Use of extracorporeal life support for emergency coronary artery bypass grafting

Biswa Ranjan Panda*, Anil Prabhu, Sylvio Provenzano and Tom Karl

Department of Paediatric Cardiac Surgery, Mater Children’s Hospital, South Brisbane, Queensland, Australia

* Corresponding author. QPCS Surgeon’s Office, Level 5A, Mater Children’s Hospital, Raymond Terrace, South Brisbane, Queensland 4101, Australia.

Tel: +61-469079580; fax: +61-31637187; e-mail: drbiswapand@gmail.com (B.R. Panda).

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Abstract

A 14-year old boy was admitted with an anomalous origin of the right coronary artery (RCA) from the left sinus of Valsalva, with an interarterial course of the narrow proximal segment. He underwent coronary ostial augmentation and main pulmonary artery translocation to the left pulmonary artery. In the post-cardiopulmonary bypass (CPB) period, he developed thrombotic occlusion of the RCA resulting in arrhythmia and ventricular dysfunction, requiring extracorporeal life support (ECLS) in the form of extracorporeal membrane oxygenation rather than CPB. After confirming this complication by cardiac catheterization, the right coronary artery territory was revascularized with a pedicled right internal thoracic artery graft. The entire procedure was performed on a beating heart using a stabilizer during ECLS. This strategy may be useful in situations with unstable haemodynamics and a low risk of blood loss.

Keywords: Extracorporeal life support • Extracorporeal membrane oxygenation • Coronary artery bypass grafting • Cardiac catheterization

INTRODUCTION

The use of extracorporeal life support (ECLS) following a repair of congenital heart disease has increased exponentially since its first use in 1973. Currently, the common indications are pre-operative instability, failure to be weaned from cardiopulmonary bypass (CPB), pulmonary hypertension, postoperative low cardiac output syndrome or cardiac arrest and as a bridge to cardiac transplantation. However, the use of ECLS in performing cardiac surgical procedures is very uncommon. In this report, we describe a patient with an anomalous RCA arising from the left sinus of Valsalva, who required emergency right internal thoracic artery grafting. The procedure was performed with ECLS (as extracorporeal membrane oxygenation [ECMO]) following a thrombosis of the augmented proximal RCA. To our belief, this is the only patient reported in the literature who underwent coronary artery bypass grafting under ECLS.

CASE SUMMARY

A 14-year old boy presented with a 3-month history of exertional chest heaviness and dizziness. The clinical examination and electrocardiogram did not show any abnormality. The transthoracic echocardiogram showed a structurally and functionally normal heart. The computed tomographic (CT) coronary angiogram revealed an anomalous RCA arising from the left sinus of Valsalva (Fig. 1A), becoming slit-like along the interarterial course between the aorta and the pulmonary artery (Fig. 1B).

Intraoperatively, the right coronary ostium was found to be close to the right–left aortic valve commissure, and the artery had a proximal intramural course along the right aortic sinus after which it arborized just outside the space between the aorta and pulmonary artery. The proximal RCA and its ostium were augmented with a triangular patch of fresh autologous pericardium. The pulmonary artery confluence was also relocated to the left in order to avoid mechanical compression of the RCA. This is our preferred strategy for most cases of anomalous aortic origin of a coronary artery [1].

Weaning from CPB was uneventful, and the flow in the augmented coronary artery was confirmed by transoesophageal echocardiography. Heparin was reversed. During the preparation for chest closure, the patient had episodes of arrhythmia and the right ventricular function deteriorated. With a suspicion of coronary thrombosis, a 100 IU/kg bolus dose of heparin was administered, and veno-arterial ECLS was instituted through the original aortic and a new right atrial cannula. The ECLS circuit consisted of a centrifugal pump (Rotaflow®, Maquet, Inc.) and an oxygenator (Quadrox-i Small Adult®, Maquet, Inc.). On ECLS, the right heart contractility and colour improved immediately. We felt that more information was needed to decide upon a rescue strategy.

The patient was transferred to our cardiac catheterization laboratory on ECMO for coronary angiography. This study was not able to demonstrate antegrade flow into the RCA (Fig. 2). The patient was immediately returned to the operating theatre, still on ECLS. The pedicled right internal thoracic artery was harvested, and the RCA revascularized with the aid of a stabilizer (Octopus® 2 Tissue Stabilization System, Medtronic, Inc.). The heart was beating throughout the procedure. ECLS flow was maintained, even when the stabilizer was applied. Visualization was optimal with the use of a blower mister (Axius Blower-Mister®, Octopus® 2 Tissue Stabilization System, Medtronic, Inc.).
Intraoperative blood salvage was carried out with continuous flow technology (CATS plus®, Autotransfusion system—Fresenius Kabi AG, Bad Homburg, Germany). There was further improvement of the right ventricular function noted on the post-revascularization transoesophageal echocardiogram. The patient was weaned from ECLS on the following day, and the chest was closed 48 h after surgery. He had an uneventful postoperative recovery and was discharged from the hospital on the sixth postoperative day. At the 18-month follow-up, the patient is asymptomatic and has normal ventricular function. A stress Sestamibi myocardial perfusion scan showed a normal tracer uptake in all segments of the ventricular myocardium. A CT coronary angiogram demonstrated a patent coronary anastomosis and a good calibre RCA.

**DISCUSSION**

An anomalous aortic origin of a coronary artery is a potentially life-threatening condition, particularly in the presence of ischaemic symptoms. Our repair strategy has a physiological basis and is suitable for most anatomical variants. However, it is possible that, in this case, the RCA was too small, or that a technical problem prevailed.

ECLS (as ventricular assist device or ECMO) is an important mechanical support modality for the failing circulation in children with heart disease. In the scenario of post-cardiac surgical cardiogenic shock, it provides circulatory support for short- to intermediate-term myocardial dysfunction. It stabilizes the patients’ cardiopulmonary dysfunction, allowing for the normalization of metabolic support without the deleterious effects of high-dose inotropes and aggressive ventilation. At the same time, it also provides a chance to investigate for the presence of missed or residual lesions, as in our case.

ECLS has also proved its value during cardiac catheterization for patients with borderline haemodynamics. The best example is the use of ECLS during high-risk percutaneous coronary intervention in patients with post-myocardial infarction cardiogenic shock [2]. ECLS has also been proved useful for the support of neonates with critical aortic stenosis during a balloon valvotomy [3]. Ward et al. [4] have reported the use of ECLS during high-risk pulmonary artery stenting. In a series of 9 patients, Ettedgui et al. described the role of ECLS in 9 patients undergoing catheterization. The primary procedure performed in 6 of these patients was a balloon or blade atrial septostomy [5]. Percutaneous left heart decompression across the atrial septum is a common practice in cardiomyopathy or myocarditis patients while on ECLS. Also, the role of ECLS (as veno-venous or veno-arterial ECMO) in the management of congenital diaphragmatic hernia and carinal resection is well established.

The role of ECLS in performing cardiac surgery has been limited. The use of ECLS may be considered when there is a low probability of opening a cardiac chamber or great vessel and if there is little chance of massive blood loss. The use of ECLS in place of CPB may limit the deleterious inflammatory side effects of CPB, while providing similar operator comfort and patient safety. By using the ECLS circuit already in place, we believe that an additional inflammatory insult from exposure to a new blood surface CPB system interface can be avoided.

In our case, ECLS was beneficial in stabilizing the patient during ischaemia from a right coronary artery thrombosis and resultant arrhythmia and right ventricular dysfunction.

**Figure 1:** (A) A CT scan with three-dimensional reconstruction showing the anomalous origin of the right coronary artery with a narrow proximal segment. (B) CT scan showing the interarterial course of the proximal narrow segment.

**Figure 2:** An aortic root angiogram showing the occlusion of the right coronary artery.
CONCLUSION

Coronary bypass grafting on a beating heart with the aid of stabilizer during ECLS is technically feasible and may be of benefit in selected cases requiring preoperative ECLS.

Conflict of interest: none declared.

REFERENCES


