

Original Article

Factors Influencing Perioperative Occult Blood Loss in Elderly Hip Fracture Patients: A Retrospective Analysis

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Abstract

Objective: To analyze the incidence and influencing factors of perioperative occult blood loss in elderly hip fracture patients. **Methods:** 145 cases of elderly hip fracture patients treated at our hospital from July 2022 to December 2023 were retrospectively analyzed. Patients were grouped based on the presence or absence of perioperative occult blood loss. **Results:** A total of 145 elderly hip fracture patients were included, with an average occult blood loss of 574.58 ± 63.21 ml. Occult blood loss occurred in 42 cases, with an incidence rate of 28.97%, while 103 cases did not experience occult blood loss, with an incidence rate of 71.03%. **Conclusion:** Perioperative occult blood loss in elderly hip fracture patients is common and is associated with factors such as the type of surgery, anesthesia, postoperative drainage, and autologous blood transfusion. These factors constitute risk factors for perioperative occult blood loss in this patient population and warrant clinical attention and early preventive measures.

Keywords: Elderly, Hip Fracture, Influencing Factors, Occult Blood Loss

Introduction

Currently, the world is experiencing a gradual deepening trend of aging. It is estimated that by 2025, the number of elderly people over 60 years old in China will reach about 300 million¹. As age increases, the incidence of osteoporosis in both males and females also rises. Combined with poor muscle strength, the body's coordination ability is significantly reduced, directly increasing the risk of fractures. Hip fracture is a common type of fracture in clinical practice. According to statistics², its incidence rate accounts for about 7%, and the incidence rate of hip fractures in the elderly over 60 years old reaches 23.8%. This has become an important cause of hip joint dysfunction and death in the elderly.

Studies have shown³ that when hip fractures occur in the elderly, they usually require extended bed rest, which can easily lead to serious complications such as deep vein thrombosis, pneumonia, and bedsores. The case fatality rate reaches 10%, and within 1 year, the case fatality rate is about 20%.

Clinically, surgical treatment is often adopted for hip fractures to relieve pain and restore joint function. However, some patients may experience anemia post-surgery. For example, Krishnan S. et al.⁴ have noted that 50% of patients with femoral neck fractures develop anemia upon admission, with the incidence increasing after surgery. The sources of anemia include intraoperative dominant bleeding, postoperative dominant bleeding, and perioperative occult blood loss. Occult blood loss is defined when the degree of anemia does not match the blood loss during surgery, and postoperative hemoglobin levels are significantly lower than preoperative levels. This condition is related to a large amount of blood entering the tissue space during the surgery⁵.

Relevant reports⁶ indicate that perioperative occult blood loss in elderly hip fracture patients accounts for about 50% of total blood loss. Clinically, more attention is often paid to dominant bleeding during and after surgery, while perioperative occult blood loss is easily overlooked. This

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oversight can cause greater harm to physical functions, prolong bed rest, and increase the risk of complications such as postoperative infection and anemia, which hinders timely recovery.

Therefore, it is crucial to fully understand the factors influencing occult blood loss in elderly hip fracture patients during the perioperative period. Although previous studies have identified various influencing factors such as age, surgical method, underlying disease, and fracture type, they have not deeply analyzed the relationship between these factors and occult blood loss⁷. This retrospective cohort study employs multivariate logistic regression and Pearson correlation analysis to enhance clinical understanding of occult blood loss and provide guidance for clinical practice.

Materials and Methods

Study Population

A total of 145 elderly patients with hip fractures, treated from July 2022 to December 2023, were retrospectively included in this study. Patients were grouped based on the presence or absence of perioperative occult blood loss. Those who experienced blood loss were included in the blood loss group, and those who did not were included in the no blood loss group.

Inclusion criteria:

1. All patients met the disease diagnosis criteria outlined in the "Guidelines for the Diagnosis, Treatment and Management of Elderly Hip Fractures"⁸.
2. All patients were aged ≥ 60 years.
3. Complete clinical data were available for all patients.

Exclusion criteria:

1. Pathological fractures or open fractures.
2. Fractures in other parts of the body.
3. Individuals with audiovisual impairment, mental illness, or cognitive impairment.

Data Collection

The clinical data and disease-related characteristics of all patients were collected through the hospital's electronic case management system. These data included sex, age, body mass index, time from injury to surgery, presence of hypertension, presence of diabetes mellitus, fracture type, surgery type, anesthesia method, postoperative drainage, use of heparin, and autologous blood transfusion.

Calculation of Occult Blood Loss and Group Classification

The occult blood loss of all patients was calculated strictly according to the Gross equation: Occult blood loss = total red blood cell loss - dominant red blood cell loss + blood transfusion. occult blood loss ≥ 480 ml was defined as present and classified into the blood loss group; conversely, occult blood loss < 480 ml indicated no occult blood loss and classified into the group without blood loss.

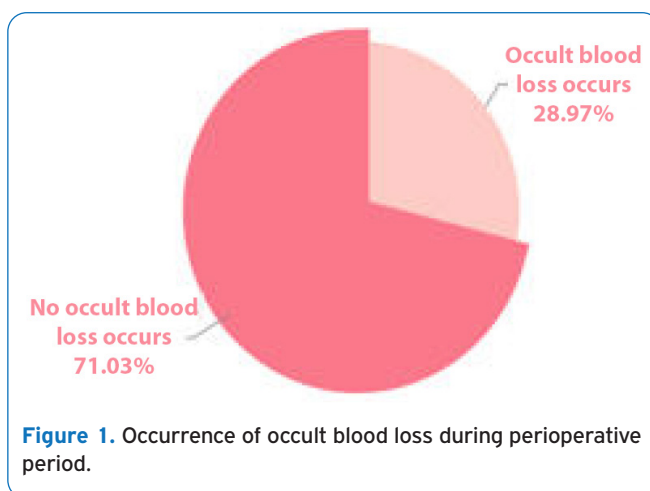


Figure 1. Occurrence of occult blood loss during perioperative period.

Observational Indicators

The incidence of perioperative occult blood loss was assessed in all patients, who were grouped accordingly, and the clinical data of the two groups were compared. Variables showing differences were incorporated into a multifactorial logistic regression model to determine factors influencing the occurrence of perioperative occult blood loss. Subsequently, Pearson correlation was used to analyze the relationship between each factor and perioperative occult blood loss.

Statistical Analysis

SPSS 25.0 statistical software was used for data analysis. Categorical data were presented as percentages and analyzed using the χ^2 test. Normally distributed continuous data were expressed as mean \pm standard deviation (SD) and analyzed using the t-test. Non-normally distributed data were presented as median and interquartile range [M (P25, P75)]. A significance level of $P < 0.05$ was considered statistically significant. Variables showing significant differences between groups were included in a logistic regression model, with occult blood loss occurrence as the dependent variable and clinical data as independent variables. Variables were gradually screened using a significance level of $P = 0.05$ to determine factors influencing perioperative occult blood loss. Pearson correlation analysis was performed to assess relationships between variables, with a significance level of $P < 0.05$ indicating correlation.

Results

Incidence of Occult Blood Loss in Elderly Patients with Hip Fracture

A total of 145 elderly patients with hip fracture were included in this study. The occult blood loss was (574.58 ± 63.21) ml. Specifically, 42 cases (28.97%) experienced

Table 1. Comparison of clinical data between the two groups.

Clinical data		n	Blood loss group (n=42)	Group without blood loss (n=103)	χ^2/Z	P
Sex	Male	80	23	57	0.004	0.949
	Female	65	19	46		
Age [years old (P25, P75)]		145	73.00 (71.00,75.00)	73.00 (70.00,76.00)	-0.565	0.572
Body mass index [kg/m ² (P25, P75)]		145	24.85 (23.60,25.90)	25.00 (24.30,26.20)	-1.112	0.266
Time from injury to surgery [d (P25, P75)]		145	4.00 (3.00,4.30)	4.00 (4.00,5.00)	-1.453	0.146
Complicated hypertension	Yes	49	18	31	2.171	0.141
	No	96	24	72		
Complicated diabetes mellitus	Yes	44	15	29	0.806	0.369
	No	101	27	74		
Fracture type	Femoral neck fracture	59	17	42	0.001	0.973
	Femur Intertrochanteric Fracture	86	25	61		
Type of surgery	Total hip arthroplasty / Hip hemiarthroplasty	58	29	29	20.787	<0.001
	Hollow screw fixation	87	13	74		
Type of anesthesia	Subarachnoid block	64	26	38	7.570	0.006
	General anesthesia	81	16	65		
Postoperative drainage	Yes	59	25	34	8.691	0.003
	No	86	17	69		
Heparin use	Yes	66	19	47	0.002	0.966
	No	79	23	56		
Autologous blood transfusion	Yes	53	23	30	8.454	0.004
	No	92	19	73		

occult blood loss, while 103 cases (71.03%) did not (Figure 1).

Comparison of Clinical Data Between Two Groups

Significant differences were observed between the blood loss group and the group without blood loss in terms of surgery type, anesthesia method, postoperative drainage, and autologous blood transfusion ($P < 0.05$) (Table 1).

Multivariate Analysis of Factors Influencing Perioperative Occult Blood Loss

Logistic regression analysis indicated that the type of surgery, anesthesia method, postoperative drainage, and autologous blood transfusion were all significant factors influencing the occurrence of perioperative occult blood loss (Table 2).

Correlation Analysis of Factors and Perioperative Occult Blood Loss

Pearson correlation analysis revealed significant correlations between the type of surgery, anesthesia method, postoperative drainage, and autologous blood transfusion with perioperative occult blood loss ($P < 0.05$) (Table 3 and Figure 2).

Discussion

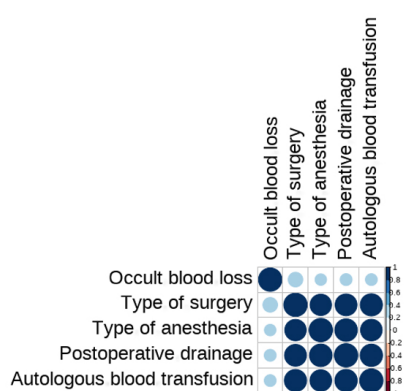
Occult blood loss refers to imperceptible bleeding resulting in decreased hemoglobin and hematocrit, typically accumulating in tissue spaces due to trauma or surgery⁹. This type of blood loss is often difficult to detect directly and can be easily overlooked in clinical settings. However, when occult blood loss occurs, it can induce a fever response,

Table 2. Multivariate analysis of occult blood loss during peri-operative period.

Factor	Assignment	Regression coefficient	Standard error	z value	Wald χ^2	P value	OR value	OR value 95% CI
Type of surgery	0 = Hollow screw fixation	1.739	0.399	4.356	18.974	<0.001	5.692	2.603~12.449
	1 = Total hip arthroplasty/ Hip hemiarthroplasty							
Type of anesthesia	0 = General anesthesia	1.022	0.378	2.707	7.326	0.007	2.780	1.326~5.828
	1 = Subarachnoid block							
Postoperative drainage	0 = No	1.093	0.378	2.894	8.376	0.004	2.984	1.423~6.258
	1 = Yes							
Autologous blood transfusion	0 = No	1.080	0.378	2.855	8.153	0.004	2.946	1.403~6.183
	1 = Yes							

Table 3. Correlation analysis between various factors and perioperative occult blood loss.

Factor	r	P	95% CI
Type of surgery	0.379	<0.001	0.2298-0.5101
Type of anesthesia	0.229	0.006	0.0680-0.3774
Postoperative drainage	0.245	0.003	0.0852-0.3922
Autologous blood transfusion	0.242	0.003	0.0817-0.3892

**Figure 2.** Correlation between various factors and perioperative occult blood loss.

elevate body temperature, and accelerate metabolism, leading to increased nutrient consumption¹⁰⁻¹². This condition directly prolongs hospitalization and recovery times.

Moreover, occult blood loss can induce anemia, which hinders wound healing by reducing blood supply to the patient's skin and muscles. Therefore, understanding the incidence and influencing factors of occult blood loss during perioperative surgery is crucial for optimizing patient outcomes.

The occult blood loss rate among 145 elderly patients with hip fractures was 28.97%, with an average occult blood loss of (574.58 ± 63.21) ml. This finding aligns closely with the research by Yang L. et al.¹³, who observed a total blood loss of 1741 ml and an occult blood loss of 465 ml in patients undergoing joint replacement surgery. Delayed intervention may hinder early mobility and functional training, potentially increasing the risks of delayed wound healing, lung infections, and lower extremity venous thrombosis, thereby adversely affecting patient prognosis. In this regard, conducting a comprehensive analysis of factors influencing occult blood loss during the perioperative period and formulating tailored intervention measures are crucial for promoting rapid patient recovery post-surgery.

A previous multicenter retrospective cohort study¹⁴ found that patients undergoing total hip replacement may have a higher risk of perioperative occult blood loss compared to those undergoing hemiarthroplasty. This finding aligns with the results of our study, which also identified a close association between the type of surgery and perioperative occult blood loss. Currently, various clinical surgical methods exist for treating hip fractures, including total hip arthroplasty/hip hemiarthroplasty and hollow screw fixation. Among these, total hip arthroplasty/hip hemiarthroplasty carries a higher probability of occult blood loss due to its complexity, involving more extensive blood vessel manipulation and longer operative durations. This not only increases visible blood loss during surgery but also exacerbates blood loss from oozing, hematoma formation,

and postoperative inflammatory reactions in surrounding tissues, thereby heightening the risk of occult blood loss^{5,16}.

As a common clinical method of local anesthesia, subarachnoid block involves injecting anesthetic drugs into the subarachnoid space from the patient's lower back to block nerve signals. While effective for pain management, this method also blocks sympathetic nerves, reducing arteriovenous sympathetic activity. This can lead to local blood vessel dilation, thereby increasing blood loss during and after surgery and contributing to perioperative occult blood loss^{17,18}.

Clinical studies comparing general anesthesia and subarachnoid block during total hip arthroplasty have indicated higher perioperative occult blood loss in patients undergoing subarachnoid block¹⁹. Our study similarly identifies anesthesia as a risk factor for perioperative occult blood loss, supported by Pearson correlation analysis demonstrating a significant relationship between the two variables. These findings further underscore the impact of anesthesia on occult blood loss in elderly patients with hip fractures.

Occult blood loss refers to blood entering tissue spaces, which can lead to hemoglobin loss from the circulatory system. When occult blood loss reaches a certain level and tissue spaces become saturated, pressure within the space significantly increases, potentially halting bleeding and compressing the site of blood loss^{20,21}. Based on this mechanism, placing a drainage tube can facilitate blood drainage from tissue spaces, thereby reducing the patient's hemoglobin levels within 24 hours post-surgery. Occult blood loss may continue until the drainage tube is removed. In the study by Guo WK et al.²², it was found that the absence of a drainage tube after total hip replacement surgery can reduce the amount of occult blood loss. However, similar studies in hip fracture patients are lacking. This study aims to fill this gap. Our findings indicate that postoperative drainage is a critical factor influencing perioperative occult blood loss, highlighting a close association between occult blood loss and the presence of drainage.

Scholars have proposed in their research²³ that autologous blood transfusion is a factor affecting the occult blood loss after pedicle screw fixation surgery for scoliosis. Techniques such as centrifugation and negative pressure suction used in autologous blood transfusion can directly damage red blood cells, leading to varying degrees of hemolysis upon reinfusion into the body, thereby increasing occult blood loss. This association underscores the potential for autologous blood transfusion to elevate the risk of perioperative occult blood loss, aligning with findings from clinical studies. In a previous investigation on hip arthroplasty²⁴, the reinfusion of unwashed red blood cells was observed to trigger hemolytic reactions during filtration. On average, for every 1.3 liters of autologous blood reinfused, hemoglobin levels increased by 50 g/L. However, without proper washing, reinfusion of red blood cells can lead to their deformation, complicating efforts to address anemia and potentially exacerbating occult blood loss²⁵.

Although this study aims to provide a comprehensive discussion on the incidence and influencing factors of perioperative occult blood loss in elderly patients with hip fractures, there are several limitations that should be acknowledged. Firstly, the study adopts a retrospective cohort design, which may not fully eliminate potential confounding factors. Secondly, the sample size in this study is relatively small and predominantly consists of patients from a single hospital, potentially limiting generalizability. Therefore, future clinical research should prioritize expanding sample sizes and considering multi-center and multi-regional collaborations to enhance the external validity and applicability of the findings.

Conclusion

In conclusion, elderly patients with hip fractures are susceptible to perioperative occult blood loss, which correlates with factors such as the type of surgery, anesthesia method, postoperative drainage, and autologous blood transfusion. These factors significantly impact the perioperative management of such patients. The risk factors associated with occult blood loss warrant clinical attention, and proactive measures should be implemented early to prevent its occurrence.

Ethics approval

The study was approved by the Ethics Committee of Beijing Tongren Hospital of Capital Medical University (Approval number: 2022LLS0420).

Authors' contributions

LZ designed the study and drafted the manuscript. LZ and HZ conducted the collection and analysis of experimental data. LZ and XZ critically revised the manuscript for important intellectual content. All authors have reviewed and approved the final manuscript.

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