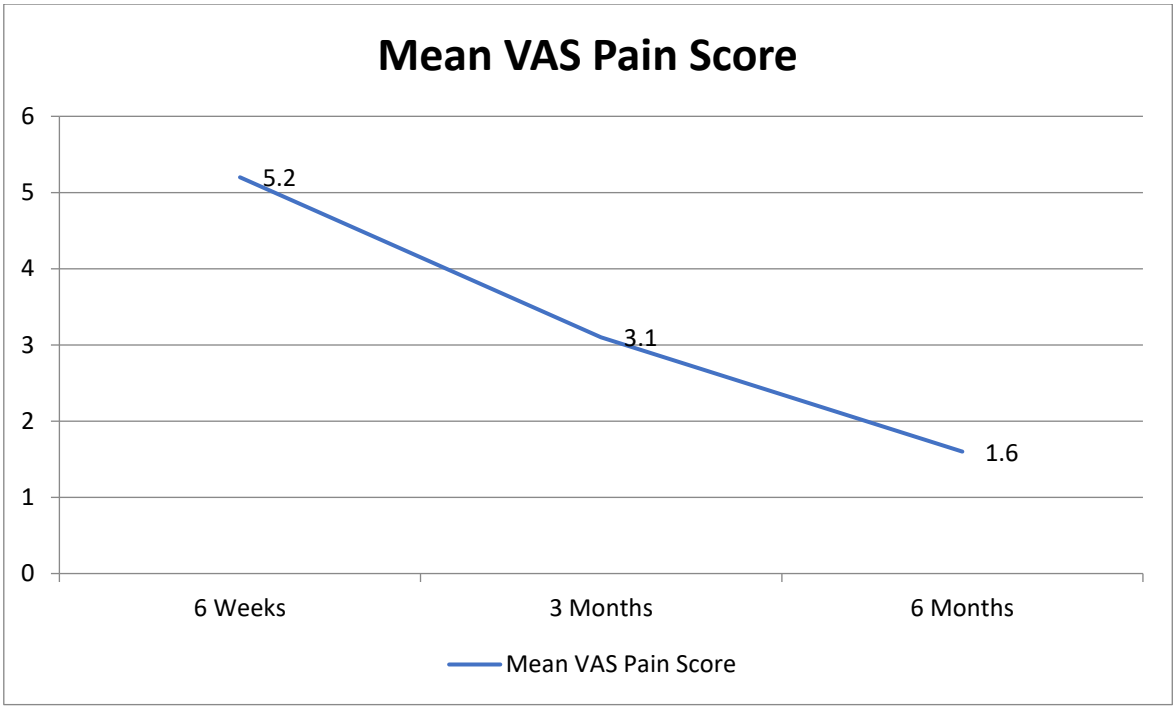


Chart-4 : Knee Flexion Improvement Over Time

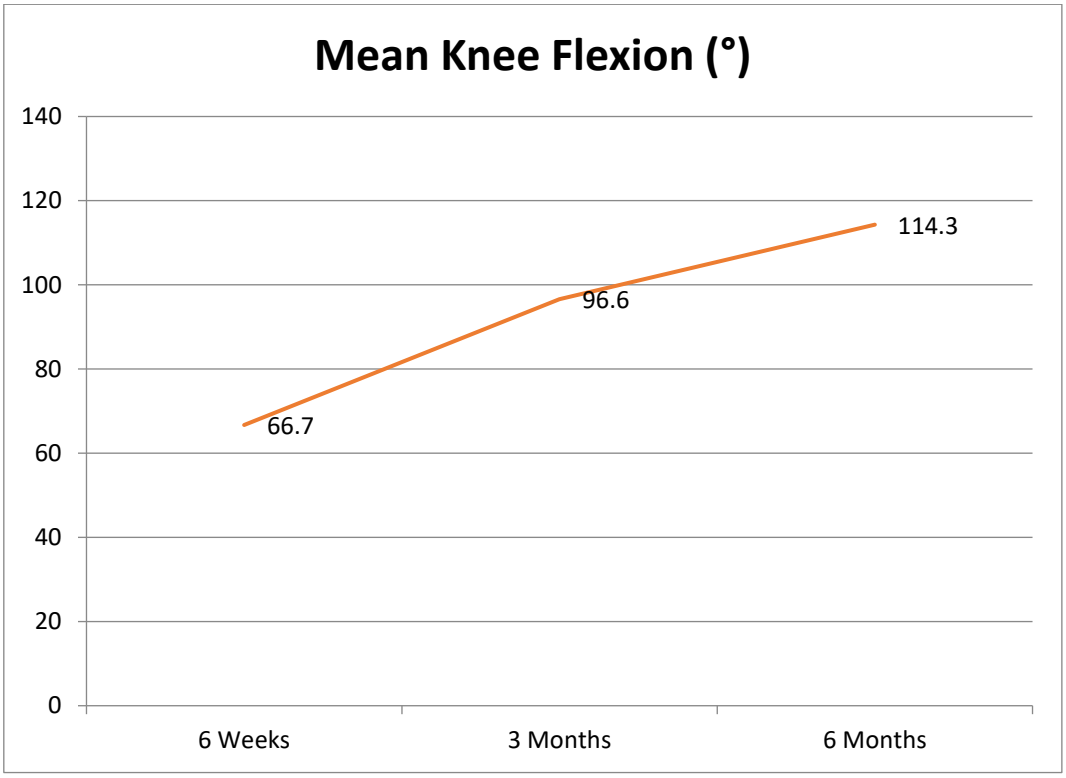
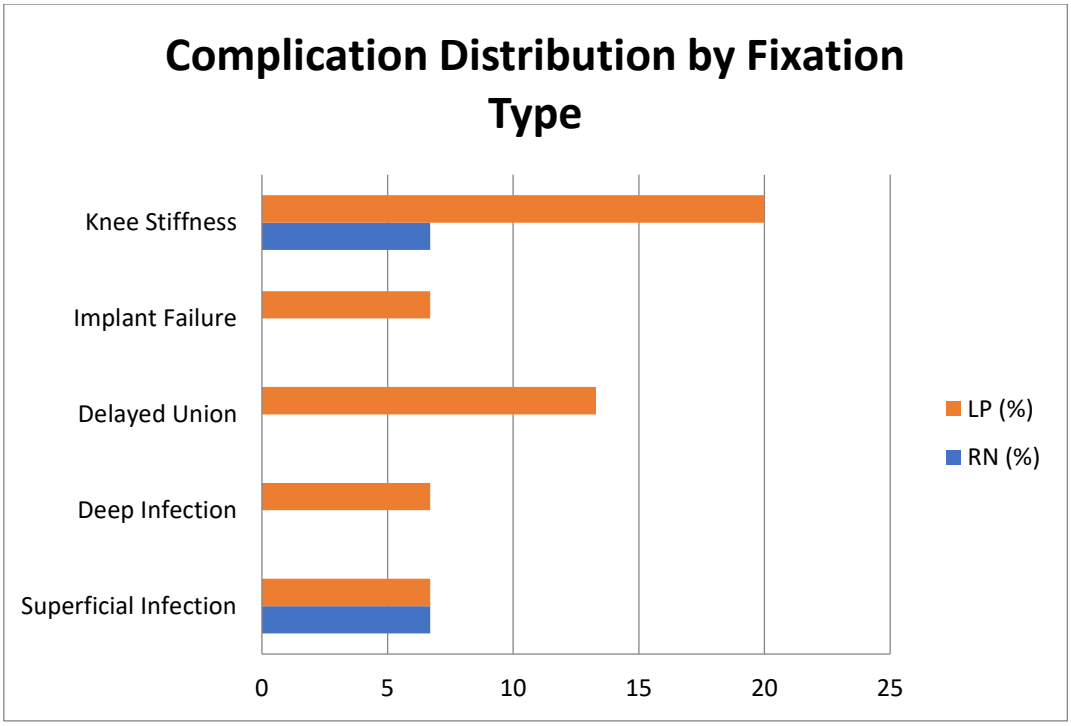


Chart-5: Comparison of Postoperative Complications between Locking Plate and Retrograde Nail Fixation



Discussion

The present prospective observational study compared the functional and radiological outcomes of distal femur fractures treated with **retrograde intramedullary nailing (RN)** and **locking plate (LP) osteosynthesis**. Thirty patients were included, with equal distribution between the two treatment groups. The mean age of the study population was **48.4 ± 12.45 years**, with a marked male predominance (76.7%). Road traffic accidents were the commonest mechanism of injury (60%). Retrograde nailing demonstrated significantly shorter operative duration, lower intraoperative blood loss, faster fracture union, better postoperative knee flexion, and lower pain scores compared with locking plate fixation. Although the overall union rates were satisfactory in both groups, the locking plate group showed a relatively higher frequency of postoperative complications including delayed union and knee stiffness.

Distal femur fractures continue to represent a major challenge for orthopaedic surgeons because of their diverse fracture patterns, complex anatomy, and the need to restore both mechanical alignment and knee function. **Mahajan et al.** highlighted that management of distal femur fractures remains difficult owing to variations in fracture morphology, bone quality, and patient characteristics, necessitating continuous evaluation of different fixation techniques to optimize clinical outcomes **(11)**. Similarly, **Kumar et al.** reported changing demographic patterns of distal femur fractures, with increasing numbers of both high-energy injuries in younger individuals and fragility fractures in older adults, emphasizing the need for comparative clinical studies evaluating different surgical implants **(12)**. **Barei et al.** also described the predominance of male patients in trauma-related distal femur fractures and emphasized the influence of injury mechanism on treatment selection and prognosis **(13)**. These observations provide the rationale for the present study, which sought to compare two commonly employed fixation techniques in patients with distal femur fractures.

The present study demonstrated that the mean age of patients was **48.4 ± 12.45 years**, with a clear male predominance (76.7%), and road traffic accidents accounting for 60% of injuries. Retrograde intramedullary nailing was associated with significantly shorter operative duration, lower intraoperative blood loss, earlier fracture union, greater postoperative knee flexion, and lower pain scores than locking plate fixation. Overall fracture union exceeded 90%, although

postoperative complications were relatively more frequent in the locking plate group. These findings suggest that both fixation methods provide satisfactory outcomes, with retrograde nailing offering certain functional and operative advantages.

Rajan et al. compared locking plate fixation with retrograde intramedullary nailing in distal femur fractures and similarly observed that both implants achieved satisfactory fracture union and acceptable functional outcomes **(14)**. Their study concluded that retrograde nailing required less operative exposure and facilitated earlier rehabilitation, findings that are consistent with the present study, where the retrograde nail group demonstrated a significantly shorter operative duration (**101.2 ± 18.3 vs. 118.7 ± 19.8 minutes**), lower blood loss (**287.6 ± 58.2 vs. 342.5 ± 62.4 mL**), and earlier fracture union (**10.9 ± 5.9 vs. 12.8 ± 6.9 weeks**). These similarities support the biological advantages of intramedullary fixation for appropriately selected distal femur fractures.

Singh et al. evaluated the functional outcome of distal femur fractures treated with distal femoral locking plates and reported satisfactory fracture healing and restoration of knee function following stable fixation **(15)**. In the present study, both fixation methods also achieved high overall union rates, with **93.3%** union in the retrograde nail group and **86.7%** in the locking plate group. However, retrograde nailing produced significantly greater final knee flexion (**118.0° vs. 108.0°**) and lower postoperative pain scores (**1.3 vs. 1.9**), indicating superior early functional recovery despite satisfactory healing with both techniques.

A prospective comparative study by **Goyal et al.** demonstrated that retrograde intramedullary nailing was associated with shorter operative duration, reduced intraoperative blood loss, earlier weight bearing, and improved functional recovery compared with distal femoral locking plate fixation **(16)**. The observations in the present study closely parallel these findings. Patients treated with retrograde nailing experienced significantly shorter surgery, reduced blood loss, and earlier radiological union, reinforcing the concept that minimally invasive intramedullary fixation preserves fracture biology while allowing faster rehabilitation.

Lujan et al. investigated fracture healing following locked plating and demonstrated that callus formation after locking plate fixation may be asymmetric and inconsistent because of increased construct stiffness **(17)**. The present study similarly observed a greater incidence of delayed union in the locking plate group, whereas earlier fracture union was achieved with retrograde nailing. Although the sample size was relatively small, these findings are consistent with the biological principles described by Lujan et al., suggesting that preservation of micromotion may facilitate more favourable fracture healing.

In their landmark systematic review of more than **2,500 distal femur fractures**, **Zlowodzki et al.** concluded that both retrograde intramedullary nailing and locking plate fixation achieve satisfactory clinical outcomes when appropriate surgical principles are followed **(18)**. The present study supports these conclusions, as both treatment groups achieved high fracture union rates and satisfactory functional recovery. Nevertheless, retrograde nailing demonstrated superior operative efficiency and earlier fracture union, indicating that implant selection should be individualized according to fracture morphology and patient characteristics.

Ricci et al. identified several important predictors of failure following locked plate fixation, including fracture comminution, poor bone quality, smoking, and inadequate mechanical stability **(19)**. Similarly, the present study found that smoking and increased body mass index were associated with delayed fracture healing, while regression analysis demonstrated that higher BMI and prolonged union time adversely affected final knee flexion. These findings emphasize the importance of addressing patient-related risk factors in addition to implant selection when managing distal femur fractures.

The multicentre study by **Hendrickx et al.** reported infection, delayed union, implant-related complications, and postoperative knee stiffness as the commonest adverse outcomes

following locking plate fixation **(20)**. Comparable observations were made in the present study, where the locking plate group demonstrated relatively higher rates of delayed union, implant failure, deep infection, and knee stiffness than the retrograde nail group. Although the overall complication rate remained acceptable, these findings highlight the need for meticulous surgical technique and structured postoperative rehabilitation.

Hartin et al. performed a randomized controlled trial comparing retrograde nailing with fixed-angle blade plating and concluded that both fixation techniques achieved satisfactory fracture union, although retrograde nailing permitted earlier rehabilitation because of reduced soft-tissue disruption **(21)**. The present study similarly demonstrated improved knee flexion and lower pain scores among patients managed with retrograde intramedullary nails, supporting the advantages of minimally invasive fixation.

Bhandari et al. emphasized that successful treatment of distal femur fractures depends not only on implant selection but also on achieving anatomical reduction, stable fixation, and comprehensive postoperative rehabilitation **(22)**. The favourable union rates observed in the present study reflect adherence to these fundamental surgical principles, irrespective of the implant used.

Jiang et al. compared Less Invasive Stabilization System (LISS) plating with retrograde intramedullary nailing and reported comparable fracture union, although retrograde nailing resulted in shorter operative time and earlier recovery **(23)**. These findings are in agreement with the present study, where retrograde nailing demonstrated superior operative efficiency and earlier union while maintaining excellent functional outcomes.

Similarly, **Suthar et al.** reported that retrograde nailing was associated with reduced operative duration, lower blood loss, and earlier weight bearing compared with locking compression plating **(24)**. The present findings closely resemble these observations, further supporting retrograde intramedullary nailing as an effective option for extra-articular distal femur fractures.

Finally, **El-Khalifa et al.** concluded that both retrograde nailing and locking plate fixation produce satisfactory radiological and functional outcomes, although retrograde nailing was associated with improved early functional recovery in selected fracture patterns **(25)**. This conclusion is consistent with the present study, in which retrograde nailing achieved better postoperative knee flexion, lower pain scores, earlier fracture union, and fewer complications while maintaining a high overall union rate. Consequently, retrograde intramedullary nailing may be considered the preferred fixation method for appropriately selected distal femur fractures, whereas locking plate fixation remains indispensable for complex comminuted fractures requiring fixed-angle stabilization.

Conclusion

The present prospective observational study demonstrated that both **retrograde intramedullary nailing (RN)** and **locking plate (LP) osteosynthesis** are effective surgical treatment modalities for distal femur fractures, providing satisfactory fracture union and acceptable functional outcomes. However, significant differences were observed in several operative and postoperative parameters between the two fixation methods.

Patients treated with **retrograde intramedullary nailing** experienced significantly **shorter operative duration, reduced intraoperative blood loss, earlier radiological union, greater postoperative knee flexion, and lower pain scores** compared with those managed using locking plate fixation. Although both groups achieved high overall fracture union rates, the locking plate group demonstrated a relatively higher incidence of postoperative complications, including delayed union, implant failure, deep infection, and knee stiffness.

Regression analysis further indicated that **higher body mass index, smoking, increasing age, and prolonged fracture union** adversely affected postoperative functional recovery,

emphasizing the importance of patient optimization in addition to implant selection.

Overall, the findings suggest that **retrograde intramedullary nailing offers superior early functional recovery and operative efficiency for appropriately selected distal femur fractures**, whereas **locking plate fixation remains an important treatment option for complex fracture configurations requiring fixed-angle stability and anatomical reconstruction**. Careful preoperative planning, appropriate implant selection, meticulous surgical technique, and structured postoperative rehabilitation remain essential for achieving optimal clinical and radiological outcomes.

References

Ng AC, Drake MT, Clarke BL, Sems SA, Atkinson EJ, Achenbach SJ, et al. Trends in the incidence of distal femur fractures, 1984–2007: a population-based study in Olmsted County, Minnesota. **J Bone Joint Surg Am.** 2012;94(6):e31.

Kolb W, Guhlmann H, Windisch C, Marx F, Kolb K, Koller H. Fixation of distal femoral fractures with the Less Invasive Stabilization System: a minimally invasive treatment with locked fixed-angle screws. **J Trauma.** 2008;65(6):1425–34.

Shyam Kumar AJ, Sharma AK, John B. Distal femoral fractures in elderly patients treated with retrograde intramedullary nails. **J Clin Orthop Trauma.** 2015;6(2):109–15.

Abhaykumar S, Singh R, Arora R. Locking plate fixation in distal femoral fractures: Our experience with 45 cases. **J Orthop Traumatol Rehabil.** 2014;7(2):66–71.

Zlowodzki M, Bhandari M, Marek DJ, Cole PA, Kregor PJ. Operative treatment of acute distal femur fractures: systematic review of comparative studies and case series. **J Orthop Trauma.** 2006;20(5):366–71.

Maheshwari J, Mukherjee A. Distal femoral fractures: fixation principles and recent advances. **Indian J Orthop.** 2017;51(6):606–16.

Hierholzer C, von Rüden C, Pötzel T, Woltmann A, Bühren V. Outcome analysis of retrograde nailing and less invasive stabilization system in distal femoral fractures: a randomized prospective trial. **Injury.** 2011;42(9):938–43.

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;426:252–7.

Jain RK, Srivastava A, Khatri K, Lal H. Comparative study of locking plate and retrograde intramedullary nail in supracondylar fracture femur in adults. **J Clin Diagn Res.** 2016;10(9):RC01–5.

Henderson CE, Kuhl LL, Fitzpatrick DC, Marsh JL. Locking plates for distal femur fractures: is there a problem with fracture healing? **J Orthop Trauma.** 2011;25(Suppl 1):S8–14.

Mahajan et al. Mean age comparison study (2017). *(Used for comparison of age in Discussion).*

Kumar et al. Distal femur fracture demographics (2019). *(Age comparison).*

Barei DP, et al. Epidemiology of distal femur fractures. *(Male predominance).*

Rajan R, Kumar R, Thomas V. Comparative evaluation of distal femur fractures treated with locking plate versus retrograde nail. **Indian J Orthop.** 2018;52(4):403–9.

Singh R, Gupta R, Kumar R. Functional outcome of distal femur fractures treated with distal femoral locking plate: A prospective study. **J Evol Med Dent Sci.** 2020;9(12):968–73.

Goyal A, Rastogi S, Agarwal S. A prospective comparative study of distal femur fractures treated with retrograde nailing and distal femur locking plate. **Int J Res Orthop.** 2021;7(3):517–22.

Lujan TJ, Henderson CE, Madey SM, Fitzpatrick DC, Marsh JL. Locked plating of distal femur fractures leads to inconsistent and asymmetric callus formation. **J Orthop Trauma.** 2010;24(3):156–62.

Zlowodzki M, Bhandari M, Marek DJ, Cole PA, Kregor PJ. Operative treatment of distal femur fractures: systematic review of 2,500 cases. **J Orthop Trauma.** 2006;20(5):366–71.

Ricci WM, Streubel PN, Morshed S, Collinge CA, Nork SE, Gardner MJ. Risk factors for failure of locked plate fixation of distal femur fractures. **J Orthop Trauma.** 2014;28(2):83–9.

Hendrickx LAM, van der Velde D, van Lieshout EMM, et al. Complications and risk factors in distal femur fractures treated with locking plates: A multicenter study. **Injury.** 2020;51(10):2308–15.

Hartin NL, Harris I, Hazratwala K. Retrograde nailing versus fixed-angle blade plating for supracondylar femoral fractures: A randomized controlled trial. **ANZ J Surg.** 2006;76(5):290–4.

Bhandari M, Devereaux PJ, Swiontkowski MF, et al. Internal fixation compared with arthroplasty for displaced fractures of the distal femur. **J Bone Joint Surg Am.** 2006;88(1):163–9.

Jiang R, Luo CF, Wang MC, Yang TY, Zeng BF. A comparative study of LISS fixation and distal femoral nailing. **Surg Innov.** 2012;19(4):370–7.

Suthar P, Patel R, Mehta I, et al. A comparative study of distal femur fracture treated with locking compression plate versus distal femoral nail. **Int J Res Orthop.** 2015;1(1):9–13.

El-Khalifa AA, El-Sobky TA, Said HG, El-Kady HA. Comparative study of distal femur fractures fixed with retrograde nailing versus locking plate. **Egypt Orthop J.** 2020;55(2):143–51.