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Anesthetic management for ascending aorta replacement in a patient who refused autologous transfusion for religious reasons

Shinju Obara, Masayuki Nakagawa, Shinichiro Takahashi, Masahiko Akatu, Tsuyoshi Isosu, and Masahiro Murakawa

Department of Anesthesiology, Fukushima Medical University School of Medicine, 1 Hikari-gaoka, Fukushima 960-1295, Japan

Abstract
We report on the anesthetic management of a 69-year-old female Jehovah's Witness undergoing cardiopulmonary bypass to replace the ascending aorta; the patient refused transfusion of stored autologous or allogeneic blood products for religious reasons. The strategy involved preoperative hematopoiesis with recombinant human erythropoietin and iron, intraoperative acute normovolemic hemodilution, the use of a cell-saver system, administration of high-dose tranexamic acid, controlled hypotension, avoidance of low body temperature, simplification of the surgery, and lower blood dilution during cardiopulmonary bypass.

Key words Acute normovolemic hemodilution · Cardiac anesthesia · Jehovah's Witness

Introduction

Jehovah's Witness (JW) patients refuse preoperatively donated autologous blood transfusions for religious reasons. Therefore, careful measures need to be taken when such patients undergo operations that are expected to produce significant blood loss. We present a case of a JW patient undergoing cardiopulmonary bypass (CPB) for replacement of the ascending aorta.

Case report

A 69-year-old female JW (height, 149 cm; body weight, 47 kg), who had undergone a left anterior descending artery angioplasty due to angina pectoris in another hospital at the age of 50 years, was referred to our hospital with a diagnosis of ascending aortic aneurysm, with no complaints. Surgery was planned to replace the ascending aorta. The patient refused to accept the transfusion of stored autologous blood or allogeneic blood products during surgery, but agreed to the administration of albumin products and autologous salvaged red blood cells obtained using a cell-saver system (CS), and she agreed to undergo acute normovolemic hemodilution (ANH). Her medications included aspirin, isosorbide dinitrate, metoprolol tartrate, and amlodipine besylate. The administration of aspirin was stopped 7 days before the surgery. Her vital signs were as follows: heart rate, 80 beats·min^{-1}; blood pressure, 120/60 mmHg; respiratory rate, 10 breaths·min^{-1}.

The patient received subcutaneous injections of recombinant human erythropoietin (rHEpo, 6000 units) and was intravenously (i.v.) infused with parenteral iron (80 mg) three times per week to increase hemoglobin levels. After 7 weeks, an adequate response was obtained (hemoglobin increased from 11.7 g·dl^{-1} to 15.4 g·dl^{-1}; hematocrit value increased from 34.5% to 47%). Computed tomography of the thorax revealed that the maximum diameter of the ascending aorta was 64 mm and the aneurysm extended into the innominate trunk. Transthoracic echocardiography showed a left ventricular ejection fraction of 68%. An echocardiogram showed moderate aortic regurgitation and enlargement of the sinus of Valsalva and aortic valve ring (diameters, 33 mm and 25 mm, respectively). Coronary angiography revealed stenosis of the left anterior descending artery (75%). Stress myocardial scintigraphy revealed no myocardial ischemia. Cerebral magnetic resonance imaging revealed lacuna infarctions without evidence of a neurological disorder. Laboratory examinations revealed absence of any abnormalities.

The patient was not premedicated. As a coronary precaution, nicorandil was infused (i.v.) at 3 mg·h^{-1} prior to the induction of anesthesia. General anesthesia was induced using midazolam (3 mg, i.v.) and fentanyl (0.2 mg, i.v.) and maintained with propofol Target Con-

Address correspondence to: S. Obara
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trolled Infusion (TCI) (2–3 $\mu g \cdot ml^{-1}$) and intermittent fentanyl infusion. Tracheal intubation was performed after the administration of rocuronium (0.6 $mg \cdot kg^{-1}$). Monitoring devices included the bispectral index, an arterial line, a central venous line, a cerebral oximeter monitor (INVOS; Somanetics, Troy, MI, USA), a transesophageal echocardiography probe, and a neuromuscular transmission monitor (TOF-Watch; Bluestar Enterprises, Chanhassen, MN, USA). Before incision, ANH was performed in the right internal jugular vein to withdraw blood using the side port of a 9-French introducer. The patient was infused with 1000 ml of bicarbonate Ringer's solution (Bicarbon; Ajinomoto, Tokyo, Japan), and 1000 ml of whole blood was collected. A continuous blood circuit was maintained using ANH and CS in the CPB circuit. Tranexamic acid (TA; 5 g) was infused during anesthetic induction and initiation of CPB. Before CPB, we deliberately maintained the patient's mean arterial pressure within 70%–80% of baseline values, using bolus nicardipine and sevoflurane inhalation.

Prior to the institution of CPB, the femoral artery and right atrium were cannulated, and anticoagulation was performed using bovine heparin (170 $IU \cdot kg^{-1}$). The aorta was cross-clamped at the aortic arch between the innominate artery and the left common carotid artery. Selective antegrade cerebral perfusion via the innominate artery was used during normothermic circulatory arrest. After replacement of the ascending aorta, the patient was weaned from CPB without inotropic support; normal ventricular and valvular function was demonstrated on transesophageal echocardiography. The lowest hematocrit value during CPB was 23%. Reversal of the residual heparin effect was achieved using protamine (60 mg i.v.; post-protamine activated coagulation time [ACT], 137 s). Subsequently, carbazochrome sodium sulfonate (100 mg), menatetrenone (30 mg), and TA (4 g) were administered. The durations of CPB and the aortic cross-clamp were 97 min and 72 min, respectively. Olprinone hydrochloride (0.1 $\mu g \cdot kg^{-1} \cdot min^{-1}$) was administered after terminating CPB; CS (230 ml), washed blood (600 ml) from the CPB circuit, and 1000 ml of whole blood collected previously were re-infused before the patient was transferred from the operating room. The lowest body temperature recorded was 35°C. A total dose of 28 $\mu g \cdot kg^{-1}$ fentanyl (total, 1.3 mg) was required by the patient for the entire operation. The volume of urine was 675 ml, and measurable blood loss was 5 ml. The durations of the surgery and anesthesia were 294 and 367 min, respectively. After the surgery, the patient was transferred to the surgical intensive care unit, where mechanical ventilation was continued under sedation and the trachea was extubated 18 h after the operation. She was transferred to the surgical ward the next day and exhibited no bleeding or other major complications during the postoperative period. The patient was discharged on postoperative day 26 when her hematocrit value was 42%.

Discussion

JW patients refuse preoperatively donated autologous blood transfusion for religious reasons [1]. Whole blood, red cell concentrates, platelet products, fresh frozen plasma, and prestored whole blood are always refused. However, this patient agreed to receive albumin products, globulin preparations, fibrin adhesive, CPB, and cell-salvage. Persuading a patient to accept ANH and red blood cells obtained using CS is important [2], because a refusal to permit transfusion for an operation that might involve significant blood loss would lead to anemia, and possibly death [3,4]. Using fresh autologous blood contributes to fewer coagulation abnormalities, and reduces postoperative bleeding and the need for allogeneic blood products [5]; however, a sufficient preoperative hematocrit value is necessary for successful blood donation. Treatment with rHEpo enhances erythropoiesis after preoperative autologous blood donation [6], and iron supplementation encourages maximum erythropoiesis. This enables the patient to attain the highest possible hematocrit value. JW patients sometimes insist on a continuous blood circuit with ANH, CS, and CPB. In this particular patient, we tentatively and successfully used a continuous circuit, even though the patient did not request it.

Generally, blood volume is diluted 25%–33% during CPB in adult patients [7]. In the present patient, we used a smaller CPB circuit to avoid extreme dilution and inadequate oxygen delivery, and the dilution was 21%. Habib et al. [8] reported that complications such as stroke and myocardial infarction increased significantly once the hematocrit value decreased below 22%. Fortunately, the lowest hematocrit value recorded during CPB in the present patient was 23%.

Although the aneurysm extended to the innominate artery, we replaced only the ascending aorta to simplify the operation and shorten the duration of CPB, because prolonged CPB can cause coagulation disorders. This case was also complicated due to moderate aortic regurgitation resulting from the aortic ring enlargement; therefore, aortic tailoring was performed rather than aortic valve replacement.

Because controlled hypotension reduces the volume of blood lost during surgery [9], we lowered the arterial pressure, using sevoflurane and nicardipine before initiating CPB. After weaning the patient from CPB, olprinone was infused at a rate of 0.1 $\mu g \cdot kg^{-1} \cdot min^{-1}$ to lower arterial pressure and increase cardiac output [10]. The mean arterial pressure was maintained within 70%–80%

of baseline values. Because the patient had a lacunar infarction and there was concern about a perioperative cerebral infarction, we closely monitored her cerebral oxygenation values to detect cerebral ischemia [11] during surgery, and there were no neuropsychological complications.

Because hypothermia inhibits platelet activation [12] and increases blood loss, we conducted a normothermic CPB to maintain temperature throughout the operation.

TA inhibits plasmin-induced platelet activation and can inhibit plasmin-induced fibrinolysis after extracorporeal circulation [13]. Although the effectiveness of high-dose TA has been reported [14,15], there is no consensus on the optimal dose of TA. In the present patient, a total dose of 190 $mg \cdot kg^{-1}$ TA was administered intravenously, in accordance with previous case reports [2,14]. Aprotinin has been used as an antifibrinolytic drug to prevent excess bleeding, but we avoided it because the Blood Conservation Using Antifibrinolytics in a Randomized Trial (BART) study [16] revealed a higher death rate in patients receiving aprotinin.

In summary, we have described the anesthetic management for ascending aorta replacement in a patient who refused to undergo preoperatively donated autologous blood transfusion for religious reasons. Strategies included preoperative administration of rHEpo and iron, ANH, CS, high-dose TA, and modification of the surgical and CPB techniques. This management resulted in a successful outcome, but adapting the operational procedure requires careful consideration in each case based on the patient's condition.

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