A Study of Preoperative Autologous Blood Donation Timing

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Abstract This study aims to determine the safe and effective autologous blood drawing time for preoperative autologous blood donation (PABDs) by comparing the outcome of two different schedules of PABDs. A total of 144 patients who underwent elective surgery (radical resection of digestive tract tumor, lumbar spine surgery and Intracranial tumor resection) were retrospectively reviewed. 88 patients had donated autologous blood 2 days before the operation (group 1); 56 patients had donated autologous blood more than 3 days before the operation (group 2). Hb and Hct before the operation and on postoperative days one and three, allogeneic blood transfusions, total bleeding, postoperative length of stay, and length of stay were measured and compared. Hb at postoperative day one was lower in group 2 than in group 1 ($P < 0.05$). Furthermore, Hb in group 1 was higher at postoperative day one than at postoperative day three ($P < 0.05$). Differences in postoperative Hct, allogeneic blood transfusions, total bleeding and postoperative length of stay between these two groups were not statistically significant ($P > 0.05$). The difference in the average number of postoperative hospitalization days between these two groups was not statistically significant ($P > 0.05$). The 2 days of PABD did not lead to any adverse recovery effect. It would be helpful to conduct preoperative autologous blood transfusions.

Keywords Preoperative autologous blood donation (PABD) · Elective surgery · The drawing blood time

Introduction

Although technology of blood collection, separation and detection is advanced, blood transmitted diseases has decreased more than before. However, based on limitation of technology, blood transmitted diseases cannot avoided completely. Preoperative autologous blood donation (PABD) means patients' self-blood are collected and kept before surgery, and then transmitted to themselves during the surgery. Preoperative autologous blood transfusion has favorable application values in reducing adverse reactions of blood transfusion, maintaining normal blood indexes, improving abnormal blood rheology and alleviating lack of blood supply [1–5]. Collecting blood repeatedly before surgery can stimulate the proliferation of bone marrow cell and regeneration of red blood cell, enhance hematopoietic function after surgery, accelerate hematopoietic speed after surgery, benefit wound recovery and decrease infection. PABD has better application value in decreasing adverse reaction during the transfusion, maintaining normal blood index, improving abnormal hemorheology, releasing lack of blood supply and so on [6–10]. It is used in a variety of elective operations such as orthopedic, cardiac surgery and obstetrics. After autologous blood donation, hemoglobin of patients decrease. Therefore, in order to avoid impact on recovery after surgery, it should be conducted several days before surgery. However, there is no clear standard on the timing for preoperative autologous blood donation. AABB standards still allow autologous collections as little as 72 h preceding operation [11]. Most studies considered that autologous blood donation should be conducted at least

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72 h before the operation, and some blood donations needed a longer period of time in advance [12–15]; which resulted in longer hospitalization time, increased health care costs and burden on patients. In order to improve this problem, a number of medical institutions have arranged the autologous blood donation time for some patients to be within 2 days before surgery. However, the safety and effectiveness of this timing remains unclear. There is currently no standard to follow, which is not conclusive for the common application of preoperative autologous blood transfusions. This study was designed to compare the influence of these two timing schedules on recovery: within 2 days before surgery, and more than 3 days before surgery; to explore the safety (adverse events) and postoperative Hb and average days in hospital of autologous blood donation within 2 days before surgery, and provide reference for its clinical application.

Materials and Methods

Objects of the Study

We reviewed the surgery reports and transfusion states of 144 Patients undergo elective operations who were admitted to the Department of General Surgery, Department of Orthopedics and Department of Neurosurgery of our hospital from January 2014 to May 2015. This study was approved by the Hospital Ethics Committee, and signed informed consent for autologous blood donation was provided by the participants. A retrospective study was conducted. Inclusion criteria: (1) ≥ 18 years old and ≤ 66 years old, male body weight > 50 kg, female body weight > 45 kg, American Society of Anesthesiologists (ASA) grading: grade I–II, preoperative hemoglobin (Hb) ≥ 120 g/L, red blood cell specific volume (Hct) ≥ 0.36 and platelet count (PLT) $\geq 110 \times 10^9/L$; (2) the applied amount of preoperative blood preparation was ≥ 3 U, except for organic disease at the surgical target site, and the body is generally in good condition; (3) cardiac function $\geq$ grade II; (4) no serious cardiovascular disease history of myocardial infarction, cerebral infarction and so on in the past six months; (5) no infection. Patients were divided into two groups according to their blood collected interval: group 1, patients who underwent autologous blood donation within 2 days before the surgery; group 2, patients who underwent autologous blood donation more than 3 days before the surgery. Differences in preoperative general data (Table 1) between these two groups were not statistically significant ($P > 0.05$).

Schedule of Autologous Blood Donation

There were two donation schedules. (1) Autologous whole blood: the patient's autologous whole blood was collected,

the donation amount was determined according to the preoperative preparation of blood, body weight, Hb and Hct levels, as well as the patient's overall state; and the single maximum donation amount was 400 ml. (2) Autologous hemapheresis donation: a full automatic blood collection tube (Terumo BCT) was used, concentrated erythrocytes were collected, the erythrocyte hematocrit was 0.8, donation amounts were determined according to the patient's related indexes (height, weight and Hb) and amount of reserved blood. During the collection process, the doctor should observe the patients and inquire on any presence of discomfort. If a prodrome of adverse reactions such as facial creeps and numbness of the limbs appears, intravenous calcium gluconate should be given in a timely manner. After collection, an erythrocyte preservative solution was added to the concentrated autologous erythrocytes; which enabled the erythrocyte hematocrit to finally reach 0.50–0.65 (Reference: GB18469-2012). After collection, blood was stored in a refrigerator at 4 °C for intraoperative or postoperative reinfusion.

Observation Indexes

(1) Hb and Hct levels of patients on postoperative days one and three; (2) amount of bleeding and allogeneic blood transfusions during surgery; (3) average number of postoperative hospitalization days, the presence of postoperative infections, and healing of the incision.

Statistical Analysis

Data were processed using statistical analysis software SPSS 19.0. Quantitative data was expressed as $\bar{X} \pm s$, comparison of quantitative data between groups was conducted using independent sample *t* test, and count data were compared using Fisher's exact test. $P < 0.05$ was considered statistically significant.

Student's *t* test was used to compare general information, quantity of self-blood collection, Hb and Hct after surgery, quantity of bleeding during surgery and average days in hospital between two groups, and Fisher's exact test was used to compare self-blood collection reaction rate between two groups.

Results

Situations of Autologous Blood Donation

The difference in autologous blood donation (Table 1) between these two groups was not statistically significant ($P > 0.05$).

Table 1 General data before surgery

Variable	Group 1 (n = 88)	Group 2 (n = 56)
Male/Female	64/22	39/17
Age	50.3 ± 10.2	48.8 ± 13.1
Hb (g/L)	139.9 ± 11.0	138.3 ± 11.3
Hct (%)	42.8 ± 2.9	41.8 ± 3.1
Autologous blood collection quantity (ml)	307.4 ± 86.9	312.3 ± 77.9

Comparison of Hb and Hct Levels on Postoperative Days One and Three

Hb levels on the first day after surgery were higher in group 1 than in group 2 ($P < 0.05$) it may not be clinically relevant; while Hb levels in group 1 were lower on the third day after surgery than on the first day after surgery ($P < 0.05$), (Table 2). The differences in changes in Hct levels between these two groups were not statistically significant ($P > 0.05$).

Blood Lose Allogenic Blood Transfusion Rate

There was no statistically significant between two groups in allogenic blood transfusion rate ($P > 0.05$) The difference in the average number of postoperative hospitalization days between these two groups was not statistically significant ($P > 0.05$; Table 3).

All patients in these two groups did not have transfusion reactions such as fever, allergy and bacterial pollution during the autologous blood transfusion process. Complications such as postoperative wound infection and poor healing did not occur in any patient.

Discussion

In recent years, clinical blood transfusion faces a number of safety problems such as rare blood source, blood borne disease infection, alloimmunization and immunosuppression. For the collection time of autotransfusion, a time of at least 72 h before the operation is recommended by most foreign studies [12, 13]. Furthermore, this surgery requires the preparation of a large amount of blood; and autologous blood donation and storage is recommended to be

conducted at least four weeks before the operation [16]. This traditional autologous blood donation method prolongs hospitalization time, affects turnover rate, and brings many inconveniences to doctors and patients; thus, May prevent the development of the clinical application of autologous blood transfusion. In order to change this limitation, a number of medical institutions plan to adjust the autologous blood donation method. Currently, autologous blood donation and storage within 2 days before the surgery is non-rare, but studies on its effectiveness and safety evaluation are rare.

In this study, postoperative Hb levels decreased in all patients compared with levels before the surgery, The reason may be that after autologous blood donation, functional extracellular fluid and protein entered into the blood, promoted liver protein synthesis, and slowed down the metabolism and decomposition of proteins; thus, no hypoproteinemia occurred [17]. Based on the phenomenon that Hb levels at the first day after surgery in patients who underwent blood collection within 2 days before surgery were higher than in patients who underwent blood collection more than 3 days before surgery, and that Hb levels at the third day after surgery in patients who underwent blood collection within 2 days before surgery were lower than at the first day after surgery, we hypothesize that the blood cell reserve pool also needs to be replenished, and that the replenishment process was carried out a few days after autologous blood donation. Thus, Hb levels decreased after collection, with the extension of the interval between autologous blood donation time and surgery. Moreover, overall reproductive output of blood increased and daily blood growth rate decreased [18]. Postoperative Hb levels in patients who underwent autologous blood donation within 2 days before the surgery were not lower than Hb levels in patients who underwent autologous blood

Table 2 The level of Hb and Hct on 1st and 3rd days after surgery

Time	Hb (g/L)		Hct (%)	
	Group 1 (n = 88)	Group 2 (n = 56)	Group 1 (n = 88)	Group 2 (n = 56)
+1 Post-op day	118.2 ± 16.5*	111.5 ± 15.5	35.7 ± 4.8	34.3 ± 5.8
+3 Post-op day	112.5 ± 19.7 [△]	110.7 ± 14.9	34.4 ± 4.7	33.7 ± 4.6

* Comparison of Group 1 and Group 2, $t = 2.43$, $P < 0.05$

[△] Comparison of +3 post-op day and +1 post-op day in Group 1, the level of Hb: $t = 2.02$, $P < 0.05$

Table 3 Quantity of bleeding on operation, allogeneic blood transfusion rate, average days of hospitalization after surgery and average days in hospital

	Group 1 (n = 88)	Group 2 (n = 56)
Quantity of bleeding (ml)	418.4 ± 352	417.3 ± 320.7
Allogeneic blood transfusion rate (%)	21.6	21.4
Average days of hospitalization after surgery (days)	13.5 ± 5.5	14.5 ± 8.7

donation more than 3 days before the surgery, suggesting that collection time within 2 days before the surgery did not increase the incidence of postoperative anemia.

It is generally considered that patients with a longer interval between autologous blood donation and surgery would recover faster, and the interval between autologous blood donation and surgery is related to a patient's erythrocytes regeneration [19]. The average erythrocyte regeneration time after a blood donation of 550 ml in healthy men not taking iron supplements is 36 days (59), and a small quantity of erythrocyte regeneration occurs in 5–10 days after blood donation [20]. Recent studies revealed that patients with a shorter interval between autologous blood donation time and surgery may obtain the hematopoietic ability at an earlier time, in order to allow rapid recovery to normal blood levels [6]. The reason may be that the infusion of fresh blood [21], as well as the short interval between blood collection time and surgery, can better stimulate the production of endogenous erythropoietin. The influence of PABD time on erythrocyte regeneration needs further evaluation.

In this study, the difference in the average number of postoperative hospitalization days between these two groups was not statistically significant ($P > 0.05$); that was to say, autologous blood donation within 2 days before surgery did not increase the number of postoperative hospitalization days. Studies have reported that when autologous blood donation was conducted two weeks before the surgery, infusion effect was reduced due to the increase in low function erythrocytes in autologous blood during storage [6]. The difference in allogeneic blood transfusion between these two groups was not statistically significant, and PABD within 2 days before the surgery did not increase the amount of allogeneic blood transfusion. This study revealed that PABD within 2 days before the surgery can reduce allogeneic blood transfusion, and did not affect postoperative recovery.

In summary, autologous blood donation and storage within 2 days before surgery did not cause any adverse affect on the patient's postoperative recovery. In this study, only two collection periods were compared. The influences of blood collection time on postoperative recovery, especially on the immune function of patients, needs to be further investigated.

Compliance with Ethical Standards

Conflict of interest All authors declare that they have no conflict of interest.

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