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ASSESSMENT OF FUNCTIONAL OUTCOME OF THE ASIA PROXIMAL FEMORAL NAIL ANTIROTATION FIXATION IN PER-TROCHANTERIC FRACTURES IN ADULTS — A PROSPECTIVE INTERVENTIONAL STUDY

Orthopaedics

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ABSTRACT

Per-trochanteric fractures are a common cause of morbidity in patients of both young and old age group who suffer high-velocity trauma. Owing to the changing demography of developing countries leading to a rise in population of older age group with osteoporotic bone disease, there is also seen an increase in incidence of per-trochanteric fractures in this age group. We present here a prospective analysis of outcome of treatment of per-trochanteric fractures with Proximal Femoral Nail Asia Antirotation 2nd generation (PFNA II) in 41 adults (>18 years), 31 of them having intertrochanteric fractures (11 with stable and 20 with unstable fractures according to Evans classification) and 10 having subtrochanteric fractures. The mean age of the patients was 45.5 years, and the male-female ratio was 34:6. The average Parker Palmer mobility score was 7.59 ± 3.59. The average Salvati Wilson score at one-year follow-up was 33.61 ± 0.42 with the range as 28–38. The average Harris hip score at one year of follow-up was 87.95 ± 5.67, the range being 70–90.

PFNA-II seems to be a promising device for fixation of per-trochanteric fractures in Indian adults.

KEYWORDS

INTRODUCTION

Per-trochanteric fractures are one of the most common fractures of the hip especially in the elderly. The increased incidence of these fractures corresponds to the increased elderly population, superadded with osteoporosis. The fractures involve those extending from the extracapsular basilar neck area to the region along the lesser trochanter, proximal to the development of the medullary canal, and include both the intertrochanteric as well as the subtrochanteric fractures.

More than 50% of the intertrochanteric fractures belong to the unstable group and these unstable fractures occur more commonly in old aged individuals and those with low bone mineral density.[1]

The subtrochanteric fractures with a bimodal distribution involve the young and healthy individuals owing to high-energy trauma, the elderly owing to osteoporotic bones, and women owing to thin cortices and weak muscular forces.[2,3] Furthermore, the bone in the hip region has thicker cortex and less vascularity, thus posing increased risk of healing disturbances. Additionally, torsional effects created by the muscular forces at the hip transmit forces up to 6 times the body weight across the subtrochanteric region of the femur during routine activities. Therefore, subtrochanteric fractures are difficult to manage and are associated with many complications.[4]

Surgical fixation can be done using extramedullary or intramedullary devices. A surgical technique allowing anatomic alignment and a stable fixation with early mobilization is accepted as the standard approach for intertrochanteric fractures.[5,6]

Intramedullary devices are frequently used and have attained good clinical results owing to lower failure rates and good biomechanical advantage, allowing immediate postoperative and long-term full-weight bearing of the hip.

The Gamma nail was an intramedullary device with high learning curves and technical and mechanical failures like collapse of the fracture area, cut-out of the implant, fracture of the femur shaft, and susceptibility to fail at its weakest point, the lag screw-implant interface.[7]

The AO ASIF in 1996, therefore, developed the Proximal Femoral Nail (PFN) to reduce the risk of implant related complications. However, to overcome its drawbacks like the Z-effect (Werner-et al.), reverse Z-effect (Boldin et al.),[8] proximal screw cut-out, Varus collapse, and iatrogenic fracture of the lateral cortex, the Proximal Femoral Nail Antirotation (PFNA) was devised by AO/ASIF in 2004. However, since it was designed for the Western population, the proximal end of the nail did not match with the specific anatomy of elderly Asian population. Thus, AO/ASIF in 2008 developed the Asia Proximal Femoral Nail Antirotation (PFNA-II) specifically for Asian patients. The innovative helical blade design provided better compaction of cancellous bone, increased contact area between implant and the femoral head, and a better hold on both compact and cancellous bones.[9]

Since its introduction, however, there have not been many studies in the literature focusing the functional outcomes of PFNA-II in Indian population. Thus, the aim of this study was to evaluate the functional outcome of PFNA-II fixation of per-trochanteric femur fractures, by analyzing the Parker Palmer mobility score, Salvati Wilson score, and Harris hip score.

MATERIALS AND METHODS

Forty-one Indian patients with per-trochanteric fractures were classified based on the Orthopedic Trauma Association classification, Evans classification, Boyd and Griffin classification for intertrochanteric fractures, and Russell and Taylor classification for subtrochanteric fractures for the purpose of sample standardization. These patients were operated upon with PNFA-II at our center and were regularly followed up at 4 weeks, 8 weeks, 12 weeks, 6 months, and 1 year of intervals.

A detailed history was noted and thorough clinical, hematological, and radiological (pelvis with both hips in antero-posterior and lateral views) examinations were performed. Femoral nail lengths were calculated. All patients, put on skeletal traction till surgery, underwent the surgeries in spinal or combined spinal and epidural anesthesia, in supine position on a traction table and under the guidance of an image intensifier.

Surgical technique:

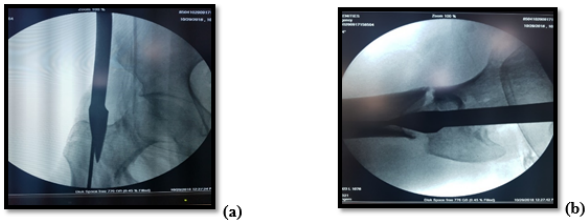
A skin incision, restricted to 3–5 cm in size was made at the intersection of perpendicular dropped from the anterior-superior iliac

spine and a straight line from the midshaft of femur through the tip of greater trochanter, extrapolated cranially and obliquely in the direction of fibers of gluteus medius (Figure 1). The soft tissue around the greater trochanter and the piriformis fossa was cleared using artery forceps without detaching the attachments at the greater trochanter. The length and level of incision for open reduction depended on the site and comminution of fracture.

Figure 1: Incision for entry measuring 3 cm made obliquely in the direction of fibers of gluteus medius

Entry Point:

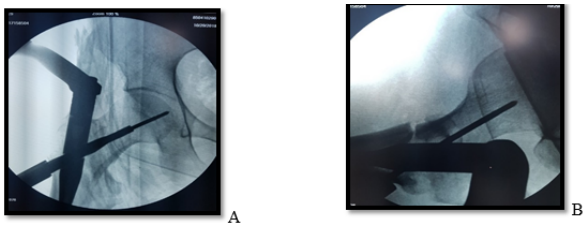
The entry was made just medial to the tip of greater trochanter in antero-posterior view and at point passing through the line bisecting the neck of the femur in two equal anterior and posterior halves using a Steinmann Pin or Guidewire, under the guidance of an image intensifier, over which the awl was introduced (Figure 2). While making the entry, the limb was kept adducted about 300 with respect to the torso.



(a) (b)

Figure 2: Insertion of awl in a) Antero-posterior view; b) Lateral view

After sequential reaming, the nail of desired size was introduced over the guidewire. The guidewire for the helical blade was introduced into the neck in such a way that the blade would be placed into the center of the head of the femur in the antero-posterior and lateral views and keep the tip-apex distance between 12–25 mm (Figure 3).



A B

Figure 3: Guide wire insertion and reaming for helical blade seen in a) Antero-posterior view; b) Lateral view.

Once the insertion of blade was completed, the blade was locked (after loosening the traction in case of intertrochanteric fractures) to achieve maximum possible compression and prevent rotation. Distal lock was static in unstable fractures.

Postoperative details:

Patients were kept on injectable antibiotics (ceftriaxone + sulbactam) for at least 5 days postoperatively till the second check dress was done, and then switched over to oral antibiotics. Patients were advised to come for regular follow-ups at 4 weeks, 8 weeks, 12 weeks, 6 months, and 1 year of intervals.

Postoperative rehabilitation:

Knee and ankle mobilization, static quadriceps strengthening and calf pumping exercises on first post-operative day; toe touchdown (except in comminuted fractures and old aged patients, in whom straight away partial weight bearing was started) on second; and abductor strengthening exercises and partial weight bearing 1–2 weeks post-operatively were initiated; the abductor and adductor strengthening exercises were continued even after clinical union to improve the functional outcome. Full-weight bearing was initiated after radiological signs of union, followed by patient being given a proper gait training.

Measurement of the Salvati Wilson Score

Table 1: The Salvati Wilson score

Characteristic	Score
Pain	
All the time; unbearable; strong medication frequently required	0
All the time, but bearable; strong medication occasionally required; salicylates	
frequently required	2
None or little at rest; with activities; salicylates frequently required	4
On starting activity, then better; after a certain activity; salicylates occasionally required	6
Occasional and slight	8
No pain	10
Walking	
Bedridden	0
Wheelchair	2
Walking frame	4
One stick; limited distances up to 400 yards	6
One stick; long distances	8
Unaided and unrestricted	10
Muscle power and motion	
Ankylosing and deformity	0
Ankylosing with good functional position	2
Poor muscle power; flexion < 60°; abduction < 10°	4
Fair muscle power; flexion 60 – 90°; abduction 10 – 20°	6
Good muscle power; flexion > 90°; abduction > 20°	8
Normal muscle power; full range of movement	10
Function	
Bedridden	0
House-bound	2
Limited housework	4
Most housework	6
Very little restriction	8
Normal activities	10

The Salvati Wilson Score was graded as excellent (>32), good (24–31), fair (16–23), and poor (<16), the maximum score possible in the system being 40.

Measurement of the Parker Palmer mobility score

Table 2: The Parker Palmer mobility score

Walking ability	No difficulty	Alone with an assistive devices	With help from another person	Not at all
Able to walk inside house	3	2	1	0
Able to walk outside house	3	3	1	0
Able to go shopping, to a restaurant, or to visit family	3	2	1	0

The maximum score in this scoring system is 9.

Range of movements (ROM) – at hip, measured using goniometer. The range is as follows:

- Flexion: 0 to 110°–130°
- Extension: 0° to 20°
- Abduction: 0° to 45°–55°
- Adduction: 0° to 35°–45°
- External rotation: 0° to 40°–50°
- Internal rotation: 0° to 30°–40°

The Harris hip score:

The Harris hip score, with a total of 10 items, scores a maximum of 100 (the best possible outcome) and minimum of 0. It covers domains of pain (1 item, 0–44 points), function (7 item, 0–47 points), absence of

deformity (1 item, 4 points), and range of motion (2 item, 5 points). A total score of <70 is considered as a poor result, 70–79 as fair, 80–89 as good, and 90–100 as an excellent result.

Table 3: Proforma for recording Harris hip score

Harris Hip Score

Hip ID:
Study Hip: ☐ Left ☐ Right
Examination Date (MM/DD/YY): / /
Subject Initials: ___ ___ ___
Medical Record Number:

Interval: _____

Harris Hip Score

Pain (check one)
- ☐ None or ignores it (44)
- ☐ Slight, occasional, no compromise in activities (40)
- ☐ Mild pain, no effect on average activities, rarely moderate pain with unusual activity; may take aspirin (30)
- ☐ Moderate Pain, tolerable but makes concession to pain. Some limitation of ordinary activity or work. May require Occasional pain medication stronger than aspirin (20)
- ☐ Marked pain, serious limitation of activities (10)
- ☐ Totally disabled, crippled, pain in bed, bedridden (0)

Limp
- ☐ None (11)
- ☐ Slight (8)
- ☐ Moderate (5)
- ☐ Severe (0)

Support
- ☐ None (11)
- ☐ Cane for long walks (7)
- ☐ Cane most of time (5)
- ☐ One crutch (3)
- ☐ Two canes (2)
- ☐ Two crutches or not able to walk (0)

Distance Walked
- ☐ Unlimited (11)
- ☐ Six blocks (8)
- ☐ Two or three blocks (5)
- ☐ Indoors only (2)
- ☐ Bed and chair only (0)

Sitting
- ☐ Comfortably in ordinary chair for one hour (5)
- ☐ On a high chair for 30 minutes (3)
- ☐ Unable to sit comfortably in any chair (0)

Enter public transportation
- ☐ Yes (1)
- ☐ No (0)

Stairs
- ☐ Normally without using a railing (4)
- ☐ Normally using a railing (2)
- ☐ In any manner (1)
- ☐ Unable to do stairs (0)

Put on Shoes and Socks
- ☐ With ease (4)
- ☐ With difficulty (2)
- ☐ Unable (0)

Absence of Deformity (All yes = 4; Less than 4 =0)
- Less than 30° fixed flexion contracture ☐ Yes ☐ No
- Less than 10° fixed abduction ☐ Yes ☐ No
- Less than 10° fixed internal rotation in extension ☐ Yes ☐ No
- Limb length discrepancy less than 3.2 cm ☐ Yes ☐ No

Range of Motion (*indicates norm al)
- Flexion (*140°) _____
- Abduction (*40°) _____
- Adduction (*40°) _____
- External Rotation (*40°) _____
- Internal Rotation (*40°) _____

Range of Motion Scale

211° - 300° (5)	61° - 100 (2)
161° - 210° (4)	31° - 60° (1)
101° - 160° (3)	0° - 30° (0)

Range of Motion Score _____

Total Harris Hip Score _____

Data were collected and analysed to assess the change in the clinical and functional status by comparing the immediate postoperative Salvati Wilson score, Parker Palmer mobility score, and Harris Hip score with the respective scores at the final follow-up.

RESULTS

The incidence of per-trochanteric fractures in our study was more among males as compared to females, with 34 (82.9%) of the patients being male and 7 (17.1%) female. The mean age of the patients was 50.24 ± 18.5 years. In 29 (70.7%) patients, the right side was involved. Out of the 41 patients, 31 patients had intertrochanteric fractures and 10 had subtrochanteric fractures; and of the 31 patients of intertrochanteric fractures, 11 had stable intertrochanteric fractures and 20 had unstable intertrochanteric fractures according to the Evans classification (Table 4). Therefore, stable fractures accounted for 26.8% patients of the study group. Of the 41 surgeries performed, 12 required open reduction of the fracture for internal fixation. PFNA-II was used in 28 out of the 41 patients. The average Parker Palmer mobility score was 7.59 ± 3.59 (Table 5). The average Salvati Wilson score at one-year follow-up was 33.61 ± 0.42 with the range as 28–38 (Table 6). The average Harris hip score at one year of follow-up was 87.95 ± 5.67, the range being 70–90 (Table 7) (Figures 4 and 5).

Table 4: Distribution of patients based on Evans classification

Evans Classification	Frequency	Percent
Stable	11	26.8
Unstable	20	48.8
Total	31	75.6

Table 5: The Parker Palmer mobility score at 1 year of follow-up

Parker Palmer Score	Frequency	Percent
6	3	7.3
7	20	48.7
8	17	41.5
9	1	2.4
Total	**41**	**100**

Table 6: The Salvati Wilson score

Salvati Wilson Score	Frequency	Percent
Excellent	36	87.8
Good	5	12.2
Total	41	100

Table 7: Analysis of the Harris hip score

Harris Hip Score	Frequency	Percent
Excellent	2	4.9
Fair	16	39
Good	23	56.1
Total	**41**	**100**

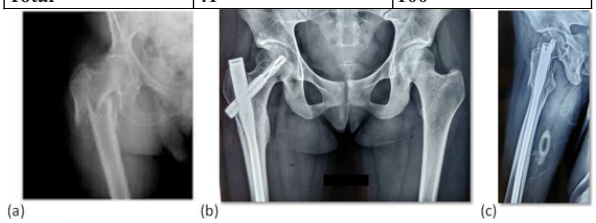


Figure 4: Radiographs of a 23-year-old female patient with closed subtrochanteric fracture: (a) pre-operative radiograph AP view, (b) postoperative radiograph AP view at one-year of follow-up, and (c) postoperative radiograph in lateral view at one-year of follow-up

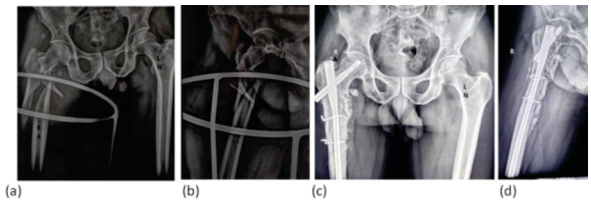


Figure 5: Radiographs of a 50-year-old male patient with comminuted intertrochanteric fracture: (a) pre-operative radiograph in AP view, (b) pre-operative radiograph in lateral view, (c) postoperative radiograph AP view at one-year of follow-up, and (c) postoperative radiograph in lateral view at one-year of follow-up

DISCUSSION

Per-trochanteric fractures are a common morbidity in patients of both young and old age group who suffer high-velocity trauma. Stable intertrochanteric fractures are those in which posteromedial cortex remains intact and calcar femorale is not affected. Unstable intertrochanteric fractures are those in which comminution of posteromedial buttress exceeds a simple lesser trochanteric fragment, those with subtrochanteric extension or those with reverse oblique fracture patterns.

Surgical management is the preferred treatment for unstable fractures. Successful treatment of intertrochanteric fractures depends on surgeon-independent variables like bone quality (osteoporosis), fracture pattern, and fracture stability. The challenge with the management of per-trochanteric fractures lies in the early and adequate fixation of the fracture and early mobilization of the patient while avoiding the complications associated with the procedure. Historically, many operative treatment modalities have been used, but the current era of evidence-based medicine is in favour of intramedullary fixation for the unstable fractures and equivocal support for intramedullary and extramedullary fixation for the stable trochanteric fractures.

Our study aimed at analysing the functional outcome of PFNA-II fixation in per-trochanteric fractures in Indian adults with the assessment of the Parker Palmer mobility score, Salvati Wilson score, and Harris hip score. Forty-one patients were included in our study. The reduction was achieved by closed or open technique as per the need of the fracture; static locking of the distal bolt was preferred if the fracture had comminution.

The outcome of PFNA-II fixation in per-trochanteric fractures in our study in terms of the Harris hip score was excellent to good in 25 patients and fair in 16 patients, with the average score at one year of follow-up being 87.95 ± 5.67. This was in accordance with the Harris hip score observed in the studies conducted by Li J et al. (86.19 ± 6.53)[10] and Shenoy K et al. (mean 84.3)[11] and was slightly more than that observed by Luo X et al. (81.3 ± 8.2)[12] at one year of follow-up.

The Salvati Wilson score obtained excellent in 87.8% of the patients in this study was higher as compared to that obtained in the studies conducted by Koyuncu S et al. (excellent in 59.8% patients),[13] Chopra B et al. (excellent in 36% patients)[14], and Santhamoorthy T et al.

(excellent in 36.3% patients).[15] The mean Salvati Wilson score in our study was 33.61 ± 0.42, which was also higher than the mean score obtained by Sahin E et al. (mean 31).[16]

Lastly, the mean Parker Palmer mobility score in our study was 7.95 ± 3.59, which was comparable to that observed by Shah N et al. (mean 8.28)[17] and Santhamoorthy T et al. (mean 8.1)[15] and greater than that observed by Gavaskar A et al. (5.4 ± 1.1)[18] and Xu Y et al. (5.98 ± 1.40).[19]

The limitation of our study was a small sample size, but its strength lies in being a prospective study design and with standard operative protocols.

CONCLUSION

Our study presented important data on the functional outcome of PFNA-II fixation in per-trochanteric fractures in adults. Further studies with larger sample size and encompassing other relevant clinical and radiographical parameters are advocated.

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