Allogeneic Red Blood Cell Transfusion Rate and Risk Factors in Elderly Patients with Femoral Neck Fracture After Hemiarthroplasty

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Research article

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Abstract

Objective: To determine the rate and risk factors of allogeneic red blood cell transfusions (ABT) in elderly patients with femoral neck fracture (FNF) after hemiarthroplasty (HA).

Methods: We conducted a study on elderly patients (≥ 65 years old) who were admitted to the geriatric trauma orthopedics ward of Beijing Jishuitan Hospital for HA treatment from March 2018 to February 2019 due to FNF. The perioperative data were collected retrospectively, and univariate and multivariate stepwise logistic regression analysis were performed to determine the postoperative ABT rate and its risk factors.

Results: 445 patients were included in the study, of which 177 (39.8%) received ABT after surgery. Multivariate stepwise logistic regression analysis showed that preoperative low hemoglobin (Hb), high intraoperative blood loss (IBL), advanced age, and low body mass index (BMI) are independent risk factors of ABT after HA in elderly FNF patients.

Conclusion: ABT after HA is a common phenomenon in elderly patients with FNF. Their postoperative ABT needs are related to preoperative low Hb, high IBL, advanced age, and low BMI. Therefore, ABT can be reduced from the above aspects.

Introduction

Hip fractures are an important reason for the hospitalization of elderly people. Millions of elderly patients worldwide suffer from hip fractures due to minor violence each year ^[1]. Compared with other types of fractures, the incidence of hip fractures in the elderly is high, the mortality rate is high, and the patients are prone to loss of independence ^[2]. The current treatment methods include conservative treatment and surgery. Surgical treatment can reduce bed time, get patients out of bed as soon as possible, and reduce bed-ridden complications. It has been adopted by most physicians. FNF is one of the types of hip fractures. HA is currently a recognized method for the treatment of FNF. It is suitable for elderly displaced FNF with low functional requirements and no acetabular wear ^[3]. Compared with total hip arthroplasty, FNF patients treated with HA have shorter operative time, less IBL, lower incidence of postoperative dislocation, shorter hospital stay, and lower cost ^[3, 4]. Nevertheless, it still has many short-term and long-term shortcomings, such as: ABT, groin pain caused by acetabular wear and the potential risk of requiring revision surgery ^[3, 4]. Among them, ABT is the most common, especially for the elderly. ABT has many serious adverse reactions ^[5, 6], including: acute hemolytic transfusion reaction, blood-borne infections (such as human immunodeficiency virus, hepatitis), prolonged hospital stay, increasing blood resource tension and patient medical burden. Because the elderly have poor tolerance to blood transfusion, blood transfusion-related complications are more likely to occur. Although there are reports in the literature on the risk factors of blood transfusion after hip fracture, we know that the amount of blood loss caused by FNF and intertrochanteric fractures is different. The choice of different surgical procedures for the same type of fracture will also affect the amount of blood loss, which in turn affects the postoperative blood

transfusion rate. At present, there are few research reports on ABT after HA in elderly FNF patients. Therefore, this study will take these patients as the research object to study the predictors of ABT in elderly FNF patients after HA, in order to help clinicians identify high-risk patients, carry out early intervention, and reduce the rate of postoperative ABT.

Materials And Methods

1.1 Patients

Inclusion criteria: ①Age ≥ 65 years old, ②FNF caused by low-energy injury (such as standing height fall, osteoporosis, etc.), ③HA for FNF, ④No history of bleeding diseases such as bone tumors, chronic liver diseases, and blood system diseases. Exclusion criteria: ①open soft tissue fractures, ②multiple fractures, ③pathological fractures. We selected patients who were admitted to the elderly trauma orthopedics ward of our hospital from March 2018 to February 2019 due to hip fractures, and finally included 343 patients who met the selection criteria. All patients received standard HA treatment in our hospital. Based on the policy of restricted blood transfusion, we only transfuse red blood cells to patients with Hb lower than 80 g / L or Hb lower than 100 g/L, but with unstable vital signs or obvious symptoms (heart rate > 100 beats / min, systolic blood pressure < 90 mmHg, chest pain, massive bleeding or extreme weakness). All patients were treated with low molecular weight heparin anticoagulation during the perioperative period, and tranexamic acid was used during the operation. This study was approved by the Ethics Committee of Beijing Jishuitan Hospital, with the ethics approval number: Ji Lun Ke Shen Zi No. 201807-11. All participants signed informed consent.

1.2 Potential risk factors

The risk factors evaluated include the patient's gender, age, BMI, comorbid diseases (such as hypertension, diabetes, coronary atherosclerotic heart disease, cerebrovascular disease, chronic lung disease), whether to take antiplatelet drugs (aspirin and / or clopidogrel), Hb before surgery, time from fracture to surgery, type of anesthesia (general anesthesia or intraspinal anesthesia), American Association of Anesthesiologists (ASA) classification, IBL, and duration of surgery.

1.3 Statistical analysis

Statistical analysis was performed using SPSS 22.0. Quantitative data that obey the normal distribution are expressed as mean $\pm$ standard deviation ($\bar{x} \pm s$), and independent sample t test is used for comparison between groups; quantitative data that do not follow a normal distribution are represented by the median (interquartile range) [M(P25, P75)], and the rank sum test is used for comparison between groups; the qualitative data is expressed by frequency and percentage, and the χ^2 test is used for comparison between groups. Single factor analysis was used to evaluate the relationship between different factors and ABT. Then multi-factor stepwise logistic regression was used to control the confounding effect. Continue to exclude predictors until the p values of all predictors are less than 0.05.

Results

2.1 The general characteristics

The study included 445 patients, aged 65–101 years, with an average age of (82.13 ± 6.96) years. Among all patients, 141 were males (31.69%) and 304 were females (68.31%).

2.2 The univariate analysis

The univariate analysis in Table 1 showed that there was no statistical difference between the two groups in gender, comorbid diseases, ASA grade, time from fracture to surgery, duration of surgery, and whether antiplatelet drugs were taken 1 week before surgery. The preoperative Hb and BMI of the blood transfusion group were significantly lower than those of the non-transfusion group, and the IBL and age were significantly higher than those of the non-transfusion group.

Table 1
Univariate analysis of ABT after HA in elderly patients with FNF

Variable	Non transfusion group	Blood transfusion group	t/Z/ χ^2 Value	P Value
Number of patients	268	177		
Gender			3.576	0.059
Male	94	47		
Female	174	130		
Age(Year)	81.09 $\pm$ 6.78	83.72 $\pm$ 6.94	-3.979	< 0.001*
BMI(kg/m ²)	22.93 $\pm$ 3.73	21.11 $\pm$ 3.95	4.920	< 0.001*
Whether to take antiplatelet drugs one week before surgery			0.446	0.504
yes	68	40		
no	200	137		
hypertension			3.005	0.083
yes	166	95		
no	102	82		
diabetes			3.335	0.068
yes	85	42		
no	183	135		
Atherosclerotic heart disease			0.036	0.849
yes	72	49		
no	196	128		
Cerebrovascular disease			1.903	0.168
yes	80	43		
no	184	134		
Chronic lung disease			0.116	0.733
yes	41	25		
no	227	152		

Variable	Non transfusion group	Blood transfusion group	t/Z/ χ^2 Value	P Value
Preoperative Hb(g/L)	128.80 ± 12.41	113.18 ± 14.69	12.071	< 0.001
Fracture to operation time (days)	3.0(2.0,6.0)	3.0(2.0,6.0)	-0.284	0.777
ASA classification			2.670	0.102
<III classification	94	49		
≥III classification	174	128		
Anesthesia method			5.817	0.016
General anesthesia	5	11		
Intravertebral anesthesia	263	166		
operation duration(min)	64.68 ± 17.65	62.85 ± 18.42	1.050	0.294
IBL(ml)	190.75 ± 82.32	227.12 ± 93.38	-4.322	< 0.001
ABT quantity(ml)	—	467.80 ± 237.25		

2.3 Multivariate stepwise logistic regression analysis

The multivariate stepwise logistic regression analysis showed that low preoperative Hb, high IBL, advanced age, and low BMI were independent risk factors for ABT after HA in elderly FNF patients. Among them, the Wald value of preoperative Hb was the largest, indicating that low Hb before surgery has the greatest impact on ABT after surgery (Table 2).

Table 2
Multivariate stepwise logistic regression analysis of ABT after HA in elderly patients with FNF

Risk factors	OR	95%CI	Wald Vaule	P Vlaue
Age (Year)	1.056	1.020–1.094	9.430	0.002*
IBL (mL)	1.007	1.004–1.009	22.816	< 0.001*
Preoperative Hb(g/L)	0.913	0.894–0.933	72.159	< 0.001*
BMI (kg/m ²)	0.916	0.860–0.975	7.585	0.006*

Discussion

A total of 445 patients were included in the study. The outcomes of this study presented that preoperative low Hb, high IBL, advanced age, and low body mass index (BMI) were independent risk factors of ABT after HA in elderly FNF patients.

Regarding the blood transfusion rate after hip fracture surgery, there have been different reports in domestic and foreign literature. This may be related to the age, fracture type, comorbid diseases, blood transfusion policy, etc. of the subjects in each study. Arshi A et al. ^[7] studied 8416 elderly hip fracture patients over 65 years of age and found that 28.3% of them were transfused after surgery. Many previous studies have concluded that compared with FNF, the risk of blood transfusion after femoral intertrochanter fracture is increased ^[7, 8]. This study did not include patients with femoral intertrochanteric fractures, but the postoperative ABT was even higher. It may be because our hospital is a large-scale upper first-class general hospital with orthopedics and burns as the key department. Part of the patients admitted were referred from primary hospitals. The patients were older, had many complicated diseases, and had relatively severe illness, which also resulted in the relatively high postoperative ABT rate in this study. In the study of Wang JQ et al. ^[9], the elderly patients with HA after FNF were also taken as the research objects, but they found that the postoperative blood transfusion rate was only 13.9%, which was significantly lower than the 44.0% in this study. Then what are the reasons? In the study of Wang JQ et al. ^[9], the average age of the blood transfusion group was (78.95 ± 5.26) years old, the non-transfusion group was (80.82 ± 5.23) years old, while in this study, the blood transfusion group was (83.72 ± 6.94) years old, and the non-transfusion group was (81.09 ± 6.78) . It can be seen that the patients in this study are older, and advanced age itself is one of the risk factors for postoperative ABT.

At present, there is no clear regulation on the standard of blood transfusion for elderly patients with hip fracture ^[10]. Carson JL et al. ^[11] systematically reviewed the results of 31 studies (including 12587 patients) and suggested that the restrictive blood transfusion strategy of controlling the blood transfusion standard at Hb 7–8 g/dL can reduce the ABT rate by 43%. It will not increase the mortality, complication rate and readmission rate within 30 days after surgery, nor will it affect the recovery of patients after surgery. The research of Xie Xuhong et al. ^[12] shows that for elderly patients undergoing surgical treatment of hip fractures, restricted blood transfusion is safe and effective, and it does not affect the prognosis of patients, and is significantly better than unrestricted blood transfusion in terms of adverse reactions after blood transfusion and blood saving. Based on the above reasons, this study adopted a restrictive blood transfusion strategy.

Multivariate stepwise logistic regression analysis showed that low preoperative Hb, high IBL, advanced age, and low BMI were independent risk factors for ABT in elderly FNF patients after HA. In this study, the preoperative Hb of the blood transfusion group was (113.18 ± 14.69) g/L, which was significantly lower than the preoperative Hb (128.80 ± 12.41) g/L of the non-transfusion group ($p < 0.05$). This result is consistent with many previous studies ^[7, 9, 13]. Adunsky A et al. ^[14] found that patients with preoperative Hb lower than 120 g/L have a 5-fold increase in the risk of postoperative blood transfusion. It is speculated that the reason may be due to the poor immune response and compensatory ability of

patients with low Hb before surgery when faced with stresses such as surgery and blood loss. Shokoohi A et al. ^[15] further reported that for every 1 g/dl increase in Hb on admission, the chance of a patient's blood transfusion decreased by about 49%.

There are many reasons for preoperative anemia ^[6] ¶ Acute and chronic hemorrhagic anemia: acute hemorrhagic anemia caused by fractures; chronic hemorrhagic anemia caused by bleeding from digestive ulcers, intestinal polyps or hemorrhoids. ¶ Nutritional anemia: anemia caused by lack of hematopoietic materials, and iron deficiency anemia is the most common, and megaloblastic anemia caused by lack of folic acid and vitamin B is rare. ¶ Anemia of chronic disease: refers to anemia characterized by disorders of iron metabolism that occurs in the course of some chronic diseases, and is common in anemia combined with chronic infection, inflammation, and tumor. ¶ Other anemia: it may involve a variety of complex pathogenic mechanisms and comorbidities. The elderly are more likely to have preoperative anemia due to multiple diseases, reduced absorption and utilization of hematopoietic materials, and reduced hematopoietic reserves. Yoon BH et al. ^[16] believed that intravenous iron supplementation with restrictive blood transfusion is safe and effective for elderly patients with hip fractures.

We also found that IBL is an independent risk factor for ABT. The IBL of the transfusion group was (227.12 ± 93.38) ml, which was significantly higher than that of the non-transfusion group (190.75 ± 82.32) ml ($p < 0.05$). It is consistent with the results of Wang JQ et al. ^[9]. Under normal circumstances, the amount of intraoperative blood loss increases the risk of blood transfusion. Xie J et al. ^[17] believed that intraoperative use of tranexamic acid can reduce intraoperative bleeding, reduce postoperative ABT, and will not increase the risk of postoperative thromboembolic events or other adverse events. Tranexamic acid was used in all patients in this study.

Consistent with previous studies ^[7, 13], we found that advanced age is an independent risk factor for ABT in elderly FNF patients after HA. This may be related to the lower baseline Hb of older people. In addition, elderly patients are more likely to experience unstable vital signs and acute blood loss related symptoms after surgery due to reduced organ function and weak compensatory ability to surgical stress, thus increasing the demand for ABT.

Our research shows that a lower BMI is a risk factor for postoperative ABT, similar to previous experimental results ^[7, 18, 19]. Frisch N et al. ^[18] studied more than 2300 patients and found that after total hip and knee replacement, patients with high BMI had a lower blood transfusion rate. The author believes that the protective effect of BMI on the risk of blood transfusion may be related to the increase in overall blood volume with the increase of BMI. Although obese patients may lose more blood due to larger incisions during surgery, compared with patients with lower BMI, their estimated blood loss during a particular surgery may have a lower proportion of total blood volume ^[18]. In addition, lower BMI may also be an indicator of malnutrition in the elderly.

Different from the study of Yan Ge et al. ^[13], in our study, whether antiplatelet drugs were taken 1 week before surgery did not affect ABT in FNF patients after HA. The experiment of Abdulhamid AK ^[20] included 325 FNF patients, of which 163 had long-term use of antiplatelet drugs and 162 had not used antiplatelet drugs. It was found that there was no statistical difference between the two groups in terms of IBL or postoperative blood transfusion requirements. In this experiment, many elderly patients with cardiovascular and cerebrovascular diseases have a high risk of stopping antiplatelet drugs, so antiplatelet drugs were not stopped during the perioperative period.

Previous studies reported that blood transfusion increased the incidence of complications and leads to blood shortage, prolonged hospital stay and increased hospital costs ^[21–22]. For elderly FNF patients undergoing HA, these problems cannot be ignored. In addition, for elderly patients with potential risk factors, it is necessary to improve blood management. It is currently believed that through risk assessment, careful surgical planning and optimization of preoperative evaluation, the need for blood transfusions during the perioperative period of elderly patients undergoing major surgery can be reduced ^[23].

This study had several limitations. Firstly, this study was a retrospective trial, not a randomized controlled trial. Secondly, the sample size was limited which will inevitably be affected by inherent data;. Another trial with large sample size was still needed in the future. Thirdly, all data in this study came from a hospital. Therefore, it was necessary to conduct a prospective multi-center study to validate our results.

Conclusion

ABT after HA is a common phenomenon in elderly patients with FNF. Their postoperative ABT needs are related to preoperative low Hb, high IBL, advanced age, and low BMI. Therefore, ABT can be reduced from the above aspects.

Abbreviations

ABT: allogeneic red blood cell transfusions

FNF: femoral neck fracture

HA: hemiarthroplasty

Hb: hemoglobin

IBL: intraoperative blood loss

BMI: body mass index

ASA: American Association of Anesthesiologists

Declarations

Ethical statement

This study was approved by the ethics committee of the Beijing Jishuitan Hospital(ethical batch number 201807-11), and informed consent was obtained from all participants.

Consent for publication

All authors final approval of the version to be published.

Competing interests

All of the authors had no any personal, financial, commercial, or academic conflicts of interest separately.

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Authors Contribution

Conception and design of the research: Yue R. Acquisition of data: Yue R, Yang MH. Analysis and interpretation of the data: Yue R, Zhang P. Statistical analysis: Zhang P. Obtaining financing : None. Writing of the manuscript : Yue R, Deng XH, Yang MH and Zhang P. Critical revision of the manuscript for intellectual content : Yue R.

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

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