ORIGINAL ARTICLE

A Prospective Study to evaluate the efficacy of Proximal Femoral Nail vs. Dynamic Hip Screw in Treatment of Intertrochanteric Fracture of Femur

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Abstract:

Introduction:
An increasing incidence of intertrochanteric fractures with advancing age is more. The dynamic hip screw (DHS), used in extramedullary fixation, is a common treatment of these fractures. Proximal Femoral Nail (PFN), introduced by the AO (Arbeitsgemeinschaft für Osteosynthesefragen), the Association of the Study of Internal Fixation (ASIF) in 1997, has become more common in treatment of intertrochanteric. Although the effects of PFN and DHS in treatment of intertrochanteric fractures have been reported, the results and conclusions are not consistent.

Objectives:
To investigate a significant difference and to compare the outcome of intertrochanteric fractures treated with Dynamic Hip Screw and Proximal Femoral nail.

Material and Methods:
This study included 50 cases of intertrochanteric fractures of femur treated by a DHS and PFN. Fracture table was used for all patients under image intensifier.

Results:
The average age of the patient was 62.3 years. Out of 50 patients 24% had stable, 58% unstable and 18% reverse oblique pattern of fracture. In DHS group average blood loss was 250 ml while in PFN group average blood loss was 100ml. In PFN, there was more number of radiation exposures intra-operatively. The average operating time in DHS group was 87 minutes while in PFN group it was 55 minutes. . The complications were 15%; implant failure 6%,4% infection,2% non-union and 4% greater trochanter splintering. In the PFN group the amount of sliding on X-rays was less as compared to DHS. The patients treated with PFN started early ambulation as they had better Harris Hip Score in the early period at 1 and 3 month. Both the implant had almost similar functional outcomes.

Conclusion:
Closed and grade-1 open fractures of the tibia shaft, managed with interlocking intramedullary nailing involves minimal surgical trauma and negligible blood loss while provides the advantages of early ambulation, lower rate of infection, delayed union, non union and mal-union.

Keywords:
Tibia fracture, Diaphysial fracture, Intramedullary Nail, Interlocking Nail.

Introduction:

Due to the rising age of modern human populations incidence of an intertrochanteric fracture is increasing[1,2]. With advancing life expectancy and geriatric care more patients who were conservatively treated in the past are now candidates for surgery, thus the need for a study to better understand the intertrochanteric fractures and the best possible means to fix them.

The dynamic hip screw (DHS), commonly used in extramedullary fixation, has become a standard implant in treatment of these fractures[3,4]. Proximal femoral nail (PFN) and Gamma nail are commonly used devices in the intramedullary fixation. Previous studies have shown that the Gamma nail did not perform as well as DHS because it led to a relatively higher incidence of post-operative femoral shaft fracture[5,6]

PFN, introduced by the AO (Arbeitsgemeinschaft für Osteosynthesefragen), the Association of the Study of Internal Fixation (ASIF) group in 1997, has become popular in treatment of intertrochanteric fractures because of addition of antirotation screw to the main lag screw. However, both benefits and technical failures of PFN have been reported[7-9].

It was believed that the intramedullary hip screw could enhance the repair of pertrochanteric fractures. But there is a debate as to which implant should be used in unstable fractures with special mention to osteoporotic bone and old age.

Present study was aimed at comparing the DHS with the intramedullary hip screw device prospectively, including comparison of operative time, intraoperative blood loss, and length of incision, postoperative infection rate, lag screw cut-out rate, and reoperation rate.

Material and Methods:

This study had a simple design with prospective, randomized, interventional trial. The duration of study was from January 2012 to June 2017. The main inclusion criteria were patients admitted with the diagnosis of intertrochanteric fracture femur. The patients were randomly selected on first come and first inclusion basis in a specialized tertiary health care centre. Fifty consecutive operated cases were selected and the patients were informed about the study in all respects and informed consent was obtained from each patient. Out of 50 patients, 25 were treated with DHS and 25 with PFN.

The inclusion and exclusion criteria used in selecting eligible patients in the study were the individuals with intertrochanteric fractures excluding subtrochanteric and pathological fractures. The inclusion criteria for the patient in this study were the surgically fit patients more than 50 years of age who had been diagnosed as having intertrochanteric fractures. The exclusion criteria were patients unfit for the surgery, with compound or pathological fractures, admitted for re-operation and those who have not given written consent for surgery.

All the patients were carefully evaluated pre-operatively, which included detailed history to determine the cause of fracture and other diseases. The radiograph of pelvis with both hips and lateral view of the affected hip was taken. The fracture was classified using Orthopaedic Trauma Association (OTA) classification. Skin traction was applied to all cases. DHS or PFN implant was randomly selected by surgeon. For DHS, length of compression screw was measured from tip of the head to the base of greater tronchanter on radiograph (AP view), subtracting magnification. Neck shaft angle was determined using goniometer on radiograph (AP view) on unaffected side. Length of the side plate was determined to allow hold of at least 8 cortices to the shaft distal to the fracture. For PFN, nail diameter was determined by measuring diameter of the femur at the level of isthmus on an AP radiograph. Neck shaft angle was measured in unaffected side in AP radiograph using goniometer and a standard length PFN (250 mm) was used in all our cases.

Fracture table was used for all cases under spinal anesthesia. The fracture table helps in reduction and as it allows free access for the C-arm in both views. A combination of 3rd generation Cephalosporin and Amino glycoside was administered intravenously 30 minutes prior to the skin incision. The same combination was used for 48 hours postoperatively in standard doses.

All patients in this study were treated with physical methods such as early mobilization, manual compression of the calf and elastic stockings.

Patients were encouraged ankle and calf exercises from day one and mobilized non-weight bearing from the second postoperative day depending upon the physical condition of the patient. All drains were removed by 24 hours. The wounds were inspected on the 3rd and 6th post-operative day. Stitches were removed on the 11th day. Patients were followed up at one monthly interval till fracture union and then at 6 monthly interval for 1 year and then at yearly interval. The important parameters assessed were:

Clinical: Wound condition, function on Harris hip score, shortening.

Radiological: Union, amount of collapse, complication like screw cut out and Z phenomena.

All the cases included in our study were operated as soon as possible. The delay was due to physician clearance and delay in reporting to hospital. The average delay of surgery in our study was 3 days.

Results:

The study involved 50 confirmed cases of intertrochanteric fracture femur of either sex from January 2012 to June 2017. Out of 50 cases, 25 were treated by a dynamic hip screw and 25 were treated by proximal femoral nail. Table-1 shows the number of patients who were fixed the implant with given specification / dimension. In this study, the maximum age was 85 years and minimum was 50 years. The average age was 69.3 years. There were 20 male and 30 female patients. The fracture due to domestic fall occurred in 31patients (62%) while 19 patients (38%) met with road traffic accident. Patients with road traffic accidents were younger while patients with domestic fall were older. The right side was involved in 21 cases while left side in 29 cases (Figure no.1-3).

All the fractures were classified as per the AO classification adopted by OTA. There were total 12 A-1 fractures, 29 A-2 fractures and 9 A-3 fractures. The various types of fractures treated with either DHS or PFN are shown in Table-2.

Intra-operative details.

In present study, we considered various intra-operative parameters like radiographic exposures, duration of surgery, amount of blood loss and other intra-operative complications. DHS surgery took more duration as compared to PFN. The duration of surgery as calculated from the time of incision to skin closure was counted in each case. The average duration of surgery for the PFN (mean time, 55 minutes) was significantly shorter then DHS (mean time, 87 minutes). The mop count and collection in suction drain was used to calculate blood loss. Blood loss was more for DHS. The average blood loss in the PFN group was 100 ml and in the DHS group was 250 ml (Table-4). Five out of 25 patients in DHS group required blood transfusion either intra or post-operatively.

Intra-operative complications DHS.

The difficulty in reduction was encountered in cases that were delayed and in case of comminuted fractures. In 3 of 25 cases, there was improper placement of Richard's screw. The screw was placed superiorly. Difficulties were encountered in reverse oblique fractures as the fracture site extended to entry point. The screw had to be inserted more proximally which resulted in varus angulation. On table, surgeon had to switch to PFN in 2 cases in reverse oblique fracture. These cases were considered with PFN group.

Intra-operative complications PFN.

There were iatrogenic fractures of the lateral cortex of proximal fragment in 1 of 25 of PFN. This occurred in initial cases probably due to wrong entry point and osteoporotic bone. In 3 of 25 cases, we failed to put anti-rotation screw, as it could not be accommodated in the neck after putting neck screw. We had no difficulties in distal locking. All the cases were locked distally with at least one locking bolt. There were no instances of drill bit breakage or jamming of nail.

Table No. 1: The dimensions of implants used in the study.

	Dimensions	Patients
DHS: (Dynamic Hip Screw)		
Barrel angle (in degrees)	130°	06
	135°	16
	140°	03
Number of holes	4	13
	5	09
	6	03
Screw length (in mm)	85	02
	90	20
	95	03
PFN: (Proximal Femoral Nail)		
Nail diameter (in mm)	9	15
	10	05
	12	05
Screw angle	130°	03
	135°	22

Table No. 2: Fracture type, gender wise distribution and type of implant used.

Fracture type	Male	Female	PFN	DHS
A1-1	1	3	-	4
A1-2	3	2	-	5
A1-3	3	-	1	2
A2-1	4	6	5	5
A2-2	6	8	7	7
A2-3	1	4	3	2
A3-1	2	1	3	–
A3-2	–	2	2	–
A3-3	–	4	4	–
Total	20	30	25	25

PFN = Dynamic Hip Screw; DHS = Proximal Femoral Nail.

Table No. 3: Distribution of the patients with fracture grades.

Fracture Grade	Number of patients	%
I	03	06
II	08	16
III	16	32
IV	08	16
V	05	10
VI	10	20
Total	50	100

Table No. 4: Comparison of the two types of implant fixation in the patients.

Sr. No.	Parameters	DHS	PFN
1	Mean operating time (in minutes).	87	55
2	Mean intra-operative blood loss (in ml).	250	100
3	Number of radiation exposures (in minutes)	15	40
4	Total complications (%)		
	Implant failure.	4%	2%
	Non-union.	2%	0%
	Infection.	4%	0%
	Trochanter splintering / Others.	2%	0%
5	Amount of sliding (in mm) at the end of 1 year on the X-rays.	7.3	5.4*
6	Harris Hip Score (at 1 and 3 month)	24.4/93	33/93*
7	Mean hospital stay (in days) (Range of days)	14.24 (12–16)	12.96 (11–15)

* $p < 0.05$ difference between DHS and PFN

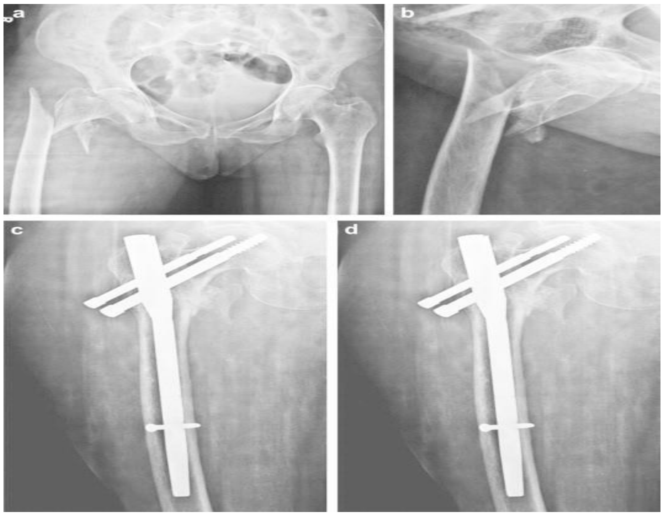

Fig. 1: 61 Year-old female patient with intertrochanteric fracture fixed with PFN. (a) Pre-operative antero-posterior view. (b and c) Immediate post-operative antero-posterior and lateral view. (d) Antero-posterior view radiograph at 12 week follow-up.

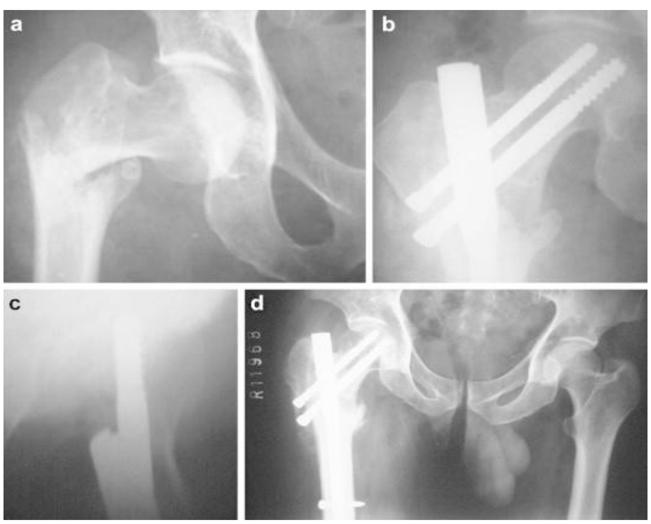

Fig. 2: 70 Year-old male patient with intertrochanteric fixed with PFN. (a and b) Pre-operative antero-posterior and lateral view. (c and d) Antero-posterior and lateral radiograph at 12 week follow up.

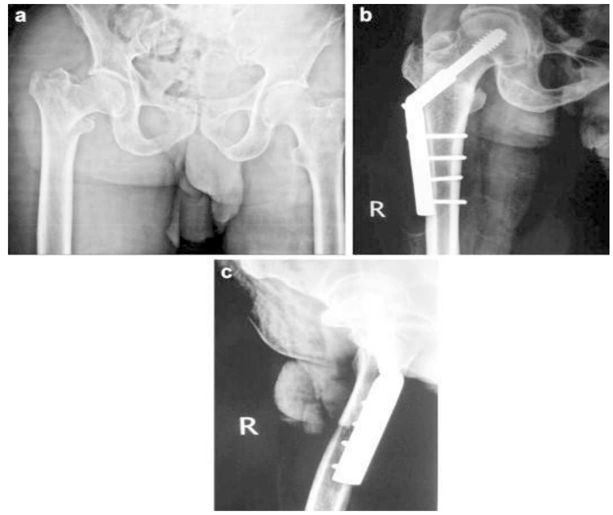

Fig. 3: 73 Year-old male patient with intertrochanteric fixed with DHS. (a) Pre-operative antero-posterior view. (b and c) Antero-posterior and lateral radiograph at 12 weeks follow up.

The radiation exposure was more in case of PFN (mean 70) as compared to DHS (mean 40). The average hospital stay was 14.24 days (12–16) days in case of DHS while 12.96 days (11–15) in case of PFN (Table-4). There were 2 cases of infection in the DHS group. They were observed within 15 days of surgery and were treated by local debridement and antibiotics. These cases did not require implant removal. In the PFN group, one patient developed pulmonary oedema. In the DHS group, one patient developed deep vein thrombosis. There was one death each in both groups the deaths occurred in both cases 3 months after surgery. In both cases, the cause of death was not related to the surgery.

The sliding of both groups was compared at the end of 1 year on the X-rays as described by Hardy et al[4]. There was an average of 5.4 mm of sliding in the PFN group as compared to 7.3 mm in the DHS group ($p < 0.05$). The average shortening in the PFN group was 5.5 mm as compared to 9.9 mm in the DHS group (Table-4). Even though there was more shortening in the DHS group it was not significant enough to cause any functional impairment. There was 1 (2%) case of implant failure in PFN group and a revision surgery was required. The reason for implant failure was usual 'Z' pattern of implant. In the DHS group, there were 2 (4%) cases of implant failure. One was due to screw cut out and other was due to plate breakage. In both the cases revision surgery was required. In the PFN group, there were no cases of non-union. In the DHS group, there was one case of non-union which was due to jamming. This patient responded to bone grafting. The greater trochanter splintering was seen in 2 (4%) patients but it did not cause any complication later and healed well. Greater Trochanter was either fixed with Ethibond suture or tension band wiring.

Functional HIP scores.

All patients were subjected to the Harris hip score[5] at the 1 month, 3 months, 6 months, one yearly and two yearly follow ups. In the DHS group, 1 month hip score (mean 24.4) was less than that of the PFN group (mean 33), $p < 0.05$. However, this difference disappeared in the two groups on the sixth monthly and yearly follow-ups with both scores being same (DHS 93 and PFN 93). At 2 years, the score was similar for both implants, which were 97.

Discussion:

In our study the average age of the patient was 69.3 years which was comparable to other studies[3,9-11]. We had male: female ratio of 1:1.5, unlike male predominance reported in the Indian studies[11]. The most common mode of injury in our study was domestic fall 62%, which is comparable to most of the other studies[2,11]. This was also affected by the age as older patients are more likely to get the fracture by domestic falls. In our study, 24% were stable fracture pattern and 76% were unstable. In 58% of the cases left limb was involved. Osteoporosis was measured by the Singh's index. More osteoporosis was present in the older patient and post-menopausal females. In our study 32% had grade – III osteoporosis.

In the last 3–4 decades treatment of intertrochanteric fractures has changed significantly. A large number of fixation implants have been devised and discarded. The type of fracture and condition of patient still decides the course of treatment.

The development of the DHS in the 1960's saw a revolution in the management of unstable fractures[12]. The device allowed compression of the fracture site without complications of screw cut out and implant breakage associated with a nail plate. However, extensive surgical dissection, blood loss and surgical time required for this procedure often made it a contraindication in the elderly patients with co-morbidities. The implant also failed to give good results in extremely unstable and the reverse oblique fracture[13].

In the early 90s, intramedullary devices were developed for fixation of Intertrochanteric fractures[12]. These devices had numerous biomechanical and biological advantages over the conventional DHS[6,7]. Long term studies however, revealed that the use of these devices was associated with higher intra-operative and late complication often requiring revision surgery. This has lead to modifications in the device and technique of the intramedullary devices. A review of literature show several studies on the comparison of the DHS to intramedullary nail[8,9,14,15]. All of them aimed to compare intra and post-operative complications, post-operative function, union rates and implant failure rate between the two.

Sliding properties.

The sliding properties of both implants vary considerably. Sliding is an essential principle in the management of intertrochanteric fractures. Sliding permits impaction of the fracture fragments thus promoting healing. Kyle et al[16] in their extensive study of the biomechanical principles of the sliding hip screw, have identified key factors that promote sliding. A reduction in the bending forces is vital, since bending forces reduce slide and cause jamming of the implant.

The bending forces are increased by longer extension of the screw, smaller screw angle and heavier patients. In their subsequent studies on the sliding in second generation locked nails, Kyle et al[16] have noted that increased forces are required to initiate sliding in intra medullary devices as compared to sliding hip screw with plate. Amongst all intramedullary devices the Gamma nail requires the largest force. The explanation lies in the barrel of the side plate. The barrel provides a free passage for the screw to slide, thus the longer the barrel length, lesser the forces required to initiate sliding.

Barrel plate angle

The most routinely used barrel plate angle in most studies is 135°. This is because of the ease of insertion and the more anatomical restoration of femoral neck angle. However, the 150° side plate has several advantages, since the forces are acting more in line with the screw less bending forces act across the screw so relatively less force is required to initiate sliding resulting in more impaction[15,16]. Valgus hips are, however, more prone to develop early osteoarthritis.

Sliding length

Several authors have noted a positive correlation between sliding length and union[17,18]. It is reported that fractures fixed with a sliding length (i.e. the distance from proximal tip of the barrel to the distal thread of the screw) of less than 10 mm had 3 times higher rate of failure than those with sliding length more than 10 mm[17]. This is particularly true in devices that have a 32 mm threaded screw length with a 32 mm barrel. They recommended a short barrel for screws with less than 85 mm screw length[18].

The average operating time for the patients treated with PFN was lesser as compared to patients treated with DHS (Table-4). We had a greater operating time in the beginning, which reduced greatly in the later part of the study. This signifies the learning curve of the PFN. The average hospital stay was higher in DHS as compared to PFN (Table-4). As in cases of PFN, all the stitches were removed on 10th day in most of the patients.

Total complications in our study were 15%. Three of our patient had implant failure. There was one case of non-union, which responded to bone grafting. Four percent of our patients had greater trochanter splintering while inserting the nail. Infection was present in 4% of the patient. They were seen within 20 days of surgery and were treated and did not require implant removal.

By radiological comparison, the amount of sliding observed between the immediate post-operative X-ray and one year follow up X-ray in both the groups, it was noted that the amount of sliding in the PFN group was less as compared to the DHS. This was a result of the proximal part of the nail blocking the head and neck fragment. This finding is in accordance with the studies of Kyle et al[16] and Hardy et al[4].

The success of PFN depended on good surgical technique, proper instrumentation and good C-arm visualization. All the patients were operated on fracture table. For better access to the greater trochanter, placement of the patient on the fracture table is important. The upper body is abducted away 10–15°. The anatomical reduction and secure fixation of the fracture are essential for good surgical result. The entry point of the nail was taken on the tip or the lateral part of the greater trochanter.

As the nail has 6° of valgus angle, medial entry point causes more distraction of the fracture. The hip pin is inserted 5 mm away from the subchondral bone in the lower half in the AP view and center on the neck in the lateral view. The cervical pin is placed parallel to the hip pin in AP view and overlapping it in the lateral view. It should be 10 mm shorter than the hip pin from the subchondral bone. This ensures that the cervical screw will not take the weight load but only fulfill the anti-rotational function. Failure to do this leads to the "Z effect". In which the cervical pin backs out and the hip pin pierces the joint or the vice-versa.

Distal locking was done with the interlocking bolts. In most of the cases only dynamic hole was locked. In our study, one of the important factor was the cost of the implant as PFN is costly than the DHS, but at the end, it did not cause much of the difference as we observed less operative time thus reducing the cost, no or less need of transfusion of blood, decreased use of post-operative antibiotics reducing the cost of the treatment, and with less hospital stay and early return to daily activities.

DHS, introduced by Clawson in 1964, remains the implant of choice due to its favorable results and low rate of complications. It provides control compression at the fracture site. Its use has been supported by its biomechanical properties, which have been assumed to improve the healing of the fracture. But DHS requires a relatively larger exposure, more tissue trauma and anatomical reduction. All these increase the morbidity, probability of infection and significant blood loss. It also causes varus collapse leading to shortening and inability of the implant to survive until the fracture union.

The plate and screw device will weaken the bone mechanically. The common causes of fixation failure are instability of the fractures, osteoporosis, lack of anatomical reduction, failure of fixation device and incorrect placement of the screw.

We found PFN to be more useful in unstable and reverse oblique patterns due to the fact that it has better axial telescoping and rotational stability as it is a load shearing device[14,18,19]. It has been shown biomechanically more stronger because they can withstand higher static and several fold higher cyclical loading than DHS. So the fracture heals without the primary restoration of the medial support. The implant compensates for the function of the medial column.

PFN also acts as a buttress in preventing the medialization of the shaft. The entry point of the PFN is at the tip of the greater trochanter so it reduces the damage to the hip abductors unlike the nails, which has entry through pyriformis fossa. The hip screw and the anti rotation cervical screw of the PFN adequately compress the fracture, leaving between them, adequate bone block for further revision, should the need arise.

Nail or plate

The sliding hip screw with plate remained the choice of implant for fixation of intertrochanteric fractures. With the arrival of the intramedullary hip screw, it was thought that the sliding hip screw would be replaced forever. However, this is not true. The intramedullary hip screw has its own set of complications, more exposure to radiation, a higher learning curve and all at a higher cost. The DHS is still the implant of choice in the stable types of intertrochanteric fractures. If the proper intra-operative guide lines are adhered, then the results in this group of patients are excellent. In our study, we had to change the plan from DHS to PFN in two cases intra-operatively.

In the more unstable types of fracture, the intra medullary hip screw has distinct advantages over the plate and should be the preferred implant for fixation. The need to achieve an anatomical reduction is mandatory since there is less sliding with this implant. Any gap on the post-operative X-rays could always lead to a future non-union.

In conclusion, both the implants are here to stay, it is the fracture geometry and bone quality which will influence the choice of fixation. The quality of the reduction and proper positioning of the implant are the keys to achieving the best postoperative outcome.

Conflict of Interest - Nil
Sources of Support - Nil

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