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Congenital & Pediatric: Case Report

Virtual Imaging of Unruptured Sinus of Valsalva Aneurysm and Autologous Pericardial Patch

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An asymptomatic 78-year-old man with no major medical history was diagnosed with an unruptured sinus of Valsalva aneurysm. The complexity of the anatomic relationships around the aneurysm when observed only by preoperative contrast-enhanced computed tomography and transthoracic echocardiography made it difficult to choose a treatment strategy. Accordingly, virtual imaging was reconstructed from the computed tomography data. Autologous pericardial patch closure with sparing of the aortic valve and annulus was successfully performed on the basis of virtual imaging.

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No guidelines for the treatment of an unruptured sinus of Valsalva aneurysm (SVA) have been published because of the rarity of this condition.[1] Surgical procedures for such aneurysms depend on the anatomic relationships involved; commonly used techniques include direct suture repair, patch closure, aortic root replacement, and aortic valve-sparing operations.[2] Few reports describing preoperative surgical planning and detailed intraoperative procedures have been published. In a previous study, we reported the effect of virtual imaging in planning complicated thoracic aortic operation.[3] In this report, we describe the use of virtual imaging to plan the successful treatment of an unruptured SVA. We also present a preoperative virtual imaging video and a detailed intraoperative video.

An asymptomatic 78-year-old man with no major medical history was referred to our hospital with a diagnosis of an unruptured SVA. Transthoracic echocardiography (TTE) showed an SVA protruding immediately below the tricuspid valve in the right ventricle (Figure 1A). TTE showed no congenital malformation or valvular disease, physical examination showed no abnormality, and laboratory test results were within the reference ranges. Electrocardiography showed saddleback ST-segment elevations in leads V_1, V_2, and V_3. Contrast-enhanced computed tomography (CT) showed the SVA protruding into the right ventricle; however, we were unable to clearly discern the distance between the orifice of the SVA and the aortic annulus or the precise location of the aneurysm within the sinus of Valsalva (Figures 1B-1D).

For clarity, we processed the CT images using virtual imaging software (Vesalius3D; PS-Tech) to reconstruct a 3-dimensional image of the heart (Video 1). Virtual imaging offered a clear view of the sinus of Valsalva (Figure 2A). The orifice of the SVA was located in the right sinus of Valsalva, and the SVA orifice diameter was 6.8 mm (Figure 2B). The distance between the SVA orifice and the aortic annulus was approximately 5 mm (Figure 2B). The orifice of the right coronary artery was separate from the SVA (Figure 2B). Virtual imaging provided critical preparatory information for treatment; it showed that the SVA could be safely closed with an autologous pericardial patch, sparing the aortic annulus and valve.

We conducted an operation to obviate any future risk of SVA rupture. A median sternotomy was performed, and cardiopulmonary bypass was established by ascending aortic cannulation and bicaval cannulation. Aortotomy was performed through a transverse incision starting 10 mm above the sinutubular junction. The aortic leaflets were normal, and the SVA orifice was located in the right sinus of Valsalva (Figure 2C). The SVA was protruding into the right ventricle and was determined to be a Konno and Sakakibara classification type IIIv aneurysm. The orifice was oval, and its maximum diameter was about 6.8 mm. It was not close to the right coronary artery orifice. The distance from the SVA orifice to the aortic annulus was about 5 mm. Seven 2-0 polyester mattress sutures with

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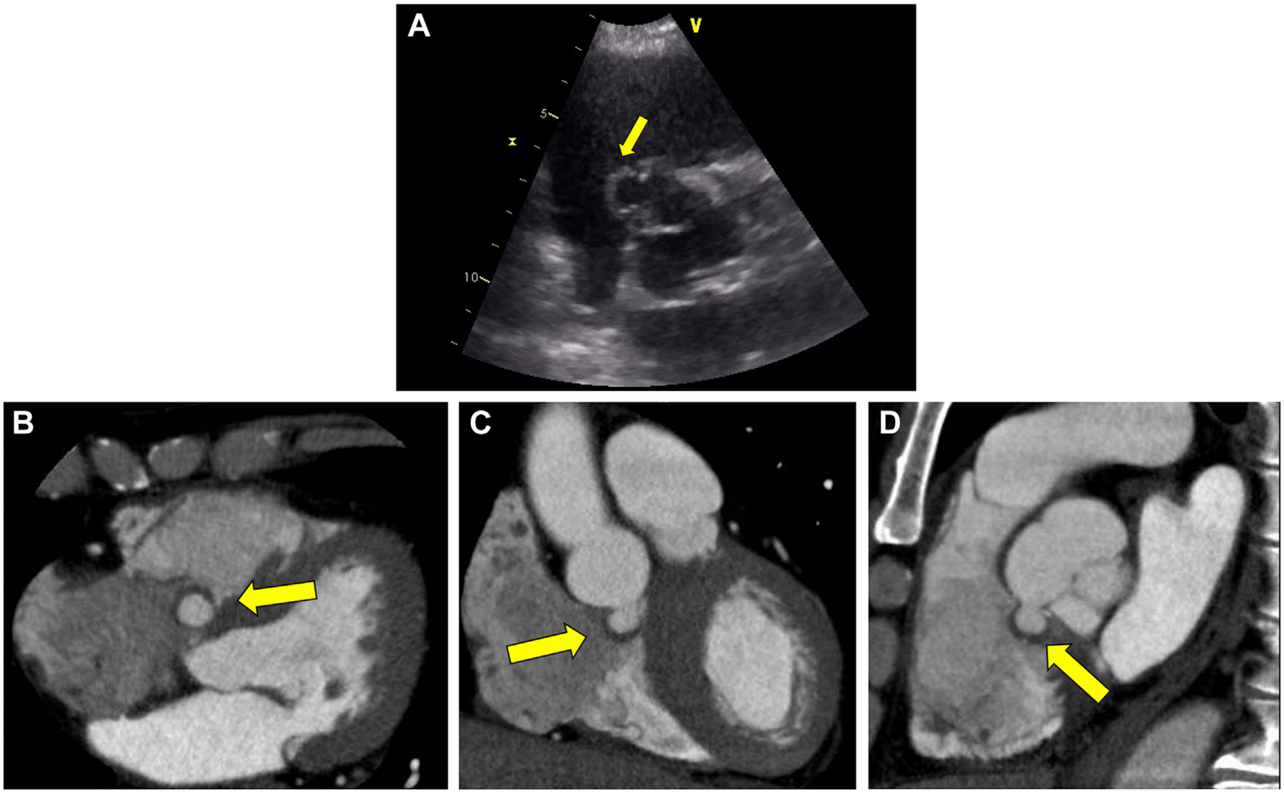

FIGURE 1 (A) Transthoracic echocardiography showed a sinus of Valsalva aneurysm protruding into the right ventricle. (B) Horizontal, (C) coronal, and (D) sagittal computed tomography sections are shown. The arrow indicates the sinus of Valsalva aneurysm.

pledgets were inserted into the aortic annulus and the sinus of Valsalva from inside the SVA. Autologous pericardial patch closure was then performed (Video 2). A running 5-0 polypropylene suture was added around the patch (Figure 2D). The aortic cross-clamping time was 49 minutes, and the cardiopulmonary bypass time was 85 minutes. The postoperative course was uneventful. The SVA was not enhanced on contrast-enhanced CT (Figure 3A). We know of no persuasive evidence that anticoagulation or antiplatelet therapy is needed after autologous pericardial patch closure, but we prescribed aspirin 100 mg daily for the first 3 months as a precaution. TTE showed no aortic regurgitation or tricuspid regurgitation, and no relapse or complications were seen at the 2-year follow-up.

COMMENT

Unruptured SVAs are rare. They may be acquired, but they are more often congenital.[1] Congenital SVAs tend to occur with other congenital defects, especially ventricular septal defect.[4] SVAs arise most commonly from the right sinus of Valsalva (66%), followed by the noncoronary (28%) and left (6%) sinuses of Valsalva.[4] Most patients are asymptomatic, but clinical symptoms may arise when SVAs compress or distort surrounding structures.[2]

In this case, virtual imaging produced by our software offered clear visualization and accurate 3-dimensional measurement.[5,6] We previously reported the efficacy of virtual imaging with preoperative planning for anatomically complicated thoracic aortic operation.[3]

In this case, preoperative virtual imaging clearly showed that the relationship between the SVA orifice, aortic annulus, and right coronary ostium would allow an autologous pericardial patch to be safely applied. Virtual imaging allows relatively intuitive and time-efficient exploration of the anatomy from any angle, along with easy measurements of complex geometry. Thus, virtual imaging seems especially likely to prove useful in cases of anatomic anomalies, as in this case of SVA.

This is particularly true when, as in this case, the anomaly is so rare that there are no published guidelines to direct the surgeon. Each surgeon must therefore reason from imaging data, and virtual imaging tends to promote fuller exploitation of imaging data. The natural history of unruptured SVAs remains unknown; however, because a rupture may be fatal, precautionary operation

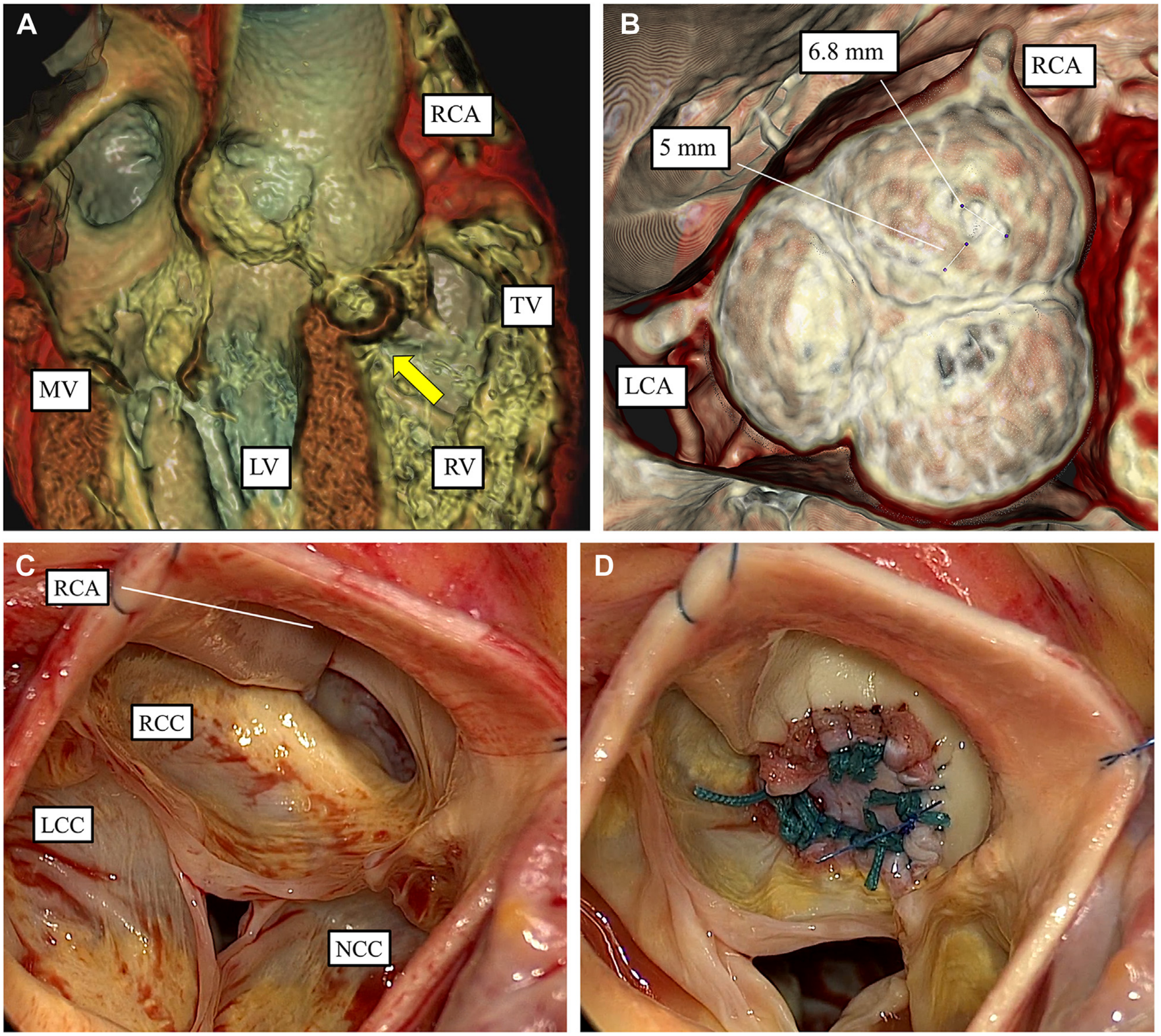

FIGURE 2 (A) Virtual imaging revealed complex anatomy. The arrow indicates the sinus of Valsalva aneurysm. (B) Virtual imaging simulated the surgeon's view. (C) The sinus of Valsalva aneurysm orifice was located in the right sinus of Valsalva. (D) The sinus of Valsalva aneurysm was treated with an autologous pericardial patch. (LCA, left coronary artery; LCC, left coronary cusp; LV, left ventricle; MV, mitral valve; NCC, noncoronary cusp; RCA, right coronary artery; RCC, right coronary cusp; RV, right ventricle; TV, tricuspid valve.)

seems indicated.[4] Intraoperative examination of the anatomy in this case confirmed the preoperative virtual imaging findings (Figure 3B). Our technology may well be used in addition to conventional CT and TTE for safer operation, and it seems optimal for anatomically complex operation.

In conclusion, the virtual imaging used in this study enabled us to accurately and precisely assess a complex anatomic region before operation. As demonstrated in this case, this technology could provide outstanding assistance to optimize anatomically complicated cardiac surgical procedure.

The Videos can be viewed in the online version of this article [https://doi.org/10.1016/j.atssr.2023.11.009] on http://www.annalsthoracicsurgery.org.

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DISCLOSURES

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PATIENT CONSENT

Obtained.

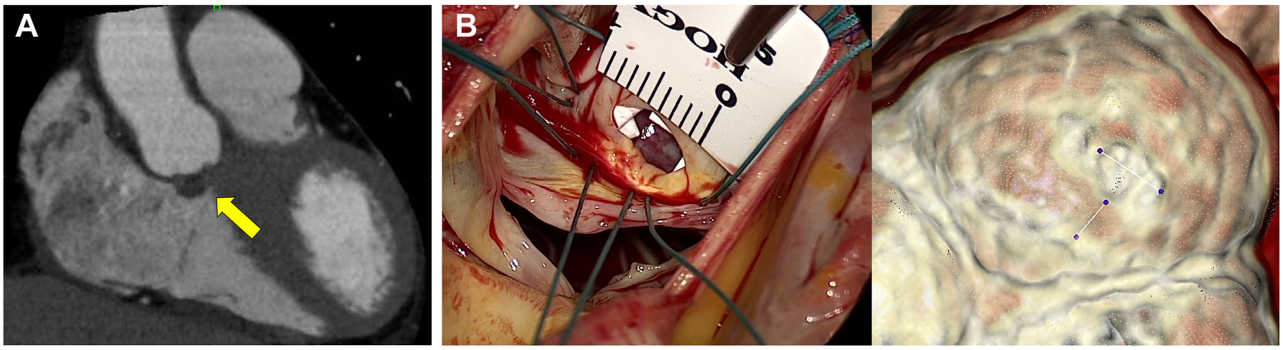

FIGURE 3 (A) The flow in the sinus of Valsalva aneurysm disappeared. The arrow indicates the sinus of Valsalva aneurysm. (B) The intraoperative view matched the preoperative virtual imaging.

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