

The proximal femoral nail in treatment of unstable intertrochanteric fractures

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Abstract

Background

The advantages of intramedullary fixation of per trochanteric hip fractures over dynamic screw-plate devices in the clinical setting are still a matter of debate. The purpose of the study was to assess the functional outcome and complications of unstable trochanteric fractures treated by proximal femoral nail.

Patients and Methods

This study was prospectively reviewed the clinical results of 48 patients. All fractures were fixed with proximal femoral nail (PFN), between May 2014 to May 2017 (30 women, 18 men) main age were 52 years with 48 unstable per trochanteric fractures 25 (31-A2), 23 (31-A3). Mean follow-up period was 24 months (range, 12 to 36 months). Results in this study closed reduction were achieving in 36 patients and open in 12 patients. Excellent results in 75% of patients, good in 16.7% of patients and poor in 8.3 %.

Complication

were occurred in 7 patients (14.5%), one patient at the follow up cut-outs of the neck screw, one patient had delayed union of the fracture., 2 patients suffer from superficial wound infection and 3 patients had DVT.

Conclusion

Proximal Femoral Nail is a better implant for unstable type of intertrochanteric and subtrochanteric fractures as our study shows excellent and good results.

Keywords

Unstable intertrochanteric Fractures, Proximal Femoral Nail, Dynamic Screw of the Hip.

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Introduction

The trochanteric fracture is one of the most important causes of mortality and morbidity in the geriatric population, often associated with generalized physical deterioration,[1]. Before 1960s, treatment for trochanteric fractures was of necessity nonoperative in elderly patients, this approach was associated with high complication rates,[2,3]. Techniques of operative fixation have changed dramatically since the 1960s. Operative management has consequently become the treatment of choice for intertrochanteric fracture, [4]. Early surgical intervention is advocated in the majority of these patients to reduce the complications associated with long-term immobilization, [5,6]. Several fixation devices have been developed to overcome the difficulties encountered in the treatment of unstable trochanteric femoral fractures, to aid fracture fixation, facilitate early ambulation and reduce the risk of failure, with improved functional results when treating these intertrochanteric fractures,[1-3]. Implants can be

classified into two groups extramedullary and intramedullary devices. [3,4,7]

However there is, 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 [4-8,9].

The intramedullary hip screw devices developed (PFN), since its introduction in 1997, in many clinical studies [10,11] have shown good functional results with intra-operative problems was few and decreased rate of complications. to improve the rotational stability of the proximal fracture fragment PFN was developed with additional advantage of an unreamed intramedullary femoral nail with an antirotation and load-bearing, femoral neck screws and offer, 12.13 several potential theoretical advantages: a. More efficient load transfer, b.the lever arm was short to decreases tensile force on the implant c. Incorporates a

sliding hip screw mechanism, which allows controlled fracture impaction. Theoretically it has shorter operative time and decrease soft-tissue dissection than a sliding hip screw [12,13,14,15]

This study was designed to assess functional outcome and complications of the PFN device in patients with unstable trochanteric fracture.

Patients and Methods

The study was a prospective Cohort study that will include patients presented to emergency departments of Suez Canal university hospitals, and was approved by the Ethical Committee of our Institution all consecutive patients with trochanteric and subtrochanteric extension femoral fractures having an unstable pattern, of both sex and any age between May 2014 to May 2017.

Exclusion criteria: ipsilateral femoral neck or shaft fractures, medically unfit patients whom can't undergo anesthesia and surgery in general, severe soft tissue problems in area of surgical approach (burns, necrosis, and acute infection), Patients with a pathological fracture, inability to walk before the fracture, neurological disorders, multiple injuries (polytrauma), and dropped out patients during the study period were excluded.

The informed consent was written by patient and obtained before to their inclusion in this study.

Plain radiographs were obtained on admission and all fractures were categorized according to AO/ASIF classification [14] (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). The primary end-point was defined as complete radiological and clinical healing of the fracture (at four months and one year). Other second end-points were intra-operative problems, revision surgery (related to the failure of primary surgery) and mortality. Baseline characteristics were. All patients underwent fixation using proximal femoral nail. Patients were made to do high sit up, isometric quadriceps & deep breathing exercises from 1st day post operative. legs dangling & ROM exercise for both knees was started from day 2. Non weight bearing walking begun with crutches or walker as soon as patients become confident (on an avg at 4-7 days post operative). Follow up period done monthly during the first 6 months every & at 1 year. At each follow up patients were assessed in terms of local wound status, pain, and ambulation status, local part x ray to assess implant position, fracture healing Harris hip scoring system for all patients & the results were rated as excellent, good, fair or poor.

Surgical Procedures:

The PFN used in this study was a solid SS (316 L) nail of 240 mm in length and 10 or 11 mm in diameter, and it inserted without need of reaming to the femoral medullary canal. A second hip pin was used to provide rotational stability was inserted in the femoral head-neck fragment. [13]. The PFN may be distally locked either dynamically or statically. The patient position during surgery on a traction table, with the affected limb slightly adducted to enable the surgeon to insert of the implant. All patients received a prophylactic intravenous antibiotic, anticoagulants during their stay in hospital,

Results

Among the 48 patients 30 women and 18 were males and their mean age being 52 years (rang 42 -70). 24 of them due to simple fall, 14 were due to RTA & 10 were due to falling from height, table (1) Closed reduction achieved in 32 patients. Open reduction required in 16 patients. The reduction was anatomical in 13 patients, good in 32 patients, and acceptable in 3 patients. The reduction was considered good, acceptable or poor –according to the modified criteria of Baumgaertner et al [16]

Table (1): gender & etiology

	Gender		Etiology		
	M	F	Fall	F.H	MCA
No	18	30	24	10	14
%	37.5	62.5	50	21	29

Twenty five Patients in this study classified as AO (31A2), and twenty three as (31A3) table (2) and as shown in case presentation, the side affected were 27 right side and 21 were left side.

Medical comorbidities requiring treatment before surgery encountered in 32 patients. Method of anesthesia (general or regional) 38 patients were under spinal and the other 10 patients were under general anesthesia.

The time interval between admission of the patient into the hospital and operation ranged from zero to four days, with mean of 1.82 days.

The interval period admission and operation were varied from 1 day to 4 days, 12 patients (25 %) were operated in the same day of admission, 6 patients (12.5%) were operated one day post admission, 12 patients (25%) were operated two days post admis-

sion, 12 patients (25%) 3 days and 6 patients were operated 4 days post admission.

Table (2): Distribution of patients according to fracture classification

Classification AO31	Sub type	NO	%
A1	1,2,3	0	0
A2	2	10	20.83
A2	3	15	31.25
A3	1	8	16.66
A3	2	10	20.83
A3	3	5	10.41
Total		48	100

Mean operative time was 105 mins. (range-60-150 mins). Average blood loss was 400cc (100- 1500ml). The mean fluoroscopy time was 60 secs. (varied between 40 to 180 secs), table (3)

Intra-operative complications. There were 12 local intraoperative complications; Problems with insertion of the hip screw(s) included breakage of the K-wire, perforation of the femoral head and converging of the K-wires. Distal interlocking was troublesome in nine patients. In four the drill bit and/or screw were missed the nail, In all patients both the cervical screws and distal locking inserted.

In 3 patient cerclaging was done at distal locking site due splintering of fracture.

Table (3): intra operative data

	Operative time			Blood loss			Fluoroscopy time		
	60min	90min	150min	>150	150-300	300<	>60 sec	60-120	120<
N	24	14	10	25	16	7	24	18	6
%	50	29	21	52.1	33.3	14.6	50	37.5	12.5

Post operative complications

One patients developed superficial infection & treated with appropriate antibiotics of week without any intervention, 3 patients developed DVT and colored duplex ultra sound were done revealed 2 patients had popliteal DVT and 3 patient s had extensive DVT and all patient received low molecular heparin according their weight and follow up revealed complete recovery and all of them continue on oral anticoagulant for 6 month.

Among patients who completed 6 months follow up, one patients suffer from delayed bone union one of them need reoperation freshening the fracture site and bone graft and achieve bone union after 4 months from the last operation and the other one converted into bipolar with calker after complaining from cut out the femoral neck after 6 months post operative .

Sixteen patients were able to walk non weight bearing with crutches or walker during the 1st 10 days of post-operative period, at 6 weeks 28 patient able to weight bearing and all 48 were able to do full weight bearing at 18 weeks of postop.

38 of the 48 patients (79%) were able to squat and sit cross leg at their final follow up, table (4).

Table (4): Time of union and full weight bearing

Time of union and full weight bearing	No	%
6 weeks	28	58.4 %
12 weeks	38	79.2 %
18weeks	48	100 %

Mean duration of hospital stay was 6 days (3 to 14 days). Average follow up period was 24 months (12 months to 36 months).

The average shortening of the operated limb after fracture healing was 1.3 cms (range 0.5-2.8 cm).

Post-operative hospital stay twenty six patients (54.2 %) were discharged one day post operatively, while 10 patients (20.83%) were discharged two days post operatively and 12 patients (25%) were discharged one week post-operative.

The mean Harris hip score at 6 weeks ranged from 58 minimum, to 84 maximum, with mean of 69.6 in 28 patients and at 18 weeks, The Harris hip score were ranged from 70 minimum, to 98 maximum, with mean of 83.7 in 48 patients 75% of our patients had excellent result & 16.7% of our patients had good result and 8.3 % had poor functional results, table (5).

Table (5): HHS post-operative

HHS 6 Week				HHS 1 YEAR			
P	F	G	E	P	F	G	E
6	10	20	12	3	1	8	36
12.5	20.8	41.7	25	6.25	2.1	16.7	75

A 42 years old male patient, worker, presented after RTA by RT intertrochanteric fracture. He has no medical chronic illness. On arrival to the hospital, primary and secondary surveys done, he has stable vital signs, no internal bleeding or other associated injury. X-ray of pelvis showed RT intertrochanteric fracture. Figure (1) and (2).



Figure (1): fracture trochanteric 31A3.3



Figure (2): skin incision

The fracture classified as 31 A3.3 on AO classification, He admitted to the hospital, stayed 3 days preoperatively. The fracture fixed by PFN using spinal anesthesia and supine position. The operative time was 100 minutes. Closed reduction under fluoroscopy done. Time of radiation exposure was 70 sec. figure (3,4)



Figure (3): post operative x ray



Figure (4): follow up xray

The intraoperative blood loss was 300 ml. The patient was stayed two days post operatively then discharged. The fracture shows radiological and clinical union at 8 weeks. The H.H.S of the patient at 6 weeks was 29; at 12 weeks was 58, at 18 weeks was 70 and at 24 weeks was 87.

Discussion

Inter trochanteric fractures are very frequently faced by orthopaedic surgeons worldwide and 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 To avoid these complications operative treatment is favored.

The AO/ASIF in 1997 introduced a third generation intramedullary device called proximal femoral nail. It also works on principal of controlled collapse at fracture site but being intramedullary it has short lever

arm, placed closed mechanical axis of femur so it is a load shearing device. The advantages of this device are less soft tissue dissection required, addition of 6.5 mm antirotation screw to reduce rotation of cephalo-cervical fragment, it facilitates early mobilization, longer implant length, small & higher level placed valgus angle, small diameter & fluting tip reducing stress riser effect, easy identification of entry portal i.e. tip of greater trochanter, Higher placement of distal locking screws avoiding abrupt changes in stiffness of construct thereby reducing stress riser effect. But proximal femoral Nail also has some potential disadvantages like Reverse Z effect, Z effect and high learning curve.

In comparison of this study results with the results of others studies in the literatures which used the proximal femoral nail to fix the intertrochanteric fractures. Those studies are.

- 1) Ambulgeker *et al*, [17] operated and followed up a 17 patients with unstable intertrochanteric fractures, at 2009 to 2010, and all the patients were above 60 years old at time of operation.
- 2) From 2012- 2014, Gupta *et al*, [18] operated and followed up a 160 patients with intertrochanteric fractures, 72 male and 88 female, aged 63- 78 years (mean 70.2 year).
- 3) Ramanarayan *et al*, [19] operated and followed up a 25 patients with intertrochanteric fractures, with age range from 54 to 94 years, whom divided into 17 stable and 8 unstable fractures.
- 4) From 2012 to 2013, Yadav *et al*, [20] operated and followed up 7 males and 13 females (total 20 patients), aged 21- 80 years, (mean of 63 years).

Regarding the age of patients, the mean age of patients in this study was 52 years ranged from 42 to 70 years. The study of Gupta *et al*, [18] showed that the mean age of patients was 70.2 years while the study Yadav *et al*, [20] showed that the mean age of patients was 63 years. The younger age of patients in this study is due to increasing the rate of high energy trauma such as falling from height and road traffic accident (72.73%). This supports the view that bone quality play an important role in causation of fracture in elderly, which occur after trivial fall. [18, 20]

In this study, there were female predominance (female: male ratio 5:3), which shows no difference with other studies, such as the study of Gupta *et al* where there was female predominance (55 %), and the study of Morihara *et al* where the female percentage was 80.5 %, which explained by the fact that the females are more prone to osteoporosis after menopause, [18, 21].

The mode of trauma in this study were road traffic

accident (29%), slip and fall (50%) and fall from height (21%), compared to the Yadav *et al* study were the road traffic accident occupy only 25% , and slipping and fall 75% and there were no cases of falling from height. This type of high energy trauma can explain the young age of patients and the male predominance. [20]

We used the AO classification for intertrochanteric fractures in this study, in which it subdivided into 31 A1, 31 A2 and 31 A3. Gupta *et al* and Morrihara *et al* also were used the same classification. Table (6) shows a comparison between this study and those studies. The highest percentage of patients in this study were A2 classification (45.45%), which is the same with Morrihara *et al* (51.7%), but having difference with Gupta *et al* were the highest percentage was A3 classification (50%), [18, 21].

Table 6: Comparison according AO classification

AO classification	This study	Gupta <i>et al</i>	Morrihara <i>et al</i>
31 A1	0%	12.5%	41.4%
31 A2	52%	37.5%	51.7%
31 A3	48%	50 %	6.9%

The study of Ramanarayan *et al* shows a mean time between admission to hospital and operation was 6.68 days, in comparable with this study in which the pre-operative time was 1.82 days, which reduce the cost of treatment. Non weight bearing mobilization was started in 16 patients on 10 days post operative day as pain tolerance. In this study 54.2% of patients discharged one day post operatively, 20.8% discharged two days post operatively and 25 % discharged one week post operatively due to management of post complications no other studies clearly stated the time of discharge. [19]

In all patients standard 130 /135 stainless steel proximal femoral nail was used. Closed reduction was achieved in 32 patients (66.7%). The operation time in this ranged from 60 minute minimum to 150 minute maximum with mean of 105 minutes. In comparable with Ambulgeker *et al* study in which the mean operative time was 104.1 minutes and the study of Ramanarayan *et al* in which the mean operative time was 68 minutes. This show the advancing our learning curve by decreasing the operative time gradually except in some patients, intraoperatively problem that increased the operative time. [17, 19]

Ambulgeker *et al* stated the mean intraoperatively blood loss was 286 ml, while Yadav *et al* stated it was 235 ml and Morrihara *et al* 72 ml. In this study the

intraoperatively blood loss ranged from 150 to 380 ml with mean of 246 ml, which is within the same range of other studies. The lesser intraoperatively blood loss the lesser the need for intraoperatively or post operatively blood transfusion and the lesser the post operative hospital stay. In this study, there were no patients whom needed either intra or post operative blood transfusion, [17, 20, 21] The exposure to C arm radiation intraoperatively in this study ranged from 1 minute and 2.08 minutes, with mean time of 1.3 minutes, agreed by Yadav *et al* study in which the mean time was 1.22 minutes, and less than the Ramanarayan *et al* study which was 2.84 minutes. In this study, the operation team tried their best efforts to reduce the number of images taken by C arm, to reduce the hazardous effect of radiation to both the patients and the operation team. [19, 20]

Fixations of both stable and unstable intertrochanteric fractures by PFN have been reported in the literature together, with acceptance of an increasing rate of complications and poorer outcome as the fracture pattern increase in severity (stable to unstable). The risk of femoral shaft fractures was significantly decreased

because of narrower distal diameter of the PFN, if compared with other intramedullary nails. As the PFN is not dependant on multiple parts, it allows good rotational control and decreasing the risk of mechanical failure. The risk of iatrogenic proximal femoral fractures is decreased by using the PFN due to smaller diameter of lag screws that require less reaming, with decreased risk of mechanical failure.

In this study, the patients with intertrochanteric fractures whom fixed by proximal femoral nail, were needed 5 weeks minimum and 10 weeks maximum to have sound healing, clinically and radiologically, and can do full weight bearing with an average of 6.6 weeks, comparable to Gupta *et al* study in which they require 8 weeks in average. The majority of patients, (79.2%) was needed 12 weeks to have sound healing and can perform full weight bearing. [18]

At six months post operative follow up, our patients score on H.H.S ranged from 77 minimum and 98 maximum with mean of 92. Table (7) shows percentage of H.H.S grades for this study, Ambulgeker *et al* study, Ramanarayan *et al* study, and Gupta *et al* study at six months postoperatively. [17,18,20]

Table 7: Harris hip score at six months (24 week)

Harris hip score	This study	Ambulgeker <i>et al</i> study	Ramanarayan <i>et al</i> study	Gupta <i>et al</i> study
Excellent	75%	52.95%	68%	67%
Good	16.7%	35.29%	24%	28%
Fair	2.1%	11.76%	4%	5%
Poor	6.25%	0%	4%	0%

At 6 months post operatively, 75% of patients included in this study performed an excellent score on H.H.S, which is better than Ramanarayan *et al* study (68% of patients score excellent score), Gupta *et al* study (67%) and Ambulgeker *et al* study (52.95 %). By contrast, in this study the patients score good score were 18.18% which is less than all other studies. Fair score occupy only 9.09% of patients included in this study which is close to the Ambulgeker *et al* study (11.76%), but higher than both Ramanarayan *et al* and Gupta *et al* studies. At 6 months post operatively, no patients included in this study had poor score, [17,18,19]

Regarding complications, superficial infection occur in patients (4.2%) about one week post operatively because non compliance of the patient to the post operative antibiotics, and were treated successfully by daily twice regular dressing culture and sensitivity and appropriate i.v antibiotics, no deep infection oc-

cur or chronic osteomyelitis. Also 5 patients suffers from deep venous thrombosis (DVT), in spite of low molecular prophylactic heparin, which were below the level of popliteal vein, and treated by therapeutic dose of low molecular heparin and long term oral anticoagulant.

All of patients included in this study show union in average time (6 to 12 weeks). All PFN used in the study shows good stability, Three patients complained of shortening 1 to 1.5 cm, which can be managed by sole raise.

The smaller incisions, relatively less blood loss, shorter operative times, and less postoperative pain with the PFN indicate that the PFN has an advantage, earlier restoration of pre-injury walking ability and a better overall functional outcome.

Conclusion

The proximal femoral nailing is a reliable method for fixation of stable and unstable intertrochanteric fractures, with less operating time, surgical exposure, blood loss, and complications. It provide stable fixation that improve fracture healing and early weight bearing with early return of the patient to pre fracture level of function.

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