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Original Research Article

Clinical and functional outcome of intertrochanteric femur fractures treated using PFNA2 in patients with osteoporosis

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Abstract

Background: Intertrochanteric femur fractures are one of the most common fractures around hip in elderly population. These fractures are commonly treated with intramedullary nailing. Different designs of intramedullary nails are available. Proximal Femoral Nail Anti-rotation 2 is a newer nail design introduced for Asian population. Aim of this study is to analyse clinical and functional outcome of intertrochanteric femur fractures treated with PFNA2 in patients with osteoporosis.
Materials and Methods: Patients presenting with Intertrochanteric fractures, less than 2 weeks old, with Singh's Index </= 3 were included in the study. Quality of reduction was assessed using neck shaft angle, tip apex distance and Cleveland index in postoperative radiographs. The duration of surgery, number of fluoroscopy images taken, intraoperative blood loss and duration of hospital stay were noted. Patients were followed-up for 6 months. Functional outcome was assessed using modified Harris hip score.
Result: Twenty-three patients with intertrochanteric femur fracture were treated PFNA2. Thirteen patients had neck-shaft angle difference <5^{o} between operated side and normal side. Five patients had tip apex distance of >25mm. The average modified Harris hip score was 90.52. Overall, three complications were seen in this study.
Conclusion: PFNA2 is safe and effective fixation implant in the treatment of intertrochanteric femur fracture in Indian patients due to less blood loss, less intraoperative complications, minimal soft tissue damage and good union rate. Good functional outcome can be achieved once radiological parameters are restored, i.e., neck-shaft angle difference <5^{o}, TAD<25mm and Cleveland index in centre-centre position.

Keywords: Neck shaft angle tip apex distance cleveland index intramedullary nail intertrochanteric fracture

1. Introduction

Intertrochanteric femur fractures are one of the most common fractures around hip in elderly population [1]. These fractures are associated with increased morbidity and need early surgical

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fixation to attain pain relief and early mobilization. It is important to achieve stable fixation in these patients as implant failure will require revision/reconstruction surgery which is difficult, especially in patients with poor general conditions [2]. Intramedullary nailing has shown good results for intertrochanteric fracture [3].

There are different designs of intramedullary nails available for intertrochanteric fractures like PFN (proximal Femoral Nail) with compression screws coupled with a de-rotation screw and PFNA2 (Proximal Femoral Nail Antirotation-2) with a single helical blade [4].

The design of PFNA2 is developed to provide better stability for intertrochanteric fractures, in the presence of osteoporotic bone. The helical blade of PFNA2 is developed to increase the bone-implant interface and result in the compaction of cancellous bone, thereby providing excellent stability of fixation [5]. This blade can be inserted without reaming out bone from the head/neck region and it provides additional anchoring, particularly in osteoporotic bone. It allows immediate weight bearing by causing controlled impaction of the metaphyseal fracture zone. Biomechanical studies have proven that the helical blade has superior resistance to rotation and varus collapse [6].

There are different studies which have compared conventional PFN with PFNA [7-10]. This study aims to analyse the clinical and functional outcomes PFNA2 in the surgical treatment of intertrochanteric femur fracture in patients with osteoporosis.

2. Methodology

2.1 Source of data

This is a prospective longitudinal study which includes patients with an intertrochanteric femur fracture, who are admitted under department of Orthopaedics from October 2020 to March 2022 and are willing for surgery. Singh's index [11] was used to grade osteoporosis in all patients using pre-operative X-rays. Pre-operative radiographs were used to classify intertrochanteric fractures based on Boyd and Griffin classification. All patients were followed up and assessed on post-operative day 2, after 2 weeks, after 6 weeks, after 3 months and after 6 months. Post-operative quality of reduction was assessed using radiographs by comparing the neck shaft angle [12] of the operated hip to that of the normal hip, tip apex distance [13] and Cleveland index [14].

The functional assessment was done using a modified Harris hip score [15]. In patients with satisfactory reduction and screw position, toe touch weight bearing was started immediately after surgery. In those patients with mal-reduction and/or unsatisfactory screw position, non-weight bearing walker/crutch mobilization was started after surgery. After 6 weeks, X-rays were done and partial weight bearing was started, as per pain tolerance. Two X-ray views were taken to assess the radiological outcome. The radiological union was described as bridging trabeculation at the fracture site, on two views, in the absence of complications.

2.2 Inclusion criteria

- Patients with intertrochanteric femur fracture < 2 weeks old.
- Age >60 years.
- Those who are medically fit for surgery.
- Those who are willing for surgery.

2.3 Exclusion criteria

1. Open fracture/Associated polytrauma.
2. Pathological fracture.

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3. Not willing for surgery/medically unfit for surgery.
4. Patients with distal neurovascular deficits.
5. Established non-union from previous fractures.
6. Congenital anomalies of hip.

Surgery was carried out under spinal anesthesia in all patients. After positioning the patient on traction table, fracture was reduced by closed manipulation. Reduction was confirmed using fluoroscopy guidance in anteroposterior and lateral view. Once good reduction was achieved, 5cm skin incision was taken approximately 5 cm proximal from the tip of the greater trochanter. Entry point was taken and guide wire was inserted slightly lateral to the greater trochanter. With the soft tissue protector, the proximal femur was manually opened with a 17mm reamer and appropriate nail was inserted. The helical blade was inserted using light blows with the hammer. Blade was locked after confirming reduction. Distal locking was by using the jig for standard PFNA2. Intraoperative and postoperative events were recorded. The intraoperative time was recorded from the time that close reduction was started to the time that wound was sutured.

3. Results

Twenty three patients were enrolled in this study. The average age was 75.73 years. Thirteen were males and ten were females. Eleven patients had grade 3, Eight had grade 2 and four had grade 1 osteoporosis as per Singh's index. (Table 1).

Table 1: Demographic statistics

S. No.	PFNA2 (23)
Age (Average) in years	75.73
Sex	
Male	13(56.52%)
Female	10(43.47%)
Singh's Index	
Grade 3	11(47.82%)
Grade 2	08(34.78%)
Grade 1	04(17.39%)

The mean duration of surgery was 52.82 min. The mean blood loss 135.65 ml. The mean value of fluoroscopic images taken 29.34. The mean duration of hospital stay was 5.69 days (Table 2).

Table 2: Operative details

	PFNA2
Duration (min)	52.82
Blood loss (ml)	135.65
Fluoroscopy (no.)	29.34
Length of hospital stay (days)	5.69

3.1 Neck shaft angle (NSA)

Post-operatively neck shaft angle of the operated hip was compared to that of the normal hip using radiographs. The difference of less than 5^o was considered excellent, 5 to 10^o as good and more than 10^o as poor reduction. Thirteen patients had excellent reduction and eight patients had good reduction. Two implant-related complications were seen in the PFNA2 group, both had poor reduction. Both these patients had fair functional outcome.

3.2 Tip apex distance (TAD)

Five out of twenty three patients had tip apex distance of more than 25 mm (Table 3). Out of five patients with TAD > 25 mm, three had good functional outcome and two had fair functional outcome.

3.3 Cleveland index

Thirteen patients had optimal (center-center, inferior-center) and ten patients had sub-optimal position as per Cleveland index. Out of ten sub-optimal, two patients had implant related complications. (Table 3).

Table 3: Summary of results

N = 23	**PFNA2 group**
Modified Harris Hip score (final follow-up)	90.52
Tip-Apex distance (>25 mm)	5
Cleveland Index (sub-optimal position)	10
Neck shaft angle (difference between operated and normal side)	
<5	13
5-10	8
>10	2
Radiological union (in weeks)	24
Complications	
Screw back out	1
Screw cut out	0
Screw in the joint	1
Superficial infection	1
Overall complications	3
Implant failure (screw back out and cut out)	2

3.4 Functional outcome by modified harris hip score

The average Modified Harris hip score at final follow-up was 90.52. Thirteen patients had excellent, eight patients had good and two had fair results (Fig. 1). The average score in patients with complications was 78.

Table 4: Modified Harris Hip Score

Modified Harris Hip Score	**Number of patients**	**Percentage (%)**
Excellent	13	56.52
Good	8	34.78
Fair	2	8.69
Poor	0	0

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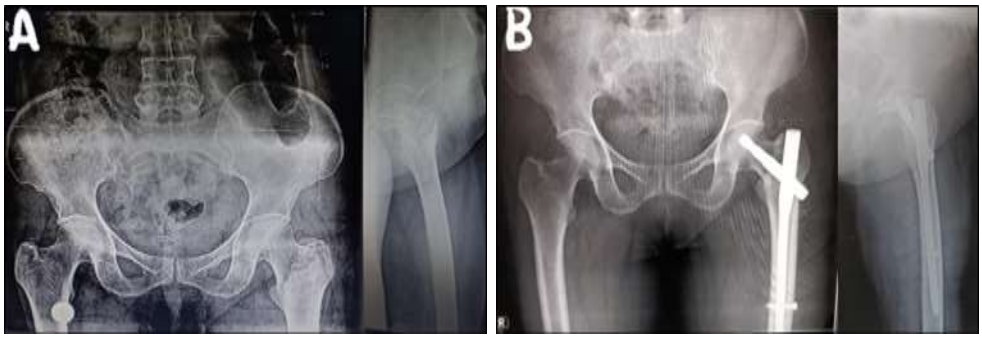

Fig 1: (A) shows pre-operative x-ray of Boyd and Griffin Type 1 intertrochanteric fracture of left femur. (B) shows post-operative x-rays

3.5 Complications

There were three overall complications. One patient had screw back out, one had screw migration into the joint (Fig 2) and one had superficial infection. The superficial infection healed with regular dressing.

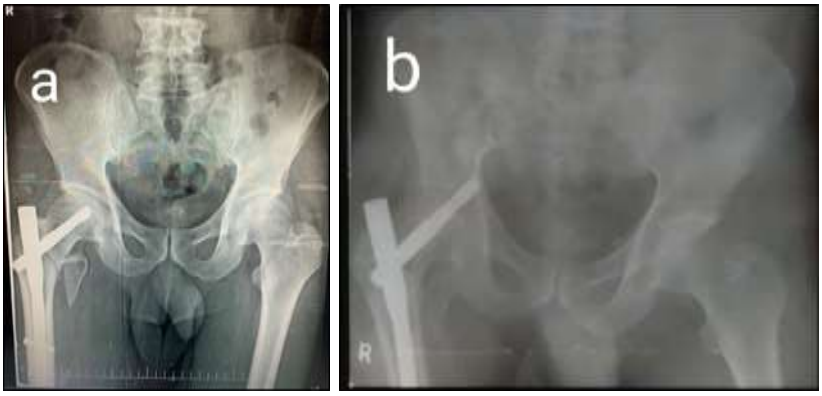

Fig 2: a) Post-operative day 2 X-ray of PFNA2. b) Post-operative 6 months X-ray showing screw migration into the joint

4. Discussion

The intertrochanteric femur fractures in elderly need early fixation and mobilization to prevent morbidity and mortality. Intramedullary device holds good advantage in fixing such fractures because of small surgical wound, easy implant insertion and stable fixation.

The design of PFNA2 is developed to provide better stability for intertrochanteric fractures, in the presence of osteoporotic bone. The medio-lateral angulation of this device is 5 degrees. This allows a slightly more lateral entry point through the tip of the greater trochanter. The distance of the proximal end of the PFNA2 nail with the helical blade has been shortened to 45 mm and the length of the helical screw end cap has been reduced to 2.5 mm. This results in decreased friction between the nail and soft tissue and decreases activity-induced hip pain. PFNA2 has a more flattened lateral surface that decreases the length of the region of impingement on the lateral cortex and reduces the risk of fracture during insertion. Thus, PFNA2 is better suited for Asian population.

The PFNA2 is designed to achieve better stabilization of the femoral head and neck by using a single helical blade rather than a screw system for fixation. The helical blade increases the bone-implant interface resulting in compaction of cancellous bone, thereby providing excellent stability of fixation.

Rotation of the head-blade combination as a whole is prevented by an intrinsic locking

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mechanism. The controlled impaction of the metaphyseal bone caused by the helical blade helps in allowing immediate full weight bearing.

There were 13 males and 10 females. The perioperative morbidity was assessed by calculating the duration of surgery, blood loss and number of fluoroscopic images taken. The duration of surgery and number of fluoroscopic images were significantly lower in this study due to use of single helical blade. The mean blood loss was lower in this study due to decreased operative time and smaller incision for the placement of PFNA2 blade. This is similar to the study conducted by Zeng *et al*. [16] and Takigami *et al*. [17].

When tip apex distance was more than 25 mm, the functional outcome was fair. This suggests that maintaining a tip apex distance of less than 25 mm is necessary to achieve better functional outcome at follow up. Nikoloski *et al*. [8] recommended a tip apex distance of 20-30 mm in case of PFNA-2. They observed a higher incidence of cut out/cut through, when TAD was more than 30 mm or less than 20 mm.

As per the Cleveland index, maintaining an optimal position (center-center, inferior-center) of the screw is necessary for good outcome [16]. Complications were more when the screw position was in sub-optimal position. When the index was center-center no complications were seen and had better outcome.

Maintaining the neck shaft angle difference between operated and normal side, less than 5° showed better results [17]. When the difference was less than 5°, functional outcome was good. The complications seen in this study had poor reduction with neck shaft angle>10°.

The functional outcome was excellent in thirteen patients, good in eight patients and fair in two patients as per modified Harris Hip Score. The overall functional outcome in PFNA2 was excellent.

According to Macheras *et al*., PFNA2 avoided lateral cortex impingement experienced with PFNA, providing fast and stable fixation of intertrochanteric femur fractures [18].

In our study, 91.30% patients had excellent to good functional outcome according to modified Harris hip score. 2 patients (8.69%) had fair outcome because of neck-shaft angle difference $>10^{o}$ and tip apex distance >25 mm. Majority of patients were able to do their routine physical activities at final follow up in our study. At final follow-up of intertrochanteric femur fractures treated by PFNA2, excellent clinico-radiological and functional outcome were seen in majority of these patients. According to this study, proximal femoral nail antirotation 2 is an ideal implant for fixation of intertrochanteric femur fractures leading to high rate of union as well as decrease the postop.

5. Limitations of the study

All patients were followed up for a short duration of 6 months. All the surgeries were not performed by the same surgeon.

6. Conclusion

PFNA2 is safe and effective fixation implants in the treatment of intertrochanteric femur fracture in Indian patients due to less blood loss, less intraoperative complications, minimal soft tissue damage and good union rate. Good functional outcome can be achieved once radiological parameters are restored, i.e. neck-shaft angle difference $<5^{o}$, TAD<25mm and Cleveland index in centre-centre position.

7. Disclosure of interest

There are no conflicts of interest concerning this article.

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