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Original Research Article

# Comparison of Intramedullary and Extramedullary Fixation Devices in Unstable Trochanteric Fractures

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**Abstract:**

**Objectives:** The main objective of the study was to compare functional outcome and complications associated with a proximal femoral nail, an intramedullary device with those of a traditional extramedullary device, the dynamic hip screw, in patients with unstable trochanteric fracture.

**Method:** In this prospective, randomized study, total of 86 patients were randomized to the intramedullary group [Group A (n = 40)] or the extramedullary group [Group B (n = 46)]. All relevant perioperative information and complications were recorded, and assessments of functional outcome were made.

**Results:** The extramedullary group required a longer operative time ('p' value 0.001) and was associated with greater blood loss ('p' value 0.002) than the intramedullary group. The re-operation rate as well, was lower in the group A compared with the group B, although there were no statistically significant differences in the overall complication rate between the two groups ('p' value 0.221). There were no significant differences in functional outcome between both groups.

**Conclusions:** The intramedullary device is useful in the treatment of unstable trochanteric fractures.

**Keywords:** Proximal Femoral Nail, Dynamic Hip Screw, Unstable Trochanteric Fractures.



## Introduction

It has always been a controversial point of discussion when it comes to the management of unstable trochanteric fractures. Trochanteric fracture of the femur is common in the geriatric population, often associated with generalized physical deterioration. Several fixation devices have been developed to overcome the difficulties encountered in the treatment of unstable trochanteric femoral fractures. Despite enormous improvements in the operative management of such patients, the morbidity rate is still high in geriatric group. [1]

Several implant designs have been developed in an attempt to aid fracture fixation, facilitate early ambulation and reduce the risk of complications with improved functional outcomes when treating these trochanteric fractures. [1-3] Implants can be divided into two groups – extramedullary and intramedullary devices. There is, however, a lack of definitive clinical evidence on whether one type of device should be preferred over the other. Extramedullary device performed less well in unstable trochanteric fractures, with high rates of failure. [4-7,9] PFN, since its introduction in 1997, in several clinical studies [7-10] have shown good results with few intra-operative problems and a low rate of complications.

PFN was developed to improve the rotational stability of the proximal fracture fragment with additional advantage of an unreamed intramedullary femoral nail with an antirotation and load-bearing, femoral neck screws.

Biomechanical studies have shown that intramedullary devices are more stable under loading, [11] although associated with more reoperation rates as shown in few studies. [12] Furthermore, the tip of the nail was redesigned to decrease the risk of intra and post-operative fractures of the femoral shaft by a significant reduction in bone stress. [13]

The clinical relevance of the presumed advantages and lower complication rates are still to be established. Many trochanteric fractures are still treated with a long plate sliding hip screw or other extramedullary devices. This study was designed to compare functional outcome and complications of the PFN device with those of a traditional extramedullary device, the dynamic hip screw (DHS), in patients with unstable trochanteric fracture.

## Material and Methods

In this prospective study, all consecutive patients with trochanteric femoral fractures having an unstable pattern, of either sex between 20 to 60 years of age were randomized to undergo fixation with the DHS or the PFN device between August 2014 and July 2015 at Orthopaedics Department of Indira Gandhi Institute of Medical Sciences, Patna, Bihar. Patients with a pathological fracture, fractures extending more than 5cm in sub trochanteric region, inability to walk before the fracture, other fractures interfering with rehabilitation, neurological disorders, multiple injuries (polytrauma), and dropped out patients during the study period were excluded. Informed written consent from patient was obtained prior to their inclusion in study.

Plain radiographs were obtained on admission and all fractures were categorized according to AO/ASIF classification14 (31-A1.1, A1.2, A1.3 and 31-A2.1 are stable trochanteric fracture and 31-A2.2, A2.3 and all 31-A3 are unstable trochanteric fracture).

**Table 1: Salvati and Wilson scoring system of Hip Function**

| Characteristic | Scores |
|---|---|
| **Pain** | |
| All the time; unbearable; strong medication frequently required | 0 |
| All the time, but bearable; strong medication occasionally required; salicylates frequently required | 2 |
| None or little at rest; with activities; salicylates frequently required | 4 |
| On starting activity, then better; after a certain activity; salicylates occasionally required | 6 |
| Occasional and slight | 8 |
| No pain | 10 |
| **Walking** | |
| Bedridden | 0 |
| Wheelchair | 2 |
| Walking frame | 4 |
| One stick; limited distances up to 400 yards | 6 |
| One stick; long distances | 8 |
| Unaided and unrestricted | 10 |
| Muscle power and motion | |
| Ankylosing and deformity | 0 |
| Ankylosing with good functional position | 2 |
| Poor muscle power; flexion < 60°; abduction < 10° | 4 |
| Fair muscle power; flexion 60 – 90°; abduction 10 – 20° | 6 |
| Good muscle power; flexion > 90°; abduction > 20° | 8 |
| Normal muscle power; full range of movement | 10 |
| **Function** | |
| Bedridden | 0 |
| House-bound | 2 |
| Limited housework | 4 |
| Most housework | 6 |
| Very little restriction | 8 |
| Normal activities | 10 |

Data was compiled using MS office Excel 2020 and statistically analysed using SPSS version 22. For non-parametric distribution, Mann-Whitney U Test, Chi - square tests were used and parametric data was compared using Independent samples t test. A P-value of < 0.05 was considered to be statistically significant.

## Results

There were a total 86 patients in the study. Of these, 40 were randomised to intramedullary fixation by PFN and 46 to extramedullary fixation by DHS.

A total of 86 patients with unstable trochanteric femoral fractures were included in the study between June 2016 and November 2017. Of these, 40 were randomized to the PFN group (group A) and 46 to the DHS group (group B). The mean age was 46 years in group A (range 26 – 60 years) and 47 years in group B (range 24 – 60 years). The gender distribution was 65% women and 35% men in the group A, and 54% women and 46% men in the group B.

The mean ± SD operative time was significantly longer in the group B (84.89 ± 14.96 min) than in the group A (65.37 ± 11 min) ($P < 0.05$), whereas the mean ± SD fluoroscopy time was significantly longer in the group A (3.38 ± 1.96 min) compared with the group B(2.35 ± 0.75 min) ($P < 0.05$). The mean ± SD external blood loss during surgery was significantly lower in the group A (62 ± 8.2 ml) compared with the group B (188 ± 37.17 ml) ($P < 0.05$). The mean length of hospital stay (11 days) did not differ statistically between the two treatment groups or with the different type of fracture. No statistically significant differences were found in the complication rate between the two treatment groups (Table 2). For fractures in the group B, one wound infection required antibiotics and one patient required reoperation due to breakage of the implant. In group A, one patient had a superficial wound infection that did not require re-operation and responded nicely to antibiotics, and two patients in the group B required secondary surgery, one for implant failure (Fig. 1) and another for non-union. No proximal or distal femoral fractures were noted in the group A patients. Functional outcome assessed using the Salvati and Wilson scoring system in the two treatment groups is shown in Table 3. There were no statistically significant differences between the two groups. Fig. 1 shows the pre and postoperative radiographs of a 40-yearold man with an A2-type trochanteric fracture. The radiographs for this patient demonstrated that the screws were well positioned postoperatively at 4 months and that there was consolidation without deformity at 1-year follow up.

**Table 2: Complications in Patients with Unstable Trochanteric Fractures Treated with PFN or DHS**

| Complication | PFN (n=40) | DHS (n=46) |
|---|---|---|
| Femoral shaft fracture | - | - |
| Non- union | - | 1 |
| Cut- out | - | 1 |
| Migration of screw | - | - |
| Breakage of Implant | - | 1 |
| Deep vein thrombosis | - | - |
| Wound Infection | 1 | 1 |
| **Total** | 1 | 3 |
| Data show numbers of patients. No statistically significant differences between the two treatment groups or for different types of fracture. | | |

**Table 3: One year Follow up Salvati and Wilson Scores in patients with unstable trochanteric fracture treated with PFN or DHS**

| **Treatment** | | | **Salvati and Wilson score** | |
|---|---|---|---|---|
| **Excellent (≥32)** | | **Good (24-31)** | **Fair (16-23)** | **Poor (≤15)** |
| **Group A (PFN) n=40** | 26 | 9 | 4 | 1 |
| **Group B (DHS) n=46** | 27 | 13 | 2 | 4 |
| Data show numbers of patients. No statistically significant differences between the two groups. | | | | |

**Figure 1: Radiograph of a dynamic hip screw for the treatment of an unstable trochanteric fracture, showing cut out of Richard screw at 3 months**

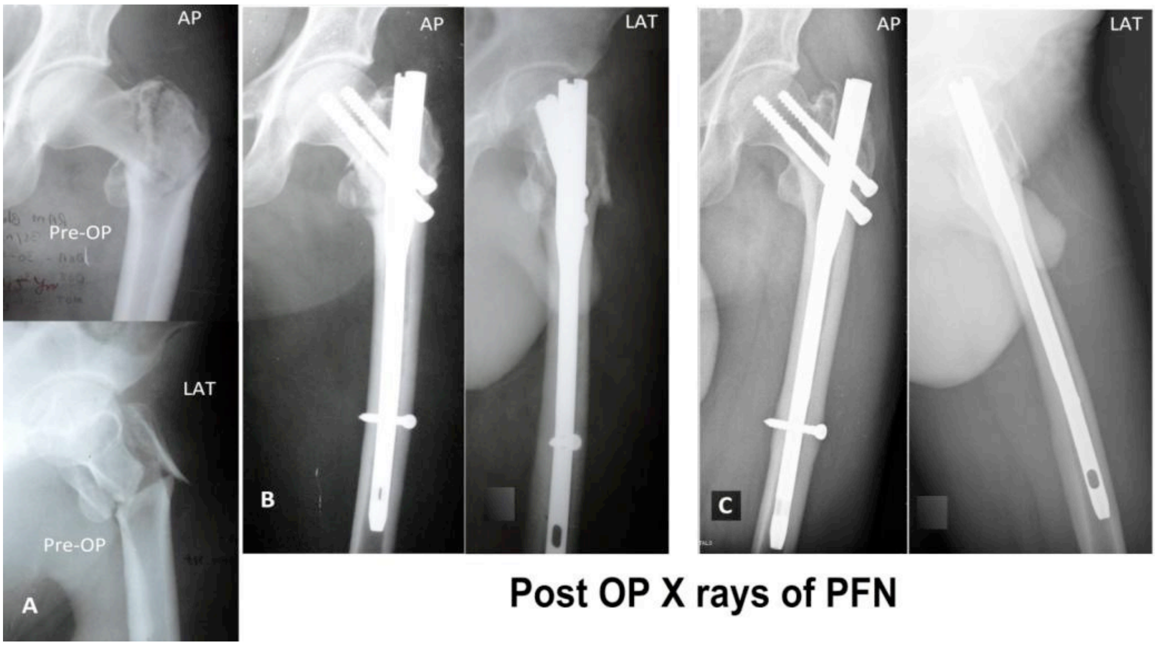


**Figure 2: Radiographs of a 40-year old man with an A2-type trochanteric fracture: (A) pre-operatively; (B) 4 months after the operation; (C) 1 year after the operation**

## Discussion

It has been a matter of debate for over a decade regarding ideal management plan to treat unstable trochanteric fractures. The successful treatment of trochanteric fractures depends on many factors, including the patients factor (age, general health, time from fracture to treatment, comminution, bone quality, concurrent medical treatment), surgeon factor (competency, stability of fixation) and the implant factor [11]. Discussion about the ideal implant for the treatment of trochanteric fractures continues, mainly due to the fact that there is insufficient knowledge on the biological and biomechanical factors that lead to the uneventful healing of this type of fracture in patients, most of whom are elderly. Amongst the currently available devices, all have their advantages and disadvantages.

The DHS, initially introduced in 1964, remained the implant of choice for the treatment of trochanteric fractures for a very long time till intramedullary implants were introduced, because of its favourable outcomes. Working on the principal of controlled compression at the fracture site, the DHS has achieved a low rate of non-union and fixation failure [17]. A disadvantage with DHS placement is that it requires a relatively large exposure and excessive soft tissue stripping. Being an extramedullary implant the screws and side plate create stress risers in the bone that increases the risk of fracture distal to the implant [18,19]. Whereas PFN being an intramedullary implant can withstand higher static and cyclical loading as compared to an extramedullary implant (DHS). The proximal femoral nail has lower incidence of shaft fracture distal to the implant as result of stress riser by virtue of having a smaller distal shaft diameter, which reduces stress concentration at the tip.

Another important complication is cut-out of the screw most commonly seen in osteoporotic bones [20,21] possibly as the result of varus deviation and rotation, most often seen in communited/ unstable fracture pattern apart from poorly performed procedures. Cut out of the screw mostly occurs in the superomedial quadrant of the femoral head which in many anatomical and biomechanical studies have shown to be the weakest part for the implant [22-23]. These patterns of fixation failure are most often seen in DHS, which is mostly due to insufficient purchase of the implant in the femoral neck and lack of rotational stability. Surgical fault responsible for this failure is not following the tip apex distance concept. The ideal implant for the treatment of unstable trochanteric fractures is an easily inserted, intramedullary device that allows for controlled impaction across the fracture zone while preventing fracture site rotation [24]. Neck screws of the device must achieve sufficient purchase in the femoral head in order to delay or resist cut-out.

Some studies have suggested that rotation of the head/neck fragment appears in all types of head holding devices in these fractures, so hampering the progress of this rotation until fracture healing has occurred seems to be the issue to be solved [24]. The presence of a second proximal neck screw in PFN may increase rotational stability of the cervico-cephalic fragments [25]. Intramedullary fixation of unstable trochanteric fractures with an intramedullary fixation device (PFN) might, therefore, be a better method of treatment. It is indicated in some studies that intramedullary devices helps in facilitating early postoperative rehabilitation [3,26].

In DHS, the greatest dynamic effect producing controlled collapse at the fracture site occurs in the early postoperative period if the weight bearing is allowed and this change in the fracture position can affect early walking ability, especially in unstable fracture patterns in trochanteric area. Another reason for delayed post-operative rehabilitation in DHS group may be the greater exposure and more extensive soft tissue release as compared to PFN group. The PFN device is implanted through a small incision above the greater trochanter. This entry point causes less damage to the superior gluteal nerve and gluteus medius muscle than other entry points in the piriform fossa.

Our study prospectively compares the PFN device and the DHS device randomly allocated in patients with unstable trochanteric fractures. The findings showed that fracture fixation in group B patients required a significantly longer operative time and were associated with significantly greater intraoperative blood loss than group -A patients. There was, however, no significant difference in the final functional outcome between the two groups. The re-operation rate was lower in the group A as compared to group B, although the overall complication rate did not differ statistically between the two groups.

## Conclusion

In conclusion, the PFN is an intramedullary load-bearing device that allows for immediate postoperative weight bearing, with an antirotation screw allowing controlled impaction of the metaphyseal fracture zone. The PFN device reduced iatrogenic tissue trauma and re-operation rate, although it was associated with higher X-ray exposure compared with the DHS. The present study showed that the PFN device can be used effectively to treat trochanteric fractures and may be the best choice particularly in unstable trochanteric fractures because of its low re-operation rate.

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