International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2021; 7(3): 655-660

www.orthopaper.com
Received: 10-05-2021
Accepted: 12-06-2021

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Study of functional outcome of intertrochanteric femur fractures fixed with proximal femoral anti-rotation (PFNA2) nail

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DOI: https://doi.org/10.22271/ortho.2021.v7.i3j.2816

Abstract
Introduction: Intertrochanteric fractures are one of the commonly occurring injuries in elderly patients and are high among females and those with osteoporosis. Unstable intertrochanteric femur fractures are treated commonly with intramedullary nails. Newer designs like Proximal Femoral Nail Antirotation-2 have been introduced for Asian population. The aim of our study was to compare the radiological and functional outcome of unstable intertrochanteric femur fracture treated with Proximal Femoral Nail Antirotation-2 nails.
Methodology: This study was carried out at Department of Orthopaedics, Tertiary care Hospital. During this period, 36 patients with intertrochanteric femur fractures were identified of which 34 patients were enrolled in the study based on the inclusion and exclusion criteria. With 4 patients being lost to follow-up during the course of study before completing at least 6 months of follow-up, we had 30 patients remaining to study.
Results: Harris Hip score was applied to assess outcome. 22(74%) had good to excellent results. 8 (26%) had fair to poor results. However, radiologically none of the patients had poor results. We cannot readily rule out objective bias in our radiological assessment.
Conclusion: Early surgery on patients with trochanteric fractures improved its ability to return to independent living and complications of prolonged immobilization are prevented. PFNA2 has advantages like less surgical time for fixation, less fluoroscopy time, optimum for small neck, less blood loss and it is better suited for Asian population.

Keywords: PFNA2, intertrochanteric fractures, proximal femur fractures

Introduction
Commonest site of Proximal femoral fractures is at highest mechanical stress i.e., across the junction between cortical bone and trabecular bone. These fractures account for approximately 9% to 33% of all hip region fractures [1]. For many, this fracture was often a terminal event resulting in death due to cardiac, pulmonary or renal complications. Approximately 10 to 30% of patients die within one year of an intertrochanteric fracture [2].
Proximal femoral region is usually exposed to high stresses during activities of daily living. Axial loading forces through the hip joint create a large momentum arm, with significant lateral tensile stresses and medial compressive loads. In addition to the bending forces, muscle forces at the hip also create torsional effects that lead to significant rotational shear forces. During normal activities of daily living, up to 6 times the body weight is transmitted across the proximal femoral region of the femur. As a result of these high forces, the bone in this region is a thick cortical bone with less vascularity and results in increased potential for healing disturbances. Hence intertrochanteric fractures with posteromedial comminution and subtrochanteric fracture is difficult to manage and associated with many complications.
Little attention was paid to these fractures in the past, as they occur through the cancellous bone with excellent blood supply and they healed without any active treatment. However conservative treatment usually resulted in malunion with varus and external rotation deformity resulting in a short limb gait and a high rate of mortality due to complications of recumbence and immobilization.

The goal of treatment of an intertrochanteric fracture is the restoration of the patient to his or her pre-injury status as early as possible. This led to internal fixation of these fractures to increase patient comfort, facilitate nursing care, decrease hospitalization and reduce complications of prolonged recumbency [3].

The greatest problems for the orthopaedic surgeon treating this fracture are instability and the complications of fixation that result from instability. Stability refers to the capacity of the internally fixed fracture to resist muscle and gravitational forces around the hip that tend to force the fracture into a varus position. Intrinsic factors like osteoporosis and comminution of the fracture and extrinsic factors like choice of reduction, choice of implant and technique of insertion, contribute to failure of internal fixation.

The type of implant used has an important influence on complications of fixation. Sliding devices like the dynamic hip screw have been extensively used for fixation. However, if the patient bears weight early, especially in comminuted fractures, these devices can penetrate the head or neck, bend, break or separate from the shaft.

The purpose of the present study was to verify the theoretical advantages of the proximal femoral nail autorotation (PFNA2) device and whether it actually alters the eventual functional outcome of the patient.

Aims & Objectives

- The aim of this study was to study intramedullary devices PFNA2 used in the treatment of intertrochanteric fractures in terms of Clinical and radiological follow-up.
- To compare the surgical treatment of intertrochanteric fractures of the femur with PFNA2 device, with respect to:
  - Fluoroscopic time
  - Duration of surgery
  - Blood loss
  - Fracture union and Functional outcome
- To compare results with standard studies and draw conclusion.

Materials and Methods

This study was carried out at Department of Orthopaedics, Tertiary care Hospital. During this period, 36 patients with intertrochanteric femur fractures were identified of which 34 patients were enrolled in the study based on the inclusion and exclusion criteria. With 4 patients being lost to follow-up during the course of study before completing at least 6 months of follow-up, we had 30 patients remaining to study.

This study was mainly an observational prospective study. Such patients were followed up prospectively for a minimum of six months post-operative time.

Inclusion Criteria

- Both male and female patients above 20 years of age with isolated, closed, and type 31-A1, 2, 3 intertrochanteric fractures as classified with AO system.
- Consent for the surgery and to participate in the study.

Exclusion Criteria

- Pathologic fracture
- Multiple trauma patients
- Fractures in skeletally immature patients
- Old neglected fractures
- Refusal to provide informed consent
- Fractures with neuromuscular disorders / neurovascular insufficiency

Management

(A) Primary Management: Patients satisfying the selection criteria were identified after emergency management as per ATLS protocol in the casualty. History taking, general examination and local examination were conducted in the trauma care center. Once stabilized, relevant X-rays were asked for. Fractures were classified according to AO classification. Temporary immobilization was given by Ankle traction on Bohler Brown Splint.

(B) Pre-operative Management: Necessary investigations for surgical fitness were conducted. All fractures with edema were splinted and regular thigh girth charting was done with oral proteolytic enzymes, intravenous antibiotics and limb elevation. The fractures were operated as soon as the fitness for anesthesia was obtained.

(C) Selection of implant: In all our patients we used PFNA2 nail. Implant length were evaluated according to length of the opposite limb.

(D) Anaesthesia: Spinal, epidural or general anaesthesia was given to the patient as per the anesthetic's opinion. But spinal anaesthesia was most preferred.

(E) Surgery: Position: Surgery was performed on fracture table for fracture fixation. The foot was flexed on a shoe of fracture table board with variable adjustment for fracture alignment and ease of reduction. The unaffected lower l iamb was flexed and abducted to allow easy access for the image intensifier. Preoperative reduction was obtained in AP and Lateral view. The affected limb was scrubbed and prepared with diluted Savlon. Painting and draping were done under aseptic and antiseptic conditions. Draping was done in such manner that the area from above hip to lower third leg was exposed for proper recognition of anatomical landmarks, Intravenous antibiotic was administered prior to incision.

Reduction

The fracture was reduced by traction in neutral, slight internal or external rotation depending on the nature of the fracture and checked by anteroposterior and lateral views on the image intensifier. All fractures were reduced by the closed method. The objective of reduction was to confer weight bearing stability and correct varus and rotational deformities. In stable fractures this is achieved by reduction of the Calcar femoral.

Method of fixation

PFNA2

All of the fractures were treated on the fracture table in a supine position under fluoroscopy guidance and the fractures were closely reduced and nailing was performed in all of them according to standard protocol for the PFNA2. The nail blade angle of the device used was 125° or 130°.

(F) Postoperative Care: There was no defined postoperative patient protocol, but all patients were given peri- operative antibiotics for 6 days and deep venous thrombosis prophylaxis. Patients were allowed to sit up in bed on the second post-operative day. Static quadriceps exercise was started on the second and third post-operative day. Sutures were removed after 10 to 14 days. Patients were mobilized non - weight bearing as soon as the pain or general condition permitted. Weight bearing was commenced depending upon the stability of the fracture and adequacy of fixation, delaying

it for patients with unstable or inadequate fixation.
All the patients were followed up at 6 weeks 3 months and 6 months intervals for a period of 6 months and check x- rays were taken to assess fracture union and signs of failure of fixation.

(G) Data collection, Follow-up & Evaluation: Data related to demographics, mechanism of injury, details of trauma, hospitalization detail, operation description, post-operative rehabilitation, complications, clinical and functional outcome were collected during the period of hospital stay and follow up visits in the OPD clinic. The patients were followed up in the outpatient department. At the time of follow up a thorough clinical evaluation was done for progress of union, healing of trauma wound and joint stiffness. Once the fracture had shown early signs of union, partial weight bearing was started on the injured limb. On follow up the patients were evaluated clinically and radiologically according to the Performa decided.

(H) Statistical Analysis: Descriptive statistical methods and expression of results in terms of mean, chi-square test and others using Microsoft excel software with significant p value <0.05 were used for computation of data.

Results

Age: The most common age group was in the range of 61 – 80 years, with a mean of 61.8 yrs.

Sex: 68.73% of the total patient was female in this series with male to female ratio was ~2:1.

Mode of injury: The most common mode of injury was trivial fall (24 patients).

Side: Left side is involved in 66% of the patient (20 patients).

Life style: There was almost equal distribution of patients in the moderate (household) {16 patients} and strenuous (laborer) {14 patients} age groups. People with sedentary life style do not seem to be affected by trochanteric fractures.

Evan's classification: There were 17 stable fractures and 13 unstable fractures.

Injury Surgery Interval: 90% cases were operated within 1 week of injury. Average injury surgery interval was ~ 4 days Mean surgical time was 67 minutes, while mean Fluoroscopy Time was 57 minutes and mean Blood loss (intra operative) was 115 ml.

Hospital Stay: 28 patients had hospital stay of less than 1 week. No patient had stay more than 2 weeks.

Distribution according to Singh's Index

In most of the patient's level of osteoporosis was either 3 or 4 confirming that intertrochanteric fractures usually occur in osteoporotic bone.

Table 1: Singh's index

Singh index	PFNA2
6	0
5	2(6.66%)
4	14(46.62%)
3	8(26.64%)
2	4(13.32%)
1	0
	30

Radiological Union

Radiological union was said to be achieved on the evidence of obliteration of fracture lines and trabecular continuity between the two fragments on AP & lateral x-rays in three cortices.
20 cases showed union by 4 months, 7 cases at 5 months and none of cases showed union at 6 months duration. None of cases had implant failure at 6th month of follow-up.

Table 2: Union Rates (weeks)

Union	PFNA2
8-10weeks	1(6.66%)
10-12weeks	11(73.26%)
12-16weeks	3(9.99%)
>17 weeks	0
	30

Complication

One patient had superficial skin infection at surgical site which healed eventually by wound care, 1 patient had varus deformity at the fracture site.

Outcome evaluation

Table 3: Results

Results	PFNA2
Excellent	16(53.28%)
Good	6(19.98%)
Fair	6(19.98%)
Poor	2(6.66%)
Total	30

Harris Hip score was applied to assess outcome. 22(74%) had good to excellent results. 8 (26%) had fair to poor results. However, radiologically none of the patients had poor results. We cannot readily rule out objective bias in our radiological assessment.

Discussion

Early operative treatment of trochanteric fractures reduces both mortality and morbidity giving best chance of early independency and reducing the risk of prolonged bed rest. Various modalities are available for the management of intertrochanteric fractures. These include both intramedullary and extramedullary implants. The surgeon must understand the implant options available and strive to achieve accurate realignment and proper implant placement.
In India, the proximal femoral nail A2 is available with a length of 240-250 mm. It crosses the mid-diaphysis of the femora (with a mean length of 400 mm) and occasionally abuts against the bowed femora of an average Indian subject. This may give rise to intra-operative femoral shaft fractures

and thigh pain, because the implant touches the anterior cortex of the femur.

Is Modification in Asians Necessary?

Egol KA, Chang EY, Cvitkovic J, Kummer FJ, Koval KJ did a study on the mismatch of current intramedullary nails with the anterior bow of the femur. They inferred those Intra-operative complications such as splintering and fractures are due to oversized implants that are manufactured according to western population parameters.

The anterior curvature of the femur affects insertion of the intramedullary nail. This may cause cortical penetration or fracture angulation, if the mismatch between the nail and femoral curvatures is significant. In addition, the gamma nail and proximal femoral nail have a proximal diameter of 17 mm, which is too large for average Indian femora, and may lead to widening of the trochanter and fractures. Modification of the gamma nail by reducing its diameter and length has been performed in a Chinese population.

This study was carried out at Department of Orthopaedics, Tertiary care Hospital.

Age Distribution: The average age incidence in our study was 61.8 years. The mean age for males was 54 years and for females was 70 years. Majority of the patients belonged to the age group of 61-80 years. Studies done in Indian population have shown similar mean age of patients; while studies done elsewhere show a higher mean age group.

Table 4: Comparision with other studies (Age)

Authors	Average Age (in years)
Yong	78
Suriyajakyuthana	70
Kesemenli	67.6
Evans	62.2
Murray & Frew	62.5
Present Study	62.6

- The contributing factors for the low average age in Indians will be malnutrition and osteoporosis.
- The life expectancy of the people from western countries is 10 years more than Indian population.

All the fractures that occurred in patients younger than 58 years were either due to a fall from height or a road traffic accident. This supports the view that bone stock plays an important role in the causation of fractures in the elderly, which occur after a trivial fall. No attempt was made to measure the degree of osteoporosis by the Singh index, as it involves a great inter-observer variability and depends on good quality x-rays. In addition, the accuracy of the Singh index has been questioned by authors such as Koot *et al.*

White and colleagues did a study of rate of mortality for elderly patients after fracture of the hip in the 1980's and they concluded that the average age for trochanteric fractures is 75.4 years.

Gender incidence

This study has a gender incidence of male to female of 1:2.

Table 5: Comparision with other studies (Male to female ratio)

Baumgaertner *et al.*	27 : 73
G.S Kulkarni	46 : 54
Ian. J Harrington	13 : 87
R.K Gupta	40 : 60
Sanjay Agrawala	29 : 71
Present study	30 : 70

The above studies show there is a strong female predominance due to various reasons. The age of the females suggests they are post-menopausal which causes osteoporosis indicating decreased bone quality and fracture due to trivial trauma.

Side involved

In our study, the left hip fractures were found in 66% of cases. Studies conducted by Kesemenli and Arun Kumar Singh show right hip fractures to be more common, whereas a study by Suriyajakyuthana [95] shows left hip fractures to be more common.

Table 6: Comparision with other studies (side involvement)

Authors	Right	Left
Kesemenli	62%	38%
Arun Kumar Singh	60%	40%
Suriyajakyuthana	46.4%	53.6%
Present Study	34%	66%

Distribution according to co-morbid status

Hypertension is the most common co-morbidity in this study. Diabetes mellitus, ischemic heart disease and chronic obstructive pulmonary disease were also associated.

Fracture distribution according to Evans classification

This study has 17stable fractures and 13 unstable fractures. Ali Sedighi[82] had 72% stable fractures and 28% unstable fracture.

Table 7: Comparision with other studies (stable and unstable fractures)

Study	Stable	Unstable
Ali Sedighi	72%	28%
Baumgaertner	45%	55%
Present study	56.67%	43.33%

Baumgaertner in 1995 had similar results with stability. They had 45% stable fixation and 55% unstable fixation.

Tip apex distance according to age

This study shows that 28 patients had a Tip Apex distance less than 2.5 cm and only 4 patients had TAD more than 2.5 cm. R K Gupta had similar results in his 64 patients with 10 patients have Tip Apex Distance more than 2.5 cm and 54 patients have Tip Apex Distance less than 2.5 cm. The patients with TAD less than 2.5 cm had no complications.

Baumgaertner, S.G good, Ali Sedhigi, Ted Tuescu in their studies have concluded that patients with Tip Apex distance less than 2.5 cm had given good results once again strengthening the fact that Tip Apex distance is a major predictor of good fracture union and cut out failure.

Position of implant post-operatively

In this study the post-operative screw placement shows that in

30 patients of PFNA2 group, it is centrally placed in 20 patients, superior in 2 patients, postero-inferior in 2 patients, centro-posterior in 4 patients, centro-inferior in 2 patients.
Patients with lag screw placed in central and centro-inferior positions had given good functional outcome. According to Vinay Parmar also lag screw placement in central and inferior positions had given good outcomes.

Duration of hospital stay
This study shows that the mean duration for hospital stay is 6.11 ± 3.6 days. The minimum stay was 5 days and maximum stay was 14 days. Because of improved medical facilities and treatment for co-morbidities the average hospital stay is reduced compared to previous studies. In the earlier days, when the patients with intertrochanteric fractures were treated conservatively, the patients were admitted for an average of 6 weeks. This can be seen in the studies of Evans [6] and Murray & Frew. The present-day studies of Yong and Kesemenli show that the duration of hospital stay is less than 3 weeks, which is comparable with our study.

Harris hip score at 1 year
Harris Hip score was applied to assess outcome. 23(74%) had good to excellent results, 7(26%) had fair to poor results.

Table 8: Harris Hip Score at 1 year

Study	Mean HHS
Yih Shiunn Lee	86.9 ± 5.3
M. Guven and Kjell Matre *et al.*	88.9 ± 6.27
Prajapati P *et al.*	86 ± 4.57
MV Valera *et al.*	91.08 ± 5.9
Present study	86.13 ± 8.72

The functional outcome results show that even today intertrochanteric fractures treated with dynamic hip screw give good functional results.

Early Post-operative Complications
In our study, 29 patients had no early post-operative complication. 1 patient developed superficial infection, which was treated aggressively with intravenous antibiotics and adequate debridement, after which it healed well.

Conclusion
Early surgery on patients with trochanteric fractures improved its ability to return to independent living and complications of prolonged immobilization are prevented. PFNA2 has advantages like less surgical time for fixation, less fluoroscopy time, optimum for small neck, less blood loss and it is better suited for Asian population.

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