



Original Article

## A PROSPECTIVE STUDY TO ASSESS THE FUNCTIONAL AND RADIOLOGICAL OUTCOME OF PROXIMAL FEMORAL NAIL IN MANAGEMENT OF TROCHANTERIC AND SUBTROCHANTERIC FEMUR FRACTURE

Dr Adarsh Dwivedy<sup>1</sup>, Dr Abhishek Yadav<sup>2</sup>, Dr Pritkaran Singh Bazad<sup>3</sup>

<sup>1-3</sup> Junior Resident, Department of Orthopaedics, Pacific Institute of Medical Sciences, Umarda, Udaipur, Rajasthan, India

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### Corresponding Author:

**Dr Adarsh Dwivedy**

Junior Resident, Department of Orthopaedics, Pacific Institute of Medical Sciences, Umarda, Udaipur, Rajasthan, India.

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### ABSTRACT

**Background:** Trochanteric and subtrochanteric femur fractures are common orthopaedic injuries associated with significant morbidity, prolonged immobilization, and functional disability, especially in elderly patients. Proximal femoral nail (PFN) has emerged as a preferred implant because of its biomechanical advantages, minimally invasive technique, and stable fixation in unstable fracture patterns.

**Aim:** To evaluate the functional and radiological outcome of proximal femoral nail in the management of trochanteric and subtrochanteric femur fractures.

**Materials and Methods:** This prospective quasi-experimental study was conducted in the Department of Orthopaedics, Pacific Institute of Medical Sciences, Udaipur, from April 2024 to October 2025. A total of 45 patients with trochanteric and subtrochanteric femur fractures were included and treated with proximal femoral nailing. Patients were evaluated clinically and radiologically during follow-up. Functional outcome was assessed using Harris Hip Score, while radiological union and postoperative complications were also recorded.

**Results:** The mean age of patients was 50 years, with male predominance (68.89%). Trivial fall was the most common mode of injury (37.78%). Intertrochanteric fractures constituted 68.89% of cases, while subtrochanteric fractures constituted 31.11%. Closed reduction was achieved in 62.22% of patients. The mean duration of hospital stay was 5.5 days. Radiological union was achieved at a mean duration of 18.7 weeks. Postoperative complications included proximal screw migration, wound infection, malunion, non-union, and deep vein thrombosis. At final one-year follow-up, majority of patients achieved good to excellent functional outcome according to Harris Hip Score.

**Conclusion:** Proximal femoral nailing is an effective and reliable method for management of trochanteric and subtrochanteric femur fractures. It provides stable fixation, satisfactory radiological union, early mobilization, and favorable functional outcome with acceptable complication rates.

**Keywords:** Proximal femoral nail, Intertrochanteric fracture, Subtrochanteric fracture, Harris Hip Score, Functional outcome, Radiological union.

### INTRODUCTION

Trochanteric and subtrochanteric fractures of the femur are common orthopaedic injuries associated with significant morbidity, prolonged immobilization, and functional disability, particularly in elderly patients. The incidence of these fractures has increased with rising life expectancy, osteoporosis, and increasing road traffic accidents.<sup>1</sup> Elderly patients usually sustain these fractures following low-energy trauma such as trivial falls, whereas younger individuals commonly present after high-energy injuries.<sup>2</sup>

Intertrochanteric fractures account for nearly half of all proximal femoral fractures and are more common in osteoporotic females.<sup>3</sup> The subtrochanteric region extends from the lesser trochanter to approximately 5 cm distal to it and is subjected

to high biomechanical stress during weight bearing.<sup>4</sup> Strong muscular forces acting on the fracture fragments often lead to displacement, making reduction and fixation technically difficult.<sup>5</sup> In addition, the predominance of cortical bone and relatively poor vascularity in this region contribute to delayed union and implant failure.<sup>6</sup>

The primary aim in management of proximal femoral fractures is early stabilization to allow rapid mobilization and reduce complications associated with prolonged recumbency such as deep vein thrombosis, pressure sores, pneumonia, and joint stiffness.<sup>7</sup> Conservative treatment methods previously used were associated with high rates of malunion, non-union, and prolonged immobilization; therefore, surgical fixation has become the preferred treatment modality.<sup>8</sup>

Various implants have been used for fixation of these fractures, including dynamic hip screw (DHS), dynamic condylar screw (DCS), angled blade plate, and intramedullary devices.<sup>9</sup> Extramedullary implants may fail in unstable fracture patterns due to excessive collapse and varus deformity. Intramedullary devices offer biomechanical advantages because they are positioned closer to the mechanical axis of the femur, thereby reducing bending stress and improving load sharing.<sup>10</sup>

Proximal femoral nail (PFN), introduced by the AO/ASIF group in 1997, has become a widely accepted implant for trochanteric and subtrochanteric fractures.<sup>11</sup> PFN provides rotational stability, shorter lever arm, minimal soft tissue dissection, and stable fixation, especially in unstable and osteoporotic fractures.<sup>12</sup> Early mobilization, reduced blood loss, shorter operative time, and satisfactory functional recovery are additional advantages associated with PFN.<sup>13</sup>

Despite these benefits, complications such as screw migration, implant failure, malunion, and non-union may still occur if reduction and implant placement are inadequate.<sup>14</sup> Therefore, careful surgical technique and proper implant positioning are essential for successful outcomes.

Considering the increasing incidence of proximal femoral fractures and the growing use of proximal femoral nailing, the present study was undertaken to evaluate the functional and radiological outcome of proximal femoral nail in the management of trochanteric and subtrochanteric femur fractures.

## **OBJECTIVE**

To evaluate the functional and radiological outcome of proximal femoral nail in management of trochanteric and subtrochanteric fractures of femur.

## **MATERIALS AND METHODS**

This prospective quasi-experimental study was conducted in the Department of Orthopaedics at Pacific Institute of Medical Sciences, Umarda, Udaipur, over a period of 18 months from April 2024 to October 2025. A total of 45 patients with trochanteric and subtrochanteric femur fractures who fulfilled the inclusion criteria were included in the study.

### **Inclusion Criteria**

1. Patients aged 18–90 years with trochanteric or subtrochanteric femur fractures.
2. Patients willing to participate and provide informed consent.

### **Exclusion Criteria**

1. Pathological fractures.
2. Open fractures.
3. Patients medically unfit for surgery.
4. Patients not willing to participate in the study.

After admission, detailed history, clinical examination, and radiological evaluation were performed. Routine preoperative investigations including complete blood count, blood sugar, renal function tests, serum electrolytes, ECG, and chest radiograph were carried out. Necessary physician and cardiology fitness were obtained whenever required.

All patients were treated surgically with proximal femoral nail fixation under spinal or epidural anaesthesia on a fracture table under image intensifier guidance. Fracture reduction was achieved by closed or open technique depending upon fracture configuration and intraoperative reduction status. Appropriate proximal femoral nail and locking screws were inserted according to standard operative protocol.

Postoperatively, patients received intravenous antibiotics, analgesics, and physiotherapy. Early mobilization with non-weight-bearing ambulation was initiated as tolerated, followed by progressive weight bearing according to radiological evidence of union.

Patients were followed up clinically and radiologically at 1 month, 3 months, 6 months, and 12 months after surgery. Functional outcome was assessed using the Harris Hip Score, while radiological union was evaluated using serial

radiographs. Postoperative complications such as infection, malunion, non-union, screw migration, and deep vein thrombosis were also recorded.

The collected data were compiled and analysed using Statistical Package for Social Sciences (SPSS) software. Results were expressed in percentages, mean, and standard deviation. Appropriate statistical tests were applied wherever necessary.

## RESULTS

A total of 45 patients with trochanteric and subtrochanteric femur fractures were included in the study and managed with proximal femoral nailing. The age of patients ranged from 19 to 82 years with a mean age of 50 years. Majority of patients belonged to the 51–60 years age group.

**Table 1: Age Distribution of Patients**

Age Group (Years)	Number of Patients	Percentage
≤20	1	2.22%
21–30	5	11.11%
31–40	6	13.33%
41–50	7	15.56%
51–60	13	28.89%
61–70	8	17.78%
>70	5	11.11%

Male predominance was observed in the present study, with 31 male patients (68.89%) and 14 female patients (31.11%). The most common mode of injury was trivial fall seen in 17 patients (37.78%), followed by road traffic accidents in 15 patients (33.33%) and fall from height in 13 patients (28.89%).

**Table 2: Mode of Injury**

Mode of Injury	Number of Patients	Percentage
Trivial Fall	17	37.78%
Road Traffic Accident	15	33.33%
Fall from Height	13	28.89%

Right-sided fractures were more common and observed in 29 patients (64.44%), whereas left-sided fractures were seen in 16 patients (35.56%). Intertrochanteric fractures constituted 31 cases (68.89%), while subtrochanteric fractures constituted 14 cases (31.11%).

**Table 3: Type of Fracture**

Type of Fracture	Number of Patients	Percentage
Intertrochanteric	31	68.89%
Subtrochanteric	14	31.11%

According to Boyd and Graffin classification, Type II fractures were the most common intertrochanteric fracture pattern. In subtrochanteric fractures, Type II and Type III fractures were most commonly observed according to Seinsheimer classification. Closed reduction was achieved in 28 patients (62.22%), whereas 17 patients (37.78%) required open reduction.

**Table 4: Reduction Technique**

Reduction Technique	Number of Patients	Percentage
Closed Reduction	28	62.22%
Open Reduction	17	37.78%

The average duration of hospital stay was 5.5 days. Radiological union was achieved in most patients between 16–20 weeks, with a mean union time of 18.7 weeks.

**Table 5: Radiological Union**

Time to Union (Weeks)	Number of Patients	Percentage
≤16	7	15.56%
16–20	27	60.00%
21–24	8	17.78%
>24	3	6.67%

Postoperative complications included proximal screw migration in 5 patients (11.11%), wound infection in 3 patients (9.68%), deep vein thrombosis in 3 patients (9.68%), malunion in 2 patients (4.44%), and non-union in 2 patients (4.44%). Serial follow-up radiographs demonstrated progressive fracture healing with satisfactory implant position and maintenance of reduction throughout follow-up. Early peri-fracture callus formation was observed at 1 month, followed by progressive bridging trabeculae and fracture consolidation at subsequent follow-ups. Complete radiological union with cortical remodeling was evident in most patients by final follow-up (Figure 1, Figure 2 and Figure 3).

**Table 6: Postoperative Complications**

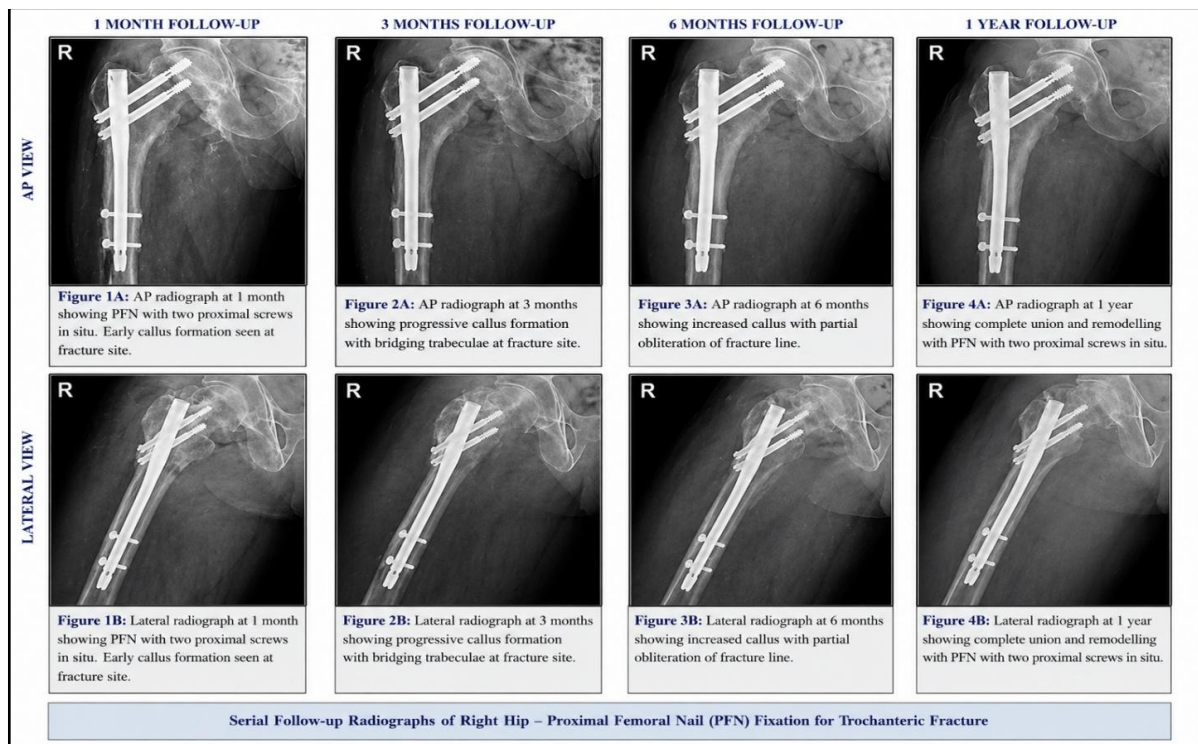
Complication	Number of Patients	Percentage
Wound Infection	3	9.68%
Malunion	2	4.44%
Non-union	2	4.44%
Proximal Screw Migration	5	11.11%
Deep Vein Thrombosis	3	9.68%
No Complications	29	64.44%

Functional outcome was assessed using Harris Hip Score during follow-up. Progressive improvement in functional outcome was observed with time. At final one-year follow-up, majority of patients achieved good to excellent results.

**Table 7: Functional Outcome According to Harris Hip Score**

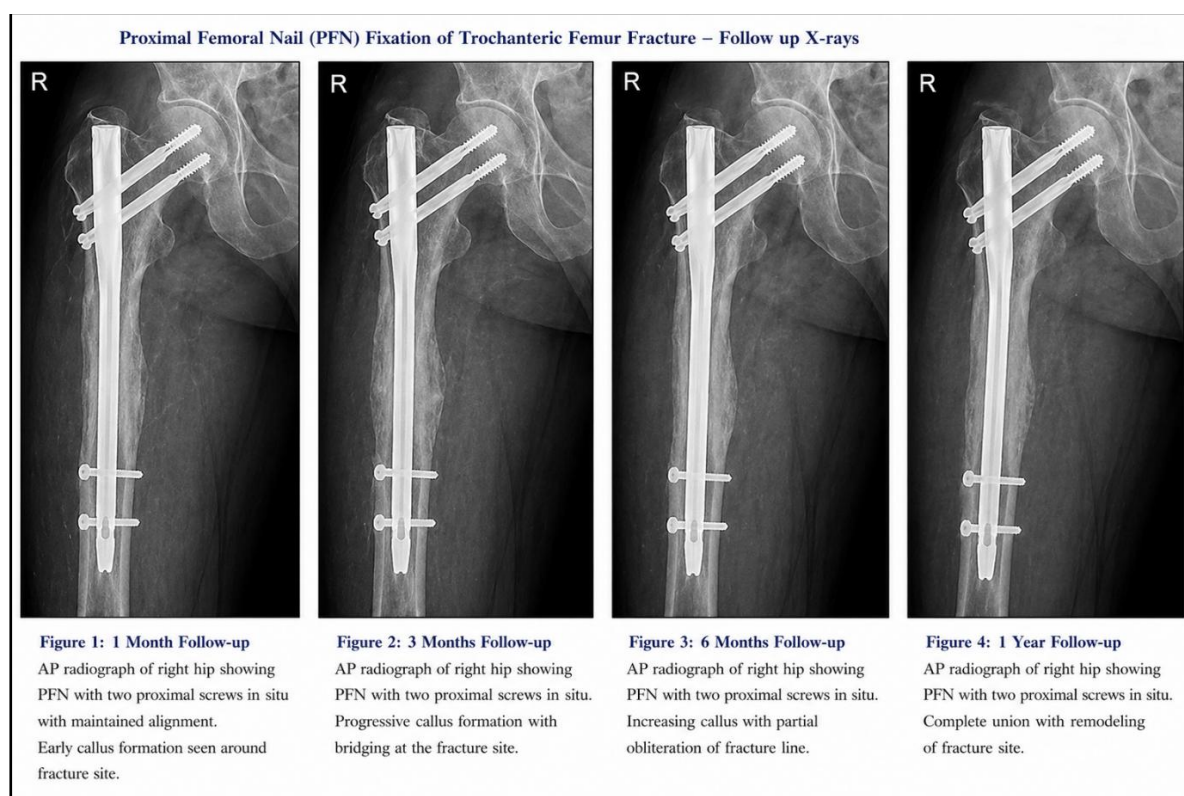
Harris Hip Score	1 Month	3 Months	6 Months	12 Months
Excellent	0	0	18	19
Good	0	7	13	15
Fair	7	26	7	5
Poor	38	12	5	3
Lost to Follow-up	0	0	2	3

At final follow-up, 19 patients (42.22%) had excellent outcome, 15 patients (30%) had good outcome, while only 3 patients (9.68%) had poor functional outcome.



**Figure 1:** Serial follow-up radiographs of the right hip demonstrating progressive fracture healing after proximal femoral nailing (PFN) for trochanteric femur fracture.

The upper row shows anteroposterior (AP) views and the lower row shows lateral views at 1 month, 3 months, 6 months, and 1 year postoperatively. At 1 month, maintained reduction with implant in situ and early callus formation is noted. At 3 months, progressive callus formation with bridging trabeculae is seen across the fracture site. At 6 months, increased callus with partial obliteration of the fracture line suggests advancing union. At 1 year, complete radiological union with remodeling of the fracture site is observed, with stable implant position and satisfactory alignment.



**Figure 2:** Serial Follow-up AP Radiographs of Right Trochanteric Femur Fracture Treated with Proximal Femoral Nail (PFN).

The figure demonstrates sequential anteroposterior radiographs of the right hip showing postoperative follow-up after PFN fixation for trochanteric femur fracture at 1 month, 3 months, 6 months, and 1 year. At 1 month, the implant is in situ with maintained fracture alignment and early peri-fracture callus formation. At 3 months, progressive callus formation with bridging trabeculae is noted across the fracture site. At 6 months, further consolidation is seen with increased callus and partial obliteration of the fracture line. At 1 year follow-up, complete radiological union with cortical remodeling is evident, with the PFN implant maintained in satisfactory position.



**Figure 3:** Serial Follow-up Radiographs of Trochanteric and Subtrochanteric Femur Fractures Treated with Proximal Femoral Nail (PFN).

The figure demonstrates sequential anteroposterior and lateral radiographs of two representative cases managed with PFN fixation.

**Case 1: Trochanteric Femur Fracture** – Follow-up images at 1 month, 3 months, 6 months, and 1 year show the implant in situ with maintained alignment. Early callus formation is visible at 1 month, progressive bridging callus is noted at 3 months, further consolidation with partial obliteration of the fracture line is seen at 6 months, and complete radiological union with remodeling is evident at 1 year.

**Case 2: Subtrochanteric Femur Fracture** – Serial radiographs at corresponding intervals demonstrate satisfactory implant position and progressive healing. Early callus formation is seen at 1 month, increasing bridging callus at 3 months, marked consolidation with near-complete union at 6 months, and complete fracture union with cortical remodeling at 1 year follow-up.

## DISCUSSION

Trochanteric and subtrochanteric femur fractures continue to pose significant challenges in orthopaedic trauma because of osteoporosis, fracture instability, comminution, and associated complications, particularly in elderly patients. Early surgical stabilization is important for restoration of mobility and reduction of morbidity and mortality.<sup>15</sup> Proximal femoral nail has emerged as a preferred implant because of its biomechanical superiority, minimally invasive technique, and ability to provide stable fixation in unstable fracture patterns.<sup>16</sup>

In the present study, the mean age of patients was 50 years, with majority of patients belonging to the 51–60 years age group. Similar observations were reported by Krishna et al. and Shivanna et al., who found increased incidence of proximal femoral fractures in middle-aged and elderly individuals.<sup>17, 18</sup> Male predominance observed in our study may be attributed to greater outdoor activities and higher exposure to trauma among males.

Trivial fall was the most common mode of injury in the present study, followed by road traffic accidents and fall from height. Similar findings were observed by Mokawem and Sinha et al., who reported low-energy trauma as the major cause of proximal femoral fractures in elderly osteoporotic patients.<sup>19,20</sup>

Intertrochanteric fractures were more common than subtrochanteric fractures in our study. Majority of fractures were managed by closed reduction, while open reduction was required in severely displaced and comminuted fractures. The minimally invasive nature of proximal femoral nailing preserves fracture hematoma and soft tissue integrity, thereby promoting biological fracture healing.<sup>21</sup>

The mean duration of hospital stay in our study was 5.5 days, which is comparable to findings reported by Koval and Zuckerman.<sup>22</sup> Early operative fixation and mobilization reduce complications associated with prolonged immobilization and contribute to shorter hospital stay.

Radiological union was achieved in most patients between 16–20 weeks, with a mean union time of 18.7 weeks. Similar results were reported by Banan et al. and Jamshad et al.<sup>23,24</sup> Intramedullary fixation acts as a load-sharing device and reduces bending stress on the implant, thereby improving fracture healing and stability.

Postoperative complications observed in our study included proximal screw migration, wound infection, malunion, non-union, and deep vein thrombosis. Proximal screw migration was the most common complication. Similar complications have been reported in studies by Parker et al. and Pervez et al.<sup>25,26</sup> However, most complications were managed successfully without significantly affecting the final outcome.

Functional outcome assessed using Harris Hip Score showed progressive improvement during follow-up. At final one-year follow-up, majority of patients achieved good to excellent functional outcome. Comparable findings were reported by Saudan et al. and Utrilla et al., who demonstrated favorable functional recovery with proximal femoral nailing.<sup>27,28</sup>

Biomechanically, proximal femoral nail offers several advantages including shorter lever arm, improved rotational stability, minimal soft tissue disruption, and better load-sharing characteristics.<sup>29</sup> These features make PFN especially useful in unstable and osteoporotic fractures where conventional extramedullary implants may fail.

The present study demonstrates that proximal femoral nailing is an effective and reliable method for management of trochanteric and subtrochanteric femur fractures, providing satisfactory radiological union, early mobilization, and favorable functional outcome. However, larger studies with longer follow-up are recommended for better assessment of long-term complications and implant survival.

## CONCLUSION

Proximal femoral nailing is an effective, reliable, and biomechanically advantageous method for the management of trochanteric and subtrochanteric femur fractures. The intramedullary position of the implant provides better load sharing, rotational stability, and resistance to varus collapse, particularly in unstable fracture patterns and osteoporotic bone.<sup>30</sup>

In the present study, most patients achieved satisfactory radiological union within an acceptable duration, with progressive improvement in functional outcome during follow-up. Majority of patients attained good to excellent Harris Hip Scores at final follow-up, indicating favorable recovery and restoration of mobility.<sup>31</sup>

The minimally invasive nature of proximal femoral nailing allows reduced soft tissue damage, preservation of fracture hematoma, shorter hospital stay, and early mobilization, thereby decreasing complications associated with prolonged immobilization.<sup>32</sup> Although complications such as screw migration, malunion, and infection were encountered, they were manageable and did not significantly affect the final outcome in most patients.

Successful outcome with proximal femoral nail depends upon proper patient selection, accurate fracture reduction, correct implant positioning, and adequate postoperative rehabilitation.<sup>33</sup>

Thus, proximal femoral nail can be recommended as a safe and dependable implant for trochanteric and subtrochanteric femur fractures, providing stable fixation, satisfactory union, and good functional recovery.

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