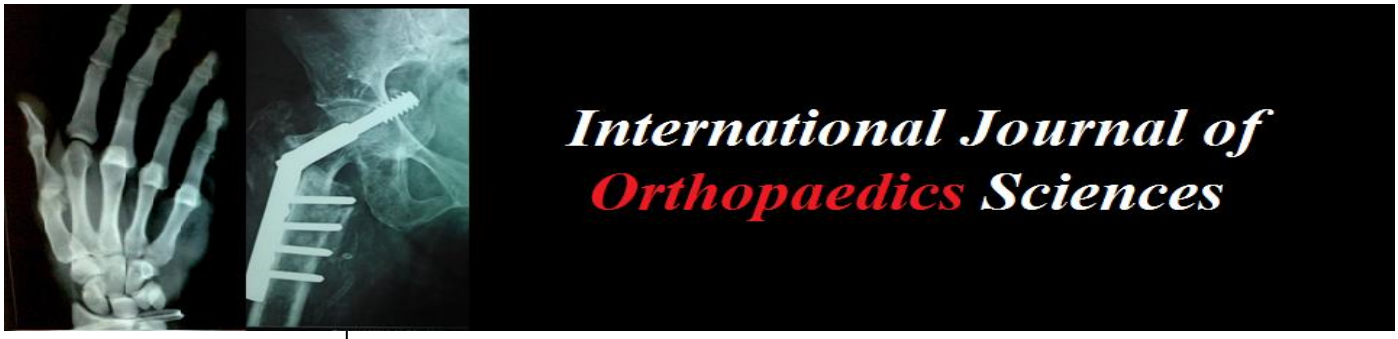

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A comparative study of dynamic hip screw and proximal femoral nail in the management of intertrochanteric fractures of femur

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Abstract
Background: The aim of this study was to compare the outcomes of proximal femoral nail (PFN) and dynamic hip screw (DHS) in treatment of intertrochanteric fractures.
Material and Methods: This was a prospective study conducted between June 2016 and June 2018. The total numbers of cases included in our study was 50 which were equally divided into two groups: one operated with DHS and other with PFN. Follow up was done at 2, 4, 6 weeks, 3 months, 6 months, and 1 year after the surgery. The patients were assessed functionally on the basis of Harris Hip Score and radiologically in the form of anteroposterior and lateral X-rays of the operated hip. The post-operative pain was also assessed as per the Harris Hip Score criteria at the end of 1 year and the post-operative gait was also assessed at the end of 1 year. Union was decided on the basis of obliteration of fracture line with bridging callus so as to allow unprotected function of the limb.
Results: The results showed that the PFN group had significantly less operative time, intraoperative blood loss, and length of incision than the DHS group. No significant differences were found between the 2 groups regarding postoperative infection rate, lag screw cut-out rate, or reoperation rate.
Conclusion: The current evidence indicates that PFN may be a better choice than DHS in the treatment of intertrochanteric fractures.

Keywords: Bone Screws, Hip Fractures, Proximal femoral nail, Dynamic hip screw

Introduction
Intertrochanteric fractures are those occurring in the region extending from the extracapsular basilar neck region to the region along the lesser trochanter. Intertrochanteric fractures of the femur are the most commonly operated fractures. Due to an increasing life span and sedentary lifestyle the incidence of these fractures is on the rise. Also the geriatric age group has a higher incidence of osteoporosis, with low energy falls from standing height accounting for approximately 90% of the community hip fractures in patients more than 50 years of age, with a higher proportion in women. Higher velocity traumatic intertrochanteric fractures are relatively rare and are more common in men less than 40 years of age. [1]
Cummings *et al*. [2] noted that neither age related osteoporosis, nor the increasing incidence of falls with age sufficiently explains the exponential increase in the incidence of hip fracture with aging. Their hypothesis was that four conditions correlated for a fall to cause a hip fracture:
1. The faller must be oriented to impact near the hip.
2. Protective responses must fail.
3. Local soft tissues must absorb less energy than necessary to prevent fracture.
4. The residual energy of fall applied to the proximal femur must exceed its strength.

This concept applies primarily to strategies to prevent hip fractures. Fall with rotational component is more common with extracapsular hip fractures [3]
Intertrochanteric fractures can be managed by conservative or operative methods.
Conservative methods were the treatment of choice until 1960 when Horowitz documented that the mortality rates in conservative methods were higher as compared to operative methods. [4]

As conservative methods resulted in higher mortality rates and complications like decubitus ulcer, urinary tract infections, pneumonia, thromboembolic complications, these methods have been abandoned. Conservative methods are now indicated under 2 conditions,

1. Elderly person with high medical risk for anesthesia and surgery.
2. Non ambulatory patient with minimal discomfort following injury.

Rigid internal fixation and early mobilization has been the standard method of treatment. Factors determining the strength of fracture implant assembly depends on the bone quality, fragment geometry, fracture reduction, implant type and implant placement. Surgeon can control only the quality of reduction, choice of implant and its placement.

As intertrochanteric fractures have the highest postoperative fatality rate amongst surgically treated fractures, they have become an important health issue and thus it is very important to study and compare different surgical options available for these fractures.

Implants for the fixation of intertrochanteric fractures can broadly be divided into

1. Extramedullary devices, example: D.H.S
2. Intramedullary devices, example: P.F.N

D.H.S (Dynamic Hip Screw) with side plate assembly is most commonly used device for fixation of intertrochanteric fractures. It is a fixation device which permits the proximal fragment to collapse or settle on the fixation device seeking its own position of stability.

The latest implant for management of intertrochanteric fracture is the P.F.N (Proximal Femoral Nail). This implant is a cephalomedullary device and has many potential advantages[5] like

1. Being intramedullary, load transfer is more efficient.
2. Shorter lever arm results in less transfer of the stress and less implant failures.
3. Advantage of controlled impaction is maintained.
4. Sliding is limited by intramedullary location, so less shortening and deformity.
5. Shorter operative time, less soft tissue dissection and less blood loss.

In view of these conditions, this study was taken up to compare the results of D.H.S and P.F.N.

Materials and Methods

This was a prospective study done between June 2016 and June 2018. The patients included in the study had to satisfy the following criteria's.

1. Inclusion criteria

a. Recent trauma history.
b. Isolated intertrochanteric fractures.
c. Stable and Unstable fractures.
d. Patients willing to give consent to participate in the study.

2. Exclusion criteria

a. Pathologic fractures.
b. Multiple fractures.
c. Old neglected fractures.
d. Fractures in paediatric age group
e. Fractures in elderly patient with high medical risk for anesthesia and surgery.

The total numbers of cases included in our study was 50 which were equally divided into two groups: one operated with DHS and other with PFN. The patients confirming into criteria were included in the study. Clinical diagnosis of intertrochanteric fracture was done with the limb in external rotation, with shortening and history of trauma. Emergency treatment in the form of analgesics was given. Anteroposterior X-ray of pelvis with both hips in 15 degree internal rotation and lateral view of the injured joint were taken. Classification of the fracture was done using the Tronzo's classification. The preoperative neck-shaft angle and the medullary canal diameter were calculated with the help of the radiographs of the normal opposite hip.

Injured limb was kept in a Thomas' splint with skin traction with adequate splintage to correct flexion deformity if any and to prevent overriding whenever present. Preoperative routine blood and urine investigations were done. Informed consent was obtained by patient for both the surgical procedure and participation in the study.

Static exercise in bed for glutei, hamstrings, quadriceps and breathing exercises were started next day of surgery. Sitting was allowed on next day of surgery with passive exercises in bed. Drain if inserted was removed after 48 hours. ROM exercises were started actively. The protocol for weight bearing was, in stable fractures partial weight bearing was started next day after surgery and full weight bearing was started after 6 weeks, while in unstable fractures non-weight bearing walking was allowed on operated side with the help of a walker or crutches next day after surgery, partial weight bearing after 6 weeks and full weight bearing was started after 3 months approximately. However weight bearing was modified as per the type of fracture, stability of the internal fixation, the fracture union and the tolerance of the patient.

Follow up was done at 2, 4, 6 weeks, 3 months, 6 months, and 1 year after the surgery. The patients were assessed functionally on the basis of Harris Hip Score and radiologically in the form of anteroposterior and lateral X-rays of the operated hip. The post-operative pain was also assessed as per the Harris Hip Score criteria at the end of 1 year and the post-operative gait was also assessed at the end of 1 year. Union was decided on the basis of obliteration of fracture line with bridging callus so as to allow unprotected function of the limb.

Observation and Results

The study comprised of 50 patients as per the inclusion criteria, divided into two groups, one operated with DHS while other operated with PFN with 25 patients in each group. Of the 50 patients there were 32 females and 18 males. The youngest patient in our series was 17 years and the oldest was 82 years. The average age of the patient for DHS was 46.96 years and for PFN was 47.72 years. 24 patients had stable type of fracture and 26 had unstable type of fracture.

The patients were divided according to the type of fracture using the Tronzo's classification. The following table (Table 1) shows us the type of implant used according to the type of fracture to the patient.

Table 1: Type of implant used according to fracture type

Type Of Fracture	Proximal Femoral Nail (Pfn)	Dynamic Hip Screw (Dhs)	Total
Type 1	5	6	11
Type 2	7	6	13
Type 3	7	6	13
Type 4	6	7	13
Total	25	25	50

The patients' average stay in the hospital was 10.32 days (Range 5 to 24) in DHS group and 9.48 days (range 3 to 20) in PFN group (*p* value >0.05). Out of the 50 patients, 2 expired during follow up due to unrelated causes (both due to myocardial infarction) and 4 patients were lost in follow up.

At 1 year follow up, 9 patients had no pain, 5 had minimal pain, 6 had moderate pain and only 1 patient had severe pain post operatively in the DHS group, while 12 patients had no pain, 8 had minimal pain and 3 had moderate pain post operatively in the PFN group. Thus, though the number of patients with none or minimal post-operative pain was more in the PFN group (20) than the DHS group (14), the difference was not statistically significant (*p* value >0.05). (Table 2)

Table 2: Post-operative pain at 1 year follow-up

Post-Operative Pain	Proximal Femoral Nail (Pfn)	Dynamic Hip Screw (Dhs)	Total
None	12	9	21
Mild	8	5	13
Moderate	3	6	9
Severe	0	1	1
Total	23	21	44

Also at 1 year follow up, 10 patients had a normal gait, 3 patients had a limp, 3 patients used a stick for walking, 4 patients used a walker and one patient used a wheel chair in the DHS group while 12 patients had a normal gait, 5 patients had a limp, 4 patients used a stick while walking and 2 patients used a walker for walking in the PFN group. There was no significant difference between the number of patients with a normal gait (10 and 12 respectively) in the DHS and the PFN group (*p* value >0.05). (Table 3)

Table 3: Post-operative gait at 1 year follow-up

Post-Operative Gait	Proximal Femoral Nail (Pfn)	Dynamic Hip Screw (Dhs)	Total
Normal	12	10	22
Limp	5	3	8
Use Of Stick	4	3	7
Use Of Walker	2	4	6
Use Of Wheel Chair	0	1	1
Total	23	21	44

At 1 year follow up, in DHS group, 6 patients were graded as excellent, 6 patients as good, 6 as fair, 2 as poor and 1 as failed. 3 patients were lost in follow up and one patient had died. At 1 year follow up in PFN group, 5 patients were graded as excellent, 9 patients as good, 8 as fair and 1 as poor. 1 patient was lost in follow up and one patient had died. Thus in stable fractures the functional outcome for both the modalities of treatment was similar. But in unstable fractures, the functional outcome was better for PFN than for DHS however, the difference was not statistically significant (*p* value >0.05). (Table 4)

Table 4: Functional outcome at 1 year follow-up

Result	Proximal Femoral Nail (Pfn)	Dynamic Hip Screw (Dhs)	Total
Excellent	5	6	11
Good	9	6	15
Fair	8	6	14
Poor	1	2	3
Failed	0	1	1
Total	23	21	44

Table 5: Harris hip score at follow-up up to 6 months

Harris Hip Score	PFN - cases		DHS - cases		Unpaired t	P
	Mean	SD	Mean	SD		
At week-2	57.44	13.76	50.36	16.71	1.635	0.109
At week-4	62.67	13.58	58.04	15.78	1.098	0.278
At week-6	71.79	10.17	69.61	11.93	0.676	0.503
At Month-3	78.48	9.70	76.95	10.51	0.495	0.623
At Month-6	81.04	9.13	80.10	10.03	0.323	0.749

In our study we found that the average Harris Hip Score for PFN was much better than DHS in the early follow up but later on the difference reduced between the two modalities of treatment. Thus PFN provides an early mobilization and rehabilitation of the patients as compared to DHS.

The average Harris Hip Score at the end of 1 year in stable fractures (type 1 and 2) for PFN was 88.73 and for DHS was 89.20 (p value >0.05). In unstable fractures (type 3 and 4) the score for PFN was 79.36 and for DHS was 69.09 (p value >0.05). Thus the functional outcome with respect to the average Harris Hip Score was better in PFN group than DHS group for unstable fractures but was not significant. (Table 6)

Table 6: Harris hip score at 1 year follow-up

Harris Hip Score at 1 yr.	PFN - cases		DHS - cases		Unpaired t	P
	Mean	SD	Mean	SD		
Stable	88.73	4.338	89.20	3.584	0.271	0.790
Unstable	79.36	6.56	69.09	17.75	1.801	0.086
Overall	83.96	7.23	78.67	16.41	1.430	0.159

One patient of DHS group developed a superficial infection which settled down with 2 weeks of intravenous antibiotics. Another patient developed a deep infection which required a debridement procedure at 2 weeks followed by a 2 weeks course of intravenous antibiotics after which the infection subsided. One patient in the DHS group developed excessive shortening (>2.5 cm) during the follow up due to increased collapse at the fracture site. One patient in the DHS group developed a bed sore; the patient was household ambulatory pre operatively and was bed ridden post operatively for some time due to medical reasons. One patient in DHS group had an implant failure due to the cut out of the DHS screw, the patient was later on treated by implant removal and hemiarthroplasty. One patient in PFN the group developed nonunion which was treated by bone grafting at 6 months post-surgery and later followed up with signs of fracture union. No peri implant fracture or loosening of the implant was noted.

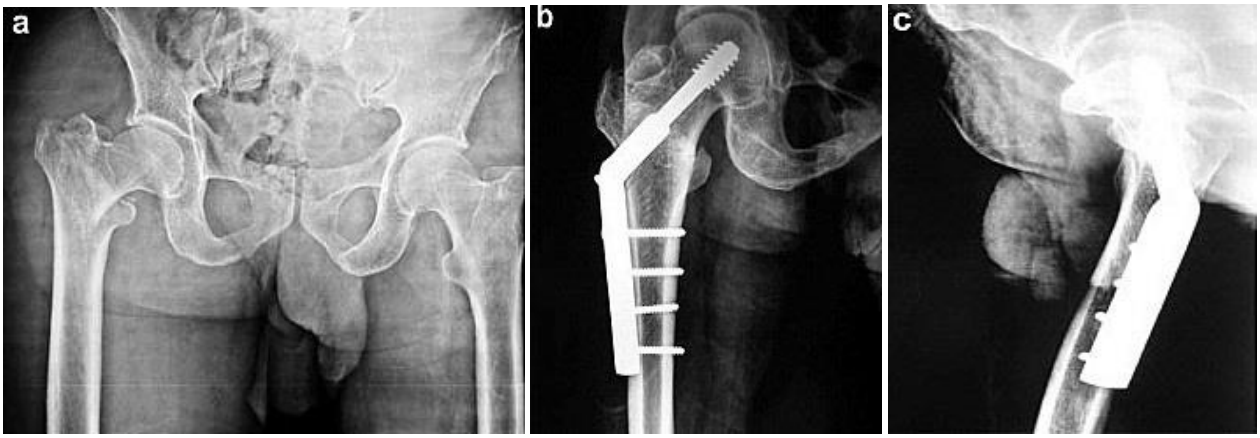

Fig 1: A 57 year old male patients with Right intertrochanteric fracture treated with DHS. a) Preoperative image. B & C) anteroposterior and lateral images showing union at 6 weeks follow up.

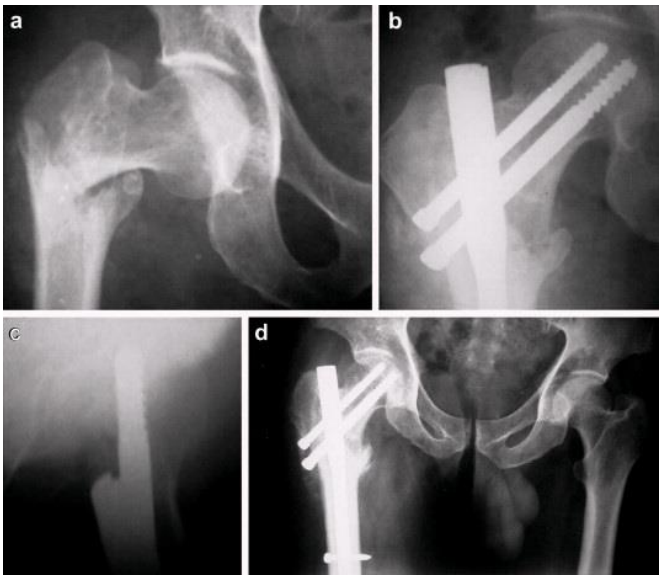

Fig 2: A 41 year old female with Right sided stable intertrochanteric fracture treated with PFN. a) Preoperative image. B & C) immediate postoperative anteroposterior and lateral radiograph. d) Anteroposterior radiograph showing union at 6 weeks follow up.

Discussion

The treatment of intertrochanteric fracture is still associated with some failures.

High stress concentration that is subject to multiple deforming forces and high incidence of complications reported after surgical treatment compels the surgeon to give a second thought regarding selection of proper implant. A large number of fixation implants has been devised and discarded. The treatment still merits the type of fracture and condition of the patient.

The development of the Dynamic Hip Screw in the 1960's saw a revolution in the management of unstable fractures. It provided control compression at the fracture site. Its use has been supported by its biomechanical properties which have been assumed to improve the healing of the fracture.

But Dynamic Hip Screw requires a relatively larger surgical exposure, more tissue dissection and anatomical reduction. All these increase the morbidity, probability of infection and intraoperative blood loss. The common causes of fixation failure are instability of the fractures, osteoporosis, lack of anatomical reduction, failure of fixation device and incorrect placement of the screw.

In the early 90's intramedullary devices were developed for fixation of intertrochanteric fractures. The Proximal Femoral Nail with a hip screw together with a smaller distal shaft diameter reduces the stress concentration and thus avoids failures. From mechanical point of view, an intramedullary device inserted by means of minimally invasive procedure seems to be better in elderly patients. The Proximal Femoral Nail is found to be more useful in unstable and reverse oblique patterns due to the fact that it has better axial telescoping and rotational stability. It has shown to be more biomechanically stronger because it can withstand higher static and several fold higher cyclical loading than Dynamic Hip Screw due to its proximity to the centre of gravity of the body as it is an intramedullary device. The implant compensates for the function of the medial column[20]. Proximal Femoral Nail also acts as a buttress in preventing the medialization of the shaft.

Facilitation of closed reduction in P.F.N. preserves the fracture hematoma, an essential element in consolidation process. Intramedullary fixation allows the surgeon to minimize soft tissue dissection, thereby reducing surgical trauma, blood loss, infection and wound complications.

In the present study, with 25 patients each in D.H.S. and P.F.N. group, 64% of the cases being females and 52% of the cases with unstable fractures, we found that the average surgical time was significantly less for P.F.N. than for D.H.S. Also the average blood loss for D.H.S. surgery was significantly more than for P.F.N. The average Harris Hip Score for P.F.N. was more than for D.H.S. in the earlier post-operative phase which shows that P.F.N. allowed faster rehabilitation of the patients, however the time required for the union of fracture for both the modalities was similar. The Harris Hip Score at the end of 1 year in stable fractures was similar for both D.H.S. and P.F.N. however the scores for unstable fractures at the end of one year were better for P.F.N. than for D.H.S. Also the functional outcome in unstable fractures was better for the P.F.N. group than for the D.H.S. group. However the difference was not statistically significant and thus warrants a larger group of study to be conducted. The rate of complications in terms of implant failure and infection was more for D.H.S. though not significant (*p* value>0.05).

Conclusions

This is a study of 50 patients with intertrochanteric fractures, divided equally into 2 groups, one treated with D.H.S. and other by P.F.N. The patients have been followed up for a period of one year after the surgery. The functional outcome of the patients has been evaluated with the help of Harris Hip Score System. In this study the average intraoperative time for

surgery and the average intraoperative blood loss have been found to be significantly less in the P.F.N. group as compared to the D.H.S. group. Also the average Harris Hip Score at the end of one year in unstable fractures have been found to be better in the P.F.N. group than the D.H.S. group but not significant, however the overall average Harris Hip Scores at the end of one year and the Harris Hip Scores in stable fractures have been found to be similar in both the groups. Also 33% of the patients with unstable fractures in the P.F.N. group have good results at the end of one year as compared to 18% in the D.H.S. group and only 8% of the patients have poor results at the end of one year in the P.F.N. group as compared to 18% in the D.H.S. group. However there was no significant difference in the duration of hospital stay and the time required for the fracture to unite in both the modalities of treatment. There were two cases of infection, one case of screw cut out and one case of bed sore in the D.H.S. group as compared to one case of nonunion in the P.F.N. group.

Thus I conclude from this study that P.F.N. has the following advantages over D.H.S. in the treatment of intertrochanteric fractures (especially unstable fractures):

a. Lesser operative time.
b. Lesser blood loss.
c. Early post-operative rehabilitation of the patients.
d. Better functional outcome.

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