

## ROLE OF PROXIMAL FEMORAL NAIL ANTIROTATION IN MANAGEMENT OF UNSTABLE INTERTROCHANTERIC FRACTURE OF FEMUR

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### Abstract

**Background:** The aim of this study is to evaluate the management of intertrochanteric fracture of the femur using Proximal Femoral Nail Antirotation (PFNA).

**Materials and methods:** Sixty patients of unstable pertrochanteric fractures were treated by closed reduction and internal fixation by proximal femoral nail antirotation from July 2015 to June 2017. Four patients were lost to follow-ups. The remaining 56 patients were followed for a mean period of 2 years. The results were evaluated by assessing the patients regarding their clinical and functional outcome at follow up as per kyle's criteria

**Results:** Peroperative failure to proximal head neck blade fixation (n=1) jamming of nail (n=2) and post operative lateral migration of head neck blade (n=1) and fracture related infection (n=1) were complications observed. End results were excellent in 46.34%, good in 36.58%, fair in 14.64% and poor in 2.43%.

**Conclusion:** Proximal Femoral Nail Antirotation (PFNA) is the biomechanically and biologically suitable implant for the management of intertrochanteric fracture of the femur.

### Key words

Proximal Femoral Nail Antirotation (PFNA); Unstable Intertrochanteric fracture; Postoperative.

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### Introduction

Development of antegrade intramedullary nail progressed through various design. Initially it was called Halifax nail after the place where Dr Subash Halder developed it<sup>1</sup>. A group of surgeons from Strasbourg changed the name of the nail to a Universal one Gamma nail as the shape resembled the Greek letter<sup>2</sup>. Various authors have reported same result in the management of intertrochanteric fracture with the use of Proximal Femoral Nailing (PFN) or Dynamic Hip Screw (DHS) augmented with Trochanteric Stabilization Plate (TSP) but the nails scored better in unstable intertrochanteric fracture. Intramedullary nail acts as a central pillar against medialization and enhances the lever arm.

Proximal Femoral Nail Antirotation (PFNA) is a versatile implant for fixation of unstable intertrochanteric fracture of femur<sup>3</sup>. The PFN-A was developed by AO/ASIF group as alternate to the PFN with a special helical blade with 5° valgus angle, flat lateral surface and smaller proximal diameter 15.5 mm. Several other companies also developed a longer version of the nail. The helical blade allows improved purchase in the femoral head by radial compaction of the cancellous bone around the blade during insertion. It improved purchase in osteoporotic bone has been determined biomechanically and prevents bone loss that occur during drilling and insertion of standard sliding screw. The helical head neck blade has its advantages of fixation stability, antirotation and ant-varus collapse. Strauss et al reported that fixation of the femoral head with a helical blade is biomechanically superior to sliding hip screw<sup>4</sup>. The PFN-A has a small distal shaft diameter resulting in lower stress concentration in the tip than in the Gamma nail. Though intertrochanteric fracture has been treated in the past by a variety of fixation devices, the present study carried out by managing this fracture by Proximal Nail Antirotation.

### Methods and materials

This prospective observational study includes sixty patients suffering from intertrochanteric fracture (AO classification 31A2 and 31A3) were treated by PFNA from July 2015 to June 2017. Informed written consent obtained from patients with pertrochanteric fracture who admitted in the Department of Orthopaedic Surgery at Chittagong Medical College Hospital. Subsequently they were managed by PFNA. The study excluded patients with combination of trochanteric fracture with ipsilateral shaft fractures, poly trauma patients, age below 4<sup>th</sup> and above 8<sup>th</sup> decade. Short PFNA were used in 56 cases and 4 cases of unstable fracture trochanter stabilized with long PFNA because of osteoporosis. These patients were evaluated preoperative parameters like duration of screening time in seconds, operating time in minutes, blood loss in milliliters, smoothness of the procedure and intraoperative complications like malreduction or failure of reduction, jamming of nail, iatrogenic fracture shaft of femur. Screening time meant the time during which a particular fracture was screening under image intensifier during surgery. In the present study, the smoothness of the operation categorized as easy and difficult in anatomical reduction. Technique of closed or mini open reduction and the opinions of the operating surgeons taken into account to label the surgery as easy or difficult.

During follow-up the patients were evaluated for date out of bed to chair, state of ambulation, ambulatory status at discharge, requirement of ambulatory assistant device, weight-bearing status at discharge and length of hospital stay. Radiographic assessments of fracture fragment position, head neck blade position, Tip Apex Distance (TAD) and extent of fracture healing were made. Overall outcome were assessed and categorizing the results as excellent, good, fair and poor using Kyle's criteria (Table-I)<sup>5</sup>. Postoperatively the patients evaluated at regular interval at 1<sup>st</sup> month, 3<sup>rd</sup> months, 6<sup>th</sup> months and annually.

**Table I :** Clinical outcome (Kyle et al)<sup>5</sup>.

Excellent	No or minimal limp No pain hip joint Full ROM hip joint
Good	Mild limp Mild occasional pain Full ROM

Fair	Limp up to moderate Moderate pain using two stick Limited ROM
Poor	Wheel chair bound Pain at any position Non ambulatory

### Operative procedure

After proper preoperative assessment and spinal anesthesia patient was taken to the traction table for fracture reduction by image intensifier. Usually a senior and a junior surgeon and two residents were participated in the all operations.

For reduction of unstable intertrochanteric fracture the normal leg was flexed and internally rotated. The fractured limb was adducted and Torso wind swept and unobstructed for image intensifier. The anterior and medial reduction was done by lever technique (From James Carr) and "Joy stick" for proximal fragment stabilization. Spiral pattern were reduced using circlage wiring. Reduction was verified by image intensifier. Tip of greater trochanter was identified by palpation and a 5 cm incision was given at the intersecting point made by horizontal line from Anterior Superior Iliac Spine (ASIS) to vertical extension line from trochanter tip.

Incision was deepened through fascia lata splitting the abductor muscle. The entry site was opened up with a cannulated curved awl and a guide wire passes into the medullary cavity. Rimming was done 1 mm increment upto 10-12 cm with the help of flexible reamer in order to accommodate the proximal end of the nail. The trochanteric region was reamed upto 17 mm according fracture geometry irrespective of distal diameter chosen. Nail of chosen size mounted on introducer Jig. Nail was then passed manually with rocking motion without using hammer. Leg was abducted after the insertion of nail. The incision was made over the skin overlying the lateral cortex in the line with slot proximal jig for introduction of the Helical Blade. A guide pin was passed through the guide sleeve across the lateral cortex into the posterior inferior cortex-center or central central Cleveland zone of femoral head under image intensifier. Then after reaming of femoral neck approximate size of helical blade was introduced over the head neck blade guide pin deep into the subchondral region maintaining the TAD. Full length reaming of head neck fragment was judged considering bone quality. Distal locking screw applied after releasing the traction.

Postoperative patient was closely observed for vital parameters, soakage of dressing, antibiotic prophylaxis using intravenous Ceftriaxone and Amikacin for 48 hours postoperatively. Wound inspection was done on 1<sup>st</sup> postoperative day. On 1<sup>st</sup> postoperative patients were made to sit up in bed and chest physiotherapy was started. Active Knee bending and static quadriceps exercise was also started. Weight bearing with walker or crutch was encouraged. All A2 fractures at the end of first week and A3 fracture at the end of third week were allowed full weight bearing with walker followed by squatting 6-8 weeks, cross legged sitting 8-12 weeks and full activity was permitted by 16 weeks.

Statistical analysis was performed using SPSS statistical package, version 15 for windows. Quantitative variables were analyzed using the student's t-test and categorical variables were analyzed by the Fisher's exact test. The level of statistical significance was set at a two-sided p-value of 0.05.

### Results

The study involved 60 cases of unstable A2/A3 intertrochanteric femoral fracture of either sex. Four were lost to follow-up before 1 year after the injury and excluded for the study. The remaining 56 patients were followed up for a period of 2 years. There were 40 men and 16 women. All patients were from 4<sup>th</sup> to 8<sup>th</sup> decade of life. The intertrochanteric fractures were categorized according to AO classification. 31A2, 31A3 fractures [A2 (n=36), A3 (n=20)] were included in this study. Mean age for A2 fracture was  $53 \pm 5.66$  years, while mean age for A3 fracture was  $59.7 \pm 7.03$  years out of total 56 patients. Out of total 56 patients, 29 patients were suffered from high energy trauma while 27 suffered from low energy trauma. It was observed from the result that high energy trauma was significant statistically ( $n^2 = 18.19$ ;  $p < 0.001$ ) in causation of 31A3 fractures as compared to 31A2 fracture. 56 Patients of trochanteric fractures underwent operative intervention resulted in satisfactory outcome. The mean duration of hospital stay was  $14 \pm 0.72$  days/ Mean screening time was 31 minutes (28-39 mins.).

Out of total 56 pertrochanteric fracture 6 were found to be in difficult category [31A2 (n=4), 31A3 (n=2)] while the rest were easy. The mean operative time for this fracture was 60 minutes (Ranges from 45 to 90 mins). The average blood loss during the surgery was 400 ml. Regarding post operative mobilization all patients were shifted from bed to chair in 1<sup>st</sup> POD. Full weight bearing was started by the end of first week in A2 patients (n=36, 64.5%). In A3 patients (n=20, 35.6) full weight bearing was delayed till the end of third week. This decision was taken considering the stability of nail bone construct and as per direction by operating surgeons. The stability of the nail bone construct was assessed depending on comminution of posteromedial cortex, reverse oblique fracture, ability to achieve anatomic or anatomic reduction and adequacy of fixation. During peroperative period time there was jamming of nail (n=1, 1.78%) and failed proximal blade fixation (n=1, 1.78%). Jamming of nail was corrected by considering the nail with lesser diameter and proximal missed head neck blade was revised using image intensifier. The proximal posterior sagging fragment was reduced and temporarily fixed with k-wires. There was no complication like drill breakage, iatrogenic fracture shaft of femur. Post operatively one patient (n=1, 1.78%) had superficial wound infection and one patient (n=1, 1.78%) had bed sore, one (n=1, 1.78%) had lateral migration of head neck blade. No cases of superior cut out of head neck blade was found. The lateral migration was not corrected as it was accepted by the patient and fracture was consolidated. There was no incidence of implant breakage or symptomatic removal of hardware. All fractures achieved union by a mean period of eight weeks.

The end results were found to be Excellent in 46.34% , Good in 36.58%, Fair in 14.64% and Poor in 2.43% of patients ( Table II). There was no statistically significant difference ( $n^2 = 5.61$ ,  $p = 0.05$ ) between A2 and A3 fractures in term of end results with the use of PFNA at follow up of 2 years .The fractures had healed in all the patients and no further treatment was required.

**Table II** : End results.

	Excellent	Good	Fair	Poor
31A2 fractures	14	17	05	0
31A3 fractures	12	4	3	1



**Case A - Fig 1a :** Trochanteric Fracture following injury A/P and Lateral view.



**Case A - Fig 1 b :** 6 weeks later following operation.



**Case A - Fig 1c :** 12 weeks later following operation.



**Case A - Fig d :** The patient walk with a single crutch.





**Case B - Fig 2a :** AO type A3.2 trans-trochanteric fracture.



**Case B - Fig 2b :** 12 weeks later shows consolidation of fracture.



**Case B - Fig 2c :** The patient was in squatting position.

### Discussion

Inter trochanteric fractures are one of the most commonly suffered fractures by patients of different age groups. The available published literature in this regard has shown these fractures being treated by a variety of devices like nail plate devices, Dynamic Hip Screws (DHS) and medullary devices like Gamma nail, PFN<sup>1</sup>. The PFNA has developed with improved biomechanics by AO/ASIF group as an alternative to the Gamma nail and seems to be associated with lower incidence of complications.

During this study 6 (Six) were found difficult category because the surgeon faced difficulty in reduction of the fracture by closed method. Reduction were done by minimally invasive , joy stick and lever techniques. This findings were comparable to the study done by Leung KS<sup>6,7</sup>.

The preoperative screening time as reported by Leung for the inter trochanteric fracture was identical to the screening time in this study and was lesser than the screening time for treated by DHS<sup>4</sup>. Operating time in this study was a mean period of 60 minute in all fractures (Range 45-90). This was almost identical to operation time for fractures treated by Gamma Nail by Leung KS<sup>7</sup>.

The blood loss during operative procedure by patient in this study was comparable to the studies done by Pajarinen j et al<sup>8</sup>. Perioperative complications like jamming of nail, failed proximal head neck blade fixation, superior cut out of head neck blade and iatrogenic fracture of femur were not found in this study while these complications were reported in the studies by Vipin Sharma et al<sup>9</sup>.

Preliminary temporary k-wire fixation during fracture reduction and optimum head-neck blade placement maintaining TAD helped to overcome complications.

This was also because the nail used in this study was proximal femoral nail antirotation rather than gamma nail. In the present study 14 patients of 31A2 and 12 with 31A3 had recovered with full range of movement and painless gait categorized as Excellent. 17 patients 31A2, 4 with 31A3 have mild limp but full range of movement while 5 patients with 31A2 and 3 31A2 were ambulant with two sticks included in Good and Fair respectively. The end results were found to be Excellent in 46.34% ,Good in 36.58% ,Fair in 14.64% and Poor in 2.43% patients in this study. This results

were similar to the study done by Vipin Sharma et al<sup>9</sup>. The results regarding post operative weight bearing were comparable to the result by Simmermacher RK et al<sup>10</sup>, who observed accelerated restoration of the prefracture activity level approximately 56-80% of patients treated with PFN-A. In contrast, several studies showed about 40-50% restoration of the prefracture level of activity among the patients who were managed with DHS construct<sup>10,11</sup>.

There was incidence of early wound infection in one patient which was same as the study by Strauss et al<sup>4</sup>. Fracture of the femoral shaft at the tip of the nail is a known complication associated with the use of intramedullary nail in the treatment of proximal femoral fracture. Such complication was absent in the study with PFNA.

Reported incidence rate of revision surgery in the DHS group was 3-14% and in Gamma nail was 5.7% while in PFNA was 1.78%. This good outcome could be due to the use of the intramedullary device and good experience of the surgeons. During operative procedures some important observations were noted and recommended for better outcomes. One should not ream unreduced fracture and beware of the anterior bow of the femoral shaft during the nail insertion trajectory. Use of hammer to seat the nail should be avoided. Traction should be released before insertion of the distal locking screws and confirmation of bony contact should be assessed with C-arm image.

#### Limitations

- i) The study was done among the small number of sample size.
- ii) It was not compared with the other procedures.
- iii) The cost of the implant is very high in our socio economic aspect.
- iv) Single center Randomized Controlled Trial (RCT).

#### Conclusion

The use of PFNA in the treatment of unstable intertrochanteric femoral fracture is biomechanically and biologically superior and a positive effect in the speed of restoration of walking. The PFNA is a suitable minimally invasive implant in expert hands for the unstable intertrochanteric femoral fracture.

#### Recommendations

- i) Multicenter RCT needed with a large sample size to define the procedure as standard
- ii) Can be done easily in well-equipped center by experienced surgeon.

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#### Contribution of authors

CKD- Conception, design, acquisition of data & final approval.

MMRC- Acquisition of data, analysis manuscript writing & final approval.

MQM- Interpretation of data, critical revision & final approval.

MSI- Acquisition of data, analysis manuscript writing & final approval.

MKU- Interpretation of data, critical revision & final approval.

MAR- Interpretation of data, critical revision & final approval.

#### Disclosure

All the authors declared no competing interests.

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