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Original Research Article

Outcome Analysis of Intertrochanteric Femoral Fractures Managed with Proximal Femoral Nailing

Sushil Kumar Singh

Assistant Professor and HOD, Department of Orthopaedics, Jannayak Karpoori Thakur Medical College and Hospital, Madhepura, Bihar, India

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Corresponding Author: Dr. Sushil Kumar Singh
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Abstract:

Background: Intertrochanteric fractures frequently occur in the elderly, especially in women with osteoporosis, and typically arise from low-energy trauma. Conservative management is associated with complications, making surgical fixation the preferred approach. Among implants, the proximal femoral nail (PFN) offers superior biomechanical stability, particularly in unstable fractures.

Aim: To assess the clinical and radiological results of PFN fixation in intertrochanteric fractures, with a particular focus on postoperative mobility utilising Kyle's criteria.

Methodology: A prospective observational analysis was performed on 80 patients with intertrochanteric fractures at the Department of Orthopaedics, Jannayak Karpoori Thakur Medical College and Hospital, Madhepura, Bihar, India from March 2023 to February 2024. Patients had PFN fixation and were monitored for functional recovery. Statistical analysis was conducted on the data, with significance established at $p < 0.05$.

Results: According to OTA classification, unstable fractures (31A2 and 31A3) comprised 62% of cases. Postoperative complications occurred in 25% of patients, with superficial infection and implant failure being most frequent (3.75%). Functional outcomes were favourable, with 40% achieving excellent, 30% good, 20% fair, and 10% poor results per Kyle's criteria.

Conclusion: PFN provides effective fixation for intertrochanteric fractures, ensuring stable union and satisfactory functional recovery. Despite a moderate complication rate, careful surgical technique and follow-up optimize outcomes.

Keywords: Intertrochanteric Fracture, Proximal Femoral Nail, Osteoporosis, Kyle's Criteria, Functional Outcome.

Introduction

Intertrochanteric fractures are one of the leading problems for the elderly population likely due to decreasing bone mineral density, and/or increased risk of falls, with age. It is reported that intertrochanteric fractures occur 3-4 times more often in older women than men, likely due to the high prevalence of postmenopausal osteoporosis in women. The mode of injury is generally low energy trauma, almost exclusively from a small fall from standing height; although, high energy trauma does occur [1].

Conservative treatment of fractures can achieve fracture union; however, complications such as coxa vara, medialization of the shaft, malunion and abnormal external rotation may lead to limb shortening, a persistent limp, and reduced quality of life. Therefore, the treatment goal in such individuals should be to obtain stable fixation that allows for early mobilization and minimizes the risk of other complications (pneumonia, pressure sores, urinary tract infections, and deep vein thrombosis) often associated with prolonged immobilization [2].

Over the years, numerous surgical procedures and equipment have emerged for the surgical management of intertrochanteric fractures. The selection of the internal fixation device will be contingent upon the fracture configuration, bone integrity, and the patient's health status. Of the mentioned devices to treat intertrochanteric fractures, the extramedullary devices, (such as, dynamic hip screw (DHS) fixation) are the main devices and have been reported to be easy to use as well as effective devices for stable fractures. The intramedullary of the mentioned devices to treat intertrochanteric fractures, the extramedullary devices, (such as, dynamic hip screw (DHS) fixation) are the main devices and have been reported to be easy to use as well as effective devices for stable fractures. The intramedullary devices (Gamma nail, proximal femoral nail, 'PFN') are reported to provide superior biomechanical stability

and reported reduction in failure rate and improved functional outcomes to unstable fracture patterns [3].

The PFN is increasingly preferred for treating unstable and osteoporotic fractures due to its minimal invasiveness, shorter lever arm, and the ability to control axial and rotational forces [4]. Therefore, surgical intervention with modern intramedullary implants is now the treatment of choice for effective early rehabilitation and functional recovery of elderly patients.

The dynamic hip screw (DHS) has been considered the gold standard for intertrochanteric fractures due to its efficacy and relative simplicity of surgical technique. However, it is associated with several disadvantages, particularly femoral neck collapse, which is associated with loss of hip offset, leg length discrepancy, and loss of hip biomechanics [5]. Although it is anticipated that there will be sliding and compression at the fracture site to achieve an optimal healing environment, unexplainable, excessive collapse can lead to functional limitations and pain, in addition to mobility decrease. Due to these disadvantages, there have been sufficient efforts toward investigating fixation devices that can provide increased stability while limiting these complications, particularly in the case of unstable fracture patterns in the case of osteoporotic bone [6].

Distinct from the previous treatment methods, the Proximal Femoral Nail (PFN) was introduced in 1996 as a novel treatment option with the benefits of intramedullary fixation using a more minimally invasive technique. Biomechanically, the PFN creates a shorter lever arm and effectively increases load sharing capacity, ultimately providing improved stability, especially in unstable and comminuted fractures. The PFN has been shown in multiple clinical studies to have favorable outcomes when compared to other modalities, particularly with respect to early mobility, blood loss, and rate of implant failure in unstable types of fractures [7].

Nonetheless, the literature also presents contradictory findings, with certain findings emphasizing increased risk of complications associated with PFN, with respect to technical insertion errors, femoral shaft fractures, and iatrogenic problems with the implant [8]. Therefore, while PFN has various biomechanical and operative advantages over DHS, its effectiveness will depend upon various factors such as appropriate patient selection, surgical expertise, and fracture configuration.

Results of utilizing the proximal femoral nail (PFN) in the management of intertrochanteric fracture will be interpreted by analyzing the various factors influencing postoperative mobility, according to Kyle's classification method. The PFN is an intramedullary device, with various mechanical advantages when compared with traditional extramedullary implants, including a reduced bending moment, limited soft tissue dissection, and early mobilization, [9] which is another area the PFN advantages remain in the setting of unstable fracture patterns and/or osteoporosis in elderly patients who are generally regarded as high-risk with devices that are completely outside of the intramedullary canal. In the present study, we have analyzed functional outcomes with specific emphasis on mobility return utilizing criteria based on Kyle's principles in assessing functional outcomes that respect current dogma of functional union, not only the radiographic union assessed in relation to quality of life after surgery [10].

Post-operative mobility is a notable indicator of a patient's ability to regain independence and resume other activities of daily life. Recovery will also remain influenced by the patient's age, quality of bone, type of fracture, surgical techniques and timing of mobilization. However with a systematic deliberation of all of these variables, we have surmised how PFN may impact recovery through improvement of stabilization and reduction of the potential for implant failure leading to better rehabilitation [11]. Kyle's criteria permit an objective and standard assessment of mobility outcomes so that clinical applicability and objective comparison can be made. Therefore, our findings present evidence to support the effectiveness of PFN in studying both radiological union and functional recovery in patients sustaining intertrochanteric fractures.

Methodology

Study Design: This study was designed as a prospective observational study to evaluate the functional and radiological outcomes of proximal femoral nail (PFN) fixation in patients with intertrochanteric fractures of the femur.

Study Area: The research was carried out in the Department of Orthopaedics at Jannayak Karpoori Thakur Medical College and Hospital in Madhepura, Bihar, India from March 2023 to February 2024.

Study Participants

Inclusion Criteria

- Patients aged 20 years and above with radiologically confirmed intertrochanteric fractures of the femur.
- Patients are willing to give informed consent and comply with follow-up.
- Patients are medically fit for surgery.

Exclusion Criteria

- Pathological fractures are other than those due to osteoporosis.
- Patients with associated polytrauma or fractures in the ipsilateral limb.
- Patients with previous hip surgeries.

- Patients are unfit for aesthesia or surgery.

Sample Size: A total of 80 patients fulfilling the eligibility criteria were included in the study.

Procedure: All patients admitted with intertrochanteric fractures were clinically evaluated, and diagnosis was confirmed using plain radiographs of the pelvis with both hips and lateral view of the affected hip. After obtaining written informed consent, patients were optimized for surgery with routine investigations and preoperative assessments. All patients underwent fixation with a proximal femoral nail under spinal or general anesthesia as per anesthesiologist's discretion. The standard surgical technique was followed, including closed reduction on a fracture table under C-arm guidance, followed by insertion of PFN using appropriate instrumentation. Postoperatively, patients were managed with antibiotics, analgesics, and physiotherapy protocols. Early mobilization was encouraged depending on patient tolerance. Follow-up was carried out at regular intervals to assess fracture union, complications, and functional outcome using Kyle's criteria.

Statistical Analysis: The collected data were compiled and analyzed using Statistical Package for Social Sciences (SPSS) software version XX. Descriptive statistics such as mean, standard deviation, and percentages were used to summarize the data. Categorical variables were assessed using the Chi-square test, whilst continuous variables were evaluated with Student's T-test. A p-value of less than 0.05 was deemed statistically significant.

Result

Table 1 illustrates the distribution of intertrochanteric fractures in accordance with the Orthopaedic Trauma Association (OTA) classification among 80 patients. The majority of fractures were classified as 31A2, representing unstable fractures, accounting for 32 patients (40%). Stable fractures, categorized as 31A1, were observed in 30 patients (38%), while 18 patients (22%) had 31A3 fractures, characterized as unstable or reverse oblique patterns. Overall, this indicates that unstable fracture patterns (31A2 and 31A3) were slightly more prevalent than stable ones, highlighting the predominance of complex fracture types in this patient cohort.

Table 1: Fractures Categorised According to the Orthopaedic Trauma Organisation Classification

Fracture Pattern	Number of Patients	Percentage (%)
31A1 – Stable	30	38
31A2 – Unstable	32	40
31A3 – Unstable/Reverse Oblique	18	22
Total	80	100

Table 2 of 80 patients, a total of 20 individuals (25%) experienced postoperative complications following treatment. The most common complications were superficial infection and implant failure, each affecting 3 patients (3.75%). Other complications, including inadequate reduction, failure to insert the de-rotation screw, difficulty in distal locking, varus deformity, shortening, Z-effect, and malunion, were observed in 2 patients each, representing 2.5% of the sample. Overall, the distribution of complications indicates that while most patients tolerated the procedure well, a notable minority encountered technical or surgical issues, emphasizing the importance of careful surgical technique and postoperative monitoring.

Table 2: Possible complications (n = 80)

Complication	Number of Patients	Percentage (%)
Failure to insert de-rotation screw	2	2.5
Inadequate reduction	2	2.5
Difficulty in distal locking	2	2.5
Varus deformity	2	2.5
Shortening	2	2.5
Superficial infection	3	3.75
Implant failure	3	3.75
Z-effect	2	2.5
Malunion	2	2.5
Total	20	25

Table 3 assessed using Kyle's criteria indicates that the majority of patients achieved favorable outcomes following treatment. Specifically, 40% of the participants were rated as having an excellent outcome, while an additional 30% were classified as good, together accounting for 70% of the study population demonstrating satisfactory recovery. A smaller proportion experienced fair outcomes (20%), and only 10% of patients were categorized as poor, reflecting minimal cases of suboptimal results.

Overall, these findings suggest that the intervention was largely effective, with most patients attaining significant functional improvement.

Table 3: Results according to Kyle's criteria	
Results	**Number (%)**
Excellent	32 (40%)
Good	24 (30%)
Fair	16 (20%)
Poor	8 (10%)

Discussion

In this study, 80 patients with intertrochanteric fractures were observed and classified using the Orthopaedics Trauma Association (OTA) classification system. Results demonstrated that 31A2 fractures, or unstable fracture patterns, were the most prevalent, occurring in 40% of people, followed closely by stable 31A1 fractures at 38%. The least common pattern was 31A3 fractures, which are defined as unstable or reverse oblique fractures, and which occurred in 22% of patients. The results of the study suggest that complex and unstable fractures, particularly unstable fractures in the young population (high energy trauma) and osteoporotic fractures (elderly), were quite common in our cohort, which is consistent with earlier studies in Orthopaedics literature.

Complications developed in 25% of the samples, indicating that while most of the patients underwent the procedure well, we need to remain vigilant for technical, or operative, complications. The complications that were most often experienced were superficial infections and implant failures, which each occurred in 3.75% of the cohort. There were non-implant failures that were stratified almost to a more detailed extent as well, meaning that inadequate reduction, distal locking complications, varus angulation complications, shortening or Z- effect complications, and malunion complications all were the result of 2.5% of the study sample. This data led us to think that when we stayed true to surgical principles that were taught to each of us, giving every patient adequate time for planning, and evaluated their surgical results post-operatively we were able to minimize complications. Wolfgang et al., 1982 [12] described mechanical complications in 9% of stable intertrochanteric fractures, and 19% in unstable intertrochanteric fractures with sliding screw plates.

Evaluation of functional outcomes based on Kyle's criteria yielded favorable findings. Overall, 40% of subjects experienced excellent outcomes, whereas an additional 30% achieved good function. Thus, even with the injury of complex-fracture types and a high complication rate, approximately 70% of patients demonstrated satisfactory recovery after surgical stabilization. The remaining fair and poor outcomes were 20% and 10%, respectively. Therefore, functional outcomes in the setting of complex fracture types and high complication rates demonstrated functional gains in many patients after treatment, which suggests pacing of overall rehabilitation. Simpson et al., (1989) [13] determined the causes of fixation failure in intertrochanteric fractures as follows: Plate extraction from the lateral cortex together with the screws; plate fracture and screw disengagement from the femoral head.

An assessment of fracture stability as it pertains to functional outcomes shows that patients with stable fractures (31A1) tend to have better outcomes compared to patients with unstable fractures (31A2 and 31A3) who are typically at risk for comorbidities and less favorable outcomes. This aligns with existing evidence from the Orthopaedics literature demonstrating that instability of a fracture is an important variable in postoperative recovery, mechanical failure, and the need for accurate reduction and fixation. Gotfried. (2012) [14] discovered fractures that were previously categorized as category 3. Preoperatively, type 1.A.2 may advance to type 3. Postoperative fractures. 2.A.3 arising from lateral cortical fractures. He ascribed the fracture of the lateral cortex to the deterioration of the bone caused by the utilisation of a 16 mm diameter lateral cortex drill for the insertion of the sliding screw.

The complication profile presented in this study demonstrates some common complications associated with the proximal femoral nail (PFN) technique, including technical issues like distal locking and Z-effects. These complications are generally relatively uncommon, and while they can affect functional recovery, if they are recognized and addressed in a timely fashion, the outcome is improved. Therefore, good preoperative planning, intraoperative imaging, and surgical protocols could indeed further reduce complications and optimize outcome in the event of unstable fracture patterns. According to Friedl et al.,s (1994) [15], the necessary over-reaming of the shaft (3 mm greater than the diameter of the nail) offers a risk to the integrity of the entire shaft. Drilling may also be a contributing factor, as frequent drilling for an adequate distal interlocking was due to a misaligned targeting device torque to the nail when it was locked in a less-adequately reamed shaft [16].

In conclusion, this study demonstrates proximal femoral nails are a safe treatment for intertrochanteric fractures with good to excellent levels of function for patients. There are stable and unstable fractures which will develop complications, although maintaining proper surgical technique and postoperative care enhances the best level of recovery we can provide for our patients. The data demonstrated that PFN is a surgical treatment option for both stable and unstable fractures and that applying a planned individualized approach to patients resulted in better patient outcomes.

Conclusion

This investigation identified proximal femoral nails (PFN) as a reliable and effective treatment option for intertrochanteric fractures, particularly in older populations with osteoporosis and unstable fracture types. Functional recovery was favorable for many of our patients, with 70% rated as excellent or good on Kyle's criteria, which shows the biomechanical benefits of PFN in providing stability and early mobilization. However, our data provides a moderate complication rate of 25%, yet the complication rates of superficial infection and device failure were reasonably low and responsive to postoperative care. Our findings are consistent with prior literature recommending PFN as superior to the extramedullary device for unstable fracture patterns. Fixation with PFN is dependent on surgical technique, patient selection, and rehabilitation, all of which are very important to the patient's outcome. Overall, PFN is a reasonable treatment option to provide stable union, low morbidity, and increased functional independence following intertrochanteric fractures.

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