# Anesthesia for Arterial Switch Operation in Simple Transposition of the Great Arteries : Experience at Siriraj Hospital

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**Abstract**

Anesthetic management of cardiac patients with complete transposition of the great arteries (TGA) undergoing arterial switch operation (ASO) is challenging. The anesthetic course and perioperative problems were studied. A prospective data collection study of 87 patients was performed between January 1991 and February 2002. The patients were divided into 3 groups : Group 1; 27 neonates with TGA with an intact ventricular septum (IVS), Group 2; 21 with TGA, with IVS who underwent two-stage ASO, and Group 3; 39 with TGA, with a large VSD. The anesthesia consisted of low-dose fentanyl, thiopental, atracurium and isoflurane. Monitoring included ECG, radial or femoral arterial pressure, CVP, LAP, core temperature, $SpO_2$, $P_ECO_2$, urine output, ABG's, Hct, ACT, serum glucose and potassium. Fortunately the courses of anesthesia were uneventful. Usual vasoactive medication administered following CPB included nitroglycerin, dobutamine and dopamine.

Groups I, 2 and 3 contained 18.5 per cent, 14.3 per cent and 33.3 per cent of patients who required adrenaline respectively. And only 7.7 per cent of patients in Group 3 had milrinone as an inotrope. Early tracheal extubation, 2 hours after admission to ICU was performed in 3 patients. Perioperative complications included bleeding, low cardiac output, diaphragmatic paresis, digitalis intoxication, metabolic alkalosis, convulsion, pulmonary hypertensive crisis and death. Two patients who developed a pulmonary hypertensive crisis were successfully managed with inhaled nitric oxide. The overall hospital mortality rate was 19.54 per cent. In conclusion, the anesthetic management for ASO in 87 simple dTGA patients was uneventful at Siriraj Hospital. The major perioperative morbidity and hospital mortality were not directly anesthetic contribution.

**Key word** : Arterial Switch Operation, Transposition of the Great Arteries, Anesthesia in Congenital Heart Disease

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Simple dextro-transposition of the great arteries (dTGA) is a common congenital heart lesion accounting for 5-8 per cent of all congenital heart defects (CHD)[1,2]. It is the most common cause of cyanotic CHD in the neonate, whereby the aorta arises from the right ventricle (RV) and the pulmonary artery arises from the left ventricle (LV). The pulmonary and systemic circulations are separate and in parallel. Their survival depends on mixing *via* the patent foramen ovale (PFO), atrial septal defect (ASD), ventricular septal defect (VSD) or patent ductus arteriosus (PDA)[2,3]. Without treatment, more than 90 per cent of these patients die within the first year of life[3]. The procedure of choice for current surgical treatment of simple dTGA is an arterial switch operation (ASO) with the left ventricle functioning as the systemic ventricle[4,5]. The optimal time to perform this procedure is within the first month of life for a neonate with an intact ventricular septum (IVS) otherwise the LV myocardial mass regresses after this time and is unable to maintain systemic perfusion immediately after the operation[6-10]. The infant with dTGA and IVS may develop progressive involution of the LV after the first two weeks of life, leading to a rapid two-stage anatomical correction. This procedure includes rapid left ventricular retraining with pulmonary artery banding (PAB) to develop sufficient myocardial mass to maintain systemic perfusion before the ASO with or without creation of a systemic-pulmonary artery shunt[11-15]. The presence of a large VSD in a patient with simple TGA is compatible with life because of sufficient mixing of blood at the ventricular level, thus an arterial switch procedure may be performed beyond the neonatal period. This present study includes three groups of neonates and infants with simple TGA undergoing arterial switch operations as well as observations for perioperative problems in these patients.

## PATEINTS AND METHOD

This prospective data collection study included 87 neonates and infants with simple dextro-transposition of the great arteries (dTGA). All patients had an arterial switch performed under hypothermic cardiopulmonary bypass between January 1991 and February 2002. They were divided into three groups according to their pathophysiologic anomaly and surgical techniques. *Group 1* included neonates with dTGA and an intact ventricular septum (IVS). Patients in *Group 2* were infants with dTGA and either an IVS or a small VSD/ASD. They also had a thin LV wall which needed a two-stage ASO. *Group 3* consisted of TGA infants with an ASD and a large VSD. Before operation, all patients were evaluated by a pediatric cardiologist and cardiac surgeon. When the patients were scheduled, they were evaluated and prepared preoperatively by an anesthesiologist. Lanoxin and angiotensin-converting enzyme inhibitors (ACEI) were discontinued 12-24 hours before anesthesia. All neonates received intramuscular phytomenadione (vitamin $K_1$) 1 mg in the evening before and in the morning on the day of surgery. All patients, except neonates, were premedicated with oral chloralhydrate (50 mg/kg) 1-2 hours before surgery. Preoperative sedation was omitted in neonates and sick babies because it may lead to oversedation and hypoventilation.

Intraoperative monitoring of the patient included an ECG, noninvasive blood pressure, radial or femoral arterial pressure, central venous pressure *via* internal jugular vein, pulse oximeter, capnograph, temperature (nasopharyngeal and rectal), airway pressure and urine output. Arterial blood gases, serum glucose, calcium, potassium, hematocrit and activated clotting time (ACT) were monitored frequently throughout the operation. Left atrial pressure was monitored immediately following the completion of cardiac repair.

Anesthesia was induced with fentanyl (1 μg/kg) and thiopental 2-3 mg/kg. Atracurium was used as a muscle relaxant to facilitate endotracheal tube placement and to maintain muscle paralysis throughout the operation. The desired level of anesthesia was achieved by using additional doses of fentanyl (total dose of 5-10 μg/kg) and a low concentration of isoflurane (0.2-0.6%) in oxygen. Heparin (3 mg/kg or 300 unit/kg) was usually given into the central venous line just before the placement of the cannulae in order to achieve an ACT>400 seconds. Protamine was administered at 1.3-1.5 times the initial dose in mg of heparin, on completion of CPB, following the removal of the cannulae.

In patients in whom deep hypothermia and circulatory arrest were performed, nitroglycerin (1-4 μg/kg) was administered as an intravenous infusion along with the maintenance of anesthesia. Nitroglycerin might be helpful for certain patients who had myocardial ischemia and ventricular dysfunction. All patients were weaned from CPB with dobutamine and dopamine infusions. If there were signs of low cardiac

output, adrenaline was used alone or combination with milrinone. Once the patient was disconnected from CPB along with the inotropic and nitroglycerin infusion, blood loss was replaced with packed red cells (PRC) to maintain the Hct at 40-45 per cent. Fresh frozen plasma (FFP, 10-20 ml/kg) and platelet concentrate (10 ml/kg) were given to control the suture line bleeding from the great arteries as well as the coronary arteries.

Group 1 and Group 3 patients underwent a primary arterial switch procedure. Group 2 patients need rapid ventricular retraining with pulmonary artery banding with or without a modified Blalock-Taussig shunt 1-3 weeks before the arterial switch operation.

At the completion of surgery, the patients were mechanically ventilated to maintain a normal carbon dioxide tension and good oxygenation. Addition PEEP (3-5 $cmH_2O$) was given to patients with pulmonary congestion. Morphine was given for postoperative pain relief. Midazolam and atracurium infusions were administered additionally when patients required prolonged ventilatory support.

### Statistical analysis

The categorical variables are presented as count and percentages. The continuous variables are presented as mean ± SD. Comparisons among the three groups were performed using an ANOVA test, and those between two groups with the Chi-square test. A p-value less than 0.05 was considered significant. The data analysis was performed using the SPSS software package (version 9.0).

## RESULTS

Eighty-seven patients with simple dTGA were involved in this study. The patient demographic data are shown in Table 1. Patients in Group 1 were neonates, while patients in Group 2 and 3 were older (infants). ASO was done using hypothermic cardiopulmonary bypass with aortic cross-clamping and blood cardioplegic arrest. Deep hypothermia and circulatory arrest (DHCA) or low-flow CPB was used for closure of the VSD and ASD as well in appropriate patients. During circulatory arrest, the patient was placed in the Trendelenburg position with an ice pack on the head. Hemodilution was necessary for hypothermic CPB. For neonates and infants, it was appropriate to target a hematocrit range of 25-30 per cent when the temperature was reduced to 18-25°C. Myocardial protection was achieved during hypothermia, and repeated doses of cold blood cardioplegia were delivered by the antegrade route. There were no statistically significant difference in the duration of anesthesia, CPB, circulatory arrest, aortic cross-clamping between Groups 1 and 2 (Table 1). The period of circulatory arrest, aortic cross-clamping and CPB of infants in Group 3 was longer than the other two groups. Transatrial closure of the large VSD in Group 3 patients was considered to take longer. There were no significant differences in anesthetic time observed among the three groups.

All patients required inotropic support during weaning from CPB. Calcium gluconate (20-60 mg/kg), dobutamine (10 μg/kg /min) and dopamine (2-5 μg/kg/min) were administered as primary cardiac stimulants. Nitroglycerin was infused as a coronary

**Table 1. Clinical data of the study groups.**

| | Group I TGA, IVS | Group II TGA, IVS, PAB | Group III TGA, VSD |
|---|---|---|---|
| Number of patients | 27 | 21 | 39 |
| Gender: male/female (n) | 18/9 | 12/9 | 29/10 |
| Age range | 2-26 d | 2-12 m | 0.5-14 m |
| Age (mean ± SD) | 14.76 ± 5.80 d | 7.23 ± 2.54 m | 4.62 ± 2.94 m |
| Body weight range (kg) | 2.20-3.80 | 3.30-7.90 | 2.80-13.00 |
| Body weight: mean ± SD (kg) | 3.03 ± 0.42 | 5.99 ± 1.28 | 4.97 ± 2.03 |
| Circulatory arrest time (min) | 5.42 ± 2.36 | 4.40 ± 2.79 | 34.71 ± 31.71 |
| Aortic cross-clamp time (min) | 56.33 ± 14.18 | 55.19 ± 6.49 | 70.56 ± 24.05 |
| CPB time (min) | 145.56 ± 24.35 | 142.52 ± 24.07 | 184.00 ± 33.26 |
| Anesthetic time (min) | 327.50 ± 70.22 | 305.24 ± 45.12 | 329.05 ± 59.13 |
| Duration of PAB (day) | - | 17.19 ± 5.70 | - |

TGA = transpostion of the great arteries, IVS = intact ventricular septum,
PAB = pulmonary artery banding, VSD = ventricular septal defect.

and pulmonary vasodilator. In instances in which LV failure was severe, adrenaline (0.5-2.0 μg/kg/min) was given. Addition, milrinone was used in cases of inadequate myocardial protection or congestive heart failure. The loading dose of milrinone was 25-50 μg/kg, followed by 0.3-0.5 μg/kg/min infusion. There were 18.5 per cent, 14.3 per cent, and 33.3 per cent patients in Groups 1, 2 and 3 who required adrenaline respectively. As milrinone was introduced to Siriraj Hospital within the last 3 years, only 7.7 per cent of Group 3 received this drug. After heparin reversal with protamine, PRC, FFP (15-20 ml/kg) and platelet concentrate (10 ml/kg) were transfused in order to raise the Hct to 40-45 per cent, and to promote clotting.

The perioperative complications of ASO in this study are shown in Table 2. A common problem in the postoperative period was metabolic alkalosis which occurred in all three groups. Acetazolamide (Diamox®) 3-7.5 mg/kg was given orally every 6-8 h. Correction of the metabolic alkalosis usually occured after receiving 2-3 doses of acetazolamide. The frequency of reoperation for hemostasis and clot removal was lower in Group 2 (1.15%) than in Group 1 (5.75%) and 3 (8.05%). One neonate in Group 1 developed digitalis intoxication, confirmed by a blood level of digitalis which was 3.2 ng/ml; this patient died at midnight, on the day of surgery. One patient in Group 1 developed left diaphragmatic paresis which need mechanical ventilatory support for 6 days. Convulsions as a result of hypocalcemia were found in two neonates in Group 1. All patients who developed convulsions had surgery done under DCHA. Neurological dysfunction was more frequent in Group 1 (4.6%) than in Group 2 (1.15%) and 3 (1.15%). Their management included hyperventilation, calcium gluconate, furosemide and phenobarbitone. All of them recovered within a week postoperatively. Minor complications in the postoperative period included a residual cardiac defect such as a small residual VSD, mild RV outflow tract obstruction and trivial aortic regurgitation which were diagnosed by transthoracic echocardiogram. Two patients in Group 1 and one patient in Group 3 developed a pulmonary hypertensive crisis. One neonate in Group 1 died because of coexisting postoperative bleeding,

**Table 2. Perioperative complications.**

| Complications | Incidence and number of patients | | | | | |
|---|---|---|---|---|---|---|
| | Group I TGA, IV | | Group II TGA, IVS, PAB | | Group III TGA, VSD | |
| | Number | Per cent | Number | Per cent | Number | Per cent |
| Metabolic alkalosis | 10 | 11.49 | 7 | 13.79 | 11 | 12.64 |
| Digitalis toxicity | 1 | 1.15 | 0 | 0 | 0 | 0 |
| Bleeding | 5 | 5.75 | 1 | 1.15 | 7 | 8.05 |
| Left diaphragmatic paresis | 1 | 1.15 | 0 | 0 | 0 | 0 |
| Neurologic dysfunction | 4 | 4.60 | 1 | 1.15 | 1 | 1.15 |
| LV failure | 4 | 4.60 | 4 | 4.60 | 9 | 10.34 |
| Pulmonary hypertensive crisis | 2 | 2.29 | 0 | 0 | 1 | 1.15 |
| Perioperative death | 6 | 6.90 | 2 | 2.29 | 9 | 10.34 |

Per cent of complications of 87 cases.

**Table 3. Time of successful tracheal extubation.**

| Postoperative day | Number of patients undergoing successful extubation | | | | | |
|---|---|---|---|---|---|---|
| | Group I TGA, IVS | | Group II TGA, IVS, PAB | | Group III TGA, VSD | |
| | Number | Per cent | Number | Per cent | Number | Per cent |
| DOS | 0 | 0 | 5 | 23.81 | 1 | 2.56 |
| POD1 | 7 | 25.93 | 8 | 38.10 | 17 | 43.59 |
| ≤POD3 | 10 | 37.04 | 4 | 19.04 | 7 | 17.95 |
| ≥POD3 | 4 | 14.81 | 3 | 14.29 | 5 | 12.82 |

DOS = day of surgery, POD = postoperative day.

while the other two patients survived and went home 2 weeks postoperatively. The treatment of pulmonary hypertensive crisis consisted of conventional therapy and medical treatment for neonates in Group 1. One infant in Group 3 need inhaled nitric oxide (iNO) for weaning from CPB. The iNO was continued to the 9th day postoperatively. This patient was discharged from the hospital one month after surgery.

The overall hospital mortality rate was 19.54 per cent. Group 3 had a higher mortality than Group 1 and 2, as shown in Table 2. Three patients died in the operating room. Myocardial infarct following reimplantation of single coronary artery was the cause of death to one patient in each Group 1 and 2. There was injury of the intramural left main coronary artery in one patient in Group 3, that was the cause of death. The causes of postoperative mortality included digitalis toxicity, hepatorenal failure (preoperative hepatic dysfunction), LV failure and pulmonary hypertensive crisis.

Concerning ventilatory support and tracheal extubation, in Group 1: 25.9 per cent of patients could be extubated on the first postoperative day, 37.04 per cent and 14.81 per cent could be extubated before and after postoperative day 3, respectively (Table 3). Successful early tracheal extubation was accomplished in one patient in Group 2 (1 h 40 min) and in 4 patients in Group 3 (1 h 30 min, 3 h, 4 h, and 5 h 30 min) after surgery. In group 2, 38.10 per cent, 19.0 per cent and 14.29 per cent of patients could be extubated on postoperative day 1, before and after postoperative day 3 respectively. One patient in Group 3 was safely extubated on the operative day, 2 h 30 min after surgery. The number of patients that could be extubated before and after the third postoperative day were 17.95 per cent and 12.82 per cent respectively. The longest requirement for ventilatory support was 2 months due to pre-existing congenital emphysematous lung disease.

## DISCUSSION

The neonate with dTGA and an intact intraventricular septum, dependent on mixing *via* a patent foramen ovale and patent ductus arteriosus (PDA), will become desperately hypoxic when the latter closes. A balloon atrial septostomy is performed to allow mixing between the pulmonary and systemic circulations. Sometime $PGE_1$ is used to maintain patency of the PDA before surgical correction. Successful anatomical repair of TGA in neonate patients with IVS has been reported(6). With appropriate perioperative management and support, the primary ASO can be safely carried out on patients up to the age of 1 month(10). In our study, we also successfully performed an arterial switch procedure in Group 1 who consisted of neonatal patients with dTGA and IVS aged 2-26 (14.76 ± 5.8) days. Successful tracheal extubation on POD1 was achieved in 25.93 per cent of the neonates. Another 37.04 per cent were extubated within 3 days of surgery which was the same as in other study(10). One patient in Group 1 developed a left hemidiaphragmatic paresis that needed prolonged ventilatory support for 6 days. One patient had a seizure due to cerebral edema which was successfully treated by phenobarbitone, hyperventilation, fluid limitation and diuretics. He was extubated on the fourth day postoperatively. Another patient had a pulmonary hypertensive crisis. The other two-day-old neonate had a bleeding problem that needed massive transfusion. Most of these patients had a metabolic alkalosis as a result of large doses of furosemide which was given in order to treat volume overload. However, one advantage of the metabolic alkalosis was to decrease pulmonary vascular resistance (PVR) and pulmonary artery pressure (PAP). One patient was inadvertently given digitalis the night before surgery and developed digitalis intoxication, confirmed by a blood level of digitalis which was 3.2 ng/ml. The patient had a severe bradycardia with no response to either atropine, isoproterenol or a pacemaker. In our study, the operative mortality of neonates with TGA and IVS was 6.9 per cent. The causes of death included myocardial failure (2), single coronary artery injury (1), pulmonary hypertensive crisis (1), digitalis intoxication (1), and hepatorenal failure (1). The patient who developed hepatorenal failure had a preoperative problem of jaundice (direct bilirubin 6.5, total bilirubin 7.6, HbsAg positive), and a serum creatinine 1.0. His liver enzymes were signficantly increased along with a prolonged prothrombin time. The patient died 3 weeks after surgery.

In Group 2; 21 patients with simple dTGA and intact venticular septum (with or without small VSD) had a staged arterial switch performed due to late referral to the surgeons. Therefore, patients in this group were older than Group 1 (Table 1). There is progressive involution of the left ventricle in the first 2 or 3 weeks following birth. The left ventricle is retrained to develop sufficient myocardial mass to accept the systemic workload by tight PA banding (PAB) to elevate the LV pressure to 75 per cent of

the systemic pressure, for 1 to 4 weeks before ASO (11,14,16). In addition, a systemic-pulmonary artery shunt is necessary in the present of severe hypoxemia. The technique to retrain a LV involves a two-stage arterial switch procedure. An alternative method is placement of a LV assisting device (LVAD) during the ASO, using the device to train the LV gradually to maintain systemic perfusion in the postoperative period(17,18). In this study, PAB was the technique of choice to retrain the LV. The duration of PAB ranged from 7 to 28 days, (mean 17.19 ± 5.7 days). There was only one patient who needed modified Blalock-Taussig shunt to prevent severe hypoxemia. The size of the interatrial communication contributes to the pathophysiologic shunts following the first-stage procedure. A small to moderate-sized ASD is preferable to a large one because the former provides the necessary volume stimulus for LV redevelopment. Postoperative complications after the first-stage procedure were severe hypoxemia, respiratory and cardiac failure(19,20).

In this study, all patients had congestive heart failure after the first-stage procedure (PA banding) which responded to antifailure medication. Postoperative complications after the two-stage ASO (Table 2) included metabolic alkalosis, reoperation for hemostasis, seizure, LV failure and death. The causes of these complications are similar to Group 1. One death occurred in the operating room because of kinking of the coronary artery, and the other one was caused by myocardial failure. One late death was reported, 11 months after surgery due to intractable right heart failure as a result of severe pulmonary hypertension (16). None of the survivors had a significant residual cardiac lesion on echocardiography.

Fortunately, anesthetic management of the two-stage arterial switch procedure in Group 2 patients was good. Intravenous infusions of dobutamine (5-10 μg/kg/min), dopamine (2-5 μg/kg/min), and nitroglycerin (0.5-2 μg/kg/min) were initiated for inotropic and vasodilator support during weaning from CPB. In addition, adrenaline was infused in cases with low cardiac output, which occurred in 14.3 per cent of patients. The average duration of the inotropic infusion was 2 $^{1}/_{2}$ days. Early tracheal extubation (times ranged from 1 h 40 min to 5 h 30 min postoperatively) was successfully performed in 5 infants. The number of early extubations on the day of surgery was higher in Group 2 (23.81%) than in Group 1 (0%) and 3 (2.56%) as shown in Table 3. This may be due to the fact that Group 2 patients were bigger and older than Group 1. Importantly, Group 2 patients had a well prepared LV and appropriate perioperative management, while Group 3 experienced preoperative congestive heart failure.

The patients in Group 3 with simple TGA and a large VSD, were 0.5-14 months old, and weighed 2.8-13.0 kg, which was more than those in Group 1, but smaller than Group 2. There was no significant difference in the length of anesthesia among the three groups. The times of aortic cross-clamping and CPB were longer in Group 3 than in Group 1 and 2 (Table 1), because the VSD closure took longer than just the switch procedure. The initial use of inotropes and nitroglycerin were similar to Groups 1 and 2. Additional adrenaline and milrinone to increase myocardial contractility was used in 33.3 per cent and 7.7 per cent respectively. Perioperative problems of Group 3 consisted of preoperative myocardial dysfunction and pulmonary vascular occlusive disease, as well as prolonged aortic cross-clamping time. Closure of VSD was done transatrially through the tricuspid valve. It is essential to avoid approaching the VSD through the right ventricle (RV), because right ventriculotomy may contribute considerable postoperative RV dysfunction(21). Milrinone is a phosphodiesterase III inhibitor, which increases cAMP by decreasing breakdown, with cardiac and peripheral vessels effects. It enhances RV contractility, reduces preload, and reduces pulmonary artery vasoconstriction(22). It is effective for the treatment of RV failure and pulmonary hypertension, so it can be given for weaning from CPB in patients with TGA and bilateral ventricular dysfunction and pulmonary vascular occlusive disease. It is often used in combination with adrenaline or noradrenaline to offset the vasodilation it causes. We found metabolic alkalosis in Group 3 the same as the two groups. Eight per cent of patients returned to the operating room for hemostasis due to more extensive suture lines and more markedly different size of aorta and PA in Group 3 than in Group 1 and 2. Postoperative LV failure occurred in 10.34 per cent which needed many inotropics to improve myocardial contractility over a long period. One patient developed a pulmonary hypertensive crisis during weaning from CPB which need iNO to decrease the PA pressure and which was continued for 9 days postoperatively. This group

had a higher mortality than Group 1 and 2. The causes of death included coronary artery injury, LV failure and uncontrolled bleeding. Successful tracheal extubation within the first postoperative day 1 was acheived in 43.59 per cent, only a minority of patients (12.82%) needed ventilatory support for longer than 3 days postoperatively. One patient in Group 3 required mechanical ventilation for 2 months due to the preexisting congenital emphysematous lung disease with superimposed infection. One patient developed severe hypoxemia on the preoperative morning and then cerebral hemorrage that was confirmed by CT scan 3 days postoperatively. He was extubated on the 15$^{th}$ postoperative day.

In general, the ASO anatomically corrects the discordant ventriculoarterial connections. Successful ASO that uses the original pulmonary ventricle (LV) which must have sufficient mass to support the systemic circulation following the switch procedure, and the timing of the operative procedure is an important variable. For this subset of patients, the ASO should be performed within the early period of life before intractable congestive heart failure or irreversible pulmonary vascular occlusive disease intervene[10,21]. Successful anesthetic management in ASO for dTGA should be processed with knowledge and understanding of pathophysiology of dTGA along with meticulous management through the course.

In conclusion, a prospective data collection study of 87 simple TGA and IVS, TGA and nonrestrictive VSD at Siriraj Hospital, undergoing ASO under general anesthesia was performed. There were 3 groups: 1) neonates TGA and IVS who underwent primary ASO; 2) infants TGA and IVS in whom twostage ASO was poformed; and 3) infants with TGA and a large VSD in whom primary ASO was performed. The three groups were similar in anesthetic duration and the occurrence of postoperative metabolic alkalosis as a common complication. Serious complications consisted of digitalis intoxication, pulmonary hypertensive crisis, LV failure and death. Patients with TGA and a large VSD had higher incidence of the two latter complications than patients with TGA and IVS. The anesthetic course was satisfactory. No serious problem was contributed by the anesthesia or its' management.

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# การดมยาสลบสำหรับการผ่าตัดสลับหลอดเลือดแดงใหญ่ในผู้ป่วยเด็กหัวใจพิการแต่กำเนิดชนิดหลอดเลือดแดงใหญ่สลับขั้ว ณ โรงพยาบาลศิริราช

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ตั้งแต่มกราคม 2534 ถึงกุมภาพันธ์ 2545 มีการผ่าตัดทำการสลับที่ของหลอดเลือดแดงใหญ่ (arterial switch operation, ASO) ในผู้ป่วยเด็กเล็กที่มีโรคหัวใจพิการแต่กำเนิดชนิดมีการสลับที่ของหลอดเลือดแดงใหญ่ที่ออกจากหัวใจ (simple transposition of the great arteries, TGA) จำนวน 87 ราย การดมยาสลบผู้ป่วยกลุ่มนี้ค่อนข้างยากซับซ้อน รวมทั้งต้องใช้ความรู้ความชำนาญและความละเอียดถี่ถ้วนค่อนข้างมาก ได้เก็บรวบรวมผลงานและประสบการณ์ในการดมยาสลบสำหรับผ่าตัด ASO มาตลอดเวลา 10 ปี เสนอดังต่อไปนี้ แบ่งกลุ่มผู้ป่วยเด็ก TGA ออกได้เป็น 3 กลุ่ม: กลุ่มที่ 1 เด็กเล็ก (neonate) 27 รายที่มี TGA และ intact ventricular septum (IVS), กลุ่มที่ 2 เด็ก TGA 21 รายที่มี IVS และทำ two-stage ASO และกลุ่มที่ 3 จำนวน 39 ราย มี TGA และ ventricular septal defect (VSD) ขนาดใหญ่ กลุ่มที่ 1 เป็นเด็กเล็กอายุตั้งแต่ 2 วันถึง 26 วัน อายุเฉลี่ย 14.76 ± 5.8 วัน น้ำหนักเฉลี่ย 3.03 ± 0.42 กก, กลุ่มที่ 2 และกลุ่มที่ 3 เป็นเด็กโตกว่ากลุ่มแรก มีอายุเฉลี่ย 7.23 ± 2.54 เดือน และ 4.62 ± 2.94 เดือนตามลำดับ มีน้ำหนักเฉลี่ย 5.99 ± 1.28 กก และ 4.97 ± 2.03 กก ในกลุ่มที่ 2 และ 3 ตามลำดับ ใช้เทคนิคการดมยาสลบใส่ท่อหายใจและควบคุมการหายใจด้วยเทคนิค balanced anesthesia ด้วย thiopental, fentanyl, isoflurane และ atracurium ขณะดมยาสลบจะ monitor ความดันเลือดแดง radial หรือ femoral,

คลื่นไฟฟ้าหัวใจ ความดันเลือดต่ำกลางที่หลอดเลือดดำ internal jugular, วัดอุณหภูมิกายที่ nasopharynx และทวารหนัก ปริมาณปัสสาวะทุก 30–60 นาที, $SpO_2$, $P_ECO_2$, arterial blood gases, น้ำตาลในเลือด โปแตสเซียม และ activated clotting time (ACT) เมื่อแก้ไขความพิการเสร็จศัลยแพทย์จะใส่สายวัดความดันใน atrium ซ้าย ขณะหย่าจากเครื่องหัวใจ–ปอดเทียม ต้องใช้ยา nitroglycerin และยากระตุ้นหัวใจช่วยทุกราย โดยใช้ dobutamine และ dopamine เป็นยาหลัก และบางรายต้องเพิ่ม adrenaline และ/หรือ milrinone เพื่อช่วยเพิ่มการทำงานของหัวใจ กล่าวคือ ต้องให้ adrenaline แก่ผู้ป่วยกลุ่มที่ 1, 2, 3 ร้อยละ 18.5, 14.3 และ 33.3 ตามลำดับ และผู้ป่วยกลุ่มที่ 3 เป็นกลุ่มเดียวที่ได้รับ milrinone ร้อยละ 7.7 หลังผ่าตัดสามารถถอดท่อหายใจได้เร็วที่สุด คือ 2 ชั่วโมงหลังเสร็จผ่าตัด และนานที่สุดคือ 1 $^1/_2$ เดือนเนื่องจากมีการติดเชื้อ มีผู้ป่วยกลุ่มละ 1 รายเสียชีวิตในห้องผ่าตัดเนื่องจากกล้ามเนื้อหัวใจตายเพราะปัญหาของหลอดเลือดโคโรนารีย์ ซึ่งมีอยู่เพียง 1 เส้นในกลุ่ม 1 และกลุ่ม 2 ส่วนเด็ก 1 คนในกลุ่ม 3 มีหลอดเลือดโคโรนารีย์ซ้ายชนิด intramural ภาวะแทรกซ้อนหลังผ่าตัด ได้แก่ เลือดออกมากทั้งจาก coagulopathy (ซึ่งให้การรักษาโดยให้เกล็ดเลือดและ fresh frozen plasma) และทำการหยุดเลือดไม่ดี (นำกลับเข้าห้องผ่าตัดและทำการหยุดเลือดอีกครั้ง) มี cardiac output ต่ำ อัมพฤกษ์ของกะบังลม, metabolic alkalosis จากการให้ยาขับปัสสาวะ มีอาการชัก พิษจาก digitalis, pulmonary hypertensive crisis และเสียชีวิตร้อยละ 6.90, 2.29 และ 10.34 ในกลุ่มที่ 1, 2 และ 3 ตามลำดับ อัตราตายในโรงพยาบาลของผู้ป่วยกลุ่มนี้ทั้งหมดคือ ร้อยละ 19.54 โดยสรุปการดมยาสลบผู้ป่วย TGA 87 รายที่มารับการผ่าตัดสลับหลอดเลือดแดงใหญ่ของหัวใจต่ำเนินไปได้โดยไม่มีภาวะแทรกซ้อนร้ายแรงใดที่เกี่ยวข้องกับการดมยาสลบ การดูแลผู้ป่วยต่อในระยะหลังผ่าตัดมีปัญหาที่พบบ่อยคือ metabolic alkalosis และ cardiac output ต่ำ สำหรับปัญหาที่นำไปสู่การเสียชีวิตขณะผ่าตัด คือ injury ต่อหลอดเลือดโคโรนารีย์ ส่วนการเสียชีวิตหลังผ่าตัดมีสาเหตุ คือ พิษจาก digitalis, กล้ามเนื้อหัวใจล้มเหลว และ pulmonary hypertensive crisis

**คำสำคัญ** : การผ่าตัดสลับที่หลอดเลือดแดงใหญ่ของหัวใจ, โรคหลอดเลือดแดงใหญ่สลับที่, การดมยาสลบเด็กหัวใจพิการแต่กำเนิด

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