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Predicting the need for blood transfusions in elderly patients with pertrochanteric femoral fractures

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ABSTRACT

Objective: The need exists for perioperative blood management measures aimed at improving patient outcomes and reducing the risks of allogeneic blood transfusion (ABT). Our study aim is to discuss an algorithm to predict the need for perioperative blood transfusion in old patients with pertrochanteric femoral fractures.

Methods: We retrospectively analysed the data from 220 elderly patients with pertrochanteric femoral fractures with regard to the probability of receiving an ABT within 72 h after surgery. The patients were divided into ABT and non-ABT groups. A univariate analysis was used to compare between-group differences with regard to 13 variables. A logistic regression analysis and a probability algorithm to predict the need for an ABT based on independent predictors were used.

Results: The non-ABT group included 131 patients (55 males and 76 females), with an average age of 77.2 ± 6.8 years; the ABT group included 89 patients (29 males and 60 females), with an average age of 79.7 ± 6.6 years. The total volume of transfused blood was 276 Units; the actual average blood transfusion was 3.1 ± 1.47 Units. Significant between-group differences ($P < 0.05$) were observed with regard to age, duration of operation, haemoglobin (Hb) at admission, intra-operative blood loss, type of fracture and type of anaesthesia. The mean volume of transfused blood in the proximal femoral nail anti-rotation (PFNA) and Gamma3 group was larger than that of the dynamic hip screw (DHS) group ($P < 0.05$). A logistic regression analysis revealed that patients with pertrochanteric femoral fractures who were elderly (>81 years), had lower Hb levels at admission (≤124 g/L), longer duration of operations ($t > 85$ min), underwent intramedullary fixation (Gamma3 and PFNA) and had more intra-operative blood loss were more likely to need an ABT. This regression model predicted 74.1% of the transfused cases.

Conclusions: An algorithm was devised to predict and manage the need for an ABT within 72 h after surgery in patients with pertrochanteric femoral fractures. A reasonable transfusion program might reduce the complications caused by anaemia and effectively avoid the risks associated with ABTs.

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Introduction

Pertrochanteric femoral fracture occurs primarily in the elderly, approximate 3–4% of all the fractures in the general population. With the aging process of the society, the number of this fracture has been increasing year by year. Such fractures constitute an important cause of hospital admissions and length of stay in the elderly. Moreover, they are associated with functional impairments and major disabilities and result in high rates of institutionalisation and mortality. Surgery with stable internal fixation, which has been recommended as the first choice of treatment [1], allows early mobilisation and reduces complications.

With the advances in techniques of orthopaedic surgery and mechanical improvements of implants, most pertrochanteric femoral fractures can be treated with minimally invasive surgery; however, post-operative anaemia is still a common phenomenon in elderly patients with pertrochanteric femoral fractures. Lower postoperative haemoglobin (Hb) level has been associated with a worse early functional recovery, longer length of stay, and higher rates of readmission and mortality [2,3]. Cross-matching is the routine preparation to prevent postoperative anaemia and complications in these patients. Furthermore, surgery for hip

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fractures ranks second in the total number of blood units administered to patients according to diagnoses groups [4]. Allogeneic blood transfusion (ABT) is also a known risk factor for immunosuppression and increases the risk of infection; moreover, over-transfusion influences patient health and has economic implications [5–7]. Therefore, many scholars have recommended a "restrictive transfusion policy" [8–10]. However, the indications for ABTs in elderly patients with pertrochanteric femoral fracture have not been standardised and remain controversial.

Previous attempts to improve the efficiency of blood ordering and transfusion in elderly patients have advocated policies for all patients with hip fractures [1]. Few studies have focused on pertrochanteric femoral fracture. The purpose of the current study was to assess the epidemiological characteristics of elderly patients requiring ABT admitted to a hospital for pertrochanteric femoral fractures. Using these data, an algorithm was built to predict the need for ABTs. We hypothesised that we would be able to predict which of the patients who were admitted for pertrochanteric femoral fracture would need an ABT. By better managing this process, patients are more likely to receive optimal medical care without straining hospital resources, thereby reducing the cost of care.

Patients and methods

Patients

This retrospective database study was based on data collected from the hospital electronic medical record (EMR) system and the blood bank database. Approval for conducting this study was received from the local research committees. A total of 408 patients were admitted for pertrochanteric femoral fractures and underwent surgical treatment between 2007 and 2012; however, only 220 of these patients met the inclusion criteria (Table 1). We excluded all patients who were treated without surgery.

Risk factors for an ABT that were assessed included patient demographics (i.e., age and gender), fracture type, American Society of Anaesthesiology (ASA) grade, anaesthesia type, time between injury and surgery, laboratory values (i.e., Hb at admission, mean corpuscular volume [MCV], international normalised ratio [INR], transaminase and creatinine), the use of anticoagulants, and surgical details (i.e., internal fixation type, duration of operation, intra-operative blood loss, and postoperative drainage). Complications such as infections (pneumonia and surgical site infection), cardiac events, cerebro-vascular events and 30-day mortality were also recorded, as well as the number of units of transfused blood.

Monitoring of Hb and transfusion protocol

At admission to hospital, all patients had a complete blood count (CBC) analysis; two samples of blood were taken for the ABO Rh group type and antibody screening and two units of packed red blood cells (RBCs) were cross-matched and ordered. An additional cross-match was carried out thereafter as necessary because the previous sample had expired according to blood bank safety regulations. A CBC was taken on post-operative days one and three, when the patients presented signs of symptomatic anaemia (i.e., tachycardia, weakness and palpitations) and after blood transfusion.

Our institute currently adheres to a "restrictive transfusion policy". According to our transfusion protocol, patients were pre-operatively transfused to an Hb level of 90 g/L. The patients were transfused post-operatively when their Hb level dropped below 80 g/L. This "transfusion trigger" was raised to 90 g/L in clinically symptomatic patients (i.e., extreme weakness, chest pain, extreme paleness or major bleeding), when vital signs were abnormal (i.e., tachycardia, heart rate [HR] >100 bpm, and systolic blood pressure [SBP] <90 mmHg); and in those with a history of heart disease (i.e., coronary, valvular problems and arrhythmia) or cerebro-vascular disease.

Table 1
Study criteria.

Inclusion criteria
(1) older than 60 years
(2) low energy injury without concomitant fractures or injuries that might require an ABT
(3) treated with close reduction and minimally invasive surgery
(4) blood count measured at admission, post-operative days one and three, and post-transfusion
Exclusive criteria
(1) pathologic fracture due to malignancy and high energy injury
(2) history of blood system diseases and Hb <80 g/L at admission
(3) severe liver or kidney dysfunction

Surgical procedure

All patients were treated on a traction table under the guidance of G-arm fluoroscopy. All of the procedures were performed by 4 senior surgeons in our institution using modified techniques, who are experienced in the management of pertrochanteric fractures. Moreover, duration of operation in this study was measured from the time of close reduction to incision closure. Surgeons did not perform surgery directly under imaging intensify in order to avoid excess of X-ray exposure. When the image intensifier was used to assess the reduction of fracture, the locations of the guide wire and internal fixations, the surgeons were behind the tinplate. Forty patients received a dynamic hip screw (DHS, Synthes, Switzerland) fixation; 84 patients received a proximal femoral nail anti-rotation (PFNA, Synthes, Switzerland) fixation, and 96 patients received a Gamma3 nail (Stryker, MI, USA) fixation.

Statistic analyses

Statistical analyses were conducted using SPSS 13.0 (SPSS Inc., USA). Univariate analyses were used to compare the group that received an ABT within 72 h after surgery with the group that did not with regard to 13 variables. Continuous, normally distributed variables were analysed using a two-sample Student's t test; continuous, non-normally distributed variables were analysed using the Wilcoxon-rank-sum test; Pearson's chi-square test and Fisher's exact test were used to compare the groups with respect to categorical variables; a one-way ANOVA was used to compare differences in groups, and the LSD method was used to compare differences between groups. A P value of <0.05 was considered to indicate statistical significance.

A multivariate logistic regression was applied to identify the significant independent predictors of ABT. The full regression model included 13 risk factor candidates. Model selection methods such as Wald-backward elimination were used to identify significant factors from the 13 explanatory variables.

Results

The data of all 220 patients were included in the final analysis. The patients were divided into non-ABT and ABT groups. Table 2 shows the general characteristics and the univariate analysis of the study population. A total of 89 patients (40.5%) received an ABT within the first 72 h after surgery, 5 patients were transfused to an Hb level of 90 g/L pre-operative, 76 patients were transfused when their Hb levels dropped below 80 g/L post-operative, and 8 patients

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