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CASE REPORT

A Newly Detected Left Ventricular Mass Following A Complex Intracardiac Repair

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ABSTRACT: Appearance of unexpected masses in the chambers of the heart during cardiac surgery can be intriguing. We report the case of a mass in the left ventricle that appeared at the time of separation from cardiopulmonary bypass in a child after a complex intracardiac repair. The child presented for surgery to a tertiary care hospital in Muscat, Oman, in 2022. Prior to the surgical repair the mass was not appreciated by echocardiography. An intraventricular baffle was used to divert left ventricular blood flow towards the outflow tract, after which an intraventricular "mass" was observed. Intraoperative transoesophageal echocardiography identified the mass as a portion of the interventricular septum that was located between the inlet and outlet ventricular septal defects.

Keywords: Echocardiography; Heart Septal Defects; Heart Ventricles; Diagnostic Imaging.

Following cardiac surgery on cardiopulmonary bypass, it is exceedingly rare to encounter in the chambers of the heart, a new mass that was not detected preoperatively. This report describes a left ventricular mass that was unexpectedly detected after separation from cardiopulmonary bypass in a child that underwent a complex intracardiac repair at a tertiary care hospital in Muscat, Oman, in 2022. Intraoperative transoesophageal echocardiography (TEE) identified the true nature of the left ventricular mass. Six-weeks prior to the surgery, the child was infected with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The child was accepted for the surgical procedure after a polymerase chain reaction (PCR) test was negative.

Case Report

A 1-year-old boy (weight = 10.7 kg; height = 85 cm) presented to the authors' institution with a transthoracic echocardiography diagnosis of situs inversus with dextrocardia and concordant atrioventricular connection. The child had a double outlet right ventricle with the aorta anterior and to the left and the pulmonary artery posterior and to the right. The inferior vena cava and left superior vena cava were connected to the left-sided morphologically right atrium that was connected to a left-sided anteriorly placed right ventricle. There was a 11 mm inlet ventricular septal defect (VSD) and a valvar pulmonary stenosis with a sub-valvar component due to posterior deviation of outlet septum. The branch pulmonary arteries were of normal size. Based on the echocardiography and cardiac catheterisation findings, an intracardiac two-ventricle ventricle repair was planned. The preoperative complete blood count showed haemoglobin at 15.9 g/dL (range: 11.5–15.5), mean cell volume of 52.9 fL (range: 73–95), mean cell haemoglobin of 18.2 pg (range: 24–33) suggesting an iron deficiency. The preoperative platelet count was 245,000/microliter (range: 140–400,000). The coagulation profile showed prothrombin time at 12.3 s (range: 9.8–11.9), activated partial thromboplastin time of 30 s (range: 26.4–38.9), fibrinogen at 2.60 g/L (range: 1.6–4.0), thrombin time of 17.20 s (range: 14.3–17.8) and intranational normal ratio (INR) of 1.16 ratio (range: 0.82–1.05).

In the operation room, intraoperative TEE displayed the right-sided left atrium and left ventricle, inlet VSD, balanced ventricles and both great vessels arising from the right ventricle [Figure 1]. Prior to establishment of cardiopulmonary bypass, the targeted celite activated clotting time (ACT) was >400 sec as per institutional protocol. This, however, was achieved only after administration of a total of 700 IU/kg of unfractionated heparin and 10 mL/kg fresh froze plasma suggesting the possibility of heparin resistance.

Intraoperatively, it was found that in addition to the inlet VSD, there was a 3 mm outlet VSD in the conal septum in the sub pulmonary area. This outlet VSD was dilated to admit a 12 mm diameter Hegar dilator. There was a muscle bundle between the inlet and outlet ventricular septal defects that was left untouched due to the concern of damaging the conduction system. A bovine pericardial baffle was fashioned in such a way that left ventricular outflow was through both the septal defects into the aorta. A Rastelli procedure using a Contegra® Conduit (size = 16 mm) to relieve the pulmonary obstruction was performed. At the time of separation from cardiopulmonary bypass, 4-chamber and deep transgastric TEE views displayed an echo dense mass close to the interventricular

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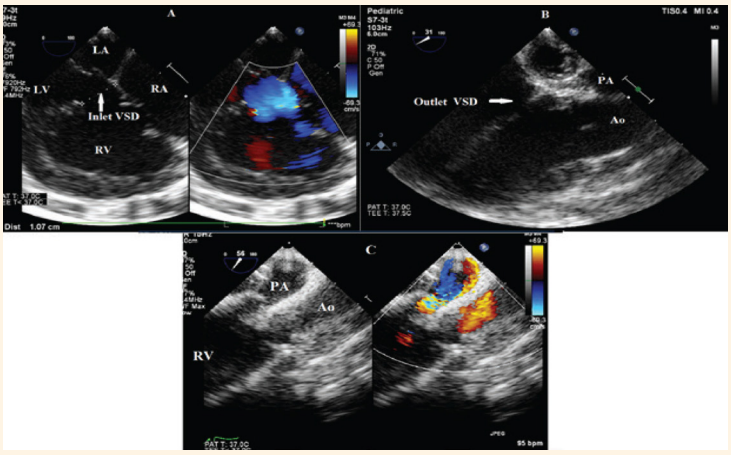

Figure 1: Mid-oesophageal 4-chamber transoesophageal echocardiography view showing (**A**) the inlet ventricular septal defect, (**B**) a modified view showing the outlet ventricular septal defect and (**C**) the double outlet right ventricle.
LA = left atrium; RA = right atrium; LV = left ventricle; RV = right ventricle; VSD = ventricular septal defect; PA = pulmonary artery; Ao = aorta.

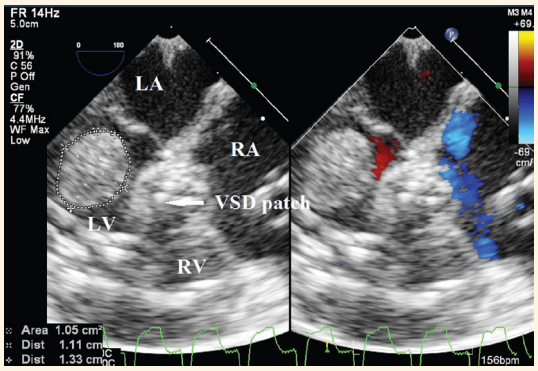

Figure 2: Mid-oesophageal 4-chamber transoesophageal echocardiography view showing a left ventricular mass.
LA = left atrium; RA = right atrium; LV = left ventricle; RV = right ventricle; VSD = ventricular septal defect.

septum (1.05 cm^2) [Figure 2; Supplementary videoclip 1]. There was laminar blood flow around the left ventricular mass that appeared to be hanging in the cavity [Figure 3A; Supplementary videoclip 2]. Modified mid-oesophageal aortic long axis view displayed the right ventricle to pulmonary artery conduit and laminar blood flow pattern around the left ventricular mass towards the aorta [Figures 3B, 4A & B; Supplementary videoclip 3]. Initially, a concern of a left ventricle thrombus was entertained. Further TEE interrogation diagnosed the mass as the small segment of interventricular septal muscle bundle between the large inlet VSD and the enlarged outlet VSD. The child was shifted to the paediatric intensive care unit on vasoactive drugs (milrinone 0.5 mcg/kg/min IV and dopamine 5 mcg/kg/min) and tracheal extubation was done after 48 hours of mechanical ventilation. The child was discharged home on the 10th postoperative day and at 3-month follow-up the child was doing well. A computed tomography imaging was done during the follow-up, which displayed the small segment of interventricular septal muscle bundle as a mass in the coronal and transverse planes [Figure 5].

The institutional ethical committee approval (SRC#CR11/2022) as well as an informed written consent from the parents was obtained to publish this report.

Discussion

A child with multiple intracardiac anomalies including a large inlet ventricular septal defect, and a smaller outlet ventricular septal defect (which was dilated during the procedure) underwent a bi-ventricular repair. An intraventricular baffle was used to divert

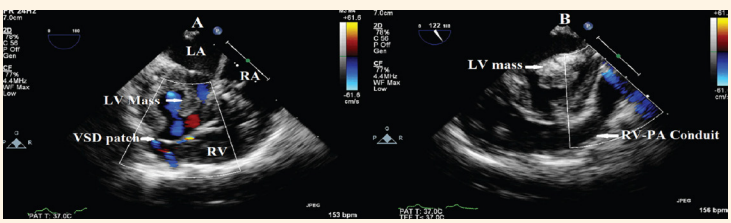

Figure 3: Mid-oesophageal 4-chamber transoesophageal echocardiography view showing (**A**) blood flow around the mass and (**B**) the long axis views showing the right ventricle to pulmonary artery conduit.
LA = left atrium; RA = right atrium; LV = left ventricular; RV = right ventricle; VSD = ventricular septal defect; RV-PA = right ventricle to pulmonary artery.

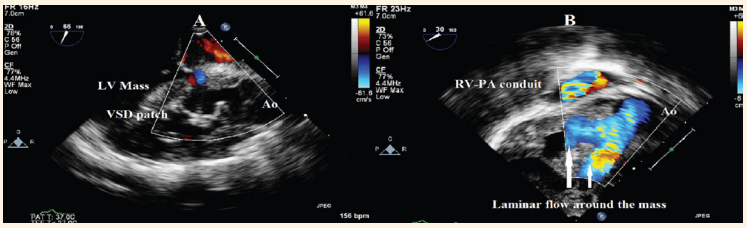

Figure 4: Mid-oesophageal 4-chamber transoesophageal echocardiography showing (**A**) a laminar blood flow pattern around the left ventricular mass towards the aorta and (**B**) an upside-down transgastric view showing the laminar flow of blood around the mass across the left ventricular tract to the aorta.
LV = left ventricular; VSD = ventricular septal defect; RV-PA = right ventricle to pulmonary artery; Ao = aorta.

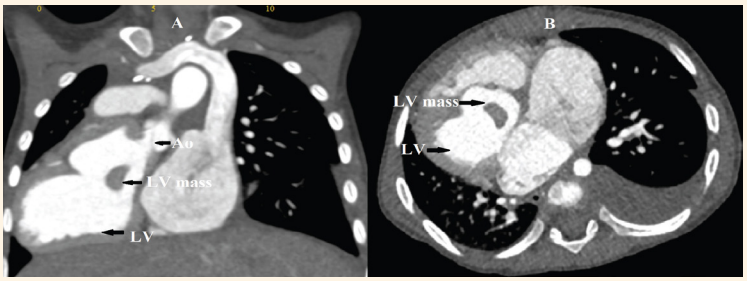

Figure 5: Postoperative (**A**) coronal and (**B**) transverse plane computed tomography images showing the small interventricular septum between the two ventricular septal defects as a mass.

the left ventricular blood flow towards the aorta, after which an echo dense 'mass' was detected in the left ventricle. The celite ACT recorded at that point of time was 420 seconds.

At the authors' institution, as per institutional protocol, the target of celite activated clotting time for initiation of cardiopulmonary bypass is >400 seconds.[1] The current patient needed a supranormal dose of unfractionated heparin to achieve this target. The preoperative complete blood count also suggested an iron deficiency. Hence, when a mass was detected suddenly, the initial concern was whether it may be a thrombus. However, as the mass appeared homogenous, the echocardiographic features excluded the possibility of a thrombus.[2] A detailed intraoperative TEE identified the mass as the ventricular septal myocardium located between the two ventricular septal defects.

The other possibilities of left ventricular masses include fibromas, secondaries or variants of normal anatomical structures (i.e. papillary muscles, false tendons, sigmoid septum, apical trabeculation, etc.).[3] These structures are present preoperatively and would not make a sudden intraoperative appearance.

In the current patient, the morphologically left atrium and left ventricle were on the right side and the morphologically right atrium and right ventricle were on the left side. Both the great vessels were arising from the right ventricle. There was an inlet ventricular septal defect as well as a 3 mm outlet defect in the conal septum in the subpulmonary area. In addition to the Rastelli procedure a complex intracardiac baffling of left ventricle to the aorta was performed. The left ventricular outflow tract was connecting the left ventricle to the anteriorly placed aorta that was arising from the right ventricle. A detailed TEE interrogation of the left ventricular outflow tract explained the origin of the mass in the left ventricle and demonstrated the unobstructed left ventricular outflow tract to the aorta [Figure 4B; Supplementary videoclip 4].

In cases of double outlet right ventricle, even in the presence of two ventricular septal defects, a mass of interventricular septum following routing of the left ventricle to the left ventricular outflow may not be encountered. This is because, one of the septal defects may be surgically closed based on the surgeon's judgement of the remaining ventricular septal defect being of an adequate size to produce an unobstructed communication between the left ventricle and the left ventricular outflow tract. In this child with a double outlet right ventricle, the subpulmonic VSD was enlarged as the inlet VSD was not large enough to produce an unobstructed flow to the left ventricular outflow tract. In order to avoid damaging the conduction system by enlarging the inlet VSD, the subpulmonic VSD was enlarged and both the septal defects were channelised to the left ventricular out flow tract. This resulted in an unobstructed drainage of the left ventricle to the aorta without damaging the conduction system. This also resulted in a portion of

the interventricular septum between the two septal defects present as a mass in the left ventricle. If there was only one inlet ventricular septal defect which requires enlargement, then one would enlarge it in anteroinferior direction to protect the conduction system. Analysis of this case suggests that creation or enlargement of an outlet ventricular septal defect may also be a safe option in terms of avoiding damage to the conduction system while simultaneously producing an unobstructed left ventricular to aorta drainage.

As to why this ventricular septal myocardium located between the two ventricular septal defects was not appreciated during preoperative echocardiographic examination may be explained as follows. The outlet VSD was much smaller in size and the shunting of blood between the ventricles was primarily through the larger inlet VSD. This probably was masking the smaller outlet VSD and hence its presence was not appreciated preoperatively.

Conclusion

This case report describes a mass that appeared in the left ventricle at the time of separation from cardiopulmonary bypass following the baffling of an inlet and outlet VSD to the left ventricular outflow tract. The mass was diagnosed as the interventricular septum that was situated between the two VSD. With the background of a prior history of COVID-19 infection and the associated hypercoagulability, blood biochemistry suggesting an iron deficiency and the heparin resistance that the child exhibited, a concern that the mass may be a thrombus was entertained initially. Intraoperative TEE conclusively identified the true nature of the mass. This case report highlights the role of TEE in resolving intraoperative dilemmas. The authors venture to suggest that routine perioperative use of TEE or transthoracic echocardiography (on occasions a TEE probe cannot be inserted) in paediatric cardiac surgery is highly recommended.

SUPPLEMENTARY VIDEOCLIPS

Videoclip 1: A videoclip of a 4-chamber mid-oesophageal transoesophageal echocardiography view displaying the left ventricular mass.

Videoclip 2: A videoclip of a 4-chamber mid-oesophageal transoesophageal echocardiography view with color Doppler flow displaying the blood flow around the left ventricular mass.

Videoclip 3: A videoclip loop displaying the baffled pathway to left ventricular outflow.

Videoclip 4: A videoclip of a 4-chamber mid-oesophageal transoesophageal echocardiography displaying the laminar blood flow around mass hrough both ventricular septal defects into aorta.

AUTHORS' CONTRIBUTION

MMM and HNK conceptualised the work. MMM and AC acquired the images. MMM, AC, PSK and AF analysed and interpreted the images. MMM drafted the manuscript. All authors critically reviewed and edited the manuscript. All authors approved the final version of the manuscript.

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