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Dynamic hip screw versus proximal femoral nail in the treatment of intertrochanteric fracture of femur

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ABSTRACT

Background: As the elderly population grows, the number of hip fractures continues to increase. This study aims to compare the clinical outcomes of dyanamic hip screw and proximal femoral nail in the fixation of intertrochanteric fracture of femur.
Methods: After obtaining approval of the ethics committee, a prospective study was conducted in the department of orthopedics, SKR Hospital, Pathankot from January 2021 till December 2022. Informed consent was taken from patients who fulfilled the inclusion/exclusion criteria and relevant clinical information was collected, including intra and post-operative details.
Results: During the study period, 65 patients with intertrochanteric fracture were included in the study, of which 33 were treated with PFN and 32 with DHS. It was observed that 91% of the patients who underwent PFN had blood loss less than 100 ml, while 72% of the patients who had DHS had blood loss between 100-300 ml. Mobilization started on the first postoperative day in 67% of PFN patients while as compared to 13% of DHS patients (p value <0.01). Among late complications, there was one case of implant failure among PFN cases, while there were two cases of non-union, two cases of implant failure and one case of late infection among DHS group of patients. It was observed that 91% of PFN group patients had excellent outcomes, while outcome was excellent in 66% of DHS group patients.
Conclusions: Our study showed that PFN is a superior method of osteosynthesis as compared to DHS in the treatment of intertrochanteric fractures.

Keywords: Complications, Dyanamic hip screw, Intertrochanteric fracture

INTRODUCTION

Hip fractures are a significant encumbrance for both individuals and society, causing disability or even death in geriatric patients and imposing enormous economic costs.[1] It has been estimated that the number of hip fractures will rise to 2.65 million by 2025 and 6.25 million by 2050, as the global elderly population increases. Trochanteric fractures account for roughly half of all hip fractures and are frequently the result of a low-energy fall.[2] Unlike femoral neck fractures, the trochanteric bone frequently retains an excellent vascular supply after fracture, with a high union rate.[3] Within the first six months, mortality after trochanteric fractures ranges from 12 to 41%.[4] In order for a patient with an intertrochanteric fracture to return to activity as quickly as feasible and to avoid the complications associated with non-ambulatory treatment, internal fixation of these fractures has become the accepted standard. Different devices have been utilized for the fixation of trochanteric femoral fractures, with the dynamic hip screw (DHS) and proximal femoral nail (PFN) being the most common. DHS, which was introduced in the 1970s, could provide both dynamic and static support for fracture stabilization. However, complications related to screw displacement, such as distal screw extrusion and secondary fracture displacement, are not uncommon.[5] The PFN was devised by the AO/ASIF in 1996 as a less invasive alternative for the treatment of

unstable trochanteric and subtrochanteric femoral fractures using an intramedullary device.[6] The proximal femoral nail antirotation (PFNA) system was introduced in 2003 with a helically shaped sliding column-blade design, providing an enhanced contact-area between bone and implant and thereby preventing rotation-induced cut-outs. A putative advantage of intramedullary devices over extramedullary devices is the elimination of the need to attach the plate to the shaft with fasteners, which can be challenging in osteoporotic bones. Additionally, the shaft fixation in PFN is closest to the hip's center of rotation. Thus, the load is transmitted along a more medial axis to the femur, resulting in a shortened level arm.[7] Today, PFN devices are extensively used in the clinic and are available in a variety of lengths, diameters, neck shaft angles, numbers of cephalic fasteners, controllability of rotation, and construction materials.[8] Even though PFN has more theoretical benefit than DHS, the literature, particularly clinical studies, is still divided as to whether PFN is superior to DHS. The purpose of this study is to compare the outcomes of DHS and PFN in the fixation of intertrochanteric fractures of the femur in terms of radiological union, early mobility and weight bearing, and complications. Using the Modified Harris Hip Score, we also sought to assess the functional outcome of both groups.

METHODS

Study design and sampling

We designed a prospective study at the department of orthopedics, SKR Hospital, Pathankot from January 2021 till December 2022. We included patients who were at least 21 years old, had closed intertrochanteric fractures, and had functionally normal lower limb joints. We excluded patients who were medically unfit for surgery, had a history of fracture fixation in the lower extremities, had an open fracture or severe comminuted fractures, or who refused to provide informed assent. Patients with ipsilateral or contralateral significant limb injuries affecting treatment or rehabilitation were also excluded. Informed written consent was obtained from all patients before enrolment in the study.

Data collection and analysis

After administering emergency care to patients who arrived at the trauma center, standard investigations were conducted. In addition to the standard trauma series of investigations, fundamental radiological examinations pertinent to the fracture were performed. After the initial treatment, each patient was evaluated for any medical condition and treated accordingly. All patients provided their informed consent. The perceived benefits of proximal femoral nail and the additional cost of the implant were conveyed to all patients. Surgical procedures were performed on stable patients as soon as possible after the pre-anesthetic evaluation. Patients were mobilized on or after the second post-operative day, depending on their pain levels and general condition. Knee flexion and static quadriceps exercises were initiated. Antibiotics were administered intravenously for 72 hours following surgery and orally for three days following suture removal. Patients were discharged after removal of sutures. The outpatient department followed up with patients monthly for up to six months, and then quarterly. On each visit, the local site was examined for any indications of inflammation or infection, the range of motion of the hip joint was evaluated, and anteroposterior and lateral radiographs of the hip joint were acquired to evaluate the progress of union. Once the patient regained quadriceps control and erect leg elevation and radiographic indications of callus formation were observed, partial weight bearing walking with a walker (toe contact walking) was initiated. Once radiographic signs of union have been detected, weight-bearing walking can begin. During the course of treatment, the patient's age, gender, mode of injury, medical history, blood loss, and complications were recorded. The patients were categorized using the Boyd and Griffin Classification and the AO Classification.[9,10] The AO Classification categorizes injuries based on their severity and location. The appearance of late complications, information regarding physiotherapy, and the overall clinical outcome using the Modified Hip Score were recorded for each patient following the initiation of rehabilitation.[11] This score evaluates the clinical outcome regarding pain, gait, and functional activities. The data were compiled in Microsoft Excel spreadsheets and analyzed with the appropriate statistical techniques. Both techniques for managing intertrochanteric fractures were compared and the descriptive variables were tabulated. Using SPSS version 25, various baseline characteristics, intra-operative findings, post-operative complications and functional outcome at final follow up was compared between DHS and PFN group of patients using Fisher’s exact test, considering p value <0.05 as statistically significant.

RESULTS

During the study period, 65 patients with intertrochanteric fracture were included in the study, of which 33 were treated with PFN and 32 with DHS. The most common age group involved in PFN and DHS group was 40 to 50 years and 51 to 60 years, however no significant difference was observed in the age distribution (Table 1). Males comprised 58% of PFN and 44% of DHS patients. Majority of the patients had fall as the mode of injury as 94% of PFN and 88% of DHS group patients had a fall. It was observed that hypertension was very common among the patients. However, there was no difference between the study groups with respect to comorbidity pattern. Based on Boyde & Griffin Classification, 42% of PFN group were in class III and 56% of DHS group were in class II. 91% of DHS patients belonged to AO classification 31 A1, while 55% of PFN group patients were 31 A1 (Table 2). It was observed that 91% of the patients who underwent PFN had blood loss less than 100 ml, while 72% of the patients who had DHS had blood loss between 100-300 ml.

Table 1: Comparison of baseline characteristics between patients undergoing proximal femoral nail and dynamic hip screw.

Patient variable	Proximal femoral nail		Dynamic hip screw		P value*
	N	%	N	%	
Age distribution (years)					
40-50	12	36	8	25	0.53
51-60	6	18	11	34	
61-70	6	18	7	22	
71-80	7	21	4	13	
81-90	2	6	2	6	
Gender distribution					
Male	19	58	14	44	0.26
Female	14	42	18	56	
Mode of injury					
Fall	31	94	28	88	0.36
Road traffic accident	2	6	4	13	
Associated medical history					
Hypertension/Diabetes	16	48	19	59	0.37
Diabetes mellitus	7	21	9	28	0.51
Other	3	9	2	6	0.66
None	11	33	11	34	0.92
Total	33	100	32	100	-

*analyzed using Fisher's exact test

Table 2: Comparison of pre- and post-operative parameters between patients undergoing proximal femoral nail and dynamic hip screw.

Patient variable	Proximal femoral nail		Dynamic hip screw		P value*
	N	%	N	%	
Boyde & Griffin classification					
I	0	0	12	38	<0.01
II	8	24	18	56	
III	14	42	2	6	
IV	11	33	0	0	
AO classification					
31A1	0	0	29	91	<0.01
31A2	14	42	3	9	
31A3	19	58	0	0	
Blood loss (ml)					
10-49	27	82	2	6	<0.01
50-100	3	9	1	3	
101-200	2	6	14	44	
201-300	1	3	9	28	
More than 300	0	0	6	19	
Blood transfusion (units)					
0	27	82	6	19	<0.01
1	4	12	2	6	
2	0	0	8	25	
3	1	3	8	25	
4	0	0	6	19	
Intraoperative hypotension	1	3	2	6	
Time required to mobilize					
1st post operative day	22	67	4	13	<0.01
2nd post operative day	8	24	3	9	
3rd post operative day	1	3	19	59	
4th post operative day	2	6	6	19	

Continued.

Patient variable	Proximal femoral nail		Dynamic hip screw		P value*
	N	%	N	%	
Post operative weight bearing (weeks)					
1	28	85	2	6	<0.01
2	4	12	22	69	
3	1	3	8	25	
Post operative full weight bearing (weeks)					
2	21	64	0	0	<0.01
3	6	18	4	13	
4	4	12	16	50	
5	1	3	10	31	
6	1	3	2	6	
Total	33	100	32	100	

*analyzed using Fisher's exact test

Table 3: Comparison of early and late complications between patients undergoing proximal femoral nail and dynamic hip screw.

Complications	Proximal femoral nail		Dynamic hip screw		P value*
	N	%	N	%	
Early complications					
Hematoma	0	0	0	0	NA
Superficial infection	0	0	2	6	0.14
Deep venous thrombosis	1	3	2	6	0.52
Late complications					
Non-union	0	0	2	6	0.14
Implant failure	1	3	2	6	0.52
Late infection	0	0	1	3	0.31
Total	33	100	32	100	

*analyzed using Chi-square

Table 4: Comparison of modified Harris hip score between patients undergoing proximal femoral nail and dynamic hip screw.

Modified Harris hip score (out of 91)	Proximal femoral nail		Dynamic hip screw		P value*
	N	%	N	%	
Excellent	30	91	21	66	< 0.05
Good	2	6	2	6	
Fair	1	3	5	16	
Poor	0	0	4	13	
Total	33	100	32	100	

*analyzed using Chi-square

Thus, a significantly higher intra-operative blood loss was observed in patients undergoing DHS (p value <0.01). We observed that 82% of the PFN patients needed no blood transfusion, while 25% of DHS patients needed 2 units of blood transfusions. Mobilization started on the first postoperative day in 67% of PFN patients while as compared to 13% of DHS patients (p value <0.01). Similarly post operative weight bearing and full weight bearing was seen to be significantly quicker in PFN patients as compared to patients who underwent DHS.

There were one case with deep venous thrombosis among PFN cases, while there were two cases each of superficial infection and deep venous thrombosis among DHS group. Among late complications, there was one case of implant failure among PFN cases, while there were two cases of non-union, two cases of implant failure and one case of late infection among DHS group of patients. Thus, the incidence of complications among PFN and DHS group of patients were similar.

In (Table 4), the distribution of patients according to modified Harris Hip score at the final outcome is described. It was observed that 91% of PFN group patients had excellent outcomes, while outcome was excellent in 66% of DHS group patients. Thus, a significantly better functional outcome of patients was observed in patients who underwent PFN as compared to those who underwent DHS.

DISCUSSION

The dynamic hip implant was once the gold standard for treating trochanteric fractures, particularly stable fractures.[12] PFN(A) is a more recent implant consisting of a funnel-shaped intramedullary nail with a minor curvature to reflect proximal femoral diaphyseal trochanteric morphology.

The primary benefit of PFN(A) is the reduction of surgical trauma to bone and soft tissue.[13] However, it is still debatable which technique is more appropriate for treating trochanteric hip fractures. PFN(A) was found to have a shorter operative time and less intraoperative blood loss than DHS, but required more intraoperative fluoroscopy time. Post-operative complications such as implant failure, non-union, and revision surgery did not differ. The evolution of implant for osteosynthesis of intertrochanteric fractures has undergone many refinements as a result of years of research. DHS has been commonly used for the past three decades. Fixation of DHS necessitates extensive surgical exposure and substantial blood loss. Complications such as varus collapse and implant cut-out are frequently observed. With the passage of time, Gamma fastening gave way to a greater emphasis on the design of a nailing construct that also addresses fracture patterns that are unstable. PFN is gaining popularity in recent years because it requires minimal surgical exposure and blood loss.

Complications such as the Z effect (lateral migration of the caudal screw, varus collapse, and perforation of the femoral head by the superior screw) and the reverse Z effect (lateral migration of the cephalic screw, varus collapse, and perforation of the femoral head by the inferior screw) are not unheard of. In their study, Bhakat et al found fewer complications in the PFN group compared to the DHS group.[14] Gupta et al. found in a case series of 400 intertrochanteric fracture patients that PFN has a superior functional prognosis with unstable fractures and requires a reduced operation time.[15]

The aggregate ratios for non-union and implant failure in PFN were 1.9% and 2.2%, respectively, according to a meta-analysis. It was 2% and 3.5% for DHS, respectively.[16] It is reasonable to infer that these two complications contributed to a revision rate of 2.4% and 2.9%, respectively, in PFN and DHS patients who received secondary fixation or arthroplasty. Various internal fixation implants with specially designed mechanical properties are being developed to combat such failures.

The proximal femoral nail anti-rotation device (PFNA) was designed with a smaller distal shaft diameter than the PFN, resulting in a lower tension concentration in the tip.

Previous studies have demonstrated that PFN(A) devices, regardless of brand, have a comparable incidence of post-operative complications.[17] Moreover, it was discovered that the relationship between a more expensive device and improved short-term outcomes is not positive.[18] This necessitates the development of new technologies and further exploration, and we believe that information gleaned from pre-clinical research with high translational potential may aid in reducing these risks. In their study of 52 patients, Kushal et al found that the DHS group had outstanding results in six (23 percent), good results in five (19 percent), acceptable results in thirteen (50 percent), and subpar results in two (8 percent).[19]

In the PFN group, there were four (15%) cases of outstanding results, fourteen (54%) cases of good results, seven (27%) cases of middling results, and one (4%), case of poor results. In their study of 30 patients, Harish et al reported that in the DHS group, six patients had outstanding results, two had good results, two had acceptable results, and none had poor results.[20] In the PFN group, eight showed outstanding results (72.73%), one showed good results (9.1%), one showed acceptable results (9.1%), and none showed subpar results. In his comparative study of 80 patients using the Locking DHS and PFN, Gill et al found that in the DHS group, exceptional results were observed in six (15%) patients, good results were observed in 14 (35.0%) patients, average results were observed in 12 (30%) patients, and unsatisfactory results were observed in eight (20%) patients.[21] In the PFN group, outstanding results were seen in eight (20.0%), good results seen in 130 (75.0%), average results seen in two (5.0%), and no subpar results were seen. The most beneficial component of intramedullary implants is their intramedullary position, which forms a mechanical buffer to avoid excessive collapse, making the lateral cortex essentially unimportant. In fractures with subtrochanteric extension, the intramedullary position's reduced lever arm may reduce fatigue failure. These mechanically superior implants are said to prevent surgical blood loss and hip muscular damage. No evidence disproves this benefit. A restricted incision at or slightly medial to the greater trochanter apex preserves the abductors, improves rehabilitation, and reduces postoperative pain.

CONCLUSION

Several fixation techniques have been proposed to enhance the clinical outcome of intertrochanteric fracture treatment. In addition to retaining the benefits of primary haematoma, the minimally invasive surgical approach without exposing the fracture region causes minimal soft tissue injury and reduces the risk of infection. Therefore, we conclude that PFN is a preferable form of osteosynthesis when treating intertrochanteric fractures compared to DHS.

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