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The hematological and clinical effects of X-ray contrast medium contaminating autologous blood for transfusion purposes

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ABSTRACT

Little information is available regarding the influence of non-ionic low-osmolar iodinated contrast medium (CM) in stored blood on the quality of blood components. We sought to evaluate the quality of such CM-contaminated blood in terms of the degree of hemolysis, production of microaggregates, level of iodine concentration, and RBC shape, and to identify the pros and cons of autologous blood donation immediately after X-ray examination using CM. In conclusion, contamination by such CM in blood collected around 2 h after the completion of X-ray examination appears unlikely to induce deleterious effects on blood components.

1. Introduction

Although the quality and safety of allogeneic blood is extremely high, pre-operative autologous blood donation is the norm in Japan for patients scheduled for surgery requiring blood transfusion and who prefer to use their own blood. The guidelines for auto-transfusion are well established, but one unresolved issue is the suitability of donating autologous blood immediately after X-ray examination using a contrast medium (CM), such as in enhanced computed tomography (E-CT).

Ionic CM, as developed in the 1960s, was associated with various clinical adverse events such as anaphylaxy, urticaria, bronchospasm, and phlebitis. Regarding the influence of ionic CM on blood components, a number of studies have also reported *in vitro* or animal studies revealing, for example, impaired deformability of RBCs, aggregation of RBCs and/or platelets, and anticoagulant effects [1,2].

Non-ionic low-osmolar CM for X-ray examination was developed in the 1970s to reduce the incidence of such adverse hematological and medical outcomes in patients. The subsequent incidence of such events has been extremely low and non-ionic low-osmolar CM is now commonly used for X-ray examination. However, the influence of non-ionic low-osmolar CM on stored blood is not well known, and for this reason autologous blood donations are not usually scheduled the same day as a patient receiving intravenous X-ray contrast. Nevertheless, in cases with a short donation period prior to surgery or in which patients wish to minimize the number of hospital visits for pre-operative medical checkup including X-ray examination, donation of autologous blood is scheduled on the same day. Where it is not possible to perform blood donation before X-ray examination using CM, blood donation would ideally be performed only after waiting for detectable CM to disappear from the body. However, the residual concentration of CM in stored blood following X-ray examination is extremely low, and performance of blood donation following X-ray examination using CM is not prohibited in the 1996 guide *Autotransfusion*. In reality, it is sometimes carried out in the clinical setting. Against this background, a delay of several hours before donating autologous blood would be hard to implement in our hospital considering the clinical

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logistics of not keeping patients waiting too long, and not otherwise inconveniencing them by requiring multiple hospital visits for procedures that could have been carried out during the same visit.

Our study therefore sought to evaluate the quality of such CM-contaminated blood in terms of the degree of hemolysis, production of microaggregates, level of iodine concentration, and RBC shape. We also aimed to identify the advantages and disadvantages of autologous blood donation immediately after X-ray examination, in particular when using non-ionic low-osmolar iodinated CM.

2. Materials and methods

2.1. Patients and the use of contrast medium

Subjects were donor-patients scheduled for cardiac surgery at Iwate Medical University Hospital, who met the following four conditions: (1) they required a medical checkup by E-CT before surgery; (2) they preferred to undergo E-CT and to donate autologous blood on the same day, and the time schedule of the radiology and/or the transfusion department dictated that the E-CT be carried out first; (3) surgery was scheduled for at least 5 weeks after the first donation of autologous blood; (4) subjects gave written informed consent (IC) concerning the use of CM-contaminated autologous blood.

As anaphylactic reaction is a well-known adverse event associated with CM, patients with iodine hypersensitivity, serious thyroid dysfunction, or any other previous history of reactions to CM had to be excluded, and IC was routinely obtained before using CM for X-ray examination. In this study, patients' vital signs were carefully monitored and we were ready to cope with any adverse events associated with reinfusion of the originally donated autologous blood.

The non-ionic low-osmolar iodinated CM routinely used for E-CT at our hospital is iopamidol (Iopamiron® 300 mgI/mL, Bayer Schering Pharma, Germany). Its osmolality is, however, still approximately 3 times higher than that of saline. Usually, 1.2 mL/kg (360 mgI/kg) of the CM is administered intravenously for E-CT.

In this study, donor-patients served as control if (1) X-ray examination using CM was not carried out before donating autologous blood and (2) cardiac surgery was scheduled for at least 5 weeks after the first blood donation.

2.2. Blood donation and reinfusion

Donation of autologous blood was carried out according to the 1996 guide *Autotransfusion: A Manual for Drawing Blood and Its Management*, produced by the Japanese Ministry of Health, Labor, and Welfare. Donor-patients were required to be in good overall health, with a hemoglobin (Hb) concentration before the first donation of at least 11.0 g/dL. Blood volume for the first donation was 400 mL, and for subsequent donations was determined by considering the pre-donation Hb level. For example, if the Hb level was between 10.0 and 10.5 g/dL, 200 mL of autologous blood was drawn. No blood was collected if the level was below 10.0 g/dL. Donations were taken at intervals of more than 7 days and all patients were started on an oral iron sulfate (200 mg/day) supplement.

Reinfusion was carried out just under 5 weeks after the first donation, as the shelf life of refrigerated blood using citrate phosphate dextrose adenine (CPDA) solution is 5 weeks. 400 mL of autologous blood was first drawn from the patient, and 400 mL of the initially donated blood was then re-infused. Donor-patients were observed carefully for clinical adverse events during and after the re-infusion of stored blood. Details are shown in Fig. 1.

2.3. Sample collection and evaluation

Before each donation, blood samples were obtained from the patient to measure complete blood count (CBC), electrolytes, iron (Fe), and lactate dehydrogenase (LDH). The CBC result was used to determine the blood volume drawn at each donation. The residual serum was immediately stored

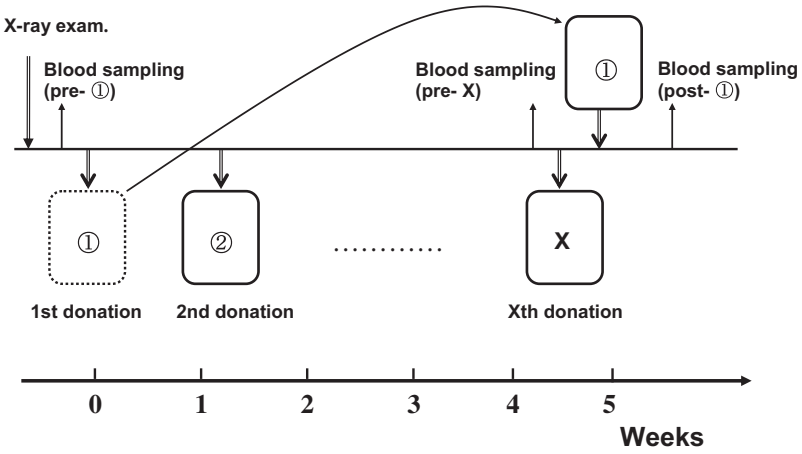

Fig. 1. Schedule for blood donations and sample collection. Blood sampling was performed before each donation of autologous blood. At the Xth donation, blood sampling was also performed after the reinfusion of old blood (post-①).