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Comparison of Functional and Radiological Outcome of Inter-Trochanteric Femur Fracture Treated with Using Conventional Proximal Femoral Nail Vs Helical Blade Anti-Rotation Proximal Femoral Nail (PFNA2) in Elderly Patients

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KEYWORDS

Functional and Radiological, Conventional Proximal Femoral Nail, Helical Blade

ABSTRACT:

Background: The aim of this study is to compare the twin screw derotation type and the helical blade type of implants, in intertrochanteric fractures in a tertiary-level centre.

Methods: 48 patients with intertrochanteric fractures were operated with either standard proximal femoral nail (PFN) or proximal femoral nail anti-rotation (PFNA2) after randomly segregating them. Demographics, various operative parameters, outcome parameters, and complications were assessed. Osteoporosis treatment was provided to all patients.

Results: The mean follow-up was 6 months. The hospital stay and Harris hip score were similar in both groups, however the radiation exposure, surgical time, and blood loss were significantly less in the case of PFNA2.

Conclusion: Both PFNA2 and PFN are effective in treating unstable trochanteric fractures in terms of functional outcomes. However, PFNA2 is better because it requires less radiation exposure ($p<0.05$) due to single guide-wire use, a short learning curve, less blood loss, shorter surgical time($p<0.05$), and fewer complications. We suggest it to be the preferred implant in trochanteric fractures in the geriatric population and other age groups.

INTRODUCTION

Intertrochanteric fractures represent one of the most common types of hip fractures, particularly in the elderly population, and are associated with significant morbidity and mortality. With increasing life expectancy and an aging demographic worldwide, the incidence of these fractures has shown a steady rise. In the elderly, such injuries often follow trivial or low-energy trauma, whereas in young adults, high-energy mechanisms such as road traffic accidents are more frequently implicated.

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By definition, intertrochanteric fractures involve the proximal femur in the region spanning between the greater and lesser trochanters, and may extend proximally or distally depending on the fracture configuration. These injuries are extra capsular and are known for their complex biomechanics, often posing challenges in achieving stable fixation, particularly in unstable fracture patterns.

The management of intertrochanteric fractures has evolved considerably over the past few decades. While conservative treatment was historically employed, surgical stabilization has now become the standard of care, as it facilitates early mobilization and reduces complications related to prolonged immobilization, such as pressure sores, venous thromboembolism, pulmonary infections, and muscle wasting. Among the various fixation devices used, the dynamic hip screw (DHS) has been a traditional choice due to its controlled collapse mechanism and predictable results in stable fractures. However, unstable fracture configurations tend to have higher failure rates with extra medullary systems like the DHS.

Intra-medullary devices, such as the proximal femoral nail (PFN), were developed to address this limitation, offering rotational stability and better load-sharing biomechanics. Despite these advantages, complications such as implant breakage, femoral shaft fractures, and screw cut-out have been observed. To overcome these drawbacks, the Proximal Femoral Nail Anti-rotation (PFNA) was introduced, utilising a helical blade that enhances purchase in osteoporotic bone, thereby providing superior rotational and angular stability.

Considering these developments, the present study seeks to compare the functional and radiological outcomes of unstable intertrochanteric fractures treated with PFN and PFNA2, with the aim of determining whether newer implants offer a significant advantage over earlier generations.

Aim: The aim of this study is to evaluate and compare the functional and radiological outcome of twin screw de-rotation type (PFN) and the helical blade type (PFNA2) of implants, in intertrochanteric fractures in a tertiary-level centre.

Objectives:

- To assess the radiological and functional outcomes of treating intertrochanteric fractures with two different types of Proximal Femoral Nail (PFN).
- To compare the stability of fracture fixation and the feasibility of initiating early mobilisation in both the groups.
- To compare the clinical results of PFN with PFNA2 and come to a conclusion on the better method.

MATERIALS AND METHODS

The study was conducted in the Department of orthopaedics, BIMS teaching hospital, Belagavi. The study was prospective, randomised, comparative study. 24 patients were randomised to each group for the study depending on few inclusion and exclusion criteria. The study duration was of 1 and 1/2 yrs (December 2023-May 2025). Sample size all the cases fitting in the Inclusion and exclusion criteria visiting BIMS were included without any sampling.

Inclusion criteria

1) Patients >45 years of age with intertrochanteric femoral fractures with Boyd and Griffin types 1 to 4
2) Patient who is fit surgery.

Exclusion criteria

1) Fractures with non union changes
2) Old malunited intertrochanteric fracture
3) Patients with arthritic changes in hip joint
4) Previous surgery on proximal femur.
5) Patients with pathological fracture
6) Patient with both IT and neck of femur fracture
7) Patient with polytrauma

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Patients were followed up weekly for first month and then monthly for next 3 months, and at 6 months. Patients were followed up with both imaging and clinical examination to assess the interventional outcome. Postoperatively, Radiological assessment was done with X-rays showing change reduction quality criteria and Tip-Apex Distance(TAD). Functional outcome was assessed by Harris hip score and healing was assessed based on X-rays.

Pre-Operative Evaluation

Patients with trochanteric fractures who met the inclusion and exclusion criteria were enrolled in the study. Before subjecting the patients for investigations and surgical procedures written/informed consent was obtained from each patient, legal guardian. All individuals underwent the required clinical and radiological evaluations and were admitted to the ward after appropriate resuscitation, urinary catheterisation, and limb immobilisation using skin traction.

All participants were screened for associated medical comorbidities, which were managed as necessary. Concomitant injuries were also identified and treated simultaneously. Prior to surgery, every patient underwent a pre-anaesthetic evaluation, and once deemed fit, surgery was performed within 3-5 days (as early as possible). Fixation was then carried out with proximal femoral nail i.e. either PFN or PFNA2. Patients were randomly assigned into two groups by simple randomisation in the operating theatre using shuffled chits. Ethical and scientific clearance from the institutional review committee was obtained before commencing the study.

Proximal Femoral Nail Implant Details

The proximal femoral nail (PFN) system is composed of the following components: a main intra-medullary nail, a self-tapping 6.5 mm hip pin, a self-tapping 8 mm femoral neck screw, 4.9 mm distal locking bolts, and an optional end cap. The nail itself is manufactured from either 316L stainless steel, and it is produced in various sizes and configurations.

- Length options: Standard PFN – 250 mm; Long PFN – 340 to 420 mm
- Diameter choices: 9, 10, 11, and 12 mm
- Neck-shaft angles available: 125°, 130°, and 135°

The proximal portion of the nail has a diameter of 14 mm, providing additional implant stability. It incorporates a 6° mediolateral valgus angle, which plays a key role in preventing varus collapse, particularly in fractures with medial comminution. The distal shaft of the nail tapers to diameters of 9–12 mm and is designed with grooves that minimise stress concentration at its tip, thereby reducing the risk of a secondary fracture below the implant.

The proximal section features two insertion holes:

- The distal hole accommodates the 8 mm femoral neck screw, functioning as a sliding screw.
- The proximal hole accepts a 6.5 mm hip pin, which acts as an anti-rotation element.

At the distal end, two locking holes are provided for the insertion of 4.9 mm cortical bolts. One serves as a static screw, while the other can be used dynamically, allowing controlled dynamization of up to 5 mm.

In our study, we utilised the standard PFN with a length of 250 mm and distal diameters of 10, 11, or 12 mm. Each implant featured a proximal diameter of 14 mm, a 6.5 mm derotation screw, and an 8 mm lag screw. Distal locking was performed using self-tapping 4.9 mm bolts, applying both static and dynamic configurations to enable 5 mm of axial dynamization. The universal design of the nail incorporated a 6° mediolateral angulation and a neck-shaft angle of 135°. No end cap was used in the PFN group.

Proximal Femoral Nail (PFNA2) – Details

The Proximal Femoral Nail Antirotation (PFNA2) system is an intramedullary implant designed for the treatment of unstable intertrochanteric fractures. The assembly typically includes:

- The proximal femoral nail,

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- An 11 mm spiral blade for the femoral neck,
- A 4.9 mm distal locking bolt,
- An end cap for nail closure.

The nail is manufactured from either 316L stainless steel or titanium alloy and is available in varied dimensions:

- Length: Standard nail – 200 mm; other options include 170 mm, 240 mm, and longer versions ranging from 260 mm to 420 mm.
- Diameter: 9 mm, 10 mm, 11 mm, and 12 mm.
- Neck–shaft angle: 125° or 130°.

The proximal diameter of the nail is 17 mm, which enhances fixation stability. It also incorporates a 5° mediolateral valgus angle, enabling insertion through the tip of the greater trochanter. The design provides:

- One proximal slot for the insertion of the 11 mm spiral blade,
- One distal slot for the 4.9 mm locking bolt.

Locking can be performed in static or dynamic mode with the help of an aiming arm system.

Surgical Context

In our study, standard nails of 200 mm in length with distal diameters of 10 or 11 mm were primarily used. Patients selected for the procedure were those medically fit and radiographically confirmed to have unstable intertrochanteric fractures. Surgery was performed using a closed reduction and internal fixation technique with PFN devices.

Participants were randomly assigned into two groups using simple randomization:

1. Group A: Treated with Standard PFN
2. Group B: Treated with PFNA2

RESULTS

The mean follow-up was 6 months. The hospital stay and Harris hip score were similar in both groups, However the radiation exposure, surgical time, and blood loss were significantly less in the case of PFNA2.

Table 1: No. Of cases

Implant used	Number	Percentage
PFNA2	24	50
PFN	24	50
Total	48	100

No. Of cases- in total 48 cases were done which were equally divided in both groups.

Table 2: Age distribution

Implant used	Range	Mean	SD
PFNA2	56-86	71.8	14
PFN	58-89	71.2	17
P value	0.7877- Not significant		

Age distribution- The mean age of PFNA2 group was 71.8 years and of PFN group was 71.2 years

Table 3: Sex distribution

Implant used	Males	Females
PFNA2	14 (58.34%)	10 (41.67%)
PFN	16 (66.67%)	8 (33.34%)
P Value	0.8275 - Not Significant	

Sex distribution- 30 of the total cases were males and 18 women and they were divided among the 2 groups without any significant difference.,

Table 4: Time interval between injury and surgery

Implant used	Range	Mean	SD
PFNA2	3-7	4.3	1.98

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PFN	3-7	4.67	2.05
P value	0.64346- Not Significant		

Time interval between injury and surgery- All the included cases were fresh cases who underwent surgery at the earliest possible time I.e as soon as patient was medically fit.

Table 5: Functional outcome

Functional Outcome	**PFNA2**	**PFN**
Excellent	8 (33.34%)	6 (25%)
Good	14 (58.33%)	14 (58.33%)
Fair	2 (8.3%)	4 (16.67%)
Poor	0	0
P Value	0.24256 - Not Significant	

Functional outcome- based on Harris hip score - In our study, According to Harris Hip Scoring System (Modified), we had Good to excellent results in in 91.7%, Fair in 8.3 % . we had no case with poor results in PFNA2 group and we had Good to excellent results in in 83.34 %, Fair in 16.67 % . we had no case with poor results in PFN group with the difference being not significant.

Table 6: Average blood loss

Implant used	**Range**	**Mean**	**SD**
PFNA2	75-120	96.4	9.4
PFN	105-150	127.5	10.6
Total	<0.0001 Significant		

Average blood loss- In our study, the average blood loss was 96.4 ml in the PFN A2 group compared to 127.5 ml in the PFN group, showing a statistically significant difference

Table 7: Average surgical time

Implant used	**Range**	**Mean**	**SD**
PFNA2	45-75	59	8
PFN	58-90	72.9	10
Total	0.00342 Significant		

Average surgical time - In our study, the average surgical time was 59 mins in the PFN A2 group compared to 72.9 mins in the PFN group, which showed a significant statistical difference

Table 8: Complications

Implant used	**Present**	**Absent**
PFNA2	2 (8.3%)	11 (91.67%)
PFN	4 (16.67%)	10 (83.34%)
Total	0.1823 Not Significant	

Complications- 2 of the PFN cases had screw cut-out and the other 2 had surgical site infection. In the PFNA2 group 1 case had screw cutout and one more case had varus collapse.

Table 9: No. Of C-arm shoots

Implant used	**Range**	**Mean**	**SD**
PFNA2	35-47	39.8	5.6
PFN	18-31	25.3	4.9
Total	< 0.0001 Significant		

No. Of C-arm shoots- On checking the average number of shoots taken during the surgery showed a significantly less number of shoots in PFNA2 group when compared with PFN group.

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Table 10: Radiological Union (weeks)

Implant used	Range	Mean	SD
PFNA2	12-24	15.1	2.4
PFN	13-24	15.4	3.7
Total	0.4555 (Not Significant)		

Radiological Union (weeks)- On an average both groups showed radiological union at around 15 weeks.

Table 11: Hospital stay

Implant used	Range	Mean	SD
PFNA2	6-10	7.4	1.8
PFN	6-10	7.9	1.6
Total	0.3724 Not Significant		

Hospital stay- The duration of hospital stay in both groups were nearly 1 week with the difference in both group being non significant.

Clinical Cases

Case 1: Basvanni (61/M) Unstable fracture with Boyd griffin grade 2

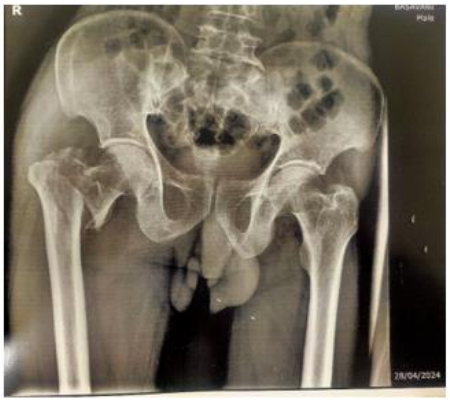

Figure 1: Pre- op Xray

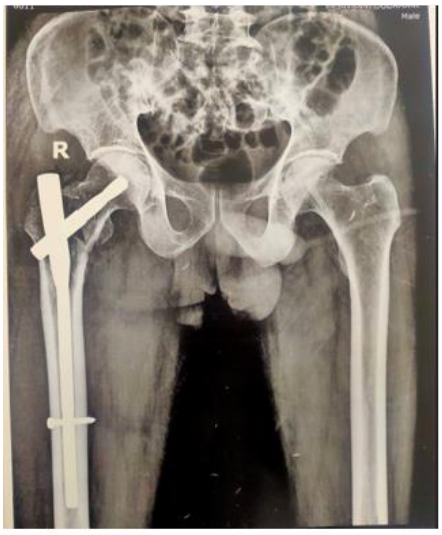

Figure 2: Immediate Post op X-ray

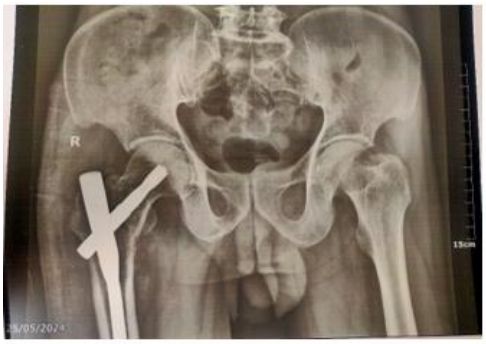

Figure 3: 1 month follow up X-ray

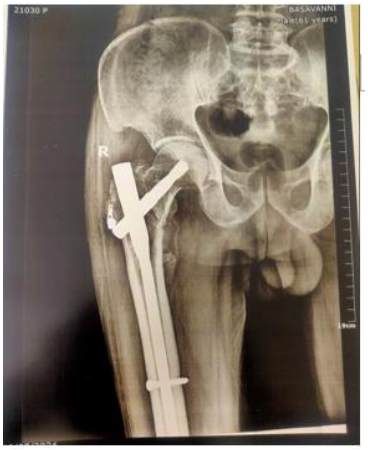

Figure 4: 3 months follow up X-ray

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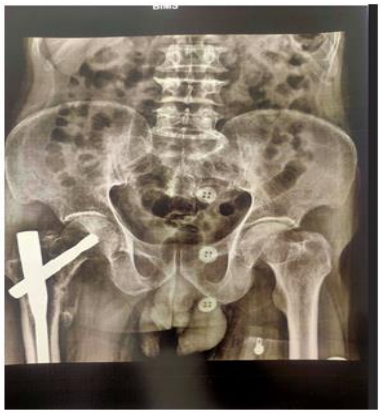

Figure 5: 6 months follow up X-ray

Figure 6: Squatting

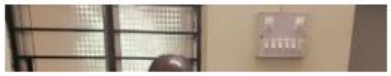

Figure 7: Sitting crossed leg

Figure 8: Flexion

Figure 9: Internal Rotation

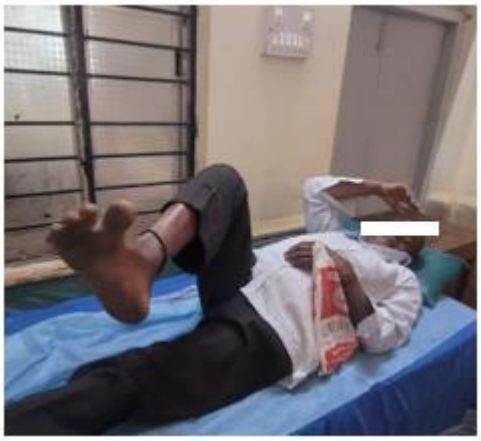

Figure 10: External Rotation

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Case 2: Unstable fracture with Subtrochanteric extension and was treated with long PFN

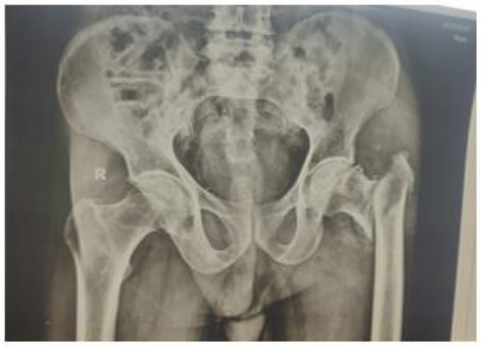

Figure 11: Pre- op Xray

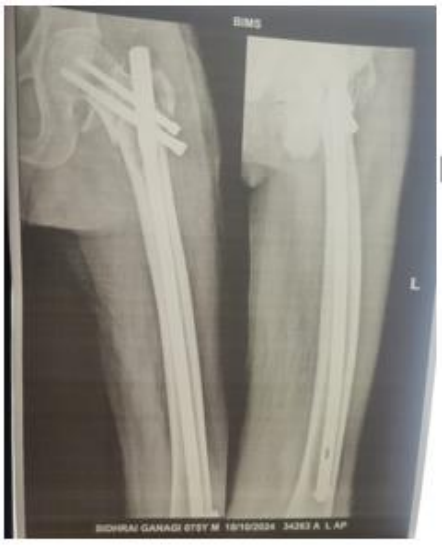

Figure 12: Immediate Post op X-ray

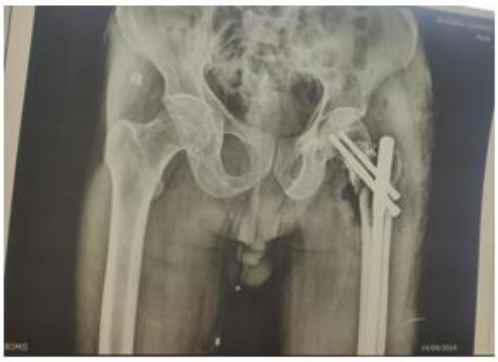

Figure 13: 1 month follow up X-ray

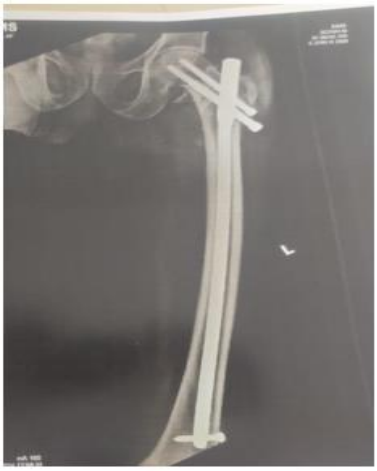

Figure 14: 3 months follow up X-ray

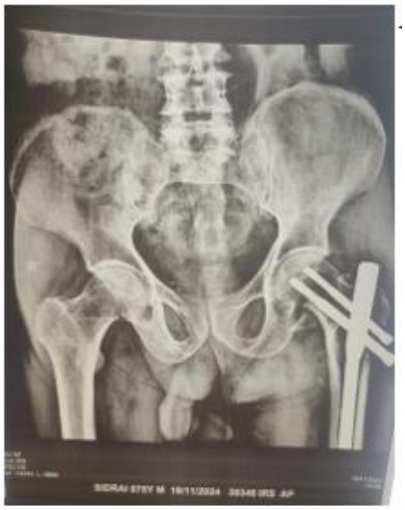

Figure 15: 6 months follow up X-ray

Figure 16: Abduction

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Figure 17: Flexion

Figure 18: Squatting

Figure 19: External Rotation

Figure 20: Internal Rotation

Figure 21: Sitting crossed leg

The management of intertrochanteric fractures of the proximal femur still presents certain challenges and occasional failures. These failures are often linked to neglect of biomechanical principles, unrealistic expectations regarding newer surgical techniques or implants, and inadequate compliance with well-established procedures. Due to the high concentration of stresses at the fracture site, exposure to multiple deforming forces, slower healing in elderly patients, and the frequently reported postoperative complications, surgeons must carefully evaluate the selection of the most appropriate implant. Currently, the most widely used fixation techniques are sliding hip screw systems and intramedullary devices. Mechanically, intramedullary fixation, especially when introduced

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using a minimally invasive approach, is often preferred in elderly patients. Closed reduction plays a vital role, as it preserves the fracture hematoma, which is essential for bone healing. Additionally, intramedullary implants limit soft tissue disruption, thereby reducing surgical trauma, intraoperative blood loss, risk of infection, and wound-related problems.

The Proximal Femoral Nail (PFN) is a more recent intramedullary implant, developed as an evolution of the gamma nail. Although the gamma nail has shown good results, clinical use has demonstrated notable drawbacks, including a steep learning curve and mechanical failures occurring in nearly 10% of cases, particularly at the lag screw–implant interface.

To address these concerns, the Arbeitsgemeinschaft für Osteosynthesefragen (AO/ASIF) designed the PFN in 1996. This device incorporates an antirotational hip pin together with a narrower distal shaft diameter, which helps lower stress concentration and reduce the risk of implant failure. The PFN combines all advantages of intramedullary fixation, including a reduction in the moment arm, possibility of closed insertion that maintains the fracture hematoma for optimized healing, decreased blood loss, and minimized risks of infection, soft tissue damage, and wound-related complications.

The PFNA2 is a newer modification of the proximal femoral nail (PFN) in which a spiral helical blade substitutes the traditional compression and anti-rotation screws. During insertion, the blade compacts the surrounding cancellous bone, creating superior stability and anchorage, particularly in osteoporotic bone. This design has been biomechanically demonstrated to reduce the risk of rotational movement and varus collapse. An additional advantage is that the PFNA blade achieves a precise fit through bone compaction while requiring less bone removal compared to conventional screws.

Experimental studies, such as that of Gotze *et al.* (1998), have shown that among osteosynthesis techniques for unstable per- and subtrochanteric fractures, the PFN is capable of withstanding the greatest mechanical loads. More recent research, including the work of Li *et al.* (2015), highlighted that the helical blade design of PFNA2 offers superior anchorage in both cancellous and cortical bone. This innovation increases the implant-bone contact area, enhances stability, and significantly lowers the risk of screw cut-out in unstable fracture configurations.

In our study, we aimed to evaluate and compare the functional and radiological outcomes of patients with intertrochanteric fractures who were surgically managed with either PFN or PFNA2.

In this study total of 48 patients operated for intertrochanteric fractures, out of which in 24 patients PFN A2 was used and in 24 patients PFN was used, mean age of patients in our study is about 71.8 yrs(56 – 86) in PFN A2 group and 71.2 yrs (58 -89) yrs in PFN group with average followup of 6 months. Out of 48, 30 were males and only 18 were females. However the males and females were also nearly equally divided in the 2 groups.

In 2012 Soucanye de landevoisin and E.Demortiere [16] study showed PFNA was best in treating intertrochanteric fractures. History, having shown the improvements in treatment of trochanteric fractures from non-operative management to operative techniques, the implants for operative techniques have been modernized based on the pros and cons of each implant being designed. Thus currently used intramedullary implants have been designed with combination of advantages of nails and compression devices/ sliding screws. The PFN A-II is also such a device designed to address the Asian population after learning so much from the previous devices.

In 2022 Yadav S, Dakshinamoorthy R.[2] Concluded that Both PFNA2 and PFN are effective in treating unstable trochanteric fractures in terms of functional outcomes. However, PFNA2 is better because it requires less radiation exposure ($p<0.05$) due to single guidewire use, a short learning curve, less blood loss, shorter surgical time($p<0.05$), and fewer complications. We suggest it to be the preferred implant in trochanteric fractures in the geriatric population and other age groups.

In this study statistical analysis revealed PFNA2 group had an average operation time of 59 mins (range, 45–75

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min), average intraoperative blood loss of 96.4 mL (range, 75 –120 mL), The Harris hip score included 8 excellent cases (33.34 %), 14 good cases (58.33%), 2 moderate cases (8.3%), and 0 poor cases when compared PFN group which had an average operation time of 72.9 mins (range, 58–90 min), average intraoperative blood loss of 127.5 mL (range, 105 –150 mL), The Harris hip score included 6 excellent cases (25 %), 14 good cases (58.33%), 4 moderate cases (16.67%), and 0 poor cases.

In the followups all the patients were not only assessed clinically but radiological assessment was also done. X-rays showed union at around 15-16 weeks mark. However in one of the PFN cases union was achieved late due to infection for which antibiotic beading was done. One more case of PFN group showed hip screw backed out, for which implant removal was done and bipolar hemiarthroplasty was done with bipolar prosthesis and SS wire.

Case- Hussainabi Desai 68yr/F - Surgical site infection with implant failure

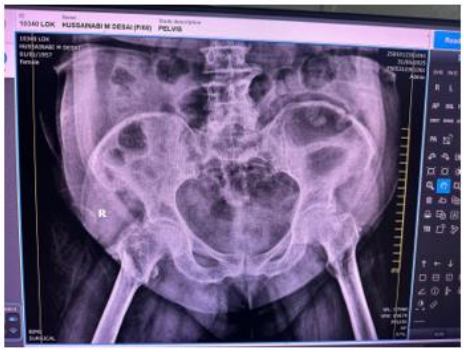

Figure 22: Pre-Op xray

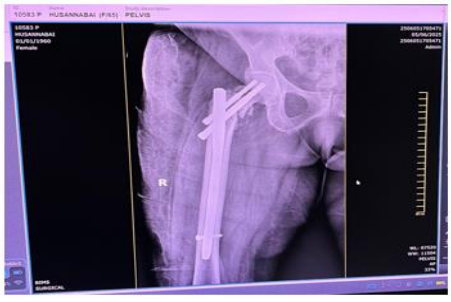

Figure 23: Immediate Post-Op xray

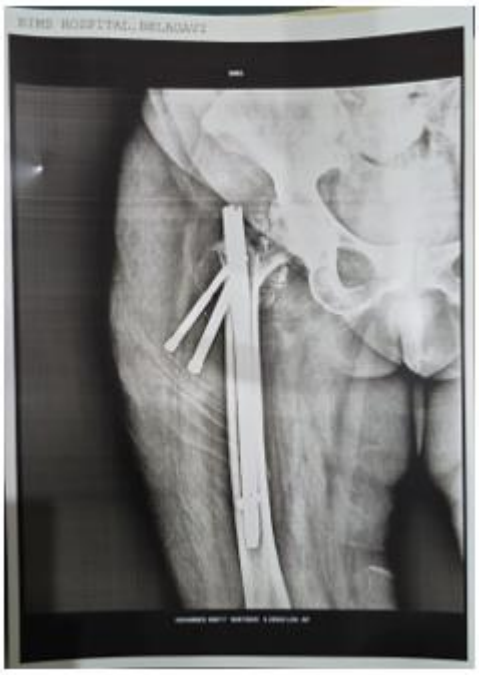

Figure 24: 1 month follow up- Implant Failure

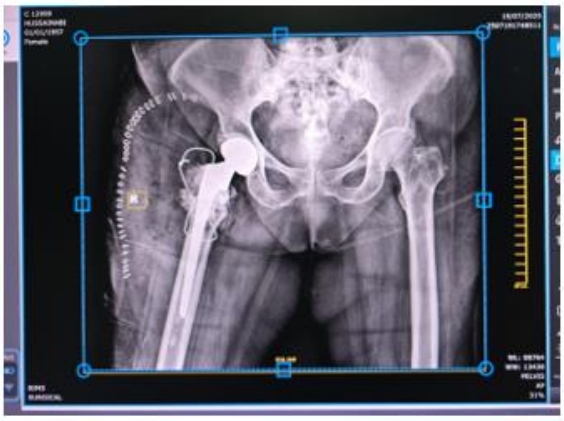

Figure 25: After hemiarthroplasty

CONCLUSION

Both PFNA2 and PFN are effective in treating unstable trochanteric fractures in terms of radiological and functional outcomes. However, PFNA2 was found to be better as it required less radiation exposure ($p<0.05$) due to single guide-wire use, a short learning curve, less blood loss, shorter surgical time($p<0.05$), and fewer complications (z effect, reverse z effect, collapse of

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fracture) when compared to PFN. Thus, we suggest it to be the preferred implant in trochanteric fractures in the geriatric population and other age groups.

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