INTRODUCTION
Globally, in neonates or infants presenting with obstructed supracardiac total anomalous pulmonary venous connection (TAPVC), the ascending vertical vein (VV) is many times left unligated after a corrective surgery with an intention to decrease pulmonary hypertension (PH)-related complications and to allow the fairly less compliant left-sided heart to adjust to the sudden increase in the preload and to provide better hemodynamics. This VV, although closes later in life, may remain patent in some cases causing a significant pre-tricuspid shunt.\(^1,2\) These children can become symptomatic and present later with right heart dilatation. The transcatheter closure of the patent VV is feasible in carefully selected patients with favorable anatomy. It has some specific complications which can be fatal and requires the anesthetist to be vigilant at every step of the intervention. General anesthesia is preferred, but with proper coordination and communication with the cardiologist, this procedure can be successfully managed under sedation and MAC.

CASE REPORT
A 2-year-old boy weighing 10 kg, operated case of obstructed supracardiac TAPVC done at 3 months of age presented with recurrent respiratory infections and slow weight gain and signs of failure. On physical examination, his vitals were stable, auscultation revealed an ejection systolic murmur at the left upper sternal border of grade 2/6 with a loud P2. The electrocardiogram (ECG) showed normal sinus rhythm. Transthoracic echo showed...
a patent ascending VV draining into the innominate vein (IV) [Figure 1] with an impressive flow from the superior vena cava (SVC) to the right atrium, dilated right heart, and moderate Pulmonary Arterial Hypertension (PAH) with good biventricular function. The cardiac magnetic resonance imaging (MRI) confirmed the presence of a patent VV with right heart dilation [Figure 1]. The laboratory investigations were with normal limits. Informed consent was obtained from the parents and transcatheter device closure of the VV was planned. A decision was taken to perform the procedure under deep sedation and Monitored Anaesthesia Care (MAC) after a detailed discussion with the cardiologist considering the technical difficulties and risks associated during and after the VV was plugged. A thorough pre-anesthetic evaluation (PAE) was done and fasting of 6 h was advised. A 22G intravenous cannula was put during the PAE for starting the IV fluids. The premedication orders consisted of a chlorhexidine bath and oral midazolam 0.5 mg/kg on the day of the procedure. In the Cathlab, any untoward events requiring conversion from sedation into general anesthesia were not disregarded and adequate backup measures were prepared, considering this was a provision of non-operating room anesthesia (NORA). The operating room was kept on standby.

The monitors including the pulse oximeter, ECG, and noninvasive blood pressure (BP) were applied. Inj. glycopyrrolate 40 mcg IV and Inj. ketamine 10 mg IV were given as immediate premedications to help prepare the patient for the procedure. Oxygen from the face mask at 6 L/min was started. The endotracheal CO$_2$ (EtCO$_2$) probe was placed into the mask near the nostrils and the respiration was monitored. Sevoflurane at 1% was started to maintain anesthesia. The maintenance fluid Dextrose Normal Saline (DNS) at 20 mL/h was started. Using a linear ultrasound probe, we visualized the left internal jugular vein (IJV) for its patency, since the VV is anatomically favorably aligned with IJV and this was one of the backup routes through which the VV would be accessible in case the manipulation via the femoral route was unsuccessful. It was not going to be used as a primary route in this case since the 7fr Mullins sheath for device deployment was larger and would have caused thrombus or trauma to the left IJV. After painting and draping, Inj. fentanyl 30 mcg IV and Inj. ketamine 10 mg IV were given. Under local anesthesia, the right femoral vascular access was made using the Seldinger technique, the patient was heparinized and invasive BP monitoring was established. After establishing femoral access, the right and left heart catheterization was done and the pressure and oximetry data were collected. There was moderate PAH. The pulmonary pressures were 57/17 (mean 39) mmHg, Qp/Qs and Pulmonary Vascular Resistance index (PVRi) were 2 and 1.77 WU, respectively. The pulmonary artery (PA) angiogram was performed in an anteroposterior projection which showed an unobstructed pulmonary venous return to the left atrium in the levophase, patent large ascending VV with a significant left to right shunt [Figure 3]. A repeat dose of Inj. ketamine 10 mg IV was given just before the deployment of the device started and sevoflurane increased to 2% to keep the patient deep.

The VV was cannulated using 6F JR4 and angiograms were done in the posteroanterior and lateral projections to assess the anatomy and relationship with the surrounding structures. A landing zone was chosen and a 14-mm Cera vascular plug (Lifetech) suitable for the given anatomy was deployed in the middle of the VV taking the precaution of not obstructing the surrounding structures. There was no residual shunt and no obstruction to the left PA, pulmonary veins (PV), left main bronchus, and descending thoracic aorta checked by echocardiogram and repeat angiograms [Figure 4]. The patient remained

![Figure 1: Transthoracic echocardiogram showing patent vertical vein](image1)

![Figure 2: Cardiac magnetic resonance imaging showing vertical vein](image2)
hemodynamically stable throughout and was shifted to the recovery room after thorough hemostasis was achieved and was completely awake.

**DISCUSSION**

Transcatheter closure of unligated VV although has been performed in many centers is an uncommon interventional cardiology procedure. It necessitates the attending anesthesiologist to be well-versed with the anatomy and physiology of the patient, the technical aspects of the procedure, and the specific challenges that can be encountered. The general concerns being NORA and handling of the pediatric airway. The syndromic congenital heart disease patients can have difficult airways. The postoperative physiology of an operated TAPVC patient can pose significant challenges due to PAH and non-compliant left heart. Complications are expected more during the device deployment. Since the device can be deployed through the more favorably aligned left IJV, Ultrasonography (USG)-guided left IJV cannulation may be necessary to avoid multiple punctures and thrombosis. The obstruction to major structures like the left IV or left IJV can occur after device deployment. The left PA obstruction can cause sudden PA crisis and sudden RV dysfunction. The obstruction of the left bronchus can present with airway collapse. Labile hemodynamics can require hemodynamic support perioperatively. The device dislodgement can occur causing embolization or obstruction of the above-mentioned major structures. The occluding device is selected according to the size, anatomy, segments, and hemodynamic characteristics of the vascular malformation.\(^3\) The different devices used include Cera vascular plug, Amplatzer vascular plug, Amplatzer PDA device, and many others.

**CONCLUSION**

The transcatheter technique for the closure of patent vertical vein should be done in carefully selected cases with favorable anatomy, and they present some specific challenges from the anesthesia point of view like pediatric airway, labile hemodynamics, PA crisis, airway collapse, embolization, and thrombus formation. A meticulous preoperative planning and coordinated team effort can help conduct the procedure safely under MAC.

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**Conflicts of interest**

There are no conflicts of interest.

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