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Comparison of whole blood collection and double-unit erythrocytapheresis in preoperative autologous blood donation

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ABSTRACT

Introduction: We compared preoperative autologous blood donation (PABD) using serial manual whole blood (WB) and PABD using a single session, double-unit erythrocytapheresis in terms of the hemodynamic recovery and clinical outcomes.

Materials and methods: This study included 56 donors in the WB PABD group and 117 donors in the double-unit erythrocytapheresis PABD group. All subjects were men with body weight >70 kg, Hb level >13.3 g/dL, Hct >40%, and who were scheduled for oral and maxillofacial surgery. Three cycles of manual WB collection for PABD or a single session, double-unit erythrocytapheresis using the Alyx was performed.

Results: There were no significant differences in donor demographic variables including age, height, weight, Hb, Hct, or red cell mass between the 2 groups. The double-unit erythrocytapheresis was completed earlier than the last manual WB PABD (at 15.3 ± 4.7 days and 6.5 ± 3.2 days before surgery, $p < 0.001$). Hct values before surgery were higher in the double-unit erythrocytapheresis PABD group than in the manual WB PABD group (39.7 ± 3.2 vs. 38.6 ± 2.7, $p = 0.024$). ΔHct and %ΔHct before the first PABD and before surgery were lower in the double-unit erythrocytapheresis PABD group than in the manual WB PABD group (−5.6 ± 2.8 vs. −6.8 ± 2.7, $p = 0.010$ and −12.3 ± 5.9 vs. −14.8 ± 5.6, $p = 0.008$, respectively). The incidence of additional allogeneic blood transfusions during or after surgery and the post-operative Hb and Hct values were similar in the 2 groups. The length of hospital stay after surgery was significantly longer in the manual WB PABD group than in the double-unit erythrocytapheresis group (6.1 ± 2.5 vs. 5.4 ± 1.9, $p = 0.043$). Of the 33 donors in the double-unit erythrocytapheresis PABD group, 7 (21.2%) reported discomforts related to the procedure, and 6 graded the discomforts (hypocalcemia, perioral tingling sense, paresthesia, dizziness, stuffiness, pain on the intravenous site, and muscle tension) as mild.

Conclusion: The single session, double-unit erythrocytapheresis prolonged the time interval between PABD and surgery and led to better hemodynamic recovery than the serial manual WB PABD, and hypocalcemic symptoms were mild.

1. Introduction

Concern about the transmission of hepatitis and human immunodeficiency viruses through transfusion has led to the use of alternative measures to reduce the exposure to

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allogeneic blood [1–5]. Of the many alternatives available, preoperative autologous blood donation (PABD) is the most widely used [1–5]. In addition, PABD can help the current shortage of blood products. The demand for blood is increasing, while the recruitment and retention of donors does not meet the demand for blood products. By reducing the use of allogeneic blood, PABD can help in augmenting blood supply [6,7].

Conventionally, PABD involves a series of manual collections of 1 unit of whole blood (WB) with weekly time intervals within the shelf-life of red cell concentrates (from 35 to 42 days when stored at +4 °C) [2]. The weekly withdrawal of blood does not allow the erythron to compensate for the loss of red blood cells (RBCs) by the time of surgery; therefore, the last collection should be performed at least 72 h before the anticipated surgery [2,8].

Using multicomponent apheresis instrumentations, it is possible to obtain 2 or more units of RBCs in a single PABD session [4]. This procedure was introduced by Haemonetics using its MCS platform, but is also possible with other apheresis instruments including the Fenwal Alyx and Terumo BCT Trima Accel [6,7,9]. Donor eligibility criteria are similar to those of PABD with manual WB collection, but it demands higher hematocrit (Hct) levels and body weight [10,11]. The absolute RBC volume drawn can be adjusted based on an FDA-approved nomogram that takes into account the donor's sex, Hct levels, weight, and height. The donor safety and sufficient product quality of this procedure has been demonstrated in many studies [11–14]. Using erythrocytapheresis of multiple units of RBCs in a single session includes the following advantages: (i) the number of donor visits to the hospital are minimized, reducing the cost and time associated with hospital visits; (ii) the time interval between blood donation and surgery is prolonged, allowing the bone marrow enough time to produce sufficient red blood cells; (iii) plasma can be recycled back to the donor; and (iv) the amount of blood product can be standardized [2,6,15,16]. Several studies have shown the advantages of erythrocytapheresis of multiple units of RBCs using apheresis instruments in PABD programs [2,4]. Nevertheless, serial manual WB donation continues to be more widely used in PABD programs than the multiple-unit erythrocytapheresis, and no reports that we are aware of have compared the efficiency and applicability of erythrocytapheresis to that of WB donation.

In order to evaluate the potential application of erythrocytapheresis in routine PABD, we compared changes in hemodynamic parameters in serial manual WB donation and in single session, double-unit erythrocytapheresis in male donors scheduled for oromaxillofacial surgery. Clinical factors including the use of allogeneic blood transfusion and clinical outcomes were also compared. Discomfort related with the apheresis procedure and donors' preferences for the procedure were also assessed.

2. Materials and methods

2.1. Donors

Data for this study was obtained from 56 donors for whom manual WB collection was performed and 117 donors for whom erythrocytapheresis was performed; these donors were enrolled in the PABD program of the Blood Bank of Seoul National University Hospital (Seoul, Republic of Korea) from December 2006 to July 2010. All donors in both groups were men who were scheduled for oral and maxillofacial surgery due to facial asymmetry or mandibular prognathism in the Seoul National University Dental Hospital. All donors had body weights of >70 kg, hemoglobin (Hb) levels of >13.3 g/dL, and Hct levels of >40% in order to comply with a post-donation Hb level of at least 11 g/dL. These criteria were established based on the theoretical calculation of the total blood volume (TBV) and red cell mass using the formula recommended by the BEST group: TBV (mL) = 70 mL × body weight (kg); red cell mass (mL) = TBV × Hct. Exclusion criteria were similar to those for the existing autologous donation program: a systolic gradient >80 mmHg or a history of syncope, unstable angina, a Hb level of <11 g/dL, coagulation disorders, acute infection of any kind, and administration of drugs for a potential bacteremia within 3 days prior to donation. Donors with pulmonary, cardiac, or hepatic alterations were also excluded. Donors were informed of the cost (approximately 190 US$ for 3 sessions of WB collection and 270 US$ for a single session double-unit erythrocytapheresis PABD in Korea), duration of the procedure, frequency of hospital visits, and whether plasma was returned so that they could choose the procedure that they wished to undergo. Donors were recommended to take oral iron from the time of PABD until admission to the hospital. All donors gave informed consent, and the study was approved by the Institutional Research Board of Seoul National University Hospital (IRB No. H-1102-036-351).

2.2. PABD with manual whole blood collection

WB was collected using simple phlebotomy, and the target volume of each donation was 320 mL. Three cycles of donation were performed in the manual WB PABD group with approximately 1-week interval between each cycle. The first PABD was usually performed no earlier than 35 days prior to the scheduled day of surgery, and the last PABD no later than 72 h before surgery. In the PABD using WB program, volume replacement therapy is performed for donors who show signs and symptoms of hypovolemia; however, no patient in the study population showed any signs or symptoms of hypovolemia or required volume replacement therapy. The WB was processed to 1 unit of packed RBCs, and the plasma was discarded. The product was stored at +4 °C until the time of surgery.

2.3. PABD with double-unit erythrocytapheresis

Double-unit erythrocytapheresis was performed using the Alyx system (Fenwal, Lake Zurich, IL, USA) with software version 2.2. Only 2 units of apheresis RBCs (total volume, 420 mL) were collected using apheresis instrument because the RBC volume in the double-unit erythrocytapheresis (with a theoretical Hct of 100%) is comparable to the absolute RBCs in 3 units of WB collected [6,14]. A single session was performed at approximately 2 weeks before the surgery. The procedure consisted of multiple cycles of