Short versus standard PFN outcome analysis in unstable intertrochantric fracture

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ABSTRACT

Background: Hip fractures in the elderly are frequent. Intertrochanteric hip fractures account for approximately half of all hip fractures in the elderly; of these, from 50% to 60% are classified as unstable. In our study we tried to compare outcome of unstable trochanteric fracture in terms length of PFN (180 vs 240 mm).

Methods: 80 patients of unstable trochanteric fracture were randomly allotted to 2 groups who were treated with closed reduction and internal fixation with proximal femoral nail of size 180 mm (group A) and 240mm (group B). Patients in both the group were compared right from the fracture configuration till the one year post-operative period.

Results: In the study of 80 patients there were 18 males (45%) and 22 females (55%) in group 1, and 23 male (57%) and 17 female (42.5%) in group 2. Group 1 patient had a better range of movements than group 2. Femoral canal impingement was present in 6 (15%) of patients of group 1 and 28(70%) patients of group 2 showed femoral canal impingement.

Conclusions: There are very few studies which compare the length of PFN to the outcome. The standard PFN group presented with complications like femoral nail impingement and hence more thighs pain and less range of movements even after one year of follow up. We conclude that for Indian group of population who have a relatively short femora gives a better result with a shorter length implant.

Keywords: Intertrochantric fracture, Fixation, Proximal femur nail

INTRODUCTION

Hip fractures in the elderly are frequent. Intertrochanteric hip fractures account for approximately half of all hip fractures in the elderly; of these, from 50% to 60% are classified as unstable.1-3 The care of patients with intertrochanteric fractures has advanced dramatically since the advent of internal fixation. Unstable intertrochanteric fractures are those with significant disruption of the posteromedial cortex because of comminution or are fractures with reverse oblique or subtrochanteric fracture lines.4 Both extra-medullary and intra-medullary implant can be used for stable intertrochanteric fracture but its well established that intra-medullary implants have a superior results in the unstable fractures.5-8 Intramedullary fixation, particularly modern intramedullary osteosynthesis techniques of trochanteric fracture gained rapid acceptance in recent years.7 Several implant-related complications of intramedullary implant have been described, such as femoral shaft fracture, failure of fixation and problems of distal locking.8 Proximal femoral nail of size 240 to 440 mm were developed to tackle these problems of other intra-medullary implant.9 But the complications were as high as with other intramedullary design.10 A short proximal femoral nail with a length of 180 mm and a proximal diameter of 15 mm is therefore developed to enable easy insertion and reduce the risk of femoral...
fracture. The nail has a 6° medio-lateral angle for easy insertion and a flexible distal tip to avoid stress generation and refractions. There are very few studies which compare the length of PFN to the outcome. In our study we tried to compare outcome of unstable trochanteric fracture in terms length of PFN (180 vs 240 mm).

**METHODS**

This randomised study was conducted at our institute Government medical college Raigarh from (December 2015 to December 2017) and registered at our university. After institutional ethical approval and written, informed consent, 80 patients of trochanteric fracture were randomly allotted to 2 groups who were treated with closed reduction and internal fixation with proximal femoral nail of size 180 mm (group A) and 240 mm (group B).

**Inclusion criteria of study**

Treated within 3 weeks of fracture, with no associated injuries, with no previous trochanteric fracture or infection, age (more than 18 years), with no previous surgical intervention of trochanter.

**Exclusion criteria of study**

Age less than 18 years, with associated injuries, with co-morbid conditions (diabetes, hypertension etc), pathological fracture, treated after 3 weeks after injury, coexistent femur fracture.

The participants were allocated randomly into one of the following groups according to the type of implant used.

Group 1: Short proximal femoral nail (180 mm)

Group 2: Standard proximal femoral nail (250 mm)

The patients were examined on 1st post-operative day, and follow-up done after 4 weeks, 8 weeks, 16 weeks, 6 months and 1 year after surgery.

**The following information were collected**

Name/age/sex, grading (AO grading of trochanteric fracture), superior or inferior communion of the trochanter, mode and duration of injury, type of implant, proximal and distal screws inserted, neck shaft angle on normal and fractured side, tip-apex distance (mean of the distance of tip of lag screw to the apex of head of femur in AP and lateral view of x-ray).

Evaluation of patients was done on the basis of

**Clinical findings**

1. Pain (Salvati and Wilson hip function scoring system)

2. Movements at hip joint (Functional hip score)

3. Deformity.

**X-ray findings**

1. Femoral shaft fracture (occurring during surgery while reaming or while insertion of nail Yes/No)

2. Femoral canal impingement (anterior or medial canal impingement from the tip of nail Yes/No)

3. Tip apex distance (mean of the distance of tip of lag screw to the apex of head of femur in AP and lateral view of x-ray).

4. Coxavara/ Varus collapse Neck shaft angle of operated side compared with normal side and varus collapse determined Yes/No

5. Cut-through of proximal screws Cut-through of anti-rotation and lag screw from superior cortex of neck of femur Yes/no

6. Loss of reduction yes/no

7. Screw penetration Penetration of lag screw or anti-rotation screw alone or both of them assessed by tip apex distance: Yes/No

8. Screw back-out Backout of lag screw or anti-rotation screw alone or both of them Yes/No

9. Union of greater and lesser trochanter Signs of union like callus formation were seen on standard x ray.

**Statistical analysis**

The difference between groups was analysed using student t test with value <0.005 as significant. Statistical analyses were performed using SPSS 16 (IBM, New York, United States) and a p<0.05 was considered to indicate statistical significance.

**RESULTS**

In the study of 80 patients there were 18 males (45%) and 22 females (55%) in group 1, and 23 male (57%) and 17 female (42.5%) in group 2. About 74.6% of patient aged ≥60 years had a low energy impact injuries (slip and fall, fall from stairs, fall from bed) and about 74.4% of patients aged <60 years had high energy trauma (fall from roof, RTA) (Table 1). Showing that less energy is required to cause this type of injury in old and osteoporotic patients, whereas significant trauma is essential to cause same fracture in younger patients.

**Table 1: Relation between severity of injury with age of patient.**

| Severity of injury | Pts aged ≥60 | Pts aged <60 |
|--------------------|--------------|--------------|
| High energy       | 28           | 11           |
| Low energy        | 9            | 32           |

On an average patients were operated within 7-10 days after injury. No patient had any significant intraoperative complication like thromboembolism or fracture shaft femur.
Table 2: T-test for comparing pain.

|                | Group 1         | Group 2         | t-value | P value |
|----------------|----------------|----------------|---------|---------|
| Pain_1         | 2.65±1.460     | 2.15±1.657     | 1.432   | 0.156   |
| Pain_4 weeks   | 5.60±1.128     | 4.30±1.324     | 4.727   | 0.000   |
| Pain_8 weeks   | 6.35±1.494     | 4.95±1.197     | 4.624   | 0.000   |
| Pain_16 weeks  | 7.05±1.632     | 5.35±1.145     | 5.393   | 0.000   |
| Pain_6 month   | 8.30±1.786     | 5.80±1.181     | 7.384   | 0.000   |
| Pain_12 month  | 8.45±1.782     | 6.20±1.091     | 6.810   | 0.000   |

Table 3: T-test for comparing movements.

|                | Group 1         | Group 2         | t-value | P value |
|----------------|----------------|----------------|---------|---------|
| Movement_1     | 35.05±4.025    | 32.15±4.907    | 2.890   | 0.005   |
| Movement_4weeks| 39.40±3.601    | 35.90±4.247    | 3.975   | 0.000   |
| Movement_8weeks| 40.40±3.875    | 36.05±4.188    | 4.822   | 0.000   |
| Movement_16weeks| 41.75±5.027  | 38.55±3.922    | 3.174   | 0.002   |
| Movement_6month| 43.10±4.075    | 39.20±4.220    | 4.205   | 0.000   |
| Movement_12month| 43.40±3.822   | 39.40±4.229    | 4.438   | 0.000   |

Table 4: Femoral canal impingement of tip of nail.

|                | Group 1         | Group 2         |
|----------------|----------------|----------------|
|                | No %            | No %            |
| 0              | 34 85.0         | 12 30.0         |
| 1              | 6   15.0        | 28 70.0        |
| Total          | 40 100          | 40 100          |

c² =24.757, p=0.000

In post-operative period, most of patients were on oral NSAIDs and third generation cephalosporin for about 2 days. Most of the patients had moderate tolerable pain immediately in post-operative period and negligible pain 1 week after surgery. On final follow-up there was a significantly more pain in group 2 than group 1 (Table 2). In group 1, 25 patients complained of mild pain, 15 patients complained pain over anterior thigh region out of which 6 patient had canal impingement of tip of nail over anterior femoral cortex, 5 patients complained pain over groin region of which 2 patient had screw penetration of head of femur, rest 5 patient complained pain over medial aspect of thigh. In group 2, 34 patients complained pain, 30 patients complained pain over anterior thigh region out of which 28 patient had canal impingement of tip of nail over anterior femoral cortex, 1 patient complained pain over groin region who also had penetration of femoral head by lag screw, 2 patient complained pain over lateral aspect of thigh of which 1 patient had anti-rotation screw back out with avascular necrosis of head of femur.

As shown above in the table there was significant difference for pain among the two groups.

Passive and active range of movements was measured in follow up period. It was constantly seen that patients of group 1 had a better range of movements then group 2. Patients of coxa vara had limited range of abduction movement. Most of the patients who had anterior thigh pain or loss of reduction tolerated less movement.

There was a significant difference for the passive range of movement tolerated by the patients among the group. Group 1 patient had a better range of movements than group 2.

Femoral canal impingement was present in 6(15%) of patients of group 1 and 28 (70%) patients of group 2 showed femoral canal impingement (Table 4).

In most of the patients with standard PFN the tip of the nail rested near the curvature of femur causing impingement over the anterior femoral cortex, such patients had complaint of anterior thigh pain and reactive osteolysis was noted around the impingement in some patient.

Due to improper reduction 2 patients of group 1 and 8 patients of group 2 peroperatively had coxa vara. On final follow up 9 patients of group 1 and 17 patients of group 2 had coxa vara (Table 5), showing 7 patients of group 1 and 9 patients of group 2 develop coxa vara in follow up period, showing no significant difference between the two groups.

Most of the patients of coxa vara attained preoperative functional status with minimal shortening and limp.
The two study groups
Group 1: Patients treated by short PFN.
Group 2: Patients treated by standard PFN.

The two groups were well controlled in the terms of their age and sex distribution. The mean age was 54.55±13.33 years.

Table 5: Coxa vara at 12 months.

|          | Group 1 | Group 2 |
|----------|---------|---------|
| No       | %       | No      | %       |
| 0        | 31      | 77.5    | 23      | 57.5    |
| 1        | 9       | 22.5    | 17      | 42.5    |
| Total    | 40      | 100     | 40      | 100     |

c² =3.647, p=0.056.

Table 6: Cut through of screw through head of femur at 12 months.

|          | Group 1 | Group 2 |
|----------|---------|---------|
| No       | %       | No      | %       |
| 0        | 39      | 97.5    | 36      | 90.0    |
| 1        | 1       | 2.5     | 4       | 10.0    |
| Total    | 40      | 100     | 40      | 100     |

c² =1.920, p=0.166 (p>0.05 showing insignificant results).

Cut through of head of femur was noted as early as 16 weeks in some patients when they were allowed full weight bearing. On final follow up, 1 patient of group 1 and 4 patient of group 2 showed cut through (Table 6), showing insignificant difference between the groups. Out of 4 patients of group 2, in 3 patients lesser trochanteric fracture and posteromedial cortex comminution were noted and all of the group 2 patient were aged >60 years.

Table 7: Loss of reduction in immediate postoperative period.

|          | Group 1 | Group 2 |
|----------|---------|---------|
| No       | %       | No      | %       |
| 0        | 38      | 95.0    | 33      | 82.5    |
| 1        | 2       | 5.0     | 7       | 17.5    |
| Total    | 40      | 100     | 40      | 100     |

c² =3.130, p=0.077

Table 8: Loss of reduction at 12 months.

|          | Group 1 | Group 2 |
|----------|---------|---------|
| No       | %       | No      | %       |
| 0        | 37      | 92.5    | 27      | 67.5    |
| 1        | 3       | 7.5     | 13      | 32.5    |
| Total    | 40      | 100     | 40      | 100     |

c² =7.812, p=0.005

On final follow up loss of reduction was seen in 3 patients of group 1 and 13 patients of group 2, showing a significant increase in the number of patients of group 2 to loose reduction in follow up period (Table 7 and 8).

6 patients of group 2 lost reduction in comparison to 1 patient of group 1 till final follow up showing a significant difference among the groups. Of 6 patients of group 2, 4 of the patients were unstable fracture with fracture lesser trochanter and posteromedial cortex.

Table 9: Screw penetration of head of femur at 12 months.

|          | Group 1 | Group 2 |
|----------|---------|---------|
| No       | %       | No      | %       |
| 0        | 38      | 95.0    | 39      | 97.5    |
| 1        | 2       | 5.0     | 1       | 2.5     |
| Total    | 40      | 100     | 40      | 100     |

c² = .346, p=0.556.

No significant difference was found between the two groups for screw penetration.

Among these 3 patients of screw penetration 2 patients had penetration of anti-rotation screw (Z effect) and one patient had penetration of lag screw (reverse Z effect).

Signigicant difference was found for screw backout among the two groups. More number of screw backout were seen among standard PFN group. Most of the patients had backout of both antirotation and lag screws.

DISCUSSION

The average length of Indian femur in males is 43 cm and in female is 41 cm and the curvature of the femur lies in the mid third of femur, the use of 250 mm PFN, the tip of nail comes to lie around the curvature and thus causing anterior femoral impingement.12,13 Impingement causes anterior thigh pain, hence lesser range of tolerable movements and it also acts as a stress riser over the anterior femoral cortex and might cause femoral fracture in both intraoperative and post-operative period and more chances for revision surgery.

We tried to analyse the outcome in terms of parameter indicating the improvement in fracture site and the final movement range and attainment of pre-fracture functional capacity after being treated either by these two nails.

The two study groups

Group 1: Patients treated by short PFN.
Group 2: Patients treated by standard PFN.

The two groups were well controlled in the terms of their age and sex distribution. The mean age was 54.55±13.33 years.
years. The mean duration between the fracture and the time of surgery was between 7-10 days. All the patients were operated under spinal anaesthesia and the mean duration of surgery was relatively less for the short PFN group than standard PFN group. However none of the patients had major intraoperative complications like femoral shaft fracture, thromboembolism etc. among the two study group. It was than observed in 2-3 post-operative day, the pain was dramatically reduced in the patients operated with short PFN comparing to the standard PFN group. This difference may be due to a shorter duration of surgery, less blood loss and less requirement of blood transfusion, less reaming of canal in short PFN group as compared to standard PFN group. Most of the patients of group 2 complained minimum constant pain over the anterior thigh region, this is attributed to the impingement of the tip of nail over the anterior femoral cortex.

Figure 1: Standard PFN showing anterior wall impingement.

Figure 2: Short PFN no anterior wall impingement.

Femoral canal impingement was found to be present in 28 of 40 patients (70%) of standard PFN group (Figure 1) while the same was present in 6 patients (15%) of short PFN group (Figure 2) and the difference was highly significant as the p<0.001. The reason for this as supported by many studies is the shorter femora in the Indian population. Neck shaft angle of the femur of patients was measured in both normal and on treated side and value less than 10 degree of normal side was considered as coxavara or varus collapse. But the presence of this deformity in the two groups of the study was insignificant as 9 patients (22.5%) of short PFN group had coxavara compared to the normal side, and 17 patients (42.5%) of standard PFN group had coxavara with a p<0.05. It was found that the varus collapse started to appear on full weight bearing i.e. 4 to 6 weeks after surgery. Patients developing this deformity often had high energy trauma with a higher grade of fracture were the posterior-medial cortex of femoral neck and lesser trochanter were fractured, and also was seen in older patients with osteoporosis and in whom the lag screw was not placed in the lower half of femoral neck.14 Coxavara was also associated with screw backout or cut through or both. Out of 26 patients with coxavara in the study 17 patients had screw backout, or cut through or both, though coxavara developed in 32% patients in the overall study but it did not hamper to attain the pre-injury functional status in most of the patients. Loss of reduction was seen in 2 patients of group 1 and 7 patients in group 2 in early post operative period on partial weight bearing. The difference among the two group was insignificant. Cut through seen at 16 weeks in 4 patients of group 2 and 1 patient of group 1. The difference among the two group was insignificant. Cut through was seen to develop more often in patients who were elderly, females with osteoporosis as seen in our study all the patients who developed cut through were more than 60 years and 3 of them were female patients. There were no significant number of patient in the study who developed screw penetration or screw backout. In the overall study 2 patient in standard PFN group and 1 patient in short PFN group had developed screw penetration the presence of this event was insignificant in both the group and also when compared to each other. Most of the patient had functional range of movement as compared to their pre injury status and short PFN group patient had a movement in range of 43.40±3.822 (functional hip score) and standard PFN group had an score of 39.40±4.229 showing a significant difference in both these groups which might be due to more pain in the standard PFN group similar study carried out on the short PFN stated that at one year follow up to 90% patient had good or excellent outcome and 80% had returned to their previous functional capacity.15 Our study results coincides with these results that nearly 95% of our patients had good outcome in terms of their movement range and returning to their normal day to day activities. Finally after 12 months the union of greater and lesser trochanter and outcome of those patients with lateral cortex defect (A3 fractures) was noted and we found that the final outcome was equivalent in both the groups, in this regards that 98% of the greater trochanter comminution and 83.33% of the lesser trochanter comminution was united with no significant difference in the two groups. The union of
lesser and greater trochanter gave patient a better range of movement. In those patient of grade A3, where short PFN was used showed a comparable results to the standard PFN. Thus concluding that the use of short or standard PFN does not affect the union of the fracture site but may have differences in the patient’s overall clinical outcome.

The basic aim of the study was to analyse and compare the outcome of patients. Most of the previous study carried out on PFN analysed mainly the effect of anti-rotation and lag screw on the outcome of the patients but relatively less number of studies have been done based on the length of the PFN, none of the studies till date compare the short PFN of length 180mm with the other implant available.16-18

CONCLUSION

Patients in both the group were compared right from the fracture configuration till the one year post-operative period. It was found that the final attainment of union of the fracture site was nearly same in both the groups but the functional outcome in terms of pain relief and functional range of movements differed a lot among the groups. While the standard PFN group presented with complications like femoral nail impingement and hence more thigh pain and less range of movements even after one year of follow up. These complication were very less with the use of short PFN. Hence we conclude that for Indian group of population who have a relatively short femur gives a better result with a shorter length implant in terms of shorter duration of surgery, ease of placing the implant, early recovery and ambulation, better pain relief with a relatively higher functional range of movements with less complication rate and thus an early return to the pre injury functional status.

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