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Original Article

Results of proximal femur nail antirotation for low velocity trochanteric fractures in elderly

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Abstract

Background: The proximal femur nail antirotation (PFNA) is the recent addition to the growing list of intramedullary implants for trochanteric fracture fixation. The initial results in biomechanical and clinical studies have shown promise. We report our results of low velocity trochanteric fractures internally fixed by proximal femur nail antirotation.

Materials and Methods: A prospective study was conducted to assess the results of 122 elderly patients with low velocity trochanteric fractures [39 – stable (AO; 31-A1) and 83 – unstable (AO; 31-A2 and A3)] treated with PFNA from December 2008 to April 2010. Followup functional and radiological assessments were done. Results obtained were compared between stable and unstable fracture patterns using statistical tools.

Results: The mean followup was 21 months (12−28 months). 11 patients were lost in followup. Union was achieved in all but one patient. Varus collapse was seen in 14 patients and helical blade cut out in one patient. Stable and satisfactorily reduced fractures had a significantly better radiological outcome. Functional outcome measures were similar across fracture patterns. 65% of the patients returned to their preinjury status. The overall complication rate was also significantly higher in unstable fractures.

Conclusion: Good results with relatively low complication rates can be achieved by PFNA in trochanteric fractures in the elderly. Attention to implant positioning, fracture reduction and a good learning curve is mandatory for successful outcomes.

Key words: Helical blade, intramedullary implant, PFNA, trochanteric fractures

Introduction

The surgical management of trochanteric fractures has evolved over the past two decades. The biomechanical advantages of intramedullary (IM) implants make Gamma nail (GN) and proximal femur nail (PFN) an attractive option especially in unstable fractures.[1] Initial reports have suggested that IM nails may have an advantage over sideplate devices in unstable fractures but have not demonstrated a clear superiority and have a reported complication rate of around 20%.[2-4] The incidence of neck screw cutout has reduced considerably with improvements in the surgical technique but still remains the most common mode of fixation failure[5,6] with IM implants. The proximal femur nail antirotation (PFNA) was developed aiming to reduce this complication and initial studies have shown promise.[7,8] With this background, we analyzed our results with the PFNA in low velocity trochanteric fractures in the elderly.

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Materials and Methods

122 patients with trochanteric fractures treated with the PFNA from 2008 December to 2010 April were reviewed. Independently mobile patients over 65 years admitted with a trochanteric fracture following a low velocity fall were included in the study. High velocity fractures (road traffic accidents, fall from a height of more than 5 feet), polytrauma patients, pathological fractures, intracapsular fractures, subtrochanteric fractures, and patients presenting more than 2 weeks after injury were excluded. Fractures were classified according to the AO classification, 31. A1–A3. Data was prospectively collected and analyzed for clinicoradiological and functional results. Implant and technique-related complications were also assessed. The institutional review board approved the study and informed consent was obtained from patients prior to surgery.

A standard surgical technique for nail and blade insertion recommended by the manufacturer (PFNA–II, Synthes, India) was followed. The procedure was carried out on a fracture table with boot traction. A total of eight surgeons performed the operations. Initial fracture reduction was attempted on the fracture table under image intensifier. Percutaneous fracture-reduction techniques were used if satisfactory reduction in two planes could not be achieved before the nailing procedure. The nail was locked distally in the dynamic mode for stable fractures (A1) and in the static mode for unstable fractures (A2 and A3).

Weight bearing as tolerated was allowed routinely from the day after surgery irrespective of the fracture subtype. Thromboembolic prophylaxis with subcutaneous low molecular weight heparin was used for 3 days postoperatively. Patients were discharged when they were able to walk confidently with assistance.

Followup assessments were conducted at 6 weeks, 6 and 12 months. Final analysis was performed between May and July 2011. At followup, visual analog scores (VAS), the mobility scores described by Parker and Palmer[9] were recorded and hip abductor strength assessment was done according to the Medical Research Council (MRC) grading.

An independent radiologist blinded to the clinical outcome assessed all radiographs. Immediate postoperative radiographs were evaluated for fracture reduction, tip apex distance (TAD), and zone position of the helical blade. Fracture reduction was classified as satisfactory and not satisfactory according to modified Baumgaertner's criteria.[10] Helical blade position in the lower half of the neck and central—central in the femoral head with a tip-apex distance of <25 mm was considered satisfactory. Blade position was classified unsatisfactory if these criteria were not met. Followup radiographs were assessed for union, loss of reduction and fixation, helical blade sliding (measured using the technique described by Watanabe *et al.*[11]), migration, and cut out.

Statistical analysis was done using SPSS 16. Categorical variables were expressed as proportions and were assessed using Pearson's chi-square test. Continous variables were expressed as means and standard deviation and analyzed using *t* tests. Internal subgroup analysis was performed comparing stable with unstable fractures and well fixed (good reduction and ideal blade position) fractures with poorly fixed (poor reduction and/or unsatisfactory blade position) fractures with respect to fracture reduction, helical blade positioning (TAD), functional outcome, and complications, and the level of significance was assessed with *P* value (significant when < 0.05).

Results

The mean age was 74 years (66–96 years) and there were 69 females and 53 males. 39 fractures (32%) were classified as AO type A1, 68 (56%) A2 and 15 (12%) type A3 fractures. Patients were followed for a minimum of 1 year. The mean followup was 21 months (12−28 months). A total of 111 patients were available for final followup after accounting for deaths and patients lost in followup. Eight patients died, three in the acute postoperative period due to systemic causes and five during followup.

Union was achieved in all but one patient. Of the 111 patients available for followup, fracture reduction was classified as satisfactory [Figure 1] in 94 patients. All unsatisfactory reductions were seen in unstable fractures ($P = 0.001$). The mean TAD was 16.4 mm±3.8 mm. The helical blade position was satisfactory in 81 patients. Poor fracture reductions ($P = 0.001$) and unsatisfactory blade positions ($P = 0.028$) were significantly high in unstable fractures. Poorly reduced fractures also demonstrated a high incidence of unsatisfactory blade positions ($P = 0.001$). The radiological results are summarized in Table 1.

The mean VAS score at the final followup was 1.6±0.99. Slight-to-moderate abductor weakness was seen in 36 patients (MRC grades III and IV). Abductor limp was seen in 42 patients. The mean Parker and Palmer mobility score was 5.4±1.1. A total of 72 (65%) patients returned to their pre-injury status and 88% were community ambulant. Fracture stability did not have significant bearing on clinical and functional outcome measures [Table 2].

A total of 21 (19%) complications were encountered. Varus collapse (change in neck shaft angle of >5°) was the most common [Figure 2]. 12 of the 14 were seen in unstable fractures ($P = 0.09$) and 10 of the 14 in poorly fixed fractures ($P = 0.001$). Other complications include helical blade cut out in one patient, medial migration of the helical blade into the hip joint in three patients [Figure 3], delayed union in a patient addressed with total hip replacement, and symptomatic back out of the helical blade due to excessive sliding in two patients. The incidence of complications was significantly low in patients with stable fractures ($P = 0.049$) and well-fixed fractures ($P = 0.033$) compared to unstable and poorly fixed fractures [Table 3].

Discussion

PFNA incorporates the use of the helical-shaped blade to achieve fixation into the femoral neck unlike the use of screws in the earlier generation IM devices. The blade insertion technique compacts cancellous bone that makes it suitable for osteoporotic fracture situations.[12] The blade concept has

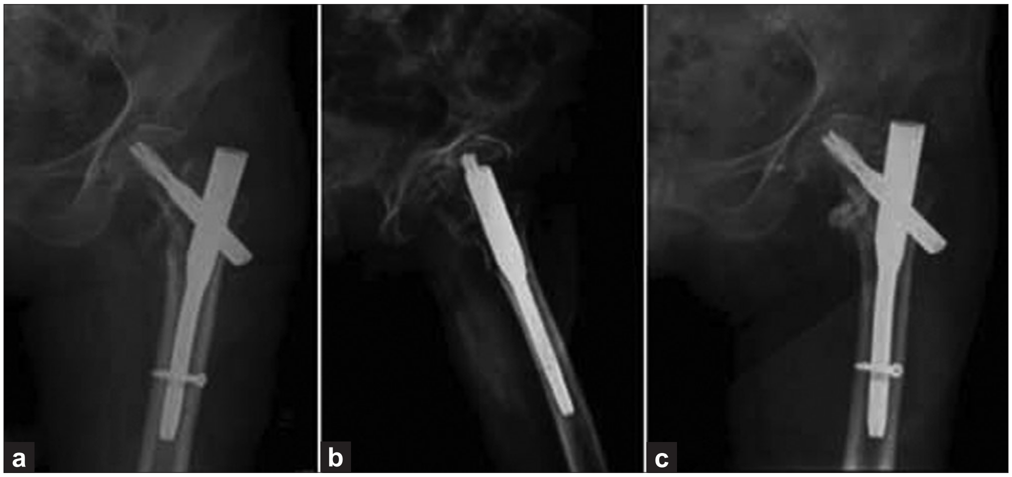

Figure 1: X-ray (L) hip joint anteroposterior view (a) and lateral view (b) showing a well-reduced type AO; 31-A2 fracture fixed with the PFNA demonstrating excellent blade position and (c) satisfactory outcome at final followup

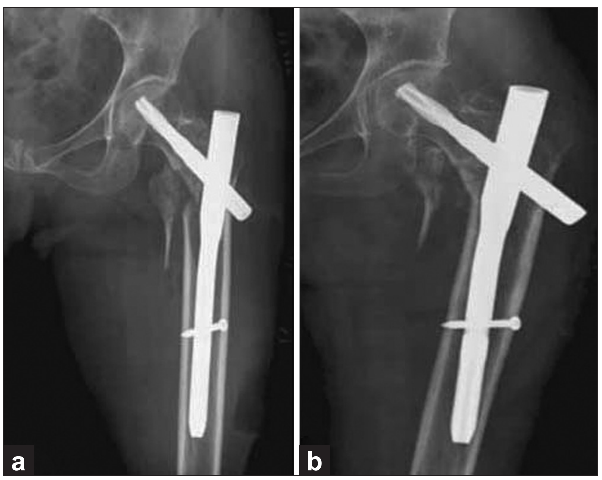

Figure 2: (a and b) Varus collapse following stabilisation of a 31-A2 fracture with a large posteromedial fragment in a 91 years female

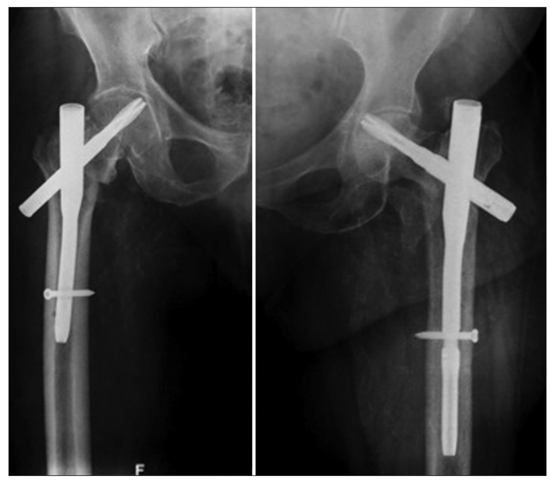

Figure 3: X-ray (Rt) and (Lt) hip joint with proximal femur showing the postoperative migration of the helical blade into the hip joint

Table 1: Radiological outcome

N: 111	Unstable fractures n = 75	Stable fractures n = 36	Total/mean	*P* value
Fracture reduction				0.001
Good	58	36	94	
Poor	17	0	17	
Blade position				0.028
Good	52	29	81	
Poor	23	7	30	
TAD (mm)	17.04 ± 6.8	15.15 ± 3.6	16.4 ± 3.8	0.01
Helical blade slide (mm)	5.7 ± 1.1	4.2 ± 0.66	5 ± 0.8	0.001
Neck shaft angle	123.4 ± 5.2°	127.3 ± 4.1°	125 ± 4.85°	0.8

Table 2: Functional outcome measures

	Stable fractures	Unstable fractures	*P* value
Visual analog score	1.6 ± 0.91	1.69 ± 1.2	0.68
Abductor limp	10 (28%)	32 (43%)	0.07
Muscle weakness	10 (28%)	26 (35%)	0.18
Mobility score	5.52 ± 1.1	5.37 ± 1.1	0.49

also been shown *in vitro* to be biomechanically superior to screws in terms of axial and rotational stability.[13,14]

Though the overall complication rate was 19%, the rate was only 9% in well-fixed fractures. A vicious cycle was evident in unstable fractures with poor reduction leading to poor implant placement and consequently higher complication rates. Unsatisfactory blade position was directly related to the fracture reduction rather than fracture stability. Though the overall TAD was high in unstable fractures, the difference was mainly due to unsatisfactory fracture reductions in the

Table 3: Complications

Complication (21)	Unstable fractures (n = 75)	Stable fractures (n = 36)	No. with poor fixation (n = 47)	No. with good fixation (n = 64)
Varus collapse (*n* =14)	12	2	10	4
Medial blade migration (*n* = 3)	2	1	2	1
Blade cut out (*n* = 1)	1	0	1	0
Symptomatic blade back out (*n* = 2)	2	0	1	1
Delayed union (*n* = 1)	1	0	1	0
Total {19%}	18 {24%}	3 {8.3%}	15 {32%}	6 {9.3%}

n = number of patients; good fixation: satisfactory reduction and ideal helical blade position according to study criteria; poor fixation: fractures with unsatisfactory reduction and/or poor blade position.

unstable fracture group. An ideal blade position could be achieved only in 73% of the patients in the current study, which may be explained by the poor reductions precluding the surgeons from achieving an ideal blade position and the learning curve on the part of the surgical team. However, the deviation is not very different from the reported incidence of around 21%.[15]

Only low velocity falls were included in the study, which is an indirect measure of osteoporosis. A cut out rate of 0.8% indicates an excellent outcome compared with the previously reported rates of 2–4% with IM devices.[16] Despite the theoretical advantages of the blade being anti-varus collapse and anti-rotation, varus collapse was the most common complication seen in the study accounting for 2/3 of all complications. 86% of all varus collapse occurred in patients with either an unsatisfactory blade position or poor reduction or both.

Majority of patients were pain free at the last followup. Minimal limp was seen in 42 (37%) patients at the last followup which may indicate damage to the abductors during surgery and a degree of shortening. 65% of the patients available for followup regained their preinjury status. 35% of patients though mobile had some detoriation in their mobility status. 88% of the patients were community ambulant with or without assistive devices at the last followup indicating that majority of the patients had benefitted from the procedure.

Overall complication rate of 19% does not indicate a significant improvement from the previous IM devices but the study showed a very low cut-out rate reflecting the effectiveness of the bone impaction technique and the anti-rotation concept of the PFNA. There were no femoral shaft fractures and the overall reoperation rate of 5.7% is comparable with the reported rate of 1.2−10%.[17,18] Apart from inherently unstable fractures, poor fracture reduction and unsatisfactory blade position in the femoral head are the chief factors in determining the complication rates. Attention to these factors and improvement in the learning curve can play a significant role in improving outcome and reducing complications with IM osteosynthesis using the PFNA.[19,20]

References

1. Anglen JO, Weinstein JN; American Board of Orthopaedic Surgery Research Committee. Nail or plate fixation of intertrochanteric hip fractures: Changing pattern of practice. A review of the American Board of Orthopaedic Surgery database. J Bone Joint Surg Am 2008;90:700-7.
2. Sadowski C, Lübbeke A, Saudan M, Riand N, Stern R, Hoffmeyer P. Treatment of reverse oblique and transverse intertrochanteric fractures with use of an intramedullary nail or a 95 degrees screw-plate: A prospective, rand- omized study. J Bone Joint Surg Am 2002;84-A:372-81.
3. Saudan M, Lübbeke A, Sadowski C, Riand N, Stern R, Hoffmeyer P. Pertrochanteric fractures: Is there an advantage to an intramedullary nail?: A randomized, prospective study of 206 patients comparing the dynamic hip screw and proximal femoral nail. J Orthop Trauma 2002;16:386-93.
4. Werner-Tutschku W, Lajtai G, Schmiedhuber G, Lang T, Pirkl C, Orthner E. Intra- and perioperative complications in the stabilization of per- and subtrochanteric femoral fractures by means of PFN. Unfallchirurg 2002;105:881-5.
5. Barton TM, Gleeson R, Topliss C, Greenwood R, Harries WJ, Chesser TJ. A comparison of the long gamma nail with the sliding hip screw for the treatment of AO/OTA 31-A2 fractures of the proximal part of the femur: A prospective randomized trial. J Bone Joint Surg Am 2010;92:792-8.
6. Pervez H, Parker MJ, Vowler S. Prediction of fixation failure after sliding hip screw fixation. Injury 2004;35:994-8.
7. Lenich A, Mayr E, Rüter A, Möckl Ch, Füchtmeier B. First results with the trochanter fixation nail (TFN): A report on 120 cases. Arch Orthop Trauma Surg 2006;126:706-12.
8. Simmermacher RK, Ljungqvist J, Bail H, Hockertz T, Vochteloo AJ, Ochs U, *et al.* The new proximal femoral nail antirotation (PFN A) in daily practice: Results of a multicentre clinical study. Injury 2008;39:932-9.
9. Parker MJ, Palmer CR. A new mobility score for predicting mortality after hip fracture. J Bone Joint Surg Br 1993;75:797-8.
10. Baumgaertner MR, Curtin SL, Lindskog DM. Intramedullary versus extramedullary fixation for the treatment of intertrochanteric hip fractures. Clin Orthop Relat Res 1998;348:87-94.
11. Watanabe Y, Minami G, Takeshita H, Fujii T, Takai S, Hirasawa Y. Migration of the lag screw within the femoral head: A comparison of the intramedullary hip screw and the gamma Asia-pacific nail. J Orthop Trauma 2002;16:104-7.
12. Windolf M, Braunstein V, Dutoit C, Schwieger K. Is a helical shaped implant a superior alternative to the Dynamic Hip Screw for unstable femoral neck fractures? A biomechanical investigation. Clin Biomech (Bristol, Avon) 2009;24:59-64.
13. Strauss E, Frank J, Lee J, Kummer FJ, Tejwani N. Helical

blade versus sliding hip screw for treatment of unstable intertrochanteric hip fractures: A biomechanical evaluation. Injury 2006;37:984-9.
14. Sommers MB, Roth C, Hall H, Kam BC, Ehmke LW, Krieg JC, *et al.* A laboratory model to evaluate cutout resistance of implants for pertrochanteric fracture fixation. J Orthop Trauma 2004;18:361-8.
15. Ahrengart L, Törnkvist H, Fornander P, Thorngren KG, Pasanen L, Wahlström P, *et al.* A randomized study of the compression hip screw and Gamma nail in 426 fractures. Clin Orthop Relat Res 2002;401:209-22.
16. Utrilla AL, Reig JS, Muñoz FM, Tufanisco CB. Trochanteric gamma nail and compression hip for trochanteric fractures: A randomized, prospective, comparative study in 210 elderly patients with a new design of the gamma nail. J Orthop Trauma 2005;19:229-33.
17. Harrington P, Nihal A, Singhania AK, Howell FR. Intramedullary hip screws versus sliding hip screw for unstable proximal femoral fractures in the elderly. Injury 2002;33:23-8.
18. Adams CI, Robinson CM, Court-Brown CM, McQueen MM. Prospective randomized controlled trial of an intramedullary nail versus dynamic screw and plate for trochanteric fractures of the femur. J Orthop Trauma 2001;15:394-400.
19. Kakkar R, Kumar S, Singh AK. Cephalomedullary nailing for proximal femoral fractures. Int Orthop 2005;29:21-4.
20. Schipper IB, Steyerberg EW, Castelein RM, van der Heijden FH, den Hoed PT, Kerver AJ, *et al.* Treatment of unstable trochanteric fractures. Randomised comparison of the gamma nail and the proximal femoral nail. J Bone Joint Surg Br 2004;86:86-94.

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