FUNCTIONAL ANALYSIS OF PROXIMAL FEMORAL FRACTURES TREATED WITH PROXIMAL FEMORAL NAIL

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ABSTRACT

BACKGROUND

Intertrochanteric femoral fractures are of intense interest globally. They are the most frequently operated fractures and they have the highest postoperative fatality rate of surgically-treated fractures and have become a serious health issue. The incidence of fractures in proximal femoral area has risen with increasing numbers of elderly persons with osteoporosis and traffic accidents in young adults. In elderly patients due to their poor bone quality, it is very difficult to achieve and maintain stable fixation.

The aim of surgery is to achieve early mobilisation and prompt return to pre-fracture activity level. The treatment of these fractures remains a challenge to the surgeon.

MATERIALS AND METHODS

The study was conducted on 20 cases of intertrochanteric fractures admitted in King George Hospital, Visakhapatnam, in the Department of Orthopaedics during November 2015 to November 2017. All cases reported to hospital were subjected to scrupulous preoperative evaluation. Those fulfilling inclusion criteria were operated upon. All the fractures were treated with proximal femoral nail. All the patients were evaluated on follow ups at the intervals of 6 weeks and 6 months according to modified Harris hip score.

RESULTS

The age distribution was from 20 to 70 years. The mean age was 58.6 years. Most of the patients with domestic fall were older in age or had osteoporosis. 65% of fractures were right sided and 35% were left sided. Fractures were classified as per Orthopaedic Trauma Association (OTA) classification in which 31 A1 were considered stable fractures and 31 A2 and 31 A3 were unstable fractures. The present study constituted 80% unstable fractures. There were 2 (10%) cases of infection seen in the study. We report no nonunion and no Z-effect with the present study.

CONCLUSION

We conclude from our study that proximal femoral nailing can be considered the most rational method of treating intertrochanteric fractures, especially the unstable and reverse oblique type fractures in elderly. PFN insertion is a minimally-invasive procedure with less operating time and less blood loss. This closed technique preserves the fracture haematoma leading to early union and early mobilisation. It can be used with equally good results in all grades of osteoporosis with minimal postoperative complications. Early mobilisation and weightbearing with rapid rates of healing was possible. But, proximal femoral nailing requires a higher surgical skill, good fracture table and image intensifier. It has a steep learning curve.

KEYWORDS

Femoral Fractures C26.404.061, Fracture Fixation E04.555.300, Fracture Healing G16.762.891.500.

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BACKGROUND

The most widely used extramedullary implant was Dynamic Hip Screw (DHS) in the surgical fixation of intertrochanteric fractures, which seems to have a biomechanical disadvantage when compared with intramedullary device, because the load bearing in proximal femur is predominantly by the calcar. Intramedullary devices such as the Proximal Femoral Nail (PFN) are more stable under loading with shorter lever arm. The distance between hip joint and the nail is reduced compared with that of a plate, thus diminishing the deforming forces across the implant. The PFN system developed by AO/ASIF has some major biomechanical innovations to overcome the limitations of the gamma nail. They include- 1. The addition of the 6.4 mm anti-rotation hip pin to reduce the incidence of implant cut-out and the rotation of the cervicocephalic fragments. 2. Smaller diameter and fluting of the tip of the nail, specially designed to reduce stress forces below the implant and therefore the incidence of low energy fracture at the tip. 3. The greater the implant length, the smaller the valgus angle and setting of this angle at a higher level (11 cm from the

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proximal end). 4. More proximal positioning of the distal locking is to avoid abrupt changes in stiffness of the construct. In this respect, it should be borne in mind that the neck screw must be adjacent to the calcar taking into account the need to place the anti-rotational hip pin. 5. Despite these modifications, an ideal implant is yet to be developed akin to the continuing complications with the existing implant armamentarium.

Aims and Objectives

1. To evaluate the functional outcome of intertrochanteric fracture treated with proximal femoral nails and the effect on activities of daily living.
2. Radiological evaluation.

MATERIALS AND METHODS

The study involved 20 cases of intertrochanteric fractures of either sex from November 2015 - November 2017. All the cases were treated with intramedullary fixation- "proximal femoral nail." Broad-spectrum antibiotics (cephalosporin) were administered an hour before surgery followed by 48 hours after surgery, parent rally and then was continued with oral antibiotics until suture removal.

Surgical Procedure- All the patients were operated under combined epidural and spinal anaesthesia with an epidural catheter remaining in situ till third postoperative day. Fractures were reduced under C-arm control on a traction table. Limb was scrubbed, then painted and draped under sterile condition. A 5 cm incision was made above the tip of the greater trochanter and deepened to the gluteus medius muscle. Tip of the greater trochanter palpated and minimal muscle attachment was cleared off. Guide pin was introduced from the tip of the greater trochanter at the virtual meeting point of a line drawn in the center of the neck and a line drawn in the femoral shaft 6° lateral to the first line. A 2.8 mm guidewire was inserted into the femoral shaft and across the fracture site in 6° of valgus. Its position was checked under the C-arm. Then, the entry was widened with the awl. Reaming of the proximal femur is done 1 mm larger than selected nail diameter. Nail was fixed on the jig and the alignment was checked. Then, the nail was inserted into the femur. The position of the holes for the hip screws was checked under the C-arm for the depth of the nail. Guidewires for the screws were inserted via the jig and the drill sleeve. The ideal position of the guidewires is parallel and in the lower half of the neck in AP views in a single line in the center of the neck in the lateral views. The proximal wire is 15 mm from the subchondral bone and the distal wire 5 mm from the subchondral bone. First, the 8 mm hip screw was inserted after reaming over the distal wire and then the 6.5 mm cervical screw. The 8 mm hip screw tip was placed 5 mm away from the subchondral bone and the cervical screw 15 mm away from the subchondral bone. Static and dynamic 4.9 mm interlocking bolts were inserted via the jig into the distal part of the nail. This was done after removing the traction. The final position of the nail was checked in the C-arm in both views and the wound was closed in layers. Patient was given an IV broad-spectrum cephalosporin one dose preoperatively and followed b.i.d. dose till 48 hours depending on the condition of the wound and patient followed by oral antibiotics until suture removal.

Postoperative Protocol- Epidural analgesia was continued till third postoperative day. The limbs were elevated on pillow and patients kept under observation in recovery room until stable, then shifted to ward. IV antibiotics were continued for first 48 hours, and then, it was followed by oral antibiotics until suture removal. Static quadriceps exercises were started on the second and third postoperative day. Active quadriceps and hip flexion exercise were started on sixth and seventh postoperative day. Dressing was done on second and fifth postoperative days. Sutures were removed on tenth postoperative day. Patients were advised for non-weightbearing mobilisation with the aid of an adjustable walking frame as soon as tolerable. Full weightbearing walking was allowed after assessing for radiological and clinical union. All the patients were evaluated on follow ups at the intervals of 6 weeks and 6 months according to modified Harris hip score.

MODIFIED HARRIS HIP SCORE

Please mark one choice for each topic-

Pain- ___None/ignores (44 points).
___Slight, occasional, no compromise in activity (40 points).
___Mild, no effect on ordinary activity, pain after activity, uses aspirin (30 points).
___Moderate, tolerable, makes concessions, occasional codeine (20 points).
___Marked, serious limitations (10 points).
___Totally disabled (0 points).

Function- Gait

Limp___None (11 points).
___Slight (8 points).
___Moderate (5 points).
___Severe (0 points).
___Unable to walk (0 points).

Support___None (11 points).
___Cane, long walks (7 points).
___Cane, full time (5 points).
___Crutch (4 points).
___2 canes (2 points).
___2 crutches (1 point).
___Unable to walk (0 point).

Distance Walked___Unlimited (11 points).
___6 blocks (8 points).
___2-3 blocks (5 points).
___Indoors only (2 points).
___Bed and chair (0 point).

Functional Activities-

Stairs ___Normally (4 points).
___Normally with banister (2 points).
___Any method (1 point).
___Not able (0 points).

Socks/Shoes___With ease (4 points).
___With difficulty (2 points).
___Unable (0 point) sitting.
___Any chair, 1 hour (5 points).
___High chair, ½ hour (3 points).
___Unable to sit, ½ hour, any chair (0 point).

Public Transportation
__Able to enter public transportation (1 point).
__Unable to use public transportation (0 point).

Grading
<70 poor; 70-79 fair; 80-89 good; 90-100 excellent.

Inclusion Criteria
Age- 20-70 years.
Gender- Both males and females were included.
Fractures about trochanteric area classified according to the Orthopaedic Trauma Association System AO/OTA 31 A1/A2/A3.

Exclusion Criteria
Age more than 70 years.
Severely-ill patients with more than two comorbidities.
Non-ambulatory patients.

RESULTS

The age distribution was from 20 to 70 years. The mean age was 58.6 years. The largest age group of patients was from 61 to 70 years. There were 8 females (40%) and 12 males (60%) in this study. Domestic fall, road traffic accident and fall at work were the modes of injury among the patients. Most of the patients with domestic fall were older in age or had osteoporosis. 65% of fractures were right sided and 35% were left sided. Two patients (10%) required open reduction and the rest were reduced by closed method. All the fractures were classified as per Orthopaedic Trauma Association (OTA) classification in which 31 A1 were considered stable fractures. 31 A2 and 31 A3 fractures were unstable fractures. The present study constituted 80% unstable fractures. There were 2 (10%) cases of infection seen in the study. All were superficial infection and were treated with antibiotics. None required debridement or implant removal and both healed well. There was 1 (5%) case of implant failure that was screw breakage. There were no cases of nonunion in this study. All the patients were evaluated on follow ups at the intervals of 6 weeks and 6 months according to Harris hip score. The mean Harris hip score at 6 weeks was 45.35 with a SD ± 9.44. The mean Harris hip score at 6 months was 80.8 with SD ± 18.08. The overall functional outcome of the patients was excellent in 6 patients 30%, very good in 7 patients 35%, good in 4 patients 20% and poor in 3 patients 15% (Table 1 and 2).

Functional Outcome	Frequency	Percentage
Excellent	6	30%
Very good	7	35%
Good	4	20%
Poor	3	15%
Total	**20**	**100%**

Table 1. Overall Functional Outcome of the Patients after Modified Harris Hip Score

Fracture Pattern	Functional Outcome				Total
	Poor	Good	Very Good	Excellent	
31 A1	1	0	3	2	6
31 A2	2	3	3	3	11
31 A3	0	1	1	1	3
Total	**3**	**4**	**7**	**6**	**20**

Table 2. Functional Outcome and Fracture Pattern

DISCUSSION

Boldin C et al in 2000 carried a prospective study on 55 patients having proximal femoral fractures treated with proximal femoral nail. They achieved good results in most of the patients with very less complications at 12 month follow up. They concluded that proximal femoral nail was a good minimal invasive implant for unstable proximal femoral fractures.[1] Pajarinen J. et al performed a randomised clinical trial comparing the dynamic hip screw and proximal femoral nail in patients with pertrochanteric fractures emphasising functional outcomes and rehabilitation. At 4 months review, patient treated with proximal femoral nail regained their preinjury walking ability, shortening of the both femoral neck and shaft was seen in patients treated with dynamic hip screw, this difference was statistically significant.[2] Klinger H. M. et al have done a comparative study of 173 unstable intertrochanteric femoral fractures treated with dynamic hip screw and trochanteric buttress plate vs. proximal femoral nail. In case of proximal femoral nail, 17.2% revisions were necessary and in case of dynamic hip screw revision with TBPP was done in 21.6% of patients.[3] A shorter operation time and a considerable shorter in patient stay were common with proximal femoral nail. They concluded that dynamic hip screw with TBPP had a higher incidence of complications in unstable trochanteric fractures than proximal femoral nail. Reska M. et al reviewed 83 patients with proximal femoral fractures treated with proximal femoral nail. In their study, except for 2 cases, postoperative course was favourable in all of their patients. They concluded a careful surgical approach and technique with a stable osteosynthesis have markedly contributed to a more rapid mobilisation of a patient with the use of proximal femoral nail.[4] Gadegone W.M and Salphale Y.S in 2006 carried out a study on 100 consecutive patients who had suffered an intertrochanteric or high subtrochanteric fractures treated with proximal femoral nail. Complications occurred in 12 patients. They concluded that osteosynthesis with the proximal femoral nail offers the advantage of high rotational stability of the head-neck fragment.[5] Cao et al in 2009 concluded that PFN can shorten the operation time to reduce the amount of blood loss and postoperative complications. They also recommended that, for stable fractures, DHS, GN and PFN can be used; for unstable fractures, PFN and GN due to their biomechanical advantages.[6] In the present study, the average age was 58.6 years with minimum age being 20 years and maximum age being 70 years. In a study done by Ozkan K et al, the average age was 62 years with minimum age being 21 years and maximum age being 93 years.[7] In a comparative study

done by Ujjal Bhakat et al, the average age was 67.8 years with minimum age being 51 years and maximum age being 79 years.[8] In a study done by W.M. Gadegon et al, the average age was 69 years with minimum age being 33 years and maximum age was 82 years.[5] In a study done by Pu JS et al on 87 unstable intertrochanteric fractures, the average age was 75.3 years with minimum age being 60 years and maximum age being 93 years.[9] In a study done by Zhi Li et al, the average age was 75.61 years with minimum age being 65 years and maximum age being 91 years.[10] In a study done by Domingo et al, the average age was 80.1 years.[11] In a study done by K Akan et al, the average age was 81 years with minimum age being 65 years and maximum age being 95 years.[12] Of all compared study groups, present study age group was the youngest. This age group had more chances of surgical fitness when compared to all other studies having a better outcome potential by age alone. In the present study, there was an increase in male-to-female ratio of 1.5:1 with 12 being males and 8 being females, which was closest to Ozkan K et al who had a male-to-female ratio of 1.5:1 with 9 males and 6 females.[7] Unlike the present study, there was female predominance in other studies like Domingo et al with a ratio of 1:3 with 76% being female patients.[11] K Akan et al who studied 80 patients with 18 being males and 62 being females with a ratio of 1:3.[12] Pu JS et al studied 87 patients with 21 being males and 66 being females.[9] Zhi Li et al studied 66 males and 90 females with a ratio of 1:1.3.[10] In the present study, 4 patients (20%) had 31 A1 fracture pattern, 13 patients (65%) had 31 A2 fracture pattern, 3 patients (15%) had 31 A3 fracture pattern. In a study done by Domingo et al, 26% patients had 31 A1 fracture pattern, 59% had 31 A2 fracture pattern and 15% had 31 A3 fracture pattern.[11] In a study done by W.M Gadegone et al, 36 patients (37.5%) had 31 A1 fracture pattern, 40 patients (41.6%) had 31 A2 fracture pattern, 20 patients (21.5%) had 31 A3 fracture pattern and 4 patients had combination of injuries.[5] In a study done by K. Akan et al, 34 patients (42.6%) had 31 A1 fracture pattern, 34 patients (42.6%) had 31 A2 fracture pattern and 12 patients (15.1%) patients had 31 A3 fracture pattern.[12] In a study done by Ujjal Bhakat et al, 17 patients (56.6%) had 31 A2 fracture pattern and 13 patients (43.4%) had 31 A3 fracture pattern.[8] In a study done by Minos Tyllianakis et al, 521 patients (45.6%) had 31 A2 fracture pattern and 25 patients (54.4%) had 31 A3 fracture pattern.[13] This study correlated with Domingo et al study[11](Table 3).

Study	Fracture Type (AO/OTA)		
	31 A1	31 A2	31 A3
Domingo, et al	26%	59%	15%
W.M. Gadegone, et al	37.5%	41.6%	21.5%
K. Akan, et al	42.6%	42.6%	15.1%
Ujjan Bhakat, et al		56.6%	43.4%
Minos Tyllianakis, et al		45.6%	54.4%
Present study	20%	65%	15%

Table 3. Comparison of Fracture Patterns in Various Studies

Total incidence of complications in the present study was low. "Z-effect" was not seen in present study, but other complications included screw breakage (1 patient), shortening (2 patients) and infections (2 patients). W.M. Gadegone et al, where 7% of the patients had superficial infection and 3% of the patients had Z-effect.[5] K. Akan et al in their study of 80 patients observed total complications in 8 patients (10%) and Z-effect in 1 patient (1.25%).[12] Werner Tutschku et al in their study of 70 patients observed total complications in 18 patients (25.7%) and Z-effect in 5 patients (7.1%).[14] In the present study, infection was present in 10% (2 patients) of the patients, which was superficial and was treated with antibiotics and regular dressing in the ward. None required debridement or implant removal or revision surgery and healed well. In their series of 295 patients with trochanteric fractures treated with PFN by Domingo et al, the average age of the patient was 80.1 years, which possibly accounted for 27% of the patients developed complications in the immediate postoperative period.[11] There was no case of nonunion or greater trochanter splintering, which is usually encountered, while inserting the nail with present study. Ujjal Bhakat et al in their study observed average shortening of 0.5 cm in the PFN group.[8] Results were evaluated by Harris hip score. In the present series, we had 30% excellent, 35% very good, 20% good and 15% poor results, which was similar to Ozkan et al that concluded the use of PFN is a good option in the treatment of intertrochanteric fractures especially the reverse oblique type.[7] The functional outcome of patients was evaluated at each follow up. The mean score was 45.35 at 6 weeks and 80.86 months, respectively. In the present study, the mean Harris hip score at 6 months was 80.8, which were comparable to Ujjal Bhakat et al who reported a mean Harris hip score of 82.8 at 6 months.[8] We also cross tabulated the functional outcome with fracture pattern, which showed 2 patients with 31 A1, 3 patients with 31 A2, 1 patient with 31 A3 fracture pattern had excellent results (Table 2).

Limitations- The stringent inclusion criteria limited to AO 31 A, B and C type fractures limited the sample size. Hence, the conclusion could not be generalised to all intertrochanteric fractures. Nevertheless, study correlated with the outcome positively with the degree of complexity of fracture pattern positively.

CONCLUSION

We conclude from our study that proximal femoral nailing can be considered the most rational method of treating intertrochanteric fractures, especially the unstable and reverse oblique type fractures in elderly. PFN insertion is a minimally-invasive procedure with less operating time and less blood loss. This closed technique preserves the fracture haematoma leading to early union and early mobilisation. It can be used with equally good results in all grades of osteoporosis with minimal postoperative complications. Early mobilisation and weightbearing with rapid rates of healing was possible. But, proximal femoral nailing requires

a higher surgical skill, good fracture table and image intensifier. It has a steep learning curve.

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