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Original Research Article

PROXIMAL FEMUR NAILING FOR UNSTABLE SUBTROCHANTERIC AND INTERTROCHANTERIC FRACTURES

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ABSTRACT

Background: Unstable intertrochanteric and subtrochanteric femoral fractures are associated with high morbidity and present significant challenges in achieving stable fixation and early mobilization. Proximal femoral nail (PFN) has gained popularity because of its biomechanical advantages and minimally invasive technique. **Aim:** To evaluate fracture union, complications, and functional outcomes in unstable intertrochanteric and subtrochanteric fractures treated with PFN. **Materials and Methods:** This prospective observational study was conducted in the Department of Orthopaedic Surgery, Coimbatore Medical College and Hospital, from September 2012 to May 2014. Twenty adult patients with unstable intertrochanteric or subtrochanteric fractures were included. Patients underwent fixation with short or long PFN under fluoroscopic guidance. Clinical and radiological follow-up was performed up to one year. Functional outcome was assessed using the modified Harris Hip Score. **Results:** The mean age of patients was 55.18 years, and males constituted 85% of cases. Road traffic accident was the most common mode of injury (45%). Closed reduction was achieved in 70% of patients, while 30% required open reduction. Mean surgery duration was 90 minutes, mean blood loss was 250 ml, and mean fracture union time was 16 weeks. Excellent to good functional outcome was observed in 55% of patients, with a mean modified Harris Hip Score of 80.5. Postoperative complications included significant shortening in 30%, lateral thigh pain in 20%, superficial infection in 10%, deep infection in 5%, and varus malunion and Z-effect in one patient each. No screw or implant breakage was observed. **Conclusion:** PFN is an effective treatment modality for unstable intertrochanteric and subtrochanteric fractures, providing satisfactory fracture union and acceptable functional outcomes with manageable complication rates.

INTRODUCTION

The incidence of intertrochanteric and subtrochanteric fractures has increased globally. Intertrochanteric fracture is defined as the fracture extending from the extra-capsular basilar neck region to region along the lesser trochanter before medullary canal development.[1] Subtrochanteric femur fracture is fracture between lesser trochanter and a point 5 cm distal to lesser trochanter.[2]

In the elderly patients, these fractures are usually due to low-energy trauma. High energy trauma, such as motor vehicle accidents and falls from height, are the primary reasons for these fractures, especially in the young individuals.

Several challenges exist in the treatment of unstable trochanteric fractures. Dynamic hip screw (DHS) and dynamic condylar screw (DCS) are been successfully implemented from a long time. However, as these procedures require larger skin incision and greater tissue handling resulting in an increased risk of infection, blood loss, and higher operating time. DHS fixation also reported varus collapse of the fracture, non-union, and implant failure.[3]

As these devices have not optimally performed in the unstable trochanteric fractures, with high rates of failure, intramedullary fixation devices have gained popularity. The primary principle used in these devices involves sliding screw in the femoral neck-head fragment, attached to an intramedullary nail.

AO/ASIF in 1996 introduced a new cephalomedullary reconstruction nail with trochanteric entry port which demonstrated higher biomechanical strength than DHS fixation and other

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modalities of fixation.[4] Further, proximal femoral nail (PFN) has also reduced the chances of infection, blood loss, morbidity and patients were allowed early weight bearing.

The stability of the fracture is significantly dependent on the fracture geometry. The most common instability patterns include reverse oblique fracture, lesser trochanter comminution, and intertrochanteric fracture with sub- trochanteric extension.[4,5]

A truly stable Intertrochanteric fracture is indicated by an adequate cortical contact with no gap medially and posteriorly after reduction. The adequate cortical contact further prevents the displacement into varus and retroversion. In the stable fracture, there is no comminution between the posterior and medial cortices and lesser trochanter has no displaced fracture. Characteristics of the lesser trochanter, including size and amount of displacement, assist in assessing the fracture stability. Up to 60% of intertrochanteric fracture are unstable and carry complication risk.[5]

Two methods are implemented for managing the trochanteric fractures. These include conservative or non-surgical method and surgical method. Conservative methods are usually used in an elderly person with high medical risk for anaesthesia and surgery or in the non-ambulatory patient with minimal discomfort following fractures. The goals of the surgical intervention are early mobilization of the patient, rigid and stable fixation of the fracture fragments, and restoration of the patient to preoperative status at the earliest.[6,7]

Several factors affect the stability of fracture fixation, such as bone quality, fracture reduction, fracture pattern, implant design, and implant placement. Therefore, the study aimed to evaluate fracture union, complications, and functional outcomes in unstable intertrochanteric and subtrochanteric fractures treated with PFN.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Orthopaedic Surgery, Coimbatore Medical College and Hospital, between September 2012 and May 2014 after obtaining approval from the Institutional Ethics Committee. A total of 20 patients with unstable intertrochanteric and subtrochanteric femoral fractures were included in the study.

Inclusion and Exclusion Criteria

Patients aged more than 18 years with unstable intertrochanteric fractures and subtrochanteric fractures who were independently ambulatory before injury were included. Unstable fracture patterns included reverse oblique fractures and fractures with subtrochanteric extension. Patients with pathological fractures, open fractures, paediatric fractures, terminal illness, life-threatening systemic disease, or those unfit for surgery were excluded from the study.

Methodology

Pre-operative Evaluation

All patients underwent detailed clinical examination and routine laboratory investigations including haemoglobin, blood sugar, blood urea, serum creatinine, blood grouping, and cross-matching. Radiological evaluation included anteroposterior radiographs of the pelvis with both hips and the affected femur. Fractures were classified according to Seinsheimer's classification for subtrochanteric fractures and Boyd and Griffin classification for intertrochanteric fractures.

Upper tibial skeletal traction was applied preoperatively to reduce pain, prevent shortening, and minimize unnecessary limb movement. Pre-operative planning included determination of nail diameter and neck-shaft angle. Intravenous prophylactic antibiotics were administered one hour before surgery.

Operative Technique

All procedures were performed under spinal anaesthesia with the patient in supine position on a fracture table. Closed reduction was attempted initially using traction and gentle rotation under image intensifier guidance. Open reduction was performed when satisfactory reduction could not be achieved by closed means.

A PFN was inserted through the tip of the greater trochanter using standard operative technique. Depending on fracture configuration, either short or long PFN with 130° or 135° neck-shaft angle was used. Lag screw and anti-rotation hip pin were inserted under fluoroscopic guidance, followed by distal locking with locking bolts. Proper screw placement and implant position were confirmed intraoperatively using image intensifier. [Figure 1]

Figure 1: Image intensifier

Post-operative Protocol

Postoperatively, patients received intravenous antibiotics for 48 hours and analgesics for pain control. Hip and knee range-of-motion exercises were initiated early under physiotherapy supervision. Partial weight bearing was started depending on fracture stability, while full weight bearing was allowed progressively based on radiological evidence of fracture union.

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Follow-up and Outcome Assessment

Patients were followed up at 6-week intervals until fracture union and subsequently every 3 months up to 1 year. At each follow-up, patients were clinically evaluated for pain, hip and knee function, walking ability, deformity, shortening, and complications. Functional outcome was assessed using the modified Harris Hip Score and categorised as excellent, good, fair, or poor.

Radiological assessment included evaluation of fracture union, implant position, tip-apex distance, varus malunion, Z-effect, screw breakage, and implant failure. Fracture union was assessed by the presence of bridging callus and absence of pain during weight bearing.

Statistical Analysis

Data were analysed using descriptive statistics. Continuous variables were expressed as mean values, and categorical variables were expressed as frequencies and percentages.

RESULTS

The study included 20 patients with a mean age of 55.18 years (range: 20–65 years). Male patients predominated (17 cases, 85%). Road traffic accident (RTA) was the most common mode of injury. The right side was involved in 12 patients (60%).

According to Seinsheimer's classification, Type II fractures were the most common fracture pattern. Most patients had no comorbidities, while systemic hypertension was the most common associated medical condition. [Table 1]

Table 1: Pre-operative Characteristics

Parameter		Characteristics	Number of Cases (n=20)
Age		Mean Age	55.18 years (Range: 20–65 years)
Gender		Male	17 (85%)
		Female	3 (15%)
Mode of Injury		Road Traffic Accident	9 (45%)
		Fall from Height	5 (25%)
		Slip and Fall	5 (25%)
		Elephant Attack	1 (5%)
Side Affected		Right	12 (60%)
		Left	8 (40%)
Fracture Pattern	Seinsheimer's	Type II	6 (30%)
		Type IIIA	4 (20%)
		Type IIIB	4 (20%)
		Type IV	3 (15%)
		Type V	1 (5%)
	Boyd and Griffin	Type II	1 (5%)
		Type III	1 (5%)
Comorbidities		Systemic Hypertension	3 (15%)
		Type II Diabetes Mellitus	1 (5%)
		Bronchial Asthma	1 (5%)
		No Comorbidity	15 (75%)
Associated Injuries		Acetabular Fracture	2 (10%)
		Calcaneal Fracture	1 (5%)
		Bladder Injury	1 (5%)

Among the 20 cases, short PFNs (25 mm) were used in 14 patients (70%), while long PFNs were used in 6 patients (30%). A 130° neck-shaft angle nail was used in 14 cases (70%) and a 135° nail in 6 cases (30%). Closed reduction was achieved in 14 patients (70%), whereas open reduction was required in 6 patients (30%) (Table 2). The mean surgery duration was 90 min, mean blood loss was 250 ml, mean hospital stay was for 28 days, and mean period for initiation of full weight bearing was 16 weeks. [Table 2]

Table 2: Distribution of Type and Angle of PFN Used

Implant Parameters		Number of Cases (n=20)
Type of PFN Used	Long PFN	6 (30%)
	Short PFN (25 mm)	14 (70%)
Neck Shaft Angle of Nail	130° Nail	14 (70%)
	135° Nail	6 (30%)
Reduction	Closed	14 (70%)
	Open	6 (30%)

Postoperative complications included significant shortening in 6 patients (30%) and lateral thigh pain in 4 (20%). Superficial infection occurred in 2 patients (10%), while deep infection and mortality due to myocardial infarction were seen in 1 patient (5%) each. [Table 3]

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Table 3: Post-operative Complications

Postoperative Complications	Number of Cases
Superficial Infection	2 (10%)
Deep Infection	1 (5%)
Significant Shortening (2 cm)	6 (30%)
Mortality due to Myocardial Infarction	1 (5%)
Lateral Thigh Pain	4 (20%)

Functional outcome according to Harris Hip Score was excellent in 5 patients (25%), good in 6 patients (30%), fair in 5 patients (25%), and poor in 4 patients (20%). The mean modified Harris Hip Score was 80.5. [Table 4]

Table 4: Functional Outcome According to Modified Harris Hip Score

Functional Outcome	Number of Patients (n=20)
Excellent	5 (25%)
Good	6 (30%)
Fair	5 (25%)
Poor	4 (20%)

The mean tip-apex distance was 23 mm, and the mean fracture union time was 16 weeks. Varus malunion and Z-effect were observed in 1 patient each. No cases of screw breakage or implant breakage were observed. [Table 5]

Table 5: Radiological and Implant-related Outcomes

Parameters	Findings
Mean Tip Apex Distance	23 mm
Mean Time for Fracture Union	16 weeks
Varus Malunion	1 patient
Z Effect	1 patient
Screw Breakage	0 patients
Implant Breakage	0 patients

Figure 1: Preoperative and Postoperative images

Figure 2: Preoperative and Postoperative images

DISCUSSION

Management of unstable intertrochanteric and subtrochanteric fractures remains challenging because of fracture instability, poor bone quality, and deforming muscular forces. PFN provides biomechanical advantages with minimally invasive fixation and allows early mobilization.

The study reported near-anatomical reduction in 85% of cases and the fracture consolidated in 16 weeks. Significant shortening was reported in 6 cases. Two

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patients had superficial infections and one had deep infection. Gadegone and Salphale analyzed 110 cases of proximal femoral fractures with an average follow-up of 2 years and found near anatomical reduction in 90% of cases and the fracture consolidated in 20 weeks.[6] None of the patient had perceptible shortening. Seven percent patients had superficial infection and were treated with antibiotics.

The current study reported a mean Harris Hip score of 80.5, one case each of Z-effect and varus displacement. Uzun et al. found a mean Harris Hip scale of 84 and secondary varus displacement in nine patients (25.7%).[7]

In our study, the mean surgery duration was 90 min, mean blood loss was 250 ml, mean hospital stay was for 28 days, and mean period for initiation of full weight bearing was 16 weeks. Simmermacher et al. reported mean surgery duration of 70 min, mean blood loss of 200 ml, mean duration of stay of 20.67 days, and mean time for full weight bearing of 16.5 weeks.[8]

The present study used long PFN in 6 cases and short PFN in 14 cases, with no periprosthetic fractures noted. Morihara et al. used only long proximal femur nail to avoid any periprosthetic fractures later.[9]

Schipper et al. compared gamma nail vs proximal femur nail for subtrochanteric fractures in 400 cases found a lower intra-operative blood loss with proximal femur nail (220 ml vs. 287 ml).10 As compared to gamma nail, proximal femur nail had higher lateral protrusion of the hip screws (7.6% vs 1.6%). Most local complications were related to suboptimal reduction of the fracture and/or positioning of the implant. Most local complications in Schipper et al. were because of implant positioning and/or suboptimal fracture reduction.[10]

In the current study, there were no screw breakage, nor was bone grafting required in any patient. In contrast, Ballal et al. reported 8 cases of screw breakage (n=216), of which six patients required revision nailing with cerclage cable. Of these, bone grafting was required in 2 cases for long nail insertion.[11]

In the present study, two patients had ipsilateral proximal femur and shaft fractures. Long proximal femur nail was used in these patients with satisfactory results. Gadegone et al. in series of 36 cases concluded that long proximal femur nail is a favourable option for ipsilateral proximal femur and shaft fractures.[12]

The study used long proximal femur nail for six cases and performed closed reduction in 14 cases. Pavelka et al. performed closed reduction in 68 out of 79 patients.[13]

There was difficulty in passing the derotation screw in two patients. Kanthimathi and Narayanan identified intraoperative technical difficulties in four patients, while six patients showed postoperative complications.[14]

The study reported difficulty in placement of anti-rotation screw in 2 patients, with secondary varus in one patient and screw cut through was seen in one patient. Deepinder reported difficulty in placement of neck screw in 4 cases out of 25 cases.[15] Secondary varus was noted in three cases and in one patient had anti-rotational screw cut through. All fractures united well.

The present study reported that 60% of the patients had excellent to good results. Goswami et al. reported that 74% of the patients (n=30) had excellent to good results.[16]

Open reduction was done in six cases. Tyllianakis et al. in his series of proximal femur nailing for extracapsular hip fractures for 40 cases had done closed reduction with minimal incision and minimal soft tissue dissection in all cases.[17]

Femur nailing for the ipsilateral neck and trochanteric fracture was done in one case with good results. Neogi et al in series of 30 cases performed proximal femur nailing for five cases of ipsilateral neck and trochanteric fracture.[18]

Limitations

The study has several limitations including small sample size, single-center design, absence of a comparison group, and lack of randomization. Therefore, the findings cannot be generalized. Larger comparative studies are required to validate these results.

CONCLUSION

Proximal femoral nail is an effective treatment option for unstable intertrochanteric and subtrochanteric fractures. It provides satisfactory fracture union and functional outcomes with acceptable complication rates. Early mobilization and stable fixation are important advantages of this technique.

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