Importance of Screw Position in Intertrochanteric Femoral Fractures Treated by Dynamic Hip Screw

Amarnath D Savur[1], Goudama Siddhartha Panicker[2], Abhishek Shetty[3]

[1]Professor, Department of Orthopaedics, Yenepoya Medical College Hospital, Deralakatte, Mangalore 575018

[2]Resident, Department of Orthopaedics, Yenepoya Medical College Hospital, Deralakatte, Mangalore 575018

[3]Assistant Professor, Department of Orthopaedics, Yenepoya Medical College Hospital, Deralakatte, Mangalore 575018

Abstract: ***Introduction**: Present study aimed to evaluate the effect of position of the screw on the failure of fixation in intertrochanteric femoral fracture treated by dynamic hip screw. **Materials & Methods**: The study was conducted on 32 patients undergoing fixation of intertrochanteric fractures with DHS. The fracture reduction was assessed according to the Garden alignment index (GAI). The position of the screw was determined by the tip apex distance. The location of the screw was also recorded according to the ratio method described by Parker. The patients were divided in two groups taking into consideration the TAD less (Group A) or more (Group B) than 25 mm. For both groups, we compared quality of reduction, number of patients with cut-out failure and Harris hip score. Data was analysed using SPSS ver 21. **Results**: No statistical differences were observed between two groups with regards to the patient's age, gender, type of fracture, Singh index, GAI and Harris hip score on the final follow-up. However, the lag screw was placed in the femoral head more inferiorly (p<0.01) on frontal and more posteriorly (p<0.01) on sagittal planes in Group B while central placement of the screw was present in Group A. None of the patients in Group A had cut-out failure while it was seen in 2 patients in Group B (10%). **Conclusion**: Our study showed that TAD is highly predictive for the screw cut-out. Our study suggested that the safest positions are the posterior and inferior locations which help to reduce the risk of cut-out failure.*

Keywords: Cut-out, Dynamic Hip Screw, Intertrochenteric fracture, Screw position, Tip apex distance

1. Introduction

With the rising life expectancy throughout the globe, the world's older population continues to grow at an unprecedented rate. Today, 8.5 percent of people worldwide (617 million) are aged 65 and over. The elderly have weaker bone and are more likely to fall due to poorer balance, medication side effects, and difficulty maneuvering around environmental hazards. It is estimated that the incidence of hip fracture will rise from 1.66 million in 1990 to 6.26 million by 2050. The incidence of hip fracture in men is projected to increase by 310% and 240% in women, compared to rates in 1990 [1].

Proximal femur fractures are divided into three categories: femoral neck and intertrochantric fractures account for 90% while subtrochantric fractures accounts for 5-10% cases. Intertrochanteric fractures unite readily due to broad fracture surfaces, adequate blood supply and they rarely lead to non-unions. However, if proper precautions are not taken fractures unite in malposition resulting in shortening, limp and restricted movements [2].

The dynamic hip screw (DHS) has been a standard implant for fixation of intertrochantric fractures since 1960s. The advantage of this device include deep insertion, controlled compression and impaction at fracture site without penetration of femoral head [3]. However reduction and internal fixation are a challenge to surgeon, especially in unstable fracture [3]. There are reported failure rate between 1.9% and 23% including cutting out of the lag screw from femoral hear, pulling off of the plate from femoral shaft, disassociation of compression hip screw from the barrel and failure of hip screw itself [3].

Cut out of the lag screw has been shown to be the most common cause of failure and is related to the position of the screw in the femoral head [4]. Central placement of the implant was recommended by some authors [4-7], while others [8,9] recommended posterior placement. However, today, there is still no clear consensus about that. The present study thus aimed to evaluate the position of the screw and its effect on the failure of fixation.

2. Material and Methods

The study was conducted on patients undergoing fixation of intertrochanteric fractures with DHS in Department of Orthopaedics, Yenepoya Medical College Hospital, Deralakatte, Mangalore. Exclusion criteria were the fractures treated conservatively and the pathological fractures secondary to tumour or Paget's disease. Basicervical or subtrochanteric fractures and reversed or transverse fractures at the level of the lesser trochanter were also excluded, because they were treated by other surgical methods such as hemiarthroplasty and proximal femoral nailing. We identified a total of 32 patients that met these criteria. All patients gave a written informed consent to take part in the study.

Preoperative radiographs and hospital records were evaluated to determine the type of the fractures and the degree of osteoporosis. All fractures were classified according to Boyd griffin's classification [10]. A subjective assessment of the degree of osteoporosis was made by evaluating the density of the bony trabeculae of the contralateral non-injured hip with Singh index [11]. All patients received a surgical treatment consisting of closed reduction under image intensification and internal fixation with 135◦ DHS. No additional fixation device such as a trochanteric stabilizing plate or cerclage wiring was used. The immediate postoperative radiographs were used to assess the accuracy of the fracture reduction and the position of the implant in the femoral head. The fracture reduction was assessed according to the Garden alignment index (GAI) [12] on the anteroposterior and lateral radiographs. An anatomical reduction was defined as the angle of 160◦ between the primary compressive trabeculae and the femoral shaft on the anteroposterior radiograph and as the angle of 180◦ between the mid shaft of the femoral neck and the femoral shaft on the lateral radiograph. The quality of the reduction was categorized as good, acceptable or poor [13]. For a reduction to be considered good, there had to be normal or slight valgus alignment on the anteroposterior radiograph, less than 20◦ of angulation on the lateral radiograph and no more than four millimetres of displacement of any fragment. An acceptable reduction was characterized by the criterion of a good reduction with respect to either alignment or displacement, but not both. A poor reduction met neither criterion.

The position of the screw was determined by the tip apex distance (TAD) described by Baumgaertner et al. [13]. The TAD was defined as the sum of the distance, in millimetres, from the tip of the lag screw to the apex of the femoral head, as measured on an anteroposterior radiograph and that distance as measured on a lateral radiograph, after correction had been made for magnification.

The location of the screw was also recorded according to the ratio method described by Parker [14]. With this method, the femoral head was divided into thirds on the anteroposterior and lateral radiographs. The ratio of the screw position gave a range of zero to 100 and a ratio greater than 66 was accepted as a superior and anterior position of the lag screw on the anteroposterior and lateral radiographs.

Radiographs of the fractures that were obtained at six weeks, three, six and twelve months postoperatively were used to demonstrate any failure of fixation. The cut-out was defined as projection of the screw from the femoral head by more than 1 mm [14]. Clinical evaluation of the final follow up was based on the assessment according to the Harris hip score [15].

The patients were divided in two groups taking into consideration the TAD less (Group A) or more (Group B) than 25 mm. For both groups, we recorded and compared quality of reduction according to the GAI, TAD, number of patients with cut-out failure and Harris hip score.

Statistical Analysis

The statistical analysis was performed by using SPSS ver. 21. The data's were analyzed using the following statistical parameters: definitions (mean, standard deviation), Mann-Whitney *U* test for comparison between two groups and chi-square test for comparison of the qualitative data. A *p* value of < 0.05 was considered to be statistically significant.

3. Results

Mean age of the study cases was 67.4 years with about a third of them were over 70 years of age (10/32). A slight female predominance was observed in present study with 53% females to 47% males. Most common mode of injury was trivial fall, seen in 81.3% (26/32) cases. As per Boyd griffin's classification, most of the fractures were of type 2 (68.8%) while 9.4% and 15.6% cases had type 3 and 4 fractures (unstable fracture) (**Figure 1**).

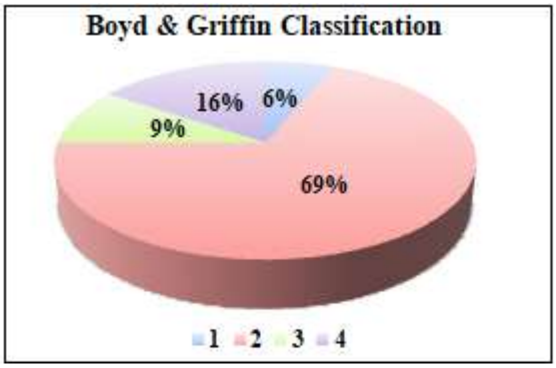

Figure 1: Distribution of cases as per Boyd & Griffins classification

In most of the patients level of osteoporosis (Singh Index) was either 3 or 4 (84.4%) confirming that intertrochanteric fractures usually occurs in osteoporotic bone (**Figure 2**).

The reduction of 24 (75%) fractures was considered to be good while remaining 8 (25%) fractures had an acceptable reduction quality. The mean Harris hip score on the final follow-up was 88.9 (range: 63 to 97). Except for 2 (6.3%) patients with cut-out of the lag screw from the femoral head, none of the patients had failure of fixation on the final follow-up. No statistical differences were observed between two groups with regards to the patient's age, gender, type of fracture, Singh index, GAI and Harris hip score on the final follow-up. However, the position of the lag screw in the femoral head was statistically different between the groups. The lag screw was placed in the femoral head more inferiorly ($p<0.01$) on frontal and more posteriorly ($p<0.01$) on sagittal planes in Group B while central placement of the screw was present in Group A (**Table 1**).

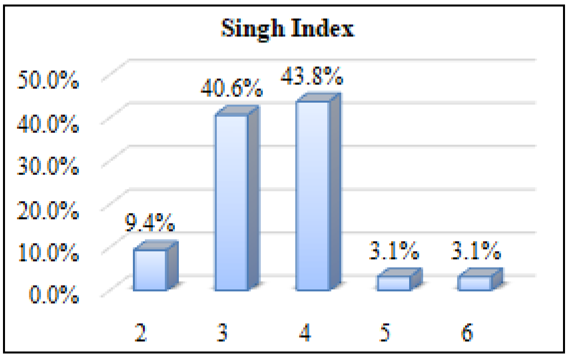

Figure 2: Distribution of cases as per Singh Index

None of the patients in Group A had cut-out failure while it was seen in 2 patients in Group B (10%). The common characteristic of these patients was the position of the screw, which was located in the femoral head more superiorly, and anteriorly after an acceptable fracture reduction.

4. Discussion

Migration of the lag screw with cut-out from the femoral head remains the most common mechanical complication after surgical fixation with DHS. Patient's age, bone quality, pattern of the fracture, stability of the reduction, type and angle of the implant and position of the lag screw in the femoral head have all been related to this mechanism of failure [5]. While all named factors are important, there is general agreement in the literature that cut-out failure is strongly associated with malpositioning of the lag screw in the femoral head [4,5,13].

Table 1: Comparison of study data between the patients with a tip-apex distance more or less than 25 mm

Patients' Characteristics	Tip Apex Distance		p-value
	< 25 mm (n-12)	> 25 mm (n-20)	
Age	62.34 +/- 11.35	60.22 +/- 13.23	0.69
Females	7 (58.3%)	11 (55%)	1
Unstable Fracture	3 (25%)	5 (25%)	1
Osteoporotic Fractures (Singh Index 3 or 4)	10 (83%)	17 (85%)	1
GAI (AP)	161.7 +/- 7.91	163.01 +/- 7.21	0.72
GAI (Lateral)	174.42 +/- 13.4	172.8 +/- 9.08	0.79
PR (AP)	49.78 +/- 7.93	38.67 +/- 11.45	<0.05
PR (Lateral)	53.47 +/- 8.02	41.76 +/- 11.21	<0.05
Harris Hip Score	88.9 +/- 4.98	89.91 +/- 7.12	0.51
Screw Cut out	0 (0%)	2 (10%)	0.25

In 1995, Baumgaertner et al. [4] introduced the concept of the TAD. It describes the position of the lag screw within the femoral head and was shown to be highly predictive of fixation failure by screw cut-out. In their study, there were no incidences of screw cut-out in any patient who had a TAD of less than 25 mm while 29% patients suffered a screw cut-out with a TAD over 25 mm. Afterwards, Pervez et al. [16] concluded that the TAD should be less than 20 mm. Guven M et al. [5] in their study also observed more screw cut outs in cases with TAD> 25 mm. In present study too, we observed no screw cut out in cases with TAD < 25 mm while 10% cases with TAD> 25 mm had suffered screw cut out.

In the presented study, the common feature of cut-out patients was the position of the screw, which was located in the femoral head more superiorly, and anteriorly after an acceptable fracture reduction. The highest rates of cut-outs occurred in the posterior-inferior and in the anterior-superior zones in Baumgaertner et al.'s study [4]. The rate of cut-out in either of these two peripheral zones was significantly higher than the rate in the center zone. They recommended central and deep insertion of the lag screw in the femoral head. Later, many other studies [4,5,17-19] also indicated that superior and anterior screw placement should be avoided and central placement of the lag screw in the femoral head was recommended.

The DHS construct allows mechanical load transmission. In stable fracture patterns, it acts as a tension band producing more force transmission through the medial cortex, stressing the implant more in tension and less in bending [20,21]. But, in unstable fractures, the lesser trochanter and the part of the calcar femoral are missing from the mechanical load transmission system because of the lack of bony support over the medial aspect of the femur. Peripheral placement of the lag screw in the femoral head inherently increases TAD. However, the placement of the screw in posterior and inferior locations of the femoral head supports the comminuted posteromedial cortex and the device allows impaction of the fracture surfaces, shortening the lever arm, decreasing the bending moment, as well as avoiding cut-out of the screw from the femoral head, consequently [20].

5. Conclusion

Our study showed that TAD is highly predictive for the screw cut-out. Our study suggested that the safest positions are the posterior and inferior locations which help to support the posteromedial cortex and calcar femoral in unstable intertrochanteric fractures and reduce the risk of cut-out failure consequently.

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