Serum albumin and fixation failure with cannulated hip screws in undisplaced intracapsular femoral neck fracture

O Riaz, R Arshad, S Nisar, R Vanker

Calderdale and Huddersfield Foundation NHS Trust

ABSTRACT

INTRODUCTION Internal fixation of undisplaced intracapsular femoral neck fractures with cannulated hip screws is a widely accepted surgical technique, despite reported failure rates of 12%–19%. This study determined whether preoperative serum albumin levels are linked to fixation failure.

METHODS We retrospectively reviewed 251 consecutive undisplaced intracapsular femoral neck fracture patients treated with cannulated hip screws in a district general hospital. Preoperative albumin levels were measured, and the fixation technique, classification and posterior tilt on radiography assessed. Fixation failure was defined as a screw cut, avascular necrosis (AVN) or non-union.

RESULTS Of the patients, 185 were female and 66 male. The mean age was 77 years (range 60–101 years). Thirty seven (15%) patients had fixation failure: 10 (4%) due to AVN; 12 (5%) due to non-union; and 15 (6%) due to fixation collapse. Low serum albumin levels were significantly associated with failure ($p=0.01$), whereas gender ($p=0.56$), operated side ($p=0.62$), age ($p=0.34$) and screw configuration ($p=0.42$) were not. A posterior tilt angle greater than 20° on lateral radiography significantly predicted failure ($p=0.002$).

CONCLUSIONS Preoperative serum albumin is an independent predictor of cannulated hip screw fixation failure in undisplaced femoral neck fractures. Nutritional status should therefore be considered when deciding between surgical fixation and arthroplasty to avoid the possibility of revision surgery, along with an increased risk of morbidity and mortality.

KEYWORDS

Femoral neck fractures – Internal fracture fixation – Nutritional status – Serum albumin

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CORRESPONDENCE TO

Osman Riaz, E: osmanriaz@doctors.org.uk

The treatment of intracapsular femoral neck fracture has been extensively debated. Femoral neck fractures are known to carry a substantial morbidity and mortality, leading to socioeconomic problems. This is further burdened by the subsequent failure of fracture fixation.

In displaced fractures, the general consensus is to treat with hemiarthroplasty or a total hip replacement. Undisplaced fractures are commonly treated percutaneously with internal fixation using three parallel cannulated screws. The rationale for this is that undisplaced fractures do not disrupt the blood supply, thus allowing adequate healing. However, several studies have shown failure rates for this method fixation to be as high 10%–20%, with factors such as older age, American Society of Anesthesiologists physical status classification system grade, poor implant positioning and posterior tilt index associated with failure.^{1–5}

Recent studies have shown poor outcomes for patients with hip fractures who have poor preoperative nutritional status. A common biomarker for nutrition is serum

albumin, and recent studies have shown increased mortality associated with a low serum albumin level.^{4,5} Other factors, such as postoperative infections and increased length of stay, are linked to poor outcomes for hip fracture patients.^{6,7} Low serum albumin levels are also predictive of mortality in elderly patients with no apparent illness.⁸

To the best of our knowledge, the relationship between serum albumin levels and healing in intracapsular fractures has not been extensively investigated. We examined this relationship in patients with undisplaced intracapsular femoral neck fracture, taking into account risk factors for failure, to assist surgeons in deciding between fixation and arthroplasty in primary fracture patients, thus potentially avoiding a second operation in this vulnerable age group.

Methods

We retrospectively reviewed the records of 251 patients aged over 60 years treated for undisplaced intracapsular

femoral neck fracture at our district general hospital between January 2009 and January 2015. Data on gender, age at operation and follow-up was obtained for each patient from the National Hip Fracture Database. Exclusion criteria included age under 60 years, undisplaced intracapsular treated with other fixation methods, such as a two-hole dynamic hip screw plate or Garden screws, and no recorded preoperative serum albumin level. Ethical approval was obtained.

Routine blood tests on admission were identified, and serum albumin levels recorded, with a normal albumin level defined as >35 g/l. Preoperative radiographs were reviewed to ascertain the type of fracture and whether it was an undisplaced or slight valgus impacted fracture (Garden classification stages 1 and 2).⁹ The posterior tilt angle was also examined on lateral x-rays (Figure 1), with a high posterior tilt angle defined as $>20^\circ$, as described by Palm et al.¹⁰ Fixation was achieved using Asnis III Cannulated Screws 6.5/8.0 mm (Stryker, Kalamazoo, MI, USA), with three screws fixed in a triangle or inverted triangle configuration, depending on surgeon preference.

MCL, mid-collum line; RCL, radius collum line

Figure 1 Determining the posterior tilt angle

Postoperative radiographs were reviewed for signs of failure or non-union. Fixation failure was defined as the re-displacement of screws and fracture. Union was defined as the patient being asymptomatic with radiological evidence of trabecular bone reformation. Non-union was described as symptomatic patient (pain) and radiological evidence of non-union 6 months postoperatively. Failure secondary to avascular necrosis (AVN) was defined as subchondral sclerosis. Revision surgery was identified from clinic letters.

Data was analysed using Microsoft Excel (Microsoft, Redmond, WA, USA) and SPSS Statistics version 22.0 (IBM, Armonk, NY, USA). Analysis of variance and Student's t-test were used, with statistical significance defined as $p < 0.05$.

Results

Following exclusion, 251 patients were included in the study, of whom 185 were female and 66 male. The mean age was 77 years (range 60–101 years). Thirty seven (15%) patients had failed fixation: 10 (4%) due to AVN; 12 (5%) due to non-union; and 15 (6%) due to fixation collapse. Thirty patients underwent revision surgery following failure, including 19 total hip replacements and 11 hemiarthroplasties. The remaining seven patients either declined further surgical intervention or were not offered revision due to ill health.

Low serum albumin levels were significantly associated with fixation failure ($p = 0.01$) (Table 1). Gender ($p = 0.56$), operated side ($p = 0.62$) and age ($p = 0.34$) were not statistically significant between patients with and without fixation failure. There were 145 (58%) Garden classification stage 1 and 106 (42%) stage 2 fracture patients; fracture stage was not associated with fixation failure ($p = 0.21$).

Screw configuration was not statistically significantly associated with failure ($p = 0.42$). Assessment of screw positioning revealed that 192 (76%) were satisfactorily and 59 (24%) unsatisfactorily positioned. However, screw position was not statistically significantly associated with fixation failure ($p = 0.93$). A posterior tilt angle of more than 20° on lateral radiographs was statistically significantly predictive of failure ($p = 0.002$).

Discussion

Previous studies have suggested that fixation failure rates for intracapsular femoral neck fractures are around 11% to 19%.^{11,12} Our findings are in line with those studies, with a recorded failure rate of 15%. To avoid the problem of revision surgery, some surgeons promote arthroplasty as the standard treatment for undisplaced intracapsular fractures. However, arthroplasty itself carries an increased risk of peri-operative complications (in particular, in cases involving cemented prostheses), longer procedures, dislocations, leg length discrepancies and mortality. We advocate a safer way of identifying patients at increased risk of failure to allow optimum outcomes.

While mortality has been linked to poor nutritional parameters, such as serum albumin,¹⁵ the effect on

Table 1 Factors associated with fixation failure				
	Failure	Non-failure	All patients	P value
Albumin, mean g/l (range)	32 (18–44)	40 (26–48)	36 (18–48)	0.01*
Posterior tilt				0.002*
High	15 (6)	2 (1)	17 (7)	
Low	22 (9)	212 (84)	234 (93)	
Operated side				0.62
Left	16 (6)	99 (40)	115 (46)	
Right	21 (8)	115 (46)	136 (54)	
Age, mean years (range)	79 (60–101)	75 (60–95)	77 (60–101)	0.34
Gender				0.56
Female	20 (8)	165 (65)	185 (74)	
Male	17 (7)	49 (20)	66 (26)	
Classification				0.21
Garden 1	13 (5)	132 (52)	145 (58)	
Garden 2	24 (10)	82 (33)	106 (42)	
Screw position				0.92
Satisfactory	18 (7)	174 (69)	192 (76)	
Not satisfactory	20 (9)	39 (15)	59 (24)	
Configuration				0.42
Triangle	19 (8)	92 (36)	111 (44)	
Inverted Triangle	18 (7)	122 (49)	140 (56)	
* p<0.05. All values n (%), unless otherwise stated.				

nutritional status on fracture healing and fixation failure is unclear. Our study therefore evaluated serum albumin with fixation failure, showing that, adjusting for parameters such as fracture grading, fixation technique, age, gender and side of surgery, albumin is an independent factor for fixation failure. In previous studies, posterior tilt angle has been shown to be an independent factor for fixation failure.¹⁰ We advocate the assessment of nutritional markers such as albumin alongside radiological measures to help guide surgeons in choosing the right surgical intervention, whether that be fixation or arthroplasty.

The association between nutritional markers and fixation failure is unknown. We hypothesise that a potential cause may be the increased incidence of low bone mineral density (BMD) in these group of patients. Hypoalbuminemia has been linked to low BMD in chronic disease,¹⁴ while cadaver studies have shown that fixation strength is affected by low BMD.¹⁵

Another cause to be considered is that of subsequent injuries to the fracture site, causing collapse and loss of fixation. A predictive factor for recurrent falls in the elderly can be poor nutritional state.¹⁶

A limitation of this study was its retrospective nature, which introduces a selection bias. Another weakness is the modes of failure of fracture fixation. We were unable to explain why some patients had AVN or non-union. To evaluate these two subgroups, we believe that larger studies, including basic science analyses, will be necessary.

Conclusions

Our study has demonstrated serum albumin to be independent predictor of internal fixation failure in intracapsular fractures. We believe this study will aid surgeons in making the correct surgical choice, by taking into account the nutritional status of the patient. Patients identified as malnourished should be candidates for arthroplasty to help prevent the complications associated with revision surgery.

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References

1. Schep NW, Heintjes RJ, Martens EP *et al.* Retrospective analysis of factors influencing the operative result after percutaneous osteosynthesis of intracapsular femoral neck fractures. *Injury* 2004; **35**: 1003–1009.
2. Clement ND, Green K, Murray N *et al.* Undisplaced intracapsular hip fractures in the elderly: predicting fixation failure and mortality. A prospective study of 162 patients. *J Orthop Sci* 2013; **18**: 578–585.
3. Conn KS, Parker MJ. Undisplaced intracapsular hip fractures: results of internal fixation in 375 patients. *Clin Orthop Relat Res* 2004; 249–254.
4. Kieffer WK, Rennie CS, Gandhe AJ. Preoperative albumin as a predictor of one-year mortality in patients with fractured neck of femur. *Ann R Coll Surg Engl* 2013; **95**: 26–28.
5. Miyanishi K, Jingushi S, Torisu T. Mortality after hip fracture in Japan: the role of nutritional status. *J Orthop Surg (Hong Kong)* 2010; **18**: 265–270.
6. Guo JJ, Yang H, Qian H *et al.* The effects of different nutritional measurements on delayed wound healing after hip fracture in the elderly. *J Surg Res* 2010; **159**: 503–508.
7. Koval KJ, Maurer SG, Su ET *et al.* The effects of nutritional status on outcome after hip fracture. *J Orthop Trauma* 1999; **13**: 164–169.
8. Bender BS, Nagel JE, Adler WH *et al.* Absolute peripheral blood lymphocyte count and subsequent mortality of elderly men. The Baltimore Longitudinal Study of Aging. *J Am Geriatr Soc* 1986; **34**: 649–654.
9. Garden RS. Low-angle fixation in fractures of the femoral neck. *Bone & Joint Journal* 1961; **43-B**: 647–663.
10. Palm H, Gosvig K, Krashennnikoff M *et al.* A new measurement for posterior tilt predicts reoperation in undisplaced femoral neck fractures: 113 consecutive patients treated by internal fixation and followed for 1 year. *Acta Orthop* 2009; **80**: 303–307.
11. Bjorgul K, Reikeras O. Outcome of undisplaced and moderately displaced femoral neck fractures. *Acta Orthop* 2007; **78**: 498–504.
12. Rogmark C, Flensburg L, Fredin H. Undisplaced femoral neck fractures—no problems? A consecutive study of 224 patients treated with internal fixation. *Injury* 2009; **40**: 274–276.
13. Laulund AS, Lauritzen JB, Duus BR *et al.* Routine blood tests as predictors of mortality in hip fracture patients. *Injury* 2012; **43**: 1014–1020.
14. D'Erasmio E, Pisani D, Ragno A *et al.* Relationship between serum albumin and bone mineral density in postmenopausal women and in patients with hypoalbuminemia. *Horm Metab Res* 1999; **31**: 385–388.
15. Sjostedt A, Zetterberg C, Hansson T *et al.* Bone mineral content and fixation strength of femoral neck fractures. A cadaver study. *Acta Orthop Scand* 1994; **65**: 161–165.
16. Chien MH, Guo HR. Nutritional status and falls in community-dwelling older people: a longitudinal study of a population-based random sample. *PLoS One* 2014; **9**: e91044.