



## Risk factors associated with the early failure of cannulated hip screws

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**Aim :** We report our experience with cannulated hip screws and analyse the risk factors associated with their early failure.

**Materials and methods :** All patients undergoing cannulated hip screws at a single UK Major Trauma Centre between November 2009 and November 2011 were retrospectively identified. Radiographs were analysed for fracture displacement, successful reduction, and screw configuration. Risk factors predicting early failure, defined as re-operation within 6 months, were identified using logistic regression models.

**Results :** 340 patients were included in the study, 70% were female and the mean age was 81 years. After six months 23% patients had undergone revision surgery. Initial fracture displacement ( $p = 0.02$ ) and unsuccessful lateral reduction ( $p = 0.04$ ) were significant predictors of early failure.

**Conclusion :** Initial fracture displacement and successful fracture reduction are the most important factors related to the risk of early re-operation. We found no evidence that screw configuration is an important predictor of outcome.

**Key Words :** neck of femur ; hip fracture ; internal fixation ; cannulated screws ; revision.

### INTRODUCTION

An estimated 70,000 to 75,000 fractures of the proximal femur occur each year in the UK with a cost of around £2 billion to the National Health Service (16). The choice of surgical treatment for

intracapsular fractures remains controversial. Recent NICE guidance suggests that displaced fractures should be treated with an arthroplasty (16). SIGN guidelines advise that “young” patients or those with undisplaced fractures should undergo internal fixation ; “older” or less fit patients should be treated with an arthroplasty (19). Internal fixation has a high reintervention rate (30-42%) due to non-union and avascular necrosis (3,5,18), whereas primary arthroplasty is associated with a 10-15% dislocation rate (10,20,21). A recent randomised controlled trial suggested that patients treated with a hemiarthroplasty have a better functional outcome (8) whereas other studies have shown that those undergoing internal fixation have a tendency

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to lower mortality (2,8,13,14,18). The majority of studies comparing the two procedures involve mostly healthy mobile patients with preserved cognitive function and it is unclear whether these findings are applicable to all patients (11). With research producing conflicting results, some authors have concluded that the definitive answer to the optimal treatment of femoral neck fractures remains elusive and further studies are still required (7).

Patient age and the quality of fracture reduction have been reported as risk factors for failure of internal fixation (1,6,22). Biomechanical studies have suggested that placement of a screw proximal to the medial calcar strengthens the construct (4) but an optimal position for screw placement has not been proven. The aim of our study was to analyse risk factors associated with early failure including screw configuration following internal fixation using cannulated screws in the treatment of intracapsular fractures of the proximal femur.

## MATERIALS AND METHODS

All patients undergoing internal fixation of an intracapsular fracture of the proximal femur with cannulated hip screws at our centre between November 2009 and November 2011 were retrospectively identified. Electronic records were analysed for baseline characteristics and whether surgery was performed during the week or at a weekend. Pre-operative radiographs were analysed jointly by two authors (RJ and ED) for the degree of displacement according to the Garden classification (9). Operation notes and intra-operative radiographs were assessed for the grade of surgeon performing the operation and the number of screws used.

Traumacad (Voyant Health, Petach-Tikva, 2012) templating software was used to calibrate intra-operative radiographs to allow measurement of suspected risk factors for early reintervention. Placement of the screws in a parallel, diverging or converging manner was noted. The angle made by the screws was recorded with a parallel placement defined as less than five degrees of divergent or convergent angle in both anteroposterior (AP) and lateral views. If three screws were used then the two most peripheral screws on each view were used to calculate these angles. Successful reduction was defined as an AP femoral neck angle of 130 to 150 degrees and 0 to 15 degrees of anteversion on the lateral image as sug-

gested by previous studies (1,12). The AP and lateral spread of the screw tips was measured from the threads of the two outermost screws on the respective views. The distance to the medial calcar was measured as the shortest distance from the most inferiorly placed screw to the calcar.

The primary outcome measure was the need for revision surgical intervention within six months of the index procedure. Electronic theatre records, clinic follow-up letters and post-operative radiographs were reviewed to identify the requirement for and timing of further surgery.

Descriptive statistics were calculated for each variable. Data were assumed to be normally distributed as appropriate. Hence, means and standard deviations were calculated for the continuous and frequencies for the categorical explanatory variables. To evaluate the effects of each explanatory variable and the odds of requiring revision surgery, multiple stepwise logistic regression was used. Here, all the 12 variables were individually assessed at each step with the inclusion criteria assessed by Akaike's information criterion (AIC) of the updated model. All analyses were conducted using R Statistical software (version 2.12.1) (18).

## RESULTS

A total of 340 patients underwent internal fixation of their intracapsular fracture with cannulated screws during the study period. Baseline characteristics of the patients are presented at Table I. The majority of patients were female (70%), the median age was 83 years (interquartile range 76-89 years) and 12% of patients died during the six month follow up period. Three quarters of procedures were performed by specialist trainees. The unadjusted risk of revision was 23%.

The potential risk factors for early failure were analysed using a stepwise multiple regression model; the final model is reported at Table II. The degree of initial fracture displacement ( $p = 0.02$ ) and an inability to achieve a successful lateral reduction ( $p = 0.04$ ) were shown to be significant explanatory variables in our study population. Patient age, level of surgeon, surgery performed at the weekend, achieving a successful AP reduction, and all screw configurations were not shown to be significant risk factors.

Table I. — Descriptive statistics – Risk factors of early failure following cannulated hip screws

Variable		No failure group n = 262 (77%)	Early failure group n = 77 (23%)	Difference between groups
Gender (n, row %)	Female	173 (74%)	61 (26%)	$\chi^2 = 4.25$ $p = 0.039^*$
	Male	89 (85%)	16 (15%)	
Garden Classification (n, row %)	Type I	38 (90%)	4 (10%)	$\chi^2 = 14.8756$ $p = 0.0019^{**}$
	Type II	61 (86%)	10 (14%)	
	Type III	108 (77%)	33 (23%)	
	Type IV	55 (65%)	30 (35%)	
Age (mean, sd)		80 (12.3)	82 (8.9)	$t = -2.58$ $p = 0.01268^*$
AP reduction (n, row %)	Not in range	70 (71%)	29 (29%)	$\chi^2 = 42.9389$ $p = 0.08647$ $\chi^2 = 11.6636$ $p = 0.0029^{**}$
	In range	192 (80%)	48 (20%)	
Lateral reduction angle (n, row %)	In range (0-15°)	124 (82%)	27 (18%)	
	Anterior angle (>15°)	6 (43%)	8 (57%)	
Screws are parallel in both AP and lateral views (n, row %)	Posterior angle (<0°)	132 (76%)	42 (24%)	$\chi^2 = 0.249$ $p = 0.6178$
	No	55 (74%)	19 (27%)	
	Yes	205 (78%)	58 (22%)	
Surgeon grade (n, row %)	Consultant	14 (78%)	4 (22%)	$\chi^2 = 3.8369$ $p = 0.1468$
	SHO	45 (68%)	21 (32%)	
Number of screws (n, row %)	SPR	202 (80%)	52 (20%)	$\chi^2 = 0.0113$ $p = 0.9514$
	2	197 (77%)	59 (23%)	
	3	65 (78%)	18 (22%)	
Day of surgery (n, row %)	Weekday	193 (77%)	57 (23%)	$\chi^2 = 0.007$ $p = 0.9332$
	Weekend	69 (78%)	20 (22%)	
Medial to calcar distance (mean in cm, sd)		5.9 (2.16)	6.3 (2.74)	$t = 0.605$ $p = 0.5478$
AP spread (mean in cm, sd)		20.9 (3.52)	20.4 (3.46)	$t = 1.0241$ $p = 0.3104$
Lateral spread (mean in cm, sd)		13.5 (4.54)	14.0 (4.83)	$t = -0.0867$ $p = 0.9312$

Table II. — Final results of the multiple stepwise logistic regression model for early failure following cannulated hip screws

Variable	Odds Ratio (OR)	95% confidence interval for OR		Significance	
		Lower bound	Upper bound		
Gender	Female	1			0.061
	Male	0.54	1.324	2.741	
Garden Classification	Type I	1			0.019*
	Type II	1.38	1.523	223.406	
	Type III	2.5	2.497	8252.278	
	Type IV	4.13	4.229	3278354.245	
AP reduction	Not in range	1			0.144
	In range	0.65	1.440	3.212	
	In range	1			
Lateral reduction within [0-5]	Anterior angle	4.49	3.815	13115551.218	0.043*
	Posterior angle	1.71	2.649	20.966	

## DISCUSSION

During our two year study period, 340 patients underwent cannulated hip screws and this large population has allowed us to analyse a number of different risk factors for early failure of this technique. A 12% mortality within six months is lower than other centres (15) and may reflect the findings from previous meta-analyses that have shown a tendency for lower mortality in internal fixation groups (2,8,13,14,18). A failure risk of 23% is lower than the 30 to 42% range reported in the literature, (3,5,18) however our study looked specifically at early failures.

We have shown a significant relationship between fracture displacement and adequate fracture reduction with the early failure of patients undergoing cannulated screw fixation. The use of a multiple logistic regression model has allowed us to account for other reported risk factors ; these two factors have remained statistically significant. Failure to adequately reduce a fracture raises the concern of subsequent failure of the implant and

should prompt consideration of conversion to arthroplasty intra-operatively.

Our data has been unable to resolve the long running debate over the best technique for screw placement. We have been unable to show a statistically significant relationship between the number of screws, their positioning, their spread or their proximity to the medial calcar and the risk of early failure. Biomechanical studies have shown that placement of a calcar screw provides strong fixation and our data would support this without reaching statistical significance (2).

The proportion of patients treated with cannulated hip screws is likely to decrease over the next few years with the implementation of the 2011 NICE Guideline (16). Despite these guidelines the debate on the optimal management of these patients continues with recent calls for large clinical trials to provide clarity (7). The authors appreciate that the strict implementation of these guidelines during our study period would have precluded 227 patients undergoing cannulated screw fixation in our population, leaving only 113 suitable for consideration

of cannulated hip screws. However within this group of 227, 31 patients were under the age of 65 years and according to other guidelines might have been considered for internal fixation of the neck of femur fractures (19). In addition a smaller subgroup exists, where the presence of significant co-morbidities, make hip arthroplasty substantially higher risk than fixation with cannulated screws. In this group fixation may still be the preferred option. Therefore despite a likely reduction in the proportion of fixation that will be performed over the coming years, the findings of our study remain applicable to many patients where internal fixation is deemed the most suitable by the treating surgeon.

## CONCLUSION

Our results allow the authors to give the clear message that the choice of patients with undisplaced fractures or, if displaced fractures are to be treated, that successful reduction is key to avoiding early failures.

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