

Original Research Article

A study on clinical outcomes of complex subtrochanteric femoral fractures with cephalomedullary nail

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ABSTRACT

Background: The aim of the study was to evaluate the clinical outcomes of complex subtrochanteric fractures treated by using cephalomedullary nail.

Methods: This is a prospective observational study of 30 cases of complex subtrochanteric femoral fractures admitted to our hospital from January 2018 to June 2019. Cases were taken according to the inclusion and exclusion criteria i.e. type IV, type V Seinsheimer's classification, above 18 years and those who are willing to participate in the study has been included and pathological fractures, open fractures were excluded. All the patients are followed up on 2 post-operative day, after 4 weeks, 8 weeks, 12 weeks and 6months. X-ray hip with thigh anteroposterior (AP) and lateral view taken during each follow up. Out comes was assessed using modified Harris hip score.

Results: In our study of 30 cases there are 22 males and 8 females and the mean age of 43.7 years. 73.3% patients are due to Road traffic accidents predominance of right side. In our study 66% had type 4 Seinsheimers and 34% cases had type 5 Seinsheimers fracture. The mean duration of hospital stay was 17 days. Mean time for full weight bearing is 12 weeks. Good to excellent results are seen in 80% of type 4 subtrochanteric fractures and 75% of cases of type 5 subtrochanteric fractures. 4 cases had surgical site infection, 3 cases had varus, 1 case had developed implant failure, and 1 case had reverse Z effect.

Conclusions: From this study, we conclude that proximal femoral nail is an excellent implant in the treatment of complex subtrochanteric femoral fractures the terms of successful outcome include a good understanding of fracture biomechanics, good preoperative planning and accurate instrumentation.

Keywords: Subtrochanteric fractures, Proximal femoral nail, Road traffic accidents

INTRODUCTION

Sub-trochanteric fractures are the fractures of proximal femur, that involve the lesser trochanter and it extend distally up to 5 cm.¹ These fractures usually accounts for about 10% to 35% of all hip fractures.² They most commonly occur after high-energy trauma mainly in younger patients, whereas osteoporotic fractures most common in the elderly and also as bisphosphonate-associated atypical fractures.³ The sub-trochanteric region is the region which has highest amount of stresses in our body. High compressive and tensile forces of muscles can

separate the fracture fragments and causes instability of the fracture. The thickness of cortical bone in sub-trochanteric region is more and its vascularity is less, which can produce healing disturbances. This fracture is difficult to manage because of the above mentioned reasons and is associated with many complications affecting fracture healing like mal-union, delayed union, non-union and implant failure. The factors responsible for these complications in subtrochanteric fractures are often due to high stress concentration in the subtrochanteric region, and difficulties in getting biomechanically sound reduction because of comminution and intense concentration of

deforming forces at the fracture site. Due to these specific anatomical features conservative treatment is not preferred, and if there are no absolute contra indications and if the patient can able to tolerate the surgery, then surgery is the treatment of choice.⁴ The goal of operative treatment is to restore the normal anatomical length, alignment and angulation and to restore adequate tension to the abductors. The two primary options mostly used for the treatment of complex subtrochanteric fractures are intramedullary fixation and extramedullary fixation.⁵ The extramedullary implants which included in the treatment of subtrochanteric fractures includes proximal femoral locking plates, but they were associated with more number of complications like higher rate of reduction loss, fixation failure and also the need for reoperation.⁶ Compared with extramedullary implants, the intra-medullary implants have several biomechanical advantages which have benefits, including less soft tissue dissection, dynamic locking and the ease of insertion, potentially less blood loss, restoration of the mechanical axis and importantly, allowing for immediate weight bearing after fixation and is considered as the gold standard treatment for subtrochanteric fracture nowadays.^{7,8}

There are only a very few studies which has done with cephalomedullary nail to evaluate the clinical outcomes of complex subtrochanteric femoral fractures and hence the relevance of this study. The purpose of our study was to evaluate the clinical and functional and radiological outcomes of complex subtrochanteric femoral fractures treated with cephalomedullary nail.

METHODS

All patients admitted in inpatient department (IPD) between from January 2018-June 2019 with complex subtrochanteric femoral fractures treated with cephalomedullary nail were included in this study. All the patients presenting with complex subtrochanteric fractures (type 4 and 5) in emergency department treated with cephalomedullary nail during the study period were included in the study. All patients who were above 18 years of age with fracture of non-pathological origin and who were able to walk prior to the fracture were included in the study. Patients with open fractures, pathological fractures were excluded from the study.

Radiographs were taken and the fractures were classified according to the Seinsheimer’s classification. Patients has been worked up and pre anesthetic checkup has done. Preoperatively intravenous antibiotics were given to patients according to the hospital protocol. All the patients have underwent fixation with the proximal femoral nail. Post operatively the patients were started on non-weight bearing mobilization from the 2nd post-operative day (POD). Patients were regularly followed up at 6 weeks, 3 months, 6 months and 1 year and patients were assessed using radiographs. The functional outcome of the patients was assessed using the Harris hip score. Minimum follow up of all the patients included in the study was one year.

Statistical analysis

All data were analysed and expressed as mean±standard deviation (SD). The statistical analysis was performed by using the statistical package for the social sciences (SPSS) 20.0 software.

RESULTS

In our study maximum age was 70 years and the minimum was 20 years, with an average age of 43.7 years.

Table 1: Age distribution.

Age group (years)	Number of cases	Percentage
0-20	2	6.67
21-40	12	40
41-60	12	40
61-80	4	13.3

There were 22 males and 8 females patients in our study. Road traffic accident was the most common mode of injury accounting for about 73.3% (22) of cases, followed by accidental fall in 13.3% cases and fall from height in 13.3% of cases. In our study about 19 patients 63.3% belongs to type 4 Seinsheimer’s and 11 patients 39.1% belongs to type 5 Seinsheimer’s fracture.

Table 2: Seinsheimer’s type.

Type of fracture	Number of cases	Percentage
Type 4 Seinsheimer’s	19	63.3
Type 5 Seinsheimer’s	11	36.7

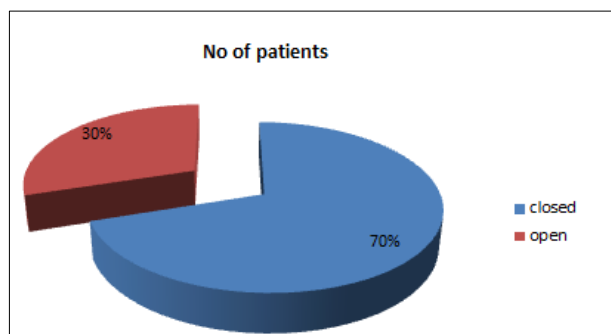


Figure 1: Reduction pattern.

5 out of 30 patients had associated injuries. One patient had fracture of ipsilateral tibial shaft which was treated with tibia intramedullary nail and bolts. One patient had contralateral neck of femur fracture which was treated with osteosynthesis with 6.5 cc screws. One patient had contralateral proximal humerus fracture which was treated with PHILOS plating and screws. One patient had clavicle fracture which was treated conservatively.

Case 1

50/M, type V Seinsheimer's subtrochanteric fracture.

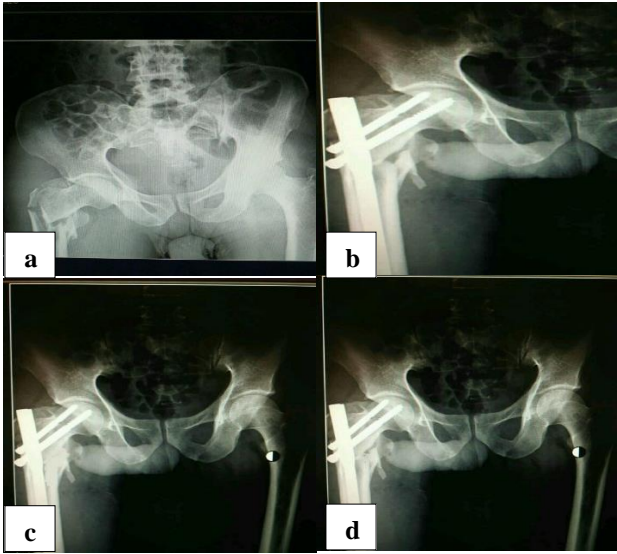


Figure 2: (a) Pre-op radiograph, (b) post-op 4 weeks, (c) post-op 8 weeks and (d) post-op 12 weeks.



Figure 3: (a) Squating (at 12 weeks), (b) sitting cross legs (at 12 weeks), (c) standing, and (d) active hip flexion of 140 degrees.

All patients were treated on selective basis. Surgery was performed with an average of 6 days with a range from 4-14 days. The delay was due to the availability of operation theatre, general and medical conditions of the patients and managing associated injuries. Duration of surgery was found to be in the range 80-130 min with the average duration was found to 100 min. Duration was found to be longer in type V sub trochanteric fractures, due to the

difficulty in achieving anatomical reduction. Average amount of blood loss was found to be 150 ml.

We has performed closed reduction in 21 (70%) of cases and for 9 (30%) patients has performed open reduction. We have performed cerclage wire for maintaining reduction in one case. In our study we had 3 cases of surgical site infection which required wound debridement and intravenous antibiotics for 3 weeks period. No other systemic complication like deep venous thrombosis, systemic infection, and fat embolism have been reported.

In our study 2 cases (6%) showed union at 7 months. 1 case (3%) had non-union and 1 case (3%) has broken proximal (compression and derotation screws) during the 3rd month of follow-up which was treated with implant removal and later treated with dynamic condylar screw. One case (3%) has found to have reverse Z effect.



Figure 4: (a) Radiograph of implant failure and (b) radiograph of reverse X effect.

DISCUSSION

Sub-trochanteric femur fractures usually occur as a result of, high velocity trauma and is often subjected to significant displacement with a difficulty in achieving closed reduction with traction. The high incidence of delayed union, nonunion and malunion of fractures has left conservative treatment abolished in modern trauma care. Seinsheimer et al has conducted a retrospective study of 56 cases and reported that in 47 cases who has undergone surgery, 9 had internal fixation failure, 3 had developed non-union (failure rate: 26%); 9 cases which received conservative treatment were all healed, out of which 5 cases (56%) had hip varus deformity of 15-29 degree.⁹ Extra medullary fixation performed with plating had a lot of disadvantages of being an extensive soft-tissue dissection, thus leading to problems like nonunion, implant failure and infection.

Intramedullary fixation allows the surgeon to minimize soft tissue dissection, thereby reducing surgical trauma, blood loss, infection, and wound complications.⁹⁻¹¹ Intramedullary (IM) nailing has arguably emerged as the standard treatment methodology, achieving union rate in up to 95% of cases. The proximal femoral nail (PFN) acts like an internal splint and so it can bear a large axial load

and this in turn allows the patient to bear weight early. It is done by using a small surgical incision, so it is minimally invasive and there is very minimal blood loss. Some of the reported disadvantages of using PFN, includes cutout of implant, lateral migration of the proximal screws and femoral medialization.

Various fracture reduction techniques, have been evolved to combat the deforming forces caused by the muscular pull, which includes; percutaneous joystick techniques with Schanz pin/Stienmann pin, bone hook, by using Hoffman retractors.

In the comminuted subtrochanteric fractures, adequate working length provides less stress to the implant. In that perspective, long IM nails can contribute less stress to the nail, In addition, patients with osteoporosis theoretically, have more advantage with the long nail than the short nail by protecting remaining bone below the nail if fall occurs afterwards because the short nail tip could elevate stress concentration on the bowing site of the femur.¹²

Good reduction which is achieved by doing minimal soft tissue dissection, use of nail of appropriate length and proper positioning of the nail and screws are necessary to avoid failure or revision. The abundant muscles present in and around the sub trochanteric region usually cause a significant displacement of the fractured fragments, which can lead to great difficulties in closed reduction. Sometimes, performing open reduction by using a small incision at the fracture site, is inevitable. Although, the concept of using cerclage wiring of fracture fragments is not new, it has potential application in periprosthetic and comminuted femoral fracture has been encouraging.¹³ There is still there a debate that there is a risk of violating the principles of the biologic internal fixation, in the case of using cerclage use. However, there a many favourable reports in the literature regarding the cerclage use in complex subtrochanteric fractures are as important of its usefulness. In our study, we have used long PFN as the choice of cephalomedullary nail in all cases.

In our study the average age at fracture was 43.7 years, this was low compared to that quoted by other authors in literature Abraham et al 50 years and in a study performed by parker et al it was 71 years.¹⁴

In our study we has male preponderance of 22 cases (66.7%) out of 30 patients. Higher female preponderance was reported in a study by Boldin et al 70% and Pavelka et al.

The average union rates reported in several of literature was found to be between 85-100%. Non-union and varus, which are the common complications of these fractures, have been reported to be in 1-10% of various studies.⁴ In our study union rate at the end of six months of follow up was found to 87.5%. In 8% cases of type IV, union was delayed due to inadequate reduction of fracture, for which dynamization was done with fracture union on follow-up

in both cases. One cases of non-union due to implant (proximal screw) breakage at six months were treated with implant removal following which the patient was put on high tibial skeletal traction and after two weeks he was treated with dynamic condylar screws and the fractures united three months thereafter. Open reduction was performed in 30% of cases of which 18% of cases are type 5. Difficulty in reduction was found to be mostly due to severe fracture comminution and also due muscle pull exerted by the flexors and abductors on proximal fragment and by the adductors on the distal fragment. In a study performed by Jiang et al open reduction was performed in about 34% of cases and no cases had intraoperative fracture or breakage of implant.¹⁵ In a prospective study done by Zhou et al open reduction was performed in nine percentage (9%) of the cases. Muller et al conducted a biomechanical analysis in 10 cadavers with subtrochanteric fractures and compared, between the cerclage group with uncercilage group.¹⁶ The result showed that the use of cerclage not only achieve satisfactory reduction, but also gives a great significance to maintain the integrity of the medial cortex, and further reduces the risk of bone nonunion and fixation failure. In our study we have used cerclage for reduction in 3% of cases and it has showed that it maintain good reduction and it is found to be not associated with any complications.

Various mechanical complications that has been associated with the proximal femoral nail, were reported by many of the authors includes Z-effect (cut-out of screw), reverse Z-effect, implant failure, non-union. Werner et al were the first, to coined the term Z-effect, which was initially detected in 7% of their cases.¹⁷ The Z-effect phenomenon described by Wener, as a characteristic lateral migration of the inferior screws (lag screws), and medial migration of the derotation (superior screw) along with the varus collapse at the fracture site, occurs during the postoperative weight bearing period. They proposed that fixation of the fracture with a neck-shaft angle of less than 125 degree was a predisposing factor for the Z-effect and also for reverse Z-effect, as well as for cut-out of screws.

In reverse Z-effect which was initially described by Boldin et al, the lateral migration of the superior screw (derotation screw) along with the medial migration of the inferior (lag screw) screw, which requires early removal.¹⁸ Simmermacher et al in their study had implant failure and cut-out of screw in 0.6% cases each.¹⁹ Rate of screw cut-out and implant failure in the literature varies from 1-11% and 1-7% respectively. Average rate of Z-effect in various literature was found to be 3-5% and that of reverse Z-effect was about 2-3%. In our study 3% has reverse Z effect and no cases had Z effect.

In our study failure rate was found to 12%, out of this 6% had fixation in varus and 3% of patients developed nonunion and 3% has developed implant failure. Simmermacher et al in their study, has found implant failure and cut-out of screw in about 0.6% of cases each.²⁰

In our study 4% of patient had implant failure and cut out of screws, subsequently we have done implant removal and dynamic condylar screw application. Limb length discrepancy is found in 6% of patients in our study and both cases have less than 2 cm shortening. Borens et al in his prospective study concludes that LLD under 2.0 cm does not matter clinically.²¹ In all our cases, there was no patient with LLD over 2.0 cm, and no one complained of discomfort in everyday life though it was derived from low expectation due to severely comminuted fractures.

Excellent results were noted in 40% of patients and good results were found in 40% of patients and fair results were found in 13.6% and poor result was found in 6.6% cases. The proportion of patients showing excellent and good results were found in 80% cases. Other studies in which modified Harris hip score was used also showed similar outcomes as our study.²² Average modified Harris hip score was 84 in our study.

Limitations

First, this study is a prospective observational study and not a comparative study with that of other fixation methods. Secondly, this study has a small number of cases and short term period of follow up.

CONCLUSION

PFN is found to be an efficient device for the treatment of complex subtrochanteric femoral fractures (type 4 and type 5 Seinsheimer's) with high rate of bony union, provided that optimal reduction of the fracture along with that good positioning of the nail and screws is achieved. The great majority of patients, were provided with stable fixation along with early rehabilitation and early mobilisation and return to pre-fracture status. Osteosynthesis with the cephalomedullary nail (PFN), offers a significant number of advantages giving a high rotational stability of the head-neck fragment and achieving a good compression at fracture site and it is found to be biomechanically sound as it is an intramedullary device, thus leading to minimal soft tissue damage and high rate of bone union. Most of the complications of using PFN, are mainly related to the surgeon and instruments, which can be further reduced by proper patient selection and a good preoperative planning. Gradual learning of the procedure and great patience, are needed to make this procedure a minimally invasive one.

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Ethical approval: The study was approved by the institutional ethics committee

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