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CASE REPORT
Cardiovascular imaging

Right coronary ischaemia caused by a sinus of Valsalva aneurysm improved by releasing mechanical stretch: a case report

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Background A sinus of Valsalva aneurysm involving a single cusp is a rare condition, and coronary computed tomography angiography with fractional flow reserve-computed tomography helps evaluate not only the anatomical aspects of the aneurysm and coronary artery but also the physiological details of coronary artery disease.

Case summary A 71-year-old woman presented with exertional chest pain and dyspnoea. Enhanced computed tomography revealed an aneurysmal change in the right sinus of Valsalva, and coronary computed tomography angiography revealed diffuse narrowing of the proximal segment of right coronary artery due to mechanical stretching by the large Valsalva aneurysm. Fractional flow reserve-computed tomography revealed a significantly low fractional flow reserve (0.50 in the distal right coronary artery). A modified Bentall procedure was performed with a 21 mm bioprosthetic valve and a 24 mm Valsalva graft conduit for the aortic root aneurysm; mitral valve annuloplasty was performed for mitral valve regurgitation. Post-operative coronary computed tomography angiography revealed no significant stenosis in the proximal segment of the right coronary artery. Furthermore, fractional flow reserve-computed tomography revealed a normalized fractional flow reserve in the distal right coronary artery. The patient experienced relief from chest pain and was discharged 19 days after the surgery.

Discussion A right coronary sinus of Valsalva aneurysm, which caused right coronary artery ischaemia, was successfully treated using a modified Bentall procedure. Coronary computed tomography angiography and fractional flow reserve-computed tomography revealed anatomical and functional improvements in the right coronary artery ischaemia post-operatively.

Keywords Case report • Sinus of Valsalva aneurysm • Coronary ischaemia • Fractional flow reserve • Coronary computed tomography angiography • Modified Bentall procedure

ESC curriculum 2.1 Imaging modalities • 2.4 Cardiac computed tomography • 3.1 Coronary artery disease

Learning points

- Coronary sinus of Valsalva aneurysms causing right artery ischaemia can be successfully treated using the modified Bentall procedure.
- Coronary computed tomography angiography-derived fractional flow reserve-computed tomography is a diagnostic tool that can help evaluate post-operative improvements.

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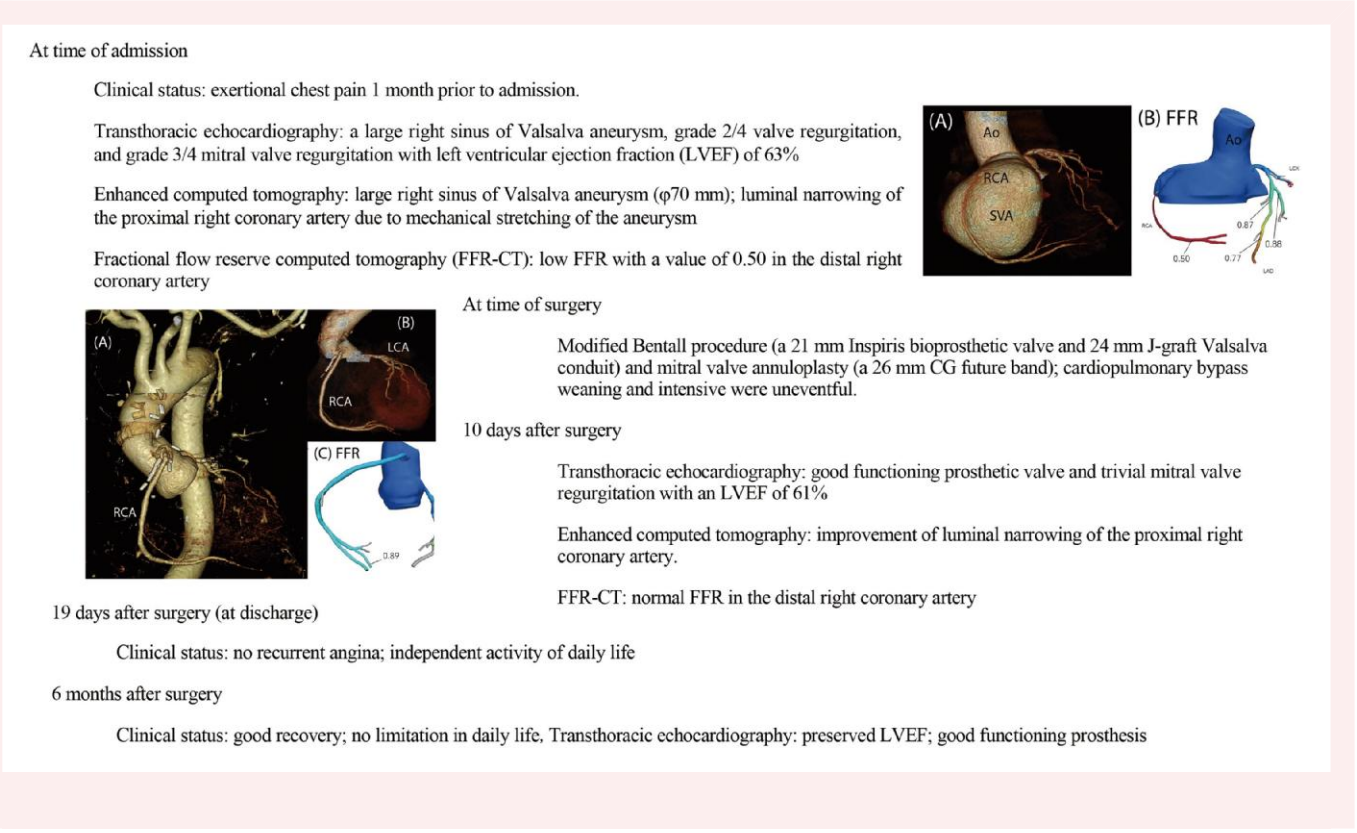
Introduction

Fractional flow reserve-computed tomography (FFR-CT) is a non-invasive technique for the assessment of both the anatomical and physiological details of coronary artery disease. Herein, we present the case of a large right sinus of Valsalva aneurysm that caused ischaemia of the right coronary artery (RCA) due to luminal narrowing of the proximal segment of the RCA; the case was diagnosed using FFR-CT that showed a low flow reserve, which improved significantly by releasing the mechanical stretch after the modified Bentall procedure.

Summary figure



Case presentation

A 71-year-old female with a 1-month history of exertional chest pain and dyspnoea was referred to our hospital. The patient neither had a physical feature of connective tissue disease nor a family history of it. She had a history of breast cancer 10 years previously, and chest magnetic resonance imaging revealed a right sinus of Valsalva aneurysm with a diameter of 40 mm. She had not been followed up for the Valsalva aneurysm for 10 years. After referral to our hospital, the patient was treated with aspirin and nicorandil. Her vital signs on arrival were stable with widened pulse pressure 103/48 mmHg and heart rate 71 b.p.m. Chest radiography revealed mild cardiomegaly, with a cardiothoracic ratio of 53% and bulging of the right cardiac border (*Figure 1*). Electrocardiography revealed negative T-wave in leads II, III, and aVF. Transthoracic echocardiography revealed good contractility of left ventricular (LV) wall with an LV ejection fraction of 63%, grade II/IV aortic valve regurgitation with severely dilated right coronary cusp (*Figure 2A and B*), and grade III/IV mitral valve regurgitation due to mitral annular dilatation. Enhanced CT revealed aneurysmal changes in the right sinus of Valsalva, with a diameter of 70 mm (*Figure 3A*). Coronary CT angiography (CTA) revealed diffuse narrowing of the proximal segment of RCA due to mechanical stretching by a large Valsalva aneurysm (*Figure 3A*). Fractional flow reserve-computed tomography demonstrated a significantly low FFR (0.50 in the distal RCA) (*Figure 3B*).

Elective surgery was planned for aortic root aneurysm and moderately severe mitral regurgitation. The modified Bentall procedure was performed with a 21 mm Inspiris™ RESILIA™ bioprosthetic valve (Edward Lifesciences) and a 24 mm Gelweave Valsalva (VASCUTEK TERUMO) conduit for aortic root aneurysms (*Figure 4A*). The aortic valve showed a normal leaflet; however, the aortic valve was dissected from the aortic wall at the commissure between the right coronary and non-coronary cusps, resulting in cusp prolapse and aortic regurgitation (*Figure 4B*). We inspected the ostium of RCA, which was stretched by the aneurysm. As the 3 mm probe could easily pass through the RCA ostium and proximal segment of the RCA, we decided not to perform coronary artery bypass grafting (CABG) in the RCA. The coronary button was made without totally dissecting the proximal segment of RCA from the aneurysmal wall because the proximal segment of RCA was severely adherent to the aneurysmal wall, and sewn to the composite graft. We also performed mitral valve annuloplasty for mitral valve regurgitation using a 26 mm CG FUTURE™ annuloplasty band (Medtronic). Cardiopulmonary bypass weaning was successful, and the patient was transferred to the intensive care unit with minimal catecholamine support.

Post-operative coronary CTA revealed no significant stenosis of the proximal segment of RCA (*Figure 5A*). In addition, FFR-CT showed

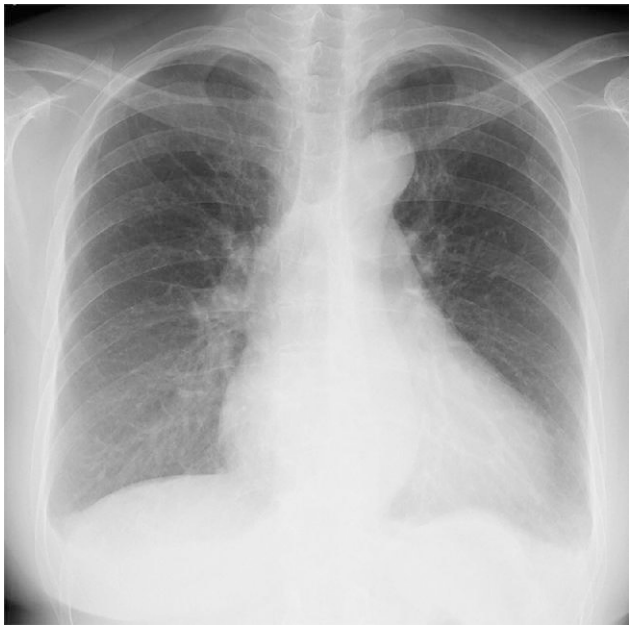


Figure 1 Chest radiograph. Bulging is seen in the mediastinal silhouette along the right border of the heart.

normal FFR in the distal segment of RCA (*Figure 5B*). The patient got relief from chest pain, and was discharged from the hospital 19 days after surgery. After 6 months of follow-up, the patient presented with neither symptoms nor signs of angina.

Discussion

A sinus of Valsalva aneurysm with one cusp is a rare condition, with an incidence of 0.09% in autopsy cases and 1.5–3.5% in patients who undergo open heart surgery.[1–3] Isolated aneurysms most often involve the right coronary Valsalva sinus, followed by the non-coronary and left coronary sinuses, with a higher reported incidence in Asian populations.[2] The clinical symptoms of Valsalva sinus aneurysms vary widely depending on whether the aneurysm ruptures, the mass effect on adjacent cardiac structures, and/or complicated aortic regurgitation. There have been many reports of non-ruptured aneurysms manifesting as myocardial ischaemia or infarction resulting from compression or occlusion of the coronary artery. Coronary CTA is a useful tool not only for diagnosing Valsalva sinus aneurysms and providing excellent anatomic depiction, but also to obviate the need for invasive angiography, which may be more difficult to engage in the orifice of the coronary artery that originates from the aneurysmal Valsalva sinus. Their dilated and thin aortic walls may be more prone to injury from the catheter; therefore, a non-invasive evaluation could avoid iatrogenic aortic dissection and/or aortic wall rupture. Coronary CTA could also provide FFR-CT, which subtends the myocardial mass and estimate myocardial blood flow at rest and in simulated hyperaemia.[4] Analogous to conventional FFR, this non-invasive technique allows evaluation of the physiologic significance of a coronary artery stenosis with the same threshold value of 0.80 or less.[5]

In our case, the patient developed exertional chest pain, and coronary CTA showed a large right sinus of Valsalva that compressed the proximal segment of RCA as well as a low FFR in the distal segment of the RCA.

Although Valsalva sinus aneurysm occurs above the aortic valve annulus, aortic regurgitation is frequently complicated by Valsalva sinus aneurysms, occurring in up to 30–50% of the patients.[3] In our case, the aortic valve and annulus were torn apart from the aortic wall at the commissure between the right coronary and non-coronary cusps due to tension from the severely dilated sinus of Valsalva, resulting in aortic regurgitation.

Operative strategies should focus on exclusion of the aneurysm, stabilization of aortic regurgitation, and relief from ischaemia. We planned a modified Bentall procedure considering the possibility of additional CABG to the distal segment of RCA. There are a few reports of successful decompression of Valsalva aneurysms resulting in improvement of ischaemia without CABG.[6–11] Although pre-operative coronary CTA showed extensive stretching and narrowing of the proximal segment of RCA and significant ischaemia on FFR-CT, the RCA ischaemia in our patient was not likely caused by atherosclerosis but mechanical stretch by the large Valsalva aneurysm, and the 3 mm probe could easily pass through the RCA ostium and proximal segment of the RCA. Therefore, we expected that the RCA ischaemia would be relieved only by reducing mechanical stretch from the aneurysm that would be achieved by the modified Bentall procedure without CABG. Post-operative coronary CTA clearly showed a non-stenotic proximal segment of RCA and FFR of normal value in the distal segment of RCA on FFR-CT.

In conclusion, the right coronary sinus of Valsalva aneurysm, which caused RCA ischaemia, was successfully treated using the modified Bentall procedure. Coronary CTA and FFR-CT revealed anatomical and functional improvements in the RCA ischaemia after surgery. This is the first report of the complete resolution of ischaemia caused by a Valsalva aneurysm diagnosed using FFR-CT.

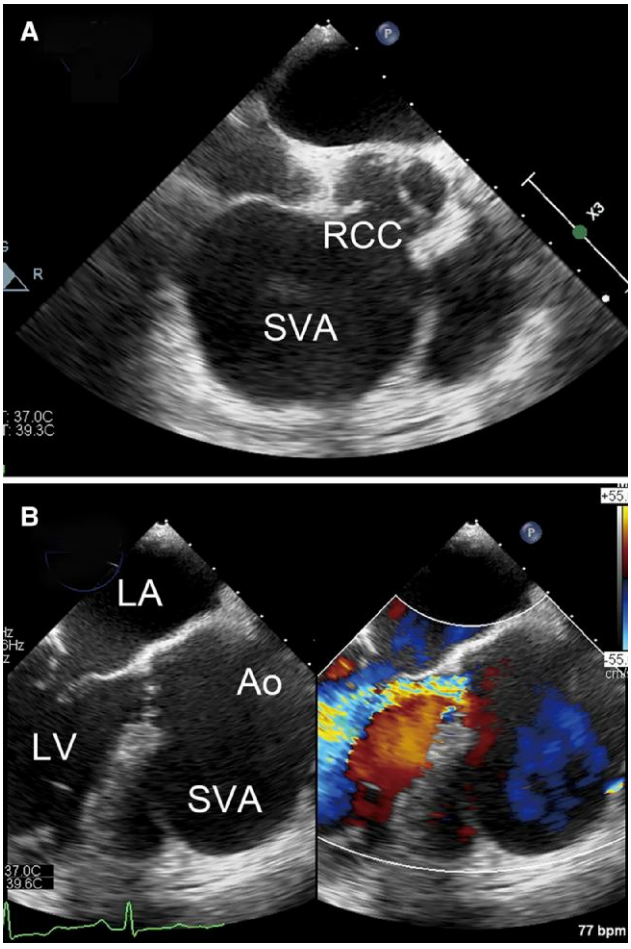


Figure 2 Transoesophageal echocardiography findings. (*A*) Short axis imaging: large right sinus of Valsalva aneurysm. (*B*) Long axis imaging: grade II/IV aortic valve regurgitation with severely dilated right coronary cusp. Ao, ascending aorta; LA, left atrium; LV, left ventricle; RCC, right coronary cusp; RV, right ventricle; SVA, sinus of Valsalva aneurysm.

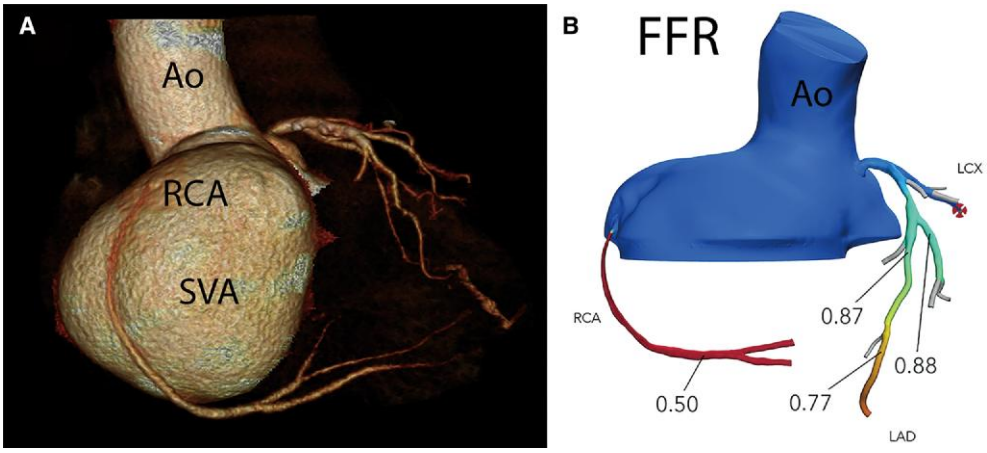


Figure 3 Pre-operative enhanced computed tomography images. (*A*) Three-dimensional reconstruction imaging of the aneurysm and coronary computed tomography angiography: stretched and narrowed proximal right coronary artery with large right sinus of Valsalva. (*B*) Fractional flow reserve-computed tomography imaging: significant decrease in FFR with a value of 0.50 in the distal RCA. Ao, ascending aorta; FFR, fractional flow reserve; LAD, left anterior descending artery; LCX, left circumflex artery; RCA, right coronary artery; SVA, sinus of Valsalva aneurysm.

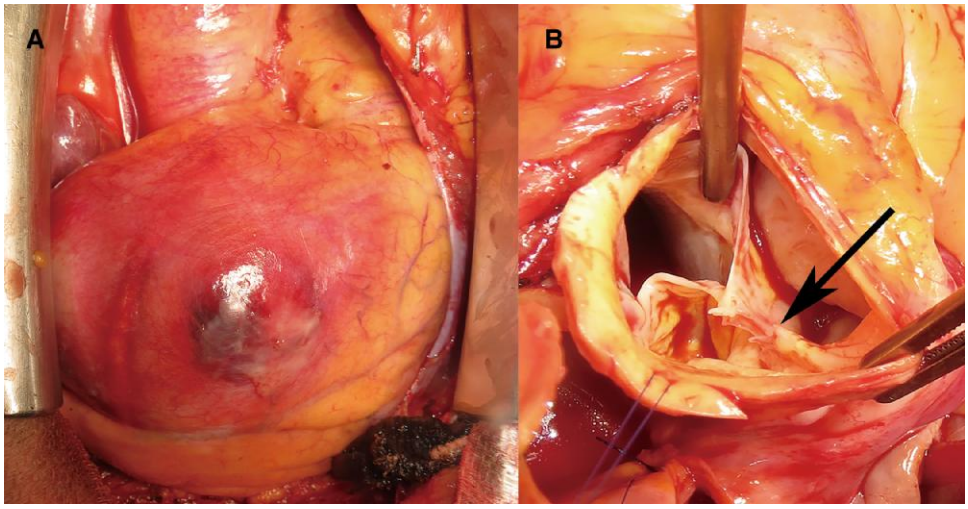


Figure 4 Operative findings. (*A*) Extremely stretched and narrowed right coronary artery on the dilated right Valsalva sinus. (*B*) Aortic valve is dissected from aortic wall at the commissure between the right coronary and non-coronary cusps.

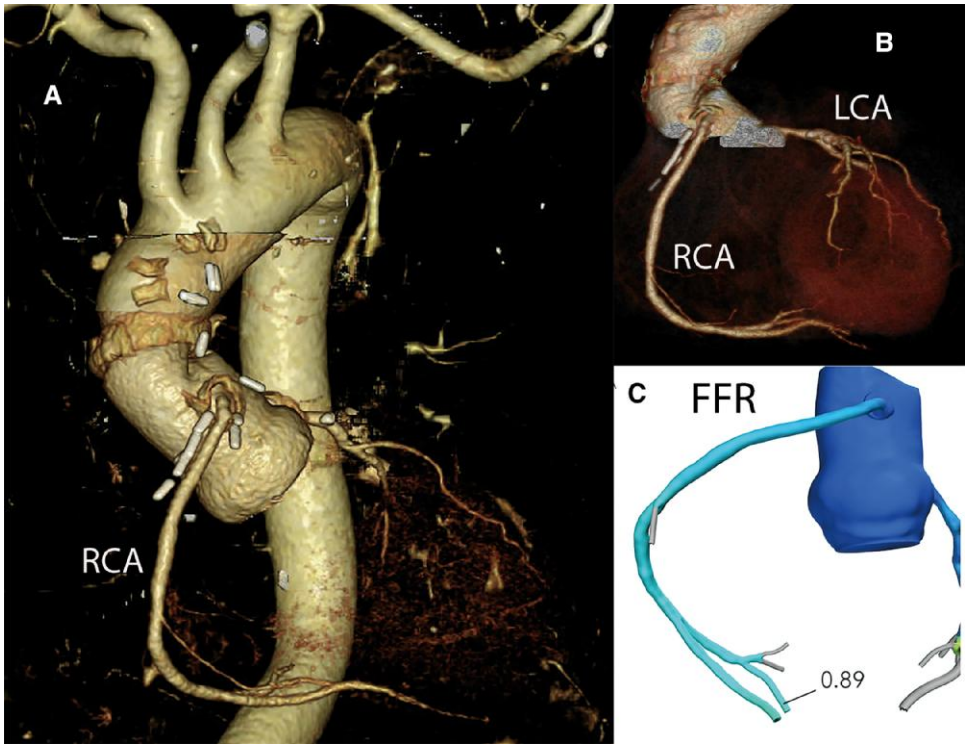
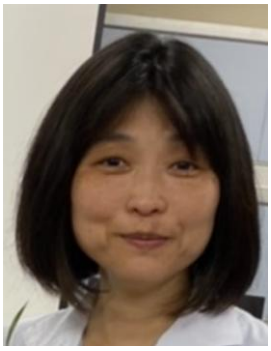


Figure 5 Post-operative enhanced computed tomography images. (*A*) Three-dimensional reconstruction imaging. (*B*) Three-dimensional reconstruction of coronary computed tomography angiography: no significant stenosis in the right coronary artery. (*C*) Fractional flow reserve-computed tomography imaging: without significant decrease in FFR with a value of 0.89 in the distal RCA. FFR, fractional flow reserve; LCA, left coronary artery; RCA, right coronary artery.

Lead author biography



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Consent: The authors confirm that written consent for the submission and publication of this case report, including images and associated text, has been obtained from the patient in line with the COPE best practice guidelines.

Conflict of interest: None declared.

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Data availability

The data underlying this article will be shared on reasonable request to the corresponding author.

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