Intramedullary Nailing Versus Dynamic Condylar Screw for Subtrochanteric Femur Fractures

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Abstract:

The objective of this study was to evaluate the clinical outcome of closed intramedullary nailing with long PFN to open reduction and internal fixation using 95 degree Dynamic condylar screw for the management of subtochanteric femur fracture in relation to fracture healing, functional mobility,complications.

Materials And Methods: *In a retrospective study, 80 patients were evaluated who had undergone intramedullary fixation with Long PFN (PFN group) or a 95 degree Dynamic condylar screw (DCS group) for traumatic subtrochanteric fractures in our institute during a 6 year period from august 2008 to January 2014. The patients were accessed during their hospital stay and clinical and radiographic analysis were performed when follow up was made at one, two, three, six, twelve, eighteen, twenty four months. A radiograph with signs of callus formation were used to asses fracture healing and Harris hip score was used to asses' hip function.*

Result: *All the 40 patients in PFN group healed uneventfully except 1 case with delayed union whereas 40 patients in DCS group achieved delayed union on an average union at 16.5 months walking and squatting ability was completely restored in every case at follow up examination 6 months postoperatively. The average operative time being 35 mins in PFN group whereas in DCS group had and average operative time of 64 mins. No nonunion were reported in PFN group whereas 17.5% patient went into nonunion in DCS group.Revision rates were 10% in DCS group with 4 patients of implant breakage and none in PFN group. Two cases had developed infection in DCS group whereas 1 case had superficial skin infection in PFN group.*

CONCLUSION: Long PFN is a reliable implant for subtrochanteric fractures, leading to high rate of bone union, no implant failure, and minimal soft tissue damage.

Keywords: *Dynamic condylar screw*

Introduction

A subtochanteric femur fracture is a fracture between the lesser trochanter and a point 5cm distal to lesser trochanter Subtrochanteric femur fractures are common and account for 10% to 30% of all proximal femoral fractures, and they can affect persons of all ages [1,2]. A bimodal age distribution is noted where young patients (mostly male) present with high energy injuries and the elderly (usually female) present with osteoporotic low- energy fractures [3,4]. Such fractures are associated with high complications rate and include non-union and implant failure, which occur regardless of the fixation method, because of the unique anatomical and biomechanical features of the subtrochanter [2,3]. Its cortex is thinner than the rest of the femoral shaft; it starts with the cancellous bone at the distal end of the intertrochanteric region and extends into the thick cortical bone of the proximal diaphysis [5,6] High compressive medial stresses and tensile lateral stresses were placed on fracture fixation devices [7,8] A medial buttress is important to minimize implant stress and fatigue failure [9-11].

In the 1970s and 1980s, internal fixation was the standard treatment for femoral shaft fractures, whereas open anatomic reduction and internal fixation with Fixed angle blade plating was recommended for subtrochanteric fractures [12-14]. Long PFN incorporate fixation of the femoral neck and head has advantages, namely shorter operating times and less blood loss, as well as lower rates of infection, non-union, and implant failure [15–17]. Plating is still recommended for fractures with proximal trochanteric extension, especially when medial cortical contact can be restored [3,18,19]. We aimed to compare closed intramedullary nailing without anatomic reduction to open reduction and internal fixation using a fixed angle device for subtrochanteric femoral fractures. The null hypothesis was that there was no difference in treatment outcomes between the two individual methods of surgical fixation of the subtrochanteric fractures.

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Table 1: Demographics

[illegible]	DCS group	PFN group
Mean age (years)	41.6	43.5
Sex(male: female)	1.6:1	2.6:1
AO classification		
A1.1 Simple fracture spiral	5	8
A2.1 Simple fracture oblique (>30°)	6	5
A3.1 Simple fracture transverse (<30°)	8	12
B1.1 Wedge fracture	3	1
B2.1 Wedge bending fracture	9	6
B3.1 Wedge fragmented fracture	7	5
C1.1 Complex spiral fracture	0	2
C2.1 Complex segmental fracture	1	1
C3.1 Complex irregular fracture	1	1

Table 2: Surgical Details and Outcomes

Outcomes	DCS group, n=40	PFN group, n=40	P value
Mean operating time (minutes)	63.5	35.75	0.048
Mean duration of hospital stay (days)	5.53	5	0.186
Mean blood transfusion (units)	17 (42.5%)	0	0
Mean union time	16.95	12.03	0
No. (%) of infection	2 (5%)	0	0.39
No. (%) of non-union	10 (25%)	0	0.002
No. (%) of revision	10 (25%)		0.003

[illegible]	DCS group n=40	PFN group n=40
Excellent	0.475	0.85
Good	0.45	0.125
Fair	0.075	0.025

Materials And Methods

Eighty patients with subtrochanteric fractures who had undergone intramedullary fixation with long proximal femoral nail or 95 degree dynamic condylar screw. All cases were performed in our institute from August 2014 to January 2014 including the follow up.

The AO/ASIF group, in their Manual of Internal Fixation, recommend a three-part classification. This is a descriptive classification based on the fracture configuration. The subtrochanteric fracture belongs to the group of femoral diaphyseal fracture 32-(X-#)–1.(X) is the sub- classification of the fracture patterns, and these patterns are subclassified into a, b, and c subgroups. Subgroup "a" represents simple fractures, group "b" represents wedge fractures, and "c" represents complex comminuted fractures. The numeric description # indicates the degree of comminution. Only fresh cases with closed fractures were included in this study .Open fractures, ipsilateral femoral shaft or neck femur,pathological fractures , and a pre-existing femoral deformity were excluded from the study.

Patients presenting to our hospitals with acute subtrochanteric femoral fractures were subjected to initial management and resuscitation followed by a detailed history taking clinical evaluation, radiograph of pelvis showing both hips and the whole femur including the knee, and other relevant investigations. Informed consent was obtained from each patient and the human research ethics committee of hospital approved the study protocol.

Implant details:

Long Proximal femoral nail

The implant consists of two proximal screws – an 8 mm and a 6.5 mm femoral neck screw – two 4.9 mm distal locking bolts, and an end cap. The nail has a proximal diameter measuring 14 mm. This increases the stability of the implant. The mediolateral valgus angle is 6°, which prevents varus collapse of the fracture even when there is medial comminution. Proximally, it has two holes: the distal one is for the insertion of an 8 mm neck screw, which acts as a sliding screw, and the proximal one is for a 6.5-mm hip pin, which helps prevent rotation. The distal diameter is tapered, which also has grooves to prevent stress concentration at the end of the nail and avoids fracture distal to the nail. The nail size ranges from 360mm-440mm Distally, the nail has two holes for insertion of 4.9-mm locking screws, of which one is static and the other is dynamic, allowing a dynamization of 5 mm. reaming of the trochanteric region and the femoral isthmus was usually necessary for inserting the nail.

DCS implant details:

The dynamic condylar screw is designed to provide strong and stable internal fixation. DCS plates are made of 316L stainless steel and are cold work for strength. The two holes closest to the barrel accept 6.5 mm cancellous screw this enhances stability of the most proximal subtrochanteric femur fracture fragments. DCP holes in the DCS side plate allow angulation of 4.5 mm cortex screw and axial compression across a shaft fracture. The DCS plates are available with 6 to 16 holes, for varied clinical situations. The DCS lag screw is available in 50mm to 145 mm lengths. The DCS compression screw can be used for additional compression: only one size compression screw is needed.

Operative Technique

PFN group:

The patients were positioned supine on the fracture table in such a way as to visualize the proximal femur in lateral and anteroposterior planes. To overcome the difficulty in accessing the tip of the trochanter and for unimpeded access to the medullary cavity of the proximal femur, the trunk was abducted at the waist by 10–15° to the contralateral side or the affected limb was adducted to 10–15°. A skin incision measuring 3–5 cm

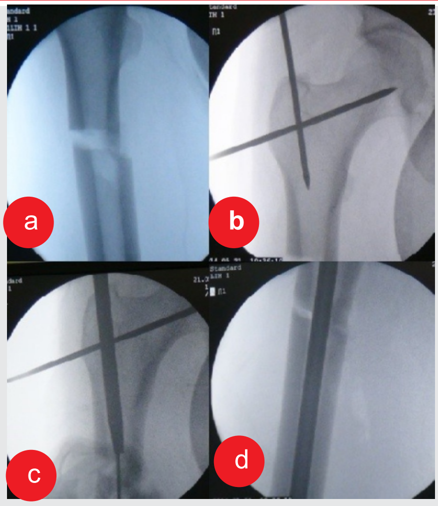

Figure. 1 AP view of subtrochanteric femur fracture (a) , entry point taken after Fixing the proximal fragment with hip pin (b), introduction of long PFN through Guide wire (c), passage of long PFN through fracture site (d)

is made 10 cm proximal to the tip of the greater trochanter on the proximal extension of the anatomical femoral bow. Then the subcutaneous tissue and deep fascia are incised and the gluteal muscle is split along its fiber. The greater trochanter is palpated. Under image intensifier control, the bone awl was used for entry point at tip of the greater trochanter in anteroposterior view, and between the anterior one-third and posterior two-thirds in the lateral view, when there was difficulty in pushing the guidewire through the cortex of the greater trochanter. Then the cannulated drill bit was passed over the guidewire and through the protection sleeve to open the medullary canal .The ball-tipped guidewire was advanced into the distal fragment. After the tissue protector had been introduced, the reaming shaft, fitted with the first reamer head, was inserted over the guidewire. Usually, reaming begins with a 9 mm medullary reamer. Reaming was performed in sequential steps by increments of 0.5 mm each. An exchange tube was then passed over the guidewire and advanced into the medullary cavity until it entered the distal fragment. The ball-tipped guidewire was then removed and replaced with a plane-tipped guidewire and then the tube was removed after confirming the position of the plane-tipped guidewire in the distal fragment of the medullary cavity under an image intensifier.

A nail of appropriate size as determined preoperatively (size of the medullary canal) was assembled into the insertion handle. After confirming satisfactory fracture reduction, the nail was inserted manually as far as possible into the femoral opening. This step was performed carefully without hammering by slight twisting movements of the hand until the hole for the 8 mm screw was at the level of the inferior margin of the neck.

The guidewire for the neck screw and the hip pin were inserted with the help of the aiming device. The hip pin was inserted first to prevent possible rotation of the medial fragment when inserting the neck screw. The length of the hip pin was indicated on the measuring device and was calculated 5 mm before the tip of the guidewire. Then the neck screw was inserted using a cannulated screwdriver. The final position was confirmed with an image intensifier. Rotation of the distal fragment was then confirmed, followed by distal locking and closure of the wound in layers. (Fig. 1a–d).

DCS group

The patients were positioned supine on the fracture table in such a way as to visualize the proximal femur in lateral and anteroposterior planes. Lateral approach and skin incision measuring 5 cm is made from the tip of the greater trochanter to the proximal extension of the anatomical femoral bow between the vastus lateralis muscle and intermuscular septum planes were dissected. The aiming device for the DCS was chosen and placed against the lateral cortex. Its position was checked using image intensification in an AP view, according to the anticipated position of the guide wire. The guide wire inserted through the aiming device. In the AP view was in the lower or caudal half of the femoral head and on the axial view it was parallel to the axis of the neck and in the middle of the neck. The guide wire was advanced into the subchondral bone and its tip kept 10 mm off the joint. Length of the DCS screw determined with help of the measuring device. Selected screw inserted which was the same length as measured. Cannulated triple reamer adjusted to the length of the

Figure 2: AP and lateral radiographs of DCS at 18 months of follow up

Figure 3: AP and lateral radiographs of PFN at 12 months of follow up

Figure 4: Implant failure in subtrochanteric femur fracture treated with DCS

screw and hole were drilled for the screw and the plate sleeve. The selected screw mounted on a handle and inserted over the guide wire and handle removed along with the guide wire. The length of the plate determined by the extent of the fracture. The DCS plate inserted and seated with the impactor. The plate is fixed to the femoral shaft with an appropriate number and size of plate holding cortical screws. Lag screw inserted when possible through the plate to compress the fracture.

Post Operative Care

Post operatively patient vital sign were monitored. Antibiotics and analgesics were continued in post-operative period. Suction drain used was removed after 48 hour. Sutures were removed on 15th post-operative day.

Patients were encouraged to sit on the bed 24 hour after surgery patients were taught quadriceps strengthening exercises and knee mobilization once the suction drain was removed. The patients were encouraged to walk non weight bearing with axillary crutches or a walker depending on the pain tolerability of each patient. All patients were followed up at the orthopedic clinic at 2 weeks for removal of sutures and then at an interval of 4 weeks until the fracture union was noted and then every 3 months for 1 year and then every 6 months for maximum 2 years . At every visit the patient was assessed clinically and a radiograph of the involved hip with femur was taken to assess fracture union and implant bone interaction [20, 21]. The main outcome measure was union time, revision surgery, infection, nonunion, mortality, duration of hospital stay, blood loss, operating time, and general health. Infection was considered present with or without evidence of an organism, if antibiotics or debridement were deemed necessary. Non-union was defined as the absence of bridging callus on 2 radiographic views 9 months after injury. Fixation failure was defined as migration or failure of the implant, or loss of reduction deemed to require revision surgery. Patient was evaluated with Harris hip score at the end of 2 years of follow up.

Dichotomous outcomes were analyzed using the Chi squared and Fisher's exact tests, and Student's t test was used for continuous outcomes. A p value of <0.05 (2-tailed) was considered statistically significant.

Results

This retrospective study includes 80 subtrochanteric femur fractures in 80 patients with mean age of 42.5 years (range 17-75 years). The male (54) to female (26) ratio 2:1(Table 1).Right side was affected in 47 patients and left side was affected in 33 patients The mechanism of injury in this study was fall at home in 21 patients (26%), road traffic accident in 56 patients (70%) and fall from stairs 3 patients (4%). Fracture type in this study according to the AO classification shown in figure 2.

All 40 patients in PFN group healed uneventfully with an average union time 12 months(range 9-16 months ,Fig 2) except 1 case with delayed union whereas 40 patients in DCS group achieved delayed union on an average at 16.5 months (range 12-24 months, figure 5-6). Walking and squatting ability was completely restored in every case at follow up examination 6 months postoperatively (Fig 2,3). Patients in PFN group was successfully reduced with traction on a fracture table with average operative time being 35 mins (range 30 – 60 mins) whereas patients in DCS group had and average operative time of 64 mins (range 50- 120 min) Requirement of blood transfusion rate was 42% in patients with DCS group and none in PFN group Table 2.. All the patients were interviewed 24 months after injury using Harris hip score Table 3.

Complications

One patient in PFN group had developed superficial skin infection which was resolved with oral antibiotics whereas DCS group had higher complication rates with 17.5 % going into nonunion 10% had implant failure (Fig 4) and required revision surgery and 5% had developed infection (Table 2). All the infections were resolved without implant removal.

Clinical Relevance: Operative management of subtrochanteric fracture with nail or plate is a debatable topic and more clinical comparative trials are needed to understand the treatment outcomes with different implants.

Discussion

Subtrochanteric fractures are usually the result of high-energy trauma and often subjected to significant displacement. Extramedullary fixation with plating has the potential disadvantages of extensive surgical exposure, severe soft tissue damage and blood loss, thus leading to problems of fracture union and implant failure. In addition, the eccentrically plating is prone to fatigue breakage due to their mechanical load-sharing effect [22-25]. In our series there were 10% rates of implant failure treated in DCS group whereas intramedullary nailing is closely linked to “biological internal fixation”, in addition to its mechanical benefits over plate fixation [24] The recent development of reconstruction nail, which changes the direction of the proximal interlocking bolts, has greatly expanded the indication of intramedullary fixation for subtrochanteric fractures [26]. The advantages of long PFN for subtrochanteric fractures were well illustrated in our series of patients. All the 40 cases of traumatic subtrochanteric fractures healed uneventfully except 1 case of delayed union. Walking and squatting ability was completely restored in each case (including the patient with delayed union) at follow-up examination 6 months postoperatively. No complications such as cutout or breakage of the implants, or peri-implant fractures were encountered.

The average operative time in our series of patients was 35 minutes for PFN group. This is significantly shorter than that reported in other papers [2,9,10,22]. We realize that the key for the success of the operation depended on the correct determination of the entry point which should be on top of the greater trochanter in anteroposterior view and in line with the Centre of the femoral canal in lateral view (Fig. 1). We believe the main reason for acceptance of Dynamic condylar screw is that the importance of correct entry point is not understood. Confidence was lost owing to the shaving-off of the lateral cortex of the greater trochanter during the initial attempt to carry out intramedullary fixation. The abundant muscles around the subtrochanteric region usually cause significant displacement of the fractured fragments, leading to difficulties in close reduction under traction. Sometimes open reduction through a small incision at the fracture site is inevitable. The complication of cutout was often reported in the literature when trochanteric fractures were treated with Long PFN for subtrochanteric fractures [28-30]. Fortunately, such complications did not occur in any of our patients. A few reasons, we believe, account for the results of the study. First, subtrochanteric fractures usually occur in relatively young patients without osteoporosis after high-energy trauma, while cutout is often noted in old patients with osteoporotic fractures. Second, this complication is closely related to the position of the lag screw. We recommend that the lag screw of Long PFN should be placed in the lower part of the femoral neck close to the femoral calcar, with screw tip reaching the subchondral bone 5 to 10 mm below the articular cartilage in anteroposterial view. In lateral view, it should be placed in the centre of the femoral neck. The lag screw will be definitely placed in the area of best bone quality. Full weight bearing was not initiated until 8 weeks after operation in all of our patients to allow preliminary callus formation to substantially decrease the load on implant would need to sustain. On the other hand, as much more attention has been paid on the result of X-ray appearance after operation than on rehabilitation by the patients themselves and complications of implant failure are deemed great problems by the patients, surgeons are hesitant to encourage early rehabilitation and weight-bearing. We believe that delayed weight-bearing after surgical operation and the relative narrow canal of the femoral isthmus might decrease the complications such as rotational malalignment, limb shortening and implant failure. Reduction was anatomic in all DCS group, but not in all PFN group. Despite this, patient in PFN group had no nonunion. Autologous bone grafting has been advocated for subtrochanteric femur fracture ,especially in high energy trauma or when medial wall comminution or a fracture gap exist [11,31] but only one of our patient required bone grafting in PFN group and 12 patient required bone grafting in DCS group: one of them were primarily bone grafted, four of them had implant failure and seven of them had nonunion. Revision surgery were performed in patients with implant failure (10%) in DCS group and adequate fixation was done along with bone grafting.

Our findings were consistent with the trend towards intramedullary nailing over Dynamic condylar screw plating for the treatment of subtrochanteric femoral fractures. Percutaneous plating may have advantages similar to those of closed intramedullary nailing, by minimizing the disruption to soft tissues around the fracture. Randomized controlled trials on percutaneous plating versus intramedullary nailing are needed.

Conclusion

Long PFN is a reliable implant for subtrochanteric fractures, leading to high rate of bone union, no implant failure, and minimal soft tissue damage Union and minimal soft tissue damage. Intramedullary fixation has biological and biomechanical advantages. The intramedullary nailing provides a buttress against lateral displacement and it decreases bending strain on the implant.

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