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A comparative study of proximal femoral fracture fixation with proximal femoral nail and Dynamic hip screw & plating

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Abstract
Introduction: Trochanteric fractures are one of the commonest injuries sustained predominantly in patients over sixty years of age. They are three to four times more common in women than in men. These usually occur through bone affected by osteoporosis; trivial fall being the most common mechanism of injury [1].
Discussion: The goal of this study was to compare the functional outcomes of patients with intertrochanteric fractures treated by two different fixation devices, the extramedullary dynamic hip screw and the intramedullary proximal femoral nail. Our study consisted of 30 patients with 30 intertrochanteric fractures out of which 15 were treated with DHS and 15 with PFN.
Conclusion: We conclude that in stable intertrochanteric fractures, both the PFN and DHS have similar outcomes. However, in unstable intertrochanteric fractures the PFN has significantly better outcomes in terms of earlier restoration of walking ability as it is an intramedullary implant which can tolerate higher cylindrical loading when compared to DHS type of implants.
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Keywords: Proximal femoral nail (PFN), dynamic hip screw (DHS), intertrochanteric (IT) fractures, osteoporosis

Introduction
Trochanteric fractures are one of the commonest injuries sustained predominantly in patients over sixty years of age. They are three to four times more common in women than in men. These usually occur through bone affected by osteoporosis; trivial fall being the most common mechanism of injury [1].

For many, this fracture is often a terminal event resulting in death due to cardiac, pulmonary or renal complications. Approximately 10 to 30% of patients die within one year of an intertrochanteric fracture [2].

Earlier, little attention was paid to these fractures, as these, which occur through cancellous bone with excellent blood supply, healed regardless of the treatment. However conservative treatment usually resulted in malunion with varus and external rotation resulting in a short limb gait and a high rate of mortality due to complications of recumbency and immobilization.

The goal of treatment of an intertrochanteric fracture must be restoration of the patient to his or her pre-injury status as early as possible. This led to recommendations for internal fixation of these fractures to increase patient comfort, facilitate nursing care, decrease hospitalization and reduce complications of prolonged recumbency [3].

The greatest problems for the surgeon providing this treatment are fracture instability and the complications of fixation that result from instability. In trochanteric fractures, stability refers to the capacity of the internally fixed fracture to resist muscle and gravitational forces around the hip that tend to force the fracture into a varus position. Intrinsic factors like osteoporosis and comminution of the fracture and extrinsic factors like choice of reduction, choice of implant and technique of insertion, contribute to failure of internal fixation.

The type of implant used has an important influence on complications of fixation. Sliding devices like the Dynamic Hip Screw have been extensively used for fixation. However, if the patient bears weight early, especially in comminuted fractures, these devices can penetrate the head or neck, bend, break or separate from the shaft.

Intramedullary devices like the proximal femoral nail have been reported to have an advantage in such fractures as their placement allowed the implant to lie closer to the mechanical axis of the extremity, thereby decrease the lever arm and bending moment on the implant. They can also be inserted faster, with less operative blood loss and allow early weight bearing with less resultant shortening on long term follow up.

The purpose of the present study is to verify the theoretical advantages of the intramedullary device over the dynamic hip screw devices and also whether it actually alters the eventual functional outcome of the patient.

Aims and objectives

To compare the surgical treatment of peritrochanteric fractures of the femur with the intramedullary device (Proximal femoral nail) and Dynamic Hip Screw device, with respect to:

- Duration of surgery
- Fracture union
- Functional outcome.
- Fluoroscopic time

Radiographic evaluation

An anteroposterior and a lateral view of the hip are usually taken to study the fracture geometry and to allow visualization of the trabecular pattern of the proximal femur which is an important clue in estimating bone quality.

Lorich and colleagues [29] noted that bone density is predictive of intertrochanteric fractures with these fractures rarely occurring in individuals with bone density >1.0gm/cm, with the incidence increasing to 16.6 fractures / per 100 persons with bone density of <0.6 g/cm.

Materials and methods

The study was conducted in St. Martha's Hospital, Bangalore where 30 patients with 30 intertrochanteric fractures of femur were selected.

Methods used in the study

A prospective study comprising of patients identified for surgical treatment of fracture in the intertrochanteric region of femur admitted to St. Martha's Hospital

All patients in the study after undergoing routine clinical examination would be subjected to following battery of investigations

1. Complete haemogram with ESR
2. Chest X ray PA view
3. Electrocardiogram
4. 2D echocardiogram
5. AP and Lateral X ray of pelvis with both hip joints and proximal half femur

Inclusion criteria

1. Peritrochanteric fractures
2. Fractures in adults

Exclusion criteria

1. Intracapsular fractures
2. Pathological fractures except osteoporosis
3. Compound injuries
4. Previous hip surgeries

The mode of injury resulting in intertrochanteric fracture was classified under 3 different categories taking into consideration whether the injury was due to a road traffic accident, trivial fall or a fall from height.

The youngest patient in this series was aged 52 years and the oldest was 90 years. 28 of our patients were older than 60 years and presented with a history of trivial fall

At the patients were initially evaluated as to their general condition, hydration and corrective measures were undertaken. The pre-injury walking ability was recorded as per the classification of Sahlstrand [74]. Anteroposterior and lateral radiographs of the affected hips were taken. The patients were then put on skin traction over a Bohler–Braun frame. The fractures were classified as per Jensen and Michealsen's modification of Evans classification of intertrochanteric fractures. Type I and type II were considered as stable fractures and type III, IV and V were considered as unstable fractures. No open fractures were encountered in this series. Patients were taken up for surgery as soon as their general condition permitted. Adequate blood transfusion, thromboprophylaxis and other supportive measures were given depending on the pre-operative condition of the patient and also post surgery based on the blood loss during surgery.

The fractures were fixed with either dynamic hip screw device (DHS) or an intramedullary device. In this study the intramedullary device used was the proximal femoral nail (PFN). Of the 30 patients in the study, 15 were treated with DHS and 15 with PFN. The length of the incision, duration of surgery and fluoroscopy time was recorded intraoperatively.

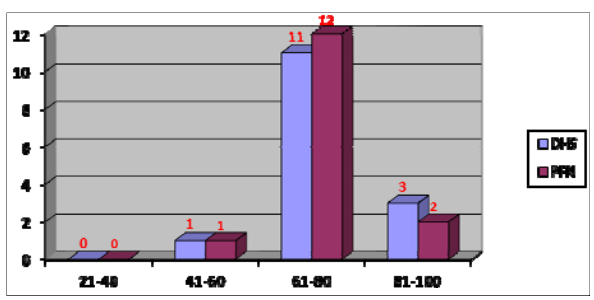
Results and Analysis

Pre-Operative Variables

1. Age Distribution

Table 1

Age (Yrs)	Method Of Fixation		Total
	DHS	PFN	
21-40	0 (0%)	0 (0%)	0 (0%)
41-60	1 (6.66%)	1 (6.66%)	2 (6.66%)
61-80	11 (73.33%)	12 (80%)	23 (76.66%)
81-100	3 (20%)	2 (13.33%)	5 (16.66%)
Total	15 (100%)	15 (100%)	30 (100%)



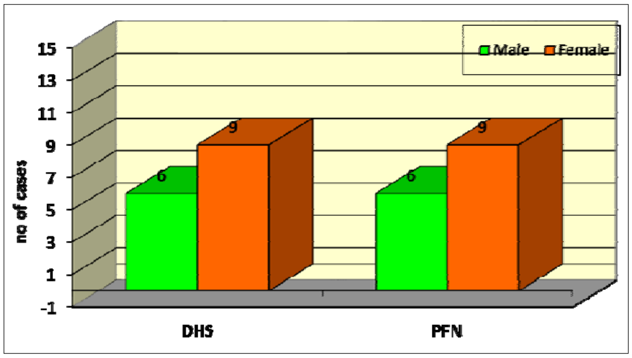
Graph 1

DHS – Dynamic hip screwPFN – Proximal femoral nail
The most common age group was in the range of 61 – 80, with a mean of 72.23 years.

2. Sex distribution

Table 2

	Method of fixation		Total
	DHS	PFN	
Female	9 (60%)	9 (60%)	18 (60%)
Male	6 (40%)	6 (40%)	12 (40%)
Total	15 (100%)	15 (100%)	30 (100%)



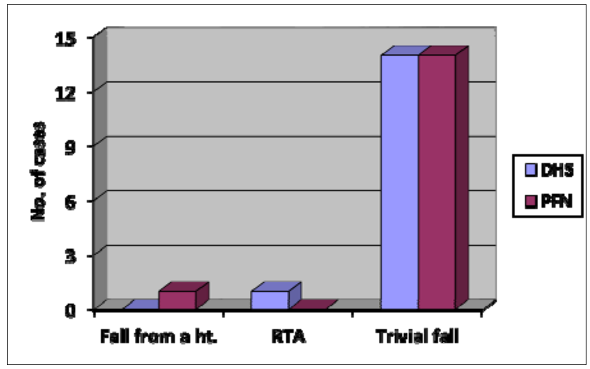
Graph 2

Majority (60%) of the patients were females with males constituting only 40% of the patients.

3. Mode of injury

Table 3

	Method of Fixation		Total
	DHS	PFN	
Fall from a height	0 (0%)	1 (6.66%)	1 (3.33)
RTA	1 (6.66%)	0 (0%)	1 (3.33%)
Trivial Fall	14 (93.33%)	14 (93.33%)	28 (93.33%))
Total	15 (100%)	15 (100%)	30 (100%)



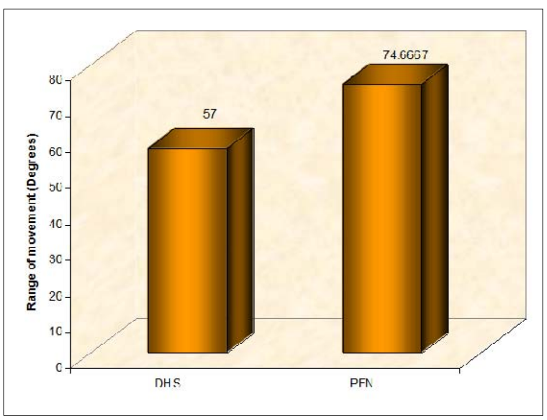
Graph 3

R.T.A – Road traffic accident.
The most common mode of injury was a trivial fall (93%).

4. Post-operative range of movement

Table 4

Method		N	Mean	Std. Deviation	Z
% of normal range of motion	DHS	15	57.0000	15.90148	3.10600
	PFN	15	74.6667	9.90430	p=.002 hs



Graph 4

The patients treated with PFN recovered 74.6667 per cent of their hip range of movement as compared to those treated with DHS who recovered only 57 per cent of their hip range of movement.

Discussion

The goal of this study was to compare the functional outcomes of patients with intertrochanteric fractures treated by two different fixation devices, the extramedullary dynamic hip screw and the intramedullary proximal femoral nail. Our study consisted of 30 patients with 30 intertrochanteric fractures out of which 15 were treated with DHS and 15 with PFN.

The average age for trochanteric fractures is reported to be 65-75 years. In our series, the highest number of patients was in the 61-85 years age group. All the fractures that occurred in patients younger than 55 years were either due to a fall from height or a road traffic accident. This supports the view that bone stock plays an important role in the causation of fractures in the elderly, which occur after a trivial fall. No attempt was made to measure the degree of osteoporosis by the Singh index, as it involves a great inter-observer variability and depends on good quality x-rays. In addition, the accuracy of the Singh index has been questioned by authors such as Koot *et al* [56].

Our series consisted of 17 stable and 13 unstable intertrochanteric fractures as classified according to Jensen and Michealsen's modification of Evans classification. The distribution of stable and unstable fractures in both groups was similar. Out of the 17 stable fractures, 8 were in the DHS group and 9 in the PFN group. Out of the 13 unstable fractures, 7 were in the DHS group and 6 in the PFN group.

The pre-injury walking ability was similar in both groups of patients treated with DHS or PFN. 80 per cent of patients in the DHS group and 73.3 per cent of the patients in the PFN group were walking without support prior to the injury.

The length of the incision in the DHS group ranged from 14cm to 18cm with a mean of 16cm as compared to a mean of only 6cm in the PFN group. The smaller incision in the PFN group meant that there was less intraoperative blood loss.

The duration of surgery in the DHS group ranged from 40 minutes to 90 minutes with a mean of 66.66 minutes. The duration of surgery in the PFN group ranged from 40 minutes to 75 minutes with a mean of 52 minutes. The difference in the operative times in both the groups was found to be highly significant and we attributed this difference to the smaller incisions in the PFN group. Baumgaertner *et al* [35]. also found that the surgical times were 10 per cent higher in the DHS group in their series. Saudan and colleagues [40] found that there was no significant difference between the operative times in the two groups in their series.

The fluoroscopy time in the PFN group (average 72.60secs) was significantly higher as compared to that of the DHS group (average 48.60secs). This was similar to the series by Baumgaertner and associates [35] who also found a significant difference in the fluoroscopic times in their series, with 10 per cent higher times for the PFN group. However in their series Saudan *et al* [40]. found no difference between the fluoroscopy times in both the groups.

The occurrence of femoral shaft fractures does not seem to be a major problem with the PFN due to a narrower distal diameter as compared to other intramedullary nails [75]. Also, rotational control is inherent in the nail design and is not dependent on multiple parts that are likely to increase the risk of mechanical failure. Due to the smaller diameter lag screws in these intramedullary nails, the proximal aspects of the nail do not need to be flared to prevent mechanical failure of the nail and hence requires less reaming of the proximal femur, thereby reducing the risk of iatrogenic proximal femoral fracture [43]. In our study, both intraoperatively and postoperatively, there were no instances of femoral shaft fractures or extension of the original fracture. This was similar to the findings of Saudan *et al* [40]. in their series. Other studies have also reported femoral shaft fracture rates of 0-2.1 per cent [76, 77]. We did not encounter any intraoperative complication in this study.

The only complications we encountered in this series were malunion and hip screw cut out. There was no significant difference between the two groups with regards to time of fracture union as all fractures united at a mean of 12 weeks. Two patients (13%) in the DHS group had a malunion where as there was no malunion in the PFN group with all the fractures uniting with less than ten degrees of varus angulation, which was statistically significant (p=0.018). Three patients (10 per cent) in our study had a hip screw cut out. Two were seen in the DHS group and one in PFN group involving an unstable intertrochanteric fracture. However two patients were relatively mobile and hence re-operation was necessary in only one patient in the DHS group. In this series the average limb length shortening of patients in the DHS group was 1.25cm as compared to 0.63cm in the PFN group which was highly significant(p=0.009). This could be due to the increased sliding of the lag screw in the DHS group, allowing greater fracture impaction, as compared to the PFN [78]. Four of the patients in the DHS group with poor results, all had 2cm or more of shortening. Three of these patients had malunion of the fractures. The patients in the PFN group neither had a shortening of more than 1cm nor a malunion.

In our study we found a significant (p=0.039) difference in the postoperative pain in the two groups with only two patients in the DHS group who were pain free at the sixth month of follow up as compared to six patients in the PFN group who were pain free at the same time of follow up. In addition three patients in the DHS group had severe pain as compared to none with severe pain in the PFN group. This difference could be due to the greater amount of impaction of the fracture fragments in the DHS group, thus altering the biomechanics of the hip, producing pain. Saudan and colleagues [40] found that the amount of persistent pain was similar in both groups in their series.

The average range of motion of the hip joints was 57 per cent of normal in the DHS group and 74.67 per cent of normal in the PFN group at sixth month of follow up. Hence, in our study, the patients in the PFN group regained a significantly better range of motion as compared to those in the DHS group (*p*=0.002).

The overall functional outcome of patients treated with the PFN was significantly better than those treated with DHS (*p*=0.037). However when we compared the stable and unstable fractures separately, we found that there was no significant difference in the outcomes of the stable fractures in the two groups (*p*=0.198). While comparing the unstable fractures in the two groups we found that the functional outcome of the patients in the PFN group was significantly better than the outcome of the patients in the DHS group with good results for all the unstable fractures treated with PFN compared to only fair and poor results for the unstable fractures treated with. We also found that patients in our study treated with a PFN regained their pre-injury walking ability at four months significantly more often than those treated with a DHS. In our series, only five of the fifteen patients (33.33 per cent) in the DHS group regained their pre-injury mobility level as compared to eight of the fifteen patients (53.33 per cent) in the PFN group at the fourth month of follow up. Similar findings were also seen in a series by Pajarinen *et al* [78]. comparing the postoperative rehabilitation of patients treated with DHS and PFN. This suggests that the use of a PFN may favor better restoration of the function in the elderly population compared with the use of a DHS. One explanation might be the significantly greater impaction of the fracture in the DHS group with shortening of the proximal femur, thus altering the biomechanics of the hip and preventing restoration of the ability to walk [78]. Moreover, the lack of compression in the PFN group did not seem to interfere with the healing of the fracture.

The smaller incisions, shorter operative times, relatively less blood loss and less postoperative pain with the PFN indicate that the PFN has an advantage over the DHS even in the treatment of stable intertrochanteric fractures where the functional outcomes are similar. In addition, with unstable intertrochanteric the PFN has a definite advantage over the DHS in terms of less limb length shortening, earlier restoration of pre-injury walking ability and a better overall functional outcome.

Summary

- The most common age group in our series was between 61-80 years with a mean age of 72.23 years.
- Trivial fall was the most common mode of injury.
- Both hips were equally involved and 60 per cent of the patients were females.
- Stable fractures constituted 56.67 per cent of the cases and unstable fractures constituted 43.33 per cent of the cases.
- 15 patients were treated with PFN and 15 were treated with DHS fixation.
- The PFN required significantly shorter incisions and operative times.
- The DHS required 24 per cent less fluoroscopy time.
- Post-operative complications included malunion and hip screw cut out
- Malunion occurred only with DHS but none with PFN. Two hip screw cut out occurred in DHS and one in PFN.

- Five of the fifteen patients treated with DHS and eight of the fifteen patients treated with PFN regained their pre-injury walking ability at the fourth month of follow up.
- Patients treated with PFN had a significantly lower pain score at the sixth month of follow up.
- Patients treated with DHS had significantly more limb length shortening as compared to those treated with PFN.
- The outcomes of the stable fractures treated with either DHS or PFN were similar.
- Unstable intertrochanteric fractures, treated with PFN, had significantly better outcomes with all patients having good results.

Conclusion

We conclude that in stable intertrochanteric fractures, both the PFN and DHS have similar outcomes. However, in unstable intertrochanteric fractures the PFN has significantly better outcomes in terms of earlier restoration of walking ability as it is an intramedullary implant which can tolerate higher cylindrical loading when compared to DHS type of implants. In addition, as the PFN requires shorter operative time and a smaller incision, it has distinct advantages over DHS even in stable intertrochanteric fractures. Hence, in our opinion, PFN may be the better fixation device for most intertrochanteric fractures.

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