Original Article

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Comparison of Clinical Outcomes of Dynamic Compression Plate Versus Locked Intramedullary Nailing in the Treatment of Femoral Shaft Fractures: A Retrospective Cohort Study

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Background: Femoral shaft fractures are among the most challenging orthopedic injuries, often necessitating surgical fixation. Although dynamic compression plating (DCP) and locked intramedullary nailing (IMN) are both standard options, their comparative outcomes in closed, non-comminuted fractures remain debated. This study aimed to compare the clinical outcomes and complications of IMN versus DCP fixation in adult patients with mid-shaft femoral fractures.

Materials and Methods: This retrospective cohort study included 40 adults with closed, non-comminuted mid-shaft femoral fractures treated at Shahid Beheshti Hospital, Babol, Iran (2022–2024). Twenty patients underwent IMN and 20 underwent DCP fixation. Demographic, intraoperative, and postoperative data-including infection, nonunion, fixation failure, intraoperative blood loss, hospitalization duration, and knee range of motion (ROM)-were extracted from medical records. Outcome definitions followed CDC and AO standards

Results: Patients in the IMN group were significantly older than those in the DCP group (32.55 ± 20.74 vs. 19.90 ± 15.96 years; p = 0.037). Operative time was longer for IMN (191.25 ± 29.95 min) compared with DCP (151.00 ± 31.23 min; p < 0.001). No statistically significant differences were found between groups in infection (p = 0.465), nonunion (p = 1.000), fixation failure (p = 1.000), ROM (p = 0.300), blood loss (p = 0.428), or hospitalization duration (p = 0.832).

***Conclusion*:** Both IMN and DCP provided similar short-term outcomes for closed femoral shaft fractures. However, due to the small sample and retrospective design, these findings are preliminary. Larger, prospective randomized trials are required to confirm the results and guide optimal surgical decision-making

Keywords: Femoral Fractures; Intramedullary Nailing; Bone Plates; Cohort Studies; Iran

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Introduction

Femoral shaft fractures are among the most frequent and clinically significant long-bone injuries in adults (1) .In young individuals, these fractures typically result from high-energy trauma, such as motor vehicle collisions (2). In contrast, in the elderly, even low-energy trauma, like a fall from standing height, may cause a fracture because of reduced bone strength (3). Depending on the mechanism and direction of the applied force, different segments of the femoral diaphysis may be involved (2).

These injuries are often associated with serious complications, given the femur's essential role in weight-bearing and locomotion (4). Major complications include severe bleeding, visceral injury, fat embolism, infection, and long-term functional impairment (5). Consequently, most patients require urgent surgical stabilization followed by close postoperative monitoring to prevent nonunion, malalignment, or permanent disability (6). Failure to provide timely and appropriate treatment increases the likelihood of nonunion, limb malalignment, and impaired mobility (7, 8).

Among various fixation techniques, dynamic compression plating (DCP) and locked intramedullary nailing (IMN) are the two most widely used methods for the management of femoral shaft fractures (9).

DCP involves open reduction and stabilization of the fracture with a metallic plate and screws, providing rigid fixation and anatomical alignment-an approach often preferred for complex or comminuted fractures (10, 11). In contrast, IMN is a load-sharing technique in which a nail is inserted into the medullary canal, allowing for early mobilization with minimal soft-tissue disruption and reduced blood loss (12).

Although several studies have compared these two techniques, their findings remain inconsistent (10, 13, 14). Some suggest that IMN leads to faster healing, lower infection and non-union rates, and better functionality (9, 15, 16), while others report no significant difference in radiological union or postoperative outcomes (17, 18). Such variation may stem from heterogeneous populations, inclusion of open fractures or polytrauma cases, and differing study designs.

Given the ongoing debate and lack of consensus, further research is warranted to clarify comparative effectiveness within a homogeneous cohort. This study therefore aimed to compare clinical outcomes, complication rates, and surgical parameters between IMN and DCP fixation in adult patients with closed, non-comminuted mid-shaft femoral fractures.

Materials and methods

This was a retrospective cohort study conducted at Shahid Beheshti Hospital, Babol, affiliated with Babol University of Medical Sciences, during the years 2022 to 2024, among patients with closed fractures of the middle third of the femur shaft. This cohort study has been reported in line with the STROCSS 2021 criteria (19). After review and approval by the Research Ethics Committee of Babol University of Medical Sciences, the study was registered with the code IR.MUBABOL.REC.1403.046. all patient information was kept confidential and anonymous.

All patients included in the study had closed, non-comminuted midshaft femoral fractures who did not have soft tissue injury or concomitant lower limb fractures, and were treated using either IMN or DCP. Patients with open fractures, bone comminution, soft tissue damage, or concomitant lower limb fractures, as well as those without treatment follow-up or with incomplete medical records, were excluded.

The sample size was calculated based on the results of previous studies. In the study by Xiaodong Xu et al. (20), the standard deviation of the visible blood loss (mL) in the Nail and Plate groups was 129.9 (S_1) and 146.7 (S_2), respectively. Considering a precision of 1 (d = 150), a significance level of 0.05 (α = 0.05), and a power of 90% (1 - β = 0.9), the minimum required sample size was determined to be 38 participants (19 in each group). The sample size was calculated using the following formula:

$$n = \frac{\left(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta}\right)^2 ({S_1}^2 + {S_2}^2)}{d^2}$$

The required data were extracted from the patients' medical records and through a researcher-designed checklist. In the group treated with an intramedullary nail, the surgery was performed as a closed reduction and fixation with a locking nail. The other group underwent open surgery using a DCP with at least 10 holes, and three screws were placed on each side of the fracture.

Results

The variables collected included age, sex, duration of surgery (in minutes) and length of hospitalization (in days). All surgeries were performed by orthopedic surgeons at the hospital.

In addition, the incidence of surgical site infection was assessed based on wound discharge after the fifth day and recorded in daily clinical notes. Other variables included decreased hemoglobin (based on comparison of pre- and postoperative values), fixation failure (fracture or displacement of the fixation device), nonunion (as determined on radiological evaluation), and knee joint range of motion (ROM). This information was extracted from the patients' medical records and included in the researcher’s checklist.

The main outcome variables were defined according to standard clinical and radiological criteria. Surgical site infection was defined according to the Centers for Disease Control and Prevention (CDC) guidelines (21), as the presence of purulent wound discharge, positive bacterial culture, or clinical signs of inflammation (redness, swelling, tenderness) occurring after the fifth postoperative day (21). Nonunion was defined as the absence of radiographic bone union six months after surgery, or lack of progressive healing over three consecutive months, based on standard AO criteria (22). Fixation failure was defined as mechanical failure of the implant, including screw loosening, plate breakage, or implant displacement requiring revision surgery (11).

Mean, standard deviation (SD), number and percentage were used to describe the basic differences between the surgery type. The Kolmogorov-Smirnov test was used to assess the normality of the data. Independent samples t-test, chi-square test and fisher’s exact test were used. linear regression was used to determine the relationship between surgery type and outcome variables. Adjusted model was constructed to control for potential confounding variables.

In this model, age and sex were included along with the type of surgery. All variables were entered simultaneously using the Enter method. All analyses were performed using SPSS version 26 software (IBM Corp.). The significance level of the tests was reported as less than 0.05.

Discussion

In the current study, there were 34 males (85.0%) and 6 females (15.0%), with a mean age of 26.22 ± 19.36 years. The baseline characteristics of the study participants stratified by surgery type are reported in (**Table 1).**

There was a significant difference in age between the Plating DCP and Locked IMN surgery groups (p=0.037).

Participants in the Locked IMN surgery group were significantly older (mean age = 32.55±20.74 years) compared to those in the Plating DCP surgery group (mean age = 19.90±15.96 years). There was no significant relationship between sex and surgery type (p = 1.000).

Table 1. Baseline Characteristics of Study Participants Stratified by Surgery Type

		Surgery Type		
		Plating DCP	**Locked IMN**	***P*-value**
Sex	Male	17 (85.0%)	17 (85.0%)	1.000†
	Female	3 (15.0%)	3 (15.0%)	
Age		19.90±15.96	32.55±20.74	0.037‡

Values are shown in count (percent) and mean ±standard deviation for categorical and continuous data, respectively.†Fisher's Exact Test was used. ‡Independent Samples T-Test was used.

The comparison of surgery outcomes, surgical factors, and hospitalization days between the Plating DCP and Locked IMN surgery groups is reported in **Table 2**. There were no significant differences between the two groups in terms of infection (p = 0.465), nonunion (p = 1.000), fixation failure (p = 1.000), range of motion (p = 0.300), blood loss (p = 0.428), and hospitalization duration (p = 0.832). However, surgery time was significantly longer in the Locked IMN surgery group compared to the Plating DCP surgery group (191.25±29.95 minutes vs. 151.00±31.23 minutes, p < 0.001).

Linear regression model evaluating the association between ROM and blood loss with surgery type are shown in Table 3. In the crude model, the mean ROM was expected to increase by 3.500 degrees for patients in the Locked IMN surgery group compared to those in the Plating DCP surgery group; however, this difference was not statistically significant (β = 3.500, 95% CI: -3.242 to 10.242, p = 0.300). In the adjusted model, the mean ROM was expected to increase by 2.896 degrees for patients in the Locked IMN surgery group compared to those in the Plating DCP surgery group; however, this difference was not statistically significant (β = 2.896, 95% CI: -4.614 to 10.406, p = 0.439).

Table 2. Comparison of Surgery Outcomes, Surgical Factors, and Hospitalization (days) by Surgery Type

		Surgery Type		
		Plating DCP	**Locked IMN**	***P*-value**
Infection	No	14 (70.0%)	16 (80.0%)	0.465†
	Yes	6 (30.0%)	4 (20.0%)	
Nonunion	No	18 (90.0%)	19 (95.0%)	1.000‡
	Yes	2 (10.0%)	1 (5.0%)	
Fixation Failure	No	19 (95.0%)	20 (100.0%)	1.000‡
	Yes	1 (5.0%)	0 (0.0%)	
ROM		134.50±11.91	138.00±8.94	0.300§
Blood loss		3.62±1.83	4.10±1.95	0.428§
Surgery Time (minutes)		151.00±31.23	191.25±29.95	< 0.001§
Hospitalization (days)		5.70±5.06	6.00±3.71	0.832§

Values are shown in count (percent) and mean ±standard deviation for categorical and continuous data, respectively. †Chi-Square was used.‡Fisher's Exact Test was used. §Independent Sample's T-Test

Table 3. Linear Regression Model Evaluating the Association Between ROM and Blood loss with Surgery Type

	ROM				**Blood loss**			
	Crude Model		**Adjusted Model**		**Crude Model**		**Adjusted Model**	
	β (CI 95 %)	*P*-value	β (CI 95 %)	*P*-value	β (CI 95 %)	*P*-value	B (CI 95 %)	*P*-value
Surgery Type Ref: Plating DCP	3.500 (-3.242, 10.242)	0.300	2.896 (-4.614, 10.406)	0.439	0.480 (-0.732, 1.692)	0.428	0.727 (-0.569, 2.023)	0.263
Sex Ref: Male	4.412 (-5.055, 13.879)	0.351	2.890 (-9.467, 15.246)	0.638	-1.488 (-3.129, 0.152)	0.074	-0.865 (-2.997, 1.267)	0.416
Age	0.105 (-0.071, 0.281)	0.234	0.048 (-0.197, 0.292)	0.695	-0.023 (-0.054, 0.008)	0.145	-0.020 (-0.062, 0.023)	0.354

Abbreviations: β, Beta Coefficient; CI, Confidence Interval These values are obtained from linear regression.

In the crude model, the mean blood loss was expected to increase by 0.480 mL for patients in the Locked IMN surgery group compared to those in the Plating DCP surgery group; however, this difference was not statistically significant (β = 0.480, 95% CI: -0.732 to 1.692, p = 0.428).

In the adjusted model, the mean blood loss was expected to increase by 0.727 mL for patients in the Locked IMN surgery group compared to those in the Plating DCP surgery group; however, this difference was not statistically significant (β = 0.727, 95% CI: -0.569 to 2.023, p = 0.263). (**Table 3).**

The linear regression model evaluating the association between surgery time and hospitalization with surgery type is presented in **Table 4**. In the crude model, the mean surgery time was expected to increase by 40.250 minutes for patients in the locked IMN surgery group compared to those in the plating DCP surgery group (β = 40.250, 95% CI: 20.663 to 59.837, p < 0.001). In the adjusted model, this association remained significant, with the mean surgery time expected to increase by 45.081 minutes for patients in the locked IMN surgery group compared to those in the plating DCP surgery group (β = 45.081, 95% CI: 23.591 to 66.572, p < 0.001).

For hospitalization, in the crude model, the mean number of hospitalization days was expected to increase by 0.300 days for patients in the locked IMN surgery group compared to those in the plating DCP surgery group; however, this difference was not statistically significant (β = 0.300, 95% CI: -2.541 to 3.141, p = 0.832). In the adjusted model, the mean number of hospitalization days was expected to increase by 0.003 days for patients in the locked IMN surgery group compared to those in the plating DCP surgery group; however, this difference was not statistically significant (β = 0.003, 95% CI: -3.169 to 3.175, p = 0.999).

Table 4. Linear Regression Model Evaluating the Association Between Surgery time and Hospitalization with Surgery Type

	Surgery time				**Hospitalization**			
	Crude Model		**Adjusted Model**		**Crude Model**		**Adjusted Model**	
	β (CI 95 %)	*P*-value	β (CI 95 %)	*P*-value	β (CI 95 %)	*P*-value	β (CI 95 %)	*P*-value
Surgery Type Ref: Plating DCP	40.250 (20.663, 59.837)	**< 0.001**	45.081 (23.591, 66.572)	**< 0.001**	0.300 (-2.541, 3.141)	0.832	0.003 (-3.169, 3.175)	0.999
Sex Ref: Male	-13.088 (-45.896, 19.720)	0.424	-0.908 (-36.268, 34.452)	0.959	-1.588 (-5.534, 2.357)	0.420	-2.337 (-7.556, 2.882)	0.370
Age	-0.002 (-0.620, 0.616)	0.996	-0.382 (-1.082, 0.318)	0.276	-0.003 (-0.077, 0.072)	0.946	0.023 (-0.080, 0.127)	0.648

Abbreviations: β, Beta Coefficient; CI, Confidence Interval Significant values are shown in bold. These values are obtained from linear regression.

The present study aimed to compare the clinical outcomes and postoperative complications of two widely used fixation techniques—IMN and DCP—in the management of closed femoral shaft fractures in adult patients. The findings indicated no statistically significant differences between the two groups regarding infection (p = 0.465), nonunion (p = 1.000), fixation failure (p = 1.000), knee range of motion (p = 0.300), intraoperative blood loss (p = 0.428), or length of hospital stay (p = 0.832). The only variable showing a significant difference was operative time, which was considerably longer in the IMN group than in the DCP group (191.25 ± 29.95 vs. 151.00 ± 31.23 minutes, p < 0.001).

In line with the study by Mohammadhoseini et al. (2023), which investigated open femoral shaft fractures, our results also revealed no statistically significant differences between IMN and DCP in terms of union time and functional recovery (18) .However, that study reported a slightly higher incidence of infection and knee pain among patients treated with IMN. (18). This partial agreement implies that both fixation techniques may offer comparable clinical effectiveness under different fracture conditions, although variations in patient profiles and fracture characteristics warrant cautious interpretation.

Conversely, Ekwunife et al. (2022), in a prospective study on closed femoral shaft fractures, observed significantly better functional outcomes and greater knee range of motion with IMN compared to DCP (16). While our findings demonstrated a similar trend toward improved function in the IMN group, these differences did not reach statistical significance . This inconsistency between the two studies might be explained by differences in sample size, follow-up duration, and treatment protocols. Nevertheless, the overall tendency observed in our study seems to support the functional advantages of IMN, as highlighted in previous research.

Thapa et al. (2016) reported that IMN resulted in faster fracture healing, improved knee motion, and a lower incidence of axial deformity compared to DCP fixation, with statistically significant differences between the groups (15). Although our findings similarly showed higher mean range of motion and a lower rate of nonunion in the IMN group, these differences were not statistically significant—likely due to the small sample size and variability among patients. Despite this, the general trend in our study supports the notion that IMN may offer functional advantages over plating, as previously documented.

Likewise, Kesemenli et al. (2012) found that IMN provided better outcomes in more complex cases, such as combined hip and femoral shaft fractures, demonstrating reduced rates of nonunion and implant failure compared with DCP (23) .The relatively lower rate of nonunion in our IMN group appears consistent with their observations, though direct comparison is limited by differences in fracture severity and patient selection between the two studies.

With respect to intraoperative blood loss, our study revealed slightly higher mean values in the IMN group; however, this difference was not statistically significant ($p = 0.428$). These results appear consistent with the observations of Xu et al. (2021), who reported greater total and hidden blood loss among IMN patients (20). This difference was mainly attributed to the intramedullary technique, particularly the reaming process, which may increase intraosseous bleeding. Similarly, Zhao et al. (2024), in a systematic review focusing on pediatric femoral fractures, found lower intraoperative blood loss and complication rates in the IMN group compared to DCP (17). Although pediatric outcomes cannot be directly extrapolated to adults, their findings reinforce the potential procedural benefits of IMN under specific clinical conditions.

Furthermore, Motififard et al. (2024) investigated cases of femoral shaft nonunion following initial IMN and demonstrated favorable outcomes for augmentative plating combined with bone grafting, compared with exchange nailing (24). This strategy resulted in greater pain reduction, improved range of motion, and faster fracture healing (24). While the biological interventions used in that study limit direct comparability with primary fracture management, their findings underscore the role of plating as a valuable salvage strategy in selected cases of nonunion.

The differences observed between IMN and DCP may be partly attributed to their distinct biomechanical and surgical principles. IMN functions as a load-sharing device, positioned along the mechanical axis of the femur, thereby distributing stress more evenly (25, 26). Such a configuration facilitates secondary bone healing through controlled micromotion (25, 26) .In contrast, DCP acts as a load-bearing construct, applying fixation externally and relying on absolute stability (27, 28); this configuration can increase bending stress, especially when anatomical reduction between fracture fragments is suboptimal. Moreover, the relatively less invasive nature of IMN, which preserves periosteal blood supply and minimizes soft tissue disruption, may further promote faster recovery and reduce postoperative complications compared with DCP (29, 30).

This study has several important limitations that should be acknowledged. First, the retrospective and non-randomized design inherently introduces a risk of selection bias. Patients were assigned to IMN or DCP groups based on the surgeon's clinical judgment rather than randomization, which led to baseline differences-particularly in age-between groups. Although adjustments were made for potential confounders such as age and sex through multivariable regression, residual bias cannot be entirely excluded.

Second, the small sample size (20 patients per group) resulted in limited statistical power, making the study potentially underpowered to detect subtle or rare differences in outcomes such as infection, nonunion, or fixation failure. Therefore, the observed lack of significant differences should not be interpreted as proof of equivalence between techniques.

Third, functional recovery was assessed solely by knee range of motion, without incorporating validated patient-reported outcome measures (PROMs) such as the Lower Extremity Functional Scale (LEFS) or Harris Hip Score (HHS). This limitation reduces the comprehensiveness of functional assessment and patient-centered interpretation. Finally, the relatively short follow-up duration may have underestimated late complications, including implant fatigue or delayed nonunion, emphasizing the need for long-term prospective studies.

Future investigations should address the limitations of the present study by employing prospective randomized controlled trials with larger sample sizes and extended follow-up periods. The incorporation of standardized clinical and radiological criteria, along with validated PROMs such as LEFS or SF-36, would improve cross-study comparability and enhance the reliability of functional evaluations. Additionally, subgroup analyses considering patient-specific factors-including age, metabolic comorbidities, smoking status, and bone quality-could help identify predictors of postoperative outcomes. Finally, cost-effectiveness assessments and long-term follow-up data are essential to provide more practical and evidence-based recommendations for surgical decision-making, particularly in resource-limited healthcare systems.

In conclusion, both intramedullary nailing and dynamic compression plating showed similar short-term outcomes in the treatment of closed mid-shaft femoral fractures. Nonetheless, due to the retrospective and underpowered design of this study, the findings should be viewed as preliminary rather than confirmatory. Further well-designed, multicenter, randomized studies are needed to validate these results and define the most effective, patient-centered fixation approach for femoral shaft fractures.

Ethics Approval and Consent to Participate

This study was conducted in accordance with the ethical standards of the Declaration of Helsinki. The study protocol was reviewed and approved by the Ethics Committee of Babol University of Medical Sciences (Ethics code:IR. MUBABOL. REC. 1403. 046).

Consent for Publication

Not applicable.

Informed Consent

Due to the retrospective nature of the study and the use of anonymized medical records, the requirement for informed consent was waived by the Ethics Committee of Babol University of Medical Sciences.

Availability of Data and Materials

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflict of Interest

The authors declare that they have no competing interests.

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Authors' Contributions

MF and MT conceptualized and designed the study. AC collected the data and performed data entry. AB contributed to the statistical analysis and interpretation of data. MT supervised the study and contributed to the preparation of the manuscript. All authors read and approved the final version of the manuscript.

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Use of AI-assisted Technologies

During the preparation of this manuscript, ChatGPT was used to assist with language editing and improving the clarity and readability of the text. After using this tool, the authors carefully reviewed, revised, and edited the content as necessary and take full responsibility for the accuracy and integrity of the final version of the manuscript.

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