

Original Research Article

Management of sub-trochanteric femoral fractures in adults using proximal femoral nail in lateral position: a prospective study

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ABSTRACT

Background: Subtrochanteric fractures are devastating injuries that not only affect the elderly but also the young. Despite marked improvement in implant design, surgical technique and patient care; subtrochanteric fractures continue to consume a substantial proportion of our health care resources.

Methods: This prospective study consists of 20 adult patients of subtrochanteric fractures of femur, who were treated with internal fixation using PFN. All patients were followed up at an interval of 4 to 6 weeks till fracture union and then once in 3 months till 1 year.

Results: Anatomical results are noted as good or poor depending upon shortening, varus deformity, hip movements and knee movements and functional result as excellent, good, fair and poor depending upon the hip pain, ambulatory status, ability to squat, and sit cross leg. In the study 2 patients had shortening of 1 cm. None of the patients had any varus deformity. Overall excellent to good results were achieved in 85% cases.

Conclusions: The potential advantages of the proximal femoral nail over extramedullary devices with regards to minimal invasiveness due to closed technique and minimal soft tissue dissection, better biomechanical design to prevent implant failure and ability to bear more stress, shows that this technique holds considerable promise in complex fractures. Early rehabilitation, less blood loss, less surgical trauma, cosmetic incision, make it the implant of choice in complex, comminuted unstable subtrochanteric fractures in adults.

Keywords: Subtrochanteric region, Proximal femoral nail, Valgus, Non-union, Load-bearing

INTRODUCTION

Hip fractures are nowadays a part of medical emergency in the elderly constituting major reason for hospital admissions and consuming finances. They are further complicated by their major occurrence in the elderly population, who in turn suffer from co-morbid medical conditions making the task of ease of management of such fractures difficult for the treating orthopaedic surgeon. From the evolution of orthopaedic implant in the medical industry a vast inventory of devices was and is available to treat and fix the hip fractures. Of the different

types of hip fractures, subtrochanteric fracture constitutes a challenging variety to treat. Subtrochanteric fractures comprise 10% to 34% of hip fractures.¹ The incidence of these subtrochanteric fractures have increased in the young population in India due to vast increase in motor vehicle use and good roads leading to increase in high velocity trauma. Pertrochanteric and subtrochanteric fractures of femur possess clinical, structural, anatomical and biomechanical characteristics that distinguish them from intracapsular fractures. They are complicated by malunion, delayed union and nonunion. These complications are due to high stress concentration,

predominance of cortical bone, and difficulties in getting biomechanically sound reduction because of comminution and due to deforming forces acting on fracture.² The different implants used for subtrochanteric fixation are roughly classified into load sharing and load bearing implants. The previous implants like fixed angled blade plate and dynamic condylar screws involved open reduction with lots of periosteal stripping and blood loss with subsequent associated risks of infection. Most of the implants widely preferred to be used for these fractures nowadays are load bearing implants like proximal femoral nail (PFN) which can be inserted by minimally invasive technique with lesser incidence of blood loss and subsequent less rates of infection.

METHODS

This prospective study consists of 20 adult patients of subtrochanteric fractures of femur, who were treated with internal fixation using PFN at the Sancheti Institute, Pune, between June 2004 and July 2006. This study was carried out to study the epidemiology of subtrochanteric fractures and to testify the anatomical and functional outcomes of treatment with PFN. All these 20 patients included in the study were followed up at regular intervals. After the patient with subtrochanteric fracture was admitted to the hospital, all the necessary clinical details were recorded in proforma prepared for this study. After discharge, these patients were followed up at regular intervals at the outpatient level for clinical and radiographic evaluation. The patients were followed up till fracture union and functional recovery after surgery. As soon as the patient with suspected subtrochanteric fracture was seen in the casualty, necessary clinical and radiological evaluation was done and the patient was immobilized using skeletal traction (upper tibial pin). All the patients were evaluated with routine investigation before surgery and fitness for surgery and consent for the operation were taken.

Statistical analysis

Statistical analysis was carried out on SPSS 16.0 version (Chicago, Inc., USA). The results are presented in mean \pm SD and percentages. The anatomical and functional results were compared by using Wilcoxon rank sum test. The $p < 0.05$ was considered significant

Surgical technique

All patients were operated under spinal and/or epidural anaesthesia. The patient was placed in lateral position on a radiolucent table with adduction of the affected limb by 10 to 15 degrees and the unaffected limb was partially flexed at the hip and the knee to prevent it from interfering with image intensification (Figure 1). The advantage of lateral position is easy identification of greater trochanter and entry point, useful in obese patients, easy to achieve reduction by open reduction technique and ease in placing distal locking screws. The

tip of the greater trochanter was located by palpation and a longitudinal incision was taken; length depending upon whether closed or open procedure was contemplated. The incision started 4 to 5 cms proximal to the tip of the greater trochanter. A parallel incision was made in the fascia lata and the gluteus medius was split in line with its fibers. Tip of the greater trochanter was exposed. In some cases the fracture was open reduced and stabilized with a circular wire or interfragmentary screws before proceeding with the nail insertion. In other cases, however, the fracture was closed reduced by traction and gentle rotation and the nail inserted.

The entry site is at the tip of the greater trochanter at its centre as confirmed by C-arm in both anteroposterior and lateral views. The entry site is opened with an awl. The guide wire is then inserted in the centre of the medullary cavity. Over the guide wire flexible reamer is inserted through the tissue protecting sleeve and reaming is done. After confirming satisfactory fracture reduction, the appropriate sized nail as determined preoperatively was assembled to the insertion handle and inserted manually as far as possible. This step was done carefully without hammering, just by twisting movements of the hand. In cases where satisfactory reduction was not possible, open reduction was done. The nail was then inserted completely in the femur till the proximal tip was flush to the tip of the greater trochanter. Then guide wire inserted with the help of the aiming device. Drilling is done over the guide wire with 6.4 mm drill bit to the desired length and confirmed by C-arm. Tapping is not done as the neck screw is self-tapping and appropriate length screw is inserted. Final position confirmed on C arm. Distal locking is performed with two locking bolts. After the fixation, thorough lavage is given with normal saline. Hemostasis is achieved and incision is closed in layers over suction drain. Sterile dressing is applied over the wound and compression bandage is given.

Postoperative protocol

Drain removal done by 48 hours. The epidural catheter was kept for 48 hours for postoperative analgesia. Sutures removed between 12th to 14th postoperative day. Patients were encouraged to sit in bed 24 hours after surgery. Static quadriceps exercises and knee mobilization was started in the immediate postoperative period. Gait training was started as per individual pain tolerability before discharge. Non weight bearing mobilization was done in comminuted unstable fractures, but in stable fractures, partial toe touch weight bearing was started early with two axillary crutches or a walker.

Follow up

All patients were followed up at an interval of 4 to 6 weeks till fracture union and then once in 3 months till 1 year. At each visit, patients were assessed clinically regarding hip and knee function, walking ability, fracture union, deformity and shortening. Fresh x-rays were taken

during each visit till fracture union progressive partial weight bearing was taught with help from physiotherapist up to full weight bearing.

RESULTS

Functional outcome of surgery was done on the basis of Anatomical results in to good or poor depending upon shortening, varus deformity, hip movements and knee movements And Functional result in to excellent, good, fair and poor depending upon the hip pain, ambulatory status, ability to squat, and sit cross leg. In our series maximum age was 86 years and minimum age was 21 years. Most of the patients were in the age group of 28 to 75 years with mean of 53.33 years. In this series with 20 patients 12 were males and 8 were females. This shows preponderance of males over females. Out of 20 cases, 7 gave history of motor vehicular accidents, suggestive of high energy trauma, 4 gave history of fall from height, while 9 gave history of slip and fall. None of our patients had any associated bony injuries. In 10 cases left side was affected and in the remaining 10 cases, right side was affected. We used the Seinsheimer classification.

Table 1: Intra operative complications.

Complication	Number of cases	%
Fracture of anterior cortex	01	5
Fracture displacement by nail insertion	00	00
Failure to get closed reduction	07	35
Jamming of nail	00	00
Failure of distal locking	00	00
Drill bit breakage	01	5
Varus angulation	00	00

Table 2: Delayed complications.

Complications	Number of cases	%
Hip stiffness	04	20
Knee stiffness	00	00
Delayed union	01	5
Non union	00	00
Shortning >1 cm	00	00
Malunion	00	00
Implant failure/screw cut out	00	00
Hip pin backout	01	5

Table 3: Functional result.

Functional results	Number of cases	%
Excellent	11	55
Good	06	30
Fair	03	15
Poor	00	00

All the cases in our study group were fresh fractures who underwent surgery as early as possible according to the medical fitness of the patients. All patients were operated at an average interval of 2 days from the date of trauma. In our study, we encountered certain complications intra operatively. In 7 patients, due to comminution and postero-medial cortical void, open reduction was required. In 1 patient, there was perforation of the anterior cortex of femoral shaft due to the distal tip of the nail for which mobilization was delayed for 4 weeks. There was 1 case of drill bit breakage, which occurred while drilling for the hip pin due to mismatch in the jig. In 1 case there was heavy bleeding from one of the deep perforators while passing the circular wire around the femur which was explored and ligated (Table 1). None of our patients had any significant postoperative complication. There were no wound healing problems. 1 patient had delayed union. 2 patients with comminuted fractures and closed nailing done had shortening of 1 cm. 1 patient had backing out of the hip pin which required removal of the hip pin. 4 patients (20%) had restriction of terminal hip flexion. None of our patients had knee stiffness due to the fracture and surgical procedure. Since many patients were from the elderly age group, knee osteoarthritis was present pre injury. None of our patients required bone grafting. There was no varus malunion or nonunion. There was no mortality recorded in our series till fracture union. No case of implant breakage or cutting out of screws was recorded. No case of superficial or deep infection was recorded (Table 2).

In our study, the average duration of hospital stay was 13.46 days. The mean time for full weight bearing was 14.35 weeks. All patients enjoyed full pre injury range of motion at knee joints. 20% patients had 10 to 20 degree terminal restriction of hip flexion. Postoperative mobility was aided in the immediate postoperative period but later all patients were ambulatory independently with or without walking aids. In our study anatomical results were assessed by presence/absence of deformities, shortening, and hip and knee range of movements. In the study 2 patients had shortening of 1 cm. None of the patients had any varus deformity. 4 patients had terminal 10 to 20 degrees of hip flexion restriction. All patients achieved full pre injury range of movements at knee joints. Some patients had pre injury restriction of knee range of movements due to preexisting osteoarthritis. And functional result was assessed by the scoring system framed by Kyle et al overall excellent to good results were achieved in 85% cases (Table 3).

Case 1

Comminuted subtrochanteric fracture with inter trochanteric extension Seinsheimer type 5 in a 28 years old male sustained in high velocity road traffic accident operated with closed reduction internal fixation with a long PFN showing good union and function.

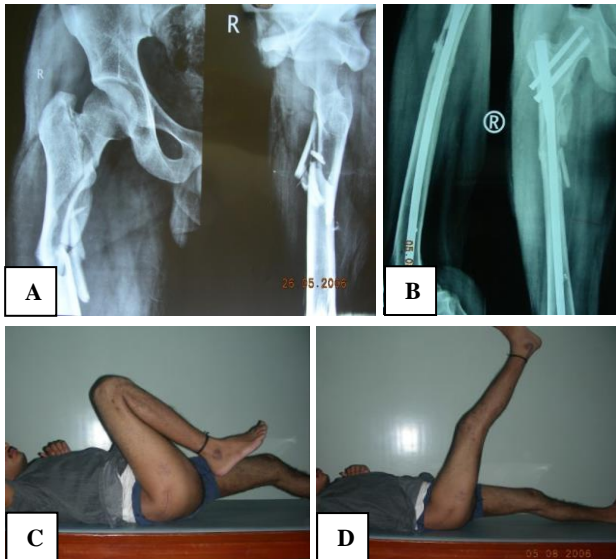


Figure 1: Case 1. A= preoperative X-rays; B=after 12 weeks; C, D= function after 12 weeks.

Case 2

Seinsheimer type 3 A fracture in a 59 years old male treated with open reduction internal fixation with cerclage wires and long PFN, showing rapid fracture healing and full range of movement at hip and knee joints with ability to squat and sit cross legged in 12 weeks.

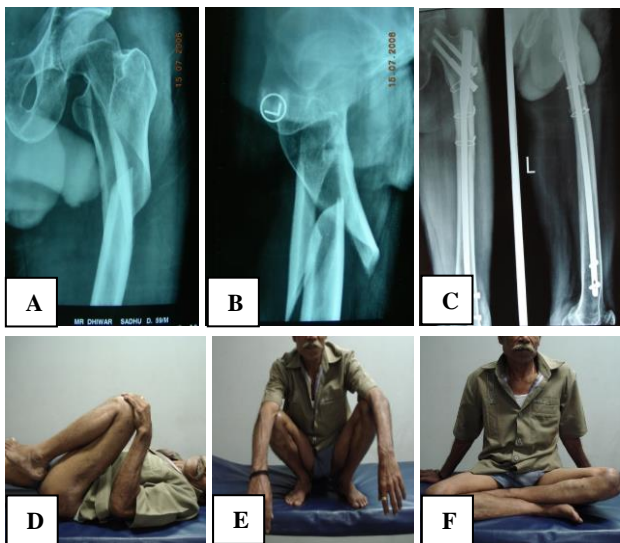


Figure 2: Case 2. A, B= preoperative X-rays; C= after 12 weeks; D-F= function after 12 weeks.

DISCUSSION

Of all the total types of pertrochanteric hip fractures, subtrochanteric fracture fixation constitute major chunk of failed fixations. Biomechanical reasons, craze of new implants or lack of adherence to time tested procedures, high stress concentration due to muscle pull deforming forces, delayed healing time because of predominance of

cortical bone, low vascularity of this particular region of the femur constitute to high incidence of complications reported after surgical treatment compel the surgeon to give a second thought regarding selection of proper implant.^{3,4}

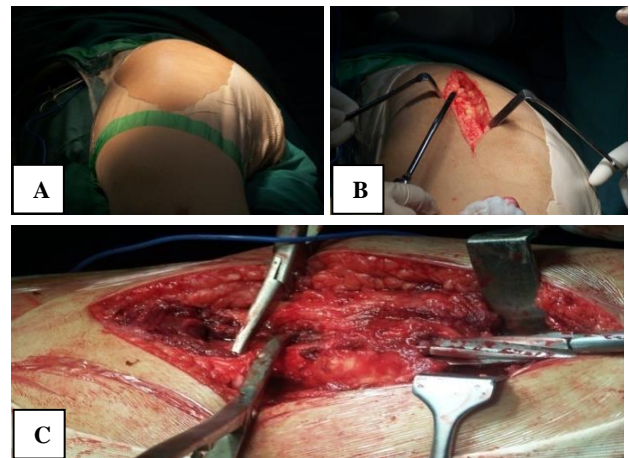


Figure 3: A= lateral position exposing greater trochanter (GT); B= incision over GT; C= entry through GT.

The different types of fixation are 95 degree blade plate system, sliding screw systems and intra medullary devices. From the mechanical point of view, an intramedullary device inserted by a minimally invasive procedure seems to be better in elderly patients.⁵ Closed reduction of the fracture preserves the fracture hematoma.⁶ Intramedullary fixation allows the surgeon to minimize soft tissue dissection thereby minimizing surgical trauma, blood loss, and infection and wound complications.⁷ PFN is a novel intramedullary implant based on experience with the gamma nail.³The Gamma nail has a high learning curve with technical and mechanical failure rates of about 10% (collapse of the fracture area, cut out of the implant, stress fracture of the femoral shaft near the tip of the implant etc).^{8,9} The Gamma nail is susceptible to failure at its weakest point--the lag screw-implant interface.¹⁰ The Arbeitsgemeinschaft fur Osteosynthesefragen (AO/ASIF) in 1996, therefore developed the proximal femoral nail with a de-rotational hip pin together with a smaller diameter distal shaft which reduces stress concentration to avoid these failures.¹¹ The PFN has all the advantages of an intramedullary device such as decreasing the moment arm, load sharing device, insertion by closed technique and ability to withstand high biomechanical loads in the sub-trochanteric area. It also has provision for stabilization of associated inter trochanteric fractures. In comparison to the Gamma nail, we found no fracture of the femoral shaft at the distal nail tip and no break in the implant.⁷⁻⁹ This probably occurs due to the smaller shaft diameter of the PFN which reduces stress concentration at the tip.¹² In an experimental study, Gotze et al, compared the loadability of osteosynthesis of unstable per and subtrochanteric fractures and found that

the PFN could bear the highest loads of all devices. Simmermacher et al, in a clinical multicenter study, reported technical failures of PFN after poor reduction, malrotation, or wrong choice of screws in 5% of cases.

In our study, there was no case of mal-reduction, however there was 1 cm shortening in 2 cases. In these 2 cases, closed procedure was done and due to comminution, exact anatomical reduction was not possible. A cut out of the neck screw occurred in 0.6% in the study conducted by Simmermacher but we did not encounter this complication in our study, rather in 1 case there was backing out of the hip pin which was removed but the fracture had united by then. Anatomical fracture reduction was found in 90% cases. This was achieved by open (65%) or closed methods (35%). Additional fixation in the form of circular wiring or interfragmentary screw was used in 35% patients to give extra stability after anatomical reduction. Intraoperative fracture displacement during introduction of nail has not been reported with the Gamma nail however, this has been a problem with the PFN especially in fractures extending into the tip of greater trochanter which is the entry site of the nail.^{7,9} We had no cases of intraoperative fracture displacement in our study. This is attributable to two reasons. Firstly, if such a fracture morphology was noted it was temporarily stabilized with two Kirschner wires to prevent displacement during insertion of the nail. In this regard, it is worthwhile noting that Indian make PFN with smaller proximal diameter of 15 mm is more suitable for use in such situations than the standard PFN having 17 mm proximal diameter. Secondly, if the entry site appeared to be too badly shattered, we preferred to use the 95 degree angle blade plate instead of the PFN to prevent this potential complication. It was also observed especially in long spiral and reverse oblique fractures that intraoperatively, insertion of the nail would cause fracture reduction. Such nail guided reduction helped us to obtain closed reduction in seemingly difficult fractures. We observed that in cases with long spiral fractures with or without butterfly fragments, meticulous open reduction with minimum soft tissue stripping and supplementary fixation with circular wiring restores anatomy and provides good bone to bone contact; a factor conducive for rapid fracture healing due very large fracture surface area. Such patients in our study, showed early fracture union and earlier return to full hip and knee range of motion. On the other hand, some patients with similar fractures, but treated with closed nailing, took longer time for fracture union and for regaining the hip range of movement and were prone to shortening also. To conclude, the decision for open versus closed nailing should be individualized to the case depending on the fracture personality. We prefer to opt for an open procedure with circular wiring for the right case, since our study shows that restoration of anatomy and good bone to bone contact with maximum soft tissue preservation are key factors for an optimal result. For more distal subtrochanteric fractures, fractures with comminution, reverse oblique fractures and in osteoporotic bones, the results with PFN are better than

sliding hip screws (DCS and DHS).¹³ In fact, a reverse oblique subtrochanteric fracture is one of the contraindications for use of the DHS, where the surgeon should use either an intramedullary implant or a 95 degree implant.

In our study subtrochanteric fractures were more common with motor vehicular accidents and fall. Age distribution was from 21 to 82 years with mean age of 51.5. Males were more in number in our study contributing to 60% of cases. The incidence of fractures on right and left side was found to be equal. In the study, Seinsheimer type 3A fracture was most common (45%) followed by type 2 a (15%) and type 5 (15%). According to Russel Taylor classification, type 1B was most common (50%) followed by type 1A. The mean duration of radiation exposure was 80 seconds, mean duration of surgery was 100 minutes, and mean blood loss was 300 ml. In 35% patients, open reduction was done with additional fixation in form of cerclage wiring or IFS. 1 patient (5%) had iatrogenic fracture of the anterolateral cortex while inserting a long PFN. Delayed union was observed in 1 patient, but the fracture united without any further intervention. None of our patients required any secondary procedure. There was 1 case (5%) of drillbit breakage and 1 case (5%) of back out of hip pin. There was no case of implant breakage, stress fracture, cut out of screws or jamming of nail. Some difficulty is also encountered in intraoperative imaging due to radio opacity of the jig. 1 extra assistant is also required to give traction and to maintain correct rotation, since we operated all our cases in lateral position on a radiolucent operating table. There is a risk of shattering the lateral femoral cortex while drilling for the proximal screws if it is too close to the fracture at the lateral cortex. The fixed CCD angle of 130 or 135 degrees sometimes unables the surgeon to pass the hip pin which tends to go beyond the superior margin of the femoral neck.

In cases with large displaced butterfly fragments, we preferred to get an anatomical alignment by open reduction and internal fixation using circular wiring. We found that there was no increase in the fracture healing time when this open technique was used, provided minimal damage to soft tissue attachments was done. Better anatomical as well as functional results were obtained with this technique. Overall, the whole procedure is highly demanding and dependent on instrumentation and imaging. None of the patients in our study had any associated injuries or fractures. The mean duration of hospital stay was 13.46 days and the mean time for full weight bearing was 14.35 weeks. Post operatively, all patients were ambulatory of which 8 required walking aid in form of stick support (7 patients) and walker (1 patient). 2 patients who had 1 cm shortening were given compensatory shoe raises.

CONCLUSION

Subtrochanteric fractures are common in high velocity trauma. High stress concentration, slow healing time and

difficulties in getting biomechanically sound reduction has led to evolution of various internal fixation devices. In spite of this, the incidence of complications is high after surgical treatment. The potential advantages of the Proximal Femoral Nail over extramedullary devices is minimal invasiveness due to closed technique, minimal soft tissue dissection, better biomechanical design to prevent implant failure and ability to bear more load as it is load bearing implant and decreased abductor lever arm. The advantage of lateral position is easy identification of greater trochanter and entry point, useful in obese patients, easy to achieve reduction by open reduction technique and ease in placing distal locking screws.. With our sample study, we conclude that the Proximal Femoral Nail is an excellent implant for the treatment of complex, unstable sub trochanteric fractures of the femur.

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