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# Comparative study to assess the functional outcome in management of inter-trochanteric fractures by proximal femoral nail versus proximal femoral nail anti-rotation

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## ABSTRACT

**Background:** Proximal femoral fractures are one of the most common fractures occurring in elderly due to osteoporosis and increase in life expectancy. The management of these fractures poses a serious challenge in terms of obtaining a stable fixation and a good post-operative outcome. In this study, we compare two intramedullary devices: Proximal femoral nail (PFN) and proximal femoral nail anti-rotation (PFN-A), used commonly for the fixation of proximal femoral fractures.
**Methods:** Patients presenting with inter-trochanteric fractures were included and randomly allocated to two groups for treatment with either PFN or PFN-A. Pre-operative radiographs of normal side were used to grade osteoporosis by Singh's index. Post-operative radiographs were used to assess the tip-apex distance and quality of reduction. Functional outcome was compared on the basis of Harris hip score at final follow-up. Patients were followed up at an interval of 1, 3 and 6 months respectively.
**Results:** The study included 30 patients with 15 patients in each group. The duration of surgery and blood loss was significantly less in PFN-A group as compared to PFN. Functional outcome as assessed by Harris hip score was similar in both the groups. Implant related complications, though less in PFN-A group, had statistically insignificant difference.
**Conclusions:** It can be safely concluded that, in spite of no differences in functional outcome between the two groups, a shorter duration of surgery and less blood loss would still make PFN-A a better choice in such patients, especially the elderly and co-morbid/compromised patients.

**Keywords:** PFN, PFN-A, Harris hip score

## INTRODUCTION

Proximal femoral fractures are one of the most common fractures occurring in elderly due to osteoporosis and increase in life expectancy; and are associated with a high mortality rate of 5% after one month and 15% after six months.[1] With growing osteoporosis and life expectancy in the older population, the incidence of these fractures has nearly doubled in recent years. Non operative treatment of these fractures is obsolete nowadays and reserved only for patients unfit for surgery; as it is associated with serious complications.[2] Surgical treatment is now the accepted standard of management to obtain acceptable reduction and early mobilization in an elderly osteoporotic individual.[3] Because implant failure has disastrous consequences and revision surgery is a highly morbid process in these patients, obtaining a good fixation is of essential importance.[4]

Various implants are available for fixation of these fractures on basic principles of either intra-medullary fixation or extra-medullary fixation, but the debate regarding the ideal implant that would provide enduring fixation for such fractures, has continued to be a topic of on-going research for several years.

Intra-medullary fixation devices being a load sharing implant allow for early weight bearing than extra-medullary devices which are load sparing implants; and thus have become popular in elderly patients due to biomechanical advantages.

In this study, we compare two intra-medullary devices: proximal femoral nail (PFN) and proximal femoral nail-anti-rotation (PFN-A) used for the fixation of proximal femoral fractures.

The imperative goals of the treatment are: anatomic reduction, minimally invasive, stable fixation, early mobilization, normalized hip mechanism, and reduced hospital stay

Upgradation in nail design and material is still running on in search of best implant for proximal femur fracture. However, the latest one was PFN-A introduced by AO/ASIF in 2003, that is an intramedullary nail with helical blade [5].

This prospective study was performed to compare the functional outcomes and complications with the use of PFN and PFNA in treatment of proximal femoral fractures; and also assess their comparative performance in the setting of osteoporosis.

## METHODS

After obtaining approval from the institutional research board and informed patient consent, this study was conducted in the department of orthopaedics at a tertiary care hospital in South Rajasthan from January 2020 to June 2021, on a sample size of 30 patients. Patients 18 years of age and above, coming to the emergency/outpatient department (OPD) with inter-trochanteric fractures and confirmed radiologically with an X-ray, were included in this study. Patients with neurovascular deficit of the injured limb, poly-trauma patients with other injuries of the ipsilateral lower limb, patients with pre-existing osteoarthritis of hip, AVN of ipsilateral hip and with old mal-united hip fractures, were excluded from this study. Emergency management consisting of basic resuscitation, if required, was carried out in casualty. A detailed history was taken, systemic examination was done, and blood samples were sent for all routine pre-operative investigations.

The AO classification was used to classify fractures after obtaining X-ray of the pelvis with both hip joints, along with X-ray of the affected limb in anteroposterior and lateral view. Pre-operative radiograph of normal side was used to assess osteoporosis by Singh's index.

The patient was positioned supine on the traction table. The trunk was angled 15 degree towards the unaffected side. The affected lower limb was held in traction and adduction in the foot piece. Reduction was achieved by traction (disengaging fracture fragments) and internally rotating the limb while maintaining traction and was confirmed with image intensifier.

A 3 cm incision was made proximal to the tip of greater trochanter slightly bent dorsally. Skin, subcutaneous tissue and deep fascia was incised. Gluteus maximus was split by blunt dissection. The tip of greater trochanter was felt with finger. Reduction of the fracture is essential before making the entry point. After confirming the anatomical reduction, entry point was made with bone awl over the tip of greater trochanter. If the reduction was not anatomical, we manipulated the fragments by percutaneously passing the Steinmann pin and temporarily holding the reduction with 'k' wires driven along the anterior cortex in such a way that it did not interfere with the path of nail.

By confirming the position in AP and lateral view, the awl was driven just proximal to the level of lesser trochanter. The medullary canal was then reamed with appropriate sized reamers, and nail of appropriate length and diameter was inserted. Two proximal screws were inserted in PFN whereas one helical blade was used proximally in case of PFN-A.

The duration of surgery and blood loss was calculated and compared between the two procedures. Post-operative radiograph was used to assess quality of reduction and quality of fixation. Quality of reduction was assessed by comparing the neck-shaft angle of the operated hip, to that of a normal hip on the AP view. A variation of: less than 5 degrees from the normal side-excellent; between 5 and 10 degrees-good; and more than 10 degrees- poor.[4]

Quality of fixation was assessed using tip apex distance (TAD). The TAD is the sum of the distance from the tip of the screw to the apex of the femoral head on AP and lateral views. A tip apex distance <25 mm is protective of the screw cutting out of the femoral head and was considered adequate for both type of implants.[4] Functional outcome was assessed at final follow up post-surgery using Harris hip score. Any implant related complications during the follow-up period were documented for both group of patients. The implant related complications seen in patients with Singh's index ≤3 were also documented.

### *Statistical analysis*

Descriptive data was presented as mean, standard deviation (SD), proportions using contingency tables. Categorical data was analysed using Chi square test and t test. Quantitative data was analysed using student T test (paired and unpaired). P value below 0.05 was considered significant.

## RESULTS

30 patients of inter-trochanteric fractures were admitted in our institute from January 2020 to June 2021 with 15 patients being in each group. The average age of PFN group was 67.13 years and PFN-A was 72.67 and the

difference was statistically insignificant. In PFN group 40% of patients were males and 60 % were females, where as in PFN-A group 53.33 % were males and 46.67 % were females.

Most common mode of injury in both the groups was from fall (PFN-80% and PFN-A-66.67%) followed by RTA (PFN-20% and PFN-A-33.33%). Most common side involved in both the groups was right side (PFN-66.67% and PFN-A-53.33%). This may be due to dominant right side in our group of population. In our study 40% cases in PFN group and 53.33% cases in PFN-A group had significant osteoporosis (Singh's index≤3). In both the groups, most of the cases had AO type 31A2 fracture (PFN-53.33%, PFN-A-53.33%). The distribution is given in Table 2.

The average duration of hospital stay in PFN group was 4.47±1.19 as compared to PFN-A group 5.07±1.28, and the difference was statistically insignificant. The average blood loss in PFN-A group (112.67±26.58) was significantly lower as compared to PFN group (141.33±34.82). The average duration of surgery in PFN-A group (51.07±18.31) was significantly lower than PFN group (66.67±19.91).

On post-operative radiograph, the average tip apex distance in PFN and PFN-A group was 18.13±4.63 and 19.73±4.54 respectively, and it was statistically insignificant. In both the groups most of the cases had an excellent reduction (PFN-66.67%, PFN-A-73.33%). The distribution is given in Table. The difference in radiological parameters between both the groups was however statistically insignificant.

The functional outcome assessed by Harris hip score at final follow-up was similar in both the groups (PFN-76.13±9.44, PFN-A-77.93±9.92), and the difference was statistically insignificant.

Three implant related complications were seen in PFN group whereas only one implant related complication was seen in PFN-A group during the follow-up period. Out of the 6 patients with Singh's index ≤3 in PFN group, 2 patients suffered from complications; whereas out of 8 patients in PFN-A group, no patient had any complication. Among the three implant related complications seen in PFN group, 2 were due to screw back out and 1 was due to Z effect. The only implant related complication seen in PFN-A group was a "screw cut out" superiorly.

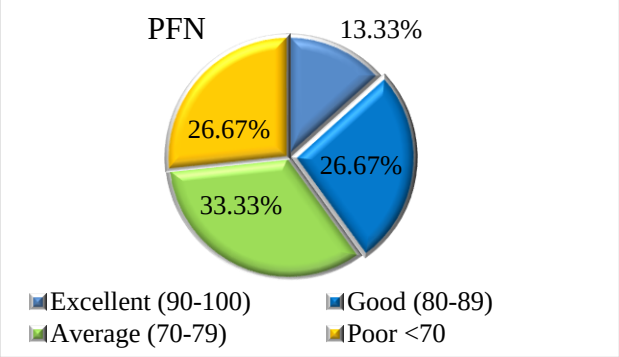


**Figure 1: PFN (Harris hip score).**

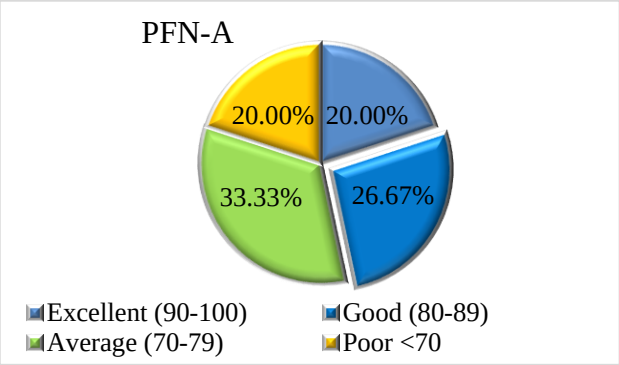


**Figure 2: PFN-A (Harris hip score).**

**Table 1: Demographic data.**

| Demographic data | PFN (n=15) | PFN-A (n=15) | P value |
|---|---|---|---|
| **Average age (in years)** | 67.13±13.32 | 72.67±12.43 | 0.25 (not significant) |
| **Gender distribution (%)** | | | |
| Males | 6/15 (40) | 8/15 (53.33) | 0.46 (not significant) |
| Females | 9/15 (60) | 7/15 (46.67) | |
| **Mode of injury (%)** | | | |
| Fall | 12/15 (80) | 10/15 (66.67) | 0.41 (not significant) |
| RTA | 3/15 (20) | 5/15 (33.33) | |
| **Side (%)** | | | |
| Left | 5/15 (33.33) | 7/15 (46.67) | 0.46 (not significant) |
| Right | 10/15 (66.67) | 8/15 (53.33) | |
| **Patients with significant osteoporosis (Singh's index ≤3) (%)** | 6/15 (40) | 8/15 (53.33) | 0.46 (not significant) |

**Table 2: AO classification.**

| AO type | PFN (%) | PFN-A (%) |
|---|---|---|
| **31A1** | 6/15 (40) | 5/15 (33.33) |
| **31A2** | 8/15 (53.33) | 8/15 (53.33) |
| **31A3** | 1/15 (6.67) | 2/15 (13.33) |

**Table 3: Intra op and post-op parameters.**

| Parameters | PFN (n=15) | PFN-A (n=15) | P value |
|---|---|---|---|
| **Duration of hospital stay** | 4.47±1.19 | 5.07±1.28 | 0.194 (not significant) |
| **Blood loss (ml)** | 141.33±34.82 | 112.67±26.58 | 0.0172 (significant) |
| **Duration of surgery (min)** | 66.67±19.91 | 51.07±18.31 | 0.033 (significant) |

**Table 4: Radiological parameters.**

| Radiological parameters | PFN | PFN-A | P value |
|---|---|---|---|
| **Tip apex distance** | 18.13±4.63 | 19.73±4.54 | 0.347 (not significant) |
| **Quality of reduction (%)** | | | |
| Excellent | 10/15 (66.67) | 11/15 (73.33) | 0.83 (not significant) |
| Good | 3/15 (20) | 3/15 (20) | |
| Poor | 2/15 (13.33) | 1/15 (6.67) | |

**Table 5: Harris hip score.**

| Functional outcome | PFN (%) | PFN-A (%) | P value |
|---|---|---|---|
| **Harris hip score** | 76.13±9.44 | 77.93±9.92 | 0.614 (not significant) |
| **Excellent (90-100)** | 2/15 (13.33) | 3/15 (20) | |
| **Good (80-89)** | 4/15 (26.67) | 4/15 (26.67) | |
| **Average (70-79)** | 5/15 (33.33) | 5/15 (33.33) | |
| **Poor <70** | 4/15 (26.67) | 3/15 (20) | |

**Table 6: Complications.**

| Parameters | PFN (%) | PFN-A (%) | P value |
|---|---|---|---|
| **Complications (implant related)** | 3/15 (20) | 1/15 (6.66) | 0.28 (not significant) |
| **Complications (in patients with Singh's index≤3)** | 2/6 (33.33) | 0/8 (0) | 0.14 (not significant) |


**Figure 3: (a) Case 1- patient operated with PFN-A; and (b) case 2- patient operated with PFN.**

**Table 7: Implant related complications.**

| Implant related complications | PFN (%) | PFN-A (%) | Total (%) |
|---|---|---|---|
| **Screw/blade cut-out** | 0 | 1 (100) | 1 (25) |
| **Screw back out** | 2 (66.67) | 0 | 2 (50) |
| **Z effect** | 1 (33.33) | 0 | 1 (25) |
| **Reverse Z effect** | 0 | 0 | 0 |
| **Implant breakage** | 0 | 0 | 0 |
| **Total** | 3 (100) | 1 (100) | 4 (100) |

## DISCUSSION

Trochanteric fractures occur mostly in elderly osteoporotic patients, and the outcome may be extremely poor if not managed properly. Anatomical reduction with stable fixation that allows early mobilization is the treatment of choice. The best treatment for trochanteric fractures is yet to be discovered. Intramedullary devices are currently used widely because of their mechanical and biological advantages. The objective of this study was to compare two intramedullary orthopaedic implants- PFN and PFN-A, widely used for the treatment of proximal femoral fractures.

A significant innovation in improving fixation in these fractures was that of a helical blade device.[4] The idea behind innovation of the helical blade was its biomechanical superiority in the setting of osteoporosis. The blade can be inserted without reaming, thereby preserving vital bone stock in the femoral head. During insertion, it compacts cancellous bone around it, providing a better purchase, with increased resistance to varus collapse and rotational stress.

In our study, the mean age of patients presenting with inter-trochanteric fractures in PFN group was 67.13 and in PFN-A was 72.67. The other studies also had similar age at the time of injury.

In our study there was a female pre-dominance (60%) in PFN group whereas in PFN-A group the male and female ratio was almost equal. Most of the studies showed female preponderance which might be due to post-menopausal osteoporosis, however in some studies there was a male preponderance owing to males being more active and mobile than females as in our Indian population.

The most common mode of injury observed in our study was due to fall in both the groups (PFN- 80%, PFN-A- 66.67%) followed by RTA, which was quite similar to the findings of other studies. Santharam et al in their study, reported maximum number of injuries due to fall (PFN- 65%, PFN-A- 55%) whereas RTA amounted to 35% and 45% respectively.[6]

Most common side involved in proximal femoral fracture was right side in both the groups which might be due to dominant right side in our group of population.

Most of the fracture type belonged to AO 31A2 in both the groups, followed by 31A1 and 31A3. Mittal et al in their study also observed that A2 fractures were the most common and were 59.09% in PFN group and 46.8% in PFN-A group. However, his study showed more cases in A3 group as compared to A1 group.[7]

In our study 40% patients in PFN group and 53.33% patients in PFN-A group had Singh's index ≤3. Sharma et al in their study had similar percent of patients (38.09% in PFN and 54.1% in PFN-A) with Singh's index ≤3.[4]

The mean operative time in our study in PFN group was 66.67±19.91 and PFN-A was 51.07±18.31. Mohan et al [(8)] reported mean operative time of 50 minutes in PFN-A which is quite similar to our mean duration of surgery in PFN-A group (51.07±18.31). In all other studies, the mean operative time observed was less in PFN-A group as compared to PFN group, however no study found the difference to be significant between the two groups. However, in our study, the difference in operative time between both the groups was significant ($p<0.05$).

In our study, the mean blood loss in PFN-A group (112.67±26.58) was significantly lower than PFN group (141.33±34.82). Other studies also showed similar results with mean blood loss being less in PFN-A as compared to PFN.

In our study, majority of patients in both the groups, had excellent reduction (66.67% in PFN group and 73.33% in PFN-A group). Sharma et al in their study had similar results as 71% patients in PFN group and 83% patients in PFN-A group showed excellent quality of reduction.[4] The criteria for quality of reduction has already been mentioned earlier.

In our study TAD ≥25 mm was seen in 2 patients (13.33%) in PFN group and 3 patients (20%) in PFN-A group. Sharma et al [(4)] in their study had 17.4% patients in PFN group with TAD ≥25 mm which was quite similar to our study (13.33%).

There was no statistically significant difference in the quality of reduction and mean TAD between both the groups in our study. Similar results were seen in studies of Sharma et al and Mallya et al.[4,9]

The difference in Harris hip score (PFN-76.13±9.44, PFN-A-77.93±9.92) in our study was statistically insignificant between the two groups (p value=0.614), a finding which was reported by most other researchers.

Sharma et al and Mittal et al in their respective studies, had HHS quite similar to that obtained in our study.[4,7]

In our study most of the patients in both the groups had HHS in the range of 70-79 (average) followed by 80-89 (good). Sharma et al in their study also had maximum number of patients in the same range in PFN group.[4]

Few implant related complications were seen in our study, with three being in the PFN group and only one in the PFN-A group. Most of the studies reported less complications in the PFN-A group when compared to PFN group, which was quite similar to the results obtained with our study.

Kumar et al in their study of 60 patients with 30 being in each group had 2 implant related complications in the PFN group and only one in the PFN-A group, while Mallya et al in their study of 78 patients with 41 being in the PFN group and 37 in the PFN-A group had 4 implant related complications in the PFN group and 2 in the PFN-A group.[9,10]

However, the difference in the implant related complications seen with our study was statistically insignificant (p value=0.28) which might be due to a smaller sample size of our study. Similar results were seen in other studies like Kumar et al and Mallya et al who also had insignificant p values (0.552, 0.256) respectively.[9,10]

Out of the 6 patients in the PFN group with Singh's index ≤3, 2 patients suffered from implant related complications whereas none of the patients in the PFN-A group with Singh's index ≤3 had any complications (0/8).

Similar results were seen in most of the studies, where less implant related complications were seen in PFN-A group as compared to PFN group in patients with Singh's index ≤3. Sharma et al in their study had 3 implant related complications in PFN group whereas PFN-A group had none in patients with Singh's index ≤3.[4]

Although, in our study no implant related complications were seen in PFN-A group in patients with Singh's index ≤3 and 2 implant related complications were seen in similar patients operated by PFN, yet the difference between both the two groups was statistically insignificant (p value=0.14). This might be due to less number of patients with Singh's index ≤3 in the PFN group.

Similar results were seen in study by Mallya et al where 4 implant related complications were seen in PFN group as compared to 2 in PFN-A group but the result was statistically insignificant.[9]

Out of the 3 implant related complications seen in PFN group, 2 were due to screw back out and 1 due to Z effect; where as the only complication seen in PFN-A group was due to screw/blade cut out.

Similar results were seen in other studies where screw back out was one of the most common implant related complication seen.

Mallya et al in their study had 2 patients with screw back out in PFN group similar to the result seen in our study. Sharma et al in their study also had 2 patients with screw back out.[4,9]

We found our results to be comparable with other studies in terms of the following parameters like surgical time, blood loss, radiological parameters and complications in patients with Singh's index ≤3.

## CONCLUSION

According to our study it can be safely concluded that PFNA has shown a better efficacy in terms of duration of surgery and blood loss. The implant related complications though were less in PFNA group as compared to PFN even in osteoporotic group; this difference was statistically insignificant. But in spite of no differences in functional outcome between the two groups, a shorter duration of surgery and less blood loss would still make PFN-A a better choice in such patients, especially the elderly and co-morbid/compromised patients.

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