A patent ductus arteriosus complicating cardiopulmonary bypass for combined coronary artery bypass grafting and aortic valve replacement only discovered by computed tomography 3D reconstruction

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Abstract

We describe the case of a 59-year old male patient undergoing combined coronary artery bypass grafting and aortic valve replacement. Manipulation of the heart during cardiopulmonary bypass significantly decreased venous return. Several measures were necessary to improve venous return to a level at which continuation of the procedure was safe. Based on the initial troubles with venous return, we decided to selectively cross-clamp the aorta. This resulted in a large amount of backflow of oxygenated blood from the left ventricle, necessitating additional vents in the pulmonary artery and directly in the left ventricle. The procedure was continued uneventfully, and postoperative recovery was without significant complications. Postoperative 2D computed tomography did not show any signs of a shunt, but 3D reconstruction showed a small patent ductus arteriosus.

Keywords: Patent ductus arteriosus • Left-to-right shunt • Cardiopulmonary bypass • 3D computed tomography scan • Coronary artery bypass grafting • Aortic valve replacement

INTRODUCTION

Symptomatic patent ductus arteriosus (PDA) is usually diagnosed and identified in young children. Nevertheless, it is well known that this shunt can also exist in adults and even in the elderly. We describe a case with a large left-to-right shunt discovered during cardiopulmonary bypass with a possible underlying PDA.

CASE REPORT

A 59-year old male patient was admitted to our department with complaints of fatigue and mild dyspnoea, NYHA Class II. He had a recent history of acute myocardial infarction for which two bare metal stents were placed; one in the left anterior descending artery and the other one in the circumflex artery. Given the history, a new coronary angiogram was performed, revealing triple-vessel disease. Preoperative transthoracic echocardiography showed an ejection fraction of 40%, severe aortic valve stenosis with a peak gradient of 75 mmHg, a mean of 45 mmHg and an aortic valve area of 0.9 cm². Echocardiographic assessment of the ascending aortic showed a diameter of 44 mm. Accordingly, computed tomography (CT) confirmed an aortic root diameter of 44 mm; no other vascular pathologies were observed.

The patient underwent a combined procedure of aortic valve replacement and coronary artery bypass grafting. The left internal mammary artery was harvested skeletonized, followed by classical cannulation of the right atrium and the ascending aorta, and a left ventricular vent was placed through the pulmonary vein. While the patient was cooled to mild hypothermia (32°C), the coronary arteries requiring bypass were identified. Manipulation necessary to identify the arteries caused venous return to decrease while the LV distended, mean arterial pressure dropped from 80 to ≏60 mmHg and cerebral oxygenation decreased significantly from 80 to 70%. The calculated pump flow decreased from 80 to <5.0 l/min. We elevated the surgical table to maximize the height differential, thereby slightly increasing venous return. Several attempts were necessary to reposition the venous cannula to improve venous return to a level at which cerebral oxygenation was stable during manipulation. The initial difficulties with venous return, despite adequate anatomical position of the venous cannula, made a shunt between the aorta and pulmonary artery a plausible diagnosis. With this risk in mind, we separated the pulmonary trunk from the aorta to cross-clamp selectively the aorta and perform an aortotomy to give selective antegrade cardioplegia. After aortotomy, there was a significant back-flow of oxygenated blood into the left ventricle which could not be processed by the left vent. Therefore, two extra vents were placed; one in the pulmonary artery and one directly in the left ventricle. This provided enough drainage to continue the procedure safely. Blood
sampling of the pulmonary artery showed highly oxygenated blood, indicating an arterio-venous shunt. Since no abnormalities were described preoperatively, we believed it was better to reduce the cardiopulmonary bypass time than extensively search for an underlying cause. Moreover, it is not so straightforward to find a cause without extensive dissection of the pulmonary artery and ascending aorta, when the exact localization is unknown. Hence, we continued the procedure, first revascularizing the heart (five distal anastomoses) to replace the aortic valve subsequently with a mechanical prosthesis (Sorin, Bi-Carbon 27 mm). During weaning from cardiopulmonary bypass, pulmonary pressure started to rise and drainage of the left ventricular and pulmonary vent diminished together with a desaturation of blood derived from the pulmonary artery. Weaning was uneventful, with a total perfusion duration of 231 min and cross-clamp time of 163 min.

No signs of lung oedema were present intraoperatively, nor during postoperative ventilation. Nonetheless, the postoperative chest X-ray revealed congestion of the left lung, possibly due to single-sided high pressure and backflow during initial manipulation of the heart when venous drainage was hampered. Reassessment of the preoperative CT (without contrast) hinted towards a connection between the aorta and the left pulmonary artery, which made PDA a likely diagnosis. To ascertain our findings, postprocedural 2D CT with contrast was performed. Still, PDA could not be established with certainty, nor were any other shunts visualized. A high-quality volumetric-rendered 3D reconstruction using Vesalius3D (PSmedtech, Amsterdam, Netherlands) clearly exposed small PDA (Fig. 1). Postoperative recovery was uneventful, except for a few episodes of ventricular tachycardia. The patient was successfully treated with Amiodaron (Cordarone, Sanofi-Aventis) and was discharged from the hospital at the 10th postoperative day.

**DISCUSSION**

In our case, the large left-to-right shunt was likely to be the result of PDA since it represents one of the most common congenital anomalies [1]. Nonetheless, the return to normal after weaning

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**Figure 1:** Left top panel, postoperative chest X-ray with signs of congestion of the left lung. Other panels are 3D reconstruction of the postoperative CT thorax with intravenous contrast. Clockwise, anterior view with most of the heart excised giving a good view of the aorta (A) and the underlying pulmonary artery; the left arrow indicates the connection between the aorta and the pulmonary artery. Posterior view with the spine left out, again giving a good view of the aorta (A) and the left pulmonary artery (P) and the arrow again indicates a PDA. Finally, a right sagittal view: the white arrow indicates the PDA between the aorta and the pulmonary artery; the white structures clearly shown just above the diaphragm are the temporary pacemaker leads. CT: computed tomography; PDA: patent ductus arteriosus.
from cardiopulmonary bypass and only a small-sized PDA on 3D CT indicated that the shunt was at most modest. Other more rare pathologies such as aortopulmonary collateral arteries or an aortopulmonary window were less likely. These pathologies are usually more severe and discovered early in childhood. To the best of our knowledge, no previous cases of a large left-to-right shunt discovered during routine adult cardiac surgery have been described. In addition, the initial difficulties with venous return made us apprehensive for a left-to-right shunt. Accordingly, we selectively cross-clamped the aorta and placed additional vents to unload the heart. Furthermore, this case report shows the ability of volume-rendered 3D reconstruction to visualize the vasculature in much more detail than before, making this difficult diagnosis and possibly other pathologies easier to diagnose.

The ductus arteriosus is essential for foetal circulation. It is a connection between the pulmonary artery and aorta. It serves as bypass for the still non-functioning lungs. If the ductus does not close, it results in a left-to-right shunt from the high-pressure aorta into the low-resistance pulmonary artery. A PDA is typically diagnosed early in childhood but can be asymptomatic. Diagnosis is commonly possible with echocardiography or CT. However, a small PDA can remain undetected by both, as demonstrated by this case.

Signs of fatigue, dyspnoea or palpitations may develop late in adulthood when hypertension develops, resulting in a higher differential pressure and thus flow through the PDA [2–4]. In our case, differential pressure was not increased due to a high aortic resistance but resulted from a decrease in pulmonary artery pressure during cardiopulmonary bypass.

Conflict of interest: none declared.

REFERENCES


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