

A prospective study comparing the efficacy of proximal femoral nail antirotation device with dynamic hip screw fixation in management of unstable pertrochanteric fractures



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ABSTRACT

Background: Pertrochanteric femoral fracture is the most common fractures of the hip especially in the elderly patients with osteoporotic bone, usually due to low-energy trauma like simple falls. Dynamic hip screw (DHS) is still considered the gold standard for treating such fractures. Not many studies compare DHS with Proximal Femoral Nail Antirotation (PFNA). We try to compare the efficacy of PFNA with DHS in management of unstable pertrochanteric fractures. **Aims and Objectives:** We aimed to evaluate and compare the clinical and functional outcomes of DHS and PFNA treatment of unstable pertrochanteric femoral fractures in elderly patients. **Materials and Methods:** This study was a prospective study which included total of 39 patients, 25 patients treated with PFNA and 14 patients with DHS. The study was conducted in Manipal Teaching Hospital from March 1, 2019, to August 1, 2021. All the patients were clinically evaluated and detail history was obtained. After the anesthesia clearance, the patients were operated. Length of skin incision, operating time, intraoperative blood loss, and complications were noted. Postoperatively, the duration of hospital stay, time of partial and full weight-bearing, time for radiological union, and complications were noted. Functional outcome was assessed using Harris hip score at 3 months and 6 months follow-up. **Results:** The mean age of the patient in this study was 74.68 years for PFNA and 75.57 years for DHS. The average time to complete the surgery was 71 min for PFNA and 92.86 min for DHS. The average blood loss was 162 ml for PFNA and 403 ml for DHS which was found to be statically significant. Partial weight-bearing on axillary crutches was started at the mean time of 3.7 weeks for PFNA and 8.1 weeks for DHS, whereas full weight-bearing was done at the mean of 8.2 weeks for PFNA and 12.1 weeks for DHS. Radiological union was seen at the average of 18.72 weeks for PFNA and 20.14 weeks for DHS which was not statically significant. The mean Harris Hip score at 3 months and 6 months follow-up was 63.84 and 88 for PFNA and 48.50 and 81.43 for DHS, respectively, which showed significantly better result with PFNA. **Conclusion:** Compared to DHS treatment, PFNA treatment in unstable pertrochanteric femoral fracture is associated with reduced blood loss, shorter operative time, and hospital stay with few intraoperative and post-operative complication. Post-operative rehabilitation with the early mobilization and return to pre-injury status was better with PFNA.

Key words: Dynamic hip screw; Proximal femoral nail antirotation; Unstable pertrochanteric fractures

INTRODUCTION

The incidence of pertrochanteric femoral fracture has significantly increased in recent decades and this tendency

will probably continue in the near future due to increase in the life expectancy and increased incidence of senile and postmenopausal osteoporosis. Despite various medical advancements in patient care and different operative

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techniques, fracture around the hip pose a huge economic burden and social impact on health-care systems due to long hospital stay, increased dependency, substantial morbidity, and mortality.¹ Pertrochanteric femoral fracture in younger population occurs due to high velocity trauma whereas in advanced age individual occurs due to spontaneous fall.² These fractures are more common in females as compared to males due to postmenopausal osteoporosis.

Majority of cases of pertrochanteric fractures are unstable and bear a high failure rate. This instability is multifactorial and includes loss of posteromedial calcar support and loss of posterolateral support or lateral wall insufficiency.³ Pertrochanteric femoral fracture can be managed operatively or nonoperatively. Conservative treatment for these types of fractures, with prolonged bed rest and traction, has been associated with varus deformity and shortening, along with general complications associated with prolonged immobilization which includes bed sore, orthostatic pneumonia, deep vein thrombosis, urinary tract infection, and complications of skeletal traction which range from pin tract infection to chronic osteomyelitis.⁴ The goal of treatment of these fractures is stable fixation, which allows early mobilization of the patient. Elderly patient with comorbid medical conditions such as diabetes, hypertension, renal, pulmonary, and cardiac problem add to the insult of the fracture and are high risk factors with life-threatening complications such as sepsis, pneumonia, decubitus ulcer, and cardiorespiratory failure. All these circumstances mentioned above need to be prevented by an urgent surgical solution with the early rehabilitation and mobilization of the patient.⁵ Operative treatment is now a treatment of choice for all trochanteric fractures due to advantages of early rehabilitation and mobilization. Surgical management with either extramedullary device (Dynamic hip screw [DHS], trochanteric stabilizing plate, fixed angle blade plate, and proximal femoral locking plate) or intramedullary device (Proximal femoral nail) is commonly used. DHS is a non-collapsible fixation device, which permits the proximal fragment to collapse or settle on the fixation device seeking its own position of stability. DHS has gained widespread acceptance during the last decade, but complications such as shortening, medialization of distal fragment, implant cut-out, uncontrolled lateralization of the proximal fragment, and varus collapse are common.^{6,7} PFN is a cephalomedullary device and potential advantages being intra medullary, with efficient load transfer, shorter lever arm resulting in less transfer of the stress, and less implant failure. Theoretically, advantage of intramedullary device over extramedullary device is that there is no need to fix the plate to the shaft with screws, which can be difficult in osteoporotic bone. Screw cut-out of femoral head and higher rate of intraoperative difficulties are

noted with PFNA.^{8,9} PFNA as compared to conventional PFN has a small distal shaft diameter, resulting in a lower concentration of stress in the tip, has a helical neck blade that prevents the bone loss that occurs during drilling and insertion of standard sliding hip screw.^{10,11} In addition, PFNA provides improved purchase in the femoral head, by radial compaction of the cancellous bone around the blade during insertion.

Aims and objectives

The aim of this study was to compare outcome and complication between DHS and PFNA in treatment of elderly patient with an unstable pertrochanteric fracture.

MATERIALS AND METHODS

All the patients with unstable pertrochanteric femoral fractures admitted in Manipal Teaching Hospital from March 2019 were prospectively followed up for 2½ years after written consent given by the patients and ethical clearance approved from the Institutional Review Committee. During this period, 39 patients with unstable pertrochanteric fractures were selected according to the inclusion criteria. Inclusion criteria include age more than 60 years, fracture <2 weeks duration, include both sexes, patient fit for surgery, and willing to give written consent. Exclusion criteria include age <60 years, metabolic bone disease, pathological fractures, polytrauma patient, previous surgery on the ipsilateral hip or femur and inability to work before injury, and severe concomitant medical conditions. Standard pre-operative planning was done. Radiographs of the pelvis with both hips anterior-posterior view and traction internal rotation view were obtained to confirm diagnosis.

All the patients were operated under general anesthesia or spinal anesthesia on a standard fracture table under C-arm guidance while ensuring strict aseptic condition. Patients were randomly divided into two groups. In Group A, patients were treated by DHS, and those in Group B were treated by PFN. For DHS, the length of compression screw was measured from the tip of the head to the base of the greater trochanter on AP view X-ray subtracting magnification. The neck shaft angle was determined using goniometer on X-ray AP view on unaffected side and length of side plate was selected in such a way that allows purchase of at least eight cortices to the shaft distal to the fracture. For PFNA nail, diameter was determined by measuring diameter of the femur at the level of isthmus on an AP view. The neck shaft angle was measured on the unaffected side on AP X-ray using goniometer and a standard length PFNA (250 mm) was used.

As a standard protocol, intravenous cefuroxime 1 g was administered half an hour before skin incision and was continued 1 g IV 12 hourly for 5 post-operative days. All the cases were operated with closed reduction and internal fixation. Intraoperatively, the duration of surgery, the radiation exposure, intraoperative blood loss, size of incision, and any associated complications were noted. Drains were removed by 48 h postoperatively. Plain AP and lateral X-ray were obtained in 1st operative day and analyzed for position of implant and fracture reduction. Fracture reduction was considered good if the cortical congruence at the calcar region was restored and if the displacement between the fragments did not exceed 2 mm in any projection. The ideal position of screw in the femoral neck for both the DHS and PFNA was defined as being central or inferior on AP radiographs and central in cross table lateral view. The wounds were inspected in 3rd and 5th post-operative day. Stitch removal was done on 14th post-operative day in out-patient department.

All the patients in our study underwent same rehabilitation protocol involving mobilization from the 2nd post-operative day depending on pain limit and physical condition of the patient. Under physiotherapist guidance, patients were encouraged to perform static quadriceps, knee and ankle mobilization exercises from day 1 and were mobilized non-weight-bearing on axillary crutches from 2nd post-operative day. Patient was followed up clinically and radiologically for a minimum period of 1 year at regular intervals of 2 weeks, 6 weeks, 3 months, 6 months, and 1 year. Clinical outcome was assessed using Harris Hip Score (HHS) at 3 months and 6 months. Radiological outcome was assessed based on progression of union in hip AP and lateral view. Radiological union was defined by presence of callus in three out of four cortices, and clinically by disappearance of pain at fracture site by palpation and on weight-bearing.

Statistical analysis was performed with SPSS version 20.

RESULTS

Twenty-five patients, 16 males and 9 females, were treated with PFNA. Fourteen patients, seven males and seven females, were treated with DHS. The mean age at the time of injury of PFNA group was 74.68 years and of DHS group was 75.57 years. In our study, the average mean age was 75 years with 88 years being the maximum and 61 years being the minimum.

The most common mode of injury was fall injury (trivial trauma) and left side was commonly involved as seen in

22 patients (56.41%). PFNA requires a smaller incision (5.43 cm) to access the entry site into the medullary canal compared to DHS which was found to be more than twice the length (12.07 cm) showing a significant difference ($P < 0.0001$). Distal locking was done using minimal percutaneous skin incision. The duration of surgery was calculated from the time of incision to skin closure. The average duration of surgery for PFNA was (71±6.7) min and for DHS was (92.86±7.5) min which shows significant difference ($P < 0.0001$). Blood loss was measured by mop count and collection in suction. The average blood loss during PFNA was 162 ml which was significantly less than DHS procedure (403 ml) ($P < 0.0001$). Two out of 14 patients in DHS required blood transfusion postoperatively. Since the incision was smaller and duration of surgery was shorter in PFNA, there was less tissue handling and less blood loss. The average hospital stay for PFNA was 5.92 days (5–7 days), while in case of DHS was 9.64 days (5–14 days). All the procedures were done with closed methods. No any additional procedures in the form of bone grafting or bone marrow injection for both PFNA and DHS group were required.

PFNA being a load sharing device as compared to DHS being a load bearing device, rehabilitation was started at an early stage (Table 1). Radiological union was assessed at 3 months, 6 months, and 12 months post-up. Attempted callus formation was seen around 3 months and all the fractures got united within 6 months. The mean time for radiological union was 18.72 weeks for PFNA and 20.14 weeks for DHS. Radiological union when compared, PFNA with DHS showed no significant difference ($P = 0.139$). At 6 months follow-up, two patients had backing out of helical screw in the PFNA but both of them got united. One patient had varus malunion of 119° due to excessive collapse with shortening of 2 cm. In the DHS group, three patients had collapse at the fracture site with backing out of lag screw, but all others showed solid union at the fracture site. Shortening of 1 cm was seen in two patients and 1.5 cm in one patient. While performing the DHS, one patient had intraoperative complication with breakage of guide wire. One patient treated with DHS sustained a peri-implant fracture just below the tip of the DHS plate following a road traffic accident at 8 months follow-up. The fracture occurred through the last screw (stress raiser), for which the DHS plate was removed and dual plating using broad and small Lcpdcp was used to fix the fracture.

At the end of 3 months, the functional outcome was calculated using the HHS. Patients treated with PFNA scored an average of 63.84 compared to DHS that showed 48.50 ($P = 0.0001$). Score increased to 88.00 for PFNA

Table 1: The average number of days/weeks taken for post-operative patient mobilization for each group

Patient Mobilization	PFNA	DHS
Active hip, knee, and ankle mobilization	2.87 days	4.29 days
Non-weight-bearing axillary crutches	1.1 weeks	1.8 weeks
Partial weight-bearing walking	3.7 weeks	8.1 weeks
Full weight-bearing walking	8.2 weeks	12.1 weeks

PFNA: Proximal femoral nail antirotation, DHS: Dynamic hip screw

Table 2: Intraoperative and post-operative clinical data

Heading	PFNA	DHS	P-value
Length of incision (cm)	5.432	12.071	0.0001
Operating time (days)	71	92.86	0.0001
Blood loss (ml)	162.4	403.57	0.0001
Hospital stay (days)	5.92	9.62	0.0001
Radiological union	18.72	20.14	0.110
Harris hip score (3 months)	63.84	48.50	0.0001
Harris hip score (6 months)	88.00	81.43	0.0001

PFNA: Proximal femoral nail antirotation, DHS: Dynamic hip screw

and 81.43 for DHS at the end of 6 months ($P=0.0001$) which showed significant difference between two groups (Table 2). Eight patients treated with PFNA and four patients treated with DHS did not come for follow-up after 6 months of treatment.

DISCUSSION

Despite various medical advancements in clinical care of the patient, management of unstable pertrochanteric fracture is a clinical challenge for the orthopedic surgeons. This type of fracture management has been a challenge especially for elderly osteoporotic patient due to high degree of instability and associated increased rate of morbidity and mortality. In addition, lack of strength and coordination in elderly patients provides undue stress over the fracture site while ambulating with support and crutches.¹² DHS is based on principle of sliding screw system, whereas PFNA has a helical blade which allows improved purchase in the femoral head by radial compaction of the cancellous bone around the blade during insertion.¹⁰ Biomechanically, helical blade provides better fixation of the femoral head and greater cut out resistance than sliding hip screw.^{10,11} Thus, the helical blade has the advantage of more stable fixation, antirotation and anti-varus collapse.¹³ PFNA can withstand higher static and several fold higher cyclical loading, compensate for the medial column, and also act as a buttress in preventing the medialization of the shaft.¹⁴

Intramedullary fixation inserted by means of minimally invasive procedure allows the surgeon to minimize soft-tissue dissection, thereby reducing surgical trauma, blood loss, infection, and wound complication.¹⁵

Petrochanteric femoral fractures occur predominantly in people >60 years of age and are 3–4 times more common in women than in men.¹⁶ In our current study, the mean age of patients was 75 years which matched the literature, but there were more males 23 (59%) as compared to females 16 (41%).

Study done by Sharma et al., showed that surgery time was significantly lower in the PFN group than the DHS group ($P<0.05$).¹⁷ Xu et al., did a prospective randomized study comparing PFNA with DHS and found length of skin incision to be (5.5 ± 2.6) cm for PFNA and (11.7 ± 2.4) cm for DHS, operating time of (68.5 ± 9.9) min for PFNA and (56.5 ± 11.8) min for DHS, and blood loss of (220 ± 109) ml for PFNA and (472.9 ± 169) ml DHS which showed significant differences ($P<0.005$) and was consistent with our study.¹⁸ In the present study, bony union was seen in all the patients treated with PFNA and DHS, was not statistically significant, and was comparable to study done by Xu et al., and Cho and Lee.^{18,19} Regarding clinical outcomes in this study, the mean HHS at final follow-up in our study was 88.00 ± 3.149 points for PFN and 81.43 ± 5.080 points for DHS. The mean HHS for PFNA was found to be 82 points in a study by Macheras et al.,²⁰ and 77.8 points by Sahin et al.²¹ Similarly, mean HHS for DHS was 62 points which was lower than that in our current study.²² In our study, patients who underwent fixation of fracture with PFNA returned to pre-injury walking status earlier than patients whose fracture were fixed with DHS. Post-operative complications were reported to be more common in DHS with three cases of shortening and varus collapse and one case of peri-implant fracture as compared to PFNA with one case of varus collapse and shortening. This favored the study done by Ouyang et al., where complication was less with PFNA than DHS.²³ We had varus collapse in four cases. Varus collapse rate was found to be 5.8% in a study by Zhang et al.²⁴ Several factors have been identified as cause of varus collapse which includes inadequate reduction and/or poorly placed helical blade of the PFNA (in superior-center position on radio graphs), early functional exercise, high activity level, increasing age, and presence of osteoporosis.

Early restoration of the patient to pre-injury state and lifestyle is the primary goal in elderly patient; however, various factors play an important role which includes adequate internal fixation, minimal blood loss, minimal anesthesia time, early mobilization, and general health of the patient.¹²

Limitations of the study

Limitation of our study was the higher number of patients who withdrew from the study after a short follow-up. This may be explained by the extreme age of the patient, too ill to attend due to pre-existing chronic medical condition, which had died during the follow-up period and residing far away from the hospital.

CONCLUSION

The PFNA is a superior implant to DHS for the treatment of unstable pertrochanteric fractures due to its easy insertion, reduced blood loss, less complications, stable fixation, and satisfactory functional and radiological outcomes.

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UJT- Concept and design, review of literature, statistical analysis and interpretation, manuscript preparation and revision; **KW-** Manuscript revision and literature review; **NR-** Manuscript revision and literature review; **KS-** Literature search and review; **PRO-** Data collection, statistical analysis and literature review; **PT-** Literature search and review.

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