Timely CT-guided diagnosis and surgical management of sinus of Valsalva aneurysm: A case series highlighting promising outcomes

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ABSTRACT

A sinus of Valsalva aneurysm (SOVA) is a rare cardiac condition characterized by an abnormal dilation of the aortic root between the aortic valve annulus and the sinotubular junction. A ruptured SOVA can be identified through various diagnostic tools, including echocardiography, cardiac computed tomography (CT), and cardiac magnetic resonance imaging. Here, we present a case series of three patients with SOVA who were promptly diagnosed via CT and successfully managed, leading to significant symptom relief for the patient. Each case in this series presented unique clinical features: the first, an asymptomatic 51-year-old female with two saccular aneurysms incidentally found during preoperative evaluation; the second, a 36-year-old male with atypical chest pain and a large ventricular septal defect associated with right coronary cusp prolapse and mild aortic regurgitation; and the third, a 24-year-old male with severe tricuspid regurgitation due to a ruptured aneurysm from the right coronary sinus, accompanied by a bicuspid aortic valve and high-origin right coronary artery. All patients underwent successful surgical repair with complete resolution of symptoms, no postoperative complications, and normalized cardiac function confirmed on follow-up imaging. This case series aims to highlight the diverse clinical presentations, timely diagnosis, and successful management of SOVA, a rare but potentially serious cardiac condition.

Keywords: Sinus of Valsalva aneurysm, case reports, computed tomography, aortic valve annulus, sinotubular junction.

Type of Article: CASE SERIES **Speciality:** Radiology

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Background

A sinus of Valsalva aneurysm (SOVA) is a dilatation in the aortic root region located between the aortic valve annulus and the sinotubular ridge [1]. In a normal heart, the left and right sinuses contain their respective coronary artery openings, while the posterior sinus serves as a non-coronary sinus. SOVA develops due to a weakening of the elastic layer at the junction of the aortic media and annulus fibrosis and may be either congenital or acquired.

Congenital SOVA often correlates with connective tissue disorders, including Marfan syndrome, Ehlers-Danlos syndrome, and other related conditions [2, 3]. Additionally, patients with bicuspid aortic valves or related heart conditions such as ventricular septal defects (VSD) and aortic regurgitation have an elevated risk of developing SOVA. From an embryologic standpoint, SOVA originates as a blind pouch, caused by increased pressure exerted on the aortic root [4]. Congenital defects that heighten these pressures may thus contribute to SOVA formation.

Acquired SOVAs are also linked to connective tissue disorders, with infections such as syphilis, bacterial endocarditis, and tuberculosis known to weaken elastic tissues. Other causes include cystic medial necrosis, chronic effects of atherosclerosis, chest trauma, and complications from aortic valve replacement surgery [5, 6].

A range of imaging techniques can be used to diagnose SOVA, with cardiac computed tomography (CT) recently gaining popularity. Historically, transthoracic and transesophageal echocardiography have been primary diagnostic methods. In cases of ruptured SOVA, echocardiography with color Doppler imaging reveals continuous blood flow during both systole and diastole due to high aortic pressure, often accompanied by fluttering of the tricuspid valve as the color jet moves into the right heart chamber [7].

Magnetic resonance imaging (MRI), contrast aortography, and CT scans are commonly used as supplementary or confirmatory diagnostics. MRI with multiplanar sequencing allows for a detailed assessment of intracardiac shunts in ruptured SOVA cases. Modern cardiac CT scanners, equipped with wide-range rotation and ECG-gated technology, enable imaging in less than a full cardiac cycle [8]. The specific novelty of this

case series lies in its demonstration of the diagnostic utility of cardiac CT in promptly identifying complex and varied SOVA presentations, including incidental findings, associated structural heart anomalies, and ruptured aneurysms. By emphasizing CT's role in accurate diagnosis and surgical planning, this series addresses a key research gap in current literature, where most diagnostic discussions focus on echocardiography, underscoring the need to expand imaging protocols in atypical or asymptomatic cases. Early diagnosis of SOVA is clinically significant as it allows timely intervention before the aneurysm ruptures or leads to serious complications such as heart failure, arrhythmias, valvular dysfunction, or intracardiac shunting. Prompt detection, particularly through advanced imaging modalities such as cardiac CT and MRI, enables accurate assessment of aneurysm size, location, and associated structural abnormalities. This facilitates appropriate surgical planning, reduces perioperative risk, and improves patient outcomes. In asymptomatic or incidental cases, early diagnosis may be life-saving by preventing sudden cardiac events. We present a case series of three patients with SOVA who were accurately diagnosed using CT, enabling timely intervention and the prevention of severe complications.

Case study 1

CT-coronary angiography of a 51-year-old female who walked into the gynecology department with the chief complaint of intermittent abnormal bleeding. The patient underwent investigations for a presurgical profile for vaginal hysterectomy. The patient had no history of significant cardiac clinical symptoms, chest pain, or dyspnea. However, CT angiography of the patient showed two saccular aneurysms measuring 2.0 × 2.30 cm and 0.8 × 0.7 cm

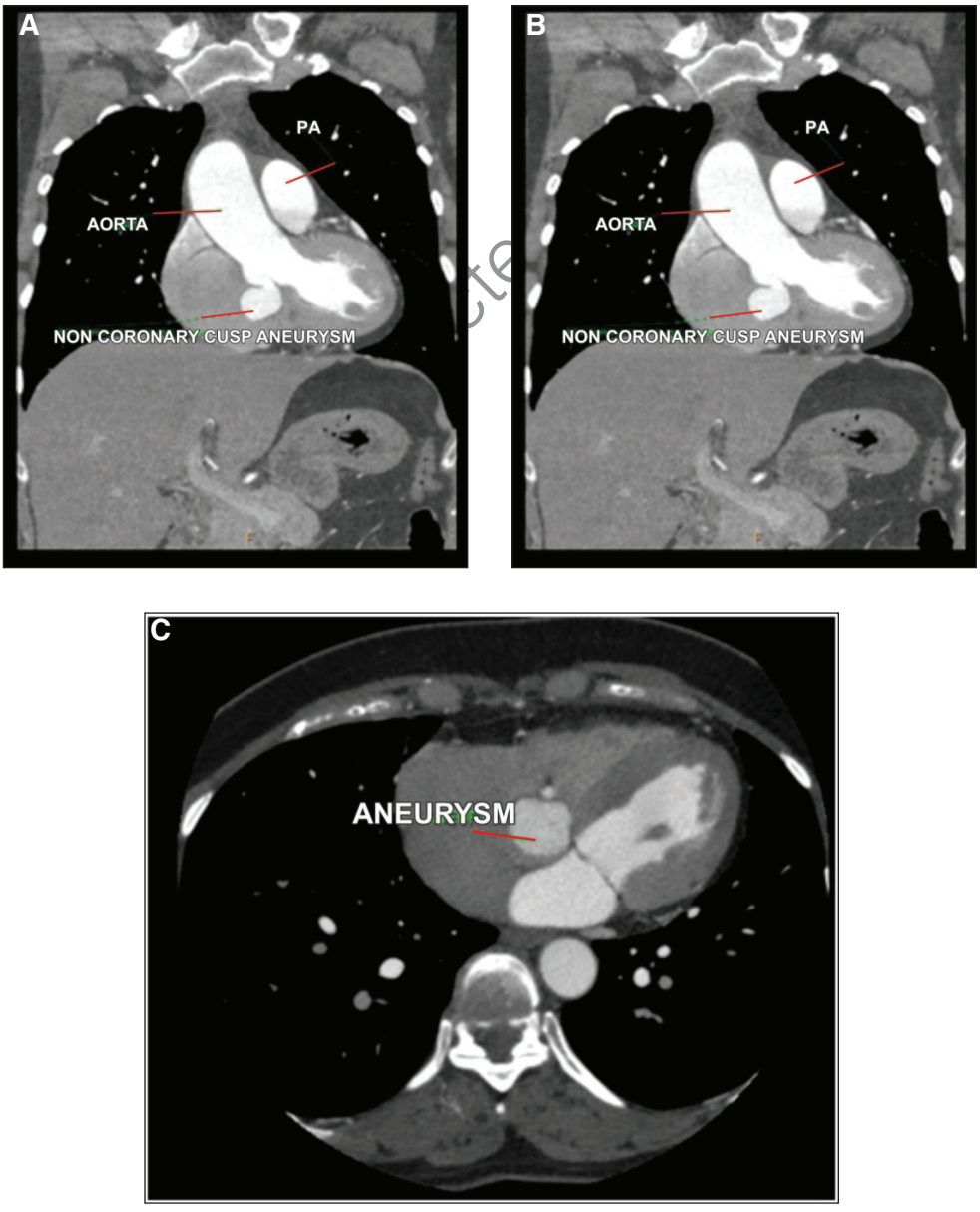

Figure 1. *Coronal and Axial MIP images demonstrating coronary sinus aneurysm.*

from the non-coronary cusp projecting into the right atrium (Fig. 1A–C) and toward the tricuspid valve, respectively.

Case study 2

A 36-year-old male patient presented himself with a history of characteristic pricking-type chest pain in the left side lasting for 2 minutes. Clinical history showed a low likelihood of angina, and shortness of breath for 1 year which aggravated on climbing stairs and walking for one and a half kilometers and relieving on rest. The patient did not complain about sweating and vomiting. The patient's 2D-echo showed large VSD shutting left to right with IVG of 74 mmHg, restricted by elongated right coronary cusp (RCC) prolapse into the VSD just below the pulmonary valve with reduced effective orifice causing prolapse of non-coronary cusp due to shorter RCC coaptation point leading to mild aortic regurgitation.

The CT pulmonary angiography of the patient revealed a saccular aneurysm measuring 2.0 × 1.9 cm from the right coronary sinus projecting into the right ventricular cavity and associated VSD (Fig. 2A–C). The neck of the aneurysm measures 2.1 cm. Ventricular septal defect is subaortic in location abutting with aneurysm arising from the right coronary sinus. The defect measures 10 mm in diameter.

Case study 3

A 24-year-old male patient presenting with dyspnea on exertion with palpitations, 2D echo revealed tricuspid regurgitation with gross thickened valves and vegetations. The CT aortogram revealed the following features:

- Bicuspid aortic valves with normal valve leaflets.
- Evidence of ruptured saccular aneurysm from right coronary sinus measuring 1.8 × 1.0 × 1.1 cm in size. The aneurysm is projecting toward tricuspid valves. The right coronary artery origin is 0.9 cm away from the aneurysm and shows a high origin from the ascending aorta (Fig. 3A–C).
- The left coronary sinus and origin of the left main coronary artery appear normal.

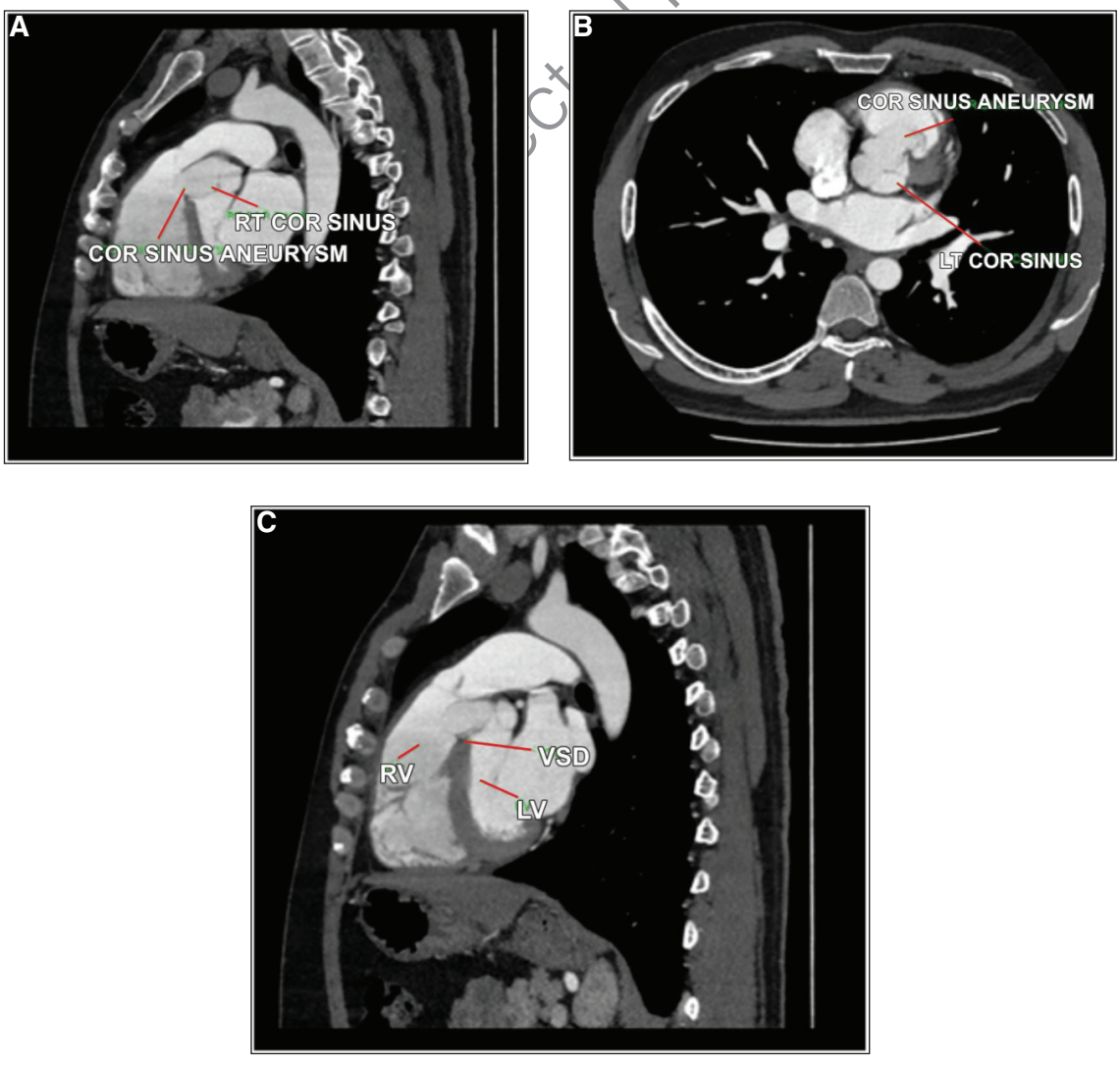

Figure 2. *Axial and Sagittal images showing coronary sinus aneurysm.*

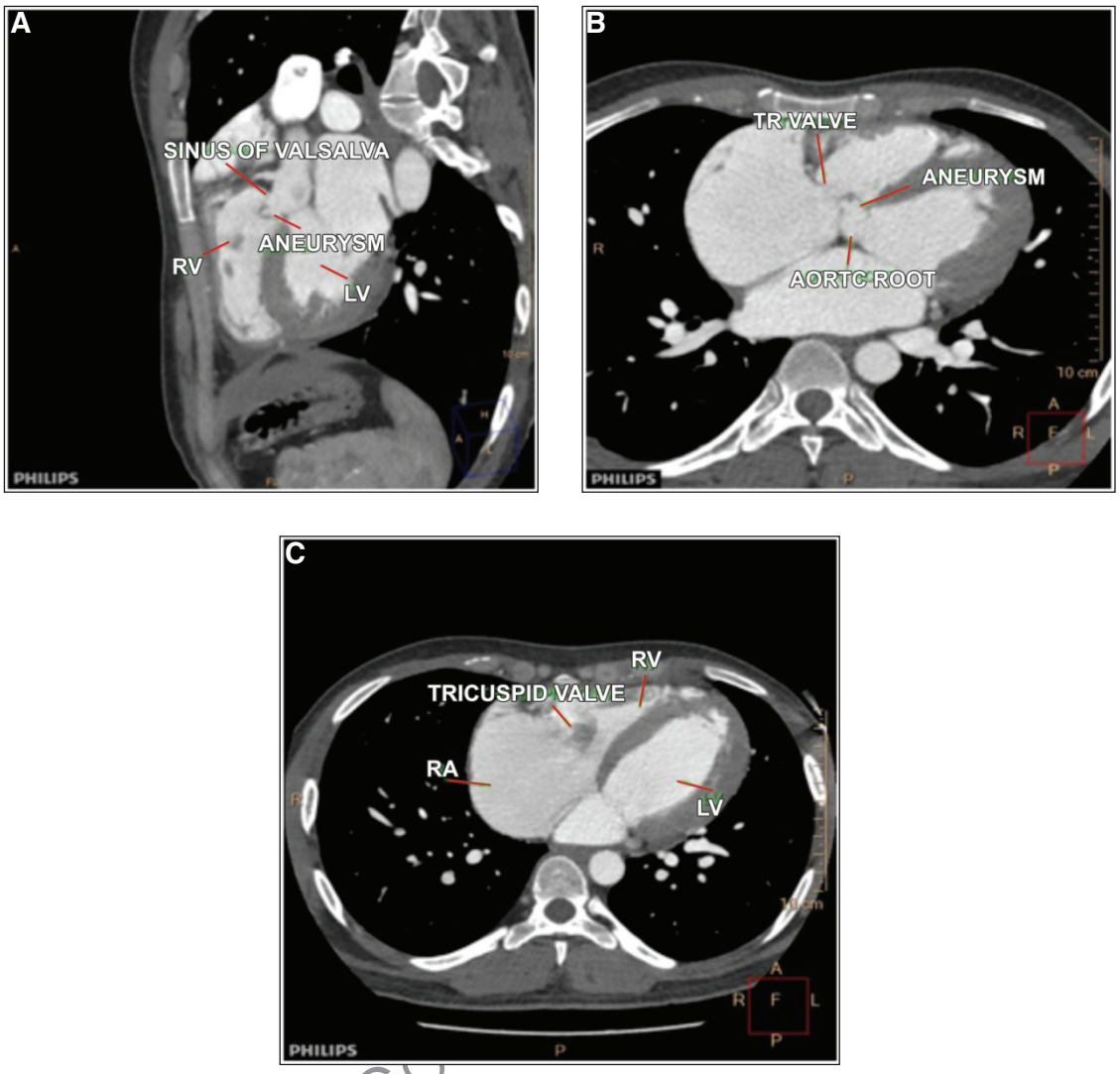

Figure 3. *Axial and Oblique MIP images demonstrating anatomy and origin of aneurysm from coronary sinus.*

- MRI screening revealed normal papillary muscles at the left ventricle, with no evidence of rupture. Severe tricuspid regurgitation is secondary to ruptured aneurysm of the right coronary sinus.

CT was the appropriate imaging modality of choice in all three patients with SOVA due to its superior spatial resolution, rapid acquisition, and capability for high-fidelity 3D reconstruction of the aortic root and adjacent structures. It allows precise assessment of aneurysmal morphology, extent, and associated complications, with greater diagnostic accuracy and reproducibility than echocardiography, facilitating optimal preoperative planning. Our cases of SOVA had large aneurysms with wide necks, which were corrected surgically and with patch closure of aneurysm opening with polytetrafluoroethylene or autologous pericardial patch. Non-surgical procedures were not suitable for the SOVA, which we treated as the neck of aneurysm was wide and not possible to obliterate them with percutaneous coiling. Small aneurysms are closed with the primary suture without the patch. All three patients underwent a highly technical cardiac surgical intervention, entailing resection of aneurysmal tissue via a combined transaortic and transpulmonary approach, coupled with reductive plastic reconstruction of the pulmonary trunk. This complex surgical technique was strategically developed to address the SOVA and to restore physiological functionality to the impacted cardiovascular structures [9]. Remarkably, the procedure was entirely successful, with the patient discharged in stable condition and no recorded postoperative complications, underscoring both the procedure's therapeutic efficacy and the surgical team's proficiency.

During a routine follow-up at 6 weeks post-surgery, the patients reported a full resolution of the previously auscultated cardiac murmur - an important clinical marker suggesting that the primary pathology was thoroughly addressed. Additionally, the patients noted substantial improvement in dyspnea, reflecting enhanced pulmonary function and a notable elevation in quality of life.

A follow-up transthoracic echocardiogram performed at this evaluation provided confirmatory evidence of the surgical success, with no visualization of residual aneurysmal tissue or other secondary complications. There were no serious post-operative adverse events in all the patients. This imaging study substantiated the procedural efficacy and demonstrated normalized cardiac function. The patient's favorable clinical trajectory post-intervention illustrates the effective resolution of SOVA and exemplifies the favorable outcomes that can be achieved through prompt and precise surgical correction of this rare cardiovascular anomaly.

Discussion

SOVAs are rare and defined as the dilatation or enlargement of one or more of the aortic sinuses between the aortic valve annulus and the sinotubular junction. The male-to-female ratio is 4:1 with a mean age of 35 years at presentation and the incidence is reported to be higher in Eastern compared with Western populations. These aneurysms most commonly originate from the right coronary sinus (70%–90%), less commonly from the non-coronary sinus (10%–20%), and rarely from the left sinus (< 5%) [10, 11]. Pathophysiology of sinus aneurysms is secondary to congenital deficiency of elastic lamellae in the wall of the affected sinus resulting in separation of the media in the sinus from adjacent aortic valve annulus leading to progressive aneurysmal dilatation and eventually to rupture [12].

SOVAs are frequently asymptomatic and consequently seldom diagnosed. They commonly arise from the right coronary sinus (in 70% of cases), and the non-coronary sinus in 25% if rupture occurs, a shunt more commonly develops into the right ventricle or right atrium. Cases of right ventricular outflow obstruction, coronary artery compression with infarction, conduction disturbances, endocarditis, and thrombus within the aneurysmal cavity have also been reported.

The most frequent complication of SOVA is rupture. Rarely, rupture is into the left atrium, left ventricle, pericardial cavity, or pulmonary artery. Aneurysm rupture usually occurs between 20 and 40 years of age but cases of rupture in infancy and octogenarians have been reported. In case of rupture, patients mostly present with a gradual onset of symptoms including chest pain, dyspnea, palpitations, fatigue, and syncope [13, 14].

Multidetector cardiac computed tomography enables precise evaluation of the entire thoracoabdominal aorta, providing comprehensive anatomical detail for accurate assessment [15]. Currently, there are no well-established guidelines for the diagnosis and management of SOVA. However, it is well recognized that definitive intervention is warranted in cases of ruptured or symptomatic unruptured aneurysms. Numerous case reports in the literature highlight the condition's clinical significance, often demonstrating atypical presentations and a spectrum of associated complications, underscoring the need for heightened clinical vigilance and individualized management strategies. However, reports of right SOVA with a concomitant fistulous tract to the right ventricular outflow tract, along with simultaneous aneurysmal dilatation of the pulmonary artery, remain exceedingly rare and sparsely documented in the literature [16–20]. In our case series, early diagnosis of SOVA with CT imaging enabled timely decision of surgical intervention preventing further worsening of symptoms and quality of life.

Surgical Outcome

All our cases of SOVA were surgically treated in view of the associated features of tricuspid valve disease and VSD. There was severe tricuspid regurgitation with vegetations due to the rupture of the sinus of the valsalva and VSD at the membranous portion. Literature on SOVA has demonstrated that patients treated surgically were followed up for early (≤30 days from surgery) and late post-operative complications, as well as surgery-related mortality, with improved clinical outcomes [21].

All the patients were followed from 6-month to 1-year period with regular 2D echocardiography and clinical examination. There was no murmur heard on the chest and no clinical symptoms of chest pain and dyspnea. In our case series, there were no procedural complications or late complications in the postoperative period.

Limitations

The study, being a case series involving three patients who presented to the outpatient department, was inherently limited by its small sample size and single-center design. Future studies could be conducted prospectively across multiple centers with a larger and more diverse patient cohort to enhance the generalizability of the observations.

Conclusion

The present case series demonstrated how the diagnosis of the pathology of SOVA can be easily performed with diagnostic tools available at most hospitals. Diagnosis with CT outweighed among other imaging modalities and accurate and prompt diagnosis of SOVA prevented life-threatening complications.

What's new?

The pathology of SOVA can be effectively diagnosed using widely accessible hospital diagnostic tools. Timely and precise CT-based detection of SOVA plays a crucial role in preventing potentially life-threatening complications.

List of abbreviations

CT	Computed tomography
MRI	Magnetic resonance imaging
RCC	Right coronary cusp
SOVA	Sinus of Valsalva aneurysm
VSD	Ventricular septal defect

Conflict of interest
The authors declare that there is no conflict of interest regarding the publication of this article.

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Consent for publication
Written informed consent was obtained from the patient.

Ethical approval
Ethical approval is not required at our institution to publish an anonymous case report.

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Summary of the case

1	Patient (gender, age)	51-year-old female 36-year-old male 24-year-old male
2	Final diagnosis	SOVA
3	Symptoms	Pricking chest pain, shortness of breath, dyspnea, palpitations
4	Medications	Symptomatic treatment as applicable
5	Clinical procedure	Surgical correction
6	Specialty	Radiology and cardiology