**Original Article**

# Comparison between proximal femoral nail and proximal femoral nail antirotation in Peritrochanteric fracture of femur

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**ABSTRACT**

**Introduction:** With increasing life expectancy of people, the incidence of peritrochanteric fractures has increased significantly. In the management of unstable peritrochanteric fractures intramedullary devices have proven advantage over extra-medullary ones. Proximal femoral nail antirotation (PFNA) is believed to be better in term of stability, rotational stability and lower cut out rate than proximal femoral nail (PFN), but is still controversial. This study was undertaken to compare the duration of surgery, intraoperative blood loss and duration of C arm fluoroscopy exposure, position of implant, varus collapse and screw cutout, and functional outcome via Harris Hip Score (HHS) between the intramedullary devices.

**Method**: This was a prospective observational study conducted in patients with diagnosis peritrochanteric fractures treated either with PFN and PFNA in National Trauma Center and Civil Services Hospital from 1st May 2018 to 30th November 2019. Out of 48 patients, 24 in each group were included who met the inclusion criteria. Both the groups were followed at 1 month, 3 month and 6 month and were compared in term demographic variables, postoperative complication, and functional outcome via HHS.

**Result**: PFNA has better outcome than PFN in term of mean operative time (48.33±17.2 vs 74.16±21.9 minutes), mean blood loss (80.41±32.19 vs 138.75±45.90 millilitre) and duration of fluoroscopy exposure (48.33±17.29 vs 74.16±21.95 second) respectively. The postoperative varus collapse and screw cut out were higher in PFN than PFNA. The HHS at 6 month follow up of PFNA group had better result than PFN with $P < 0.001$ (86.12±5.16 vs 75.16±10.11 respectively).

**Conclusion**: PFNA is better in reducing operative time, blood loss, and duration of fluoroscopy exposure. Post-operative complication is comparable but the functional outcome at 6 months follow-up of PFNA is better than PFN.

**Keywords**: Peritrochanteric, fracture, PFN, PFNA, HHS.

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## INTRODUCTION

As the life expectancy has been increased worldwide in recent years, the incidence of peritrochanteric femur fracture is estimated to rise from 458,000 to 1,037,000 by 2050 in patients 45 years old or older in united states.[1,2] Peritrochanteric fracture in elderly patients unite with residual varus or valgus deformity if managed conservatively but due to various complication in a previously comorbid patient operative management is recommended.[3] Various implants have evolved over the years for the treatment of peritrochanteric fracture. Dynamic hip screw has been used successfully for the treatment of stable peritrochanteric fracture. For fixation of unstable fractures, the use of an intramedullary nail coupled with a dynamic femoral head/neck stabilization implant is the ideal method.[4] Over time, various designs of nails incorporating a single compression screw or a compression screw coupled with an antirotation screw like the proximal femoral nail, have become popular for treating unstable fractures. Intramedullary devices like PFN and PFNA in unstable peritrochanteric fracture can be inserted with less exposure of the fracture, less blood loss, although they may require more fluoroscopic exposure.[2,4] PFNA with single helical blade was designed to increase the better stabilization of fracture and reduce complication related to PFN like screw cut-out, varus collapse and rotational instability.[5,6]

The objective of this study was to compare the duration of surgery, intraoperative blood loss and duration of C arm fluoroscopy exposure, position of implant, varus collapse and screw cutout and the functional outcome of both the implant either PFN and PFNA via Harris Hip score which could recommend the use of appropriate cephalo-medullary nails in unstable peritrochanteric fracture.

## MATERIALS AND METHODS

This was a prospective observational study done in National Trauma Center and Civil Service Hospital from May 2018 to June 2020. Before commencing the study, the proposal was submitted to the IRB of National Academy of Medical Sciences (NAMS) and ethical clearance was taken. Target sample size was obtained from the formula.

$n = 2*\sigma^2(z1-\alpha/2 + z1-\beta)^2/(\mu0 - \mu1)^2.$

Where pooled SD calculated from the paper.[7] [$z_{1-\alpha/2}$= 1.96 from table, $z_{1-\beta}$= 1.64 from z table. Thus, the required sample size for this study = 24 in each group.

Inclusion Criteria were patients with unstable peritrochanteric fracture treated with PFN or PFNA of age more than 50. Peritrochanteric fracture were classified according to ArbeitGemeinschaft fur osteosynthesefragren (AO). 31A2 and 31A3 were included in the study as this fracture are unstable.

3 1 A1 : Fracture are not communited, single fracture line extending medially

3 1 A2: Fractures having increasing comminution, separate lesser trochanteric fragment

3 1 A3 : Fracture include reverse obliquity, transverse or subtrochanteric extension pattern.

Exclusion Criteria were stable pertirochanteric fracture, pathological fractures, open fractures, multiple fractures, patient with known coagulopathy or coagulation disorder or under anticoagulant treatment, paraplegic or non-ambulatory prior to injury and mentally challenged or unable to follow instruction.

Random sampling was done. A set of samples was generated from site www.randomizer.org. Generated samples on the basis of case number were 1, 2, 4, 5, 6, 9, 11, 14, 15, 18, 19, 20, 21, 22, 23, 27, 28, 29, 30, 36, 38, 41, 44, 47 out of 48 cases. These were cases operated with PFNA and rest were operated with

PFN. Patient who met the inclusion criteria, informed and were willing to participate were included in study. Study was continued till the sampling size was met.

Patient who presented to emergency department with peritrochanteric fracture were admitted to orthopaedics ward applying skin traction. The fracture was classified according to ArbeitGemeinschaft fur osteosynthesefragren (AO). Patients admitted with peritrochanteric fracture were examined and investigated with X-ray pelvis AP and Lateral view (whenever possible).

Pre-anaesthetic evaluation was done before undergoing surgery. A day before surgery, nail diameter was estimated by measuring mean diameter of the narrowest diameter of femoral canal in both anterior posterior and lateral views. Shorter PFN/ PFNA were used in 31A2 and longer PFN/PFNA in case of 31A3. Similarly, length was calculated by measuring the distance from greater trochanter to the superior border of patella.[7] Injection Cefazolin was given half hour prior to skin incision in every case. Patients were given subarachnoid block or epidural anaesthesia and were shifted to a radiolucent fracture table with a perineal post in supine position. The unaffected extremity was placed into a boot and positioned with hip and knee at 90 degree and slight abduction of about 20 degree. The affected extremity was placed into a boot after reduction of fracture achieved.

Reduction was achieved by traction and internal rotation primarily with adduction or abduction as required. In few cases anterior force was applied to the posterior distal fragment to correct the sagittal plane deformity. Reduction was checked under C-arm fluoroscopy in anterior-posterior and lateral view. In all the cases included in this study, reduction was achieved by closed method.

Limb was scrubbed, painted and draped under sterile condition. A 5cm skin incision was taken above the tip of the greater trochanter and deepened to the gluteus medius muscle. Tip of the greater trochanter palpated and minimal muscle attachment was cleared off without dissecting the gluteus medius. The technique of positioning, reduction of fracture, scrubbing, painting and drapping was similar for both the procedure as explained above

**Procedure of PFN or PFNA insertion:**

Entry Portal: Modified trochanteric entry portal was used. In AP view the portal lies just medial to the slope of greater trochanter (GT) and in lateral view lies at the junction of anterior 2/3$^{rd}$ and posterior 1/3$^{rd.}$of GT. Entry portal made with awl and checked under C arm fluoroscopy in both AP and lateral views. Guide wire inserted and checked under C arm fluoroscopy in both the views.

**Reaming of the Proximal Femur:** Reaming was done with the reamer with subsequent increment of reamer diameter from 8 mm, 9 mm and 10 mm. We reamed with 1 mm size greater than the size of nail predetermined preoperatively or until a moderate chatter sound was heard. Additional reaming was done with trochanteric reamer to expand the entry portal at GT to reduce the hoop stress.

Nail Insertion: Nail of appropriate diameter and length predetermined preoperatively was fixed on the jig and alignment was confirmed. Then the nail was inserted into the femur. The position of the holes for the hip screws was checked in the C- arm for the depth of the nail.

**Guide wire for the screws:** Guide wires for the screws were inserted via the jig and the drill sleeve. The ideal position of the guide wires is

parallel and in the lower half of the neck in AP view, in a single line in the center of the neck in the lateral view. First the distal most proximal guide wire was inserted along the femoral calcar within 5 mm of subchondral bone. Through the proximal targeting guide attached to the nail, the most proximal guide pin was inserted parallel to the first guide pin and confirmed its position with C-arm. Further drilling with 6.5 mm cannulated drill bit for the femoral hip screw of size 8mm and with 4mm drill bit for cervical hip screw of size 6.4mm. The length of screw is measured with the calibration given on the reamer. The length of cervical hip screw was 10 mm shorter than the femoral screw to prevent the Z effect. First, the femoral hip screw of size 8 mm of appropriate length was inserted followed by cervical hip screw. Traction was released and further tightening of the proximal screw was done.

In case of PFNA, similar lateral incision 5 cm above the GT was given with retraction. Subcutaneous tissue along with dissection of gluteus maximus along the line of skin incision was carried out. GT was reached and entry portal made.

**Entry portal:** In AP view, the PFNA entry point was on the tip or slightly lateral to the tip of the greater trochanter in the curved extension of the medullary cavity, as the medial lateral angle of the PFNA is 6°. In lateral view the entry point was in line with the axis of the intramedullary canal.

Guide wire of 3.2 mm was inserted under C arm fluoroscopy guidance. Cannulated drill of the size was guided through the protection sleeve over the guide wire and was drilled as far as the stop on the protection sleeve.

Reaming was done with the reamer with subsequent increment of reamer diameter from 8.5 mm, 9 mm and 10mm. We reamed with a 1-1.5 mm size greater than the size of nail predetermined preoperatively or until a moderate chatter sound was heard. Additional reaming was done with trochanteric reamer to expand the entry portal at GT to reduce the hoop stress.

**Insertion of Proximal Helical Blade:** A stab incision was given in the area of trocar tip. The sleeve was advanced through the soft tissue in direction of lateral cortex. After removing the trocar guide wire was inserted through the golden drill sleeve in the femoral head. Ideal position of guide wire in both the AP and lateral view is the exact center of the femoral head. Guide wire was inserted subchondral into the femoral head at a distance of 10 mm below the joint level. Insertion and position of guide wire was checked under C ARM fluoroscopy. Measuring device was advanced through the protection sleeve to determine the length of blade. Cannulated drill bit was inserted to open the lateral cortex. Blade of size 10mm smaller than the length measured by measuring device was inserted to prevent the screw penetration through the femoral head and was checked under C arm fluoroscopy.

Normally helical screws are supplied in locked state. The impactor was screwed anticlockwise to unlock the helical blade. The helical blade was gently pushed towards the impactor. The blade-impactor assembly was inserted over the guide wire through the protection sleeve. Gentle blow with hammer was applied while impactor clicks on the protection sleeve. Than the impactor was gently rotated clockwise to lock the blade to bring compression at fracture site intraoperatively.

**Distal Screws:** One or two static or dynamic 4.9mm interlocking bolts was inserted via the jig in to the distal part of the nail. Out of which one was in static and another was in dynamic hole. Determination of placement of single or double screws distally was made by the quality of

reduction achieved intraoperatively. If the reduction achieved was good than a single dynamic screw were placed and in case of poor quality of reduction intraoperatively, both dynamic and static locking screws were placed.

Distal locking was done after removing the traction along with the tightening of the proximal screws. The final position of the nail was checked in the C-arm fluroscopy in both views and the wound was closed in layers without putting the drain. Following parameters were noted intra-operatively:

1. Total Time of the Surgery: Duration surgery was calculated from the time of skin incision to the closure of incision.
2. Blood Loss: It was measured by counting gauge pad shocked which approximately 50 ml for completely soaked gauge pad. Blood collected in suction drain was also measured by reducing the amount of normal saline used for irrigation of the surgical wound. As the procedure were performed via closed method no suction drain were kept.
3. Duration of Radiation Exposure: Duration of fluoroscopic exposure were determined by the time in second that were shown in the C arm machine at the end of the procedure. In this study basically two types of C arm fluoroscopy machine were used named Allenger-HF49R and OpescopeActeno. Intraoperatively fluoroscopy machine were operated by residents.

PFN and PFNA were performed on 24 patients. Patients were shifted to post-operative ward. Intravenous antibiotics were continued for 72 hours followed by oral antibiotics depending on the status of wound. Dressing was changed at 3rd postoperative day which determined the further continuation of IV antibiotics seeing the wound status. Operated limb was elevated to reduce the swelling. Ankle pump exercises were initiated once the effect of anaesthesia wore off.

On 1st post-operative day, check X-ray of pelvis and lateral view of operated hip was done with post-operative evaluation of Haemoglobin and packed cell volume. In the immediate post-operative X-ray, surgical reduction factors like anatomical reduction, proper screw/blade positioning was evaluated.

Screw positioning was considered appropriate if screw was placed into the lower half of the neck in AP view, center on a lateral view in case of PFN; and in case of PFNA, blade was placed in to the center of the neck in both AP and lateral view.[8]

Bedside mobilization was started from the 1st post-operative day. Isometric exercises of quadriceps muscles were started. Sitting and knee range of motion were started as tolerated from the 1st post-operative day. The dressing was done on 3rd, and Walker mobilization was allowed from the 4th day. Patient was discharged on the 5th post-operative day. Suture was removed on 14th post-operative day with the initiation of partial weight-bearing crutch walking.

Subsequent check X-ray were done at 1 month, 3 months and 6 months follow up. In follow-up visits, complications were checked such as loss of reduction i.e. varus collapse, cutouts, joint penetration, broken implants, peri-implant fractures, and also the Harris hip score for functional outcome was assessed at 1 month, 3 month and 6 months. The clinical result was assessed using Harris hip score. Harris Hip Score were categorized as excellent (91-100points), good (81-90points), fair (71-80points) and poor (<70points).[8] Fracture was considered to be united in subsequent follow up radio-graphically as the appearance of a bridging callus on 3 or 4 cortices in the AP and lateral views and clinically

as a lack of pain sensation around the fracture site.[9]

During data collection for this study, the consent of each subject was fully respected. Data were collected and master chart prepared in Microsoft Excel 2013. Statistical analysis was done using SPSS version 20. Demographic variables like age, AO classification were calculated using independent t- test. The functional outcome obtained by Harris Hip score were calculated using Chi square test. *p*-value less than 0.05 with confidence interval of 95% was considered significant.

## RESULTS

The PFNA nail group consisted of 24 patients (14 male and 10 female) mean age of 75.54±8.05 (ranging from 61- 88 years). The PFN nail group consisted of 24 patients (12 male and 12 female) with a mean age of 74.83± 9.70(ranging from 51-87 years).

Both the groups were followed up to 6 months postoperatively. The causes of trauma were either due to low energy trauma following a fall from standing height or due to high energy trauma, fall from a ladder, or road traffic accident (RTA) (Figure 1).

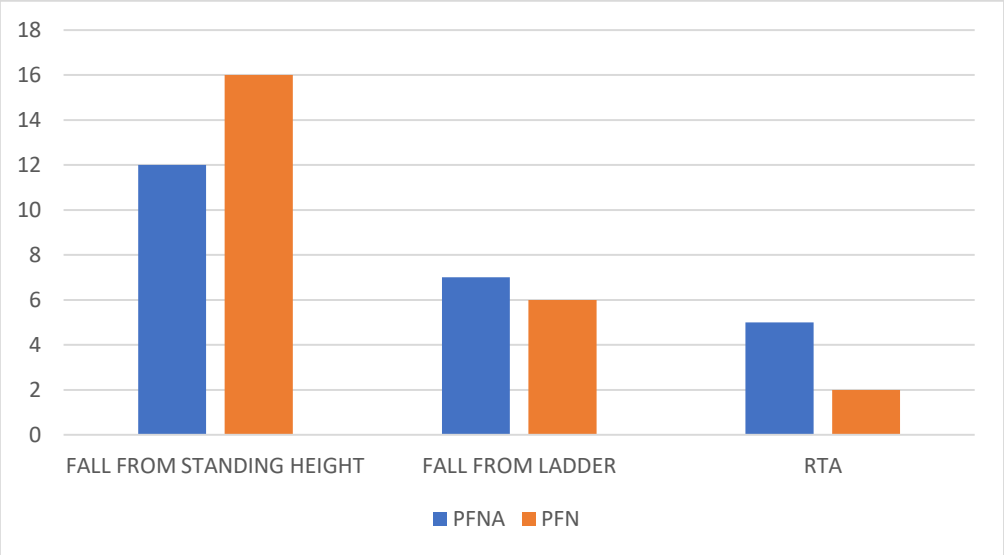


**Figure 3:** Mode of Injury (RTA, road traffic accident)

Fractures were classified according to AO, which included 19 cases of 31A2 and 5 cases of 31A3 in the PFNA group whereas 17 cases of 31A2 and 7 cases of 31A3 in the PFN group (Figure 2). In both group, the reduction was achieved via the closed method. The mean difference in operative time in PFNA was significantly lower as compared to the PFN group (48.33±17.2 vs 74.16±21.9, P<0.001)(Table 1). Mean blood loss was significantly lower in the PFNA group as compared to the PFN group (80.41±32.19vs138±45.90) P<0.001(Table 1). The mean duration of images taken intraoperatively was significantly lower in the PFNA group compared to the PFN group (48.33±17.29 in sec vs 74.16± 21.95 in sec) P<0.001 (Table 1).

The incidence of varus collapse postoperatively in subsequent follow-up in both groups was not significant statistically with a P-value of 0.202, however maximum varus collapse was noted in PFN compared to the PFNA group (Table 2). There was no incidence of screw cutout in the PFNA group at 6 months follow up whereas there was 7 case of screw cutout in the PFN group. There

was one case of screw penetration of helical screw through the femoral head which she presented at 2 months of follow-up. She was evaluated and re-operated by removing the helical screw and placement of screw of smaller length.

The functional outcome of the patient was observed using Harris Hip Score at 4$^{th}$ postoperative day, 1 month follow up, 3 months and 6 months follow up. The Harris Hip Score postoperatively compared with the score at 1 month was not statistically significant as compared to hip score at 3 months and 6 months with P-value less than 0.001 in PFN group (Table 3).

There was a significant increment of the hip score of the PFNA group at 1 month, 3 months, and 6 months compared with the score at post-operative with statistical significance with a p-value less than 0.001 (Table 4). In our study mean HHS of the PFNA group was improved significantly compared to the PFN group. The mean score of the PFNA group was 86±16 compared to the mean score of PFN 75.16±10.11 which was statistically significant (Table 5). The objectives of comparing the Harris Hip Score within the group at subsequent follow was to see whether the patient is improving clinically or not and whether it returned to pre-injury status.

We observed radiological union in 20 of the cases operated with PFNA and 18 of cases operated with PFN. Out of 24 cases operated with PFNA 12 (50%) cases united at 12 weeks follow up and 8 (33.3%) cases united in 24 weeks follow up. Similarly, out of 24 cases operated with PFN, 8 cases (33.3%) united in 12 weeks follow-up and 10 cases (41.6%) united in 24 weeks follow-up. Those who failed to show radiological union were further evaluated. Dynamization was required in 3 of the cases.

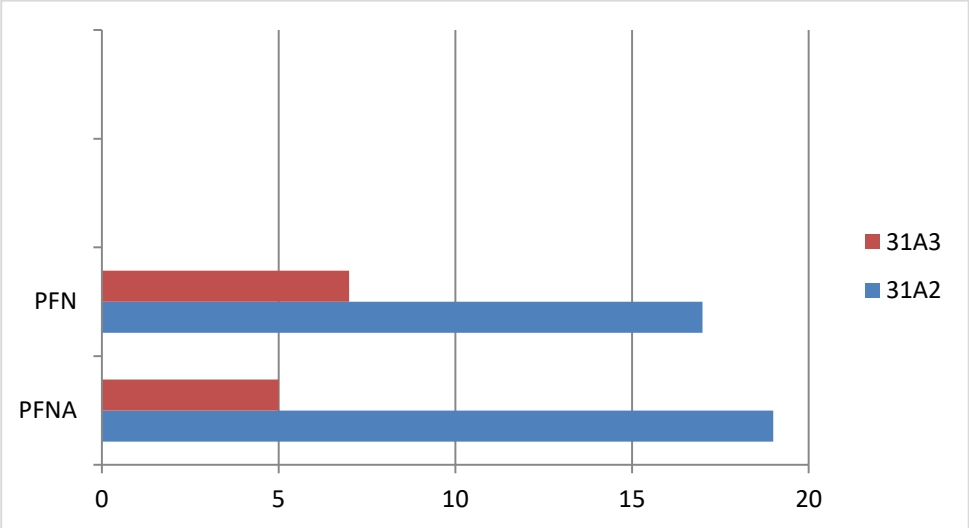


**Figure 4:** AO Classification

**Table 1:** Operative Details of the PFNA and PFN

| Operative Details | PFNA (n=24) | PFN (n=24) | t-value | P-value |
|---|---|---|---|---|
| Duration in Minutes (Mean±SD) | 48.33±17.2 | 74.16±21.9 | -4.528 | <0.001 |
| Blood Loss (Mean±SD) | 80.41±32.19 | 138.75±45.90 | -5.097 | <0.001 |
| C-ARM Exposure in Seconds (Mean±SD) | 48.33±17.29 | 74.16±21.95 | -8.114 | <0.001 |

**Table 3:** Post Operative Complication of PFNA and PFN

| Complications | PFNA (n=24) | PFN (n=24) | P-value |
|---|---|---|---|
| Varus Collapse | | | |
| Absent | 19 (55.9%) | 15 (44.1%) | 0.202 |
| Present | 5 (35.7%) | 9 (64.3%) | |
| Screw Cut out | | | |
| Absent | 24 (64.9%) | 17 (35.1%) | <0.001 |
| Present | 0 (0%) | 7 (100%) | |

**Table 4:** Harris Hip Score Of Pfn

| Harris Hip score of PFN group | Mean difference | t-value | P-value |
|---|---|---|---|
| 4th PostOperative vs 1 Months | -0.13 (35.95-36.08) | -0.121 | 0.905 |
| 4th PostOperative vs 3 Months | -18.67(35.95-54.62) | -14.77 | <0.001 |
| 4th PostOperative vs 6 Months | -40.016 (35.95-75.16) | -19.75 | <0.001 |

**Table 5:** Harris Hip Score PFNA

| Harris Hip score of PFNA group | Mean difference | t-value | P-value |
|---|---|---|---|
| 4thPostOperative vs 1 Months | -4.42 (37.08-41.50) | -5.36 | <0.001 |
| 4thPostOperative vs 3 Months | -23.17 (37.08-60.25) | -20.73 | <0.001 |
| 4thPostOperative vs 6 Months | -49.04 (37.08-86.12) | -43.83 | <0.001 |

**Table 6:** Comparision of Harris Hip Score

| Harris Hip score ( 6 months post operatively) | | | |
|---|---|---|---|
| | PFNA | PFN | P-value |
| Mean±SD | 86.12±5.16 | 75.16±10.11 | <0.001 |

## DISCUSSION

The implant of choice in unstable peritrochanteric fracture is debatable. Compared with extramedullary devices like DHS the intramedullary devices have better functional outcome in unstable peritrochanteric fracture.[10,11,12] Mechanically, intramedullary nail devices have shorter lever arms that transmit the loading force more medially. As a result, intramedullary nail devices provide a superior resistance to head collapse into the varus than extramedullary screw-plate devices and also confers sufficient stability for early postoperative ambulation.[9, 13]

In this study there was no statistical significance in gender distribution of the fracture with P value 0.556. However, the study by Mattisson et al. showed higher incidence of peritrochanteric

fracture in females compared to males.[14] The mean operative time varies significantly in PFNA compared to PFN group with a mean time 48.33±17.2 vs 74.16±21.9 respectively with P <0.001. A study by Kashid et al. found the mean operative time was 43.32±8.20 in PFN group compared to 35.20± 6.02 min in PFN group.[7] The mean operative time in PFNA was 50 minutes, whereas 80 minutes in PFN in a study by Mohan et al.[8]

There was a significant reduction in the amount of blood loss in PFNA as compared to PFN with P<0.001. In this study mean blood loss was 80.41±32.19 ml in cases operated with PFNA whereas 138.75±45.90ml in cases operated with PFN. Kashid et al. in their study found mean blood loss was also significantly lower in PFNA group as compared to PFN group (59.80 ± 14.96 ml vs. 77.80 ± 17.39 ml, p<0.001) which was comparable to our study.[7] Duration of C arm fluoroscopy exposure was also significantly reduced in PFNA than PFN with mean duration of 48.33±17.29 sec vs 74.16±21.95 respectively with P <0.001 in our study which was comparable with similar studies conducted by Kashid et al, where mean exposure was 29.52 ± 4.85 (24-40 times) in PFN compared with 18.60± 3.12 (15-26 times) in PFNA.[7]

The functional outcome was analyzed using the Harris Hip score. The mean Harris Hip Score in PFNA group at 6 month follow up was 86.12±5.16 as compared to 75.16±10.11 in PFN group, which is statistically significance with P <0.001. Excellent result in two of the cases, good result in 20 cases, fair in one case and poor result in one case operated with PFNA. In patients operated with PFN we found good result in 8 cases, fair in 6 cases and poor result in 10 cases. The functional outcome of PFNA group was better than the PFN group. Comparing the Harris Hip Score postoperatively with HHS at 1, 3 and 6 months within the group, we found that there was significant improvement in HHS respectively in subsequent follow up with the statistical significance of p<0.005 in PFNA group. There was so significant difference in HHS at 1 year follow up in a study conducted by Kashid MR et al with mean HHS of PFN group 86.8± 11.29 and that of PFNA group 88.48±7.56.[7] Similar studies conducted by Mallya et al found no significant difference in functional outcome at 6 months follow up average HHS was 74.55 for average PFNA group and 69.88 for PFN group.[15] In a study conducted by Mohan et al, HHS in PFNA group, 45 cases (90%) had an excellent results and 5 cases (10%) had good results compared to PFN group where 31 cases (75%) had an excellent results, 8 cases (20%) showed good result and 3 cases (5%) showed poor result which was comparable with our study[8].

The finding of this study is consistent with the other study showing PFNA better than PFN in reducing operative time, reducing blood loss and improvement of HHS is because of the single helical blade used in PFNA. Most of the peritrochanteric fracture occurs in an osteoporotic bone in elderly people with reduced cancellous bone and trabeculae in head and neck of the femur. Helical blade is bio-mechanically proven to increase contact area between implant and femoral head, improves fixation quality by decreasing reaming of the bone stock.[16,17] Helical blade used in PFNA has large surface area with larger core diameter as compared to screw used in PFN which ultimately provides better rotational stability and decreases varus collapse.[18,19]

## BOTTOM LINE

The PFNA provides shorter operative time, reduced blood loss, and lesser duration of C–arm fluoroscopy exposure compared to PFN. The

functional outcomes of patients treated with PFNA are better than the patients treated with PFN at 6 months follow-up. Therefore, PFNA is the better option for the treatment of unstable peritrochanteric fracture of the femur.

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