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Comparative study between proximal femoral nail and proximal femoral nail antirotation in management of unstable trochanteric fractures

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ABSTRACT

Background: In the management of peri-trochanteric fractures, intramedullary (IM) devices have proven advantage over extramedullary devices. IM devices allow for stable anatomical fixation of more comminuted fractures without shortening the abductor lever arm or changing the proximal femoral anatomy. Between IM devices like proximal femoral nail (PFN) and proximal femoral nail antirotation (PFNA), the helical blade of latter is believed to provide stability, compression and rotational control of the fracture with higher cut out strength. The following study was undertaken in an attempt to compare these two types of Intra-medullary devices.
Methods: Between January 2012 and June 2013, 50 patients with unstable intertrochanteric fractures fulfilling inclusion and exclusion criteria, were randomized into 2 groups to undergo CRIF with either standard PFN (n=25) or PFNA (n=25). They were compared in terms of demography, per-operative variables and postoperative parameters including functional evaluation till 1year postoperatively.
Results: Background demographic variables, fracture type and pre-injury ambulatory status were comparable between the groups. Operative duration of surgery, amount of blood loss and number of fluoroscopic images were significantly lower in PFNA group as compared to PFN group. Post op complications like infection, non-union, cut out/z-effect, loss of reduction, re-operation and mortality rates didn't differ significantly between the groups. Post op functional recovery as evaluated by pain, use of walking aids and Harris hip scores were similar in both groups.
Conclusions: PFNA significantly reduces the operative time, amount of blood loss and fluoroscopic imaging as compared to PFN. However PFNA offers no significant benefits over PFN in terms of post-operative functional recovery or complications.

Keywords: Proximal femoral nail antirotation, Proximal femoral nail, Trochanteric fractures

INTRODUCTION

As the life expectancy has increased worldwide in recent years, a considerable increase has occurred in the incidence of proximal femoral fractures.[1] They are usually complicated with associated co-morbidities like osteoporosis, diabetes, hypertension, renal failure. In such circumstances, non-operative treatment is mainly reserved for poor medical candidates and non-ambulant patients with minimal discomfort after fracture. Today operative treatment has largely replaced conservative measures and the goal of treatment is to achieve accurate

or acceptable anatomical and stable reduction with rigid internal fixation in order to achieve early mobilization of patients and prevent complications of prolonged recumbence. Despite marked improvements in implant design, surgical technique and patient care, peri-trochanteric fractures continue to consume a substantial proportion of our health care resources and remain a challenge to date. [2] Complications with peritrochanteric fractures arise primarily from fixation rather than union or delayed union because the peritrochanteric area is made up of spongious bones.[3] The strength of the fracture fragment-implant assembly depends upon various factors including (a) bone quality, (b) fragment geometry, (c) reduction, (d) implant design and (e) implant placement. Of these factors, surgeon can only control the quality of the reduction, choice of implant and its placement. In cases of intertrochanteric fractures, the preferred type of fixation device is controversial. The sliding hip screw is a widely used extramedullary implant in the treatment for hip fractures. However, studies have reported that this implant is not appropriate for unstable intertrochanteric fractures, and have supported various alternative modalities of fixation.[4,5] As compared to extramedullary devices, intramedullary nails can be inserted with less exposure of the fracture, less blood loss, although they may require more fluoroscopic exposure. Biomechanically, nails allow for stable anatomical fixation of more comminuted fractures without shortening the abductor moment arm or changing the proximal femoral anatomy. The common IM devices used for unstable intertrochanteric fractures today include proximal femoral nail (PFN) and proximal femoral nail antirotation (PFNA). PFN was introduced by AO/ASIF in 1996 for treatment of trochanteric fractures. It includes an Intramedullary nail through which two screws are inserted into the neck of femur. One is a lag screw that stabilizes the fracture allowing collapse and other is an antirotation screw used to provide rotatory stability to the fracture. PFNA was introduced in 2003 and it utilizes a helical blade instead of the conventionally used two screws. The helical blade is believed to provide stability, compression as well as rotational control of the fracture. Theoretically it compacts the bone during insertion into the neck and hence has higher cut out strength as compared to other devices. Hence there is less chance of implant failure especially in elderly, osteoporotic bones. The following study was undertaken in an attempt to compare these two types of Intra-medullary devices.

METHODS

Between January 2012 and June 2013, 72 adults with trochanteric fractures were operated at our tertiary care hospital. Patients over the age of 50 years with acute unilateral trochanteric fractures belonging to AO/ASIF 31-A2, AO 31-A3 who were independent ambulators, prior to injury were included and prospectively studied. Institutional ethical clearance was taken. Patients with pathologic fractures, open fractures, polytrauma, neuromuscular disorders or severe cardio-pulmonary insufficiency were excluded. 50 patients fulfilling inclusion and exclusion criteria, were randomized into 2 groups to undergo CRIF of trochanteric fractures with either a standard PFN (Synthes) or PFNA (Synthes). All patients gave written informed consent before the surgery. Out of the 50 patients, 25 underwent fixation with proximal femoral nail (PFN) and the remaining 25 with proximal femoral nail antirotation (PFNA). Surgical exposures were similar to both implants except for the techniques and instrumentation used in either systems. Background and demographic variables including age, gender associated comorbidities and pre-injury ambulatory status were recorded. Fractures type was assessed and recorded as per AO/ASIF classification system using orthogonal radiographs of the affected hip. All patients were administered spinal or epidural anaesthesia and positioned supine on a fracture table prior to closed reduction of fracture. Per operatively, the duration of surgery, amount of blood loss, number of images shot on the image intensifier was recorded. All patients received three doses of prophylactic antibiotics including the pre-op dose given within 30 minutes prior to skin incision. Post operatively all patients received thrombo-prophylaxis with low molecular weight heparin for the duration of hospital stay or first 10 post-op days, whichever was shorter, followed by Aspirin for 4 weeks. All patients were allowed touch down weight bearing ambulation using a walking frame starting from the first post op day till 6 weeks, following which progressive weight bearing was allowed depending on the status of fracture union. Clinical and radiological assessment of fracture union/complications for all the patients was done pre-operatively and post-operatively at 06 weeks, 3months, 6months and 1year. Functional evaluation was done at 1year post op using Harris Hip Score.

Statistical analysis

Statistical analysis was done using SPSS software (IBM Version-20). Statistical difference between continuous variables were assessed using Student t-test. Categorical variables were compared using Chi square test. Statistical significance was set at P value of 0.05 or less.

RESULTS

The mean age of patients in PFN and PFNA groups was 64.36 ± 8.28 years and 65.36 ± 8.66 years respectively and did not differ significantly ($p = 0.678$). Further, the subjects of two groups were also gender matched as the number of females and males was same in the two groups. The fracture types as per AO classification also did not differ ($p = 0.489$) between the two groups as shown in Table 1.

All fractures in either of the groups were reduced by closed methods. The mean operative time was significantly lower in PFNA group as compared to PFN group (35.20 ± 6.03 minutes vs. 43.32 ± 8.20 minutes, ($p < 0.001$). Mean blood loss was also significantly lower in

PFNA group as compared to PFN group (59.80 ± 14.96 ml vs. 77.80 ± 17.39 ml, (p<0.001). The mean number of images taken per-op was significantly lower in PFNA group as compared to PFN group (18.60 ± 3.12 vs 29.52 ± 4.85 (p <0.001) as given in Table 2.

Table 1: Demography and basic characteristics of the two groups.

Basic characteristics	PFN (n=25)	PFNA (n=25)	P Value
Age (years)			0.678
Mean ± SD	64.36±8.28	65.36 ± 8.66	
Range (min to max)	(51 to 82)	(51 to 84)	
Gender			1.000
Females	14 (56.0%)	14 (56.0%)	
Males	11 (44.0%)	11 (44.0%)	
AO classification			0.489
31A-2.2	16 (64.0%)	19 (76.0%)	
31A-2.3	5 (20.0%)	3 (12.0%)	
31A-3.1	4 (16.0%)	2 (8.0%)	
31A-3.2	0 (0.0%)	1 (4.0%)	

Table 2: Operative details of the two groups.

Operative details	PFN (n=25)	PFNA (n=25)	P value
Duration (minutes)			
Mean ± SD	43.32 ± 8.20	35.20 ± 6.03	P<0.001
Range (min to max)	(30 to 60)	(30 to 50)	
Blood loss (ml)			
Mean ± SD	77.80 ± 17.39	59.80 ± 14.96	p<0.001
Range (min to max)	(60 to 120)	(40 to 100)	
Images (no)			
Mean ± SD	29.52 ± 4.85	18.60 ± 3.12	p<0.001
Range (min to max)	(24 to 40)	(15 to 26)	

Two cases developed post op superficial wound infection in either of the groups which were managed conservatively to have good results and no patients in either of the groups had any evidence of DVT or thromboembolism in the postoperative period. Although the mean hospital stay (postoperatively) was lower in PFNA group as compared to PFN group, the difference was not statistically significantly (8.00 ± 2.89 days vs. 6.60 ± 2.35 days, p =0.066). There were no peri-implant fractures or implant breakage in the two groups. There was 1 case of non-union each in either of the groups which required a second surgery. The incidence of cut out/z-effect and re-operation didn't differ significantly between the groups (p =0.552) as presented in Table 3.

Table 3: Postoperative complications.

Implant related complications	PFN (n=25)	PFNA (n=25)	P Value
Cut out/Z-effect			0.552
Yes	2 (8.0%)	1 (4.0%)	
Re operation			0.552
Yes	2 (8.0%)	1 (4.0%)	

Table 4: Loss of reduction.

Loss of reduction	PFN (n=25)	PFNA (n=25)	P value
Shortening (>1 cm)			0.684
No	21 (84.0%)	22 (88.0%)	
Yes	4 (16.0%)	3 (12.0%)	
Varus malalignment			0.552
No	23 (92.0%)	24 (96.0%)	
Yes	2 (8.0%)	1 (4.0%)	

The loss of reduction including shortening (>1 cm) (p =0.684) and varus malalignment (p =0.552) were similar between the two groups though they were relatively lower in PFNA group as compared to PFN group as seen in Table 4. 1 patient in PFN group and 2 in PFNA group died due to causes unrelated to the surgery. Among live patients, 4 patients in PFN group and 3 in PFNA group had persistent pain in their affected hips at final follow-up, however the difference was not significant (p =0.727). 9 and 6 patients in PFN group and PFNA group respectively used walking aids at the end of study period, however, the difference between them wasn't significant (p =0.401). 16 patients in PFN group and 18 patients in PFNA group returned to pre fracture status. The return to pre fracture status also did not differ (p =0.374) between the two groups. The mean Harris hip score of PFNA group was relatively higher as compared to PFN group but the difference was not significant (p =0.562) as given in Table 5.

Table 5: Final outcome measures.

Final outcome measures	PFN (n=25)	PFNA (n=25)	P value
Mortality	1 (4.0%)	2 (8.0%)	0.552
Persistent pain	4 (16.7%)	3 (13.0%)	0.727
Use of walking aids	9 (37.5%)	6 (26.1%)	0.401
Return to pre fracture status	16 (66.7%)	18 (78.3%)	0.374
Harris hip score (1 year post operatively)			
Mean ± SD	86.8± 11.29	88.48±7.56	0.562
Range (min to max)	(50 to 95)	(64 to 95)	

DISCUSSION

This study was conducted on 50 adult patients with unstable trochanteric fractures who were managed operatively using either PFN or PFNA following closed reduction at a tertiary care centre. The patients in both the groups were comparable in terms of demography and the fracture type.

The mean duration of surgery was significantly lower in PFNA group as compared to PFN group. This was mainly because of the use of a single helical blade in PFNA as compared to two screws in PFN. The PFNA involves gentle tapping of the helical blade over a guide pin thereby avoiding the steps involved in reaming of canals for lag screw and de-rotation screw as required in a PFN. The positioning of the guide wire for insertion of helical blade is also easier as compared to two guide wires for PFN. The mean blood loss was significantly lower in PFNA group as compared to PFN group. The decrease in blood loss in PFNA group is attributed to decreased duration of surgery and smaller surgical incision for the placement of PFNA Blade as compared to longer surgical time and longer incision for insertion of lag Screw and de-rotation screw in PFN Group. However the amount of blood loss was not severe enough to necessitate a blood transfusion in any case. Exposure to X–rays, as determined by the number of intraoperative fluoroscopic images taken showed significantly lower scores for PFNA as compared to PFN. The reasons for this are the same as that for increased duration of surgery in case of PFN. Zeng et al found that PFNA use was associated with a significant reduction in duration of surgery, overall complication rate, post-operative fixation failure rate, and intraoperative blood loss as compared to PFN.[6] Takigami et al also found that the surgical time and operative blood loss were lower with the use of PFNA as compared to PFN.[7] The findings of our study with respect to duration of surgery, amount of blood loss and radiation exposure are comparable with above studies.

The mean duration of hospital stay (postoperatively) did not differ between the two groups. There were no cases of post-operatively DVT/thromboembolism, peri-implant fractures or implant failures in either of the groups. Postoperative complications including wound infection, cut out/z-effect, non-union and reoperation rates were similar between the groups. However 2 patients in the PFN group showed Z –Effect, a complication specific to PFN, while one patient in the PFNA group showed cut – out of the helical blade. All these cases had relatively poorer bone stock with some amount of varus malreduction of the fractures. Incidence of shortening (>1 cm) and varus did not differ significantly between the groups. Andrej and associates in their study recommended a TAD (tip apex distance) of 20 to 30 mm in case of helical blade devices as compared to conventional compression screw devices and observed bimodal incidence of cut out/cut through when the TAD was >30 mm or <20 mm.[8] Mora et al recommend PFNA for the treatment of trochanteric femoral fractures in the elderly as PFNA's blade demonstrated a lower incidence of cut out in their study.[9] They argued that the blade improved fixation stability decreasing bone loss of the remaining bone stock, increased the contact area between implant and the femoral head and compacted the cancellous bone. We could not appreciate a significant difference in terms of cut out/cut through between the two groups in our study. The incidence of persistent pain in the affected hip, use of walking aids, return to pre-fracture status in both the groups were comparable. The mean Harris hip scores of the groups were between 85 - 90 and the groups were not significantly different from each other.

The prospective nature of the study and randomization of patients strengthened the study. However the smaller sample size and shorter duration of follow-up are limiting factors.

CONCLUSION

The study suggests that both PFN and PFNA perform well, showing equally good functional outcomes following fixation of unstable trochanteric fractures. PFNA offers no significant benefits over PFN in terms of post-operative complications. However as compared to PFN, use of PFNA significantly reduces the duration of surgery, the amount of operative blood loss and fluoroscopic imaging.

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