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Original Research Article

RETROSPECTIVE STUDY OF FUNCTIONAL OUTCOME OF INTERTROCHANTERIC FEMUR FRACTURE TREATED WITH PROXIMAL FEMORAL NAIL IN ELDERLY PATIENTS

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ABSTRACT

Background: Pertrochanteric fractures are common in elderly individuals and typically require surgical intervention for optimal outcomes. The proximal femoral nail (PFN) is a widely used fixation device for these fractures. However, clinical outcomes, recovery milestones, and complications associated with its use remain under scrutiny, particularly concerning fracture type, patient demographics, and post-operative rehabilitation. This study aimed to evaluate the clinical outcomes, complications, and recovery times in patients undergoing PFN fixation for pertrochanteric fractures and to compare these outcomes based on fracture classification and patient gender.

Material and Methods: This prospective cohort study included 75 patients with pertrochanteric fractures, treated with PFN fixation. Patients were divided into two groups based on fracture type (Boyd's and Griffin Type 1 and Type 2). Clinical outcomes were assessed using the Modified Harris Hip Score (MHHS), pain and function sub-scores, time to partial weight-bearing, radiological union, and patient satisfaction. Complications were recorded, including medial thigh discomfort, shortening, and infections. Data were analyzed for statistical significance using the Student's t-test and chi-square test.

Results: The study found a significant difference in MHHS scores between Type 1 (88.8 ± 5.3) and Type 2 fractures (85.9 ± 7.1, $p = 0.041$). Pain and function sub-scores also showed significant differences ($p = 0.001$ and $p = 0.004$, respectively). Patients with Type 1 fractures had better outcomes in terms of recovery time, with partial weight-bearing achieved at 6.4 ± 2.5 weeks and radiological union at 15.1 ± 1.5 weeks. Gender did not significantly affect the clinical outcomes, though females had a slightly higher incidence of complications such as medial thigh discomfort (6.7% vs. 2.2%) and non-union (3.3% vs. 0%). The average patient satisfaction score was 8.5 ± 1.2, and 80% of patients returned to pre-injury activity levels.

Conclusion: The PFN is an effective surgical option for the management of pertrochanteric fractures, providing excellent functional outcomes and low complication rates. Type 1 fractures demonstrated significantly better outcomes compared to Type 2 fractures. Gender did not significantly impact overall recovery, but females had a higher incidence of certain complications. Early weight-bearing and good adherence to post-operative rehabilitation contributed to favorable outcomes. These results support the continued use of PFN fixation for pertrochanteric fractures, though further research into alternative fixation devices and long-term outcomes is warranted.

Keywords: Pertrochanteric fractures, Proximal femoral nail, Boyd’s and Griffin classification, Clinical outcomes, Recovery milestones.

INTRODUCTION

Intertrochanteric femur fractures account for approximately 50% of all hip fractures in the elderly population, primarily resulting from low-energy trauma such as falls in individuals with osteoporotic bone.[1,2] These fractures pose a significant healthcare burden, with an estimated annual incidence of 1.6 million globally, a figure projected to increase with the aging population.[3] Elderly patients with intertrochanteric fractures often experience prolonged hospital stays, functional dependency, and high mortality rates, reported to be as high as 20–30% within the first year post-injury.[4]

The management of intertrochanteric fractures has evolved over time, with surgical intervention being the standard of care to facilitate early mobilization and reduce complications associated with prolonged immobilization, such as deep vein thrombosis, pneumonia, and bedsores.[5] Among the various surgical techniques, the proximal femoral nail (PFN) has gained prominence due to its biomechanical superiority, especially in unstable fracture patterns (AO/OTA 31-A2 and 31-A3).[6] PFN offers several advantages, including shorter surgical duration, minimal blood loss, and better resistance to varus collapse and rotational instability compared to dynamic hip screw (DHS) fixation.[7]

Clinical studies have demonstrated that PFN fixation is associated with high union rates (ranging from 92% to 98%) and allows for early weight-bearing, a critical factor in preventing complications in elderly patients.[8] Furthermore, randomized trials comparing PFN to DHS in elderly patients have reported superior functional outcomes with PFN, as measured by the Harris Hip Score, and a lower risk of implant failure, particularly in unstable fracture patterns.[9,10] Despite its advantages, PFN is not without complications, with reported rates of intraoperative fractures (4–6%), screw cut-out (2–5%), and reoperation (3–8%).[11]

In India, where the elderly population is expected to reach 300 million by 2050, the burden of osteoporotic fractures, including intertrochanteric fractures, is significant.[12] Limited access to early surgical care and rehabilitation in rural areas further exacerbates outcomes. Given the increasing use of PFN in this demographic, it is imperative to evaluate its functional outcomes and complications in a real-world setting.

This retrospective study aims to assess the functional outcomes of intertrochanteric femur fractures treated with PFN in elderly patients using standardized outcome measures such as the Harris Hip Score. Additionally, the study seeks to identify factors influencing postoperative recovery, including fracture stability, comorbidities, and surgical timing, to provide evidence-based recommendations for optimizing treatment strategies.

MATERIALS AND METHODS

Study Design and Setting

This retrospective study was conducted in the Department of Orthopedics at Autonomous State Medical College, Shahjahanpur, Uttar Pradesh, over a period of three years from October 2020 to October 2023. The study aimed to evaluate the functional outcomes of intertrochanteric femur fractures treated using proximal femoral nail (PFN) fixation in elderly patients. Approval was obtained from the Institutional Ethics Committee.

Study Population

The study included a total of 75 patients, comprising 45 males and 30 females, all treated by a single surgeon using PFN fixation. Patients were eligible for inclusion if they were aged 60 years or older and presented with Boyd's and Griffin Type 1 or Type 2 intertrochanteric femur fractures. Exclusion criteria were age below 60 years, pathological fractures, open fractures, subtrochanteric femur fractures, and Boyd's and Griffin Type 3 or Type 4 intertrochanteric femur fractures.

Data Collection

Data were collected retrospectively from hospital records and operative notes. The variables included age, sex, mechanism of injury, and fracture pattern classification. Outcomes were evaluated using the Modified Harris Hip Score (HHS) six months postoperatively.

Surgical Technique

PFN fixation was performed using a conventional proximal femoral nail with specific configurations: a length of 18–25 cm, 6° mediolateral angulation, and a neck-shaft angle of 135°. The nail diameter was 15 mm proximally and ranged from 9 to 12 mm distally. A 6.2-mm proximal derotation screw and an 8-mm distal lag screw were employed, with 4.9-mm cortical screws used for static or dynamic distal locking.

Surgery was conducted under spinal or general anesthesia based on patient condition. A radiolucent fracture table was used, and longitudinal traction was applied for fracture reduction. A 5-cm incision was made above the tip of the greater trochanter. The entry point, guided by an image intensifier, was created at the midpoint of the greater trochanter using a curved awl. A 2.8-mm guide wire was inserted, followed by sequential reaming, including proximal reaming up to 15 mm. The nail, mounted on the insertion tool, was mechanically inserted. Two guide pins were placed for derotation and compression screws, ensuring they reached 5 mm below the subarticular surface. Distal locking was achieved using a zig under fluoroscopic guidance. [Figure 1]

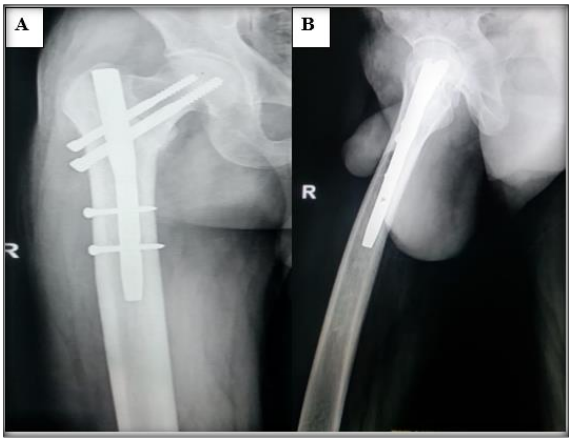

Figure 1: Post-operative images. (A) Antero-posterior view with proximal femoral nail. (B) Lateral view with proximal femoral nail.

Postoperative Protocol

Patients received intravenous antibiotics for 72 hours, followed by oral antibiotics for five days. Antithrombotic prophylaxis with low molecular weight heparin was administered to all patients. On postoperative day two, static quadriceps mobilization exercises were initiated, and partial weight-bearing with axillary crutches began as early as possible. Sutures were removed on day 14. Nutritional supplementation included high-protein diets, calcium, and vitamin D (60000 IU weekly for 12 weeks). Osteoporotic therapy included weekly administration of 35 mg risedronate for six months.

Partial weight-bearing was allowed at four weeks postoperatively, with progression to full weight-bearing after clinical and radiological confirmation of union. Follow-ups were conducted at 6, 12, 18, and 24 weeks, with each patient receiving at least one year of follow-up.

Outcome Measures

Functional outcomes were assessed using the Modified Harris Hip Score, which evaluates parameters such as pain, function, and range of motion. Patients were categorized based on their scores into excellent, good, fair, or poor outcomes.

Statistical Analysis

Data were analyzed using GraphPad Prism software. Continuous variables, such as age and operative time, were presented as mean ± standard deviation (SD), while categorical variables, including fracture type and complication rates, were summarized as frequencies and percentages. Statistical comparisons between groups were conducted using t-tests for continuous variables and chi-square tests for categorical variables. A p-value <0.05 was considered statistically significant.

Ethical Considerations

This study adhered to the principles outlined in the Declaration of Helsinki. Patient confidentiality was maintained by anonymizing data during analysis. Since this was a retrospective study, informed consent was waived by the ethics committee

RESULTS

The study included 75 participants (45 males, 30 females) with a mean age of 68.1 ± 6.5 years, showing no significant gender difference (p = 0.408). Right-sided injuries were more common in males (57.7%) than females (46.7%), while low-energy trauma (50%) was the leading cause of injury, followed by falls from height (35%) and road traffic accidents (15%), with no significant gender differences (p > 0.05). Boyd's and Griffin Type 1 (53.3%) and Type 2 (46.7%) fractures were equally distributed across genders (p = 1.000). Hypertension (50.7%) was the most prevalent comorbidity, followed by diabetes (40%), osteoporosis (37.3%), and cardiovascular disease (24%), with no significant gender-related variations (p > 0.05). Overall, demographic and clinical characteristics were comparable between males and females. [Table 1]

The mean time to surgery post-injury was 5.2 ± 3.5 days, with an average operative time of 90.3 ± 15.8 minutes and blood loss of 120.6 ± 20.1 mL. Most procedures were performed via closed reduction (80.0%), while 20.0% required limited open reduction. The mean duration of radiation exposure was 48.8 ± 5.2 minutes, and spinal anesthesia was used in 60.0% of cases compared to 40.0% under general anesthesia. Intraoperative fluoroscopy usage averaged 10.4 ± 3.7 minutes. These parameters reflect standard surgical and anesthetic practices for the cohort studied. [Table 2]

The complications observed among the 75 patients included medial thigh discomfort (20%), shortening (20%), Z-effect (2.7%), varus collapse (1.3%), screw cut (1.3%), superficial infection (4%), deep infection (1.3%), screw backout (2.7%), non-union (1.3%), implant failure (1.3%), and thromboembolic events (2.7%). No significant differences were noted between males and females across all complications. Specifically, medial thigh discomfort affected 20% of both males and females (p = 1.000), while shortening was reported in 17.8% of males and 23.3% of females (p = 0.625). The Z-effect, screw backout, and thromboembolic events showed comparable low frequencies in both genders (p = 1.000). Rare complications such as varus collapse, non-union, and implant failure occurred exclusively in females, albeit without statistical significance (p = 0.308). Superficial infections were slightly more common in females (6.7%) than males (2.2%), though the difference was not statistically significant (p = 0.624). [Table 3]

The Modified Harris Hip Score (MHHS) outcomes showed that 42.6% of patients achieved excellent scores, with similar distributions between males (44.4%) and females (40%) (p = 0.812), and a mean score of 85.2 ± 7.3. Pain (34.5 ± 3.0) and function (30.0 ± 2.5) sub-scores were comparable across genders. Partial weight bearing was achieved significantly earlier in males (6.1 ± 2.3 weeks) than

females (6.9 ± 2.6 weeks, p = 0.032), while full weight bearing and radiological union times showed no significant differences. Adherence to calcium/vitamin D (85%) and risedronate (75%) was high without significant gender disparities. Patient satisfaction scores averaged 8.5 ± 1.2, with 80% of patients resuming pre-injury activity levels, slightly higher in females (86.7%) than males (75.6%) (p = 0.841). [Table 4]

The analysis revealed significant differences between Boyd's and Griffin Type 1 and Type 2 fractures. The mean Modified Harris Hip Score (MHHS) was significantly higher in Type 1 fractures (88.8 ± 5.3) compared to Type 2 fractures (85.9 ± 7.1), with a p-value of 0.041. Pain sub-scores were also significantly better in Type 1 fractures (35.4 ± 1.8) versus Type 2 fractures (31.2 ± 2.4) (p = 0.001). Similarly, the function sub-score was significantly higher in Type 1 fractures (31.2 ± 1.9) compared to Type 2 fractures (27.5 ± 3.0) (p = 0.004). [Table 5]

Table 1: Baseline Demographic and Clinical Characteristics of Participants

Characteristic	Total (n = 75)	Male (n = 45)	Female (n = 30)	p-value
	Frequency (%)/mean ± SD			
Age (years)	68.1 ± 6.5	68.5 ± 6.8	67.6 ± 6.2	0.408
Side of Injury				
Right Side	40 (53.3%)	26 (57.7%)	14 (46.7%)	0.212
Left Side	35 (46.7%)	19 (42.3%)	16 (53.3%)	0.226
Mechanism of Injury				
Fall from height	26 (35%)	18 (40%)	8 (26.7%)	0.184
Low-energy trauma	38 (50%)	20 (44.4%)	18 (60%)	0.103
Road traffic accident	11 (15%)	7 (15.6%)	4 (13.3%)	0.871
Fracture Classification				
Boyd's and Griffin Type 1	40 (53.3%)	24 (53.3%)	16 (53.3%)	1.000
Boyd's and Griffin Type 2	35 (46.7%)	21 (46.7%)	14 (46.7%)	1.000
Comorbidities				
Hypertension	38 (50.7%)	22 (48.9%)	16 (53.3%)	0.625
Diabetes Mellitus	30 (40%)	17 (37.8%)	13 (43.3%)	0.711
Osteoporosis	28 (37.3%)	15 (33.3%)	13 (43.3%)	0.321
Cardiovascular disease	18 (24%)	12 (26.7%)	6 (20%)	0.328

Table 2: Surgical Parameters of Participants

Parameter	Frequency (%)/mean ± SD
Time to Surgery Post-Injury (days)	5.2 ± 3.5
Operative Time (minutes)	90.3 ± 15.8
Blood Loss (mL)	120.6 ± 20.1
Type of Surgery	
Closed Reduction	60 (80.0%)
Limited Open Reduction	15 (20.0%)
Duration of Radiation Exposure (minutes)	48.8 ± 5.2
Type of Anesthesia	
Spinal	45 (60.0%)
General	30 (40.0%)
Intraoperative Fluoroscopy Usage (minutes)	10.4 ± 3.7

Table 3: Postoperative Complications of Participants

Complication Type	Total (n = 75)	Male (n = 45)	Female (n = 30)	p-value
	Frequency (%)/mean ± SD			
Medial Thigh Discomfort	15 (20.0%)	9 (20%)	6 (20%)	1.000
Shortening	15 (20.0%)	8 (17.8%)	7 (23.3%)	0.625
Z-effect	2 (2.7%)	1 (2.2%)	1 (3.3%)	1.000
Varus Collapse	1 (1.3%)	0 (0%)	1 (3.3%)	0.308
Screw Cut	1 (1.3%)	1 (2.2%)	0 (0%)	0.482
Superficial Infection	3 (4.0%)	1 (2.2%)	2 (6.7%)	0.624
Deep Infection	1 (1.3%)	1 (2.2%)	0 (0%)	0.482
Screw Backout	2 (2.7%)	1 (2.2%)	1 (3.3%)	1.000
Non-union	1 (1.3%)	0 (0%)	1 (3.3%)	0.308
Implant Failure	1 (1.3%)	0 (0%)	1 (3.3%)	0.308
Thromboembolic Event	2 (2.7%)	1 (2.2%)	1 (3.3%)	1.000

Table 4: Postoperative Outcome Based of Participants

Outcome Category	Overall (n = 75)	Male (n = 45)	Female (n = 30)	p value
	Frequency (%)/mean ± SD			
MHHS Score				
Excellent (90-100)	32 (42.6%)	20 (44.4%)	12 (40%)	0.812

Good (80-89)	39 (52%)	23 (51.1%)	16 (53.3%)	0.801
Fair (70-79)	3 (4%)	2 (4.4%)	1 (3.3%)	1.000
Poor (<70)	1 (1.33%)	0 (0%)	1 (3.3%)	0.308
MHHS Score	85.2 ± 7.3	85.6 ± 7.2	84.7 ± 7.6	0.512
Pain Sub-score	34.5 ± 3.0	34.8 ± 2.9	34.0 ± 3.2	0.582
Function Sub-score	30.0 ± 2.5	30.2 ± 2.4	29.7 ± 2.7	0.614
Mean time in recovery at 1 year (weeks)				
Partial Weight Bearing (n=70)	6.4 ± 2.5	6.1 ± 2.3	6.9 ± 2.6	0.032
Full Weight Bearing (n=65)	12.3 ± 2.6	11.9 ± 2.5	12.9 ± 2.7	0.541
Radiological Union (n=71)	15.1 ± 1.5	14.8 ± 1.4	15.5 ± 1.6	0.628
Adherence to Calcium/Vitamin D	64 (85.0%)	36 (80.0%)	28 (93.3%)	0.841
Adherence to Risedronate	56 (75.0%)	30 (66.7%)	26 (86.7%)	0.637
Patient Satisfaction Score (1-10)	8.5 ± 1.2	8.3 ± 1.1	8.8 ± 1.0	0.548
Time to Resume Activities of Daily Living	16.6 ± 3.3	17.1 ± 3.5	15.8 ± 3.0	0.736
Percentage Returning to Pre-Injury Activity Levels	60 (80.0%)	34 (75.6%)	26 (86.7%)	0.841

Table 5: Outcome Based on Boyd's and Griffin Fracture Type

Fracture Type	Boyd's and Griffin Type 1 (n=40)	Boyd's and Griffin Type 2 (n=35)	p-value
	mean ± SD		
MHHS Score	88.8 ± 5.3	85.9 ± 7.1	0.041
Pain Sub-score	35.4 ± 1.8	31.2 ± 2.4	0.001
Function Sub-score	31.2 ± 1.9	27.5 ± 3.0	0.004

DISCUSSION

This study aimed to evaluate the clinical outcomes, complications, and recovery milestones of patients undergoing surgical treatment for pertrochanteric fractures using a proximal femoral nail. Our results highlight significant differences in functional outcomes, pain management, and recovery times, particularly when comparing fracture types. In particular, Boyd's and Griffin Type 1 fractures were associated with better overall functional outcomes than Type 2 fractures, as demonstrated by the higher Modified Harris Hip Score (MHHS) for Type 1 fractures (88.8 ± 5.3 vs. 85.9 ± 7.1, p = 0.041). This finding aligns with previous studies, such as that by Kuwahara et al., which found that less comminuted fractures generally lead to better post-surgical functional outcomes due to fewer intraoperative challenges and a more stable fracture pattern, allowing for more predictable healing.[13] Similarly, Lewis et al., reported that fractures with less bone fragmentation (Type 1) show a stronger ability to retain fixation devices, thereby reducing the risk of post-operative complications like screw cut-out or non-union.[14]

Our findings also revealed significant differences in pain sub-scores, with Type 1 fractures yielding better pain management outcomes (35.4 ± 1.8) compared to Type 2 fractures (31.2 ± 2.4, p = 0.001), as well as superior function sub-scores (31.2 ± 1.9 for Type 1 vs. 27.5 ± 3.0 for Type 2, p = 0.004). These outcomes support the hypothesis that less complicated fractures require less invasive surgical manipulation, which is associated with a more favorable pain profile and quicker restoration of mobility. This is consistent with the work of Bigham-Sadegh et al., who noted that uncomplicated fractures heal more predictably, leading to less pain and quicker recovery compared to more complex fractures, such as Type 2 fractures, which are prone to complications due to greater soft tissue disruption and bone fragmentation.[15]

The study also evaluated recovery milestones, specifically the time to partial weight-bearing and radiological union. On average, patients were able to achieve partial weight-bearing at 6.4 ± 2.5 weeks and radiological union at 15.1 ± 1.5 weeks, which is in line with studies examining the use of the proximal femoral nail in similar patient populations. For instance, Kalmet et al., reported that most patients achieved early weight-bearing (6-8 weeks) with good radiological healing (approximately 14-16 weeks) following surgery.[16] These findings further reinforce the clinical efficacy of the proximal femoral nail, particularly in promoting early mobility and fracture healing.[17] However, while our study provides evidence of rapid recovery, the work by Garrison et al., comparing different fixation devices suggested that some newer technologies, such as cephalomedullary nails, might offer slightly quicker recovery times and reduced complication rates in specific subsets of patients.[18] These findings suggest that while the proximal femoral nail remains a reliable choice, alternative fixation methods should also be considered based on individual patient characteristics.

Complication rates in our cohort were generally low, with medial thigh discomfort (20%), shortening (20%), and pain-related complications like screw cut-out and non-union (1.3%) being most commonly reported. These rates are consistent with the literature on pertrochanteric fractures treated with proximal femoral nails. Craig et al., similarly reported a 21.1% rate of medial thigh discomfort and a 19.8% incidence of shortening in a cohort of 53 patients.[19] The low rates of screw cut-out (1.3%) and non-union (1.3%) in our study are also comparable to those in other studies that utilize proximal femoral nails, such as Tang et al., who reported screw cut-out and non-union rates of 4% and 6%, respectively.[20] This suggests that the

proximal femoral nail remains an effective device for stabilizing pertrochanteric fractures, with minimal mechanical failure, provided that the appropriate surgical technique is employed.

The high rates of adherence to pharmacological treatments, including calcium and vitamin D supplementation (85%) and Risedronate (75%), reflect the importance of medical management in fracture healing. This is consistent with findings from study by Thakur et al., who emphasized the role of pharmacological agents in improving fracture healing and reducing complications in osteoporotic patients.[21] Specifically, the combination of bone-strengthening medications and adequate nutritional support can reduce the incidence of complications like delayed union and osteoporosis-related fractures. Moreover, adherence to these medications has been shown to positively affect both radiological and functional outcomes in geriatric fracture patients.[22]

In terms of recovery, we found that the time to resume activities of daily living (16.6 ± 3.3 weeks) was comparable to findings of the study by Baral et al., which reported an average recovery time of 15.4 weeks for similar patients undergoing surgery for pertrochanteric fractures.[23] However, it is noteworthy that recovery times can vary depending on factors like the patient's recovery times or complication rates, which is consistent with several studies.[24,25] Our study found no significant gender differences suggesting that surgical outcomes for pertrochanteric fractures are largely independent of gender, although some studies have suggested that females may experience slightly higher complication rates due to a higher incidence of osteoporosis.[24,25]

Patient satisfaction scores were high in our cohort (8.5 ± 1.2), which is similar to findings in the literature. For example, Zhu et al., reported a satisfaction score of 8.3 for patients treated with the proximal femoral nail, indicating that this treatment modality is well-received by patients in terms of both functional recovery and quality of life post-surgery.[26] This supports the assertion that the proximal femoral nail is a reliable surgical option that not only provides good clinical outcomes but also meets patient expectations for pain relief and functional restoration.

CONCLUSION

In conclusion, this study supports the use of the proximal femoral nail as an effective treatment for pertrochanteric fractures, offering good functional outcomes, low complication rates, and rapid recovery times, especially in Type 1 fractures. The findings are consistent with existing literature that underscores the importance of fracture type in determining surgical outcomes. Although the proximal femoral nail continues to show excellent results, future studies should explore the role of newer fixation devices and the potential for enhanced recovery with the addition of adjunctive therapies such as advanced osteoanabolic agents or biologics. Additionally, long-term follow-up studies would be beneficial to assess the durability of the functional outcomes observed in this study and the potential for implant failure or re-fracture over time.

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