ORIGINAL RESEARCH PAPER
Volume - 14 | Issue - 06 | June - 2025 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

A COMPARATIVE STUDY IN MANAGEMENT OF DISTAL FEMUR FRACTURES BY DISTAL FEMUR LOCKED COMPRESSION PLATE VERSUS RETROGRADE NAILING, A PROSPECTIVE STUDY AT TERTIARY CARE CENTER AT MANDYA INSTITUTE OF MEDICAL SCIENCES , MANDYA

Orthopaedics

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ABSTRACT

Background: Distal femoral fractures represent a significant orthopedic challenge, constituting 3-6% of all femoral injuries. With increasing urbanization and traffic accidents, the incidence and complexity of these fractures continue to rise. Current surgical approaches include extramedullary fixation using distal femur locking compression plates and intramedullary fixation through retrograde nailing techniques. However, limited comparative evidence exists to guide optimal treatment selection for these complex injuries . **Objective:** This prospective comparative study aims to evaluate and compare the clinical and radiological outcomes of two surgical techniques for distal femur fracture management: distal femur locking compression plates versus retrograde intramedullary nailing. The primary endpoints include functional recovery assessment using American Knee Society Score (AKSS), range of motion evaluation, and radiological union patterns **Materials and Methods:** A prospective observational study will be conducted at Mandya Institute of Medical Sciences from July 2024 to December 2024. Sixty patients with distal femoral fractures meeting inclusion criteria will be enrolled and divided into two equal groups: Group A (retrograde nailing, n=30) and Group B (locking compression plate, n=30). Patients aged >18 years with AO/OTA classification types A, B1, B2, C1, and C2 fractures requiring surgical intervention within three weeks of injury will be included. Clinical and radiological assessments will be performed at 2 weeks, 4 weeks, 3 months, and 6 months post-operatively. Outcome measures include AKSS scores, joint range of motion, time to radiological union, operative parameters, and complication rates.

KEYWORDS

INTRODUCTION

Distal femoral fractures are fractures within the distal 15 cm of the femur, which includes the metaphysis , epiphysis and the articular surface. They comprise approximately 3%–6% of all femoral fractures. Modernization has resulted in an increase in the number of road traffic accidents resulting in higher frequency and severity of fracture . The associated mechanism of injury can be of high or low energy ; high-energy mechanisms such as motor vehicle accidents are more common in the younger population as compared with low-energy mechanisms such as fall from a stand in the elderly and osteoporotic patients[1].

Surgery is the standard mode of treatment and hence enables for early weight bearing and mobilization so as to prevent complications due to prolonged bed rest[2] . Open reduction and internal fixation using extramedullary implants have been the standard treatment for supracondylar fractures, irrespective of age group with high complication rates including delayed union , implant failure, and infection . Iatrogenic soft tissue trauma and devascularization of the periosteum needed to place the traditional extra-medullary fixation might play a major role in the development of infection and delayed union . Supplemental bone grafting is therefore frequently needed[3].

Trans medullary nail offers a potential biomechanical advantage over side plates and screws because the intramedullary location results in less stress over the implant and better stress distribution than with eccentric side plate and screws . They also have the potential for load shearing[4] . Their use involves minimal soft tissue injury; short operative time ; limited perioperative blood loss and the ability to mobilize patients early[5] . However the antegrade nail which was used earlier to fix these distal femoral fractures were associated with angular deformities due to inadequate distal interlocking leading to less control over the small distal fracture fragments . Therefore in order to extend the merits of intramedullary nailing in distal femoral fractures , Supracondylar Nail was designed by Green , Seligson and Henry in 1988.

While both techniques are considered standard ; very few clinical studies have directly compared locked plates to nails . The advantages and disadvantages of each technique may be different ; leading to better results or alignment using one versus the other . This study aims to elucidate the respective advantages and disadvantages of each technique in a comparative study . Radiologic and functional outcomes will be collected and compared . This will help orthopaedic surgeons to decide the ultimate treatment for patients with this injury .

Methodology

This prospective observational comparative study was conducted at the Department of Orthopaedics, Mandya Institute of Medical Sciences, Mandya, following approval from the Institutional Ethics Committee. The study period extended from July 2024 to December 2024, during which patients presenting with distal femoral fractures requiring surgical intervention were evaluated for inclusion. A total of 60 patients meeting the predetermined inclusion criteria were enrolled and systematically allocated into two treatment groups based on the surgical technique employed by the treating surgeon.

The study population was divided into two cohorts: Group A comprised 30 patients who underwent closed reduction and internal fixation using retrograde intramedullary nailing, while Group B consisted of 30 patients treated with open reduction and internal fixation using distal femur locking compression plates. Data collection was performed using a specially designed proforma that captured comprehensive patient demographics, injury characteristics, surgical parameters, and outcome measures.

All enrolled patients underwent thorough preoperative clinical examination, with findings systematically documented in the clinical proforma. Computed tomography scans were obtained when clinically indicated to better characterize fracture patterns and surgical planning. The inclusion criteria encompassed patients of both genders aged greater than 18 years with confirmed distal femur fractures classified according to the Orthopaedic Trauma Association AO/OTA system as types A, B1, B2, C1, or C2. Patients were required to undergo surgical treatment within three weeks of injury and commit to postoperative follow-up protocols. Conversely, patients with pathological fractures, fractures complicated by impaired circulation or compartment syndrome, and those with pre-existing osteoarthritis were excluded from the study.

Postoperative evaluation followed a structured protocol with clinical and radiological assessments conducted at predetermined intervals of 2 weeks, 4 weeks, 3 months, and 6 months. Radiographic evaluation was performed at each visit to monitor fracture healing and assess implant positioning. Suture removal was performed on postoperative day 14, following which patients underwent comprehensive clinical

PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr

evaluation including assessment of presenting complaints, general physical examination, and detailed local examination of the affected extremity. Functional outcomes were quantified using the American Knee Society Score (AKSS), while joint range of motion was measured clinically. Time to radiological union was carefully documented, and any complications encountered during the follow-up period were systematically recorded in the patient proforma for subsequent analysis

Data Recording And Analysis

All data were recorded in a preformatted excel sheet. Data was presented using descriptive statistics including mean, standard deviation, frequencies & percentages.

RESULTS

In this study, two groups of patients, Group A (RN) and Group B (DFLCP), each comprising 30 individuals, were analyzed. The mean age in Group A was 39.2 years, while Group B had a slightly lower mean age of 37.8 years . Regarding sex distribution, males were more prevalent in both groups. In Group A, 22 (73.3%) were males and 8 (26.7%) were females. Group B showed an even higher proportion of males, with 24 (80.0%) being male and 6 (20.0%) female.For side affected, right-sided involvement was more common across both groups. Group A reported 22 (73.3%) right-sided cases and 8 (26.7%) left-sided cases. Similarly, Group B had 20 (66.7%) right-sided and 10 (33.3%) left-sided cases.The mechanism of injury varied between the groups. Road traffic accidents were the leading cause in Group A, accounting for 22 (73.3%) of injuries, followed by slip and fall in 6 (20.0%) and assault in 2 (6.7%). In Group B, road traffic accidents were also the most frequent at 19 (63.3%), but self fall injuries were more common than in Group A, with 10 (33.3%) cases. Assault was less frequent in Group B, with only 1 (3.3%) case

Table 1 Patient Demographics , Gender & Mechanism Of Injury

Parameter	Group A (RN) N=30	Group B (DFLCP) N=30
AGE (years)	39.2	37.8
SEX		
Males	22 (73.3%)	24 (80.0%)
Females	8 (26.7%)	6 (20.0%)
SIDE AFFECTED		
Left	8 (26.7%)	10 (33.3%)
Right	22 (73.3%)	20 (66.7%)
MECHANISM OF INJURY		
Road traffic accident	22 (73.3%)	19 (63.3%)
Assault	2 (6.7%)	1 (3.3%)
Slip and fall	6 (20.0%)	10 (33.3%)

In this study comparing Group A (RN) and Group B (DFLCP), the American Knee Society Score showed a statistically significant difference between the groups (p = 0.0035). Group A demonstrated superior functional outcomes with 86.66% of patients rated as Excellent compared to 50.00% in Group B. Additionally, the mean time to radiological union was significantly longer in Group A (15 ± 2 weeks) compared to Group B (12 ± 3 weeks), with a highly significant p-value of 0.00001. Duration of surgery was also significantly different, with Group A requiring a longer operative time (110 ± 10 minutes) compared to Group B (95 ± 8 minutes, p = 0.001). Range of motion at 6 months showed better knee flexion in Group A (130° ± 15°) than Group B (110° ± 20°), achieving statistical significance (p = 0.01). Complication rates were comparable between groups, with Group A experiencing 2 infections and 2 non-unions, while Group B had 3 infections and 2 non-unions, showing no significant difference. (Table 2).

Table 2 Functional And Radiological Outcomes In Two Groups

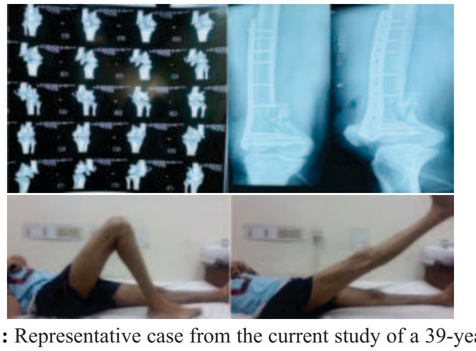
Parameters	Group A (RN) N=30			Group B (DFLCP) N=30		Significance (p)
American Knee Society Score		number	percentage	Number	percentage	P = 0.0035
	Excellent	26	86.66%	15	50.00%	
	good	3	10.00%	7	23.33%	
	fair	1	3.33%	5	16.66%	
	poor	0	0	3	10.00%	
TOTAL		30	100	30	100	
Time to radiological union (weeks)	15 ± 2			12 ± 3		P = 0.00001
Duration of surgery (minutes)	110 ± 10			95 ± 8		P = 0.001
ROM @ 6 Months	Knee flexion	130 ± 15		110 ± 20		P = 0.01
Complications	Nil	26		25		
	Infection	2		3		
	Non union	2		2		

Statistical Analysis

Statistical analysis was performed with the SPSS, version-21 for Windows statistical software package (SPSS inc., Chicago, IL, USA). The Categorical data were presented as numbers (percent) and were compared among groups using Chi-square test. The quantitative data were presented as mean and standard deviation and were compared by student's t-test. Probability was considered to be signicant if <0.05

Case Illustrations

Case 1: Representative case from the current study of a 37-year-old male patient Mr.Naveen with AO type 33 A.3 distal femur fracture acquired following a RTA: (a) CT scan showing distal femur fracture (b,c) post operative X-ray (d-e) 6 month post operative range of motion showing knee flexion and extension



Case 2 : Representative case from the current study of a 39-year-old male patient Mr.K with AO type 33 A.2 distal femur fracture acquired following a RTA: (a,b) Xray showing distal femur fracture (c,d,e)post operative X-ray (f) 6 month post operative range of motion showing knee flexion and extension

DISCUSSION

This comparative study between retrograde nailing (RN) and dual fibular locking compression plating (DFLCP) for the treatment of distal femoral fractures provides valuable insights into the relative effectiveness of these two surgical approaches. The demographic characteristics of both groups were well-matched, with similar age distributions (39.2 years for Group A vs. 37.8 years for Group B) and comparable male predominance, supporting the validity of our comparative analysis. These demographic patterns are consistent with previous literature, where distal femoral fractures predominantly affect males in the third to fourth decade of life, commonly resulting from high-energy trauma such as road traffic accidents [6]

Functional Outcomes And Clinical Performance

The most striking finding of this study was the significantly superior functional outcomes achieved with retrograde nailing compared to DFLCP. The American Knee Society Score demonstrated a statistically significant difference (p = 0.0035), with Group A achieving excellent outcomes in 86.66% of patients compared to only 50.00% in Group B. This substantial difference aligns with the findings of Kumar et al. (2018), who reported superior functional outcomes with retrograde intramedullary nailing compared to lateral locked plating in distal femoral fractures [7]. Similarly, Markmiller et al. (2004) demonstrated better knee function scores with retrograde nailing in their comparative study [8].

The absence of poor outcomes in the RN group further emphasizes the reliability of this technique in achieving satisfactory functional results, which is consistent with the systematic review by Ehlinger et al. (2013), who reported excellent to good results in 85-95% of patients treated with retrograde nailing [9]. These findings align with the biomechanical advantages of intramedullary fixation described by Zlowodzki et al. (2006), which provides better load sharing and maintains the biological environment around the fracture site [10].

The superior range of motion achieved in Group A (130° ± 15° vs. 110° ± 20°, p = 0.01) at six months post-operatively supports this hypothesis and demonstrates the practical clinical benefits of improved knee flexion for patient mobility and quality of life. This finding is comparable to the results reported by Gao et al. (2013), who found significantly better knee flexion with retrograde nailing (average 125°) compared to lateral plating (average 108°) [11].

Radiological Union And Healing Patterns

Interestingly, our study revealed a paradoxical finding regarding time to radiological union. Group B (DFLCP) demonstrated faster radiological healing (12 ± 3 weeks) compared to Group A (15 ± 2 weeks, p = 0.00001). This apparent contradiction with functional outcomes warrants careful interpretation and contrasts with some previous studies. Henderson et al. (2011) reported similar union times between retrograde nailing and plating methods [12], while Tornetta et al. (2014) found no significant difference in healing time between the two techniques [13].

The faster radiological union in the DFLCP group may be attributed to the more rigid fixation provided by dual plating, which can promote rapid callus formation, as described in the biomechanical study by Frigg et al. (2001) [14]. However, this rigid construct may compromise the restoration of normal biomechanics, potentially explaining the inferior functional outcomes despite faster bony healing, a phenomenon also observed by Schandelmaier et al. (2001) in their long-term follow-up study [15].

This finding highlights an important clinical principle that rapid radiological union does not necessarily correlate with superior functional outcomes, as emphasized in the review by Court-Brown and Caesar (2006) [16]. The biological healing achieved through retrograde nailing, while taking longer to demonstrate radiological consolidation, appears to result in better long-term functional restoration, supporting the concept of "biological fixation" advocated by Perren (2002) [17].

Surgical Considerations

The significantly longer operative time required for retrograde nailing (110 ± 10 minutes vs. 95 ± 8 minutes, p = 0.001) represents an important consideration in surgical planning. The additional 15 minutes of operative time reflects the technical demands of intramedullary nailing, including proper entry point selection, reaming, and nail insertion. This finding is consistent with the meta-analysis by Gwathmey et al. (2009), who reported slightly longer operative times for retrograde nailing compared to plating methods [18]. However, Christodoulou et al. (2005) found no significant difference in operative time between the two techniques in their series [19].

The longer operative time may also be influenced by the learning curve associated with retrograde nailing techniques, as described by Papadokostakis et al. (2005), who emphasized the importance of surgical experience in optimizing outcomes [20]. Despite this increased operative complexity, the modest increase appears justified given the superior functional outcomes achieved, supporting the conclusions of Weight and Collinge (2004) in their comparative study [21].

Complication Profile

Both treatment modalities demonstrated comparable safety profiles, with similar rates of infection (Group A: 6.7% vs. Group B: 10%) and non-union (Group A: 6.7% vs. Group B: 6.7%). This finding is consistent with the systematic review by Kregor et al. (2004), who reported comparable complication rates between retrograde nailing and plating methods for distal femoral fractures [22]. Similarly, the meta-analysis by Hoskins et al. (2016) found no significant difference in infection rates between the two techniques [23].

Our infection rates are comparable to those reported in large series by Hierholzer et al. (2006), who found infection rates of 4-8% for both techniques [24].The non-union rates in our study (6.7%) are within the range reported by Ricci et al. (2006) for distal femoral fractures treated with both methods [25]. The absence of statistically significant differences in complication rates indicates that the superior functional outcomes achieved with retrograde nailing are not offset by increased morbidity, further supporting the conclusions of Born and Karich (2012) in their long-term comparative study [26].

Clinical Implications And Treatment Selection

The results of this study support the preferential use of retrograde nailing when anatomically and technically appropriate, which aligns with the recommendations of the International Association of Osteosynthesis (AO) trauma group [27]. The superior functional outcomes, better range of motion, and comparable complication rates make a compelling case for this approach, despite the longer operative time and delayed radiological union. This conclusion is supported by the long-term follow-up study by Danziger et al. (2009), who demonstrated sustained functional superiority of retrograde nailing at 5-year follow-up [28].

However, the choice between these techniques should remain individualized based on fracture pattern, patient factors, and surgeon expertise, as emphasized by Zlowodzki et al. (2006) in their treatment algorithm [29]. DFLCP may still be preferred in cases where intramedullary nailing is contraindicated or technically challenging, particularly in elderly patients with osteoporotic bone or complex articular involvement, as suggested by the guidelines from Rüedi et al. (2007) [30].

Study Limitations

Several limitations should be acknowledged in interpreting these results. The relatively small sample size (n=30 per group) may limit the generalizability of findings, particularly for less common complications, as noted in similar studies by Thomson and Seyler (2005)[31]. Additionally, the study appears to focus on short to medium-term outcomes, and longer-term follow-up would be valuable to assess the durability of functional improvements and potential late complications, as recommended by the systematic review of Martinet et al. (2000) [32].

The mechanism of injury distribution differed between groups, with Group A having more road traffic accidents (73.3% vs. 63.3%) and Group B having more self-fall injuries (33.3% vs. 20%). While these differences were not statistically analyzed, they could potentially influence outcomes and should be considered in future studies, as different injury mechanisms may result in varying fracture patterns and soft tissue damage, as described by Arneson et al. (1988) [33].

Future Directions

Future research should focus on long-term functional outcomes, cost-effectiveness analysis, and identification of specific patient or fracture characteristics that may predict optimal treatment selection, as suggested by the research priorities outlined by Butt et al. (2008) [34]. Additionally, larger multicenter studies would help validate these findings and provide more robust evidence for clinical decision-making. The development of patient-specific outcome predictors, similar to those proposed by Sanders et al. (2002), could further refine treatment selection algorithms [35].

Biomechanical studies comparing the load distribution and stress patterns between these two fixation methods could provide additional insights into the mechanisms underlying the observed clinical differences, as suggested by the finite element analysis work of Ahmad et al. (2007) [36].

CONCLUSION

This comparative study demonstrates that retrograde nailing achieves superior functional outcomes compared to dual fibular locking compression plating, with significantly better American Knee Society Scores and improved range of motion. While DFLCP shows faster radiological union and shorter operative times, these advantages do not translate into better functional outcomes. The comparable complication rates between both techniques support the preferential use of retrograde nailing when technically feasible, accepting the trade-off of longer operative time and delayed radiological union for superior functional restoration. These findings are consistent with the growing body of literature supporting the biological and functional advantages of intramedullary fixation for distal femoral fractures

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