Study on functional outcome of subtrochanteric femur fractures treated with proximal femoral nail

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Abstract
Introduction: The difficult nature of treating subtrochanteric fracture stems in part from the fact that this injury pattern is anatomically distinct from other proximal femoral peritrochanteric fractures and also from the femoral shaft fractures. The present study was made attempt to evaluate the functional outcome of subtrochanteric femur fractures treated with proximal femoral nail.
Materials and Methods: The present study conducted on subtrochanteric femur fracture cases admitted in GSL medical college and general hospital, Rajahmundry during December 2013 to July 2015. Ethical Committee Clearance was obtained before beginning of the study. All patients were maintained on traction before surgery. All surgeries were done under spinal or epidural anaesthesia, low molecular weight heparin prophylaxis is given subcutaneously for the high risk patients during the hospitalization.
Result: Majority of the cases were due to high energy trauma of Road traffic Accidents involving relatively younger patients. The operating time for 72% cases was between 1 to 2 hours. Operating time decreased with increasing familiarity of the implant system. The average length of Hospital stay was 17.6 days. At the end of five months, all except three patients could mobilise independently without any aid. According to harris hip score, 3 (12%) patients had excellent outcome, 18 (72%) patients had good outcome and 4 (16%) patients had fair outcome.
Conclusion: In conclusion, Proximal femoral nail is a good implant for subtrochanteric fracture of the femur. The advantages are minimal exposure (closed technique), better stability and early mobilisation. Fractures united in all cases and postoperative functional outcome was satisfactory.

Keywords: Subtrochanteric femur fractures, Proximal femoral nail, Harris hip score, Functional outcome.

Introduction
In the last 50 years, the treatment of subtrochanteric femur fractures has evolved with increased understanding of both the fracture biology and biomechanics. Previously, nonsurgical treatment of these fractures was associated not only with significant malrotation and shortening, but also with morbidity and mortality associated with prolonged immobilization.

The difficult nature of treating subtrochanteric fracture stems in part from the fact that this injury pattern is anatomically distinct from other proximal femoral peritrochanteric fractures and also from the femoral shaft fractures. As a result, it must be treated with specially designed implants which can withstand significant muscular forces for longer periods of healing. These stronger muscular forces deform the fracture fragments and make reduction difficult and as comminution is common in subtrochanteric region the implant must withstand significant early loading. Subtrochanteric fractures needed special care when dealing with difficulties in their management and reported significant rates of complications with their surgical treatment.[1,2]

Only recently has a better understanding of fracture biology, reduction techniques, and biomechanically improved implants has allowed subtrochanteric fractures to be addressed with some success.

In 1996, the Arbeitsgemeinschaft fur Osteosynthesefragen AO/ASIF developed the proximal femoral nail (PFN) as an intramedullary device for the treatment of such fractures.[3] In addition to all advantages of an intramedullary nail, it has several other favourable characteristics like it can be dynamically locked, allows early mobilization, has high rotational stability and is done with minimal soft tissue damage.

Objectives
To evaluate the functional outcome of subtrochanteric femur fractures treated with proximal femoral nail.

Materials and Methods
The present study conducted on subtrochanteric femur fracture cases admitted in GSL medical college and general hospital, Rajahmundry during December 2013 to July 2015. Ethical Committee Clearance was obtained before beginning of the study.

Inclusion criteria
1. Acute subtrochanteric femur fractures in all patients aged above 18 years.
2. Patients willing to be part of this study.

Exclusion criteria
1. Fractures in patients below the age of 18 years.
2. Open fractures
3. Pathological subtrochanteric femur fractures

Data collection method
All patients were maintained on traction before surgery. All surgeries were done under spinal or epidural anaesthesia, low molecular weight heparin prophylaxis is given subcutaneously for the high risk patients during the hospitalization. The length of hospital stay, any blood

transfusions or hospital acquired complications were recorded.

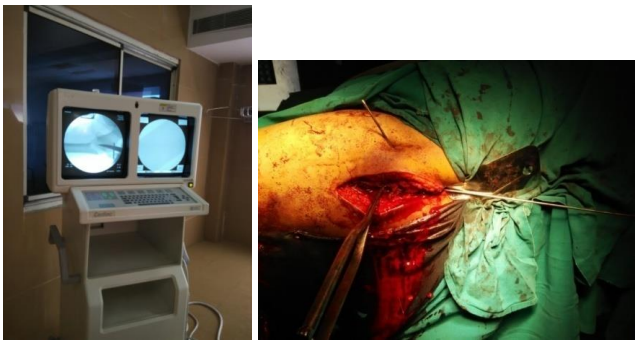
The PFN was developed by AO/ASIF. The Indian versions are available and have been used in our study.[4,5]

Fig. 1: Instrument set

The patient was positioned supine on the fracture table under spinal or epidural or general anesthesia as the condition of the patient permitted. Pre-operatively one dose of antibiotic was also administered. The fracture was reduced by longitudinal traction on fracture table and the limb was placed in neutral or slight adduction to facilitate nail insertion through the greater trochanter. Prior to positioning and draping, the opposite extremity measurements of rotation and length of this extremity were determined.

Position of patient on fracture table

Approach to greater trochanter; making entry point with awl over greater trochanter tip



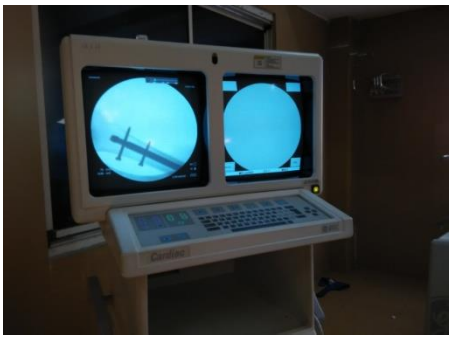
Entry point over greater; Passing guide wire trochanter tip

Nail with Jig; PFN with jig in place

Passing of guide pins through sleeves

Guide pins positioned in passing the screws femoral neck

Hip and anti rotation screw fixation positions confirmed in image intensifier



Distal locking

Fig. 2 : Operative procedure

The entry portal for the PFN was made at the tip of the greater trochanter, halfway between its anterior and posterior extent. A guide wire was inserted at the tip of the greater trochanter under C-arm control. The guide wire is advanced into the femoral shaft in such a way that it is located in the middle of the shaft in both directions. In cases where standard PFN was used, we manually reamed the proximal part of the femur with a 14 mm reamer; while where long PFN was used we had to ream the distal femur also with increasing diameters of reamers.

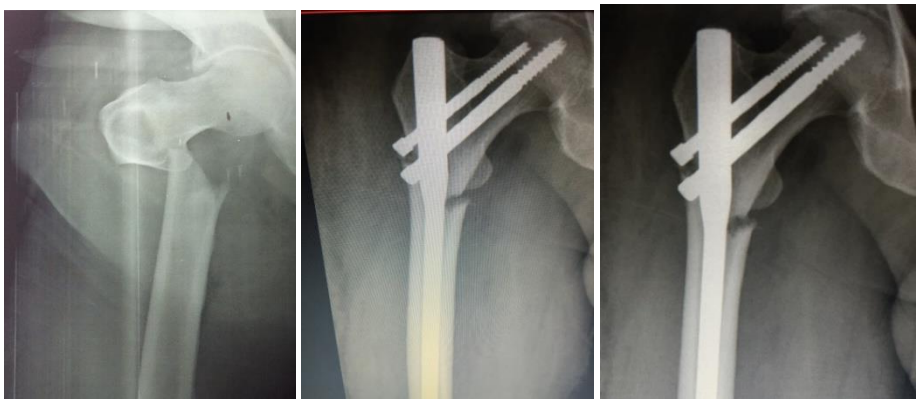
After mounting the appropriate sized nail on the insertion device, the nail was introduced manually into the femoral shaft. Via the aiming arm, which was attached to the insertion device, first the guide wire for the Lag screw was introduced into the femoral neck in such a way that the 8 mm screw was placed in lower half of the neck on the antero-posterior view and centrally on the lateral view. Thereafter, the guide pin for the 6 mm anti rotational hip screw was introduced. Following placement of guide wires measurement of the screws is taken followed by drilling over the guide wire and lag screw is inserted keeping tip apex distance within acceptable norms. Derotation screw is measured ten mm less than the lag screw and inserted in the same way. Afterwards depending on the type of fracture, distal interlocking either fixed statically or dynamically via the same aiming arm in standard PFN and with free hand in long PFN. The stability of the construct was assessed and wounds were closed in layers over negative suction drain. Antiseptic dressing was done.

Static quadriceps exercises were started on 1st post operative day. Dynamic quadriceps exercises and

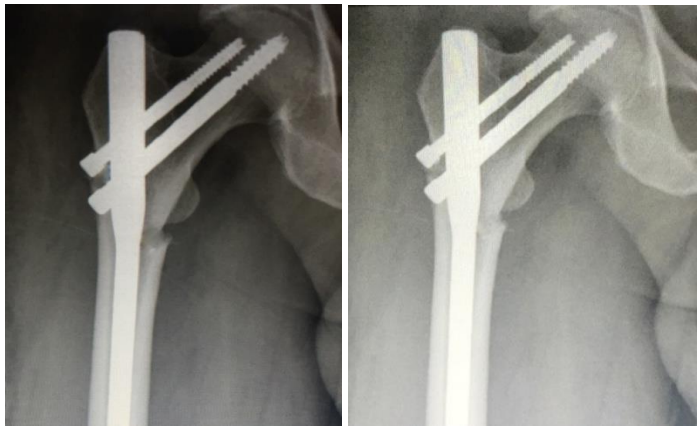
continuous passive motion for passive range of motion was started on 2nd post operative day from 0 to 30 degrees. It was gradually increased depending on pain tolerance of the patient and continued till 90 degrees of flexion was achieved. All patients were mobilized non weight bearing with the axillary crutches from 3rd postoperative day.

Evaluation criteria

Patients were asked to follow up regularly in out patient department at 1 monthly interval for first six months, later every 3 months till 1 year. Clinico-radiological examination of the patient was done. The post-operative evaluation was based on Harris Hip score.[6] X-ray was done on date of each follow up and presence of callus, measurement of lateral slide of lag screw, screw cut out , Z-effect, reverse Z-effect were evaluated. Results can be assessed by Harris Hip score.



Pre op post op 6 weeks



6 months 1 year

Flexion at hip 130° Extension at hip 15° **Knee 120°**


Abduction 40° **Adduction 30°**



Full weight bearing **Internal rotation 20°** **External rotation 35°**

Fig. 3: Clinical photographs

Statistical analysis

It was performed by using MS Excel-2007 and SPSS software trial version 20.0. Descriptive statistical data was presented as mean ± standard deviation and percentages. Chi-square test was performed to assess the association among various categorical variables.

Results

Patients were distributed across all age groups. 17 (68%) male patients and 8 (32%) female patients.

Table 1: Distribution of cases

Parameters	Frequency	Percentage
Mode of injury		
Fall	7	28.0
RTA	18	72.0
Side of injury		
Right	11	44
Left	14	56
Time to surgery		
< 3 Days	7	28
3 - 7 Days	16	64
> 7 Days	2	8

18 cases were involved in Road traffic Accidents, Rest of the patients sustained falls. All except two patient underwent the surgery within 7 days of admission. In one patient, surgery was delayed for controlling blood sugars and in another patient surgery was delayed due to cardiac problem

Table 2: Postoperative independence of ambulation

	12 weeks	20 weeks	24 weeks
Walk Independently	3	22	25
Crutch	12	2	Nil
Zimmer Frame	10	1	Nil

At the end of five months, all except three patients could mobilise independently. One patient with a contralateral intertrochanteric fracture was using a Zimmer frame to mobilise. Two patient were using crutches to mobilise upto six months postoperatively

Table 3: Functional outcome

	6 weeks	6 months	12 months
Patients attending Follow up (%)	32	52	18
Squatting (%)	20	60	80
Walking 15 metres (%)	90	100	100
Rising from chair	42	50	96

Table 4: Result

Results	No. of patients	Percentage (%)
Excellent	3	12.0
Fair	4	16.0
Good	18	72.0
Total	25	100.0

Based on Harris Hip score obtained 3 (12%) patients outcome was excellent, 18 (72%) patients were good and 4 (16%) patients had fair outcome

One patient had a superficial infection at the surgical wound site which subsided with parenteral antibiotics. One patient developed cardiac chest pain on the first postoperative day. We had shortening in two cases both due to mild varus deformity happened with a single screw fixation and where another patient due to Z effect suffered screw cut through which stopped short of cortex before union occurred.

Discussion

The dynamic compression hip screw has been a popular method of internal fixation for subtrochanteric fractures of the femur.[7,8] It provides compression along the femoral neck, and if the fracture reduction is stable, load-sharing occurs between the bone and implant.[9] But, if stable reduction with postero medial continuity and compression is not achieved, there will be progressive medial displacement of the femoral shaft, which results in loss of bony contact and fixation failure and nonunion. If medialization of more than one-third of the femoral diameter at the fracture site occurs there is sevenfold increase of failure rate.[10] And the most common mode of mechanical failure in delayed union or nonunion with sliding hip screw is the progressive varus collapse of the femoral head with proximal migration and eventual cutting out of the femoral head screw[8], due to these complications now a days proximal femoral nailing is preferred.

The use of intramedullary nail in peritrochanteric fractures has been increasing, and more scholars choose it because it is easy and fast to apply and can give stability even in inherently unstable fractures.[11,12]

The proximal femoral nail which is commonly used for fixation of peritrochanteric fracture femur was developed by AO/ASIF. The Indian versions are available and have been used in our study.[4,5] It is available in two varieties, the standard and the long cannulated. The standard PFN consist of a 240 mm long nail. The distal part of the nail is available in 9, 10 or 11 mm diameter and its proximal part is 14mm in diameter. The long PFN comes in different lengths of 340, 380 and 420 mm and is side specific. They are cannulated nails with diameter of the distal part as 10mm.[13]

In the present study, males formed 68% and females formed 32% and usually most cases 72% are RTA, belonging to age groups between fourth and fifth decade about 36% and sixth and seventh decade about 32%. This signifies that these fractures are mostly just not because of osteoporosis but mainly because of high velocity injuries unlike other peritrochanteric fractures of femur.

Most of the fractures in our study group about 60% are type 2, 32% are type 3 and 8% are type 4 significantly matching with recent studies that type 2 fractures of 2a, 2b and 2c are commonest variety . Ashish Vinod Batra et al study showed that 40% are type 2 and 30% as type 3.[14]

Open reduction in irreducible fractures is described in many papers. 80% of our cases reduction was possible with closed method and only 20% cases we needed to open to achieve length, rotation and satisfactory angulation. While study conducted by Kanthimathi et al has reported that 78% are reduced by closed method and 22% by open method.[15] May be this disparity is because of the sample character differing in between the two studies.

In trochanteric entry nails such as proximal femoral nail, entry point should be made over tip of trochanter as described by AO manual. George J. Haidukewych recommended a starting point that is slightly medial to the exact tip of the greater trochanter.[16]

In our study entry point is taken slightly medial to the tip of greater trochanter following the George J. Haidukewych instructional course, against the original technique described in AO manual. Due to this in our study immediate post operative coxa vara is prevented.

Most of the patients size 9 mm nail has adequately contoured for the femoral anterior bow without any impingement on the anterior cortex. In other studies there is no description about why they choose size 9 in most of the patients.

Short PFN were used for the type 1a and 1b, 2a fractures following B.F. Ongkiehong a et al stating that minimum distance between distal screw and fracture site should be 4 to 5 cm.[17] Rest of fracture types where comminution is present and the fracture is at lower level Long PFN used as implant of choice.

Baumgaertner et al described that the tip-to-apex distance to be useful intraoperative indicator of deep and central placement of the lag screw in the femoral head, to fix the fracture. This is most important measurement of accurate placement and has been shown in multiple studies to be predictive of success.[16] In our study the lag screw of the PFN placed in the lower part of the femoral neck, close to the femoral calcar, with the screw tip reaching the subchondral bone, 10 mm below the articular cartilage in the AP view and In the lateral view placed in the centre of the femoral neck keeping the tip apex distance within acceptable limit of less than 25 mm. The derotation screw 10 mm shorter than lag screw is preferred in most studies and is followed in ours.

In one case we could not pass the second screw because of the small neck similar to the experience of P Kamboi et al this patient had progressed to radiological union but with the development of screw back out and cut through almost to the superior cortex.[18]

In our study, duration of surgery for 18 cases (72%) is 60-120 minutes, 5 cases (20%) more than 120 minutes and 2 cases (8%) less than 60 minutes. Average operating time is about 90 minutes, few centres reported average operating time is 70 min and some reported 90 minutes.[13,15] The

difference in duration could be because of the surgical expertise of a surgeon, sample character and depending on how many different surgeons operated at different centres. Most of the studies did not emphasise on that.

Average time for radiological union in our study is 19 weeks (4.8 months). Radiological union in other studies is Ashish et al 19 weeks, Prasad M. Gowda et al 18 weeks, B Kanthimani et al 12.6 weeks.[14,15,19] Our results of achieving union in 19 weeks are on par with the rest of the studies.

Patients are encouraged to sit and start quadriceps exercises, on the first post operative day. On second post operative day, patients with no comminution, transverse and short oblique fractures are allowed to start partial weight bearing with walker support and gradually converted to weight bearing as tolerated.

Highly comminuted fractures or fractures in follow up with the screw migration or single screw are kept non weight bearing and under monthly observation, both radiologically for observing progression of union and functionally, whether they are doing active range of movements at knee and ankle.

Complications like non-union, failure of the implant, and heterotrophic ossification were not encountered in our series, which are consistent with most other series. One patient who had abrasions over lateral aspect of thigh developed a superficial infection which subsided with antibiotics.

Most of the hip function assessment scoring systems as they are applied to the western population they does not include Indian scenario, where squatting and cross legged sitting are essential to carry on our day to day activities. We have included squatting and cross legged sitting in addition to Harris hip score and given a grade fair and above only if they are able to squat and sit cross legged. And in present series we have 100% patients achieving this basic need. Functional assessment of the patients using Harris hip score[6] has shown that excellent in 12%, good in 72% and fair in 16%. Most other studies showed good results in 80%.

The traditional thought process is that, the medial and posteromedial fracture fragments are the most important elements in determining the severity of the peritrochanteric hip fractures. However, the importance of lateral trochanteric wall in stabilizing peritrochanteric fractures has been recognized by several authors.[20-22] The lateral wall, first reported by Gotfried, is the proximal extension of the shaft of the femur.[20] In an unstable three or four part peritrochanteric fracture, the lateral wall is a fragile bony structure. An intact lateral wall plays a key role in stabilization and fixation of the unstable peritrochanteric fractures, which is even more important than implant placement such as TAD (tip apex distance).[22]

The lateral trochanteric wall is believed to be an important factor in stabilizing peritrochanteric fractures,[18] keeping the lateral wall intact or stable can assist in fracture healing and greatly reduce the rate of malunion or nonunion.[23] A proximal lateral femur locking compression plate (PFLCP) can provide a stress shield for the lateral trochanteric wall and prevent the lateral migration of proximal fragments. While the concept of the dynamic hip screw with a trochanteric stabilizing plate is to prevent or reduce the medial displacement.

However, if the plate blocks further compression in trochanteric stabilizing plate fixation of the fracture, before the fracture has become stable, the ends may angulate into varus with the lag screws loosening, cut-out or breaking the plate as a result.[10,24] Proximal femoral locking compression plate achieves compression at the initial surgery and no further compression is possible later on as it is a locking type of implant and also plating needs extensive surgical exposure, severe soft tissue damage, more blood loss, and non-union .keeping these disadvantages in mind.

Still for lateral wall fractures we need better implants, for the rest of the subtrochanteric fractures we can manage with proximal femoral nails with best results. With the above results we can come to a opinion that Proximal femoral nail is a implant with many advantages over the traditional implants.

Conclusion

In conclusion, Proximal femoral nail is a good implant for subtrochanteric fracture of the femur. The advantages are minimal exposure (closed technique), better stability and early mobilisation. Fractures united in all cases and postoperative functional outcome was satisfactory. Proximal femoral nail could be a preferred implant of choice in treating subtrochanteric fractures especially in elderly since it allows early and stable mobilization. A larger study may be desirable.

Source of funding

None.

Conflict of interest

None.

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