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Research Article

CLINICAL AND RADIOGRAPHIC OUTCOMES OF PROXIMAL FEMORAL NAILING IN UNSTABLE PERITROCHANTERIC FRACTURES: A PROSPECTIVE STUDY

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Abstract: ***Introduction:*** Unstable peritrochanteric fractures of the femur are frequently encountered in orthopaedic practice and are associated with significant morbidity, particularly in elderly patients with osteoporotic bone. Proximal femoral nailing (PFN) has emerged as a preferred fixation modality because of its biomechanical advantages, minimally invasive nature, and ability to permit early mobilization.**Materials and Methods:** This prospective observational study was conducted at Sree Mookambika Institute of Medical Sciences between February 2024 and January 2025 among 70 patients with unstable peritrochanteric fractures treated with proximal femoral nailing (PFN). Functional outcome was assessed using the Harris Hip Score (HHS), while radiological union was evaluated using the Radiographic Union Score for Hip (RUSH) at 6 weeks, 3 months, and 6 months postoperatively. Operative parameters, duration of hospital stay, and postoperative complications were also analysed. Statistical significance was considered at $p < 0.05$. **Results**The mean age of the study population was 52.9 ± 9.8 years, with male predominance (62.9%). Trivial fall was the most common mechanism of injury (35.7%). The mean operative duration was 69.2 ± 9.4 minutes, mean blood loss was 114 ± 24 mL, and mean hospital stay was 6.4 ± 1.5 days. Mean HHS improved significantly from 56.9 ± 7.8 at 6 weeks to 73.4 ± 5.2 at 3 months and 86.3 ± 5.4 at 6 months ($p < 0.001$). Mean RUSH score improved progressively from 14.1 ± 2.0 at 6 weeks to 21.2 ± 2.8 at 3 months and 28.4 ± 1.9 at 6 months, with fracture union achieved in 97.1% of patients at final follow-up. The overall complication rate was 7.1%.**Conclusion**PFN provides stable fixation with excellent functional recovery, high union rates, minimal complications, and early rehabilitation in unstable peritrochanteric fractures. Its biomechanical superiority and minimally invasive approach make it an effective treatment option, particularly in unstable fracture patterns.

Keywords: Proximal femoral nail; Peritrochanteric fracture; Harris Hip Score; RUSH score; Intertrochanteric fracture; Functional outcome.

INTRODUCTION

Peritrochanteric fractures of the femur are among the most commonly encountered injuries in orthopaedic trauma practice and contribute substantially to morbidity, reduced mobility, and mortality, especially in elderly patients with osteoporosis [1]. In older individuals, these fractures are most often caused by low-energy trauma such as trivial domestic falls, whereas younger patients usually sustain these injuries following high-energy events such as road traffic accidents and falls from height [1].

In the past, these fractures were commonly managed conservatively with skeletal traction and prolonged immobilization. Although fracture healing could be achieved with non-operative treatment, it was frequently associated with complications such as pressure sores, pulmonary infections, deep vein thrombosis, malunion, prolonged bed rest, and increased mortality [2]. Advances in fracture biomechanics, implant technology, surgical techniques, and perioperative care have gradually shifted the treatment approach toward early surgical fixation and mobilization as the standard of care [3].

Peritrochanteric fractures are generally classified as stable or unstable depending on the integrity of the posteromedial cortex and lateral femoral wall. Unstable fracture patterns, especially comminuted and reverse oblique fractures, are particularly difficult to manage because they are associated with a higher risk of varus collapse, rotational instability, screw cut-out, and

implant failure [4, 5]. Achieving stable fixation becomes even more challenging in osteoporotic bone, where poor bone quality further increases the likelihood of mechanical complications.

Extramedullary implants such as the dynamic hip screw (DHS) have traditionally been used for the treatment of intertrochanteric fractures and provide satisfactory results in stable fracture patterns. However, their effectiveness in unstable fractures is limited because of the greater bending forces and longer lever arm acting across the fracture site [4, 6]. To address these limitations, intramedullary devices such as the proximal femoral nail (PFN) were introduced. As a load-sharing implant positioned closer to the mechanical axis of the femur, PFN reduces bending stress and offers improved biomechanical stability [7, 8].

In addition, PFN provides several clinical advantages, including controlled fracture impaction, better rotational stability of the femoral head-neck fragment, minimal soft tissue dissection, shorter operative time, and preservation of fracture hematoma through minimally invasive insertion techniques [7,8]. These benefits facilitate early mobilization and weight-bearing while reducing postoperative morbidity and duration of hospital stay [9]. Because of these biomechanical and clinical advantages, PFN has become one of the preferred treatment options for unstable peritrochanteric fractures.

Despite its widespread use, the outcomes of PFN fixation can still be affected by factors such as fracture configuration, bone quality, quality of reduction, implant positioning, and surgical expertise. Moreover, prospective Indian studies evaluating both functional recovery and radiological union following PFN fixation remain limited.

Therefore, the present study was undertaken to evaluate the functional and radiological outcomes of proximal femoral nailing in unstable peritrochanteric fractures using the Harris Hip Score (HHS) and Radiographic Union Score for Hip (RUSH), along with the assessment of operative parameters and associated complications.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Orthopaedics at Sree Mookambika Institute of Medical Sciences from February 2024 to January 2025. Patients with unstable peritrochanteric fractures of the femur who underwent proximal femoral nailing (PFN) were enrolled consecutively and followed up for a minimum duration of six months postoperatively. Ethical clearance was obtained from the Institutional Ethics Committee, and written informed consent was obtained from all participants before inclusion in the study.

The sample size was calculated using the single-proportion formula with a 95% confidence interval and 5% allowable error, yielding a minimum required sample size of approximately 73 patients. Based on patient availability and study feasibility, 70 patients were included in the final analysis.

Patients aged more than 18 years with unstable peritrochanteric fractures who were medically fit for surgery and willing to comply with follow-up were included. Patients with stable intertrochanteric fractures, pathological or open fractures, associated neurovascular injuries, polytrauma, or previous ipsilateral hip surgery were excluded.

All patients underwent detailed clinical and radiographic evaluation using anteroposterior and lateral radiographs of the pelvis and affected hip. Routine preoperative investigations and anaesthetic assessment were performed before surgery.

All procedures were performed under spinal or regional anaesthesia on a fracture table under fluoroscopic guidance. Closed reduction was attempted in all cases, while open reduction was reserved for irreducible fractures. Appropriately sized PFNs were inserted through the greater trochanteric entry point with proximal and distal locking as required. Operative duration, intraoperative blood loss, and implant positioning were recorded.

Postoperative rehabilitation included quadriceps strengthening and ankle pump exercises from the first postoperative day, followed by assisted ambulation from postoperative days 2–3. Partial weight-bearing was initiated from 6 weeks as tolerated, while full weight-bearing was allowed after radiological evidence of fracture union.

Patients were evaluated at 6 weeks, 3 months, and 6 months postoperatively. Functional outcome was assessed using the Harris Hip Score (HHS), and radiological union was evaluated using the Radiographic Union Score for Hip (RUSH). Complications including infection, screw back-out, implant failure, and non-union were also documented.

Data were analysed using SPSS version 27.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. A p-value <0.05 was considered statistically significant.

RESULTS

Demographic Profile:

A total of 70 patients with unstable peritrochanteric fractures were included in the study. The mean age of the study participants was 52.9 ± 9.8 years. Male patients constituted the majority of the study population, accounting for 44 cases (62.9%), whereas females comprised 26 cases (37.1%). Regarding the side involved, the right side was affected in 36 patients (51.4%), while the left side was involved in 34 patients (48.6%). Analysis of the mechanism of injury revealed that trivial fall was the most common mode of injury, observed in 25 patients (35.7%), followed by road traffic

accidents (RTA) in 19 patients (27.1%). Fall from height accounted for 14 cases (20.0%), whereas other causes constituted 12 cases (17.1%) (Table 1 and Figure 1).

Table 1: Demographic Distribution of Study Participants (n = 70)

Parameter	Category	Frequency (n)	Percentage (%)
Mean age (years)	52.9 ± 9.8		
Gender	Male	44	62.9
	Female	26	37.1
Side involved	Right	36	51.4
	Left	34	48.6
Mechanism of injury	Trivial fall	25	35.7
	RTA	19	27.1
	Fall from height	14	20
	Others	12	17.1

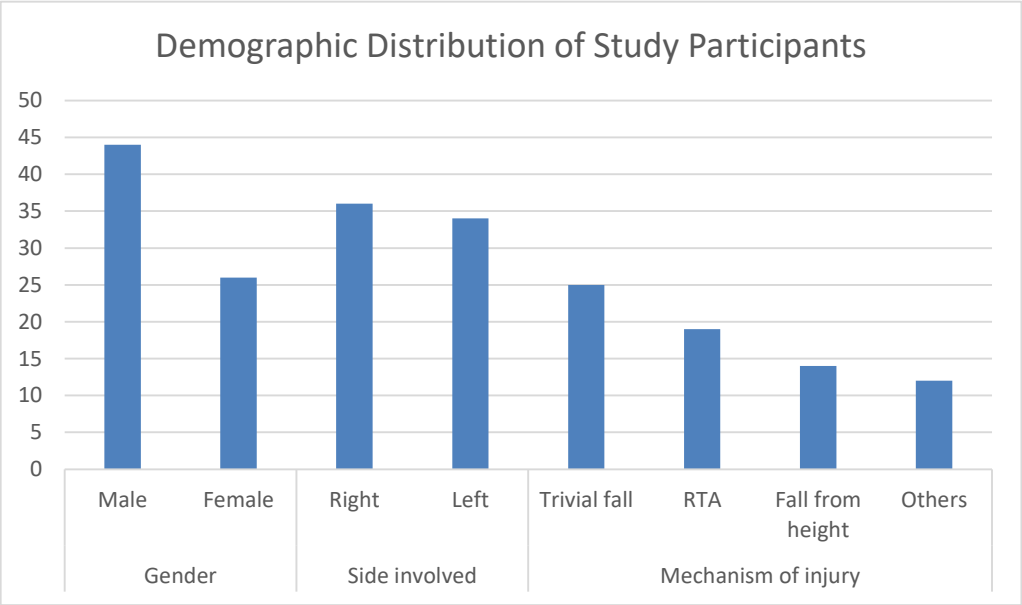

Figure 1: Demographic Distribution of Study Participants

Operative Parameters:

The operative parameters and intraoperative findings of the study participants are summarized in Table 2 and Figure 2. The mean duration of surgery was 69.2 ± 9.4 minutes, with the operative time ranging from 50 to 115 minutes. The mean intraoperative blood loss was 114 ± 24 mL. The average duration of hospital stay among the patients was 6.4 ± 1.5 days.

Table 2: Operative Parameters and Intraoperative Findings

Parameter	Mean ± SD (Range)
Duration of surgery (min)	69.2 ± 9.4 (50–115)
Blood loss (mL)	114 ± 24
Hospital stay (days)	6.4 ± 1.5

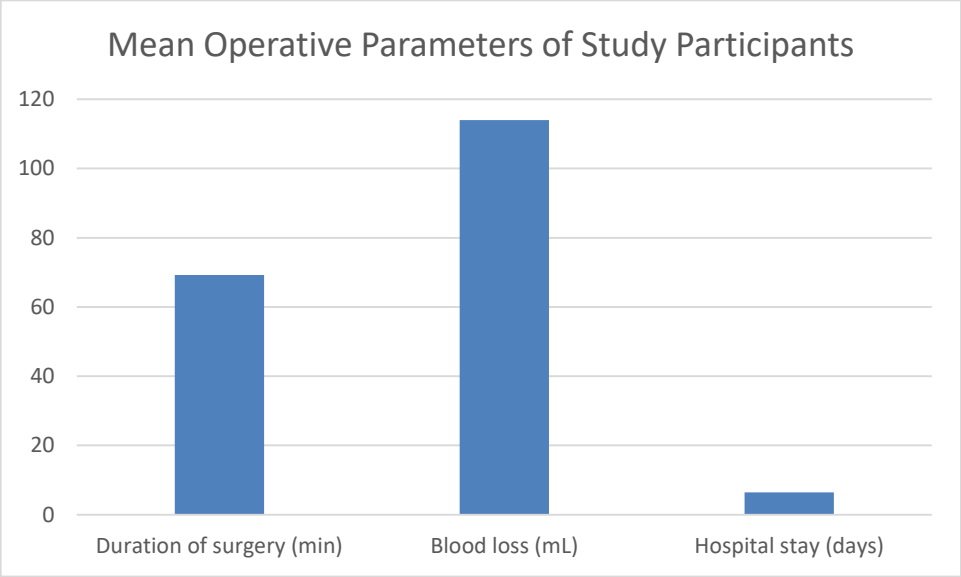

Figure 2: Mean Operative Parameters of Study Participants

Functional Outcome Assessed by Harris Hip Score (HHS):

The functional outcome of the patients was assessed using the Harris Hip Score (HHS) at different follow-up intervals and is presented in Table 3 and Figure 3. The mean HHS at 6 weeks was 56.9 ± 7.8, indicating poor to fair functional outcome during the early post-operative period. At 3 months follow-up, the mean HHS improved significantly to 73.4 ± 5.2, corresponding to fair to good functional recovery. Further improvement was observed at 6 months, with a mean HHS of 86.3 ± 5.4, indicating good to excellent functional outcome. Statistical analysis demonstrated a significant improvement in functional scores over successive follow-up periods, with a p-value of <0.001 at both 3 months and 6 months. These findings suggest that proximal femoral nailing provides satisfactory functional recovery and progressive improvement in hip function in patients with unstable peritrochanteric fractures.

Table 3: Functional Outcome Assessed by Harris Hip Score (HHS)

Follow-up	Mean ± SD	Interpretation	P-value
6 weeks	56.9 ± 7.8	Poor–Fair	—
3 months	73.4 ± 5.2	Fair–Good	<0.001
6 months	86.3 ± 5.4	Good–Excellent	<0.001

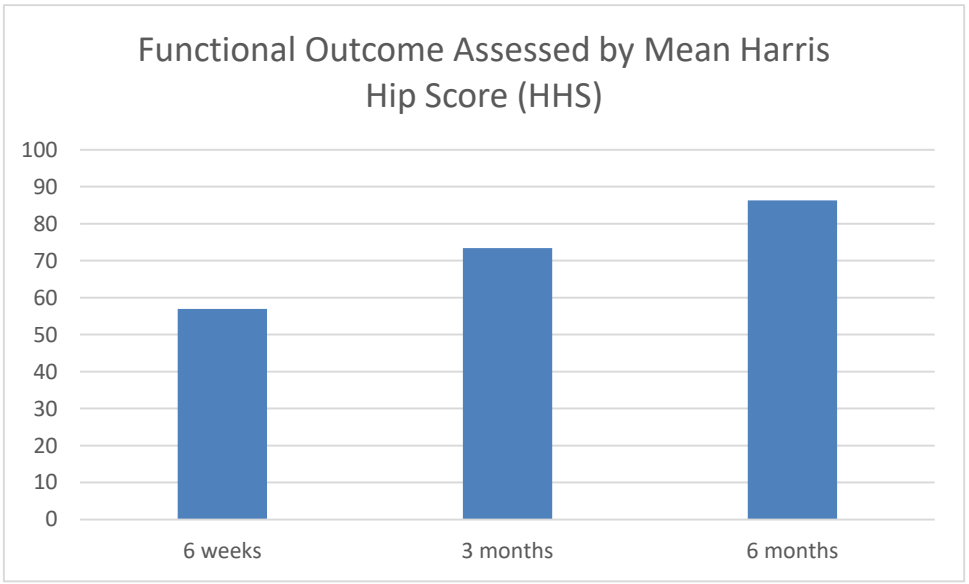

Figure 3: Functional Outcome Assessed by Mean Harris Hip Score

Radiological Outcome Assessed by RUSH Score:

The radiological outcome of the patients was evaluated using the Radiographic Union Score for Hip (RUSH) at different follow-up intervals and is summarized in Table 4 and Figure 4. At 6 weeks follow-up, the mean RUSH score was 14.1 ± 2.0, with radiological union achieved in 6 patients (8.6%). At 3 months, the mean RUSH score improved to 21.2 ± 2.8, and radiological union was observed in 39 patients (55.7%).Further significant improvement was noted at 6 months follow-up, where the mean RUSH score increased to 28.4 ± 1.9, with union achieved in 68 patients (97.1%).

Table 4: Radiological Outcome Assessed by RUSH Score

Follow-up	Mean ± SD	Union Achieved n (%)
6 weeks	14.1 ± 2.0	6 (8.6%)
3 months	21.2 ± 2.8	39 (55.7%)
6 months	28.4 ± 1.9	68 (97.1%)

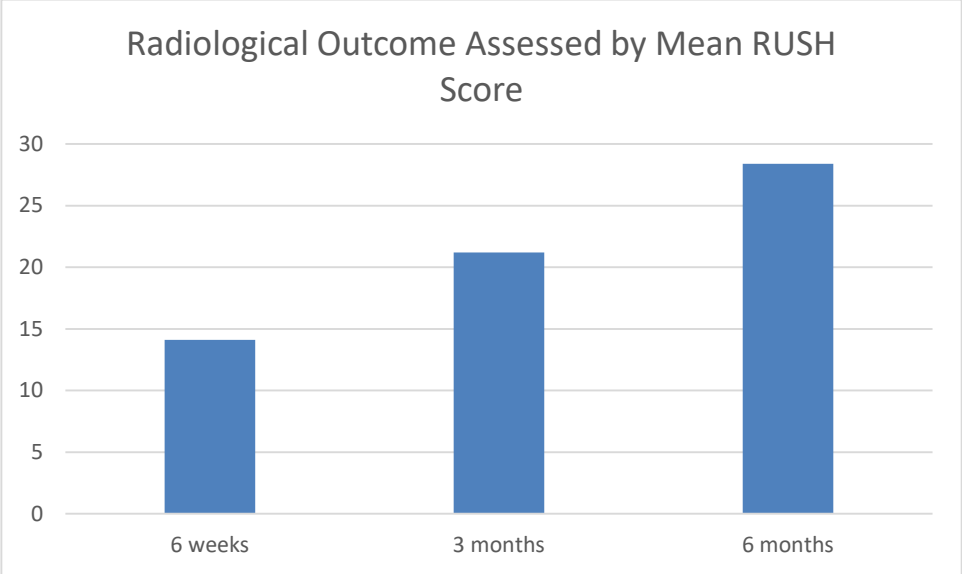

Figure 4: Radiological Outcome Assessed by Mean RUSH Score

Comparison of Functional and Union Outcomes with Previous Studies:

The functional and union outcomes of the present study were compared with previously published studies and are presented in Table 5 and Figure 5. The present study included 70 patients and demonstrated a radiological union rate of 97.1%, with a mean Harris Hip Score (HHS) of 86.3 and an overall complication rate of 7.1%. Mandice et al. (2018), involving 24 patients, reported a union rate of 100%, mean HHS of 88.7, and complication rate of 8.3%. Rashid et al. (2024) observed a union rate of 94.8%, mean HHS of 86.5, and complication rate of 10% among 48 patients. Kapila et al. (2018), in a study of 50 patients, reported a union rate of 92%, mean HHS of 84.4, and complication rate of 12%. Similarly, Bhakat et al. (2013) demonstrated a union rate of 90%, mean HHS of 85.6, and complication rate of 10% among 40 patients.

Table 5: Comparison of Functional and Union Outcomes with Previous Studies

Study	Sample Size (n)	Union Rate (%)	Mean HHS	Complication Rate (%)
Present study	70	97.1	86.3	7.1
Mandice et al., 2018	24	100	88.7	8.3
Rashid et al., 2024	48	94.8	86.5	10
Kapila et al., 2018	50	92	84.4	12
Bhakat et al., 2013	40	90	85.6	10

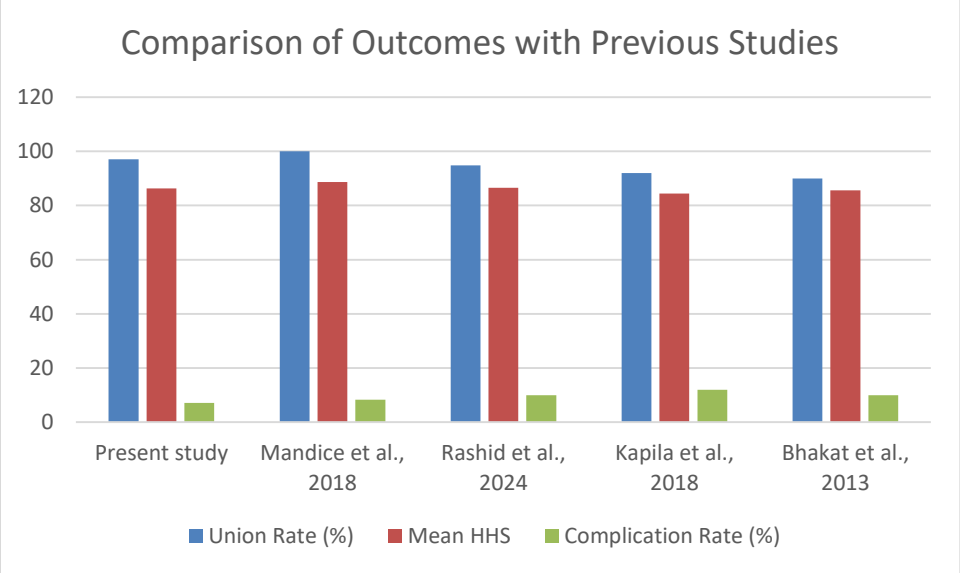

Figure 5: Comparison of Functional and Union Outcomes with Previous Studies

DISCUSSION

Demographic and Clinical Profile

Management of unstable peritrochanteric fractures remains challenging because these injuries are frequently associated with osteoporosis, fracture instability, prolonged immobility, and postoperative complications. Successful treatment primarily depends on achieving stable fixation that allows early rehabilitation and restoration of functional mobility. In the present series, the average age of patients was 52.9 ± 9.8 years, which was comparable with observations reported by Mandice et al. and Rashid et al. [12,13]. The predominance of male patients in our cohort may be attributed to greater exposure to high-energy trauma and occupational activities commonly seen in the Indian population. Low-energy falls constituted the most frequent mechanism of injury (35.7%), supporting previous evidence that osteoporotic fragility plays a major role in the occurrence of these fractures among older individuals. Similar epidemiological trends have also been described by Dhanwal et al. [1].

Operative Parameters and Surgical Advantages

The intraoperative findings observed in the present study further highlight the utility of proximal femoral nailing in the management of unstable peritrochanteric fractures. The mean operative time was 69.2 ± 9.4 minutes, with an average blood loss of 114 ± 24 mL and mean hospital stay of 6.4 ± 1.5 days. Similar operative outcomes have been reported in previous studies evaluating intramedullary fixation techniques, including those by Dousa et al. [6,8]. The relatively shorter operative duration and lower blood loss associated with PFN may be related to its minimally invasive surgical approach and reduced soft tissue handling. In addition, the intramedullary position of the implant provides biomechanical advantages over extramedullary devices such as the dynamic hip screw (DHS) by decreasing the bending moment and improving load-sharing stability across the fracture site [4,8].

Functional Outcome

Functional assessment using the Harris Hip Score demonstrated progressive improvement during follow-up. The mean HHS improved from 56.9 ± 7.8 at 6 weeks to 73.4 ± 5.2 at 3 months and 86.3 ± 5.4 at 6 months ($p < 0.001$). These findings indicate satisfactory restoration of hip function and successful postoperative rehabilitation following PFN fixation. Comparable outcomes have been reported by Mandice et al. (88.7), Rashid et al. (86.5), and Bhakat et al. (85.6) [12-14]. Stable fixation, preservation of fracture biology, and early mobilization likely contributed to the favorable functional recovery observed in the present study. Similar observations regarding functional improvement following PFN fixation have also been documented in previous orthopedic studies [9, 12].

Radiological Outcome

Radiological assessment using the Radiographic Union Score for Hip (RUSH) demonstrated progressive fracture healing throughout follow-up. The mean RUSH score improved from 14.1 ± 2.0 at 6 weeks to 21.2 ± 2.8 at 3 months and 28.4 ± 1.9 at 6 months. Fracture union was achieved in 97.1% of patients at final follow-up, which is comparable with union rates reported in previous studies ranging from 90% to 100%, including studies by Kapila et al., Mandice et al., and Rashid et al. [12-14]. The high union rate may be explained by the biomechanical advantages of PFN, including load-sharing fixation, controlled impaction, and enhanced rotational stability [7, 8].

Complications

The overall complication rate in the present study was 7.1%, which was lower than rates reported in several earlier studies. Superficial infection was the most common complication and was managed conservatively. No cases of deep infection, implant breakage, or major implant failure were encountered. Proper reduction, optimal implant positioning, and maintenance of an appropriate tip-apex distance may have contributed to

the low complication rate. Baumgaertner et al. emphasized the importance of tip-apex distance in preventing fixation failure and screw cut-out complications [5]. Previous studies have similarly identified poor reduction and improper screw placement as important causes of mechanical complications such as screw cut-out and Z-effect phenomenon [4, 5].

The findings of the present study support the role of PFN as an effective fixation modality for unstable peritrochanteric fractures. The implant provides stable fixation, facilitates early mobilization, and achieves favorable functional and radiological outcomes with minimal complications. These advantages are particularly important in elderly patients with osteoporotic bone, where early rehabilitation and restoration of mobility are essential for reducing morbidity and improving quality of life. [1,3]

Certain limitations of the present study should be acknowledged. The study was conducted at a single center with a relatively modest sample size, which may limit generalizability of the findings. In addition, the follow-up duration was limited to six months, preventing assessment of long-term implant-related complications and functional outcomes. The absence of a comparative control group such as DHS or PFNA fixation also limited direct comparison between treatment modalities. Nevertheless, the present study provides valuable prospective evidence supporting the effectiveness of PFN in unstable peritrochanteric fractures.

CONCLUSION

The present study demonstrates that proximal femoral nailing is a safe and effective treatment option for unstable peritrochanteric fractures, providing favorable functional recovery, high union rates, and low complication rates. The biomechanical advantages of PFN contribute to stable fixation and early mobilization, particularly in osteoporotic bone. Further multicentric studies with larger sample sizes and longer follow-up are recommended to validate these findings.

Conflict of Interest: The authors declare no conflict of interest.

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