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Complete Repair of Coarctation of the Aorta and a Ventricular Septal Defect in a 1,480 g Low Birth Weight Neonate

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Although outcomes of neonatal cardiac surgery have dramatically improved in the last two decades, low body weight still constitutes an important risk factor for morbidity and mortality. In particular, cardiac surgery in neonates with very low birth weight (≤1.5 kg) is carried out with greater risk because most organ systems are immature. We report here on a successful case of early one-stage total repair of coarctation of the aorta and a ventricular septal defect in a 1,480 gram neonate.

Key words: 1. Neonate
2. Infant, low birth weight
3. Aortic coarctation
4. Heart septal defect, ventricle

CASE REPORT

A 3-day-old neonate who was born 1,530 g at 39 prenatal weeks was diagnosed with a ventricular septal defect, a patent ductus arteriosus, and a coarctation of aorta. This patient was transferred to our hospital for cardiac surgery. Other vital signs were normal except for a high respiration rate of 65 breaths per minute. Besides the diagnoses above, an aortic arch hypoplasia was discovered by echocardiography (ascending aorta 6 mm, first aortic arch 3.72 mm, second aortic arch 2.90 mm, isthmus 1.83 mm). The flow of blood through the patent ductus arteriosus was from right to left in systole, and from left to right in diastole. There were a large ventricular septal defect in the perimembranous trabeculation and a small atrial septal defect. The patient was medicated with prostaglandin E1 to delay the operation and observed in the Neonatal Intensive Care Unit. At 7 days old, we decided to do operation because the symptoms of heart failure, including tachypnea and oral feeding difficulty, had become worse. On the operation day, the patient's age was 9 days and weight was 1,480 g.

A cardiopulmonary bypass (CPB) machine by Cobe Century, oxygenator by Terumo RX-05, line by Hanmi (A line 1/4, V line 1/4), and hemofiltration machine by Dideco were used. The volume of the priming fluid in the cardiopulmonary bypass machine was 605 cc (plasma solution 330 cc, 20% albumin 50 cc, RBC 200 cc, Bivon 20 cc, and mannitol 5 cc). Cardioplegia solution was used with cold crystalloid solution (Custadiol®). A median sternotomy was performed. An 8-Fr cannula was inserted into the aorta and a 4-Fr intravenous cannula was inserted into the right atrium. Then the ductus arteriosus was ligated after operation of the cardiopulmonary bypass machine. A 14-Fr intravenous cannula was inserted into the inferior vena cava, and a 10-Fr vent

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cannula was inserted into the right upper pulmonary vein.

An 18 G Pediatric Aortic Root Cannula (DLP® Medtronic) was inserted into the proximal aorta; then the cardioplegia solution was injected after the upper part of the ascending aorta was clamped. The incision of the right atrium was performed after cardiac arrest. Then the patch closure with glutaraldehyde-fixed auto pericardium was performed for the repair of the ventricular septal defect. A primary suture was performed for the atrium septal defect. After the incised right atrium was sutured, the left common carotid artery and the left subclavian artery were ligated temporarily. Antegrade cerebral perfusion was performed through the innominate artery. The rectal temperature was 25.9°C, and the perfusion rate was 90 mL/min. The cerebral perfusion pressure was not observed due to the failure of the maintenance of the A-line in the right radial artery. The cerebral oxymeter was monitored during the operation. After dissection of the aortic arch, cerebrovascular artery, and descending aorta, removal of part of the coarctation was performed. Extended end-to-side anastomosis between the descending aorta and the aortic arch was performed. Total cerebral perfusion time was 20 min. After untying the ligation of the left common carotid artery, the left subclavian artery, and the ascending aorta, the body temperature was increased while maintaining the perfusion rate of the CPB at 300 mL/min and the perfusion pressure at 45-55 mmHg. The CPB weaning was successful, and norepinephrine 0.08 ug/kg/min, dobutamine 5 ug/kg/min, dopamine 5 ug/kg/min, and milrinone 0.75 ug/kg/min were administered. The total CPB time was 120 min and aortic cross clamp time was 67 min. A modified ultrafiltration was used after the operation. The patient recovered hemodynamic stability in the cardiovascular intensive care unit (ICU), and was weaned from the ventilator 3 days after the operation. The patient was transferred to the neonatal ICU on postoperative day 7, and discharged 1 month postoperatively. At the last follow-up, the patient's age was 76 days old and weight was up to 3.1 kg.

DISCUSSION

It has been reported that one-stage complete repair for prematurity with congenital heart diseases or neonates with low birth weight resulted in more growth and lower mortality than palliative repair in many studies. However, even in hospitals with a great deal of experience, age and weight of neonates are major risk factors for cardiac surgery [1-4]. In particular, most surgeons are reluctant cardiac surgery in neonates with low birth weight (≤2.5 kg) can be complicated because of the difficulty of cardiopulmonary bypass management, occurrence of frequent complications including cerebral hemorrhage, difficult surgical technique due to poor surgical field and weak tissue [3-5]. Even when cardiac surgery has been performed successfully, the risk of postoperative complications related to the lungs and infections were high. Therefore, postoperative management was difficult.

Cardiac surgery is carried out with more risk in neonates with very low birth weight (≤1.5 kg) because most organ systems are immature. The likelihood of hypocalcemia due to a low concentration of ionized calcium caused by depletion of skeletal calcium is high. An inappropriate temperature can occur because of an immature temperature control system. Renal and hepatic immaturity make fluid management difficult and drug metabolism and excretion erratic. Perhaps most importantly in this population, cardiovascular and pulmonary immaturity make the postoperative management of infants who are in a physiologically transitional stage from fetus to neonate somewhat unpredictable. The immature heart has low compliance so that neonates cannot endure volume overloading. Therefore, delicate control of input and output is needed [4]. In addition, using the cardiopulmonary bypass can frequently cause complications related to the lungs because the possibility of an inflammation reaction are increased by immature lung function. Therefore, it is important to use the minimum amount of priming volume in the cardiopulmonary bypass [4-6]. Kim et al. reported a case of cardiac surgery for a coarctation of aorta with a ventricular septal defect using 150 cc priming volume in a low birth weight neonate of 1,250 g. The minimum amount of the priming volume in the cardiopulmonary bypass is especially important in low birth weight neonates. In the case of the patient in this study, although the modified ultrafiltration was performed after weaning from the cardiopulmonary bypass, the weight of the patient increased 200 g after the operation because of the priming volume of 605 cc was too much. Management of the

patient was difficult after operation because edema caused by an inflammation reaction occurred. Therefore, we think that we need to more effort for decreasing of the amount of the priming volume.

This study is the only report of one-stage complete repair of the ventricular septal defect and the coarctation of aorta after Kim et al. reported the first published case. Therefore, we report here on a successful case of early one-stage total repair of coarctation of aorta and ventricular septal defect in a 1,480 g neonate.

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