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ORIGINAL PAPER

Risk factors in cutout of sliding hip screw in intertrochanteric fractures: an evaluation of 937 patients

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Abstract The aim of this study was designed to assess the risk factors of lag-screw cutout in the treatment of intertrochanteric fracture with a dynamic hip screw (DHS). From 2003 to 2007, 1,150 patients who had acute unilateral intertrochanteric fractures of the femur were enrolled to the study. All fractures were managed by closed reduction and internal fixation with 135° DHS devices. Patient demographics, fracture patterns, reduction and fixation and perioperative course parameters were all recorded. The follow-up period was 38 months on average (range 16–60 months). Finally, 937 patients were available for evaluation of final results in which we focused on lag-screw cutout. Excluding complications not related to screw position, 64 patients (6.8%) with screw cutout were encountered, and the remaining 873 patients had uneventful union, with the average union time of 17.5 weeks (range15–24 weeks). Upon analysis with logistic regression, the tip–apex distance (TAD) was shown to be the most important predictive factor for cutout, followed by screw position, fracture pattern, reduction and patient age. In order to decrease the risk of lag-screw cutout, it is important to ensure good fracture reduction and to place the lag screw in either the middle/middle or inferior/middle position with appropriate TAD.

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Introduction

Although many devices can achieve rigid fixation for intertrochanteric fractures, the sliding hip screw system is the most commonly used device [16, 19]. The commonest mechanical failure of fixation in using the sliding hip screw system is cutout of the implant from the femoral head [6, 10, 12, 20, 21, 23, 24]. Few papers have addressed the risk factors of screw cutout in the treatment of intertrochanteric fracture using a sliding hip screw, and the case numbers evaluated were relatively small [2, 3, 13, 21]. The purpose of this study was to evaluate in a larger series the possible risk factors of screw cutout in treatment of intertrochanteric fractures using a sliding hip screw.

Materials and methods

Between 2003 and 2007, there were 1,150 consecutive patients with acute unilateral non-pathological intertrochanteric fractures treated by closed reduction and internal fixation with a dynamic hip screw (DHS, AO, 135° angle) in our institute. During the operations, all fractures were reduced as anatomically as possible and were fixed as rigidly as possible, and all lag screws were place in the femoral head, with the tip within 10 mm of the articular surface of the head. These 1,150 patients were included in the initial evaluation of this retrospective study. Patients lost to follow-up (23), failure of union due to other reasons such as falling with a periprosthetic fracture (25), and death before fracture union (165) were excluded in final evaluation. The remaining 937 patients with either uneventful fracture healing [873, 93.2%; union time 17.5 (15–24) weeks] or screw cutout [64, 6.8%] were included in the final evaluation. In this study, we focused on lag-screw cutout. All patients received

Table 1 Variables and differences in fracture reduction for cases of cutout in comparison with successfully healed cases

Variable	Cutout group	Successfully healed group	*p* value
Number of patients	64	873	-
Sex (M/F)	34 (53%)/30 (47%)	534 (61%)/339 (39%)	0.204[a]
Age (≧80/<80)	39 (61%)/25 (39%)	388 (44%)/485 (56%)	0.011[a]
Age (≧70/<70)	57 (89%)/7 (11%)	677 (78%)/196 (22%)	0.031[a]
Age (≧60/<60)	63 (98%)/1 (2%)	838 (96%)/35 (4%)	0.326[a]
ASA	3 (0.9)	3 (0.8)	0.261[b]
BMI	25 (2.1)	25 (2.6)	0.725[b]
Reduction: good/poor	51 (80%)/13 (20%)	774 (89%)/99 (11%)	0.033[a]
Fracture pattern (stable/unstable)	25 (39%)/39 (61%)	532 (61%)/341 (39%)	0.001[a]
TAD (≧25/<25)	53 (83%)/11 (17%)	143 (16%)/729 (84%)	<0.001[a]

ASA American Society of Anesthesiologists, *BMI* body mass index, *TAD* tip–apex distance

[a] Chi-square test

[b] Student's *t* test

the standard postoperative protocol: (1) Protected weight bearing with a walking stick for three months, and (2) calcium and vitamin D supplementation.

The follow-up period was 38 months on average (range 16–60 months). All patients had complete records for sex, age, body mass index (BMI), American Society of Anesthesiologists (ASA) class rating [1], and pre-operative and post-operative standard anterior–posterior (AP) and lateral radiographs. In radiographic evaluations, we recorded the fracture pattern according to Evans [7], tip–apex distance (TAD) [2, 3], and reduction quality. Reduction was graded on the amount of displacement and neck-shaft alignment on immediate post-operative AP and lateral radiographs, being categorised as good or poor [2, 3, 8]. A good reduction had normal or slightly valgus neck-shaft alignment in the AP radiograph, <20° of angulation in the lateral radiograph, and displacement of <4 mm on either view. Otherwise, the reduction was graded as poor. The femoral head was further divided into superior, central, and inferior thirds on the AP radiograph and into anterior, central, and posterior thirds on the lateral radiograph. Thus, nine separate zones were created to further locate the screw position [5, 11]. The above parameters were compared between patients with screw cutout (group 1) and patients with uneventful fracture healing (group 2).

All patients were measured for all response variables, which included demographic variables and important outcomes. Data were represented as mean and standard deviation (SD) for continuous response variables or percentages for discrete variables with respect to the two groups. Chi-square test was used to compare differences between the two groups for each discrete variable, and Student's *t* test was used for each continuous variable. The *p* value was set before analysis at 0.05 for each test. Logistic regression analysis was used to investigate interactions among the independent variables and their ability to predict screw cutout. Analysis of variance (ANOVA) and the post hoc test were used for multivariate statistical analysis

Results

Results of the variables and differences between group 1 and group 2 are presented in Table 1. The differences in age, TAD, reduction pattern, and fracture pattern were statistically significant between the groups ($p<0.05$). With logistic regression analysis, the TAD was shown to be the most important predictive factor for cutout, followed by screw position, fracture pattern, reduction, and patient age.

The distribution of screw position in the femoral head is shown in Fig. 1 and presented in Table 2. According to the screw positions, the lowest cutout rate was in cases of the middle/middle screw position (3/134, 2.1%). The statistical differences of screw cutout rates between cases of middle/middle screw position and cases of the other screw positions are presented in Table 2. It was found that if the screw was in the superior or posterior position, the cutout rates were highest.

The average tip–apex distance in group 1 was 35.5 mm and that in group 2 was 22.1 mm. The distribution of TAD in both groups was shown in Fig. 2.

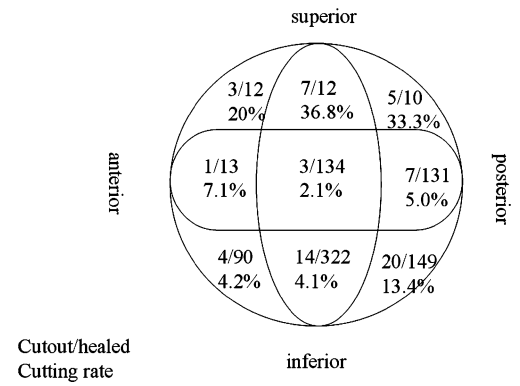

Fig. 1 Distribution of screws by zone: 873 healed and 64 cut out. The number of healed cases in each zone is represented by the *numerator*, and the number of screws that cut out in each zone is represented by the *denominator*. Ratio: cutout/healed

Table 2 Distribution of cases with different screw positions in different groups and comparisons of cutout rate between screw position with lowest cutout rate (MM) and the other screw positions

Screw position	Cutout group (case number, %)	Successfully healed group (case number, %)	Comparison of cutout rate with MM position (*p* value)
MM	3, 2.1%	134, 97.9%	-
SM	7, 36.8%	12, 63.2%	<0.001[a]
IM	14, 4.1%	322, 95.9%	0.259[a]
MA	1, 7.1%	13, 92.9%	0.272[a]
SA	3, 20%	12, 80%	0.001[a]
IA	4, 4.2%	90, 95.8%	0.368[a]
MP	7, 5%	131, 95%	0.202[a]
SP	5, 33.3%	10, 66.7%	<0.001[a]
IP	20, 13.4%	149, 86.6%	0.001[a]

IM inferior/middle, *SM* superior/middle, *MA* middle/anterior, *MP* middle/posterior, *SA* superior/anterior, *SP* superior/posterior, *IA* inferior/anterior, *IP* inferior/posterior, *MM* middle/middle

[a] Chi-square test

There were 11 cases of cutout with TAD<25 mm and two cases with TAD <20 mm (one with TAD of 16 mm and the other with TAD of 18 mm). Eight of these 13 cases had good screw position but poor fracture reduction, three had superior screw position and poor fracture reduction, and two had superior screw position and good fracture reduction. The average TAD was related to screw position, i.e., when the screw was in the superior or posterior position, the TAD was higher (Table 3).

Discussion

Treating intertrochanteric fractures with a DHS may be associated with various complications, such as loss of reduction, nonunion and malunion with varus deformity of the femoral neck, marked shortening of the affected limb, or screw cutout [6, 9, 10, 14, 16, 18, 23, 24]. In this study, we focused on screw cutout. The incidence was 6.8%, which is comparable with other series,. The two main methods described to quantify lag-screw placement are the TAD described by Baumgaertner et al. [7, 8] and the ratio method described by Parker [18]. A subsequent study has shown that a tip–apex distance of <20 mm improves the results [21]. Our study evaluated a greater number of cutout cases, and our findings were somewhat different to those in previous reports.

In our study, two screw cutouts were noted in cases with TAD <20 mm, and no screw cutout was noted in cases with TAD <15 mm, similar to results in a previous report [21]. Thus, we suggest that the TAD should be kept to be less than 15 mm in avoiding cutout of lag screw. Although our results support the hypothesis that TAD is the most important factor in predicting lag-screw cutout with DHS, it is not the only factor. In this study, age, fracture pattern, fracture reduction, and screw position were also significant factors. A significantly higher incidence of lag-screw cutout was associated with unstable fracture and older age—factors that cannot be controlled by the surgeon. These findings have not been reported in previous studies. As in previous studies [4, 12, 15, 17, 20–22], poor fracture reduction and superior screw position had an increased risk of cutout; however, in our study, posterior and not anterior screw position had a higher incidence of lag-screw cutout. The best lag-screw position found in this study was the middle/middle position, a finding different to that reported by Wu et al. [25] who reported that the best position for the lag screw was the inferior/middle position. We also found

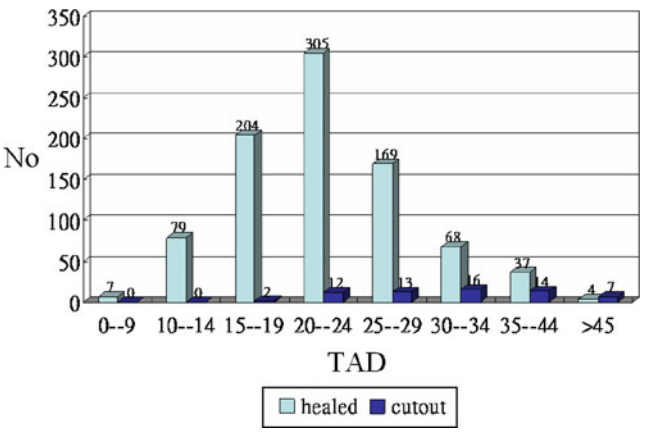

Fig. 2 Number of cutout and healed cases in different ranges of tip–apex distance (TAD)

Table 3 Correlations of average tip–apex distance (TAD) and screw positions and comparison of mean TAD between screw position with lowest TAD (MM) and other screw positions

Screw position	Mean TAD	Comparison of TAD (mm) with MM position (*p* value)
MM	19	-
SM	34.1	0.035[a]
IM	20.8	0.744[a]
MA	22.9	0.563[a]
SA	26.4	0.067[a]
IA	23.9	0.642[a]
MP	23.1	0.465[a]
SP	31.9	0.021[a]
IP	27.9	0.083[a]

IM inferior/middle,*SM* superior/middle, *MA* middle/anterior, *MP* middle/posterior, *SA* superior/anterior, *SP* superior/posterior, *IA* inferior/anterior, *IP* inferior/posterior, *MM* middle/middle

[a] Analysis of variance (ANOVA), post hoc test

that screw position had a positive correlation with TAD: if the screw was in the peripheral positions, especially posterior or superior, then TAD increased. Based on our findings, fracture reduction, implant position, and TAD are directly correlated, and these three factors should be adequately controlled by surgeons during the operation.

In conclusion, to decrease the risk of lag-screw cutout, it is important to achieve good fracture reduction and to place the lag screw in middle/middle or inferior/middle position with appropriate TAD (<15 mm). In aged patients (>70 years) and patients with unstable fracture, more attention must be paid to complications during the follow-up. However, the limitations of this study, including the fact that it was retrospective, had no preset treatment goals considering reposition and TAD, and there was no evaluation of bone mineral density, make a further prospective study necessary for more concrete conclusions.

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