Transfusion Frequency of Red Blood Cells, Fresh Frozen Plasma, and Platelets During Ruptured Cerebral Aneurysm Surgery

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■ BACKGROUND: **The use of blood products after subarachnoid hemorrhage (SAH) is common, but not without controversy. The optimal hemoglobin level in patients with SAH is unknown, and data on perioperative need for red blood cell (RBC), fresh frozen plasma (FFP), or platelet transfusions are limited. We studied perioperative administration of RBCs, FFP, and platelets and the impact of red blood cell transfusions (RBCTs) on outcome in patients undergoing surgery for ruptured a cerebral arterial aneurysm.**

■ METHODS: **A retrospective analysis was performed of 488 patients with aneurysmal SAH during the years 2006–2009 at Helsinki University Central Hospital. Patients who received RBC, FFP, or platelet concentrates perioperatively were compared with a cohort of patients from the Helsinki database of aneurysmal SAH who did not receive transfusions. A multiple regression model was created to identify factors related to transfusion and outcome.**

■ RESULTS: **RBC, FFP, or platelet concentrates were given in 7.6% (37 of 488), 3.1% (15 of 488), and 1.2% (6 of 488) of patients intraoperatively and in 3.5% (17 of 486), 1.6% (8 of 488), and 0.9% (4 of 488) of patients postoperatively. Of 37 intraoperative RBCTs, 26 were related to intraoperative rupture of the aneurysm. Intraoperative RBCTs were associated with lower preoperative hemoglobin concentration, higher World Federation of Neurosurgical Societies classification, and intraoperative rupture of an aneurysm. In multivariate analysis, intraoperative RBCT (odds ratio = 5.13, 95% confidence interval = 1.53–17.15), worse World Federation of Neurosurgical Societies classification and Fisher grade (odds ratio = 1.97, confidence interval = 1.64–2.36 and odds ratio = 1.89, confidence interval = 1.23–2.92, respectively), and increasing age (odds ratio = 1.07, confidence interval = 1.04–1.10) independently increased the risk of poor neurologic outcome at 3 months.**

■ CONCLUSIONS: **Transfusion frequencies of RBCs, FFP, and platelets were relatively low. Intraoperative RBCT was strongly related to intraoperative rupture of the aneurysm in patients with poor-grade SAH. The observed association between poor outcome and RBCT in patients with SAH warrants further study.**

INTRODUCTION

While the debate of optimal hemoglobin level for a patient with subarachnoid hemorrhage (SAH) is ongoing, the transfusion rate of red blood cells (RBCs), fresh frozen plasma (FFP), or platelets during surgery for ruptured aneurysm and factors correlating with it has received less attention (4-6, 10, 14). Earlier reports indicated that the frequency of intraoperative red blood cell transfusion (RBCT) was 5.6%–27.2% (2, 7, 8), but the incidence of intraoperative transfusion of FFP or platelets is unknown. The present study was designed to describe blood product use and associated clinical characteristics in patients operated on for ruptured cerebral arterial aneurysm at Helsinki University Central Hospital, Helsinki, Finland, between

Key words
- Fresh frozen plasma
- Intraoperative
- Neurosurgery
- Platelets
- Red blood cell
- Subarachnoid hemorrhage
- Transfusion

Abbreviations and Acronyms
FFP: Fresh frozen plasma
GOS: Glasgow Outcome Scale
P-PT, %: Plasma prothrombin time value
RBC: Red blood cell
RBCT: Red blood cell transfusion
SAH: Subarachnoid hemorrhage
WFNS: World Federation of Neurological Surgeons

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January 2006 and September 2009. The hypothesis was that the need for RBCT in our clinic is low, and FFP and platelet transfusions are used mainly in patients on long-term anticoagulation or antiplatelet therapy.

MATERIALS AND METHODS

After approval of Helsinki University Central Hospital Scientific Board, we identified patients who had undergone surgery for ruptured cerebral arterial aneurysm between January 2006 and September 2009 from the Helsinki aneurysm registry and retrieved demographics of these patients. We collected surgical and intensive care unit data and identified patients who had received RBCs, FFP, or platelets intraoperatively or during the immediate postoperative period (within 24 hours of surgery). We also included patients who had been given transfusions during preparation for surgery.

The retrieved variables included age, sex, localization of the aneurysm, preoperative Glasgow Coma Scale score 3–15, World Federation of Neurological Surgeons (WFNS) classification 1–5, Fisher grade 1–4, occurrence of intraoperative rupture of an aneurysm, comorbidities, medication, preoperative laboratory results, hemoglobin concentration, platelet count and plasma prothrombin time value (P-PT, %) before and after transfusion, the amount of transfused blood products, and blood loss. Glasgow Outcome Scale (GOS) score 1–5 at 3 months was used to evaluate outcome. In the logistic regression analysis, the GOS score was dichotomized into good outcome (GOS score 4–5) and bad outcome (GOS score 1–3) and used as the endpoint. We compared clinical characteristics of patients undergoing surgery for ruptured cerebral arterial aneurysm based on the need for transfusion of any type of blood product.

Statistics

Descriptive statistics are shown as mean ± (SD) or median (range). Fisher exact test was used for categorical variables, and Mann-Whitney U test was used for continuous variables. We used logistic regression and odds ratios to assess relationships between the 2 outcome variables and each main study variable. Variables tested for multivariate analysis of risk factors for RBCT were hemoglobin concentration, platelet count, P-PT, %, WFNS classification, Fisher grade, aneurysm location, intraoperative aneurysm rupture, aneurysm size, and sex. For outcome analysis, variables were intraoperative rupture of an aneurysm, RBCT, WFNS classification, Fisher grade, age, preoperative hemoglobin, and aneurysm location. Variables associated with study outcomes with $P < 0.1$ in univariate analysis were included in multivariable logistic regression analysis. A propensity score was calculated using covariates that were associated with intraoperative RBCT and was added to multivariate analysis assessing outcome as a covariate. Additionally, variance inflation factor was calculated to detect possible multicollinearity between the covariates. All statistical analyses were performed using IBM SPSS Statistics version 21 (IBM Corp., Armonk, New York, USA).

RESULTS

During the study period, 488 patients underwent surgery for a ruptured cerebral arterial aneurysm. RBC, FFP, or platelet transfusions were given to 70 patients either during surgery or in the immediate postoperative period. Intraoperative RBC, FFP, and platelet transfusions were given in 7.6% (37 of 488), 3.1% (15 of 488), and 1.2% (6 of 488) of patients, and postoperative RBC, FFP, and platelet transfusions were given in 3.5% (17 of 486), 1.6% (8 of 488), and 0.9% (4 of 488) of patients. In 5 patients, RBCs were transfused intraoperatively and postoperatively (Table 1).

Hemoglobin concentration was 107 g/L ± 18 before and 117 g/L ± 14 after transfusion of RBCs. P-PT, % was 63 ± 16 before and 82 ± 39 after transfusion of FFP, and platelet count was 98 10^9/L ± 15 before and 181 10^9/L ± 62 after transfusion of platelets. Among the 70 patients who received blood products, 7 were taking acetylsalicylic acid, 3 were taking warfarin, and 1 was taking clopidogrel before surgery. Hemoglobin concentration, platelet count, and P-PT, % were outside the normal laboratory reference ranges in 38.6% of transfused patients preoperatively and in 29.2% of patients with intraoperative RBCT. Tranexamic acid was given to 68.6% of patients on admission to Töölö Hospital before surgery. Of 37 patients who received RBCs during surgery, 26 had experienced intraoperative rupture of the aneurysm. Similarly, 7 of 15 patients who required intraoperative FFP transfusion and 1 of 6 patients who required platelet transfusion had intraoperative rupture of the aneurysm.

Total volumes of RBCs, FFP, and platelet concentrates transfused were 730 mL ± 503, 560 mL ± 283, and 500 mL ± 199. One patient with a large (20 mm diameter, 8 mm base) ruptured basilar aneurysm experienced a massive bleed of 10,520 mL during surgery and received 2400 mL of RBCs, 800 mL of platelets, and 1000 mL of FFP intraoperatively. Mean blood loss for patients who received RBCT during surgery was 1470 (± 1890) mL.

Intraoperative RBCT

Table 2 shows main clinical characteristics of the 488 patients divided into 2 groups based on the need for intraoperative RBCT (yes or no). Preoperative hemoglobin concentration was lower in patients who received intraoperative RBCT. There also was a significant difference in preoperative WFNS classification and Fisher grade between the 2 groups. GOS score at 3 months was lower among patients who received RBCs during surgery. There was no statistical difference in aneurysm location between the 2 groups. In multivariate analysis, lower preoperative hemoglobin value, worse Fisher grade, increase in aneurysm size, and intraoperative rupture of an aneurysm independently increased the likelihood of intraoperative RBCT (Table 3).

Table 1. Transfusion Rates of Perioperative Red Blood Cells, Fresh Frozen Plasma, and Platelets

	Before Surgery	During Surgery	Postoperative	Total
RBCs	5/488 (1.0%)	37/488 (7.6%)*	17/488 (3.5%)	52/488
FFP	5 (1.0%)	15 (3.1%)†	8 (1.6%)	23/488
Platelets	1 (0.2%)	6 (1.2%)‡	4 (0.9%)	9/488

FFP, fresh frozen plasma; RBCs, red blood cells.
*RBCs also were given before surgery in 3 patients and postoperatively in 4 patients.
†FFP was given before surgery in 4 patients and postoperatively in 1 patient.
‡Thrombocytes were given before surgery in 1 patient and postoperatively in 1 patient.