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Evaluating functional recovery following proximal femoral nail fixation in proximal femoral fractures: a study from a developing nation

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ABSTRACT

Background: Intramedullary fixation systems have become increasingly favoured over conventional dynamic hip screws in the treatment of proximal femoral fractures. This shift is attributed to several key benefits, including reduced soft tissue trauma, shorter operative times, and enhanced biomechanical properties.
Methods: A prospective randomised study was carried out at Dayanand Medical College and Hospital Ludhiana, India between January 2016 and January 2017, with proximal femoral fractures. Exclusion criteria included paediatric cases, pathological or neglected fractures, periprosthetic fractures, and femoral neck fractures. The primary aim was to evaluate fracture union and functional recovery, while secondary outcomes focused on identifying any postoperative complications.
Results: Among the 35 participants (19 males and 16 females), the average age was 59.8 years. Subtrochanteric fractures were more prevalent in older individuals, with a higher incidence on the left side. Domestic falls accounted for 52% of the injuries, while 48% resulted from road traffic accidents. The surgical procedure involved an average blood loss of 197 ml and lasted approximately 142 minutes. Fracture union was achieved in 95.23% of the cases, while implant failure was observed in 9.52%. Functional assessments showed that 68% of patients had excellent to good recovery outcomes, with minimal complications reported postoperatively.
Conclusions: Proximal femoral nail (PFN) provides secure fixation with high union rate and positive functional outcomes reinforcing its preference over traditional extramedullary fixation methods. Further comparative analyses are required with larger sample sizes to refine the choice of fixation for different fracture types.

Keywords: Proximal femoral fracture, Proximal femoral nail, Intertrochanteric fracture fixation, Internal fixation

INTRODUCTION

Over the last twenty years, the dynamic hip screw (DHS) has been widely used as the standard implant for stabilizing intertrochanteric femoral fractures.[1] While effective, its use is sometimes associated with complications such as limb shortening and inward displacement of the distal bone fragment, often resulting from excessive lag screw movement within the barrel of the plate. Other reported issues include screw migration, disengagement from the femoral shaft, failure of the implant, and joint penetration, with failure rates reported as high as 20%.[2]

Intramedullary fixation systems provide several key advantages. These include the possibility of performing

closed reduction, reduced disruption to surrounding soft tissues, and a more biologically favourable fixation approach. Such features often contribute to shorter operative times, less intraoperative blood loss, and quicker postoperative recovery with earlier patient mobilization.[2] From a biomechanical perspective, intramedullary implants benefit from a shorter lever arm, which helps lower the mechanical load and bending forces on the device. Their central position within the bone allows them to act as load-sharing constructs, enabling early weight-bearing and improved fracture stability. This central positioning also limits excessive fragment movement, thus reducing the risk of limb shortening or malalignment as the fracture heals through contact between the proximal fragment and the nail. Additionally, the design often incorporates a sliding screw mechanism, which allows for controlled compression at the fracture site while preserving stability.[2,3]

The purpose of this study is to assess the clinical outcomes of the proximal femoral nail (PFN) in managing proximal femoral fractures and to compare its effectiveness in treating subtrochanteric versus intertrochanteric fracture patterns.

METHODS

Study design

This prospective study analyzed the role of the PFN in the treatment of proximal femoral fractures. It was conducted at Dayanand Medical College and Hospital Ludhiana, India from January 2016 to January 2017, the study involved 35 patients with proximal femoral fractures.

Inclusion criteria

The study included adults aged 30-80 years with subtrochanteric or intertrochanteric fractures.

Exclusion criteria

Exclusion criteria comprised pathological fractures, fractures in children, old neglected fractures, periprosthetic fractures, and femoral neck fractures.

Outcome

The primary objectives were to assess union and functional outcomes, with a secondary aim to record any complications. Patients were regularly followed up to evaluate fracture healing and functional outcomes.

Data collection

Routine preoperative investigations included blood tests (hemoglobin percentage, bleeding time, clotting time, blood grouping and cross-matching, fasting and postprandial blood sugar, blood urea, and serum creatinine), urine tests (albumin, sugar, and microscopic examination), and X-rays (pelvis with both hips anteroposterior view and chest X-ray posteroanterior view where necessary). All patients were evaluated for associated medical problems and referred to the respective departments for treatment/optimization. Informed written consent was obtained from all patients. Associated injuries were evaluated and treated simultaneously. Patients were operated on an emergency basis as soon as possible after minimizing avoidable anesthetic risks (<72 hours).

Operative technique

For the operative technique, patients were positioned supine on a fracture table with the affected limb adducted by 10-15 degrees, followed by closed reduction of the fracture using traction and internal rotation. The image intensifier was set to capture anterior-posterior and lateral views of the hip and femur. The patient was then prepared and draped according to standard hip fracture fixation protocols, with prophylactic antibiotics administered 30 minutes before surgery. A 5 cm longitudinal incision was made proximal to the tip of the greater trochanter. The fascia lata was incised paralleled, and the gluteus medius was split along its fibers to expose the tip of the greater trochanter. In the anterior-posterior view on the C-arm, the entry point was made on or slightly lateral to the tip of the greater trochanter. The entry point was then enlarged with a reverse bone all over the guide wire.

Figure 1: Intraoperative imaging for a patient scheduled for femoral nailing.

Using a 17.0 mm cannulated conical reamer, the proximal femur was reamed over the guide wire through a protection sleeve. For standard/short PFNs, the proximal femur was manually reamed to about 7 cm. For long PFNs, the distal femur was also reamed with incrementally larger reamers. After ensuring satisfactory fracture reduction, the appropriate size nail was assembled to the insertion handle and manually inserted with slight twisting movements, avoiding hammering. The correct nail insertion depth was achieved when the future position of the femoral neck screw was just above the calcar in the distal half of the femoral neck. A 2.8 mm guide wire was inserted through a drill sleeve after a stab incision and placed 5 mm deeper

than the planned screw size. The correct position of the femoral neck screw tip was 5-10 mm from the subchondral bone. A second 2.8 mm guide wire was inserted for the hip pin, positioned approximately 10 mm less than the femoral neck screw guide wire or 20-25 mm less deep to act as an anti-rotation screw.[4]

Drilling was performed over the 2.8 mm guide wire until 8 mm short of the guide wire tip, using a 6.5 mm cannulated drill bit for the hip pin and an 11 mm bit for the femoral neck screw. The neck screw, being self-tapping, did not require tapping. It was inserted using a cannulated screwdriver, followed by the hip pin. Length and position were confirmed with C-arm imaging. Distal locking was achieved either statically or dynamically, depending on the fracture type. Perioperatively, patients' vital signs were monitored, and foot-end elevation was provided. Intravenous antibiotics were administered for 3 doses postoperatively, followed by oral antibiotics for 5 days. Analgesics were given as needed, and blood transfusions were provided based on requirements. Sutures were and patients were discharged to physiotherapy rehabilitation for full weight bearing.[4]

Follow-up

Follow-up evaluations occurred at 4 weeks, 12 weeks, and every 6 weeks until fracture union was noted, and subsequently at 6 months, 9 months, and 1 year. At each visit, patients were assessed for signs of local inflammation or infection, hip and knee function, walking ability, fracture union, deformity, and shortening. Secondary surgical procedures, if necessary, were also analyzed. Hip function was assessed using the Salvati and Wilson score system. X-rays of the hip and thigh were taken to assess fracture union and implant-bone interaction.

Statistical analysis

Statistical analysis was performed using IBM statistical package for the social sciences (SPSS) statistics, version 24.0 (IBM Corp., Armonk, NY). The one-sample Kolmogorov-Smirnov test was used to check data distribution, and the Mann-Whitney U test was used to compare parameters between the two groups. A p value of <0.05 was considered statistically significant.

RESULTS

Data were collected from a study of 35 cases of proximal femoral fractures. A total of 19 patients with subtrochanteric fractures and 16 patients with intertrochanteric fractures completed the follow-up. The mean age for patients with subtrochanteric fractures was 60.53 years (range: 30-90 years), and for those with intertrochanteric fractures, it was 57.50 years (range: 40-70 years). The study showed a higher prevalence of subtrochanteric fractures among the elderly. Of the 35 patients, 19 were male (54.28%) and 16 were female (45.72%).

Males accounted for 52.63% of subtrochanteric fractures and 66.67% of intertrochanteric fractures, though the gender distribution was statistically insignificant (p>0.05). The left side was more frequently injured, with 16 patients (68.42%) having subtrochanteric fractures and 5 patients (33.33%) having intertrochanteric fractures, totaling 21 patients (60.00%).

Subtrochanteric fractures were classified according to the AO classification, with the majority (68.5%) being B2.1. For intertrochanteric fractures, the Boyd and Griffin classification was used, and more than half (56.3%) were grade IV (Figure 2a and b).

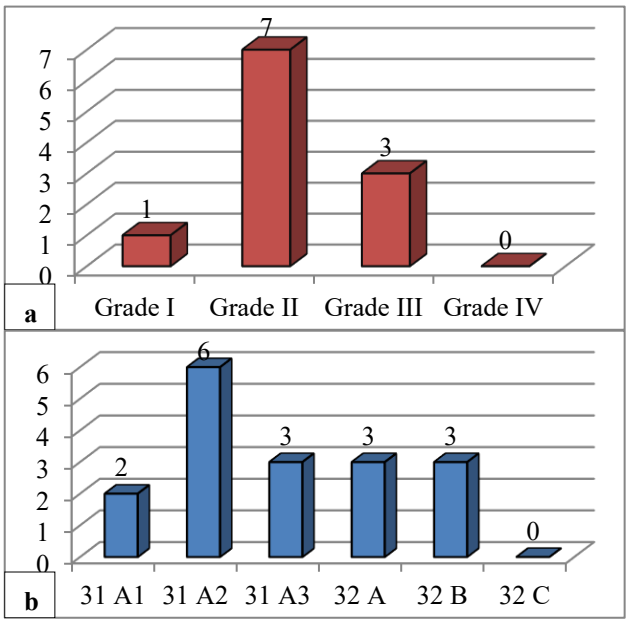

Figure 2: Classification of subtrochanteric and intertrochanteric fractures in our cohort (a) classification of intertrochanteric fractures, and (b) classification of subtrochanteric fractures.

The majority of fractures (63%) were due to trivial or domestic falls, while the remaining 37% resulted from road traffic accidents. Patients had associated injuries, including fractures of other bones (9 patients), blunt abdominal trauma (3 patients), and head injuries(1patient), faciomaxillary injuries (2 patients) and chest injury (1 patient) in our cohort.

Hypertension was a common comorbidity, present in 31.6% of patients with subtrochanteric fractures and 18.7% of those with intertrochanteric fractures. The co morbidities in individual groups is shown in Figure 3.

The duration of surgery in the subtrochanteric group exceeded two hours in approximately 70% of patients, whereas in the intertrochanteric group, only about 20% of surgeries lasted more than two hours and this difference

was statically significant (p<0.005). The mean duration of surgery was 142 minutes for subtrochanteric fractures compared to 98 minutes for intertrochanteric fractures, a difference that was statistically significant (p<0.0001). The mean duration of radiation exposure was 220 seconds in the subtrochanteric group compared to 140 seconds in the intertrochanteric group, also statistically significant (p<0.0001).

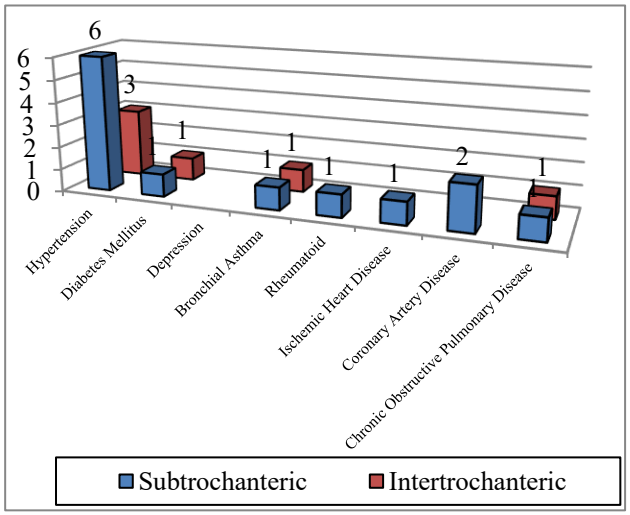

Figure 3: Comorbidities in individual groups in our study.

Closed reduction was successful in over 80% of patients, with six cases of subtrochanteric fractures requiring open reduction. Regarding blood loss, the majority (92%) of patients had blood loss between 150-250 ml (Figure 4). Two patients in the subtrochanteric group reported blood loss exceeding 250 ml, compared to one patient in the intertrochanteric group. Overall, the average blood loss in subtrochanteric group was 194 ml and intertrochanteric group was 142 ml and this difference was statically significant (p<0.005).

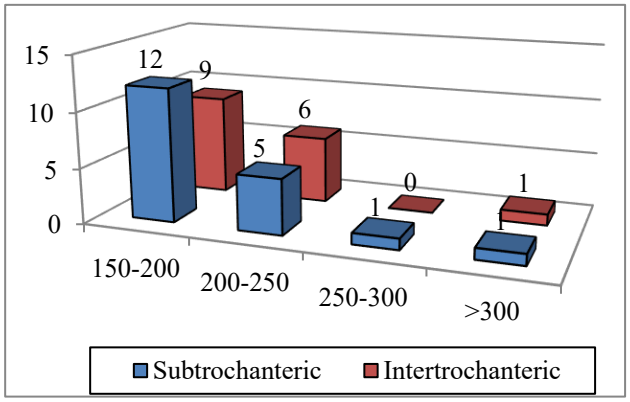

Figure 4: The amount of blood loss (ml) in millilitres in our study.

Intraoperative complications in the subtrochanteric group included failure of closed reduction, lateral cortex blowout, and failure to insert a derotation screw (Figure 5).

No intraoperative complications were observed in the intertrochanteric group.

Delayed complications in the subtrochanteric group included shortening in five patients, stiffness in three patients, and one patient each experiencing delayed union, Z-effect, and loosening of the hip screw (Figure 6).

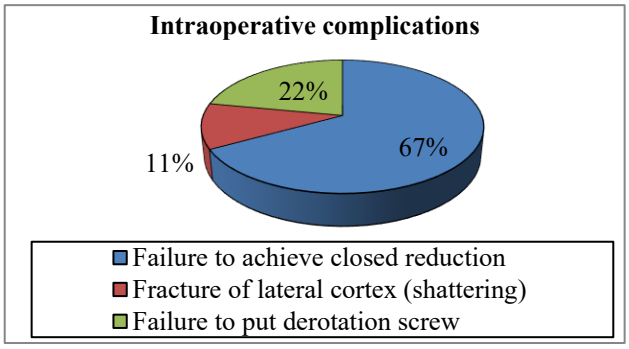

Figure 5: Intraoperative complications in our study.

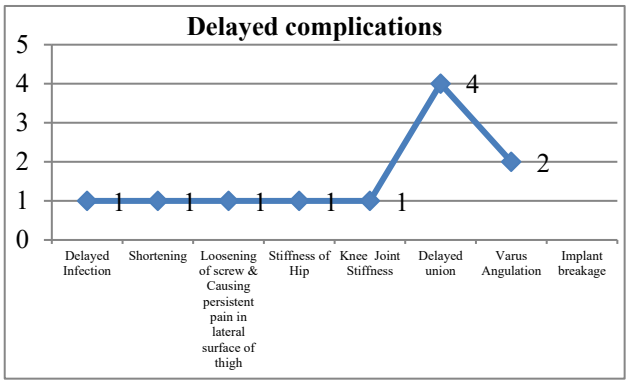

Figure 6: Delayed complication in our study groups.

Regarding the range of motion, 85% of patients achieved flexion greater than 90 degrees, 80% had abduction greater than 20 degrees, and approximately 90% had good rotation (Figure 7). The differences between the two groups were statistically insignificant (p<0.5).

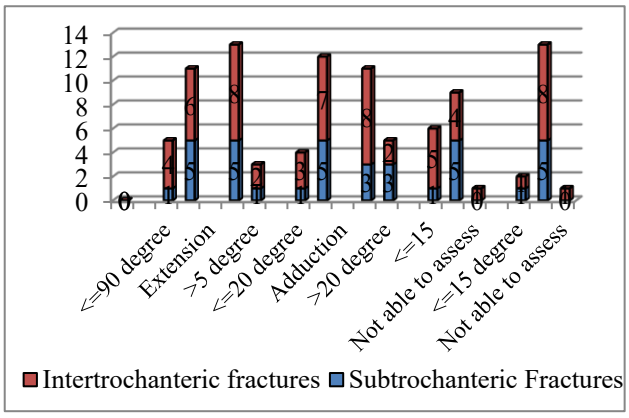

Figure 7: The average range of motion (ROM) in our study.

Functional outcomes, assessed using the Salvati and Wilson scoring system, indicated that more than 90% of patients had excellent to good outcomes in our cohort despite more complications encountered in subtrochanteric group (Figure 8).

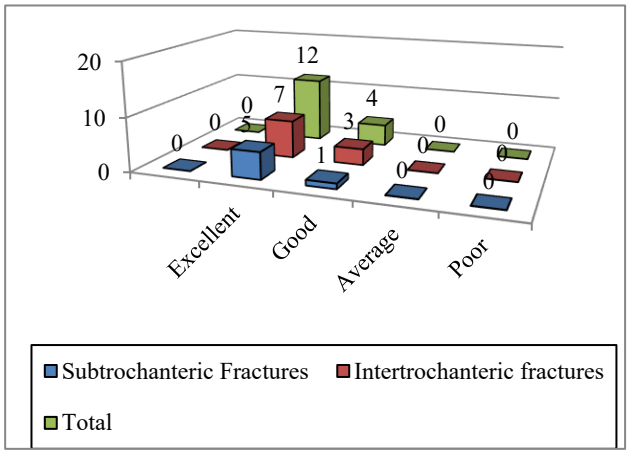

Figure 8: The functional outcome in our cohort.

DISCUSSION

This study evaluated the clinical outcomes and complications associated with the use of PFN in treating proximal femoral fractures. Among the 35 patients analyzed, 19 (54.2%) were male and 16 (45.7%) were female, showing a male predominance. This may be attributed to increased outdoor and occupational activities among men, potentially minor elevating their risk of road traffic-related trauma.

A higher incidence of fractures on the left side was observed, consistent with earlier research. For example, Fogagnolo et al. found left-sided involvement in 27 of 47 cases, while 20 were right-sided.[5] Similarly, Liu et al documented 75 left-sided fractures out of 143 total cases, compared to 68 on the right.[6] These results align with our findings, reinforcing the notion that left-sided fractures are more common.

In our cohort, 4 out of 25 patients presented with additional skeletal injuries. Several individuals also suffered from trauma to other regions, including abdominal, thoracic, cranial, and facial areas. Studies by Chuan et al and French et al similarly describe the frequent co-occurrence of multisystem trauma alongside proximal femoral fractures.[7,8]

All patients underwent surgical intervention as soon as they were clinically stable. Delays before surgery were primarily due to associated systemic injuries or underlying medical issues. The mean interval between injury and surgery was 6.39 days, closely matching the delays noted by Kamboj et al and Alyassari et al, which ranged from 3 to 14 days.[9,10]

Operative details such as the duration of surgery and fluoroscopy time were also examined. Early cases took longer to complete, but surgical times improved as surgeons became more adept with the PFN technique. The average procedure length was 142 minutes, comparable with findings from Simmermacher et al and Wang et al, who reported mean operative durations ranging from 45 to 155 minutes.[11-13] Radiation exposure during surgery averaged 140 seconds, influenced by procedural challenges such as closed reduction and the complexity of comminuted fractures—findings that resonate with Liu et al research.[14]

One intraoperative complication involved fragmentation of the fracture during nail insertion, which required the use of cerclage wiring for additional stability. Closed reduction was difficult in some cases, and optimal placement of screws proved challenging, particularly in open reductions. These difficulties may be partially attributed to anatomical variations specific to the Indian population.

The study reported a union rate of 95.23%, with delayed or non-unions being addressed through additional procedures such as dynamization or revision surgeries. These results are in line with published union rates, which generally fall between 92% and 100%.[15-17]

Postoperative complications—including hardware failure, infections, and heterotopic ossification—were managed with appropriate interventions. Issues like the Z-effect and reverse Z-effect were observed, underscoring the importance of technical accuracy during PFN placement, as documented in previous studies.[18-20]

Functional recovery, assessed using the Harris hip score, showed favorable outcomes, with most patients achieving good to excellent function. These findings support the effectiveness of PFN in facilitating postoperative mobility and are consistent with those reported by other researchers.[4,21,22]

The limitations of our study include its single-center design and relatively small sample size, which may affect generalizability. Future studies could benefit from larger sample sizes and multicenter designs to validate our findings further.

CONCLUSION

Our study underscores the efficacy of PFN as a reliable implant for managing proximal femoral fractures, especially in cases involving unstable intertrochanteric fractures. Our findings suggest that this device can be safely employed by average surgeons to address common yet challenging fracture patterns and offers several advantages including expedited surgical procedures, reduced intraoperative blood loss, maintenance of biomechanical stability facilitating bone healing, and earlier initiation of weight-bearing on the affected limb.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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