Original Article

Long proximal femoral nail in ipsilateral fractures proximal femur and shaft of femur

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Abstract

Background: Ipsilateral fractures of the proximal femur and femoral shaft are extremely uncommon injuries which occur in young adults who sustain a high energy trauma. A variety of management modalities have been tried to treat this complex fracture pattern ranging from conservative approach to recently introduced reconstruction nails. All these approaches have their own difficulties. We studied the outcome of long proximal femoral nail (LPFN) in the management of concomitant ipsilateral fracture of the proximal femur and femoral shaft.

Materials and Methods: We analysed the prospective data of 36 consecutive patients who had sustained a high energy trauma (30 closed fractures and 6 open shaft fractures) who had concomitant ipsilateral fractures of the femoral shaft associated with proximal femur fractures treated with LPFN between December 2005 and December 2011. The mean age was 39 years (range 28-64 years). Twenty nine males and seven females were enrolled for this study.

Results: The patients were followed up at three, six, twelve, and eighteen months. The mean healing time for the neck fractures was 4.8 months and for the shaft fractures was 6.2 months. The greater trochanter was splintered and widened in two cases which eventually consolidated. Two patients had superficial infection, two patients had lateral migration of the screws with coxa vara which was due to severe osteoporosis detected during the followup. We had two cases of nonunion of shaft fracture and one case of nonunion of neck fracture. Two cases of avascular necrosis of femoral head were detected after 2 years of followup. No cases of implant failure were noted. Limb shortening of less than 2 cms was noted in four of our patients. The functional assessment system of Friedman and Wyman was used for evaluating the results. In our series 59.9% ($n = 23$) were rated as good, 30.6% ($n = 11$) as fair, and 5.5% ($n = 2$) as poor.

Conclusion: Long PFN is a reliable option for concomitant ipsilateral diaphyseal and proximal femur fractures.

Key words: Fracture shaft femur, intracapsular neck fracture, ipsilateral fracture hip and shaft femur, long proximal femoral nail, pertrochanteric fracture

Introduction

Ipsilateral fractures of the proximal femur and femoral shaft are extremely uncommon injuries which occur in young adults who sustain a high energy trauma. The reported literature reveals an incidence ranging from 5 to 6%.[1] In 19-31% of the cases the proximal femur fracture is often overlooked, as the femoral fracture takes the precedence in the diagnosis and management.[2,3] The majority of the injuries were the result of a motor vehicle accident, fall from height and industrial accidents. The attributed mechanisms include axial compression against the acetabular roof, with hip in flexion and abduction. Associated injuries often are seen when the knee is in an attitude of flexion.[4,5]

A variety of management modalities have been described to treat this complex fracture pattern ranging from conservative approach to recently introduced reconstruction nails. These techniques include simultaneous transcervical screwing and shaft plating, intramedullary fixation with additional transcervical fixation,[6,7] retrograde intramedullary nailing with femoral neck-lag screws,[1] reversed intramedullary fixation with cephalomedullary locking,[8] Ender pins with percutaneous Knowles pins,[9,10] Gamma (long) nailing, and reconstruction nailing.[11,12] All these approaches have their own surgical difficulties.

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We studied functional out come with a single procedure of long proximal femoral nail (LPFN) in concomitant ipsilateral fractures of proximal femur and shaft of femur.

Materials and Methods

We treated 36 patients with ipsilateral fractures of the femoral shaft with associated trochanteric or intracapsular neck fractures with a LPFN between December 2005 and December 2011. The majority of the injuries were the result of a motor vehicle accident ($n = 26/36$). The mean age was 39 years (range 28-64 years). Twenty nine males and seven females were enrolled for this study.

The femoral neck fracture was missed in two patients. Amongst the proximal femoral fracture there were the pertrochanteric fractures ($n = 12$), basal fractures ($n = 8$), subcapital ($n = 3$) and transcervical fractures ($n = 7$) and subtrochanteric fractures (n=4). Amongst the femoral shaft fractures 6 were open fractures. The data of shaft fracture pattern and grading of comminution are described below [Table 1a and b]. The majority of the patients had middle third fractures.

All the patients had plain radiographs of the pelvis including both hips, thigh including knee and hip joint. The associated injuries are found in 12 patients. Three patients had more than three bone fracture, whereas two had more than two fractures.

Proximal femoral nails that we used had the proximal diameter of 15 mm and length varied from 38 to 42 cm. The nail had proximal 6° mediolateral angle for smooth fit in the trochanter. The radius of curvature was 2.3 mts. The proximal screw inclination angle was of 130 and 135° and the proximal screw had an anteversion angle of 10°.

All patients were operated by the first author (W. M. G).

Table 1a: The fracture pattern of the femoral shaft

Location	No. of patients
Upper third	4
Middle third	19
Lower third	13
Total	36

Table 1b: The grading of comminution (Winquist) of femoral shaft fracture

(Comminution) (Winquist)[5]	
Grade I	14
Grade II	10
Grade III	6
Grade IV	4
Segmental	2
Total	36

Surgery was performed within mean time 58 hours (range 48 to 70 h), on a fracture table. The patients were kept on traction preoperatively. All the cases were operated under spinal anesthesia.

To reduce the fracture, traction was applied in the direction of the length of the extremity. This distracts the femoral fragments and regains length of the limb. Instruments including Schanz screws, T-handle, and larger pointed reduction forceps are very helpful for reduction. All can be used percutaneously. Closed reduction was carried out and confirmed by the image intensifier on anteroposterior and lateral views. Stabilization of the trochanteric or intracapsular fractures was done by two 2.5 mm K wires. In case the reduction of proximal femoral fracture was not achieved, stabilization of femoral shaft fracture was done first by nail and then reduction of fracture neck was carried out. A fixed and stable femoral shaft fracture reduction facilitated the reduction of hip fractures. The ipsilateral hip was kept in an adducted position to introduce the guide wire. To accomplish this, the torso was pushed 10 to 15° to the contralateral side. A 5 cm incision was taken from the tip of the greater trochanter proximally. The entry point is usually on the tip of the greater trochanter. A guide wire was passed through the tip of the trochanter distally after reducing the fracture shaft femur by closed manipulation in majority of the cases. In five cases the fracture was not reducible due to soft tissue interposition; here small incision was made at the fracture site to bring the fracture fragments in alignment. Reaming was done over the guide wire according to the planned nail. The nail of appropriate size (between 10 and 12 mm) and of adequate length (between 38 and 42 cm) was implanted manually. The nail is inserted, using minimal hammering force and keeping the proximal holes of the nail parallel to the femoral neck. The reduction of the proximal femoral fracture was re-evaluated in AP and lateral views. Two guide wires are passed. Inferior guide wire should be above the calcar deep in subchondral bone. Reaming is done by step-drill and the cervical screw of 8.0 mm and the stabilizing screw of 6.4 mm were introduced. In two cases of displaced intracapsular fracture reduction of fracture neck was achieved after the stabilization of shaft fracture. Depending upon the fracture configuration and the stability, the distal static and dynamic holes were locked in all the cases.

No patient in intracapsular group needed open reduction. The mean duration for the surgery was 85 min (range 55-105 min). Active and passive exercises initiated within 72 h. The postoperative ambulatory program involved nonweight bearing activities for 6 weeks with walking frame and gradual weight bearing for another 6 weeks with axillary crutches. Blood transfusion were needed for patients with preoperative hemoglobin level <10 gm% (n=6).

Results

Postoperative radiographs showed a satisfactory reduction in 32 patients. The patients were followed up at three, six, twelve, eighteen and twenty four months (average 12 months) [Figures 1and 2].

The mean time to union for the neck fractures was 4.8 months (range, 4-8 months). We had two cases of nonunion of shaft fracture and one case of nonunion of neck fracture. Apart from two cases of nonunion, union of the shaft fractures were evident, on average after 6.2 months (range 6-9 months) The data of radiological union is depicted in Table 2.

Two cases of avascular necrosis of femoral head were detected after 2 years of followup. One patient had a femoral neck fracture which was initially missed and revised by long PFN after ten days of initial surgery [Figure 3]. Another patient of fracture shaft femur presented to us after intramedullary nailing of femur with missed fracture neck femur after 3 months of followup. This patient was revised with long PFN with additional fibular grafting in the neck. After followup of 4 months both the fractures united with limited terminal restriction of movements of the hip and knee. The greater trochanter was splintered and widened in two cases while introducing nail which eventually consolidated. Two patients had a superficial infection at the trochanteric incision which healed by dressing and antibiotic. One patient had loosening of the interlocking screws at distal end because of delayed infection after three months, therefore the screws were removed and infection was controlled. Another patient had deep infection in a case of open fracture of the shaft but intracapsular fracture healed very well in 4 months and then shaft fracture united and consolidated after 12 months of the injury. The implant was removed and infection resolved following antibiotic treatment. Seventeen patients had full range of motion; six patients had limited restriction of terminal range around hip (<20%) but had full range of knee movements and were able to perform all activities of daily living. Eleven patients had limitation of hip and knee movements between 20-50% and two patients had marked limitation of movements.

Figure 1: X-ray of shaft femur with hip joint (anteroposterior view) showing (a) Inter trochanteric fracture with shaft fracture (b) Consolidation of the fracture of the trochanter and shaft after 12 months followup

Nonunion in two cases of midshaft fracture were treated by bone grafting. One case of nonunion basal fracture neck of femur and shaft fracture was revised by abduction osteotomy and supracondylar nailing with bone grafting. Both fractures healed well with restricted terminal range of movement of 20-30%. One patient died due to pulmonary complications unrelated to surgery 1 month after he was operated. Two patients had lateral migration of the screws with coxa vara

Table 2: The radiological union in our series

Hip fractures	Time to union			
	3-4 months (%)	5-8 months (%)	nonunion (%)	8-12 months
Fracture neck femur	24 (66.6)	11 (30.6)	1 (2.8)	1(abduction osteotomy)
Fracture shaft femur	8 (22.2)	26 (72.2)	2 (5.6)	2 bone grafting

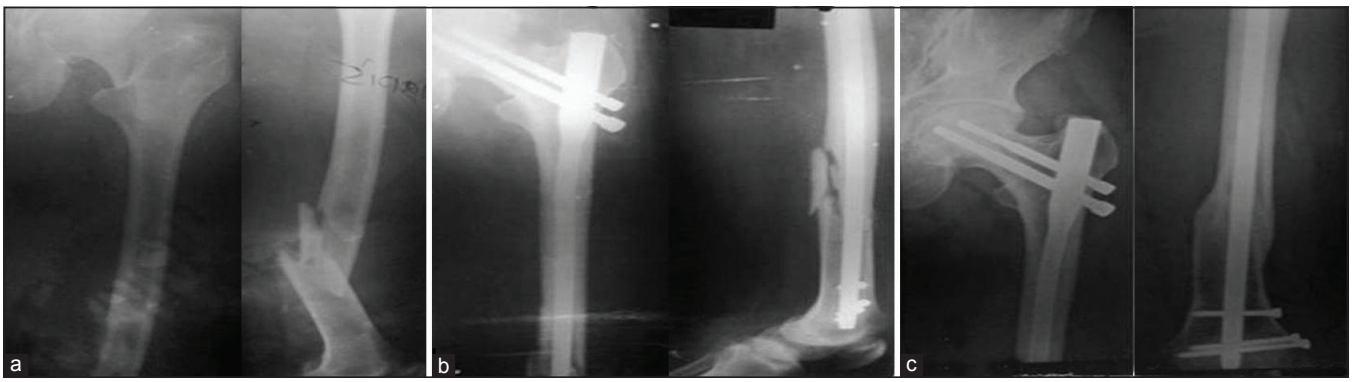

Figure 2: X-ray of shaft femur with hip joint (anteroposterior and lateral views) showing (a) Intracapsular fracture neck femur with shaft (b) 10 days postoperative (c) 10 months after followup healing of both the fractures

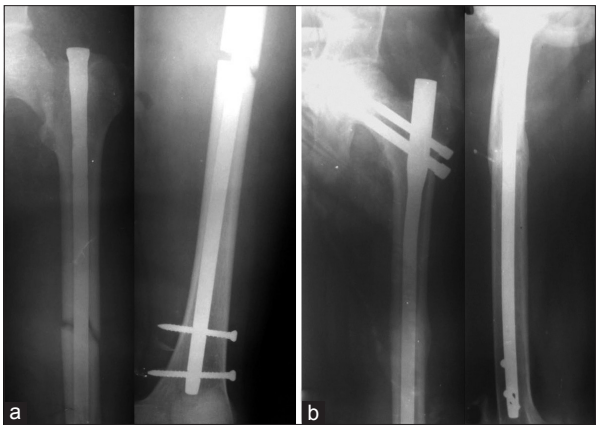

Figure 3: X-ray shaft femur with hip joint (anteroposterior views) showing (a) Missed fracture neck femur (b) X-ray of shaft femur with hip joint (anteroposterior and lateral views) showing revision surgery with PFN. Good union of both the fractures at 12 months followup

of 120-122° which was due to severe osteoporosis detected during the followup. But both the fractures healed. One of the fracture revealed Z effect without penetration in joint after 3 months of the followup. The cervical screw was removed after consolidation. No cases of implant failure (breakage of implant) were noted. Limb shortening of less than 2 cm was noted in four of our patients.

The functional assessment system adopted by Friedman and Wyman[13] was used for evaluating the results. The criteria used to evaluate our results included infection, pain, ability to work, shortening, range of movements at the hip and knee, ability to sit cross legged and squat, and rotational mal-alignment [Table 3]. All these factors were considered when the thirty two patient returned for the followup and four patients were sent questionnaires as they were unable to attend for the followup.

Discussion

Concomitant ipsilateral fractures of the femoral shaft and trochanteric or intracapsular neck fractures results from a force moving in the direction of femur proximally toward the neck of the femur which can occur in dashboard injury.[2] The femoral head, which in such a situation is well contained in the acetabulum, the entire thrust is borne by the femoral shaft and the residual force is responsible for the proximal femoral fracture.

The world literature reveals an incidence of 19-31% of fractures missed during the initial presentation.[2,3] None of the documented cases in the world literature have proved the superiority of a particular treatment protocol over the other. The pendulum has shifted from conservative management to operative treatment and the lack of consensus about best modality of fixation has lead to

Table 3: Functional assemental system adopted from Friedman and Wyman (1986)[13]

Results	Activities of daily living	Pain	Range of motion	Cases (%)
Good	No limitation	Nil	Less than 20% loss of hip or knee-motion	23-63.9
Fair	Mild limitation	Mild to moderate	20%-50% loss of hip or knee motion	11-30.6
Poor	Moderate limitation	Severe	More than 50% loss of hip or knee motion	25.5

94.5 percent of the patient in our series are included into fair to good results

evolution of various techniques and numerous implants over a period of time. Plate fixation of the femoral shaft with lag screws fixation of the femoral neck is widely used in the past.[14,15] The advantages of this technique include reliable and familiar methods of fixation for each fracture. The disadvantages include increased blood loss and periosteal stripping of the femoral shaft, extensive surgical dissection, with potential need for bone graft.

Retrograde nailing for the femoral shaft fractures, ipsilateral femoral neck fractures fixation by cancellous screws, and DHS plate, as suggested by Oh *et al*.[16,17] can provide easy fixation and favorable results are reported. Theoretically, this seems to be an attractive treatment modality, reducing the incidence of damage of blood supply to the femoral head and fixation of the hip fracture independently. We have had a limited experience with this treatment.

''Miss a nail technique'': Nailing for the comminuted femoral fracture and the cancelleous screw fixation around the nail for the fixation of the hip fracture is also an attractive option. The femoral neck fractures using multiple pins and antegrade nailing of the femoral shaft have also been described.[18] Closed reamed antegrade IM nailing with supplemental screw fixation of ipsilateral femoral neck and shaft fractures did not produce uniformly successful results because of the high rates of varus malunion of the femoral neck fracture.[8] The simultaneous fixation of femoral neck and shaft fractures by the minimal exposure method using reconstruction nail has many advantages over other methods, less soft tissue dissection, blood loss, better cosmetic appearance, and shorter hospital stay.[2] The newer types of the reconstruction nails such as Gamma Nails, the Russel Taylor reconstruction nails, and the long PFN have all been gradually added to the armamentarium of the trauma surgeons.[19,20,21] The cephalomedullary femoral reconstruction nails with a trochanteric entry point have recently become more common.[19]

The reconstruction nails available are theoretically and practically the best option when done by closed means

and locked at the either ends. The studies carried out in the anatomic specimens for the suitability of the femoral neck fixation revealed the strength of the reconstruction nail to be 2.5 times superior to the strength of screw fixation of the femoral neck.[20] The two sliding screws for stabilization of the femoral neck with distal locking capability aids the strength and stability. But the central placement of the screw is difficult. Introduction of 135° nail dictates that the screws often come to lie in a superior position on the antero-posterior view. The lack of radiolucent jig for proximal screw insertion makes visualization of the screws on the lateral projection difficult. Introduction of nail requires excessive adduction and flexion which can pose difficulty in fatty and obese patients. The risk of avascular necrosis of the femoral head looms largely due to the damage of the blood vessels at the base of the femoral neck as the nail is driven through the pyriform fossa has been reported by Swiontowski *et al*.[1] Bose *et al.*[21] reported high complication rate after Russel Taylor reconstruction nails. In their series of 11 patients, there were two delayed union, two cases of shortening of the femur, one had a mal-alignment, and three technical errors during the surgery leading to fracture complications.

The Gamma nail is a versatile implant to deal with this complex fracture pattern, but the results with these implants on the Indian femora have not achieved the success like its western counterparts. There is always a risk of fracture shaft femur,[2] by the use of oversized reaming and anterior thigh pain.[22] The single screw placement for the stabilization of the trochanter and neck gives rise to the increased incidence of superior migration of the nail and subsequent varus collapse.

The LPFN is available in 130-135° and has a 6° proximal mediolateral angle to facilitate easy insertion from the trochanter. The nail and screw support proximal head/neck fragment. LPFN allows the temporarily mechanically incompetent but biologically viable fragments to heal around the nail.[23] IM implant itself acts as a buttress to prevent excessive fracture collapse and shaft medialization.

We feel that the long PFN rigidly stabilizes both the factures adequately leading to osseous healing. It also offers the advantage of a reamed and unreamed implantation technique, high rotational stability of the head-neck fragment, and the possibility of static or dynamic distal locking. Almost all the load is transferred to the nail and negligible portion to the medial femoral cortex. Recently, introduced PFNA-long with ipsilateral basicervical femoral neck and shaft fractures was a good option for the treatment of complex fractures, with the advantages of closed antegrade nailing with minimal exposure, reduced perioperative blood loss, and biological fixation of both fractures with a single implant.

The two major complications are nonunion and osteonecrosis. Osteonecrosis represents perhaps the most devastating complication, especially in a young adult. Wiss[8] and co-workers reported a 6% incidence of osteonecrosis at an average followup of 32 months. Swiontkowski *et al.*[1] reported that 2 of 9 (22%) patients who were followed for a minimum of 3 years developed osteonecrosis. Alho[11] found that the incidence of osteonecrosis in ipsilateral femoral neck shaft fractures is less than that in simple femoral neck fracture. In our series, there were 2/36 [6%] cases of osteonecrosis after 2 years. Though numerous authors report a union rate of 100% for both fracture, nonunion of the femoral neck and shaft remains a potential serious complication. Wiss[8] and co-workers reported an 18% incidence in his patients. In our serious there was one case of nonunion of the femoral neck and two cases of the femoral shaft which required revision surgery and secondary grafting with good functional outcome.

The entry portal of the PFN through the trochanter limits the surgical injury predominantly to the tendinous hip abductor musculature only[24] unlike those nails which need the entry through the pyriformis fossa. The stabilizing and the compression screws of the PFN adequately compress the fracture leaving between them a bone block for further revision of the proximal hip should the need arises. Douša *et al.*[25] reported good results of ipsilateral fractures of the proximal femur and the femoral shaft treated by the long PFN in 147 cases. They found results do not differ from those reported by other authors. Our results corroborate with those of Pavleka *et al.*[26] 63.9% good, 30.6 % fair, and 5.5% poor.

We conclude that ipsilateral fractures of the proximal femur and femoral shaft if diagnosed early and treated aggressively by LPFN gives a better functional result by a single implant.

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