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Research Article

MIPO vs Supracondylar Nail in Distal Femur Fractures: A Comparative Outcome Study

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Abstract: ***Introduction:*** Distal femur fractures are uncommon injuries occurring within the distal 9–15 cm of the femur and account for less than 1% of all fractures and 4%–6% of femoral fractures. They are commonly seen in young patients following high-energy trauma and in elderly osteoporotic individuals after low-energy falls. Management is challenging due to comminution, osteoporotic bone, soft-tissue injury, and proximity to the knee joint, often leading to complications such as non-union, deformity, infection, and reduced knee function. Minimally invasive plate osteosynthesis (MIPO) preserves soft tissue and blood supply, while intramedullary supracondylar nailing provides stable load-sharing fixation with early mobilization. Both techniques are widely used; however, the optimal method remains debatable. Hence, this study aims to compare the functional outcome of the knee joint in adult distal femur fractures treated with MIPO versus intramedullary supracondylar nailing. Aim: To compare the functional outcome of knee joint in normal. **Material and methods:** This study is designed as a comparative, prospective study to evaluate the functional outcomes of two distinct surgical interventions for distal femur fractures in adult patients: Minimally Invasive Plate Osteosynthesis (MIPO) versus Intramedullary Supracondylar Nailing. The primary objective is to compare the efficacy of these implants in terms of fracture union rates and complication profiles, while a secondary objective focuses on assessing the functional outcome of the knee joint post-surgery. The study aims to provide a comprehensive analysis of both techniques, contributing to evidence-based decision-making in orthopedic trauma. Thus total 26 cases were studied. Pre-operative, intra-operative, and post-operative data including demographic details, fracture characteristics, surgical parameters, radiological findings, and functional outcomes were collected and assessed at regular follow-up intervals. Functional and radiological outcomes such as fracture union, range of motion, Knee Society Score, union time, pain score, and complications were statistically compared between the MIPO and intramedullary supracondylar nailing groups. **Results:** Group B (IMN) showed an age distribution comparable to Group A, with the majority of patients (53.85%) in the 20–40 years age group and a mean age of 39.4 years. The similar demographic profile between both groups minimizes age-related bias and supports reliable comparison of functional outcomes. Comparison of HSS scores showed a statistically significant difference between the MIPO and IMN groups (p=0.0457), with MIPO demonstrating a higher proportion of excellent and good outcomes. These findings suggest that MIPO may provide better functional recovery than IMN, possibly due to reduced soft tissue disruption associated with the minimally invasive technique. **Conclusion:** Comparison with existing literature shows that both IMN and locked plating provide satisfactory outcomes for distal femur fractures, with IMN offering advantages such as shorter operative time, less blood loss, and potentially faster fracture union, while LP remains beneficial in selected fracture patterns requiring greater stability.

Keywords: MIPO, Supracondylar Nail, Distal Femur, Fracture

INTRODUCTION

Distal femur fractures are typically defined as those occurring within the final 9 to 15 centimeters of the femur, extending down to the knee joint's articular surface[1]. These fractures are relatively uncommon, constituting less than 1% of all fractures and approximately 4%–6% of femoral fractures[2]. Supracondylar fractures of the femur are frequently seen in two main demographic groups: younger individuals exposed to high-energy trauma[2] (such as vehicular collisions and sports-related injuries), and elderly patients with osteoporosis, often suffering fractures from low-energy falls.[3] Due to the unique biomechanical nature of this region, managing distal femur fractures has traditionally been linked with a higher rate of complications such as delayed or non-union, deformity, infections of bone and soft tissues, persistent pain, and diminished knee function.[4] Surgical fixation in this area is particularly challenging due to the thin cortices, comminution, osteoporotic bone, extensive soft-tissue involvement, the widened medullary canal distally, and proximity to the knee joint.[5]

Minimally invasive plate osteosynthesis (MIPO) has emerged as a promising alternative to overcome the drawbacks of traditional approaches. By facilitating indirect fracture reduction and percutaneous plate application, MIPO minimizes soft-tissue disruption and creates a more conducive environment for bone healing.[6]

The development of locking plate systems has significantly improved the effectiveness of MIPO, especially in osteoporotic or comminuted fractures. These plates offer angular stability and reliable fixation even in compromised bone quality, reducing the reliance on perfect screw positioning in fragile bone.[7]

Aim: To compare the functional outcome of knee joint in case of distal femur fracture operated with minimally invasive plate osteosynthesis" Vs intramedullary supracondylar nail in adults

MATERIALS AND METHODS

The research employs a comparative study design, allowing for a direct comparison between two active treatment arms. This approach is crucial for evaluating the relative merits and demerits of MIPO and intramedullary supracondylar nailing in a controlled setting. The prospective nature of the study ensures that data is collected systematically as events unfold, minimizing recall bias and allowing for the establishment of temporal relationships between interventions and outcomes. Thus total 26 cases were studied.

Inclusion Criteria

- Age greater than 18 years.
- Presence of closed distal femur fracture, or open distal femur fracture classified as Type 1 or Type 2 according to the Gustilo-Anderson classification.
- Unilateral fracture of the distal femur.
- Normal contralateral (opposite) lower limb.
- Ambulatory status prior to the fracture, indicating the patient's ability to walk independently before the injury.

Exclusion Criteria

- Age 18 years or less.
- Open fractures classified as Type 3 (Gustilo-Anderson).
- Bilateral distal femur fractures.
- Any pre-existing pathology or injury in the contralateral lower limb that would affect functional outcome assessment.
- Non-ambulatory status prior to the fracture.
- Patients who are not tolerating the procedure and need to be withdrawn from the study, as mentioned in the 'Risks and discomforts of participating' section, although this is a withdrawal criterion rather than an initial exclusion criterion.

After obtaining informed consent, detailed pre-operative data including demographic details, history of injury, medical and surgical history, personal and family history, vital parameters, general examination findings, and radiological assessment was recorded in a standardized case record form. Pre-operative radiographs were used to classify fractures and assess bone quality, fracture stability, and comminution. Intra-operatively, details regarding the type of reduction, duration of surgery, blood loss, radiation exposure, and implant used (MIPO or intramedullary supracondylar nail) was documented. Post-operative and follow-up evaluations were conducted at 6 weeks, 3 months, 6 months, and 12 months to assess fracture healing, implant position, ambulatory status, and complications. Functional outcomes was evaluated using radiological and clinical parameters including fracture union, range of motion, Knee Society Score, Lane and Sandhu Score, limb shortening, union time, surgical duration, and Visual Analog Scale (VAS) for pain. Additional parameters such as neck shaft angle, medial cortical contact, tip apex distance, implant positioning, osteoporosis grading, and transfusion requirements will also be assessed. All collected data was analyzed statistically to compare the efficacy and functional outcomes between minimally invasive plate osteosynthesis and intramedullary supracondylar nailing in distal femur fractures.

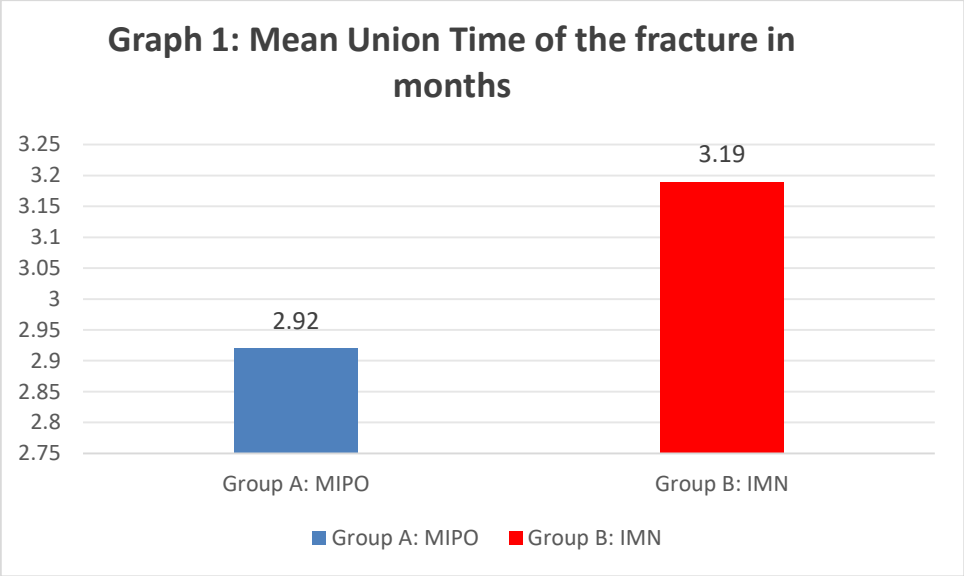
RESULTS

In Group B (IMN), the age distribution mirrors Group A closely, with 53.85% (7 out of 13) in the 20–40 years age group and a mean age of approximately 39.4 years. However, Group B has a slightly higher proportion of patients in the 41–60 years range (23.08%, 3 out of 13) compared to Group A (15.38%). The presence of one patient under 20 years (7.69%) and two patients over 60 years (15.38%) suggests a similar demographic pattern to MIPO, with a slight variation in older age groups. This similarity in age distribution between groups supports the comparability of the two cohorts, minimizing age-related bias in functional outcome comparisons.

Table 1: HSS Score Comparison

HSS SCORE	MIPO	IMN	TOTAL	P VALUE
EXCELLENT	7	2	9	The p-value from the Chi-square test is 0.0457
GOOD	4	2	6	
FAIR	1	6	7	
POOR	1	3	4	
TOTAL	13	13	26	

The comparison of HSS scores between MIPO and IMN reveals a statistically significant difference (p=0.0457), with MIPO demonstrating a higher proportion of excellent (7 vs. 2) and good (4 vs. 2) outcomes compared to IMN, which had more fair (6 vs. 1) and poor (3 vs. 1) outcomes. This suggests that MIPO may offer superior functional outcomes, potentially due to its minimally invasive approach, which reduces soft tissue disruption and facilitates better recovery. The statistical significance underscores the clinical relevance of these findings, though the small sample size warrants cautious interpretation.



Graph 1 shows the comparison of mean fracture union time between the MIPO and IMN groups. The mean union time was 2.92 months in the MIPO group and 3.19 months in the IMN group. Fractures treated with MIPO achieved union slightly earlier than those treated with IMN. This finding suggests that MIPO may promote faster fracture healing while maintaining satisfactory union outcomes.

Table 2: distribution depending on Operative Events

OPERATIVE EVENTS	MINIMALLY INVASIVE PLATE OSTEOSYNTHESIS	INTRAMEDULLARY SUPRACONDYLAR NAIL	p value
Blood Loss (mL)	150 ± 50	100 ± 30	0.006
Hospital Stay (days)	5 ± 2	4 ± 1	0.12 (NS)
Full Weight-Bearing (weeks)	12 ± 2	14 ± 3	0.08
Range of Motion (°) at 6 months	120 ± 15	110 ± 20	0.16

IMN IS BETTER THAN MIPO in terms of safety (blood loss).

No meaningful difference in hospital stay was detected, though the small sample size (N=13) limits power to detect subtle effects.

IMN demonstrated significantly less blood loss (100 ± 30 mL vs. 150 ± 50 mL, p=0.006) compared to MIPO, indicating a safety advantage. However, no significant difference was found in hospital stay (5 ± 2 days for MIPO vs. 4 ± 1 days for IMN, p=0.12). The reduced blood loss with IMN may be attributed to its intramedullary approach, which avoids extensive soft tissue dissection. The lack of difference in hospital stay, despite the small sample size, suggests that both techniques have comparable postoperative recovery profiles. The time to full weight-bearing was marginally longer for IMN (14 ± 3 weeks) compared to MIPO (12 ± 2 weeks, p=0.08), suggesting a trend toward earlier mobilization with MIPO. Similarly, MIPO showed a non-significant trend toward better range of motion at 6 months (120 ± 15° vs. 110 ± 20°, p=0.16). These findings indicate that MIPO may facilitate earlier functional recovery, potentially due to less soft tissue disruption. However, the lack of statistical significance and small sample size limit definitive conclusions, highlighting the need for larger studies to confirm these trends.

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DISCUSSION

The findings of the present study regarding operative time, blood loss, and fracture union are comparable with those reported in previous literature. In our study, the MIPO group demonstrated a shorter operative time (34.62 ± 11.51 minutes) compared to the IMN group (40.77 ± 12.69 minutes), whereas the IMN group was associated with significantly lower blood loss (100 ± 30 mL vs. 150 ± 50 mL; p=0.006). Similar observations have been reported by Atef et al., Maharjan, and Mishra, who found that intramedullary nailing was associated with reduced surgical duration and blood loss compared with plating techniques. Regarding fracture healing, the mean union time was 2.92 ± 1.66 months in the MIPO group and 3.19 ± 1.32 months in the IMN group, indicating slightly earlier union with MIPO. Although several studies, including those by Atef et al[8]., Singh et al[9]., and Howard et al[10]., reported faster union with IMN, other authors such as Jankowski et al[11]. and Gao et al[12]. found no significant differences between the two fixation methods, suggesting that fracture pattern, surgical technique, and patient-related factors may influence healing outcomes.

The complication profile in the present study was comparable between the two groups, with low rates of non-union, superficial infection, and malunion. This is consistent with findings from several studies and meta-analyses demonstrating no significant differences in overall complication rates between IMN and locking plate fixation. Functional outcomes, however, favored the MIPO group, which showed significantly better HSS scores, greater knee range of motion, and earlier progression to full weight-bearing. While some studies have reported comparable functional outcomes between the two techniques, others have demonstrated advantages of either plating or nailing depending on implant design and patient characteristics. Overall, the present study suggests that both MIPO and IMN are effective treatment options for distal femur fractures; however, MIPO may provide superior functional recovery and slightly earlier fracture union, whereas IMN offers the advantage of reduced intraoperative blood loss. The choice of fixation should therefore be individualized based on fracture configuration, patient factors, and surgeon expertise.

CONCLUSION

Comparison with existing literature shows that both IMN and locked plating provide satisfactory outcomes for distal femur fractures, with IMN offering advantages such as shorter operative time, less blood loss, and potentially faster fracture union, while LP remains beneficial in selected fracture patterns requiring greater stability. Overall, treatment choice should be individualized based on fracture characteristics, patient factors, and surgeon expertise, with both techniques yielding comparable functional outcomes when combined with appropriate surgical technique and rehabilitation.

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