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Failure of femoral neck fracture fixation in younger patients

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ABSTRACT

Background: Failure of femoral neck fracture fixation in younger patients frequently lead to significant morbidity. This study aims to evaluate the associated risk factors, to help achieve better outcomes.
Methods: Records of 25 men and 6 women aged 23 to 50 (mean, 39.8) years who underwent fixation for femoral neck fractures using cancellous screws (n=29), a dynamic hip screw (n=1), or a locking plate (n=1) were reviewed. Patients with or without fixation failure were compared.
Results: The mean follow-up period was 28.4 (range, 24–38) months. Of the 31 patients, 24 had bone union and 7 had fixation failure secondary to non-union (n=1), screw cut-out (n=4), and avascular necrosis (n=2). The Revised Trauma Score on admission was 4 in one patient with fixation failure and >6 in all other patients. Comparing patients with or without fixation failure, excess alcohol consumption (5/7 vs. 6/24, p=0.024), smoking (6/7 vs. 9/24, p=0.025), and operative time in minutes (57±16 vs 108±58, p=0.00004), fracture type of OTA 31 B2 or 31 B3 (7/7 vs. 14/24, p=0.027) were significant risk factors.
Conclusions: Excess alcohol consumption, smoking, operative time >85 minutes, and displaced fractures were risk factors for femoral neck fixation failure.

Keywords: Femoral neck fractures, Fracture fixation, Risk factors

INTRODUCTION

The number of hip fractures per year worldwide is expected to increase from 1.66 million in 1990 to 6.26 million in 2050; only 3% of these occur in younger patients.[1-3] Treatment methods depend on the fracture pattern and patient age.[2,4] In older patients, non-displaced fractures should be treated with femoral head preservation surgery and displaced fractures with total hip arthroplasty. In younger patients, early anatomic reduction and stable fixation to salvage the femoral head is the treatment of choice. Nonetheless, it is associated with early postoperative complications such as non-union, avascular necrosis, and fixation failure, with rates ranging from 10 to 30%.[4,5] Risk factors for poor outcome include patient age, comorbidities, fracture displacement, time to surgery, and method of reduction.[2] This study evaluated the risk factors for femoral neck fracture fixation failure in younger patients.

METHODS

This study was conducted at a tertiary care hospital (Singapore General Hospital) in Singapore. Records of 25 men and 6 women aged 23 to 50 (mean, 39.8) years who underwent fixation for femoral neck fractures using cancellous screws (n=29), a dynamic hip screw (n=1), or a locking plate (n=1) from January 2005 to December 2008 were reviewed. Patients with pathological fractures were excluded.

Potential risk factors for fixation failure were recorded including sex, age, comorbidities (excess alcohol consumption, smoking, chronic steroid use, heart failure,

chronic pulmonary condition, hepatic disease, diabetes mellitus, and hypertension), fracture type, trauma severity, time to surgery, type of implant used, and operative time. Excess alcohol consumption was defined as >2–3 units per day and 14 units per week for women, and >3–4 units per day and 21 units per week for men, according to the National Health Service recommendations in Singapore. Bone union was defined as asymptomatic and callus bridging the fracture. Non-union was defined as painful hip movement with hypertrophic or atrophic evidence of non-union at 6 months. Avascular necrosis of the femoral head was based on the Ficat classification. Fixation failure was defined as early re-displacement of the fracture and screw cut-out.

Patients with or without fixation failure were compared using the Pearson Chi-squared test, Fisher's exact test and Kruskal-Wallis test as appropriate. A p value of <0.05 was considered statistically significant.

RESULTS

The mean follow-up period was 18.4 (range, 12–38) months. Of the 31 patients, 24 had bone union and 7 had fixation failure secondary to non-union (n=1), screw cut-out (n=4), or avascular necrosis (n=2). The characteristics of patients who had failure of fracture fixation are described in Table 1. The Revised Trauma Score on admission was 4 in one patient with fixation failure and >6 in all other patients (Table 2).

Table 1: Characteristics of patients with fixation failure.

Variable	Statistic	
Total number of fracture fixation failure, N		7
Gender, N (%)	Male	7 (100)
	Female	0
Mean age, years (SD)		42.3 (7.1)
Orthopaedic trauma association fracture type, N (%)	31-B2	3 (42.9)
	31-B3	4 (57.1)
Mean operative time, min (SD)		107.9 (57.7)
No. of cancellous screws used, N (%)	Two screws	1 (14.3)
	Three screws	6 (85.7)
Mean operative delay, hours (SD)		25.0 (42.0)
Comorbidities, N (%)	Excess alcohol consumption	5 (71.4)
	Smoking	6 (85.7)
Mean time to failure, months (SD)		8.1 (11.5)
Reason for Failure, N (%)	Screw cut-out	4 (57.1)
	Avascular necrosis	2 (28.6)
	Non-union	1 (14.3)
Revision surgery, N (%)	Bipolar hemiarthroplasty	5 (71.4)
	Locking plate fixation	1 (14.3)
	95º angular blade plate fixation	1 (14.3)

Table 2: Calculation of the revised trauma score.

Glasgow coma scale	Systolic blood pressure (mm Hg)	Respiratory rate	Coded value
13–15	>89	10–29	4
9–12	76–89	>29	3
6–8	50–75	6–9	2
4–5	1–49	1–5	1
3	0	0	0

* Revised Trauma Score=0.9368 Glasgow Coma Scale + 0.7326 systolic blood pressure + 0.2908 respiratory rate. The score ranges from 0 to 7.8408. It is heavily weighted towards the Glasgow Coma Scale to compensate for major head injury without multisystem injury or major physiological changes. Patients with a score of <4 should be treated in a trauma centre. The score correlates with the probability of survival.

Comparing patients with or without fixation failure, excess alcohol consumption demonstrated a significant difference (5/7 vs 6/24 Pearson Chi-squared test p=0.024, Fisher's exact test p=0.0665), smoking also demonstrated a significant difference (6/7 vs 9/24 Pearson Chi-squared test p=0.025, Fisher's exact test p=0.037), operative time was significantly different p=0.0004 (57 minutes ±16 for Non failure group and 108 min±58) and Orthopaedic Trauma Association (OTA) fracture type of 31 B2 or 31 B3 difference was (7/7 vs 14/24 Pearson Chi-squared test p=0.038 while p=0.0661 using the Fisher's exact test) (Table 3). 12 patients with no fixation failures had

comorbidities of diabetes mellitus (n=3), thalassaemia minor (n=2), hypertension (n=1), end-stage renal failure on haemodialysis (n=1), hyperlipidaemia, (n=1), epilepsy (n=1), hypercoagulation (n=1), rheumatoid arthritis (n=1), or irritable bowel syndrome (n=1), whereas in the fixation failure group, the identified comorbidities were excessive alcohol consumption (n=5) and smoking (n=6).

Table 3: Comparison of patients with or without fixation failure.

Risk factor	Fixation failure		P value
	Yes (n=7)	No (n=24)	Chi Square/ Fisher's Exact
Excess alcohol consumption	5	6	0.024/0.0665
Smoking	6	9	0.025/0.037
Fracture type			0.038/0.0661
Undisplaced	0	10	
Displaced	7	14	
			P value
Operative time (minutes)	108±58	57±16	0.0004
Operative delay (hours)	25±42	21±22	0.74

DISCUSSION

In younger patients undergoing fixation for femoral neck fractures, the rate of non-union is around 6%.[2,7] Patient demographics, comorbidities, and the impact of trauma differ between younger and older patients.[8,9] Based on superselective angiography, the rate of non-union is inversely related to age, but independent of the supporting blood vessels.[7]

Patients with comorbidities are associated with more postoperative complications. Excess alcohol consumption and smoking were risk factors for poor bone quality. Smoking was the strongest predictor for fixation failure in younger adults (p=0.025). Nonetheless, the bone mineral density in smokers and non-smokers is comparable[10], because bone mineral density only indicates a lower bone mass rather than reduced trabecular mechanical property. In addition, smoking may affect collagen and healing of bone and tissues. Chronic smoking may lead to chronic obstructive pulmonary disease (COPD), and give rise to extra-pulmonary manifestations of osteoporosis. The severity of COPD is inversely proportional to the bone mineral density of the femoral neck and lumbar spine as well as to the T score.[11,12] In addition, the use of inhaled corticosteroids result in adrenal suppression, which is a risk factor for bone loss. Inhaled corticosteroids have deleterious effects on bone.[13] Nonetheless, chronic oral steroid therapy was not correlated with postoperative complications.[2]

Alcohol intake is associated with decreased bone mineral density of the total hip and femoral neck in a stepwise manner; bone mineral density is approximately 5% higher in abstainers than those who have ≥14 drinks per week.[14,15] This may be due to the association between chronic alcoholism and low 25-hydroxyvitamin D levels and secondary hyperparathyroidism. In addition, raised urinary deoxypyridinoline, a marker of bone resorption, is associated with liver cirrhosis and osteoporosis.[16]

Severity of fracture is associated with rates of non-union and avascular necrosis[7]. In younger patients, greater force is required to fracture the femoral neck and thus damage to the surrounding blood vessels is greater; changes in blood flow may compromise the healing process.

According to the British Physician Association, accurate reduction and internal fixation should be performed within 24 hours of femoral neck fractures. Reduced blood supply or the tamponade compression of fractures may worsen local blood circulation leading to hypoxia and ischaemia of the femoral head. This necessitates surgery to restore osseous circulation and eliminate the tamponade effect. However, in most femoral neck fractures, the posterior retinacular vessels remain intact and emergent reduction and fixation may actually damage the blood circulation of the femoral head.[7,17] In addition, operative time of >85 minutes is associated with postoperative complications, owing to compromise of the femoral head blood supply intra-operatively. It is suggested to place screws posteriorly, where a small distance between the screw and the femoral neck cortex would result in the femoral cortex acting as a fulcrum of the screw to prevent fracture redisplacement.[4] A greater screw-shaft purchase over the femoral neck was associated with non-union.

One limitation of this study was the small sample size. Analysis of each risk factor may give better insight into the appropriate management in patients with different demographics, comorbidities, and fracture types.

CONCLUSION

Excess alcohol consumption, smoking, operative time >85 minutes, and displaced fractures were risk factors for femoral neck fixation failure.

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