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Research Article

# Functional And Surgical Outcome of Distal Third Shaft Fracture of Femur Treated with Distal Femoral Intramedullary Locking Nail (DFN), An Observational Prospective Study

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## ABSTRACT

**Background:** Fractures of the distal third femoral shaft present a major orthopedic challenge due to their anatomical proximity to the knee joint and the complex biomechanical stresses acting on this region. These fractures often result from high-energy trauma and are associated with complications such as malunion, nonunion, and knee stiffness. The distal femoral intramedullary locking nail (DFN) has gained popularity as a minimally invasive fixation method offering improved stability, reduced soft-tissue trauma, and early mobilization.
**Aim:** To evaluate the surgical and functional outcomes of distal third femoral shaft fractures treated with distal femoral intramedullary locking nail (DFN).
**Materials and Methods:** This prospective observational study was conducted on 38 patients aged 20–80 years with distal one-third femoral shaft fractures at MGM Medical College & LSK Hospital, Kishanganj, Bihar, over 18 months. Patients were treated with DFN fixation and followed up for 12 months. Union rate, time to union, malunion, nonunion, infection rate, and functional recovery were assessed using the Knee Society Score (KSS) and Lower Extremity Functional Scale (LEFS). Statistical analysis was performed using SPSS v26 with significance set at $p < 0.05$.
**Results:** The majority of patients were males (73.7%) aged 30–49 years, with road traffic accidents accounting for 73.7% of injuries. Mean operative time was 92.6 ± 15.4 minutes and mean blood loss 210 ± 40 ml. Radiological union was achieved in 94.7% of patients, with most fractures uniting within six months. Overall union rate was 78.9%, while delayed union, malunion, and nonunion occurred in 10.5%, 5.3%, and 5.3% of cases respectively. Mean KSS was 86.1 ± 7.2 and mean LEFS 70.4 ± 8.3, indicating satisfactory functional recovery in 78.9% of patients.
**Conclusion:** DFN is a reliable, effective, and minimally invasive fixation method for distal third femoral shaft fractures, providing high union rates, early rehabilitation, and good functional outcomes with minimal complications.

***Keywords****: distal femur fracture, intramedullary nail, DFN, functional outcome, knee society score*

## INTRODUCTION:

Fractures involving the distal third of the femoral shaft pose a major orthopedic challenge due to their proximity to the knee joint, complex biomechanics, and risks of malunion, nonunion, and joint stiffness.[1] These injuries usually result from high-energy trauma such as road traffic accidents or falls and are often associated with polytrauma.[2] Various fixation methods, including plating, retrograde intramedullary nailing, and external fixation, have been employed, but the optimal treatment remains debated.[3]

The **distal femoral intramedullary locking nail (DFN)** offers a minimally invasive, load-sharing construct that preserves soft tissue and allows early mobilization.[4] It provides multiple distal locking options to enhance metaphyseal stability, accommodating the widened canal and thinner cortices of the distal femur.[5] Compared to conventional plating or dynamic condylar screw fixation, DFN minimizes soft-tissue trauma and facilitates faster rehabilitation with comparable union rates and reduced complications.[6,7]

Despite its advantages, literature on DFN remains limited, with few prospective evaluations addressing functional and surgical outcomes.[8] This **observational prospective study** aims to analyze the results of DFN fixation in distal third femoral shaft fractures, focusing on union rate, time to union, functional recovery, and complications, thereby contributing evidence-based guidance for improved orthopedic management.

**Objectives:**
To evaluate the **surgical and functional outcomes** of patients with distal third femoral shaft fractures treated with **distal femoral intramedullary locking nail (DFN)** in terms of union rate, time to union, malunion, nonunion, infection rate, range of motion at the knee joint (using Knee Society Score and Lower Extremity Functional Scale), and procedure-related complications.

**Materials and Methods**
**Study Design:** This was a prospective observational study conducted in the Department of Orthopaedics, MGM Medical College & LSK Hospital, Kishanganj, Bihar, over 18 months after approval from the Institutional Ethics Committee.
**Study Population:** Patients aged 20–80 years presenting with distal one-third femoral shaft fractures treated with a Distal Femoral Intramedullary Locking Nail (DFN) were included.

**Sample Size:** Based on prevalence (p = 2.5%) and 5% allowable error, the minimum sample size calculated was **38 patients**.

**Inclusion Criteria:**
1. Age 20–80 years
2. Distal third shaft fracture of femur
3. Willingness for regular follow-up

**Exclusion Criteria:**
1. Pathological or intra-articular fractures
2. Active infection at the fracture site
3. Previous surgery on the same limb
4. Systemic illness affecting bone healing

**Methodology:**
Eligible patients were enrolled after consent. All underwent standard preoperative evaluation, closed or open reduction, and DFN fixation under C-arm guidance. Postoperatively, patients received antibiotics, early mobilization, and physiotherapy. Follow-ups were scheduled at **6 weeks, 3, 6, 9, and 12 months**.

**Outcome Measures:**
- **Primary:** Union rate, time to union, malunion/nonunion, and infection rate
- **Secondary:** Functional outcome (Knee Society Score, Lower Extremity Functional Scale), complications, and patient satisfaction

**Ethical Considerations:**
Ethical clearance was obtained from the Institutional Ethics Committee of MGM Medical College & Hospital. Written informed consent was obtained from all study participants prior to enrollment.

**Statistical Analysis:**
Descriptive statistics were used to summarize demographic, clinical, and outcome data. Continuous variables were presented as mean ± standard deviation or median with interquartile range, while categorical variables were expressed as frequencies and percentages. Data analysis was performed using **SPSS version 26**. A p-value of <0.05 was considered statistically significant.

**Results & Analysis:**
**Table 1: Age Distribution of Patients (n = 38)**

| Age Group (Years) | Number of Patients | Percentage (%) |
|---|---|---|

| | | |
|---|---|---|
| 20–29 | 5 | 13.2% |
| 30–39 | 8 | 21.1% |
| 40–49 | 10 | 26.3% |
| 50–59 | 7 | 18.4% |
| 60–69 | 5 | 13.2% |
| 70–80 | 3 | 7.9% |
| Total | **38** | **100%** |

In our study comprising 38 patients with distal one-third shaft fractures of the femur, the age distribution revealed that the majority of patients (26.3%) were in the 40–49 years age group, followed by 21.1% in the 30–39 years group. Patients aged 50–59 years constituted 18.4% of the study population, while both the 20–29 years and 60–69 years age groups accounted for 13.2% each. The lowest representation was observed in the 70–80 years age group, comprising 7.9% of the total cases.

**Table 2: Sex Distribution of Patients (n = 38)**

| Sex | Number of Patients | Percentage (%) |
|---|---|---|
| Male | 28 | 73.7% |
| Female | 10 | 26.3% |
| Total | **38** | **100%** |

Among the 38 patients included in the study, the majority were male, accounting for 73.7% (28 patients), while females constituted 26.3% (10 patients).

**Table 3: Mechanism of Injury (n = 38)**

| Mechanism of Injury | Number of Patients | Percentage (%) |
|---|---|---|
| Road Traffic Accidents | 28 | 73.7% |
| Falls | 10 | 26.3% |
| Total | **38** | **100%** |

In this study, road traffic accidents emerged as the most common mechanism of injury, accounting for 73.7% (28 cases) of distal one-third femoral shaft fractures. Falls were responsible for the remaining 26.3% (10 cases)

**Table 4: Intraoperative Data Analysis (n = 38)**

| Parameter | Mean ± SD |
|---|---|
| Mean Duration of Surgery (minutes) | 92.6 ± 15.4 |
| Mean Intraoperative Blood Loss (ml) | 210.0 ± 40.0 |

The intraoperative data analysis of the 38 patients in our study revealed that the mean duration of surgery was 92.6 ± 15.4 minutes, indicating a moderately consistent operative time across cases. The mean intraoperative blood loss was 210.0 ± 40.0 ml.

**Table 5: Infection Rate (n = 38)**

| Type of Infection | Number of Patients | Percentage (%) |
|---|---|---|
| No Infection | 35 | 92.1% |
| Superficial Infection | 2 | 5.3% |
| Deep Infection | 1 | 2.6% |
| Total | 38 | 100% |

In our study, 92.1% (35 out of 38 patients) did not develop any postoperative infection. Superficial infections were observed in 5.3% (2 patients), while deep infection occurred in only 2.6% (1 patient).

**Table 6: Radiological Union Status at Follow-up (n = 38)**

| Follow-up Duration | Radiological Union Achieved | Number of Patients | Percentage (%) |
|---|---|---|---|
| 3 months | Yes | 8 | 21.0% |
| 6 months | Yes | 24 | 63.2% |
| 9 months | Yes | 3 | 7.9% |
| 12 months | yes | 1 | 2.6% |
| Total | – | **36** | **100%** |

Radiological union was achieved in 36 out of 38 patients (94.7%) during the follow-up period. At 3 months, 21.0% (8 patients) showed evidence of union, while the majority—63.2% (24 patients)—achieved union by 6 months. A smaller proportion, 7.9% (3 patients), attained union at 9 months, and 2.6% (1 patient) showed union at 12 months.

**Table 7: Union Rate (n = 38)**

| Union Status | Number of Patients | Percentage (%) |
|---|---|---|
| **United** | 30 | 78.9% |
| **Malunion** | 2 | 5.3% |
| **Delayed Union** | 4 | 10.5% |
| **Non-union** | 2 | 5.3% |
| **Total** | **38** | **100%** |

In this study, 78.9% (30 out of 38 patients) achieved successful union of the distal one-third femoral shaft fracture. Delayed union was observed in 10.5% (4 patients), while malunion and non-union were each reported in 5.3% (2 patients).

**Table 8: Postoperative Complications (n = 38)**

| Complication | Number of Patients | Percentage (%) |
|---|---|---|
| **Anterior Knee Pain** | 5 | 13.2% |
| **Knee Stiffness** | 3 | 7.9% |
| **Implant Failure** | 1 | 2.6% |
| **Superficial Infection** | 2 | 5.3% |
| **Deep Infection** | 1 | 2.6% |
| **Neurovascular Injury** | 0 | 0% |
| **Deep Vein Thrombosis (DVT)** | 0 | 0% |
| **Total with ≥1 Complication** | **9** | **23.7%** |

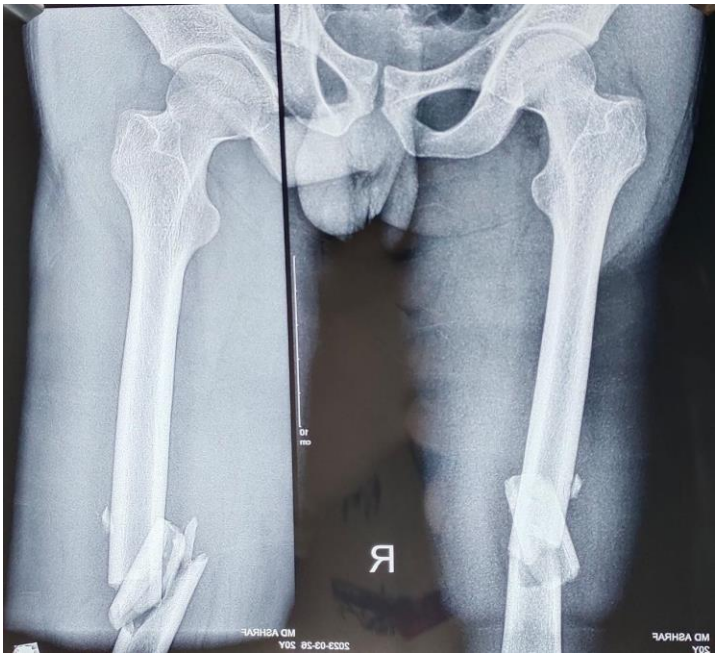
Postoperative complications were observed in 23.7% (9 out of 38 patients). The most common complication was anterior knee pain, reported in 13.2% (5 patients), followed by knee stiffness in 7.9% (3 patients). Superficial infection occurred in 5.3% (2 patients) and implant failure and deep infection were each seen in 2.6% (1 patient).

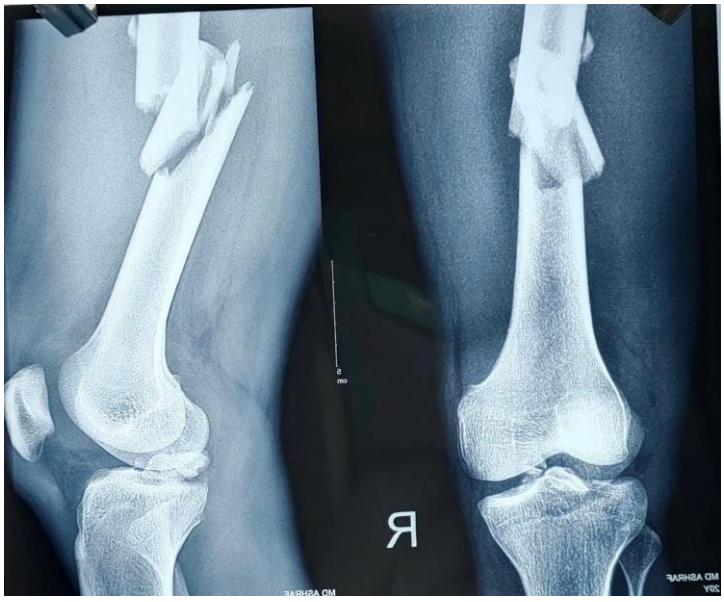
**Table 9: Functional Outcomes (n = 38)**

| Outcome Measure | Mean ± SD / No. of Patients (%) |
|---|---|
| **Knee Society Score (KSS)** | 86.1 ± 7.2 |
| **Excellent (≥85)** | 22 (57.9%) |
| **Good (70–84)** | 11 (28.9%) |
| **Fair (60–69)** | 3 (7.9%) |
| **Poor (<60)** | 2 (5.3%) |
| **Lower Extremity Functional Scale (LEFS)** | 70.4 ± 8.3 |
| **Satisfactory Recovery (≥65)** | 30 (78.9%) |
| **Unsatisfactory Recovery (<65)** | 8 (21.1%) |

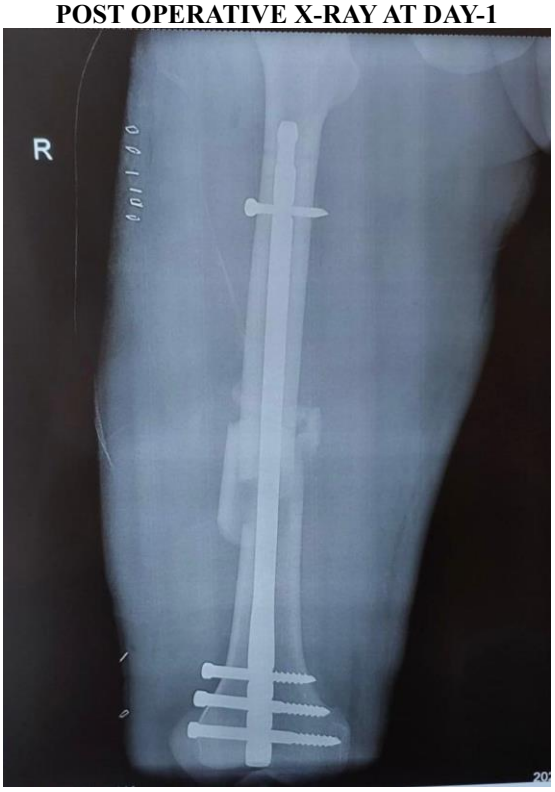
Functional outcomes in the study were evaluated using the Knee Society Score (KSS) and the Lower Extremity Functional Scale (LEFS). The mean KSS was 86.1 ± 7.2, with 57.9% (22 patients) achieving an *excellent* outcome (≥85), 28.9% (11 patients) classified as *good* (70–84), 7.9% (3 patients) as *fair* (60–69), and 5.3% (2 patients) having *poor* functional outcomes (<60). The mean LEFS score was 70.4 ± 8.3, and 78.9% (30 patients) demonstrated *satisfactory recovery* (≥65), while 21.1% (8 patients) had an *unsatisfactory recovery* (<65).

**PRE OPERATIVE X-RAY.**





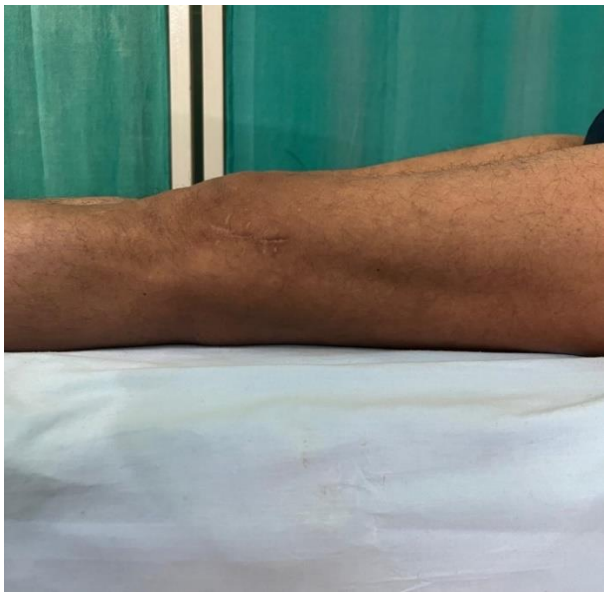
**POST OPERATIVE X-RAY AT DAY-1**




**POST OPERATIVE X-RAY AT 18 MONTHS**


**POST OPERATIVE X-RAY AFTER IMPLANT REMOVAL**

**PICTURE SHOWING LEFT KNEE JOINT IN FULL FLEXION and EXTENSION AFTER 18 MONTHS.**



**Discussion:**

In my study comprising 38 patients with distal one-third shaft fractures of the femur, the majority of patients (26.3%) were in the 40–49 years age group, followed by 21.1% in the 30–39 years group. A similar age distribution pattern was observed in the study by **Sah SK et al. (2023)** [9], where the mean age was 30.47 years, with the most affected age group being the younger adult population, likely due to their increased exposure to high-velocity trauma. Our study also showed a clear male predominance, with 73.7% males and 26.3% females, consistent with the findings reported by **Gomes N et al. (2024)** [10], who noted that 82% of the patients in their study were males. This male predominance has been attributed to greater involvement of men in outdoor activities, vehicular travel, and occupational hazards, which increase the risk of high-energy trauma. Likewise, **Tsegaye YA et al. (2024)** [11] reported that distal femoral fractures predominantly affected males, aligning with our demographic profile. The consistent trend across studies suggests that distal femoral shaft fractures are more common among adult males in their productive age group, with road traffic

accidents being a major contributing factor. This demographic insight is critical in designing targeted preventive strategies and patient education programs.

In this study, road traffic accidents (RTA) were the leading cause of injury, responsible for 73.7% of the distal one-third femoral shaft fractures, while falls accounted for 26.3%. These findings are consistent with the study by **Gomes N et al. (2024)** [10], where RTA was the predominant cause of injury, affecting the right limb more commonly. Similarly, **Sah SK et al. (2023)** [9] reported that road traffic accidents were the most common mechanism, emphasizing the role of high-energy trauma in causing distal femoral fractures in active adults. This pattern reflects the growing burden of road traffic-related orthopedic injuries in developing regions and urbanizing populations.

Regarding operative parameters, our study showed a mean duration of surgery of 92.6 ± 15.4 minutes and a mean intraoperative blood loss of 210.0 ± 40.0 ml, which are comparable with other published studies. For instance, **Handolin L et al. (2004)** [12] also observed that DFN is associated with acceptable operative times and minimal intraoperative blood loss, reinforcing its feasibility in routine orthopedic settings. Additionally, **Lakshmikanth ME et al. (2024)** [13] emphasized the advantages of DFN in minimizing soft tissue dissection and periosteal stripping, which likely contributes to reduced blood loss and shorter surgical time. Collectively

In our study, the postoperative infection rate was low, with 92.1% of patients remaining infection-free. Only 5.3% (2 patients) developed superficial infections, and 2.6% (1 patient) experienced a deep infection. These findings are in close agreement with the results reported by **Handolin et al. (2004)** [12], who noted three superficial infections and no deep infections in their series of distal femoral fractures treated with DFN. **Likewise, Sah SK et al. (2023)** [9] reported superficial infection in only 2 cases out of 30, highlighting the low risk of deep surgical site infection associated with DFN when appropriate surgical protocols and asepsis are maintained. The low infection rates across these studies further affirm the safety of DFN as a fixation method for distal femoral fractures.

Radiological union was achieved in 94.7% of our patients, with the majority (63.2%) achieving union by 6 months, and smaller proportions uniting at 3, 9, and 12 months. Our findings are comparable with those of **Moed et al. (1998)** [14], who reported a low non-union rate of 6% and an average union time of 12.6 weeks, particularly with early nail dynamization. Similarly, **Sadic S et al. (2014)** [15] documented a healing rate of 93.6% with a mean union time of 19.4 ± 6.1 weeks, **while Gangavalli AK et al. (2016)** [16] observed regular fracture healing in 14 out of 15 cases, with only one case of delayed union.
In our study, 78.9% (30 out of 38 patients) achieved successful union, while delayed union was seen in 10.5%, and malunion and non-union occurred in 5.3% of cases each. These findings are well-aligned with previous literature. For instance, **Sadic S et al. (2014)** [15] reported a healing rate of 93.6%, with non-union in 6.25% and delayed union in 2%. Similarly, **Moed BR et al. (1998)** [14] noted a non-union rate of 6%, which is comparable to our findings. **Gangavalli AK et al. (2016)** [16] observed regular fracture healing in the majority of their patients, with only one case of delayed union, reinforcing that DFN provides a high likelihood of union with minimal intervention.

Postoperative complications were noted in 23.7% of our patients, the most frequent being anterior knee pain (13.2%), followed by knee stiffness (7.9%), which are commonly reported morbidities associated with retrograde femoral nailing. These results are similar to those of **Prasanna A et al. (2019)** [17], who reported mild-to-moderate knee discomfort in a subset of patients, and **Moed BR et al. (1998)** [14], who found minimal knee pain and high average knee scores, emphasizing that anterior knee pain remains a known but manageable issue in retrograde approaches. Our observed implant failure rate of 2.6% is also in line with the findings of **Handolin L et al. (2004)** [12], who reported locking screw breakage in two cases, indicating occasional hardware-related issues with DFN.

Functional outcomes in our study were assessed using the Knee Society Score (KSS) and the Lower Extremity Functional Scale (LEFS). We observed a mean KSS of 86.1 ± 7.2, with 57.9% of patients achieving excellent results, and 28.9% classified as good, indicating that a significant majority of patients regained near-normal knee function following DFN. These findings are consistent with those of **Prasanna A et al. (2019)** [17], who reported 52% excellent and 13% good functional outcomes based on the Lysholm knee scoring system, reinforcing the high functional potential of DFN when followed by appropriate rehabilitation. Similarly, **Gangavalli AK et al. (2016)** [16] found that 13 out of 15 patients had either excellent or good outcomes using the HSS scoring system.

Our mean LEFS score of 70.4 ± 8.3, with 78.9% of patients achieving satisfactory recovery, further highlights the positive impact of DFN on lower limb function. This is in agreement with the findings of **Tsegaye YA et al. (2024)** [11], who reported that 48.3% of patients had excellent functional outcomes and 30% had good outcomes, based on the Neer's scoring system. Their study also emphasized that regular follow-up and closed fracture types were key predictors of favorable results—factors also controlled in our study.

## CONCLUSION:

This prospective observational study evaluated the functional and surgical outcomes of distal one-third femoral shaft fractures treated with distal femoral intramedullary locking nailing (DFN) in a cohort of 38 patients. The majority of the patients were middle-aged males, with road traffic accidents being the predominant mechanism of injury. The surgical procedure demonstrated a consistent operative time and controlled blood loss, with a low incidence of intraoperative and postoperative complications.

Radiological union was achieved in 94.7% of cases, with most fractures uniting within six months. The overall union rate was 78.9%, with a small proportion of patients experiencing delayed union, malunion, or non-union. Postoperative complications occurred in 23.7% of cases, with anterior knee pain being the most frequent, followed by knee stiffness, superficial infection, and implant-related issues.

Functional outcomes were favorable, as reflected by a high mean Knee Society Score (86.1 ± 7.2) and a substantial proportion (78.9%) of patients achieving satisfactory Lower Extremity Functional Scale (LEFS) scores. These results affirm that DFN is a reliable, effective, and minimally invasive technique for managing distal third femoral shaft fractures, providing high union rates and good functional recovery with a low complication profile.

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