Five-year Experience With Arterial Switch Operation in the First Hours of Life

Kyrylo Chasovskyi, MD, PhD, Yaroslav Mykychak, MD,† Nadiia Rudenko, MD, PhD,‡ Hanna Vorobyova, MD, PhD,‡ and Illya Yemets, MD, PhD†*

We assessed morbidity after 2 management strategies for arterial switch operation (ASO) in a single institution: first hours of life surgery and conventional approach. From September 2009 to September 2014, 346 consecutive patients who underwent ASO were enrolled. The study group included 92 patients who underwent ASO in the first 24 hours after birth (group I). The control group consisted of 254 patients who underwent ASO after 24 hours of life in the conventional way (group II). Three outcomes were analyzed: postoperative ventilation time (VT), post-extubation hospital length of stay (peLOS), and a composite morbidity index, defined as postoperative VT + peLOS + occurrence of selected major complications. Overall 30-day survival was 98% (2 [2%] group I vs 5 [2%] group II, $P = 1.000$). Fifty (13.3%) major complications were observed: 14 (15%) in group I and 36 (15%) in group II ($P = 0.635$). Although peLOS and morbidity index did not differ significantly between groups, postoperative VT (42 hours [24, 67] vs 27 hours [22, 47], $P = 0.008$) and total hospital stay were significantly longer in group II (18 days [10, 19] vs 14 days [12, 18]). A median volume of 80 mL (60-100 mL) of autologous umbilical cord blood was collected (80 mL, group 1 vs 60 mL, group II; $P = 0.090$). Homologous blood cell transfusion was avoided in 70 patients (78%) in group I and in 13 patients (6%) in group II ($P < 0.001$). Arterial switch operation during the initial 24 hours of life has similar outcomes in view of morbidity and mortality to the conventional approach.

Semin Thoracic Surg 29:70–76

Keywords: blood, CHD, arterial switch operation, neonates, cardiopulmonary bypass

Novel surgical strategy for prenatally diagnosed d-TGA includes collection of umbilical cord blood and surgery within the first hours of life.

Central Message

Compared with the conventional approach, ASO during the initial 24 hours of life has similar outcomes in view of morbidity and mortality.

Perspective Statement

Precise timing for arterial switch operation (ASO) remains disputable. Our results demonstrate similar morbidity and mortality between patients undergoing ASO in the first hours of life and patients undergoing ASO on the first days of life. Significantly reduced length of preoperative and total hospital stay with reduced homologous blood exposure were observed in patients who underwent ASO in the first hours of life.

INTRODUCTION

During the last 2 decades, arterial switch operation (ASO) has become the main option for the treatment of neonates with dextrotransposition of the great arteries (d-TGA).[1] Although the conventional approach to surgical management of d-TGA includes waiting for several days after birth, prostaglandin (PGE) infusion, and balloon septostomy (BAS), the timing for ASO is now debated.[2] On the one hand, neonates do not tolerate early surgery well, but on the other hand, delay of neonatal ASO for more than 3 days is associated with increased morbidity and costs of treatment.[3] Risks related to BAS, prolonged exposure to PGE and patent ductus arteriosus physiology, longer duration of hypoxemia, and lower cerebral oxygen delivery made up a significant background for an earlier ASO.[4] Five years ago, we suggested that ASO can be performed within the first hours of a patient's life using autologous umbilical cord blood (AUCB).[5] In this current study, we examined morbidity after 2 surgical strategies for ASO in a single institution: first hours of life and conventional approach.

PATIENTS AND METHODS

This study was approved by the institutional review board of the Ukrainian Children's Cardiac Center.

*Department of Intensive care and Perfusiology, Ukrainian Children's Cardiac Center, Kyiv, Ukraine
†Department of Cardiac Surgery, Ukrainian Children's Cardiac Center, Kyiv, Ukraine
‡Department of Cardiology, Ukrainian Children's Cardiac Center, Kyiv, Ukraine

Disclosures: All of the authors declare that there are no conflicts of interest regarding this manuscript.

Funding: No funding was provided for this study.

This paper was presented in part at the 96th Annual Meeting of the American Association for Thoracic Surgery, May 14-18, 2016.

Address reprint requests to Department of Intensive Care and Perfusiology, Ukrainian Children's Cardiac Center, Kyrylo Chasovskyi, MD, PhD, Chornovola St 28/1, 01135 Kyiv, Ukraine. E-mail: kchasovskiy82@gmail.com

1043-0679/$-see front matter
http://dx.doi.org/10.1053/j.semtcvs.2017.01.011

Table 1. Patient Characteristics

Variable	Group I* (n = 92)	Group II† (n = 254)	*P* Value
Age at surgery (h), median (IQR) [min-max]	4 (3, 5) [1,5-24]	144 (96, 192) [36-696]	<0.001
Weight (kg), mean (SD)	3.3 (0.6)	3.4 (0.6)	0.174
Prenatally diagnosed, n (%)	87 (95)	39 (16%)	<0.001
Diagnosis, n (%)			N/A
TGA-IVS	65 (71)	165 (65)	
TGA-VSD	25 (27)	77 (30)	
TGA, VSD, LVOTO	1 (1)	0	
TGA, VSD, CoAo	1 (1)	12 (5)	
Coronary patterns‡			N/A
1	62 (68)	174 (72)	
2	15 (17)	43 (18)	
3	13 (14)	26 (11)	
Preop intubation, n (%)	1 (1)	62 (24)	<0.001
BAS, n (%)	1 (1)	201 (73)	<0.001
CPB time (min), mean (SD)	154 (29)	155 (32)	0.703
Cross-clamp (min), mean (SD)	85 (21)	85 (14)	0.952
Open chest as strategy, no. (%)	4 (4)	5 (2)	0.258
Postoperative ventilation time (h), median (IQR)	27 (22, 47)	42 (24, 67)	0.008
Complications, n (%)	14 (15)	36 (15)	0.635
Neurologic deficit persisting at discharge, no. (%)	1 (1)	5 (2)	1.000
Arrhythmia necessitating permanent pacemaker	1 (1)	2 (0.8)	1.000
Unplanned cardiac reoperations with CPB, no. (%)	0	3 (1.2)	0.568
Phrenic nerve palsy requiring diaphragmatic plication, no. (%)	1 (1)	7 (3)	0.686
Mediastinitis requiring sternum reopening, no. (%)	2 (3)	2 (1)	0.291
Unplanned cardiac reoperations without CPB, no. (%)	5 (5)	12 (5)	0.760
Unplanned noncardiac reoperations	4 (4)	5 (2)	0.253
LOS (d), median (IQR)			
Preop ICU	0	3 (2, 4)	<0.001
Post-extubation	13 (10, 15)	13 (10, 19)	0.744
Total hospital	14 (12, 18)	18 (14, 24)	<0.001
Morbidity index§, mean (SD)	1 (1, 1,4)	1,1 (0.8, 1.9)	0.471
30-day mortality, n (%)	2 (2)	5 (2)	1.000

AUCB, autologous umbilical cord blood; BAS, balloon atrial septostomy; CoAo, coarctation of the aorta; CPB, cardiopulmonary bypass; ICU, intensive care unit; IQR, interquartile range; IVS, intact ventricular septum; LOS, length of stay; LVOTO, left ventricle outflow tract obstruction; N/A, not applicable; Preop, preoperative; SD, standard deviation; TGA, transposition of the great arteries; VSD, ventricular septal defect.

*Patients underwent ASO in the first 24 hours of life.

†Patients underwent ASO after 24 hours of life.

‡Coronary pattern categories: 1 = usual arrangement, 2 = circumflex off right coronary artery, 3 = double loop, single ostium, or intramural.

§Index, defined as ventilation time + post-extubation hospital length of stay + occurrence of selected major complications.

Between September 2009 and September 2014, 346 consecutive neonatal ASOs were performed at the Ukrainian Children's Cardiac Center. The study group included 92 patients who underwent ASO in the first 24 hours after birth (group I). The control group consisted of 254 patients who underwent ASO after 24 hours after birth (group II) at age less 30 days of life. Patients' characteristics are listed in Table 1. Patients with Taussig-Bing anomaly were excluded from this study.

Among the study population, 126 (36.4%) neonates with d-TGA were diagnosed prenatally, including 87 (95%) of 92 group I patients and 39 (16%) of 254 group II patients (Table 1). In prenatally diagnosed patients, AUCB was harvested and used during surgery (Video 1). Informed consent (for AUCB collection) was obtained from pregnant women before admission to the maternity hospital. Collection procedures were performed in accordance with the international standards.[6]

Contraindications for the collection and transfusion of AUCB were rhesus or ABO incompatibility and confirmed maternal viral or bacterial infections. The nearest maternity hospitals were selected as study partners to decrease time between delivery and heart surgery. After obstetric examination, the date of delivery was planned