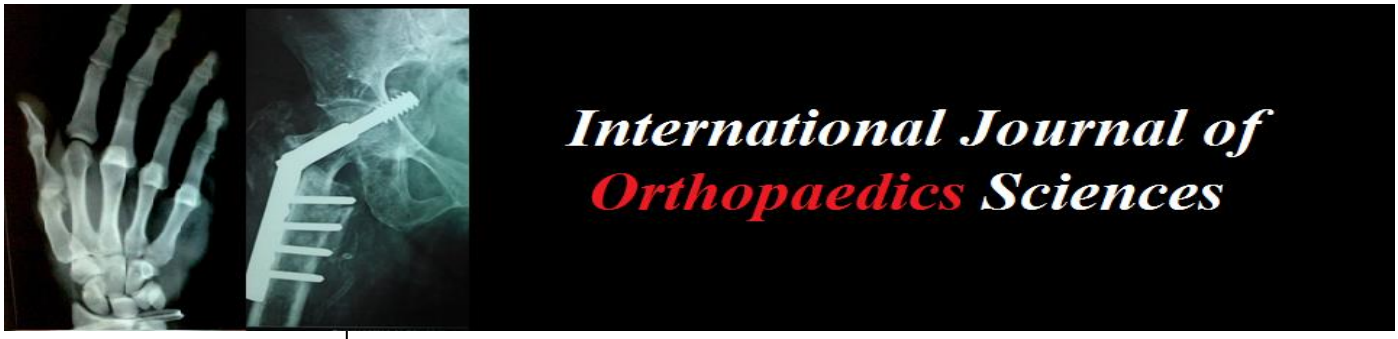

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Clinical and functional outcome of inter-trochanteric fractures in the elderly patients using Proximal Femoral Nail Anti-rotational-II (PFNA-II)

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Abstract
Introduction: Intertrochanteric fractures of the femur constitute nearly half of all the fractures around the hip and are known to be associated with long- term functional impairment, nursing home admission and increased mortality. Intertrochanteric fractures are routinely operated, which enables early recovery and faster rehabilitation of the patient. The choice of implant used in the management of intertrochanteric fractures has been a subject of debate, especially with the development of various devices over the years. The aim of present study was to evaluate clinical and functional outcome of intertrochanteric fractures in elderly patients using proximal femoral nail anti-rotation-II (PFNA-II).
Methods: The present study was carried out 30 patients to evaluate clinical and functional outcome of intertrochanteric fractures in elderly patients using proximal femoral nail anti-rotation-II (PFNA-II). On examination, presence of any tenderness, deformity, limb length discrepancy and range of motion were noted. Functional outcomes were assessed with the help of Harris Hip Score.
Results: The mean time to full weight bearing was calculated to be 9.5 (range 6-12) weeks. At final follow-up, half of the patients reported no pain in the hip while 11 cases had slight, occasional pain The mean time to union in our study was calculated to be 11.3 weeks. The mean range of motion at 6 months follow-up was 226 (range 175-270) degrees. The average Harris hip score was 90.6 (range 85-100). In this study, according to Harris hip score all patients were graded excellent or good scores
Conclusion: The present findings suggest that PFNA applied in elderly patients with inter-trochanteric fracture can get satisfactory effects, clinical outcome and a lower radiological complication rate.

Keywords: Hip, Intertrochanteric, PFNA-II, Harris hip score

Introduction
Hip fractures are among the most commonly encountered injuries. Epidemiological studies have shown an increasing incidence of these fractures as a direct result of increasing life expectancy. By 2025, the expected worldwide incidence of hip fractures is going to be 2.6 million and jump to 4.5 million by 2050 [1]. Asia is expected to share 37% of the disease burden by 2025 and almost 45% by 2050 [2]. These fractures remain a constant cause of high morbidity, reduced quality of life, and premature mortality among older adults [3, 4].
Hip fractures are serious fall injuries and are known to be associated with long- term functional impairment, nursing home admission and increased mortality [5]. As the population ages, the number of hip fractures is likely to increase which will ultimately increase the health care costs related to these injuries. More than 95% hip fractures are caused due to fall [6], most often by sideways low energy fall with impact onto the hip [7]. Out of those who fall, 20% to 30% suffer moderate to severe injuries such as hip fractures or head traumas that reduce mobility and independence, and increase the risk of premature death mostly caused due to complications of fractures [8].
Intertrochanteric fractures of the femur constitute nearly half of all the fractures around the hip caused by trivial trauma such as a fall from standing height. These are fragility fractures and occur mainly in a characteristic population with associated risk factors such as advanced age, female gender, osteoporosis, a history of falls, neurological impairment, diminished vision and gait abnormalities [9].

As these fractures are known to cause high morbidity and mortality, operative intervention is almost always recommended. However, often, these patients have pre-existing comorbidities which eventually dictate the treatment outcome [10]. Since, the intertrochanteric region is a rich metaphyseal bed, fracture union is the norm. Shortening and imperfect gait with mild residual discomfort, however, are not uncommon; and the 1-year mortality remains around 20% to 30% [9].

Intertrochanteric fractures can result from both high-energy as well as low-energy trauma. Majority of these fractures occur in the elderly after a simple fall [11]. In people younger than 60 years [12], who are predominantly men, these fractures are associated with severe trauma like road traffic accidents or fall from height.

Historically, these fractures were managed non-operatively with immobilization of the affected limb under traction. Nowadays, intertrochanteric fractures are routinely operated and this also enables early recovery and faster rehabilitation of the patient. The choice of implant used in the management of intertrochanteric fractures has been a subject of debate, especially with the development of various devices over the years. These implants can broadly be divided into two groups: extramedullary devices (fixed angle nail plate, proximal femoral locking plate, dynamic hip screw and Medoff plate), which are the more traditional ones, and intramedullary devices (trochanteric fixation nail, Gamma nail, reconstruction nail, proximal femoral nail, proximal femoral nail anti-rotation and proximal femoral nail anti-rotation-II), which have gained more popularity in recent times. However, the diversity of devices used for intertrochanteric fractures has made it challenging to identify the ideal treatment option. Thus, the optimal implant to be used in case of intertrochanteric fractures remains controversial.

The aim of this study was to evaluate clinical and functional outcome of intertrochanteric fractures in elderly patients using proximal femoral nail anti-rotation-II (PFNA-II), which is the latest addition in the long list of intramedullary implants designed to stabilize and treat intertrochanteric fractures with an aim to overcome most of the problems faced with the earlier versions.

Methods

The present study was carried out in the Post Graduate Department of Orthopedics, Bone and Joint Surgery Hospital, an associated Hospital of Govt. Medical College, Srinagar. In this study a total of 30 patients of inter-trochanteric fractures, managed with using proximal femoral nail anti-rotation-II (PFNA-II), who met the inclusion criteria were included from October 2019 to June 2021. The inclusion criteria were patients age above 60 years, Intertrochanteric fractures AO type 31-A1, 31-A2 & 31-A3. The patients with pathological fractures, patients with any other concomitant injury which could affect rehabilitation, patients with pre-existing neurological deficit of lower limb, patients with severe osteoarthritis of the hip, patients with >two weeks old fracture and patients with compound fractures were excluded from the study. After pre-operative assessment, the patients were taken up for surgery. A bolus dose of antibiotic (1.5-gram intravenous cefuroxime) was given half an hour before the surgery.

Surgical procedure

The surgeries were performed under spinal or general anesthesia as per the discretion of the anesthetist. The patients were placed in supine position on a traction table. Closed reduction of the fracture was performed under image intensifier control using standard reduction technique, or open reduction was done, if the closed reduction was not satisfactory. Neck-shaft angle reduced to 5° of unaffected side and fracture site displacement of 4mm was considered as satisfactory reduction. A 3-5 cm longitudinal skin incision proximal to the tip of the greater trochanter was given (Figure 1A). A parallel incision of the fasciae of the gluteus medius was given and the muscle was split in line with the fibers. Next, entry point was determined for the guide wire insertion. A 3.2mm guide wire was passed using a curved awl under C-arm guidance. After confirming the nail diameter, the femoral canal was enlarged to the desired diameter with serial medullary reamers with the 8.5 mm diameter reaming head, reaming to a diameter of 0.5 to 1.5 mm greater than the nail diameter. After connecting the PFNA II implant of the desired size to the insertion handle was inserted. Thereafter, appropriate aiming arm was mounted and fixed firmly to the insertion handle. The drill sleeve and trocar were inserted through the protection sleeve. Entire sleeve assembly was then advanced for PFNA II blade through the aiming arm to the skin. A stab incision in the area of the trocar tip was given. Sleeve assembly was inserted as far as the lateral cortex. Trocar was then removed. Next, the guide wire was inserted subchondrally into the femoral head at a distance of 10 mm below the joint level. The measuring device was advanced to the protection sleeve and length of the required blade was measured. If the guide wire's position was found to be subchondral, 10 mm were subtracted to measure the PFNA-II blade length correctly. Carefully, the drill sleeve was removed without changing the position of the guide wire. The cannulated drill bit was then pushed over 3.2mm guide wire. Next, the reamer was pushed over the guide wire to open the lateral cortex. Thereafter, PFNA-II blade was assembled with the impactor after unlocking the blade. Blade- impactor assembly was then inserted over the guide wire as far as possible into the femoral head. The PFNA-II blade was inserted up to the "stop" by applying gentle blows with the hammer. To lock the PFNA-II blade, the impactor was turned clockwise. PFNA-II blade locking was verified intraoperatively. The PFNA-II blade gets locked if all gaps are closed. A stab incision was given and the drill sleeve assembly was inserted for the distal locking through the static or dynamic locking hole on the aiming arm to the bone. Next, the locking bolt was inserted through the protection sleeve using a large hexagonal screwdriver. The end cap was inserted over the guide wire and locked with the help of cannulated screwdriver. Finally, hemostasis was achieved and wound closed in layers. Antiseptic dressing was applied and patient shifted to the
observation ward.

Post-operative protocol and follow-up

All the patients were mobilized and explained the rehabilitation protocol before sending them home. Patients were advised for toe-touch weight bearing mobilization using crutches or walking frame, range of motion exercises and quadriceps strengthening exercises and ankle pump exercises. The patients were closely followed at 2, 6 weeks, 3 and 6 months post-operatively. For stable fractures, toe-touch weight bearing mobilization was started immediately, partial weight-bearing after the second post-operative week and full weight bearing at 6 weeks depending on the radiological assessment. In case of the unstable fractures, toe-touch weight

bearing mobilization was also started immediately. Partial weight-bearing on the affected limb was allowed after 6 weeks and full weight-bearing at 12 weeks when there was a bridging callus formed as evident on the follow up radiographs. At the final follow-up patient was assessed for pain, limp, use of support for walking, distance patient was able to walk and functional activities. Radiographs were assessed for union, implant position and neck–shaft angle. On examination, presence of any tenderness, deformity, limb length discrepancy and range of motion were noted. Functional outcomes were assessed with the help of Harris Hip Score.

Results

The mean age of the patients was 72.3 (range 63-86) years. There were 14 (47 %) male patients and 16 (53 %) female patients with male to female ration of 1:1.1 ration in this study. Maximum number of patients 14 (47 %) was in the age group of 61-70 followed by the 71-80 age group with 12 (40 %) patients. In the present study, majority of patients 20 (67 %) sustained an intertrochanteric fracture after a simple fall from standing height. 16 (53 %) patients had right side involvement and 14 (47 %) had left side involvement. In the present study, almost half the patients 14(47 %) had sustained AO 31-A2 type of intertrochanteric fracture. AO 31-A3 type fractures were second most common comprising in 9 (30 %) cases (Table 1). Exactly one half of the patients in the study had underlying hypertension and only a few were noncompliant to treatment. Diabetes was the second most common ailment found in the patients in the study. Around 17% had hypothyroidism and another 17% suffered from some cardiac issues. In aggregate, 53% patients had one or more underlying medical condition for which patient optimization was done prior to the procedure.

Table 1: Demographic characters of patients

Demographic characters	No. of patients	Percentage
Gender		
Male	16	53
Female	14	47
Age group		
61-70 Years	14	47
71-80 Years	12	40
>80	4	13
Mode of injury		
Simple fall	20	67
Fal from height	7	23
Road traffic accident	3	10
Side		
Right	16	53
Left	14	47
AO Fracture type		
31-A1	7	23
31-A2	14	47
31-A3	9	30
Reduction method used		
Closed	24	80
Open	6	20

The mean interval between the time of admission and surgery was calculated to be 5.9 days. The mean duration of hospital stay in our study was 8.5 days. Mean operation time was calculated to be 62.5 minutes. The mean blood loss was calculated as109.2 ml. The mean fluoroscopy time was calculated to be 70 seconds.

The mean time to full weight bearing was calculated to be 9.5 (range 6-12) weeks.

At final follow-up, half of the patients reported no pain in the hip while 11 cases had slight, occasional pain without jeopardizing their routine activities. However, 10% of the patients claimed to feel pain after engaging in more than activities of daily living. Also, one patient had moderate pain which required sporadic intake of pain-relieving medication. 60% of the patients at final follow-up were walking normally, similar to their pre- injury status. 11 had slight limp on walking and only one had moderate limp.

The mean time to union in our study was calculated to be 11.3 weeks. The mean range of motion at 6 months follow-up was 226 (range 175-270) degrees. 6 (20 %) patients in our study had a shortening on the affected side, only 1 (3 %) among them had a shortening of 2 cm or more. 2 (6 %) of the patients had a varus malunion.

The complications encountered in this study are depicted in table 2.

Table 2: Complications

Complication	No. of patients	Percentage
Moderate hip pain	1	3%
Limb shortening	6	20%
Superficial wound infection	1	3%
Helical blade back-out	1	3%
Hardware irritation	1	3%
Knee stiffness	2	7%

The average Harris hip score was 90.6 (range 85-100). In this study, according to Harris hip score all patients were graded excellent or good scores (Table 3).

Table 3: Results according to Harris hip score

Grade	Score	No. of patients	percentage
Excellent	90-100	15	50
Good	80-89	15	50
Fair	70-79	0	0
Poor	<70	0	0

Discussions

The intertrochanteric fracture of proximal femur is a major public health problem globally, especially in the elderly population. Indian population is naturally at a higher risk of sustaining hip fractures due to increased incidence of osteoporosis [13]. As many as half of the women and one in three Indian men above the age of 50 have a low bone mass [14]. Hip fractures are common in this group of population 50% of hip fractures in elderly patients are intertrochanteric fractures [15]. These fractures lead to, not just, physical impairment, reduced quality of life, but also cause significant mortality. Management of such fractures aims to achieve early union and mobilization of the patient where some form of internal fixation is the method of choice [16].

Commonly used internal fixation devices for intertrochanteric fractures are of two types: extra-medullary and intra-medullary. Dynamic hip screw (DHS), which is an extra-medullary device has long been an implant of choice or gold standard in the management of intertrochanteric fractures. Nowadays, the treatment options for intertrochanteric fractures are diverse and have constantly been evolving over the years. Several fixation methods are available to the surgeon. The treatment, however, is guided by the type of the fracture and the quality of the bone. While DHS has uniformly given good results in the management of stable inter- trochanteric fractures [17], in unstable intertrochanteric

fractures (AO Type 31A2 and Type 31A3) it has a higher incidence of cut-out failure (6% to 19%) [18, 19]. On the other hand, an intramedullary device with a shorter lever has better biomechanics which provides more load sharing and limits the collapse at the fracture site [20]. The proximal femoral nail anti-rotation (PFNA), a modification of proximal femoral nail (PFN), was introduced in 2003, which features a helical blade. Biomechanical cadaveric studies demonstrated that PFNA fixation using a helical blade was better compared to the sliding hip screw. PFNA had both rotational as well as angular stability and also an improved purchase in the osteoporotic bone due to the bony impaction it achieved in the femoral head and neck [21].

However, PFNA was designed for the Caucasian population and therefore had several shortcomings in the treatment of Asian patients with a different femoral geometry [22]. Serious complications occurred when PFNA was used for Asians [23] and that led AO/ASIF to design a new proximal femoral nail anti-rotation Asia (PFNA 2) [24]. In the present study, a total of 30 elderly patients with age above 60 years and good pre-injury ambulatory status were chosen and treated with PFNA-II.

The mean age was 72.3 years. For men, the mean age was 70 years whereas it was slightly more at 74.4 in women. Studies done by Kasha *et al*. [25] and Shin *et al*. [26] had patients with similar mean age, 69.4 and 74 respectively.

There were an almost equal number of male and female patients included in the study, 14 men and 16 women. This is different than most other studies where women significantly outnumbered the men. The female: male ratio was uniformly greater than 1.5: 1 in studies done by Sadic *et al*. [27], Kasha *et al*., Kumar GN *et al*. [28] and Shin *et al*. The reason for this disparity could be that though the incidence of hip fracture, including intertrochanteric fractures, in elderly women is more than that in their male counterparts, not every patient that was admitted in our hospital was treated with PFNA 2 and a set of inclusion and exclusion criteria were used before patient selection. However, there was a female predominance in patients above 75 years of age which is consistent with several other studies.

In the present study, right sided fractures (53.3%) were slightly more compared to left (46.7%). This is similar to studies carried out by Macheras *et al*. [29] (54.6%), Kasha *et al*. (53.8%) and Harshwardhan *et al*. [30] (53.3%). However, as the sample size in our study was small, the right sided predominance could be purely coincidental.

Intertrochanteric fractures are fragility fractures and the main mechanism of injury is a simple fall from standing height in an elderly person. 67% patients in the present study sustained an intertrochanteric fracture following a fall onto the hip. Likewise, a low energy trivial trauma was responsible for the injury in majority of the cases in other studies such as those by Li M. *et al*. [31] (76%).

Majority of the patients (60%) included in our study had an unstable fracture pattern. Study done by Gavaskar *et al*. [32] (68%) had a similar proportion of unstable intertrochanteric fractures. Most of the cases (47%) in our study belonged to the A2 group. The higher number of unstable pattern fractures could be attributed to the preference for DHS in stable intertrochanteric fractures.

50% of our patients had underlying hypertension. Diabetes and hypothyroidism were among the other common medical conditions, the study patients suffered from. Around 66% patients were also found to have medical comorbidities in the study by Macheras *et al*., with most of them being hypertensive.

The operative time in the present study was calculated from the time of skin incision to closure and ranged between 30 min to 105 min. The mean duration of the procedure was, however, 62.5 min. Factors such as the fracture pattern and the experience of the operating surgeon determined the time consumed in the surgery. Closed reduction was achieved in 24 of the patients while the remaining 20% required minimal opening of the fracture site.

A learning curve was noticed and the procedure time also reduced as the number of cases increased. The first ten patients had a mean operative time of 68.5 min which gradually decreased as the experience with the implant improved and the last ten patients had a considerable drop in mean operative duration (54.5 min). Gill *et al*. [33] in a study of 62 patients also recorded an average time of 61.4 min which is comparable to our study. Another intraoperative parameter measured was the volume of blood lost during the surgery by an indirect method of counting the number of gauze pieces used. While the blood lost was in excess of 200ml in 4 of the patients, the mean blood loss was found to be 109.2ml as almost half of the study patients lost less than 100ml of blood during the procedure. Harshwardhan *et al*. (110.8 ml) and Gill *et al*. (103.9) had almost similar values in their studies.

In this study 3% of our patients developed superficial wound infection. This is slightly higher compared to study done by Kripalani *et al*. [34] (1.8%).

The average time to union in our study was found to be 11.3 weeks. This is similar to results seen in the study by Harshwardhan *et al*. and comparatively better than those by Kasha *et al*. (14.2 weeks) and Kripalani *et al*. (13.7 weeks).

The mean Harris Hip Score at final follow up was found as 90.6 which is considered excellent. Other studies have also reported excellent or good results with PFNA-II in their patients.

Conclusion

The present findings suggest that PFNA applied in elderly patients with inter-trochanteric fracture can get satisfactory effects, clinical outcome and a lower radiological complication rate.

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