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RESEARCH ARTICLE

TO STUDY THE MANAGEMENT OF PROXIMAL FEMORAL FRACTURES BY PROXIMAL FEMORAL NAIL

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ABSTRACT

Peritrochanteric fractures mainly comprise of fractures of trochanter and subtrochanteric region. Despite marked improvements in implant design, surgical technique and patient care, peritrochanteric fractures continues to consume a substantial proportion of our health care resources.

Trochanteric fractures are common in the elderly people. The more latest implant for management of trochanteric fractures is proximal femoral nail, which is also a collapsible device with added rotational stability. This implant is a centromedullary device and biomechanically more sound. It also has other advantages like small incision, minimal blood loss.

Aims and Objectives is to study the management of proximal Femoral fractures by proximal Femoral nail and to study perioperative difficulties and postoperatitve outcome in these fractures.

Material and Methods: The present study consists of 25 adult patients of peritrochanteric factures of femur, who are treated with Proximal Femoral nail. Patient were followed up six weeks, three months, six months and 12 months. Movements, union and limb length were assessed clinically and postoperative complications like delayed union, nonunion, malunion and implant failure were studied radiologically during these visits. Modified Harris Hip Score was used for evaluation of hip function.

Observation and Results: In our series of 25 operated cases, 3 cases were expired before first follow up due to other medical problems and old age. 3 cases were lost follow
up after first follow up. So taking into consideration of 19 cases of which we had 12 months regular follow up, by using Modified Harris Hip Score we got 47.37% excellent, 47.37%good and 5.26%poor results. Complications like malunion and shortening of more than 1 cms was seen in 1 case each and implant failure was seen in 3 cases.

Conclusion: Though the learning curve of this procedure is steep, with proper patient selection, good instrumentation, image intensifier and surgical technique, PFN remains the implant of choice in the management of Peritrochanteric fractures.

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INTRODUCTION

Peritrochanteric fractures are devastating injuries that most commonly affect the elderly and also in young, have a tremendous impact on both the health care system and society in general. Peritrochanteric fractures mainly comprise of fractures of trochanter and subtrochanteric region. Despite marked improvements in implant design, surgical technique and patient care, peritrochanteric fractures continues to consume a substantial proportion of our health care resources. Trochanteric fractures are common in the elderly people.

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The frequency of these fractures has increased primarily due to the increasing lifespan and more sedentary life style brought on by urbanization. Trochanteric fractures occur in the younger population due to high velocity trauma, whereas in the elderly population it is most often due to trivial trauma. The incidence of trochanteric fractures is more in the female population compared to the male due to osteoporosis. In a Swedish study of more than 20,000 patients, the incidence of hip fractures in women doubled every 5.6 years after the age of 30 years. (The association of age, 1993) The trochanteric fractures can be managed by conservative methods and there is usually union of the fracture. If suitable precautions are not taken the fracture undergoes malunion, leading to varus and external rotation deformity at the fracture site and shortening and limitation of

hip movements. It is also associated with complications of prolonged immobilization like bedsores, deep vein thrombosis and respiratory infections. Since this fracture is more common in the elderly patients, the aim of treatment should be prevention of malunion, and early mobilization. Taking all the factors into consideration surgery by internal fixation of the fracture is ideal choice. There are various forms of internal fixation devices used for Trochanteric Fractures; of them the most commonly used device is the Dynamic Hip Screw with Side Plate assemblies. This is a collapsible fixation device, which permits the proximal fragment to collapse or settle on the fixation device, seeking its own position of stability. The more latest implant for management of trochanteric fractures is proximal femoral nail, which is also a collapsible device with added rotational stability. This implant is a centromedullary device and biomechanically more sound. It also has other advantages like small incision, minimal blood loss. Pertrochanteric and subtrochanteric fractures of femur posses clinical, structural, anatomical and biomechanical characteristics that distinguish them from intracapsular fractures. Subtrochanteric fractures comprises about 10 to 34% of hip fractures. (David G.Lavelle, 2008) Subtrochanteric fractures are complicated by malunion and delayed or nonunion. The factors responsible for these complications in subtrochanteric fractures are high stress concentration, predominance of cortical bone and difficulties in getting biomechanically sound reduction because of comminution and intense concentration of deforming forces. (Kyle Richard and Campbell Sara, 1998) The present choice of treatment of subtrochanteric fractures is open reduction and internal fixation. Many internal fixation devices have been recommended for use in subtrochanteric fractures, because of high incidence of complications reported after surgical treatment with each implant. A lack for satisfactory implant in surgical treatment of subtrochanteric fractures has led to series of evolution in design of a perfect implant. Subtrochanteric femoral fractures are associated with high rates of non-union and implant failure, regardless of the method of fixation. Only recently has a better understanding of biology, reduction techniques and biomechanically improved implants allowed for subtrochanteric fractures to be addressed with consistent success. In spite of the advances in anesthesia, nursing care and the surgical techniques, hip fractures remain a significant cause of morbidity and mortality in the elderly population. In view of these considerations, the present study of Surgical Management of Peritrochanteric Fractures is taken up.

Aims and Objectives

To study the management of proximal Femoral fractures by proximal Femoral nail. To study perioperative difficulties and postoperatitve outcome in these fractures.

Proximal Femoral Nail

In 1996, the AO/ASIF developed the proximal femoral nail (PFN) as an intramedullary device for the treatment of unstable per-, intra- and subtrochanteric femoral fractures. Proximal femoral nail has all the advantages of an intramedullary device, such as decreasing the moment arm, can be inserted by closed technique, which retains the fracture hematoma an important consideration in fracture healing decreases blood loss, infection, minimizes the soft tissue dissection and wound complications. (Ely L Steinberg *et al*., 2005) In addition to all advantages of a nail to be implanted intramedullarily, it has several other favorable characteristics. Pre-drilling is not necessary, it can be dynamically locked, it has a high rotation stability, and mechanical stress concentration on the implant-bone interface is low. (Ely L Steinberg *et al*., 2005) The currently used Gamma nail as an intramedullary device also has a high learning curve with technical and mechanical failure rates of about 10% (collapse of the fracture area, cut-out of the implant, fracture of the femur shaft). (Albareda *et al*., 1996; Valverde *et al*., 1998) The Arbeitsgemeinschaft fur Osteosynthesefragen (AO ASIF) therefore developed the proximal femoral nail with an antirotational hip pin together with a smaller distal shaft diameter to avoid these failures.

In an experimental study, Gotze *et al*. (1998) compared the loadability of osteosynthesis of unstable per-and subtrrochanteric 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 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%. (Simmermacher *et al*., 1999) Christian Boldin *et al*. found no fracture of the femoral shaft and no break in the implant, in comparison to the Gamma nail. This is because of the tapered narrow tip of the nail which prevents the stress concentration. (Christian Boldin *et al*., 2003) Harris, I Rahme, D in their study of subtrochanteric femur fractures treated with a PFN compared to a 95 degree blade plate found that the fixation failure rated was 24% in the blade plate group. There no fixation failures in the PFN group. (Harris *et al*., 2003)

MATERIALS AND METHODS

The present study consists of 25 adult patients of peritrochanteric factures of femur, who are treated with Proximal Femoral nail. This study was carried out to testify the anatomical and functional outcomes of treatment with proximal femoral nail. All these 25 patients included in the study were followed up at regular intervals up till one year after surgery. As soon as the patient with suspected subtrochanteric or trochanteric fracture was seen, necessary clinical and radiological evaluation done and admitted to the ward after necessary resuscitation and splintage using skin traction. All routine preoperative investigations were done. Nail diameter was determined by measuring diameter of the femur at the level of isthmus on an AP x ray. Neck shaft angle was measured on the unaffected side on an AP x-ray using goniometer. A standard length PFN nail (250mm) is used in all our cases. Determination of diameter of the neck on AP x-ray.

Proximal femoral nail implant details

The implant consists of a proximal femoral nail, self tapping 6.5mm hip pin, self tapping 8 mm femoral neck screw, 4.9 distal locking screws, and an end cap. Proximal femoral nail is made up of either 316L stainless steel or titanium alloy which comes in following sizes.

1) Length: standard PFN –250 mm. Long PFN- 340, 380, 420mm.
2) Diameter: 9,10,11,12 mm
3) Neck shaft angle range: 1250, 1300,1350

The nail is having 14mm proximal diameter. This increases the stability of the implant. There is 60 mediolateral valgus angle, which prevent varus collapse of the fracture even when there is medial comminution. The distal diameter is tapered to 09 to 12 mm which also has grooves to prevent stress concentration at the end of the nail and avoids fracture of the shaft distal to the nail. Proximally it has 2 holes the distal one is for the insertion of 8 mm neck screw which acts as a sliding screw, the proximal one is for 6.5 mm hip pin which helps to prevent the rotation. Distanec between the two holes is 25mm which hepls in pre op evalution to decide wheather the two screw are going to fit or not because there is short neck in Indian patients. Distally nail has two holes for insertion of 4.9 mm locking screws, of which one is static and the other one is dynamic which allows dynamization of 5 mm.

Patient positioning and fracture reduction

The patient was placed in supine position on fracture table with adduction of the affected limb by 10 to 150 and closed reduction of the fracture was done by traction and gentle rotation. The unaffected leg was flexed and abducted as far as possible in order to accommodate to image intensifier. The image intensifier was positioned so that anteriorposterior & lateral views of the hip and femur could be taken. The patient was then prepared and draped as for the standard hip fracture fixation. Prophylactic antibiotic was given to all patients 30 minutes before surgery.

Percutaneous fixation of fracture: In Trochanteric fractures we fixed the fracture percutaneously using two “k”wires which pass along the anterior cortex of greater trochanter and neck of femur into the head of femur. By doing so we can prevent the fracture opening up on adduction of limb for nail insertion.

Approach : The tip of the greater trochanter was located by palpation in thin patients and in hefty patients we used image intensifier and 5 cms longitudinal incision taken proximal from the tip of the greater trochanter. A parallel incision was made in the fascia lata and gluteus medius was split in line with the fibres. Tip of the greater trochanter is exposed.

Determination of the entry point and insertion of guide wire : In AP view on C-arm, the entry point is on the tip or slightly medial to the tip of the greater trochanter. In lateral view, guide wire position confirmed in the center of the medullary cavity. The guide wire is inserted in this direction to a depth of 30cms with a T handle.

Opening of the femur: Over the guide wire, a cannulated rigid reamer is inserted through the protection sleeve and manual reaming was done as far as the stop on the protection sleeve.

Insertion of the PFN: After confirming satisfactory fracture reduction an appropriate size nail as determined pre operatively was assembled to the insertion handle and inserted manually as far as possible into the femoral opening. This step was done carefully without hammering by slight twisting movements of the hand until the hole for 8mm screw is at the level of inferior margin of neck. In cases where satisfactory reduction was not possible by closed means, open reduction was done.

Insertion of the guide wire for neck screw and hip pin: These are inserted with the help of the aiming device tightly secured to the insertion handle and using the drill sleeve systems. A 2.8 mm guide wire was inserted through the drill sleeve after a stab incision with its position in the caudal area of the femoral head for neck screw. This guide wire is inserted 5 mm deeper than the planned screw size. The final position of this guide wire should be in the lower half of the neck in AP view and in the center of the neck in lateral view. Proper positioning of the nail will aid in proper anteversion of the neck screw as there is inbuilt anteversion in the hole on the nail. A second 2.8 mm guide wire is inserted through the drill sleeve above the first one for hip pin. The tip of this guide wire should be 5mm deeper than the planned hip pin but approximately 25-20 mm less deep than planned neck screw.

Insertion of the hip pin: The hip pin is inserted first to prevent the possible rotation of the medial fragment when inserting the neck screw. The length of the hip pin is indicated on measuring device and is calculated 5 mm before the tip of the guide wire. Drilling is done over the guide wire with 6.5 mm drill bit to a depth upto the length of hip pin previously measured. The same length 65 mm hip pin is inserted with the help of hexagonal cannulated screwdriver. Length and position to be confirmed with C-Arm Guide wire is then removed.

Insertion of the neck screw: A measuring device is inserted over the 2.8 mm guide wire until it touches the bone. The correct length is indicated on the measuring device and calculated to end approximately 5 mm before the tip of the guide wire. This length is set on the 8 mm reamer by securing the fixation sleeve in correct position. Drilling is done over 2.8 mm guide wire till the fixation sleeve prevents further drilling. Tapping is not done as the neck screw is self tapping. Neck screw is inserted using cannulated screw driver. Final position confirmed with image intensifier in which position of the nail tip and screw tip at horizontal level to be stressed.

Distal locking: Distal locking is usually performed with two cortical screws. For standard PFN, aiming was used. A drill sleeve system was inserted through a stab incision. A drill hole is made with 4 mm drill bit through both cortices length is measured directly from the drill marking. Locking screw is inserted through protection sleeve position confirmed with image intensifier.

Closure: After the fixation is over, lavage is given using normal saline. Incision closed in layers. Sterile dressing is applied over the wounds and compression bandage given.

After treatment: Postoperatively, patients pulse, blood pressure, respiration, temperature were monitored. Foot end elevation is given depending on blood pressure. Antibiotics were continued in the post operative period. Analgesics were given as per patients compliance. Blood transfusion was given

depending on the requirement. Sutures removed on 10th postoperative day. Patients were encouraged to sit in the bed after 24 hours after surgery. Patients were taught quadriceps setting exercises and knee mobilization in the immediate post operative period. Patient was taught gait training before discharge from the hospital. Only in very unstable fracture patterns weight bearing was not advised. Rest of the patients were encouraged to weight bear partially with axillary cruthes or walker depending on the pain tolerability of individual patient.

Discharge: Patients were discharged from the hospital when independent walking was possible with or without walking aids.

Follow up : Patient were followed up six weeks, three months, six months and 12 months. Movements, union and limb length will be assessed clinically and postoperative complications like delayed union, nonunion, malunion and implant failure will be studied radiologically during these visits. Average time for union will be studied At every visit patient was assessed clinically regarding hip and knee function, walking ability, fracture union, deformity and shortening. At the end of 12 months results will be assessed by Modified Harris Hip score. As per this score results will be graded as excellent; good and poor. X-ray of the involved hip with femur was done to assess fracture union and implant bone interaction.

Intraoperative difficulties and solutions difficulties'

- When there is medial or posterior void due to comminution because of this malpostion of the nail in the proximal fragments not correcting abduction flexion though it was properly placed in the distal fragment.
- Angulation and displacement of proximal fragment Because of excessive abduction and flexion it was difficult to obtain proper entry portal and anatomaical reduction at fracture site.
- When there was marked dispalcement or sagging of the distal fragment.
- Technical difficulties of instrumentation.

Solution

- We used two K wires for holding the reduction percutaneously before taking incision.
- We also use shwans pin for doing reduction in some difficult cases.
- So we feel these solutions are useful to encounter the difficulties occur intraoperatively.

OBSERVATIONS AND RESULTS

In our series maximum age was 90 years minimum is 40 years. Most of the patients were between 60-80 years. Average mean age is 67.84 years. In our study males are predominant contributing 17(68%) and females are 8(32%). In our study household trauma accounting 21(84%) and RTA 4(16%). Right is more common 14(56%) than left 11(44%). As per Fracture AO classification (Table-1) In this study A2 type of fractures are more common contributing 68%, A1 and A3 type of fractures are 16% each.

Table 1. Type of Fracture according to AO classification

Type of fracture	No of cases	Percentage
A1-1	0	-
A1-2	3	12%
A1-3	1	4%
A2-1	2	8%
A2-2	7	28%
A2-3	8	32%
A3-1	1	4%
A3-2	0	-
A3-3	3	12%

In our study we consider the various intraoperative parameters such as duration of surgery, blood loss and difficulty in reduction. Duration of surgery was more for the initial operated cases. More in case in which we had to do open reduction for the fracture. Blood loss measured by mop count (each fully soaked mop containing 50ml blood). More loss was seen in patients who require open reduction. In our study we had one case in which proximal fragment goes in to flexion and adduction in which we had difficulty in reduction for this we had to do open reduction and then fix the fracture. Mean duration of operation (min.) 81.60. Mean blood loss (ml) 109.00. In our study mean hospital stay was 18.64 days. We had 19 cases of signs of union i.e. callus formation at fracture site In 6 weeks and 3 cases of no signs of union at 6 weeks in which we had implant failure. We lost follow up of 3 cases before first follow up. All the 19 cases which showed early signs of union at 6 weeks were followed up and at the end of 3 months they showed progressive callus formation. Three cases of no signs of union at 6 weeks had lost follow up after that.

Postoperative complications (Table-2): We had no cases of wound infection postoperatively. We encounter three cases of implant failure like backing out of the proximal screws, maluninon, z effect and cut out of the neck screw. We had one case of shortening more than 1 cm. We had no cases of non union and delayed union.

Table 2. Postoperative complications

Complication	No. of cases	Percentage
Knee joint stiffness	0	
Delayed union	0	
Non union	0	
Mal union	1	4%
Shortening >1 cm	1	4%
Implant failure	3	12%

In our series of 25 operated cases, 3 cases were expired before first follow up due to other medical problems and old age. 3 cases were lost follow up after first follow up. So taking into consideration of 19 cases of which we had 12 months regular follow up. In our study we used Modified Harris Hip Score for evaluation of hip function (Table 3). Results were grade as excellent, good and poor.

Table 3. Results by Modified Harris Hip Score

Result	No of cases	Percentage
Excellent	9	47.37%
Good	9	47.37%
Poor	1	5.26%

DISCUSSION

The treatment of peritrochanteric fracture of proximal femur is still associated with some failures. Before the introduction of proper implant usually these fractures were treated conservatively till 1960. Due to this majority of patients landed in the complications like Malunion Nonunion Bedsore DVT Hypostatic pneumonia. To avoid these complications immediate mobilisation of the patient and restoration of good length operative methods for the choice of the treatment. Varieties of implants were introduced from earlier life Smith Peterson nail, Jewette nail, DHS, Richard's screw and recently used gamma nail reconstruction nails. All the implants had some advantages and disadvantages. Jewette nail fixed angle nail, plates had the complication like penetration of the nail and cut through superior portion of the head. Later on sliding hip screw was introduced but its use in unstable fracture femur was not good due to excessive collapse. Development of intramdellary device gamma nail or reconstruction nail which having advantage of shorter lever arm with load sharing device. These intramedullary device allows the surgeon to minimize soft tissue dissection there by reducing surgical trauma, blood loss, infection and wound complication. PFN is a novel, modern intramedullary implant based on experience with the gamma nail. The currently used gamma nail as an intramedullarydevice also has a high learning curve with technical and mechanical failure rates of about 10%.The gamma nail is susceptible to fail at its weakest point, the lag screw-implant interface. The Arbeitsgemeinschaft fur osteosynthesefragen (AO ASIF) in 1996, there fore developed the proximal femoral nail with an antirotational hip pin together with a smaller distal shaft diameter which reduces stress concentration to avoid these failures. Proximal femoral nail has all advantages of an intramedullary device, such as decreasing the moment arm, can be inserted by closed technique, which retains the fracture haematoma an important consideration in fracture healing, decrease blood loss, infection, minimizes soft tissue dissection and wound complications.

In an experimental study, Gotze *et al*. (1998) compared the loadability of osteosynthesis of unstable per and subtrochanteric fractures and found that the PFN could bear the highest loads of all devices. (Gotze *et al*., 1998) Proximal femoral nail had all advantages of an intramedullary device such as decreasing lever arm, can be inserted by close technique which retains the fracture hematoma an important consideration in fracture healing. It decreases the blood loss, infection, minimizes soft tissue dissection and wound infection. The assessment criteria for the efficacy of the surgical technique include duration of surgery, difficulty in reduction and blood loss. Clinical assessment includes modified Harris Hip Score from which results are graded as excellent, good and poor. In our study fractures were more common due to household trauma which is 64% and road traffic accidents 16% which compared to 75% and 25% respectively in study done by W.M.Gadegone and Y.S. Salphale in 2007. (Gadegone and Salphale, 2007) In our study trochanteric fractures were contributed A1 type 16%, A2 type 68% and A3 type 16%. Which is compared to study in 2007 of which A1 type 36%, A2 type 40% and A3 type 20%, while 4 patients had combination of injuries. (Gadegone and Salphale, 2007) Mean duration of surgery time is 81.6 min and mean blood loss was 109 ml. In intraoperative period we had difficulty in reduction in which proximal fragment in flexion and adduction in position in which we had to do open reduction. The mean duration of hospital stay was 18.64 days. In our study we had 3 cases of implant failure. In one case we had both proximal screw were backing out after first follow up. In another patient we had cut out of neck screw occurred which is comparable 0.6% cases in study conducted by Simmermarcher in 1999. In a clinical multicenter study, authors reported technical failures of the PFN after poor reduction, malrotation or wrong choice of screws.[7] One patient had z effect in which proximal screw goes towards the acetabulum and inferior screw coming out. We had one case of malunion after one year with implant failure. Average union time in our study is 6 weeks to 3 months. In our study 3 cases were expired before first follow up due other medical problem and old age. Three cases were lost follow up after first visit. Overall 94.74% of our cases had excellent to good result. In 1996 Ruland *et al.* reviewed a series of 128 patients with pertrochanteric fractures of femur and gave results of 81% very good to good and 7% fair with gamma nailing. (Ruland, 1996) Chavelly *et al* in 1997 reviewed a series of 65 patients and In 2003 Christian Boldin *et al* prospective study of proximal femoral fractures treated with PFN on 55 patients concluded that the gamma nail enables the surgeon to treat more types of hip fractures with a less invasive technique and achieve better results. (Christian Boldin *et al*., 2003; Chavelly F.Gamba, 1997) In 2002 Dousa *et al*, Banan *et al.* and in 2003 Nuber *et al*. concluded that PFN is a good choice in high subtrochanteric fractures and also the use of the PFN for unstable trochanteric fractures is very encouraging. (Dousa *et al*., 2002; Banan *et al*., 2002; Nuber *et al*., 2003)

Conclusion

In the present study of 25 patients with peritrochanteric fracture of femur were surgically managed with Proximal Femoral Nail. The data was assessed, analyzed, evaluated and the following conclusions were made:

- Peritrochanteric fracture of the femur is common in the elderly, due to osteoporosis and in young due to high velocity trauma.
- The mode of injury for Peritrochanteric fracture in the elderly is a trivial trauma, however in the young individuals it occurs following a high velocity trauma.
- As the fracture is more common in the elderly, early reduction and internal fixation increases patient comfort, facilitates nursing care, helps in early mobilization of the patient and decreases the duration of hospitalization.
- Anatomical reduction can be achieved by closed manipulative or open methods. As the incidence of comminution is high, these fractures may require a stable reduction and internal fixation. Bone grafting is required if there is a deficiency.
- PFN has the advantage of collapse at fracture site and is biomechanically sound as it is done by closed technique, fracture opened only when closed reduction could not be achieved and it is an intramedullary device.
- Another advantage of this device is it prevents excess collapse at fracture site thus maintaining neck length.

- The entry point determination is the most crucial step in this procedure which is just medial to tip of trochanter.
- The two neck screws should be placed in the centre of neck and head, the proximal one acts as derotation screw and the distal one as collapsing screw.
- The nail has a 60 mediolateral angulation which prevents medial collapse and a 1350 neck shaft angle which maintains the normal neck shaft angle.
- Post-operatively early mobilization can be begun as the fixation is rigid and because of the implant design.
- The fixation of Peritrochanteric fractures with a PFN markedly reduces the morbidity and mortality, in the elderly individuals in whom the fracture is more common.
- If the above technical details are achieved, the function of the hip joint is regained to near normal and the rehabilitation of the patient is smooth.
- Most of the complications are surgeon and instruments related which can be cut down by proper patient selection and good preoperative planning.
- With the experience gained from each case the operative time, radiation exposure, blood loss and intraoperative complications can be reduced drastically.
- Hence we conclude, though the learning curve of this procedure is steep, with proper patient selection, good instrumentation, image intensifier and surgical technique, PFN remains the implant of choice in the management of Peritrochanteric fractures.

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