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Functional Outcomes of Femoral Shaft Fracture S Treated with Intramedullary Nailing and Plate Osteosynthesis in Adults – A Comparative Study

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KEYWORDS

Femoral shaft fractures, intramedullary nailing, plate osteosynthesis, functional outcomes, radiological healing.

ABSTRACT:

Background:

Femoral shaft fractures, often caused by high-energy trauma such as motor vehicle accidents and falls, are severe injuries that require effective treatment to restore function and ensure mobility. The two main surgical interventions for these fractures are intramedullary nailing and plate osteosynthesis. While both methods are widely used, their comparative efficacy in terms of functional outcomes, radiological healing, and complication rates remains an area of ongoing research.

Objective:

This study aims to assess and compare the functional and radiological outcomes of femoral shaft fractures treated with intramedullary nailing versus plate osteosynthesis in adult patients. The incidence of postoperative infections associated with each method was also evaluated.

Methods:

An observational study was conducted over 18 months at Sree Balaji Medical College, involving 25 patients aged 18-70 years with femoral shaft fractures. The patients were divided into two groups: Group A (n=12) received plate osteosynthesis, and Group B (n=13) underwent intramedullary nailing. Clinical outcomes, radiological union at 20 weeks post-surgery, and infection rates were tracked. Statistical significance was determined using a p-value threshold of 0.05.

Results:

Intramedullary nailing led to significantly better functional outcomes, with 61.5% of patients achieving excellent results compared to 25.0% in the plating group (P-value = 0.04). The nailing group also experienced faster radiological union, with a mean of 20 weeks compared to 22 weeks for the plating group (P-value = 0.02). Infection rates were higher in the plating group (33.3%) compared to the nailing group (15.4%), though this difference was not statistically significant (P-value = 0.21). Road traffic accidents were the most common cause of injury in both groups.

Conclusion:

Intramedullary nailing provides superior functional outcomes, faster healing, and lower infection rates compared to plate osteosynthesis for femoral shaft fractures. While plate osteosynthesis is necessary for more complex fracture patterns, intramedullary nailing offers better overall recovery,

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particularly in cases that benefit from less invasive techniques and quicker mobilization. These findings support the preferential use of intramedullary nailing in the management of femoral shaft fractures.

Introduction:

The femur, recognized as the longest and strongest bone in the human body, serves as a primary weight-bearing structure in the lower limb. Due to its biomechanical properties, significant force is required to cause a fracture, with common etiologies being high-energy trauma such as motor vehicle accidents, falls from heights, or severe direct impacts[1]. Femoral shaft fractures typically present with a bimodal age distribution: younger individuals often sustain such fractures from high-energy trauma, while older adults are more likely to experience fractures from lower-energy mechanisms such as falls, exacerbated by osteoporosis[1].

The management of femoral shaft fractures has evolved significantly over the past century, transitioning from conservative methods like traction and splinting to more advanced surgical techniques aimed at restoring anatomical alignment and function. The two primary surgical interventions used today are intramedullary nailing (IMN) and plate osteosynthesis (PO). Intramedullary nailing involves inserting a metal rod through the marrow canal of the femur, allowing for minimally invasive stabilization[2]. In contrast, plate osteosynthesis requires the application of a metal plate to the bone's surface, which is then fixed with screws[3]. Both techniques have distinct advantages and potential complications, with varying outcomes based on the fracture pattern, patient factors, and surgical technique.

This study aims to compare the functional and radiological outcomes of femoral shaft fractures treated with IMN versus PO. We hypothesize that intramedullary nailing, being less invasive, results in faster recovery, fewer complications, and superior functional outcomes compared to plate osteosynthesis. However, certain fracture patterns may still necessitate the use of plate osteosynthesis for optimal anatomical reduction and stabilization.

Classification of Femoral Shaft Fractures:

Femoral shaft fractures can be classified based on various criteria such as location, fracture pattern, and whether the fracture is open or closed. Two primary classification systems are widely used:

1. **AO/OTA Classification[4]**
2. **Winquist and Hansen Classification[5,6]**

Materials and Methods:

Study Design and Setting:

This observational study was conducted at Sree Balaji Medical College and Hospital over a period of 18 months. It included patients presenting with femoral shaft fractures at the casualty and orthopaedic outpatient department. All patients were managed according to standardized protocols for trauma care.

Study Population and Sample Size:

The study involved 25 adult patients with femoral shaft fractures, divided into two groups:

- **Group A (Plating):** 12 patients who underwent plate osteosynthesis.
- **Group B (Nailing):** 13 patients who received intramedullary nailing. The sample size was calculated based on the expected outcome frequency (6.7%) and a confidence interval of 95%.

Inclusion Criteria:

- Patients aged 18 to 70 years
- Diaphyseal fractures of the femur
- Polytrauma patients without multi-system dysfunction
- Closed fractures or Gustilo-Anderson type I and II open fractures

Exclusion Criteria:

- Pathological fractures
- Grade III open fractures

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- Associated fractures such as neck of femur, intertrochanteric fractures, and acetabular fractures
- Pre-existing infections in the thigh region

Surgical Procedures:

- **Intramedullary Nailing:** Performed under spinal, epidural, or general anaesthesia. A guidewire was inserted after the fracture was reduced under imaging guidance. The medullary canal was reamed, and an appropriately sized nail was inserted. Proximal and distal locking was performed to ensure stability.
- **Plate Osteosynthesis:** A lateral approach was used, with careful dissection to expose the femur. A pre-contoured plate was applied to the bone, fixed with screws ensuring minimal soft tissue disruption. The wound was closed after the fixation was confirmed radiographically.

Outcome Measures:

Primary outcomes were:

- **Radiological Union:** Defined as the presence of callus bridging the fracture site within 20 weeks.
- **Functional Outcome:** Assessed using the Kalus W. Klem & Martin Borner criterion[7]. Secondary outcomes included complication rates, infection, and range of motion recovery.

Criteria	Excellent	Good	Fair	Poor
Non-union/Delayed Union	None	None	None	Yes
Radiographic Alignment	Normal	-	-	-
Angular Deformities	None	<5°	5-10°	>10°
Muscle Atrophy	None	<2 cm	2-5 cm	>5 cm
Hip Movements	Full range	Slight loss	>25% loss	-
Knee Movements	Full range	Slight loss	>25% loss	-

Figure 1: Kalus W. Klem & Martin Borner criterion

Post-Operative Protocol and Rehabilitation:

Immediate Post-Operative Care:

- **Pain Management:** Multimodal analgesia, including opioids and NSAIDs.
- **Fluids & Blood Transfusion:** Based on intra-operative blood loss; monitoring haemoglobin levels.
- **Antibiotic Prophylaxis:** IV antibiotics for 24-48 hours to prevent infection.
- **Thromboprophylaxis:** Subcutaneous low molecular weight heparin (LMWH) for 7-10 days; oral anticoagulants for 4-6 weeks.
- **Wound Care:** Regular dressing changes, and drain removal within 48-72 hours, if used.
- **Imaging:** Post-operative X-rays to confirm alignment and implant position.

Early Mobilization:

- **Post-Op Day 1:** Active-assisted range of motion (ROM) exercises, static quadriceps strengthening.
- **Weight-Bearing:** Partial weight-bearing for IMN; delayed for PO depending on fracture stability.

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Discharge and Follow-Up:

- Patients are discharged within 5-7 days with instructions on wound care and medications. Follow-up occurs at 6, 12 weeks, 6 months, and 1 year.

Rehabilitation Program

Phase 1 (Weeks 1-4):

- **Goals:** Manage pain, prevent complications, initiate ROM.
- **Activities:** Passive/active ROM, static quadriceps, ankle pumps, use of crutches or walkers.

Phase 2 (Weeks 5-12):

- **Goals:** Progress to full weight-bearing, increase joint mobility and strength.
- **Activities:** Active ROM, resistance training, balance exercises, partial weight-bearing exercises.

Phase 3 (Weeks 13+):

- **Goals:** Full ROM, regain strength, and restore functional mobility.
- **Activities:** Full weight-bearing, advanced strengthening, gait training, sport-specific drills.

Return to Work/Sports:

- **Sedentary Jobs:** 8-12 weeks
- **Manual Work/Sports:** 6-12 months depending on recovery.

Long-Term Follow-Up: Regular radiographs and functional assessments at 6-12 months to monitor healing and prevent complications like non-union or implant failure.

Nailing case:

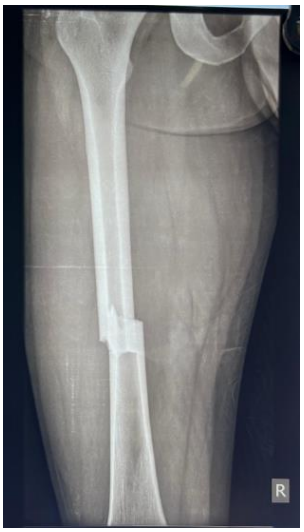

Figure 2: Pre op xray

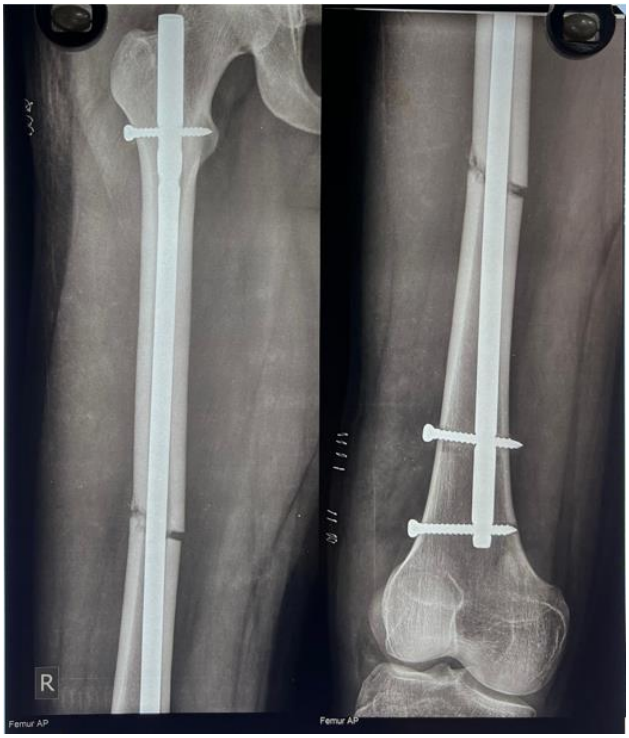

Figure 3: Immediate post op xray

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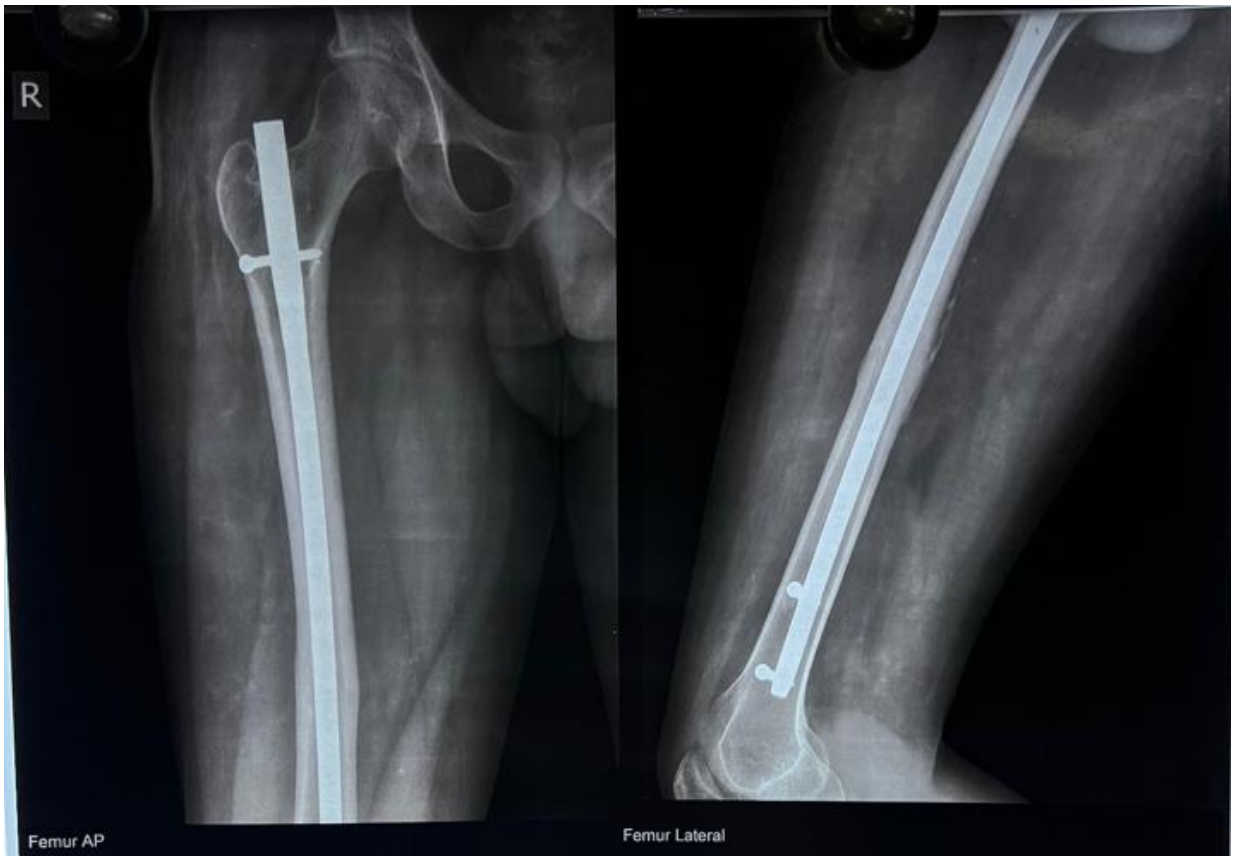

Figure 4: 6 months Post op xray

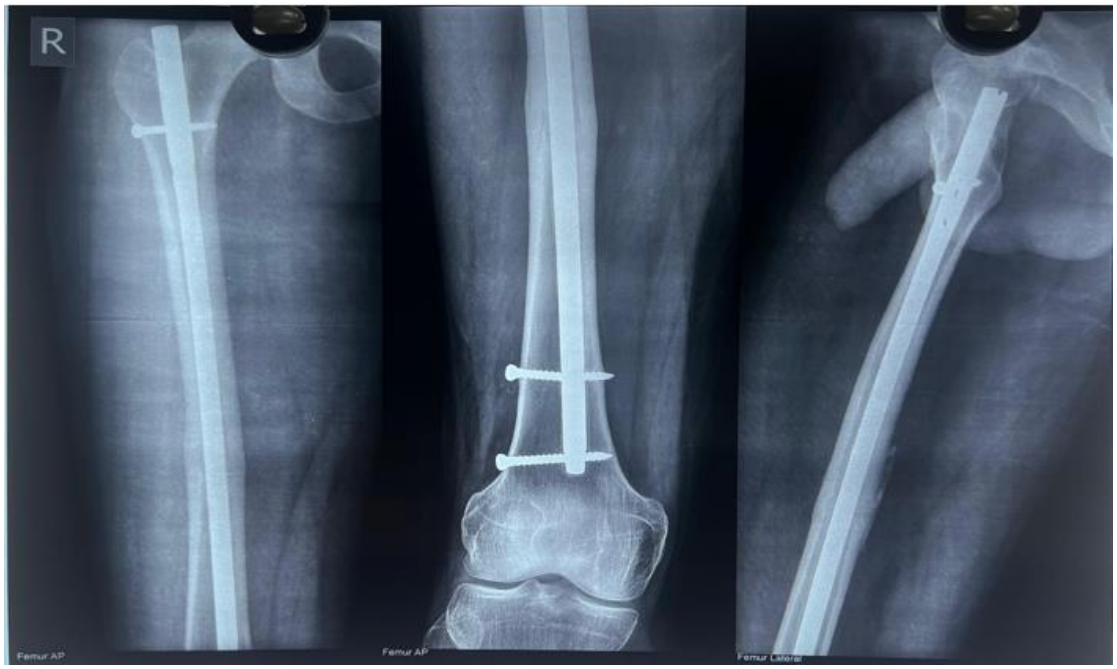

Figure 5: 1 year Post op xray

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Figure 6: Achieved range of movements after 1 year after IM nailing

Plate Fixation Patient:

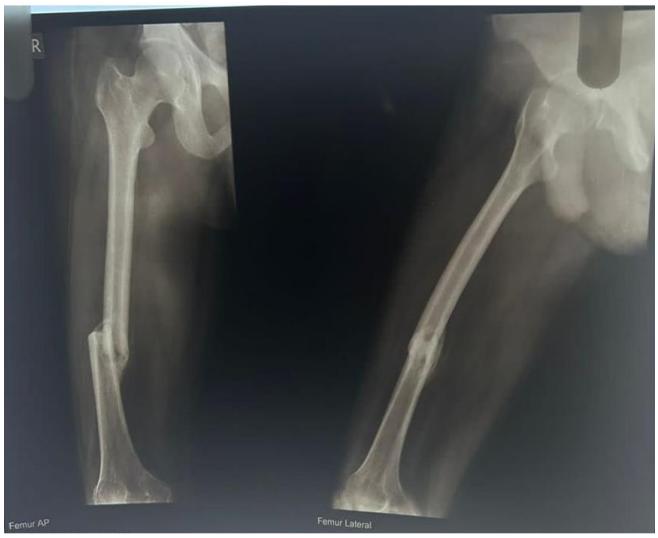

Figure 7: Pre op xray

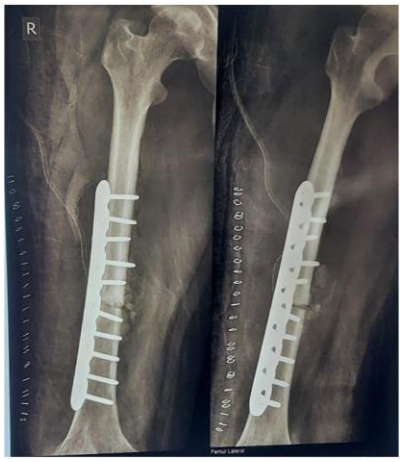

Figure 8: Immediate Post op xray

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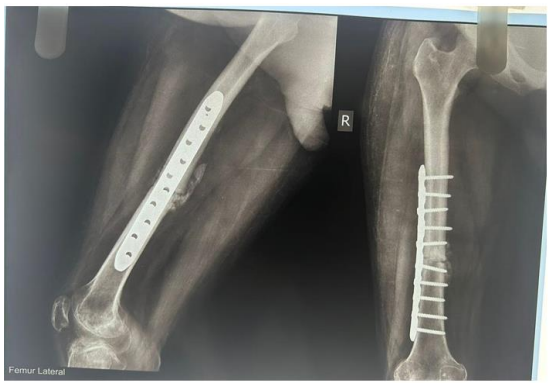

Figure 9: 6 months post op xray

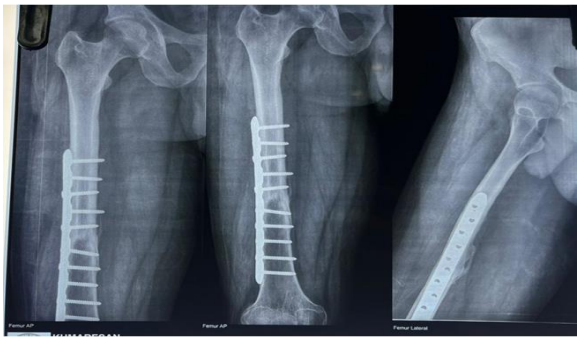

Figure 10: 1 year post op xray

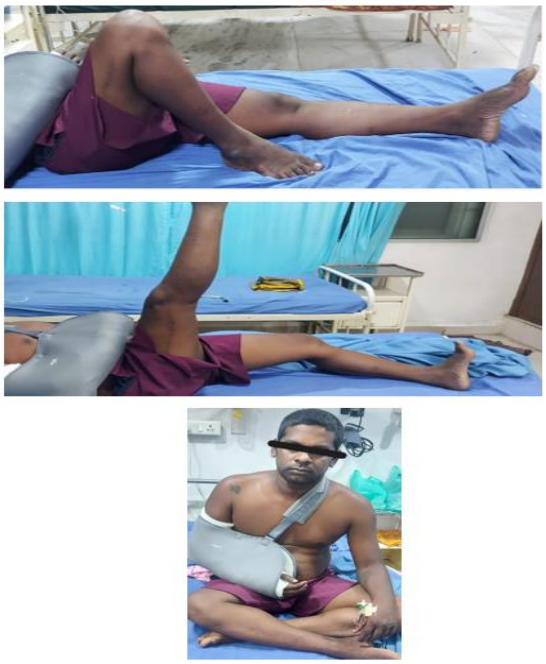

Figure 11: Achieved range of movements after 1 year after plate fixation

Results:

Demographics:
The majority of patients were male, with a male-to-female ratio of approximately 3:1. The mean age of patients was 35 years in the IMN group and 39 years in the PO group, with no significant age-related differences between the groups.

Mode of Injury:
Road traffic accidents (RTAs) accounted for 75-77% of injuries in both groups, followed by falls. One patient in the PO group sustained an injury from a workshop accident.

Fracture Characteristics:

- **Winquist & Hansen Classification:** Group B (IMN) had a higher proportion of less comminuted fractures, while more complex fractures (Type III) were more prevalent in Group A (PO) ($p = 0.03$).
- **AO Classification:** Both groups had similar distribution of simple and complex fractures, although Group A had a slightly higher proportion of more complex (Type B and C) fractures ($p = 0.05$).

Healing Outcomes:

- **Radiological Union:** The average time to radiological union was significantly shorter in the IMN group (20 weeks) compared to the PO group (22 weeks) ($p = 0.02$).
- **Functional Outcomes:** 61.5% of patients in the IMN group achieved excellent results, compared to only 25% in the PO group ($p = 0.04$).

Complications:

- **Infection Rates:** The infection rate in the PO group (33.3%) was higher than in the IMN group (15.4%), though this was not statistically significant ($p = 0.21$).
- **Associated Injuries:** Group A (PO) had a higher incidence of associated injuries, such as leg fractures and soft tissue damage, compared to Group B.

Discussion:
This study supports the superiority of intramedullary nailing over plate osteosynthesis for femoral shaft

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fractures, particularly in terms of faster healing and fewer complications. The minimally invasive nature of IMN preserves the periosteal blood supply, crucial for faster bone healing, and maintains the fracture hematoma, which promotes union[8,9]. These advantages lead to quicker recovery, shorter hospital stays, and earlier mobilization.

In contrast, plate osteosynthesis, while necessary for certain complex fracture patterns, involves more extensive soft tissue dissection and periosteal stripping, contributing to higher infection rates and longer recovery times. However, it offers precise anatomical reduction, which is critical in fractures with severe comminution or those requiring perfect alignment.

Several studies, including those by Brumback et al[10] and Ricci et al[11], have also demonstrated better outcomes with intramedullary nailing, consistent with our findings. However, the higher infection rates associated with plating may also reflect the higher complexity of fractures treated with this method.

Conclusion:

Intramedullary nailing is a superior method for treating femoral shaft fractures due to its minimally invasive nature, faster recovery, and lower complication rates. However, plate osteosynthesis remains a valuable technique for specific fractures, especially those requiring precise anatomical reduction. Careful patient selection and fracture classification are crucial in determining the appropriate surgical intervention.

Future research should continue to explore personalized treatment strategies based on fracture characteristics, patient demographics, and the availability of surgical expertise to further improve outcomes for femoral shaft fractures.

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