Aortocoronary Saphenous Vein Graft Aneurysm: Diagnosis Using Color Doppler and Contrast Transesophageal Echocardiography

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INTRODUCTION

Saphenous vein graft (SVG) aneurysms are rare and late complications of coronary artery bypass grafting (CABG).[1-5] Aneurysms are frequently asymptomatic and diagnosed incidentally on chest computed tomographic angiography.[3-5] There are rare case reports in which they were diagnosed on transthoracic echocardiography (TTE) and transesophageal echocardiography (TEE).[3,5-7] Ultrasound enhancing agents (UEAs) were used in two previous reports.[6,7] We present a case in which we used TEE with color Doppler and UEA for left heart opacification[8] to visualize the flow in the lumen of the clot-filled SVG aneurysm to the right coronary artery (RCA). The diagnosis was confirmed on contrast enhanced cardiac computed tomography (CCT).

CASE PRESENTATION

A 74-year-old man with a history of hypertension, diabetes, dyslipidemia, and coronary artery disease presented with atypical chest pain and atrial fibrillation. He had undergone CABG and aortic valve replacement with a bileaflet St. Jude mechanical valve at 58 years of age. Chest computed tomography at an outside hospital revealed a right paracardiac mass suggestive of a "pericardial cyst" (Figure 1). He was taking carvedilol, losartan, furosemide, pravastatin, metformin, and warfarin daily.

The physical examination demonstrated a healthy man in no apparent distress. His heart rate was 88 beats/min, and rhythm was irregular. His blood pressure was 128/67 mm Hg, with respiratory rate noted at 20 breaths/min. There was no evidence of jugular venous distention, with normal carotid upstroke. Cardiac examination demonstrated a normal apical impulse, normal opening and closing clicks of the aortic valve, and a grade 1 systolic ejection murmur at the base. Lung fields were clear to auscultation. There was no ankle edema, and peripheral pulses were equal and adequate.

The laboratory data revealed normal complete blood count, normal electrolytes, and mildly elevated creatinine of 1.5 mg/dL. Electrocardiography demonstrated atrial fibrillation and nonspecific T-wave abnormalities. Chest radiography showed a prominent right heart border suspicious for a right paracardiac mass (Figure 2). TTE showed normal left ventricular wall motion, estimated ejection fraction of 65%, and normal function of the mechanical aortic valve prosthesis. TTE was technically difficult but suggestive of a 4.2-cm diameter round mass adjacent to the right atrium. The mass had a central small lumen, but no flow was noted on color flow imaging (Figure 3, Video 1). These abnormal findings on TTE were suspicious for SVG aneurysm and prompted us to perform TEE for clarification.

TEE using two-dimensional and three-dimensional imaging demonstrated a 4.2-cm-diameter extracardiac mass adjacent to the right atrium pushing the right atrial wall inward (Figure 4, Videos 2–4). The periphery of this structure showed clotlike echogenic material and flow in the central echo-free lumen with color flow imaging (Figure 4, Video 3). UEA was used for left heart opacification, and flow was noted in the central lumen (Figure 5, Videos 5 and 6). Findings on TEE, color Doppler, and flow imaging with UEA were consistent with the diagnosis of clot-filled SVG aneurysm to RCA with patent lumen.

The patient was referred for coronary and graft angiography, but the SVG was not successfully engaged. CCT showed a patent left internal mammary artery graft to the left anterior descending coronary artery, a patent SVG to the diagonal branch, and an aneurysm of the SVG to the RCA (Figure 6). Because of the lack of significant ischemia, medical management was recommended. He underwent ablation for atrial fibrillation, but because of recurrence of arrhythmia he was started on amiodarone with maintenance of sinus rhythm.

DISCUSSION

A minor degree of aneurysmal dilation of the SVG is not uncommon and has been reported to be as high as 14% at 6 to 12 years after CABG.[1] Large aneurysms of the SVG graft are rare and reported mostly as single case reports or small case series. It was first reported by Riahi *et al*[2] in 1975, and since then several other case reports and reviews have been published.[2,7,9] SVG aneurysms can be true aneurysms or pseudoaneurysms.[3,4] Pseudoaneurysms of the SVG are rare, involve the proximal or distal anastomotic site, and are thought to be related to infection or surgical technique. They usually occur early within the first few months after operation,[3] and rare late occurrence has been reported several years later.[4] True SVG aneurysms account for the majority of cases and are generally reported years after CABG.[2,7,9] Occasionally true aneurysm has been reported early, within a few months after

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VIDEO HIGHLIGHTS

Video 1: TTE, two-dimensional, modified right ventricular inflow view showing a mass adjacent to the right atrium with a small central echo-free space. It appears to be inside the right atrium, but was later confirmed to be an extrinsic mass (SVG aneurysm) pushing the right atrial wall inward.

Video 2: TEE, two-dimensional, midesophageal four-chamber view clearly shows an extracardiac 4.4-cm diameter circular mass pushing the right atrial wall inward. There is a small echo-free lumen surrounded by echogenic material suggestive of clotted SVG aneurysm.

Video 3: TEE, two-dimensional, midesophageal four-chamber view with color flow Doppler. The color aliasing velocity is reduced to 15 cm/sec to visualize the low-velocity laminar coronary flow in the central patent lumen of the graft.

Video 4: TEE, three-dimensional, midesophageal four-chamber view with real-time, full-volume, wide-angle, single-beat acquisition. This image provides better appreciation of the extracardiac mass with a central lumen.

Video 5: TEE, two-dimensional, midesophageal four-chamber view early after intravenous injection of the UEA. Increased echogeneity is noted within all four cardiac chambers but is not seen in the echo-free lumen of the graft.

Video 6: TEE, two-dimensional, midesophageal four-chamber view 1 min after intravenous injection of the UEA demonstrates opacification within the graft lumen. This was later confirmed to be a clotted SVG aneurysm with a patent lumen.

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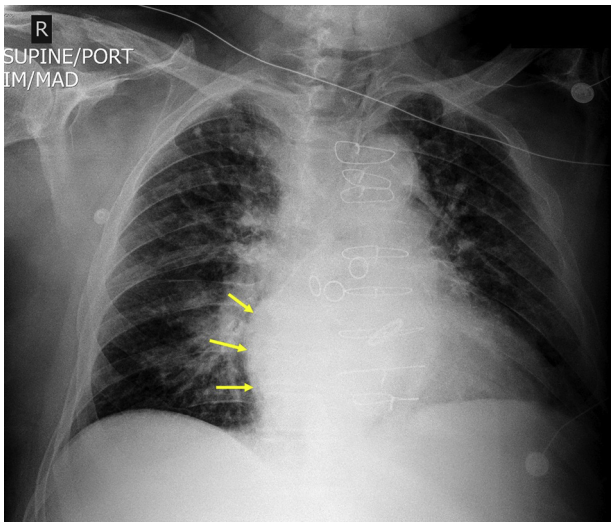

Figure 2 Posteroanterior chest radiograph shows prominence of right heart border (*yellow arrows*) suggestive of an extracardiac mass.

CABG. This is probably related to preexisting weakness of venous wall or injury at the time of harvesting.[3] Ramirez *et al*[9] performed a systematic review of cases between 1975 and 2010 and reported data on 209 cases of SVG aneurysms. They were diagnosed late, >10 years after CABG, in 68%, most frequently involved SVG to the RCA (in 38%), caused mechanical complications and extrinsic compression of adjacent structures in 35%, and ruptured into a cardiac chamber with fistula in 7.7%. The clinical presentations of SVG aneurysm include incidental finding on imaging (chest radiography, echocardiography, CCT),[3,7,9] right extracardiac mass,[5] left extracardiac mass[6] causing compression of adjacent structures,[9] ischemia,[10] rupture,[11] and fistula to the right atrium[12] or to the right ventricle.[13]

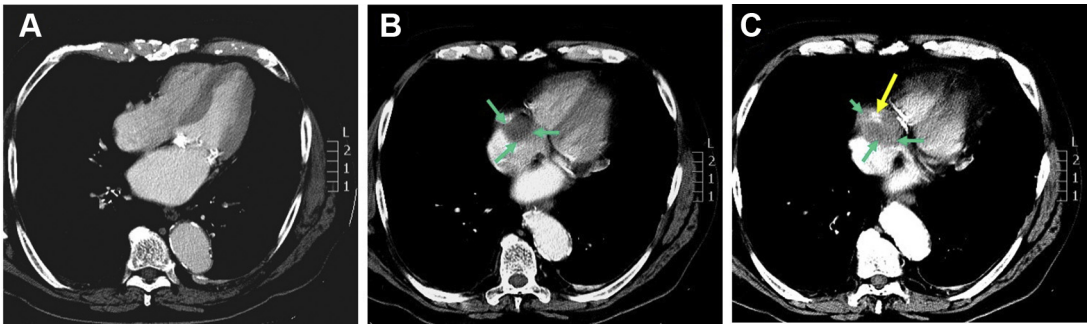

Figure 1 Nongated computed tomographic axial images from outside hospital. **(A)** Axial image of four chambers with mitral annular calcification. No pathologic mass is noted at this level. **(B)** An image inferior to **(A)**. A large homogenous mass (*green arrows*) of low attenuation with 16 Hounsfield units is noted. It was misdiagnosed as a pericardial cyst. **(C)** Contrast enhancement of the lumen (*yellow arrow*). The mass (*green arrows*) could be followed to its attachment to the aorta. Misdiagnosis may have been avoided by paying careful attention to these findings (see Figure 6).

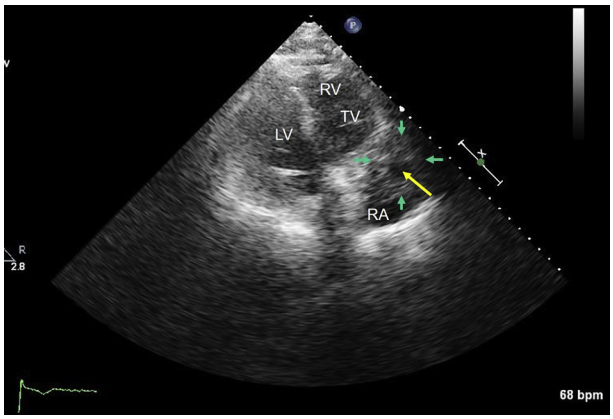

Figure 3 Two-dimensional TTE, modified right ventricular inflow view, shows a large circular mass (outlined by *green arrows*) just superior to the tricuspid valve (TV). There is a central echo-free space (*yellow arrow*). It appears to be inside the right atrium but actually is an extrinsic mass pushing the right atrial wall inward. This was later shown on TEE and CCT to be a clot-filled SVG aneurysm with a patent central lumen. *LV*, Left ventricle; *RA*, right atrium; *RV*, right ventricle.

TTE and chest radiography are usually the first diagnostic studies performed in cardiac patients. Transthoracic echocardiographic images were poor in our case but suggestive of a mass adjacent to the right atrium, prompting us to perform TEE for clarification. TEE with color Doppler and contrast-enhanced imaging provided details of graft flow and aided in the diagnosis. Coronary angiography is useful to rule out obstructive disease and evaluate grafts. At times, it is challenging to fill the large aneurysmal graft, as in this case. CCT is the diagnostic imaging modality of choice.[3] Cardiac magnetic resonance imaging has also been used.[4] The presence of a paracardiac mass on imaging studies in a patient after cardiac surgery (CABG or aortic surgery) should alert the clinician to the possibility of SVG aneurysm, pericardial hematoma, or pseudoaneurysm of the aorta.[3,5,14] Pericardial cyst is a rare cardiac lesion that should be in the differential diagnosis.[15] Experienced echocardiographers are often able to use all available echocardiographic imaging parameters to best differentiate SVG aneurysm from pericardial cyst, pericardial hematoma, or pseudoaneurysm of the aorta. However, when appropriate, additional tomographic imaging modalities such as cardiac magnetic resonance and CCT remain valuable for greater clarification and comprehensive evaluation (see Supplemental Figures 1–4).

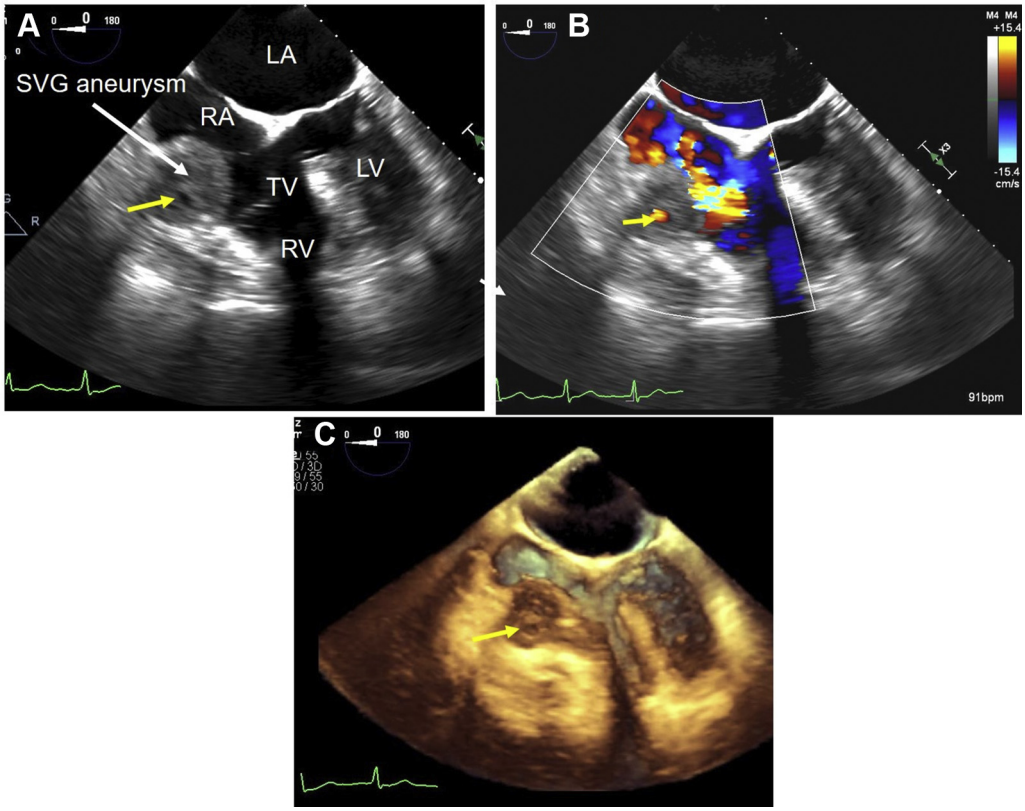

Figure 4 Transesophageal echocardiographic images from midesophageal position illustrate the features of SVG aneurysm. **(A)** Two-dimensional four-chamber view (4-CV) demonstrates an extracardiac 4.4-cm heterogenous mass (*white arrow*) pushing the right atrial wall inward. The mass has a small central echo-free lumen (*yellow arrow*). **(B)** Two-dimensional 4-CV with color flow imaging and reduced aliasing velocity (15 cm/sec) confirms the low-velocity flow within the echo-free space (*yellow arrow*). **(C)** Three-dimensional 4-CV with real-time, wide-angle, single-beat acquisition. This image provides better appreciation of the extracardiac mass with a central lumen. These echocardiographic features are consistent with the subsequently proven clotted SVG aneurysm with a patent lumen. *LA*, Left atrium; *LV*, left ventricle; *RA*, right atrium; *RV*, right ventricle; *TV*, tricuspid valve.

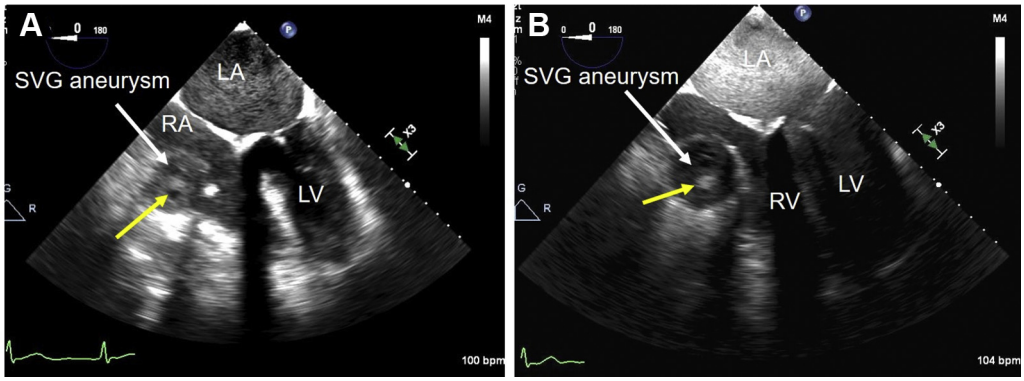

Figure 5 Two-dimensional TEE midesophageal images 4-CV without **(A)** and with **(B)** UEA. UEA (0.5 mL perflutren protein type A microspheres) was injected intravenously, followed by 3-mL flush with normal saline for left heart opacification. The mechanical index was lowered to 0.5, and gain was increased. **(Panel A)** Appearance of UEA in the left atrium (LA) but an echo-free graft lumen early after UEA injection (*yellow arrow*). **(B)** UEA within the lumen 1 min later (*yellow arrow*). These echocardiographic features are consistent with the subsequently proven clotted SVG aneurysm with a patent lumen. *LV*, left ventricle; *RA*, right atrium; *RV*, right ventricle.

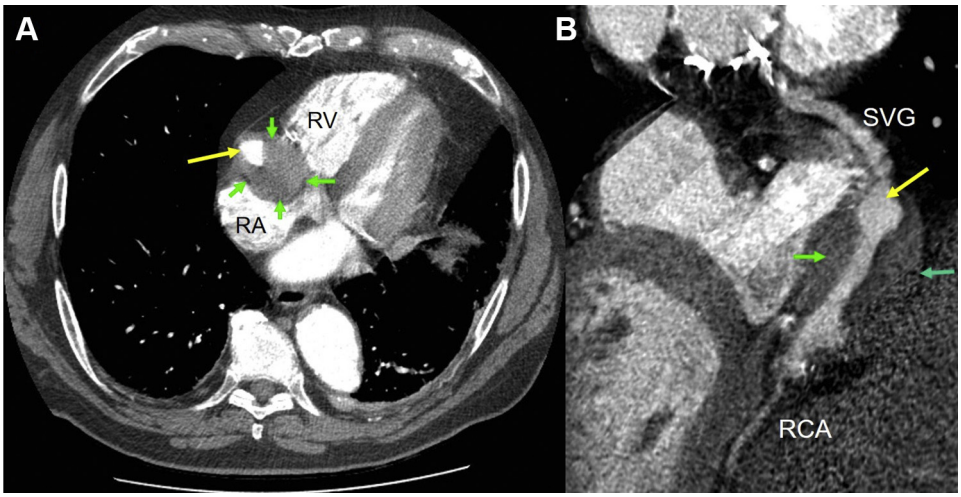

Figure 6 Gated coronary computed tomographic images. **(A)** An axial image of four chambers and a large SVG aneurysm (*green arrows*). SVG shows laminated clot with low attenuation (10 Hounsfield units [HU]) and patent central lumen filled with contrast with high attenuation of 280 HU (*yellow arrow*). **(B)** Curved multiplanar reformat showing cardiac computed tomographic features of laminated clot (between *green arrows*) and patent lumen (*yellow arrow*) of the SVG graft to the RCA. *RA*, Right atrium; *RV*, right ventricle.

CONCLUSION

In a patient with a history of CABG, a mass adjacent to the heart on chest radiography or TTE should alert the clinician to the possibility of SVG aneurysm, pseudoaneurysm of the aorta, or pericardial hematoma.[3,5,14] A high index of suspicion is required, and imaging specialists should be aware of this complication of CABG. Systematic TTE and TEE with color Doppler and flow imaging with UEA offer the opportunity to confirm the diagnosis of SVG aneurysm. Complete coronary and SVG evaluation require multimodality imaging, including CCT and selective coronary angiography.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.case.2021.09.008.

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