Modified Deep Transgastric Bicaval View for Revealing Superior Vena Caval Obstruction in a Patient Undergoing Sinus Venosus Atrial Septal Defect Repair: A Case Report

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SUPERIOR SINUS VENOSUS atrial septal defect (SV-ASD) is an interatrial defect with partial anomalous pulmonary venous connection (PAPVC) draining into the right atrium (RA). The principle for SV-ASD surgical repair involves redirecting the pulmonary venous blood back to the left atrium and closure of the atrial septal defect without causing systemic venous and pulmonary venous obstruction. Closing the ASD with a single intracardiac patch that includes PAPVC can result in superior vena cava (SVC) or pulmonary vein obstruction.[1,2] This has led to the evolution of other surgical options, such as double-patch repair and caval division repair (Warden's procedure). In double-patch repair, an atriocavoplasty is done in addition to the intracardiac patch to augment the SVC, thus avoiding SVC stenosis. However, the atriocavoplasty across the SVC-RA junction may result in sinoatrial node dysfunction by disrupting the sinoatrial node or the sinoatrial node artery. To avoid the risk of sinoatrial node injury, caval division repair (Warden's procedure) has evolved. The Warden procedure routes the proximal portion of the SVC (draining the anomalous pulmonary veins) through the atrial septal defect to the left atrium. The distal portion of the SVC is connected to the right atrial appendage to reestablish SVC blood flow to the right atrium.

Intraoperative transesophageal echocardiography (TEE) has an important role in the immediate post-cardiopulmonary bypass (CPB) period to assess the adequacy of the repair and rule out any systemic or pulmonary venous obstruction. It is thought to be difficult to get a gradient across the SVC-RA junction using the described conventional TEE views because of a lack of proper alignment of the Doppler beam with the SVC blood flow. Most often, needle pressure gradients are used to rule out SVC stenosis. The authors introduce a modified deep transgastric bicaval view that allows for an appropriate alignment of the Doppler beam with SVC blood flow at the SVC-RA junction. In this case report, the aim was to highlight the importance of the modified deep transgastric bicaval view in deciding the surgical method and changing the perioperative course of the patient.

CASE REPORT

A 2-year-old boy weighing 10 kg presented with history of recurrent lower respiratory tract infections since the age of 6 months. On examination, the second heart sound (S2) was wide split and fixed. Preoperative transthoracic echocardiography (TTE) found an 11-mm sinus venosus ASD with PAPVC of the right upper pulmonary vein (RUPV). The left ventricle was partly regressed.

After general anesthesia was induced, a pediatric transesophageal echocardiography probe (Philips IE33, xMATRIX, Philips Healthcare, Andover, MA) was inserted to confirm the preoperative findings. A sinus venosus defect was seen in midesophageal (ME) bicaval view. On withdrawing the probe to the level of the right pulmonary artery, the SVC was seen overriding the atrial septum and the RUPV was draining into the SVC at a 2-cm proximity to the SVC-RA junction (Video 1 and Fig 1). An additional left-sided SVC was detected and was draining into the enlarged coronary sinus in midesophageal 4-chamber view (Video 2 and Fig 2). The dilated coronary sinus had a dimension of 12 mm (Fig 3).

The surgeon confirmed a 2-cm × 1.5-cm sinus venosus ASD and RUPV draining into the SVC-RA junction. After assessing anatomy, a single-patch repair of the defect was performed under hypothermic cardiopulmonary bypass and cardioplegic arrest of the heart. Pericardial patch rerouting of the RUPV to the left atrium through the ASD was done. The left atrium was deaired before final closure of the ASD. The aorta was declamped, and on partial bypass the right atrium was closed in a single layer. The patient came off bypass in normal sinus rhythm without any inotropic support. TEE examination was performed to assess the residual shunt, the RUPV flow gradient, and the SVC-RA gradient. There was no residual shunt across the ASD patch. The rerouted pulmonary vein flow gradient was <2 mmHg with pulsed-wave Doppler in the ME bicaval view. There was flow turbulence seen with color flow in the SVC in the ME bicaval view indicating SVC flow obstruction. In the modified deep transgastric bicaval view, the SVC-RA gradient was found to be 13 mmHg (Figs 1 and 4; Video 3). This measurement correlated with the direct needle pressure gradient of 14 mmHg.

Cardiopulmonary bypass was reinstituted and the SVC-RA junction was augmented with a pericardial patch. After the revision surgery, TEE verification showed a gradient of 2 mmHg across the SVC-RA junction in the modified deep transgastric bicaval view (Fig 5 and Video 4). Moreover, laminar flow across the SVC-RA junction was visualized with color-flow Doppler to rule out SVC flow obstruction in the ME bicaval view. Direct needle pressure measurement found no flow obstruction at that time. The sternum was closed after

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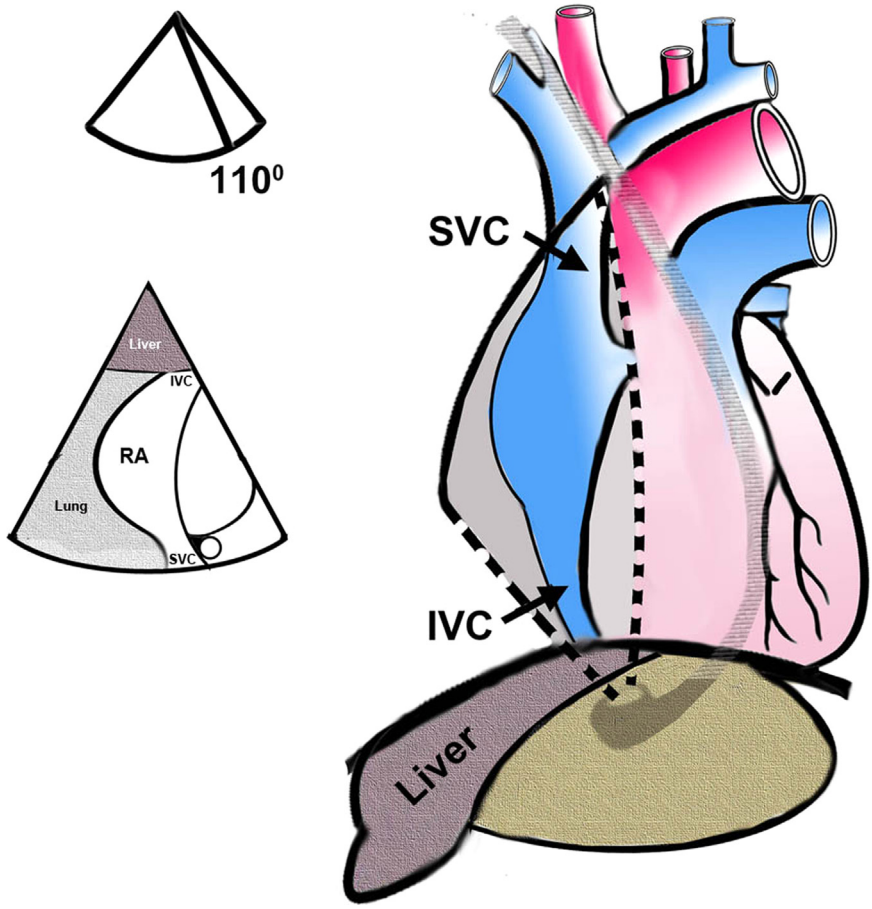

Fig 1. Line sketch to illustrate the probe position and transesophageal echocardiography (TEE) image acquisition. The TEE probe is advanced to the stomach 30 cm to 50 cm beyond the transgastric short-axis view, and then the probe is turned gently rightward (clockwise through 90°) and antiflexed, and then the multiplanar angle is increased to 90° to 110°. The SVC and the RA will be visualized in the center of the sector scan in the far field. The Doppler beam is best aligned with flow across the SVC-RA for the gradient measurement. Abbreviations: SVC, superior vena cava; IVC, inferior vena cava; RA, right atrium.

achieving hemostasis, and the patient was moved to the intensive care unit with stable hemodynamics for elective mechanical ventilation and for normal recovery. The remainder of the postoperative period was unremarkable.

DISCUSSION

The main goal of the repair of an SV-ASD involves the closure of the atrial septal defect and rechanneling of the anomalous pulmonary venous connection to the left atrium

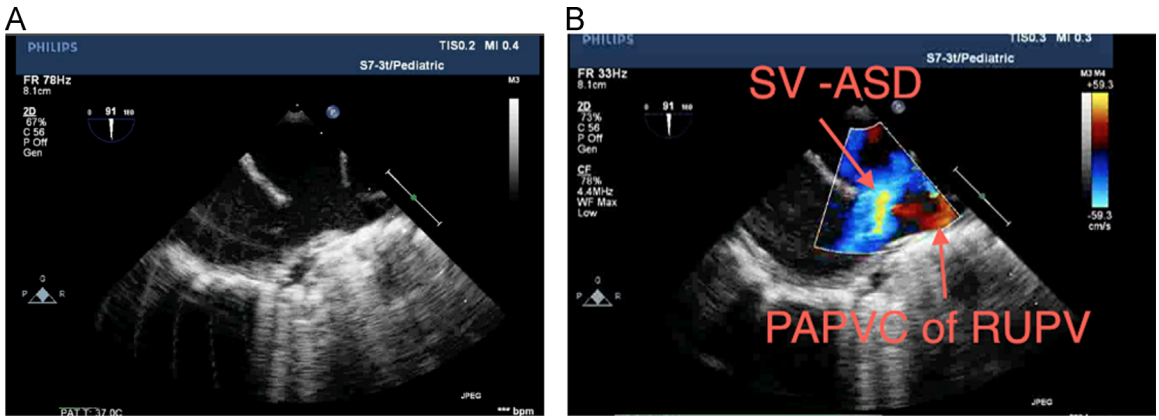

Fig 2. (A) Midesophageal bicaval view shows sinus venosus atrial septal defect (SV-ASD). (B) Midesophageal bicaval view with color-flow Doppler showing SV-ASD with left-to-right shunt and the right upper pulmonary vein draining into the superior vena cava at a 2-cm proximity to the superior vena cava and right atrium junction. Abbreviations: SV-ASD, sinus venosus atrial septal defect; PAPVC, pulmonary venous connection; RUPV, right upper pulmonary vein.