Cause of Death and Factors Associated With 5-Year Mortality After Hip Fracture Surgery

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Abstract

Aim: the aims of this study were to identify the 5-year mortality rate after hip fracture, identify factors associated with this mortality, and identify the cause of death in these patients.

Materials and Methods: A retrospective cohort study of geriatric patients (≥ 60 years of age) undergoing a hip fracture surgical procedure admitted to our institution between the 1 January 2012 and 31 December 2016 was performed. Demographic and clinical characteristics were collected. Patients or their careers were contacted by telephone or outpatient to ascertain their vital status, and cause of death if they had died at 5-year post-surgery. According to whether they were alive or death at 5-year post-surgery, patients were divided into survivor or non-survivor group. All variables including demographic data and clinical characteristics were compared for both survivors and non-survivors. Cox proportional hazards were used to determine independent risk factors for 5-year mortality. All cause of 5-year mortality in hip fracture were recorded.

Result: A total of 327 patients with a median age of 80.00 years were included. 5-year mortality was 40.1%, and the death peak was concentrated during 6 months after surgery. The final multivariate model included 4 independent mortality risk factors: advanced age, stroke, albumin, delayed surgery, with an HR (95% confidence interval) 1.052(1.025-1.080), 1.612(1.104-2.353), 0.940(0.900-0.982), 1.638(1.072-2.498), respectively. Pulmonary infection, and cardiovascular disease were the most common cause of 5-year death.

Conclusion: Our results showed that 5-year mortality was 40.1%. Advanced age, stroke, low albumin, and delayed surgery were associated with 5-year mortality after hip fracture surgery. Pulmonary infection, and cardiovascular disease were the most common cause of death.

Introduction

Hip fractures is a major source of morbidity and mortality, with mortality rates of up to 20-30% ^[1,2] in the first post-operative year and nearly half of the patients do not regain their previous levels of function ^[3]. 1.6 million patients suffer from hip fracture every year worldwide, and this number is expected to increase to 6.3 million by 2050 ^[4]. It is estimated that by 2050, more than 50% of all osteoporotic fractures will occur in Asia ^[5]. Although early mortality is high, the majority of patients survive the first year; hence, a longer-term perspective is essential, yet less well studied. Some long-term studies ^[6,7] from Western countries had reported the rate of mortality in these patients. There were, however, no studies involving chinese patients, so it was necessary to strengthen the research in this area. The primary purpose of this study is to investigate the 5-year mortality after hip fracture, a secondary objective is to analyze the risk factors and cause of death.

Patients And Methods

Data source

A retrospective study was carried out at the 7th medical center of the General Hospital of the people's Liberation of China between Jan 2012 to Dec 2016. All data had been collected prospectively and had already been submitted to the hip fracture database established, maintained by 2 doctors and 3-5 nurses, in our hospital. The data was collected on admission, during in-hospital stay, and during follow-up. Information recorded on admission included: age, sex, type and mechanism of fracture, comorbidity. American Society of Anesthesiologists [ASA] grade, surgical waiting time, type of surgery, and anesthesia type were recorded during hospital stay. The patients and/or primary caregivers were interviewed by telephone or outpatient clinic. Patients were followed from the index date until the occurrence of all-cause mortality, or the end of the study period (31 December 2017 the latest), whichever came first. The date and cause of death were also recorded.

Inclusion and Exclusion Criteria

Inclusion criteria: age over 60, fragility hip fracture (defined as following low-energy trauma), isolated hip fracture that was not associated with other injury, surgical treatment, follow-up for 5 years or more; exclusion criteria: age < 60, long-term bed rest, multiple injuries, pathological fracture, endangered patients, high-energy injury, multiple fractures, conservative treatment, refusal to follow-up and information is not available.

Procedures

A standardized protocol for co-management of these patients between orthopedic surgeons and a specific team of internists was used at our hospital from admission to discharge. On admission, routine evaluation included hip and chest radiographs, electrocardiography, laboratory analysis, and assessment by surgeon and internist. Generally, for patients with non-displaced fractures (Garden I+II), the operative treatment consisted of percutaneous or open placement of three cannulated cancellous screws. Patients with displaced femoral neck fractures (Garden III+IV), adequate functional and mental preinjury status were treated with bipolar cemented or cementless hemiarthroplasty or total hip arthroplasty. Intertrochanteric fractures were treated with dynamic hip screw or trochanteric nail depending on the fracture line, dynamic hip screw (DHS) was the main treatment for stable intertrochanteric fracture (Arbeitsgemeinschaft osteosynthesefragen/orthopaedic trauma association, OTA/AO 31A1, 2.1). All unstable intertrochanteric hip fractures, identified by classification by a senior consultant as OTA/AO 31A2.2, 2.3, and OTA/AO 31A3, that were treated with cephalomedullary nail. Postoperative rehabilitation was carried out with assistance of a physiotherapist, and usually began within 24 h after surgery with mobilization out of bed to a chair and progression to ambulation with walker. All patients received antibiotic prophylaxis for 24 h and thromboembolic prophylaxis with low-molecular-weight heparin for 35 days.

Variables

Demographic data included age, sex. Major comorbidities included hypertension, coronary heart disease, arrhythmia, heart failure, stroke, pulmonary infection, Chronic Obstructive Pulmonary Disease [COPD], dementia, diabetes, chronic renal insufficiency. Number of comorbidities was calculated as the sum of the above major comorbidities. White blood cell count, hemoglobin and serum albumin were performed for each patient at the time of admission. Fracture and treatment details including fracture type, the American Society of Anesthesiologists (ASA) score, and important therapeutic interventions (including anesthesia methods, and surgical types) were also collected. The primary outcome was the occurrence of death within 5 years after surgery, and a secondary objective was to analyze the risk factors and causes of death.

Statistical analysis

Statistical analyses were conducted with IBM-SPSS v 21 software. Quantitative variables were described as mean and standard deviation (SD) or median and interquartile range, depending on the distribution of the variable (normal or non-normal); qualitative variables are described as absolute and relative frequencies. Kaplan–Meier curves were created to describe hip fracture survival within 5-year after surgery. Patients were divided into two groups according to whether they were still alive or had died at 5-year post-surgery, and all variables were described for both survivors and non-survivors. Outcomes for the two groups were analyzed using Fisher's exact test and continuous outcomes with the t-test or Mann-Whitney-U-Test. Following this, a multivariate Cox regression analysis of all variables that showed significance ($p < 0.1$) in the preceding bivariate analysis was performed. In the final multivariate model, significance was set at $p < 0.05$.

Results

Baseline characteristics

Of the 1350 patients identified from a review of the hospital databases during the study period, 327 patients met the study inclusion criteria. Demographic and clinical characteristics were presented in table 1. The median age was 80.00 years, the proportion of patients over 80 was the highest, and 64.8% were female. Most patients had an ASA class 3 and 4. The most frequent comorbidities were hypertension that were present in 59.5% of patients, stroke in 30.0%, and diabetes in 25.7%. Femoral neck fracture was recorded in 151 (46.1%) cases, consisting of arthroplasty in 67(20.5%) cases, cannulated screws in 87 (26.6%) including 3 cases of stable intertrochanteric fractures which were treated with cannulated nails as the patients required minimally invasive treatment. Intertrochanteric fracture in 176(53.8%) patients, including DHS in 31(9.5%) cases, cephalomedullary nail in 142(43.4%), 3 case for cannulated screws. 74.6% (244) patients receive regional anesthesia (RA), whereas 25.4% (83) received general anesthesia (GA).

5-year mortality

The mortality rate within 5 year after hip fracture for the 327 patients who had surgery was 40.1%. The respective figures for mortality at 30 days, 6 months, and 1 years were 8.0%, 13.1%, and 16.8%, as presented in figure 1. The death peak was concentrated within 6 months, and then the mortality rate gradually decreased.

Risk factor for 5-year mortality

Tables 2 show the results of demographics and clinical characteristics between survivors vs non-survivors. Table 3 shows the results of the multivariate analysis, which included independent variables or factors significantly associated with 5-year mortality. The final model included 4 factors: age, stroke, albumin, delayed surgery.

Cause of death

All cause of 5-year mortality in hip fracture were presented on table 4. Pulmonary infection, and cardiovascular disease were the most common cause of 5-year death, followed by cerebrovascular disease and tumor.

Discussion

Hip fractures in the elderly were common and associated with considerable mortality^[1,2]. While many researchers^[6,8,9,10] had studied mortality after hip fracture, some studies^[8,9,10] had certain weaknesses such as a short follow-up covering mainly in-hospital mortality up to 1 year after hip fracture. Generally, information on 5-year mortality or more after a hip fracture surgery was scarce, in part due to difficulties obtaining continuous long-term data. Another reason was that hip fracture was not routinely be included as a contributing cause of death beyond 1 year. However, von Friesendorff M et al^[6] demonstrated excess mortality after hip fracture was higher even over two decades of follow-up compared to general elderly. To our known, the factors and causes of 5-year mortality after hip fractures surgery had not been studied often in china mainland. In this study, we therefore (1) determined the rate of 5-year mortality; (2) identified independent risk factors associated with 5-year mortality after hip fracture surgery; and (3) investigated the cause of 5-year death.

In previous epidemiologic studies of patients with hip fractures, the mortality rate at 5 years after hip fracture ranged from 30% to 60%^[11,12]. The reason for high variability was due to different age, race and geographical. The current study showed a mortality rate of 8.0%, 13.1%, 16.8%, and 40.1% at 30 days, 6month, 1 year, and 5 year after hip fracture surgery, respectively. The risk of mortality was concentrated during the first 6 months and then declined slightly, which was consistent with previous study^[13].

Not only short-term but also long-term mortality following hip fracture surgery remained higher than general populations^[14]. Having a mechanism, such as risk factor identification, therefore helped with pre-operative decision-making. Although higher ASA class, heart failure, dementia, and low hemoglobin were

also associated with 5-year mortality in univariate analysis, we found that only advanced age, stroke, low albumin, delayed surgery were independent predictor of poor outcomes after hip fracture surgery.

Mortality after a fall-related hip fracture in older people increases with age^[15], and it was considered one of its main predictors. Few studies^[15,16] had assessed the association between mortality after hip fractures in the elderly and age, adjusting for a limited number of comorbidities. Moreover, the risk of long-term death after hip fracture surgery had less been studied. According to Roche et al^[16], the association between age and 30 days or 1 year mortality in patients with hip fracture remained significant after adjusting for 11 comorbidities. Tosteson et al^[14] found that the association between age and 1-year mortality remained significant after adjustment for 13 comorbidities. Our results showed that the association between age and long-term mortality remained significant after adjustment for age, gender, fracture type, 10 comorbidities, numbers of comorbidities, type of surgery, type of anesthesia. So, age has a long-term effect on hip fracture mortality.

Stroke^[17] was a common risk factor for hip fracture, and the incidence of hip fracture in stroke patients was 2–4 times higher than that of normal people in the same age^[18]. Several previous studies^[16,19] had shown that elderly hip fracture patients associated with stroke were at risk mortality, however, these reports focused mainly on early mortality. Our study found that a history of stroke had a hazard ratio for death at 5 year of 1.612(1.104-2.353). This may be consistent with other authors^[20] who reported that stroke was the major cause of long-term disability in adults, and was more frailty.

Although clinical guidelines^[21] recommend that surgery for hip fracture be performed within 48 hours after the event, which based on observational studies suggesting that a shorter time to surgery was associated with improved outcomes in patients. Many literatures^[22,23,24] offered contradictory evidence regarding the optimal time for surgery, because studies^[23,24] which had better results were obtained in patients who undergo early surgery may be biased because patients with a delay in surgical treatment tend to have a higher rate of comorbidities, which means the groups being compared are not identical. However, we used multivariate analysis to exclude the influence of age, gender, comorbidity and other factors, and found that delayed surgery was an independent risk factor for 5-year postoperative death. So early surgery was associated with increased long-term mortality.

Malnutrition was common in elderly, and was associated with poor outcome. Traditionally, nutritional status was evaluated with serum protein markers such as albumin^[25]. Previous studies^[25,26] had found malnutrition to be associated with an increased inpatient mortality rate and 1-year mortality rates. Our results showed low albumin was also associated with an increased 5-year mortality, which might reflect the frailty of hip fracture with malnutrition. This may be related to the fact that malnutrition was a chronic disease with long-term effects on the body.

The causes of death in patients who sustained hip fracture were of great interest due to the medical care that these patients receive postoperatively. More than two thirds of mortality occurred in our cohort were due to cardiorespiratory complications. These findings were in agreement with a study^[27] of more

than 3383 hip fractures showing bronchopneumonia and MI as the principal causes of death. However, which was the most common cause of death after hip fracture surgery and was it suitable for long-term follow-up, there were no clear conclusions at present. Chatterton BD et al^[28] also reported pulmonary infection was the most common causes of death in a study of 4426 patients with hip fracture. Our results confirmed that pulmonary infection was the most common cause of long-term death. Cardiovascular disease (CVD) was a second most common cause of death in their cohort. However, some work^[29] had shown a genetic link between the presence of CVD and the development of subsequent hip fractures^[30]. CVD had been recognized as common determinants of mortality after hip fracture. H. G. Choi et al^[27] report cardiovascular disease to be the major cause of in-hospital death in hip fracture patients.

To our knowledge, this was the first long-term cohort study to evaluate the rate of mortality and its cause in china mainland patients who had undergone surgery for hip fracture. The strengths of this study included the use of prospectively collected data from our hospital databases, managed by people who did not participate in this experiment. Another strength factor was the number of variables collected, which included age, gender, comorbidity, number of comorbidities, biochemical parameter, ASA classification, timing of surgery, type of anesthesia mode and operation mode. However, our study had limitations. Firstly, our sample size was small. Secondly, we were unable to classify the severity of comorbidity disease in our patients. Thirdly, due to limitations of the dataset we used, we lacked data on socioeconomic factors, life-style factors, and educational level.

In conclusion, the current study showed a mortality rate of 40.1% at 5 year after hip fracture surgery, and the death peak were during 6 months after operation. In addition, our study showed that advanced age, stroke, low albumin, and delayed surgery were significantly associated with 5-year mortality. Pulmonary infection and cardiovascular disease were the predominant causes of death. This identified sub cohort of patients who could be died in the next five years after surgery. Given the poor physiological reserve of this subcohort, we recommend that they should be treated by the most experienced clinicians.

Abbreviations

Arbeitsgemeinschaft osteosynthesefragen/orthopaedic trauma association, OTA/AO

Chronic Obstructive Pulmonary Disease, COPD

American Society of Anesthesiologists score, ASA

Dynamic hip screwDHS

Declarations

Ethics approval and consent to participate All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research

committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent for publication: yes

Availability of data and materials: yes

Competing interests: The authors declare that they have no conflict of interest.

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Authors' contributions: Wang Xiaowei, Zhao Jianwen had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Concept and design: Wang Xiaowei, Sun Tiansheng. Drafting of the manuscript: Wang Xiaowei, Zheng Huayong. Statistical analysis: Wang Xiaowei. Administrative, technical, or material support: Wang Xiaowei, Zhang Jianzhen. Supervision: Zhang Jianzhen.

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Tables

Table 1
Demographics and Clinical Characteristics of all Hip Fracture
Patients

Demographics	
N	327
Median age, Y	80.00 ± 9.00
Age	49(15.0%)
60–69	105(32.1%)
70–79	152(46.5%)
80–89	21(6.4%)
≥ 90	
Sex	212(64.8%)
Female	115(35.2%)
male	
Type of fracture	176(53.8%)
Intertrochanteric fracture	151(46.2%)
Femoral neck fracture	
ASA grade	80(24.5%)
Ⅰ+Ⅱ	247(75.5%)
Ⅲ+Ⅳ	
Medical comorbidities	194(59.3%)
Hypertension	66(20.2%)
Coronary heart disease	36(11.0%)
Arrhythmia	46(14.1%)
Heart failure	98(30.0%)
Stroke	18(5.5%)
Pulmonary infection	32(9.8%)
COPD (Chronic Obstructive Pulmonary Disease)	20(6.1%)
Dementia	84(25.7%)
Diabetes	12(3.7%)
Chronic renal insufficiency (CRF)	34(10.4%)
Number of comorbidities(≥ 4)	
Time from admission to surgery	4.10 ± 2.56
Type of anesthesia	83 (25.4%)
General	244 (74.6%)
Regiona	
Type of surgery	87 (26.6%)
Cannulated screws	67(20.5%)
Arthroplasty	31(9.5%)
DHS (dynamic hip screw)	142(43.4%)
Cephalomedullary nail	

Table 2
demographics and clinical characteristics of 5-year survivors and non-survivors after surgery

Variables	Survivors(n = 196)	Non-survivor(n = 131)	P
Age	78.00 ± 11.00	82.00 ± 8.00	0.001
Gender, male	70(35.7%)	45(34.4%)	0.800
Fracture type, Intertrochanteric fracture	101(51.5%)	75(57.3%)	0.309
ASA(Ⅰ+Ⅱ)	75(38.3%)	72(55.0%)	0.003
hypertension	117(59.7%)	77(58.8%)	0.869
Coronary heart disease	36(18.4%)	30(22.9%)	0.317
Arrhythmia	18(9.2%)	18(13.7%)	0.197
Heart failure	18(9.2%)	28(21.4%)	0.002
stroke	49(25.0%)	49(37.4%)	0.016
Pulmonary infection	8(4.1%)	10(7.6%)	0.168
COPD	16(8.2%)	16(12.2%)	0.227
dementia	6(3.1%)	14(10.7%)	0.005
Diabetes	49(25.1%)	35(26.7%)	0.748
CRF	3(1.5%)	9(6.9%)	0.027
Number of comorbidities(≥ 4)	13(6.6%)	21(16.0%)	0.006
WBC at admission	8.50 ± 2.94	8.55 ± 3.86	0.554
hemoglobin at admission	115 ± 22.50	110.00 ± 26.50	0.022
albumin at admission	37.33 ± 4.03	35.09 ± 4.76	0.000
Time from admission to surgery(≥ 2 days)	123(62.8%)	101(77.1%)	0.006
Type of anesthesia General regional	46(23.5%) 150(76.5%)	37(28.2%) 94(71.8%)	0.331
Type of surgery cannulated screws Arthroplasty DHS cephalomedullary nail	47(24.0%) 46(23.5%) 15(7.7%) 88(44.9%)	40(30.5%) 21(16.0%) 16(12.2%) 54(41.2%)	0.148

Table 3
independent predictors of 5-year mortality after surgery
for hip fracture by multivariate analysis.

Risk factors	HR	95%	P-value
Age	1.052	1.025–1.080	0.001
ASA grade	1.112	0.763–1.620	0.581
Heart failure	1.293	0.808–2.069	0.283
Stroke	1.612	1.104–2.353	0.013
Dementia	1.213	0.963–2.252	0.541
Albumin	0.940	0.900–0.982	0.006
Hemoglobin	0.998	0.986–1.009	0.674
Delayed surgery	1.638	1.074–2.498	0.022

Table 4
cause of 5-year mortality for hip
fracture

Cause of death	N (%)
Pulmonary infection	43
cardiovascular disease	30
cancer	17
Cerebrovascular disease	19
Gastrointestinal disease	8
malnutrition	7
others	7

Figures

Figure 1

Survival curve for patients undergoing surgery