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Proximal femoral nail- outcome and complications: a prospective study of 125 cases of proximal femoral fractures

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ABSTRACT

Background: Fractures of the proximal femur are relatively common injuries in adults and common source of morbidity and mortality among the elderly. Fractures of the proximal femur include trochantric and subtrochantric fractures. The present study was designed to evaluate and analyze the role of proximal femoral nail (PFN) in the treatment of proximal femoral fractures.
Methods: It was a prospective study on 125 cases of proximal femoral fractures. The fractures were classified according to AO classification. Salvati and Wilson Score were used for functional assessment.
Results: In this study at 6 months follow up, union was achieved in 123 cases, open reduction was performed in 11% of cases (14 cases). Technical and mechanical complications were noted in 21% cases (27 cases). Reoperation rate was 4% (Five cases). According to Salvati and Wilson scoring system excellent results were seen in 36% of cases (45 cases), good results in 46% cases (58 cases), fair result in 13% cases (16 cases) and poor results in 5% cases (6 cases).
Conclusions: It is concluded from our study that proximal femoral nailing is an attractive and suitable implant for Proximal Femoral Fractures and its use in unstable intertrochantric fractures is very encouraging.

Keywords: Proximal femoral nail, Intertrochanteric fractures, Subtrochanteric fractures, Proximal femur fracture

INTRODUCTION

Hip fractures are the most devastating injuries in all the age groups. Extracapsular fractures (intertrochanteric and subtrochanteric fractures) primarily involve cortical and compact cancellous bone.[1,2] For the treatment of the unstable proximal femoral fracture with lacking medial support and the intertrochanteric fractures, two principal options exist. Either any kind of a sliding neck screw connected to a plate at the lateral femoral cortex and inserted after semi-open reduction or a sliding neck screw penetrating the head-neck fragment through an intramedullary nail implanted via a semiclosed technique.[3] From a biomechanical point of view the use of an intramedullary nail combined with a sliding neck screw appears to be the more appropriate technique.[4] This study was undertaken to evaluate the functional and radiological outcome of PFN system in treatment of proximal femoral fracture and the commonest technical complications, mechanical failures and intraoperative difficulties during the application of this implant. A comprehensive review of the literature regarding the use of the PFN system is also presented.

METHODS

This was a prospective study on cases of proximal femoral fractures treated between July 2014 to July 2016,

who were admitted in Department of Orthopaedics, PBM Hospital, Sardar Patel Medical College, Bikaner. Fractures were classified according to AO/ASIF-classification.[5] 125 cases were followed at regular intervals and final assessment was done at 6 months. The Salvati and Wilson score of hip function was used at the last clinical assessment.[6]

Operative technique

Patients were positioned supine on the fracture table under spinal or general anesthesia according to the condition of the patient. Fracture was reduced by longitudinal traction and the limb was placed in slight adduction to facilitate nail insertion through the greater trochanter. A straight lateral incision was made from 5 cm cranial to the tip of the greater trochanter, extending 3-5 cm proximally. A 2.8 mm threaded guide wire was inserted at the tip of the greater trochanter under C-arm control. In cases where standard proximal femoral nail (PFN) was used, the proximal part of the femur was reamed with a 14 mm reamer for a distance of about 7 cms; while where long proximal femoral nail (PFN) was used, distal femur was also reamed with increasing diameters of flexible reamers up to 11 mm. After mounting the appropriate sized nail on the insertion device the nail was introduced manually into the femoral shaft. The hip pin was introduced first, and then the neck screw of appropriate size was inserted. Afterwards depending on the type of fracture, distal interlocking either statically or dynamically was achieved via the same aiming arm in standard proximal femoral nail (PFN) and with free hand in long proximal femoral nail (PFN).

RESULTS

A total of 125 patients were enrolled for the study. There were 55 males and 70 females, with an average age of 63 years (range: 31 to 93 years). Domestic fall was the main injury mechanism accounting for 64% cases (80 cases). Forty five patients (36%) had RTA as mode of injury. Right side fractures were recorded in sixty five patients (52%) and left side fractures in sixty patients (48%). Ninty five patients (76%) had intertrochantric fractures of femur and thirty patients (24%) had fractures of subtrochantric femur. According to AO/OTA classification most intertrochantric fractures were in Type 31A2.2 (36 cases), in subtrochatric fractures most common type was 32A1.1 (20 cases). Associated injuries included twenty one patients (16.8%) of other bones fracture, blunt trauma abdomen in five patients (4%), head injury in four patients (3.2%) and facial injuries also in four patients (3.2%). The average time from injury to surgery was 7 days (range: 1 to 13 days). Average duration of surgery was 88 min (range 45 to 145 min). Closed reduction was achieved in eighty nine percent cases (111 cases). Open reduction was performed in eleven percent cases (14 cases). Mean intraoperative blood loss was 126 ml. In our study it was observed that in open reduction there was more blood loss. In our study, most commonly we used 10 mm diameter nail (92 cases) and 11 mm diameter nail was used in 33 cases.

Table 1: Intraoperative details.

S. No.	Intraoperative details	N=125
1	Mean duration of surgery	88 min
2	Reduction	
	Closed	111
	Open	14
3	Mean blood loss	126 ml

Table 2: Intraoperative complications of PFN.

S. No.	Intraoperative complications	No. of subjects
1	Failure to achieve closed reduction	14
2	Fracture of lateral cortex (shattering)	1
3	Varus angulation	0
4	Failure to put antirotation screw	7
5	Failure to lock distally	0
6	Jamming of nail	0
7	Drill bit breakage	0
8	Guide wire breakage	2

Table 3: Delayed complications.

S. No.	Delayed complications	No. of subjects
1	Reverse Z effect	2
2	Shortening	3
3	Loosening of hip pin causing persistent pain in lateral surface of thigh	8
4	Z- effect	3
5	Stiffness of hip	11

We used standard PFN of 250 mm in all intertrochantric fractures and long PFN of in all subtrochantric fractures (360 mm to 420 mm).

Table 4: Functional results (Salvati and Wilson score).

Functional result	No. of cases	%
Excellent	45	36
Good	58	46
Fair	16	13
Poor	6	5

In our study we encountered certain complications intraoperatively. In fourteen of our cases we had to perform open reduction due to wide displacement of fragments and communication of fragments. There was an iatrogenic fracture of the lateral cortex of proximal fragment (shattering) in one case. In seven cases, we

failed to put anti-rotation screw. In two cases, there were guide wire breakages while drilling over guide wire. In one case it was removed by opening from abdominal site with the help of general surgeon. In other case guide wire was removed by using cannulated hand reamer and reaming over guide wire under IITV. In our series no other complications like deep vein thrombosis, systemic infection, acute respiratory distress syndrome and fat embolism was seen. The physiotherapy was started after 2nd or 3rd postoperative day according to patient's tolerance and associated injuries. Partial weight bearing walking was started at 1 month. Full weight bearing walking was started after the radiological union of the fracture site.

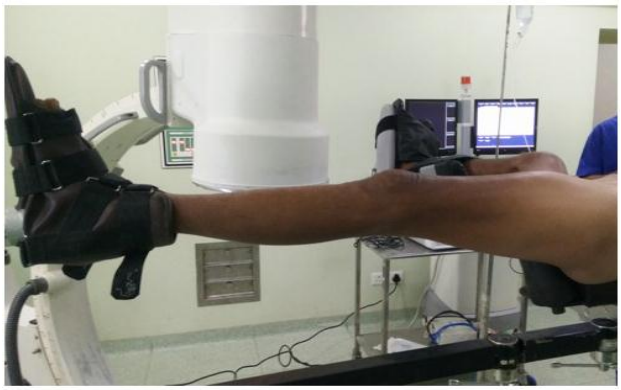

Figure 1: Position on fracture table.

Figure 2: Guide wires insertion.

The overall rate of late technical and mechanical complications was twenty one percent (27 cases). In our series we had two cases of reverse Z effect, there was migration of hip screw in the joint with backing of antirotation screw (reverse Z effect). Three cases of Z effect in our series (hip screw migrated laterally and the antirotation screw migrated medially during physiologic loading). Eight patients had persistent pain in lateral surface of proximal thigh due to loosening of the hip pin. Stiffness of hip was noted in 11 patients which required vigorous physiotherapy. In our study, three patients developed shortening with one more than 2cm. Revision surgery was done in five cases (reinsertion of screws in three cases and hemiarthroplasty in two cases). The average duration of hospital stay following surgery was days ranging from 5-20 days.

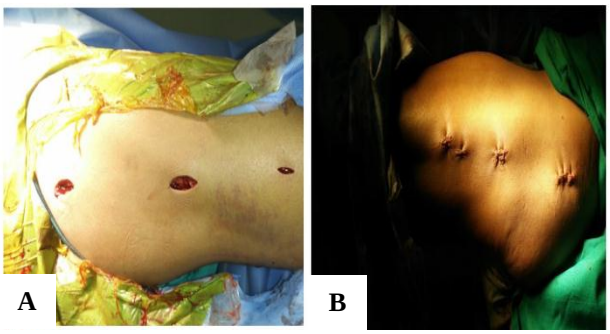

Figure 3: (A) Incisions for PFN; (B) Wound closure.

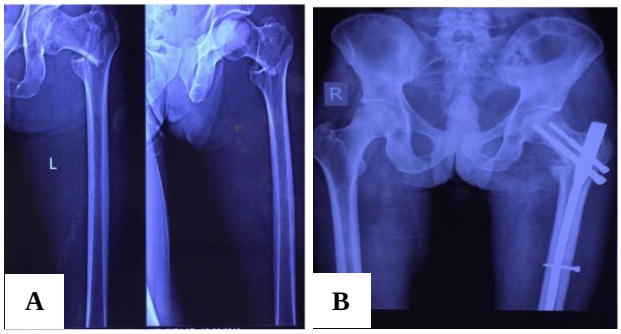

Figure 4: (A) Pre-operative; (B) Postoperative X-rays (case 1).

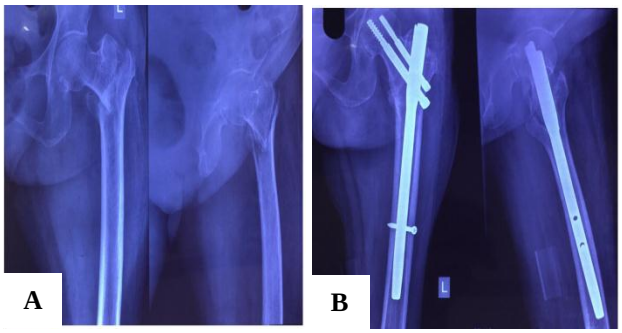

Figure 5: (A) Pre-operative, (B) Postoperative X-rays (case 2).

All patients were followed up in the out patients department up to 6 months. At each follow up radiographs of upper femur and hip were taken to assess the fracture union, implant failure and screw cut out. Radiological union was seen at 3 months for 19 patients, at 4 months- 53 patients, at 5 months- 46 patients and at 6 months- 5 patients.

Results were assessed by Salvati and Wilson scoring system and excellent results were noted in 45 cases, good in 58 cases, fair in 16 cases and poor result in 6 cases.

DISCUSSION

Unstable fractures of the proximal femur represent a significant challenge to the trauma surgeon. Surgical fixation is often technically difficult and poor surgical technique may lead to failure of primary fixation.[7,8] The best treatment for these fractures remains controversial. DHS fixation is widely preferred but failure of fixation still occurs in up to 20% of cases.[3] Common causes of fixation failure include fracture instability, osteoporosis, lack of anatomic reduction, implant failure, and incorrect placement of the lag screw in the femoral head (leading to cutting out of the screw).[9] Cephalomedullary femoral reconstruction nails with a trochanteric entry point are biomechanically stronger than extramedullary implants.[10] In unstable proximal femoral fractures, control of axial telescoping and rotational stability are essential. Intramedullary implants inserted in a less-invasive manner are better tolerated by the elderly.[11] A new device was developed by AO/ASIF: the proximal femoral nail (PFN), with an additional antirotational hip pin preventing rotation and collapse of the head-neck fragment and an especially shaped tip together with a smaller distal shaft diameter resulting in less stress concentration at the tip.[12]

Velasco and Comfort found that 63% of subtrochanteric fracture occurred in patients from 51 to more than 70 years old and 24% of patients between 17 to 50 years old.[13] In a study by Babst et al in 1998 in intertrochanteric fractures, mean age was 79.7 years (range 39-98 years).[14] According to Klinger et al in 2005 the mean age was 74 years ranging from (27 to 98 years) in patients who were treated either with DHS or proximal femoral nail.[15] Alyassari et al studied seventy patients and the average age was 84 years showing trochanteric fracture are more common in higher age group.[16] In our study fifty patients (40%) were between 20-60 years and 66% of subtrochanteric fractures were below the age of 60 years. The mean age of unstable intertrochanteric fractures was 67.73 years with range from 41 years to 95 years which is slightly towards the older age group, mainly due to Osteoporosis.

Simmermacher in their study the mean duration of surgery (skin to skin) was 68.7 min (range 25-240 min).[3] Pajarinan et al in their comparative study of DHS and PFN in proximal femoral fracture, the average time of surgery in DHS was 45 min (range 20-105 min) and in PFN was 55 min (35-200 min).[17] Wang in their study, the average operating time was 90 min (Range 60-155 min).[18] In our study duration of surgery was longer in the initial operated cases. With frequent use of proximal femoral nail surgery the duration decreased. In our study average duration of surgery was 88.24 minutes.

Fogagnolo et al reported 46 patients with an average rate of intra operative technical or mechanical complications of 23.4%, mostly problems with the distal nail locking and fracture of the lateral wall of the greater trochanter.[19] Kamboj et al studied 30 cases, in one case with trochanteric fracture extending to diaphysis encirclage wiring was done. One patient got intra operative fracture shaft of femur, three patients had poor placement of screw. The closed reduction was tried in all cases and achieved in 17 patients, in the rest of 13 cases fracture had to be opened. In their study, due to smaller diameter of the neck of Indian femora they were not able to pass anti rotational hip pin in four patients.[20] Alyassari et al in their study, two cases required open reduction, distal locking was difficult in three cases, nail insertion was difficult in one patient.[16] In our study, there was shattering of the proximal fracture fragment in one patient while insertion of the nail. In fourteen patients, it was not possible to achieve closed reduction, so open reduction was done by opening the fracture site. In seven patients it was difficult to put the derotation screws. In three cases, it could not be accommodated in the neck after putting the neck screw and in other four cases, it had to be removed after inserting as it was penetrating the superior cortex of the neck. This suggests that in Indian population the neck of femur is not broad. In Two patients, there were guide wire breakages while reaming over guide wires in femoral neck.

Pajarinan et al in their study of 83 patients, there was one case of heterotopic ossification corresponding to Brooker class 4, where PFN was used.[17] Werner et al was the first who introduced the term Z-effect, detected in five (7.1%) of 70 cases. The incidence of cut-out of the neck screw in this study was 8.6%. The Z-effect phenomenon is referred as a characteristic sliding of the proximal screws to opposite directions during the postoperative weight-bearing period.[21] Reverse Z-effect described by Boldin et al occurred with movement of the hip pin towards the lateral side, which required early removal. In their prospective study of 55 patients with unstable intertrochanteric or subtrochanteric fractures, they had three cases with Z-effect and two with reverse Z-effect.[22] Fogagnolo et al, who reported 46 patients with an average rate of intraoperative technical or mechanical complications of 23.4%. They also reported two implant failures and one fracture below the tip of the nail. They also reported heterotopic ossification in two patients fixed with PFN.[19] Simmermacher et al in a clinical multicenter study, reported technical failures of the PFN after poor reduction, malrotation or wrong choice of screws in 5% of the cases. A cut-out of the neck screw occurred in 0.6%.[3] In our series there was shortening in three patients. In one patient, fracture was comminuted which caused shortening >2 cm on healing while in two patients it was of <2 cm where there was inadequate restoration of alignment and there was no medial buttressing that led to shortening. There was five cases of implant failure, three cases with ‘Z Effect’ and two cases with ‘reverse Z effect’. Revision Surgeries were done in these cases. In eight patients, there was loosening of hip pin which caused persistent pain in lateral surface of thigh. In eleven patients, stiffness of hip joint was present.

Alyassari et al also used Salvati and Wilson scoring system for final follow up. In their study salvati and Wilson score for hip function was >20 points in 78% of the patients (maximum score is 40 points).[16] According to Salvati and Wilson score system in our study excellent results were seen in 45 cases, good in 58 cases, fair in 16 cases and poor results in 6 cases treated with proximal femoral nail (PFN).

Table 5: Comparison with other studies.

	Boldin et al[22]	Ekstrom et al	Menzes et al	Lei-Shang et al	Present study
No. of patients	55	105	155	99	125
Duration of surgery (min)	68	105	76	46	88
Bony union (%)	100	100	99	98	98.4
Failure of fixation (%)	0	11	2	0	2
Open reduction (%)	10	-	1.3	34	11
Reoperation rate (%)	10	9	12	-	4

CONCLUSION

It is concluded from our study that proximal femoral nailing is an attractive and suitable implant for proximal femoral fractures and its use in unstable intertrochanteric fractures is very encouraging. This study has also shown that this device can be safely used by the average surgeon to treat common but sometimes difficult fractures. The operation is technically demanding but gradual learning and great patience is needed in order to make this method truly minimally invasive. Most of the complications of proximal femoral nailing are surgeon and instruments related which can be cut down by proper patient selection and good preoperative planning.

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Ethical approval: Not required

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