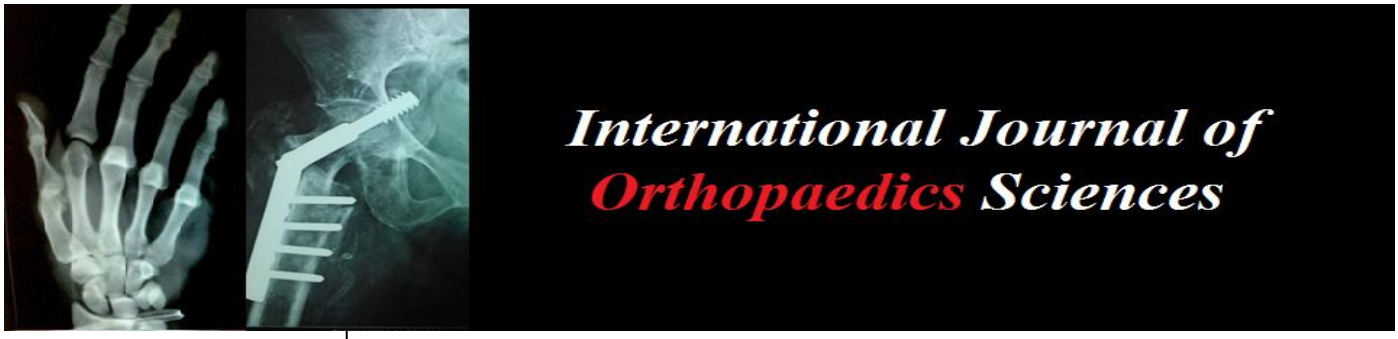

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Dr. Paramesha KC
Associate Professor, Department of Orthopaedics, MMCRI, Mysore, Karnataka, India

Dr. Anand SR
Assistant Professor, Department of Orthopaedics, MMCRI Mysore, Karnataka, India

Dr. Chandrahas A
Post Graduate, Department of Orthopaedics, MMCRI Mysore, Karnataka, India

Corresponding Author:
Dr. Paramesha KC
Associate Professor, Department of Orthopaedics, MMCRI, Mysore, Karnataka, India

Evaluation of functional outcome of subtrochanteric fracture of femur treated surgically with long proximal femoral nail

Dr. Paramesha KC, Dr. Anand SR and Dr. Chandrahas A

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Abstract
Background: Subtrochanteric area is described as the region from the lesser trochanter to 5cm distal of proximal femur. It is one of the most challenging fractures for the orthopaedic surgeons. The cause of frequent commination is that these fractures occur at the junction of trabecular bone and cortical bone where the mechanical stress is highest. Non-Operative management of subtrochanteric femur fractures poses difficulties in obtaining and maintaining a reduction, making operative management the preferred treatment. This study is aimed to prospectively evaluate the clinical and functional outcomes of subtrochanteric fractures treated with Long PFN.
Material and Methods: 24 patients above the age of 18 years with subtrochanteric fractures were included in the study. Patients were assessed clinically and radio logically at 6, 12, 18 and 24 weeks and at 9months and final follow-up was done at 1year. At each follow-up, functional evaluation of the patient was done.
Results: A total of 24 patients(16 males and 8 females) were evaluated with age ranging from 18 years to 75 years with most patients in between 40-60 years; 58% of the cases were road traffic accidents, 33% due to fall from height and 9% due to trivial fall with right side being more common side affected. In our study most of the cases belong to Sensheimer type III B (25%) Mean duration of hospital stay was 12 days. Out of 24 cases, excellent results were seen in 70% of cases in our study.
Conclusion: Long PFN is an effective, efficient and biomechanically stable device for the treatment of subtrochanteric fractures with a high rate of bony union and good functional outcome.

Keywords: subtrochanteric fracture, seinsheimer classification, long PFN, harris hip score

Introduction
Subtrochanteric fractures are femoral fractures occurs below the lesser trochanter to 5 cm distally in the shaft of femur [1]. These fractures account for 10% to 34% of all hip fractures [2]. These fractures have a bimodal distribution [3] and are seen in two main populations, older osteopenic patients following low energy falls and younger patients with high energy trauma. The cause of frequent comminution is that these fractures occur at the junction of trabecular bone and cortical bone where the mechanical stress is highest. The biomechanical characteristics of the area, poor vascularity caused by the predominance of cortical bone and inadequacy of reduction and internal fixation are responsible for malunion, delayed union and mechanical failure of implants used in the treatment [4-11].
Subtrochanteric region is exposed to higher stresses during daily living activities. Hence, subtrochanteric fracture is difficult to manage and associated with many complications [12].
Due to the insertions of muscles in this region, it is put through many distorting forces like flexion by the iliopsoas muscle, abduction by the gluteus medius muscle, and external rotation by the external rotators of the proximal femur fragment. The adductors are inserted in the distal region of the femur which causes the varus deformity [3, 13].
The non-surgical treatment causes delay in return to their functional activities, which will increase the morbidity and mortality caused by the extended periods of immobilization. Conservative treatment of subtrochanteric fractures of the femur is only indicated in patients associated with serious comorbidities that is contraindicated for anesthesia or surgical procedures [14].

As compared to conservative treatment, operative treatment is better tolerated by elderly because of greater comfort, early mobilization of patient, lower morbidity and mortality of patient [15].

In 1996, the Arbeitsgemein-schaft für Osteosynthesefragen AO/ASIF developed the proximal femoral nail (PFN) as an intramedullary device for the treatment of such fractures. With all advantages of an intramedullary nail, it has several other favourable characteristics: it can be dynamically locked, allows early mobilization, has high rotation stability and is done with minimal soft tissue damage [16]. Our study is a prospective study carried out at our institute on 24 patients who had suffered a subtrochanteric fracture between November 2018 and November 2019 and were treated with a Long PFN.

Material and Methods

All the patients with subtrochanteric fractures who presented to the Department of Orthopaedics, in our institute between Nov 2018 and Nov 2019 were considered for the study. Ethical clearance was granted from institutional ethical committee, Mysore Medical College and Research Institute and associated hospitals. A total of 30 patients were presented in this period. They were subjected to the inclusion and exclusion criteria of the study and a total of 24 patients qualified to be included in the study**.**

Inclusion criteria

- All patients with Subtrochanteric fracture
- All skeletal mature patient (>18yrs)
- Pathological fractures.

Exclusion criteria

- Patients not willing for surgery.
- Patients medically unfit for surgery.
- Open fractures
- Segmental fractures
- Patients with neurovascular deficit
- Pre-existing deformity in the same hip

All the cases with subtrochanteric fractures who require surgical intervention were admitted, after taking consent, analysed clinically and radiologically. All the patients selected for the study examined according to protocol, associated injuries noted, clinical and laboratory investigations carried out. After complete work up, all patients were operated with Long PFN which is third generation cephalomedullary nail. [Nebula Company, Cat No.:-180.L/R / T180.L/R]. The functional outcome assessed using Harris Hip Score (HHS).

Surgical Technique

The patient was placed in supine position on the fracture table under spinal or general anesthesia. The opposite extremity measurements of rotation and length was determined before shifting on to the operating table. The fracture was reduced by longitudinal traction and the operating limb was placed in neutral or slight adduction for easy nail insertion through the greater trochanter. Straight lateral incision taken from the tip of greater trochanter, extending 4-6 cm proximally. Gluteus maximus muscle dissected in line with its fibers. If open reduction required we extended the incision distally, incising the iliotibial band in line with the skin incision. The entry point for the PFN was at the tip of the greater trochanter, halfway between its anterior and posterior extent[Fig 1].Guide wire was inserted at the tip of the greater trochanter and was crossed the fracture site under C-arm control. The guide wire was advanced such a way that it is located in the middle of the shaft in both AP and Lateral views. We manually reamed the proximal and distal femur. After satisfactory fracture reduction under C-arm guidance, an appropriate size nail as determined preoperatively was assembled to insertion handle and inserted manually. Stab incision for drill sleeve was made and 2.8guide wire was inserted. A second 2.8 mm guide wire was inserted through the drill sleeve above the first one for hip pin. Both confirmed under C arm [Fig 2 and 3]. Drilling was done over 2.8 mm guide wire until the drill is 8 mm short of tip of the guide wire. Neck screw was inserted using cannulated screw driver. Similarly, appropriate length hip pin was inserted. Length and position of the screw was confirmed under C-arm guidance distal locking was performed with 2 cortical screws with free hand technique. Locking screw was inserted and position was confirmed under C-arm guidance. Thorough wash was given, then wound closed in layers and sterile dressing applied.

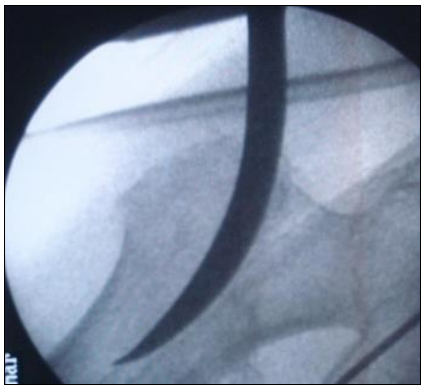

Fig 1: Entry Point at Greater trochanter

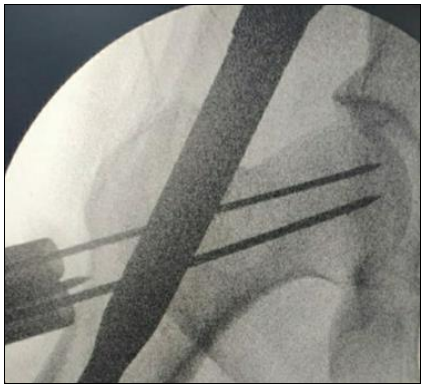

Fig 2: Guide wire position in AP view

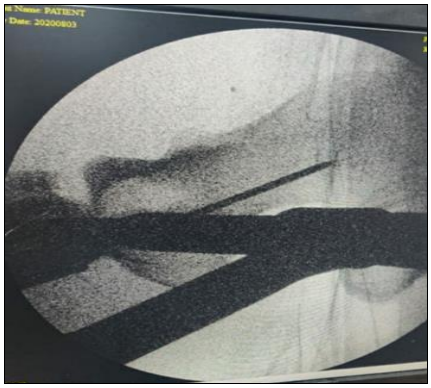

Fig 3: Guide wire position in lateral view

Post-operative protocol

Quadriceps static exercise and knee mobilization was started in the immediate postoperative period. Patients were allowed for touch down weight bearing with the help of a walker for the first 6 weeks and advanced based on healing as shown on follow-up radiograph. All patients were followed up at 6 weeks, 12 weeks and every 6 weeks thereafter till fracture union is noted; [Fig 4,5 and 6] then at 6 months, 9 months and final follow-up at 1 year. At each visit, patient was assessed clinically according to Harris Hip Score questionnaire. X-ray of the pelvis with both hip, hip with thigh Antero-posterior and Lateral full length of operated side taken. Fracture union was assessed by radiographic cortical bridging and lack of fracture line.

Fig 4: Pre-operative xray AP view

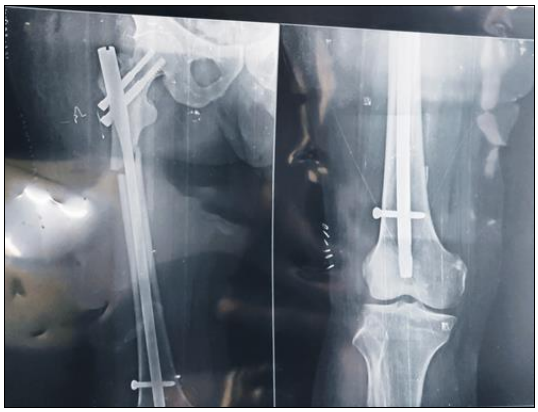

Fig 5: Immediate post-operative xray

Fig 6: At 18 weeks follow-up

Results

In our study most of the patients were in between the age group of 40-60 years [Table 1]. Male patients were greater in number compared to female patients with ratio 2:1 [Table 2]. In most of the cases the mechanism of injury was due to road traffic accident (58%) [Table 3]. In our study most of the cases belong to Sensheimer type III B (25%) [Table 4]. The average time for fracture union was 14-16 weeks [Table 5]. All cases were operated within one week of trauma.80% of cases underwent closed reduction [Fig 7] and open reduction was required in five cases (20%) in which two cases cerclage wiring was done. Mean operating time was 1.30-2 hrs.

By 12 weeks, 7 fractures (30%) were considered healed, and by 18 weeks, 19 fractures had healed (80%) and by 24 weeks all fractures (100%) were healed (Table 4). Functional outcome evaluated using HHS (Harris Hip Score) which showed 17 patients (71%) had Excellent, 3patients (13%) had good, 2 patients(8%) had fair outcome [Fig 8]. In our series, we had 2 cases of superficial wound infection controlled by intravenous antibiotics for one week. We didn't come across any case with delayed union or non-union and implant failure.

Fig 7: Type of Reduction

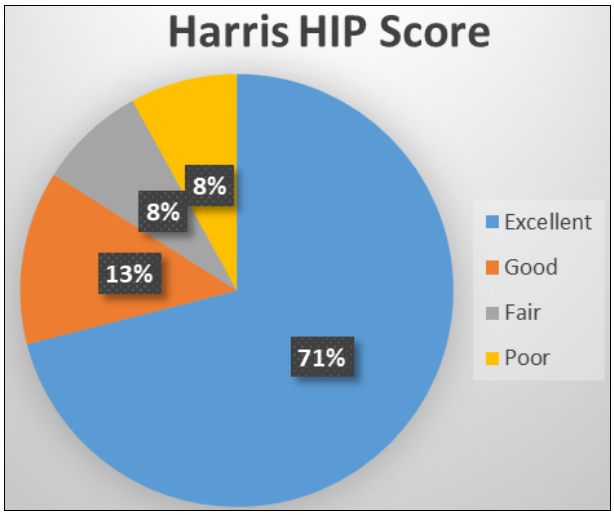

Fig 8: Harris Hip Scoring

Table 1: Age distribution

Age group	No. of Cases	Percentage%
18-30	3	12.5%
31-40	6	25%
41-60	13	54.16%
>60	2	8.3%

Table 2: Sex

Sex	Number of cases	Percentage %
Male	16	66.66%
female	8	33.33%

Table 3: Mode of injury

	No. of Cases	Percentage%
RTA	14	58%
Fall from height	8	33%
Trivial fall	2	9%

Table 4: Seinsheimer classification

Fracture type	No. of Cases	Percentage%
I	-	-
II a	4	16.66%
II b	5	20.83%
II c	1	4.1%
III a	5	20.83%
III b	6	25%
IV	1	4.1%
V	2	9%

Table 5: Time for union

No of weeks	No .of Cases	Percentage%
By 12 weeks	7	29.16%
12-18 weeks	12	50%
18-24 weeks	5	20.84%

Discussion

Subtrochanteric fractures take place in the proximal regions of the femur, the anatomical definition of which is still difficult and controversial. Boyd and Griffith were one of the first to try and define subtrochanteric fractures as fractures occurring between the lesser trochanter and a point 5cm distal to it. Subtrochanteric fractures are most commonly seen in the elderly, although they can occur in younger patients after high energy trauma. Parker *et al.* [4] reviewed the epidemiology of subtrochanteric fractures and showed that the average age of the patients was 74 years. Average age of the patients in our study is 52 years. This may be due to the increase in the incidence of fractures in younger patients due to high energy trauma.50% of patients who underwent conservative treatment showed unfavourable results in a study conducted by Velasco *et al.* in 1978 [17]. The subtrochanteric region is area of great stress concentration due to the muscular deforming forces acting on it. Due to its precarious vascularization and complex fractures with medial support failure there is a large role of fixation failure and reoperations. This is the reason that non-surgical management of subtrochanteric fracture femur is no more considered an option. The method of open reduction and fixation using DCS (Dynamic condylar screw plate), DHS (Dynamic hip screw), Angle plates or even PF-LCP (Proximal femoral locking compression plates) leads to extensive muscle stripping around the fracture site, loss of fracture hematoma, increased surgery time and disturbs the logical integrity of the region. Hence several studies have reported unsatisfactory results in almost 70% of cases.

The proximal femoral nail (PFN) is a new intramedullary device designed by AO in 1996 which introduces the benefit of the closed technique to the treatment of subtrochanteric fractures. The Indian versions of PFN are now available and have been used in our study. They are available in two varieties, the standard and the long cannulated. The standard PFN consist of a 240 mm long nail. Its proximal part is 14mm in diameter and distal part available in 9, 10, 11 and 12. Due to increased cases of stress fractures at the distal tip of short PFN in recent past [18], we preferred long PFN in all our cases. The long PFN comes in lengths of 340, 380,400 and 420 mm and is side specific. Two screws can be inserted through the proximal part, an 8.4 mm neck screw and a 6.5 mm anti-rotation screw. Open reduction was required in five cases and in 2 cases we used cerclage wire to hold the reduced comminuted fragment. Muller *et al.* [19] compared the cerclage group with uncerclage group of subtrochanteric fractures, as a result the cerclage achieves satisfactory reduction and also maintains the integrity of the medial cortex and reduces the risk of non-union and failure. Kim *et al.* [20] managed subtrochanteric fractures with percutaneous cerclage and intramedullary fixation. Christophe Sadowski MD *et al.* [21] studied 39 cases of subtrochanteric femur fractures of which 19 cases treated with 95° DCS and 20 cases with PFN, he concluded that at one year follow up, the rate of implant failure, the number of major reoperations were both lower for patients treated with PFN. Because of the complicated anatomy of the subtrochanteric region, its management is quite challenging and even with various advancements in implant techniques, there hasn't been much reduction in complication rate [22]. According to David J. Hak *et al.* [23], there are high chances of complications like malunion, delayed union and non-union with implant failure while managing a case of subtrochanteric fracture. Mohammed Mansour Elzohairy [24], Shrinand V Vaidya *et al.* [25] and C. Krettek *et al.* [26] used dynamic condylar screw for fixation of subtrochanteric fracture and found that the failure rate upto 9.7% in their study. We did not come across any implant related complications as compared to the 11% complications seen in the study by Menezes *et al.* [27]. In our study the clinical union was achieved at an average time of clinical union was between 12 and 18 weeks for most cases which is comparable to the study conducted by Smith *et al.* Series [28].

This study has clearly demonstrated the advantage of using long PFN in the treatment of subtrochanteric fractures. Fractures united in all cases and postoperative functional outcome was satisfactory. It is relatively easy procedure. Long PFN is biomechanically stable construct allowing early weight bearing and rehabilitation.

The limitations of our study include the limited number of cases and the absence of a control group treated with other methods.

Conclusion

Long PFN is an effective, efficient and biomechanically stable device for the treatment of subtrochanteric fractures with a high rate of bony union and good functional outcome. Early mobilization and rehabilitation is possible due to closed intramedullary nailing.

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