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Choice of implant in stable intertrochanteric fracture femur: PFNA vs DHS

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Abstract
Introduction: The best treatment for trochanteric fracture remains controversial Many methods have been recommended. Stable fixation that allows early mobilization is the treatment of choice. In this study, we aimed to compare the results of osteosynthesis using the PFNA and DHS system, in the treatment of stable intertrochanteric fractures including operative and postoperative complications, general complications and final outcome measurements.
Method: We randomised 60 patients with low-energy extracapsular pertrochanteric stable femoral fractures (AO category 31-A1.1-31A.2.1)7 to be treated with the dynamic hip screw or the proximal femoral nail A2. All fractures were categorised according to the AO/ASIF classification. Follow-up reviews were undertaken at four weeks, three and six months post-operatively using Harris hip score.
Results: From the first to the 6th month, there was a significant improvement in Harris hip score (p<0.05), when each time point was compared with the previous one in both groups. On 3 -month follow-up, PFNA2 group had significantly better daily functioning than DHS group, as defined by Harris hip score. At 6 months, the PFNA2 group approached but did not normalise to its pre-operative Harris hip screw values (p =0.043). In contrast, DHS group values at 6 months lagged significantly to pre-operative values (p<0.001) PFNA group has fewer complications compared to DHS group.
Conclusion: PFNA can benefit peritrochaneric fractures with less blood loss, earlier mobilization, better functional outcome and fewer complication compared to DHS.

Keywords: Intertrochanteric fracture, PFNA, DHS

Introduction
The best treatment for trochanteric fracture remains controversial [1-3]. Many methods have been recommended [4-6]. Stable fixation that allows early mobilization is the treatment of choice. While there are numerous operative devices for treatment of trochanteric fractures, none of them are totally free of complications. The use of cephalomedullary nails has overtaken the use of sliding hip screw in the treatment of intertrochanteric fractures during the past decade [2, 7-9]. This trend seems unjustified, as extensive meta-analysis of randomized trials fail to demonstrate the relative benefit of intramedullary devices [10]. Sliding hip screw has been a gold standard treatment for intertrochanteric fracture [11, 12]. Intramedullary nail fixation for intertrochanteric fractures is a well-recognized method of treatment leading to good results due to the fact that it produces stable fixation especially for unstable fractures [13–15, 16, 17]. Besides being mechanically superior, intramedullary fixation offers theoretical advantages over plates, such as minimally invasive application with reduced damage to the soft tissues and reduced likelihood of infection and possibly less operative time. Minimally invasive surgery has gained popularity in modern orthopaedics and traumatology, as it is associated with decreased postoperative pain, reduced bleeding, faster recovery of function and lower risk of postoperative morbidity [17]. This is especially important for the old, fragile patient with trochanteric fracture. Insertion of the blade compacts the cancellous bone. These characteristics provide optimal anchoring and stability when the implant is inserted into osteoporotic bone and have been biomechanically proven to retard rotation and varus collapse. The inserted PFNA blade achieves an excellent fit through bone compaction and requires less bone removal compared to a screw [6].

In our review of literature we didn't encounter any study comparing PFNA and DHS in stable intertrochanteric fracture femur. In this study, we aimed to compare the results of osteosynthesis using the PFNA and DHS system, in the treatment of stable intertrochanteric fractures including operative and postoperative complications, general complications and final outcome measurements.

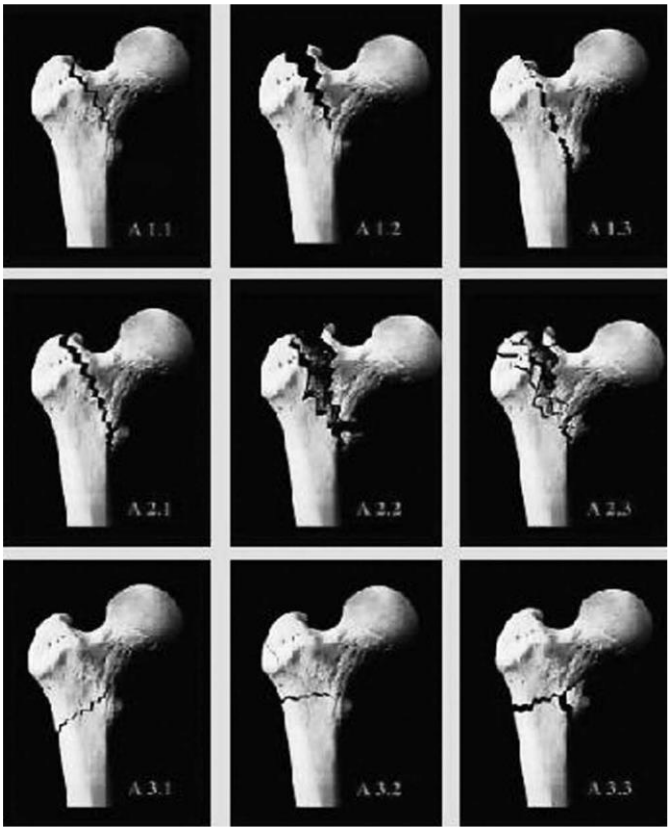

Fig 1: AO Classification

Material and Methods

Between MARCH 2015 and MARCH 2017, we randomised 60 patients with low-energy extracapsular pertrochanteric stable femoral fractures (AO category 31-A1.1-31A.2.1)7 to be treated with the dynamic hip screw (Sharma) or the proximal femoral nail A2 (Sharma). The ethics committee of our hospital approved the study plan and informed consent was obtained from all patients before the operation. Everyone admitted to our hospital with a pertrochanteric low energy stable fracture during the study period between the age group of 18 to 90 years was considered eligible for the study, but those with a pathological fracture, polytrauma, and who were unable to give informed consent or refused to participate, were excluded. Plain radiographs of both hips with proximal femur with 15 degree internal rotation at hip joint were obtained on admission, and all fractures were categorised according to the AO/ASIF classification [18]. The mode of treatment was determined by randomisation by odd and even numbers. Walking ability was classified into three categories: able to walk independently without aids, walking independently with the help of aids (crutches or frame) and walking only when assisted by another person. The operation was usually performed within two days of admission, in most cases by a senior orthopaedic resident. All fractures were reduced by closed means. Standard operative techniques, which are recommended by the manufacturer and have been described in detail in instruction manuals or earlier studies [19, 20] were used. All patients received a prophylactic dose of an intravenous antibiotic. Intra-operative factors were considered as secondary outcome measures. Plain anteroposterior (AP) and frog leg view radiographs were obtained on the first post-operative day, and analysed for reduction of the fracture and position of the implant. Reduction was assessed according to fixation stability score [21]. The cleveland index method was used to record the position of the tip of the lag screw.

Walking weight-bearing within the limits of pain was usually begun on second post-operative day. The rehabilitation protocol was uniform, regardless of the method of fixation. The patients were discharged when mobile and primary complications had been excluded.

Follow-up reviews were undertaken at four weeks, three and six months post-operatively using harris hip score. Plain AP and Frog leg radiographs were obtained at both visits. All changes in the position of the fracture and implant, like fracture collapse, screw cut out and cut through when compared with the post-operative radiographs, were recorded and considered as secondary measures of outcome. Where the patient lived and their ability to walk were recorded as in the pre-operative phase. A return to the pre-operative level was considered as a primary measure of outcome. The statistical analysis was performed using SPSS for Windows (SPSS Inc, Chicago, Illinois). Odds ratios and means were compared between the groups, with 95% confidence intervals (CI) excluding the value of one and zero respectively, being considered as statistically significant differences. P values were calculated with independent samples *t*-test and with cross-tabulation using Fisher's exact test; values of $p<0.05$ were considered as significant.

Results

There was no significant difference in one year mortality rate between two groups. Groups were similar in terms of age, sex, side of fracture and pre-operative ASA classification. 19 patients got injury due to RSA and 41 got injury due to fall. Table 2 shows changes over the follow-up period for Harris hip scores for the DHS and PFNA2 group. From the first to the 6th month, there was a significant improvement in Harris hip score ($p<0.05$), when each time point was compared with the previous one in both groups. On 3 -month follow-up, PFNA2 group had significantly better daily functioning than DHS group, as defined by Harris hip score. At 6 months, the PFNA2 group approached but did not normalise to its pre-operative Harris hip screw values (p =0.043). In contrast, DHS group values at 6 months lagged significantly to pre-operative values ($p<0.001$). Comparison of secondary outcome measures between groups is shown in Table 3. Mean duration of surgery and median incision length were significantly lower in the PFNA2 group; amount of radiation and length of hospital stay were similar. The percentage of patients that had hip pain was significantly higher in DHS. Cut outs necessitating re-operation were none. Fixation failures were none. Nevertheless, failure rates did not reach statistical significance between groups. All fractures eventually healed in both groups. No case of intra-operative or postoperative secondary fractures around the tip of the PFNA2 were noted. No additional stabilisation methods, e.g. cerclage wires, were used in either group. Average blood loss was 30 ml in PFNA2 and 100 ml in DHS.

Fig 2: pre - op lateral view

Fig 3: pre –op ap view

Fig 4: intra op lateral View

Fig 5: intra op ap view

Average duration of surgery was 32.36 minutes in PFNA2 and 49.9 minutes in DHS. Average hospital stay for DHS and PFNA2 was 4.6 and 5 days. 3 cases of superficial infection and one case of deep infection was found in DHS and 1 case of superficial infection was found in PFNA2.

Table 1: Results

	DHS	PFNA	p- value
Blood loss(ml)	100	30	<0.001
Blood transfusion	0	0	--
Duration of surgery(min)	49.67	32.37	<0.001
Harris hip score(1month)	22.73	34	<0.001
Harris hip score(3 month)	53.76	59	<0.001
Harris hip score(6 month)	88.30	92	<0.001
Collapse(mm)	10	5	
Shortening	10	5	
Implant failure	0	0	
Non-union	0	0	
Infection	5	1	
Medical complications	1	1	

Table 2: Implant

Dynamic hip screw	Proximal femoral nail
1.Barrel angle : 120: 0 patients 125: 0 patients 130: 22 patients 135: 7 patients 140: 1 patient 2.No of holes : 4 : 28 5 : 2 3.Screw length 75: 6 80: 8 85: 10 90: 5 95: 1	1. Nail diameter : 10 : 27 11: 3 2. Screw angle : 130

Table 3: Complication

Complication	DHS		PFNA2	
	Number	Percentage	Number	Percentage
Infection	5	16.67	1	3.33
Non- Infection	25	83.33	29	96.67
Total	30	100.0	30	100.0
Chi Square	2.963			
P value	0.085			
Significance	NS			

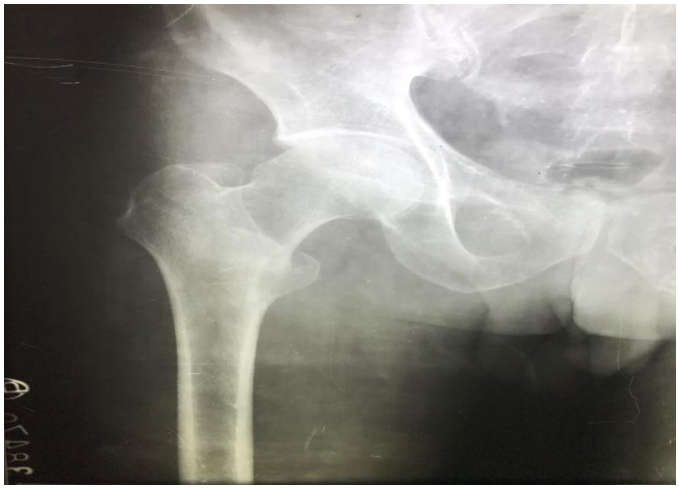

Fig 6: pre op AP view

Fig 7: lateral view at 3 month post op

Fig 8: ap view at 3 month post op

Discussion

Numerous prospective randomised trials have proved that sliding hip screw devices can successfully treat majority of intertrochanteric fractures, with implant failures occurring in <5 % of cases [4, 22–28] Initial reports have suggested that IM nails may have an advantage over side plate devices in unstable fractures but have not demonstrated a clear superiority and have a reported complication rate of around 20% [4, 29, 30]. The incidence of neck screw cut out has reduced considerably with improvements in the surgical technique but still remains the most common mode of fixation failure [24, 31] with IM implants. The proximal femur nail anti-rotation (PFNA) was developed aiming to reduce this complication and initial studies have shown promise [17].

PFNA2 is relatively recent design as compared to PFN and we found very few studies comparing PFN and PFNA2. The objective of the study was to assess and compare both the implants in terms of blood loss, operative time, return to routine work, and complication rate and Harris hip score at 3 and 6 month.

When the proximal femoral intramedullary nail is inserted, the lever arm loading on the implant around the hip shortens due to transmission of the load medially, and bending forces can be resisted more successfully due to the rigidity of the nail [32].

This superiority is thought to be a consequence of the efficient load transfer due to the closed proximity of the nail is in close proximity to the mechanical axis. Furthermore, there is a lower risk of mechanical failure due to load reduction on the implant due to the shorter lever arm and a controlled fracture impaction. The nail is intramedullary and medialization of the distal end is prevented, especially in reverse oblique fracture types. With intramedullary nail insertion, immediate postoperative weight bearing and mobilization are possible, particularly in elderly patients [10, 33].

The hip functions and disabilities in the current study had been assessed by using the Harris hip score. The reason of choosing this scale is that now it is the scoring tool that is most commonly used worldwide for assessment of hip functions in general. It has become widely used as a means of comparing results and hip pathology [34, 35].

Small incision and lower bleeding is one of the benefit of nail method. However, to achieve reduction, in some patients a longer incision may be required but the mean length of incision are 6 cm and mean reported bleeding is under 100 cc while in DHS it is 200 to 250 ml. Ioannis *et al* found median incision length of 15 cm for DHS and 4 cm for PFN in their comparative study. We found mean average length of 17 cm incision for 4 hole DHS plate and average 4 cm incision for PFN.

Operative time was 50 minute for DHS and 35 minutes for PFNA2 for our study, while loannis *et al* found average time for DHS of 75.5 min and for Gamma nail of 45.7 minutes.

Average Harris hip score at 3 months in case of DHS was 54 and for PFNA2 it was 59. While at 6 months average Harris hip score for DHS was 89 and for PFNA2 it was 92 which suggests that there is no significant difference in Harris hip score at 6 months between DHS and PFNA2 but at 3 months PFNA2 had superior Harris hip score.

Both groups were allowed weight bearing on 2nd postoperative day as per pain tolerance. At 3 month following 45% patients of DHS group were walking independently and 60 % patients of PFNA2 group were walking independently. At 6 months follow up 90% patients from DHS group and 94% patients of PFNA2 group were walking independently. This data is suggestive of earlier full weight bearing ability of PFNA2 group patients.

Abductor lurch in gait was present in 5 patients in DHS group and 3 patients in PFNA2 group, which suggests that less dissection in PFNA2 prevents injury to abductors insertion.

This study was done in stable intertrochanteric fractures only so collapse of fracture was very less and sliding was less in PFNA2 as compared with DHS because of inbuilt sliding mechanism in DHS screw.

We had 4 complication in DHS group, including 3 superficial and 1 deep infection, and 1 superficial infection in PFNA2 group. There were no cut outs, implant failure or reoperations in either groups.

Nobuaki chinzei *et al* In their study of comparison of sliding and femoral head rotation among three different femoral head fixation devices for trochanteric fractures concluded that the ability to stabilise femoral head appears to be greater with blade type materials than with screw type materials. Furthermore non cylindrical blade is preferable to a cylindrical blade [36].

In the study by Takigami *et al*. the length of the surgical procedure averaged 20.3 minutes (range 9-83 minutes). Intraoperative blood loss averaged 22.8 ml (range 5-100 ml). It would be wrong to conclude, given the length of the surgical procedure,that it is a simple procedure. Sahmir sadic *et al* in their study found that the average duration of surgery was 73.1 minutes. On average, each patient received 423.6 ml of blood or blood products [37].

The first biomechanical study of a PFNA device suggests that the inferior position of the helical blade in the frontal plane and center position in the sagittal plane is superior to the centre-centre position and provides better biomechanical stability [38]. Central-inferior and anterior-inferior positions,

after adjustment for tip apex distance and screw position, were significantly protective against cutout [39].

Nikoloski *et al* believe that the TAD rule of < 25 mm should not apply for the PFNA. They suggest avoiding a TAD < 20 mm due to possible axial cut-out and avoiding a TAD > 30 mm to avoid cephalad cut-out. In our study, 36 (32.7 %) patients had a TAD < 20 mm with one cut-out and 35 (31.8 %) ≥ 30 mm with two cut-out [40].

Subtle migration (2 mm) of the tip of the blade within the femoral head occurred in all fractures, but this did not preclude maintenance of reduction and fracture healing, and was not predicted by fracture type, reduction quality, age or gender [41].

We have suggested that PFNA offers advantages, as it can be easily inserted and provides stable fixation, which allows early mobilization of the patient. Therefore, early operation, good reposition, strict respect of technical steps and stable fixation will result in good functional recovery. The best position of the blade within the head is still unknown [37].

Parker and Handoll compared extramedullary to intramedullary devices in a meta-analysis of >3500 patients and found no significant difference in mortality rates, non-union, infection, cut out, blood loss, operation duration and radiation time [42].

operative time proved to be significantly shorter in gamma nail group in this technically demanding group of fractures. There are series showing comparable or even shorter operative times with sliding hip screws, probably reflecting the unfamiliarity in the 1990s with nails [4, 26]. Fixation with a sliding hip screw is a straight forward and fast operation in stable intertrochanteric fractures. However when unstable fractures are considered separately. Nail fixation seems to be faster [43].

Conclusion

Our study shows clinically relevant differences in post-operative Harris hip score at 1,3,6 months indicating better and early functional outcome with PFNA.PFNA can benefit peritrochaneric fractures with less blood loss, earlier mobilization, better functional outcome and fewer complication compared to DHS.

Conflict of interest: None

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