Images in cardiovascular medicine: prosthetic aortic valve and conduit dehiscence with large periconduit cavity, ascending aortic aneurysm and severe mitral regurgitation

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Introduction
Prosthetic aortic valve and conduit dehiscence with periconduit cavity and ascending aortic aneurysm is an uncommon complication of aortic root surgery. It is usually recognizable at echocardiography due to an abnormal position of the prosthetic valve and conduit in relation to the native aortic annulus in conjunction with an abnormal echolucent periaortic space that fills with color flow. Mitral regurgitation is an unusual complication of this condition.

We present a patient with severe mitral regurgitation secondary to prosthetic aortic valve and conduit dehiscence with a large periconduit cavity and aneurysm of the intervalvular fibrosa. The mechanism of mitral regurgitation is secondary to functional involvement of the anterior mitral valve leaflet and intervalvular fibrosa with anterior mitral leaflet restriction in conjunction with mild left ventricular remodeling. Significant mitral regurgitation persisted post resection of the periconduit cavity and aortic valve replacement, requiring mitral valve replacement.

This case study reports a new mechanism of mitral regurgitation in the setting of prosthetic aortic valve and conduit dehiscence.

Case description
A 63-year-old man presented with increased dyspnea and new atrial fibrillation on a background of 6 months of progressive exertional dyspnea. He has a history of complex aortic valve surgery with three prior operations. His original aortic valve surgery, insertion of a bileaflet mechanical prosthesis, was performed 12 years before admission for symptomatic stenotic bicuspid aortic valve disease. Three years before this admission, severe para-valvular regurgitation required a second aortic valve replacement with a bileaflet mechanical prosthesis. Two years before, he underwent a third aortic operation because of para-valvular regurgitation and root enlargement. At that time a Bentall procedure was performed with stentless porcine aortic valve and porcine mini root replacement and coronary reimplantation. A small amount of native aortic wall was retained between the aortic valve prosthesis and conduit. The native aortic wall was also wrapped around the conduit. A transthoracic echocardiogram and MRI, performed at another institution, 6 months before admission, reported mild aortic regurgitation, mild mitral regurgitation and normal left ventricular systolic function.

Examination revealed a normotensive, middle-aged male who was afebrile and mildly tachypneic, in atrial fibrillation.
Both pan-systolic and pan-diastolic murmurs were audible on auscultation with crackles at the lung bases. ECG confirmed atrial fibrillation with a ventricular rate of 100 beats per min and chest radiography showed mild pulmonary congestion and cardiomegaly. Blood cultures were negative.

Transthoracic (TTE) and transesophageal echocardiography (TEE) showed dehiscence of the aortic valve prosthesis and conduit from the native aortic annulus at the proximal anastomosis site (Figure 1). The dehiscence was almost completely circumferential proximally (Figure 2). The distal anastomosis was intact and the conduit was suspended from this attachment within the native wrapped aortic wall. A large circumferential periconduit cavity was present between the aortic conduit and the native aortic wall which also extended below the prosthetic valve (Figure 3). This involved the mitral intervalvular fibrosa which was aneurysmal (Figure 4). The diameter of the native ascending aorta was 60 mm. There was free communication between the LVOT and the periconduit cavity both in systole and diastole resulting in systolic expansion of the cavity, ascending aortic aneurysm and para-valvular regurgitation. There was no evidence of external aortic rupture.

The aortic aneurysm involved the base of the anterior mitral leaflet (AML) and the intervalvular fibrosa and resulted in both structural and functional abnormalities of this area. This area was grossly distorted on 2D echocardiography (Figure 1). The aortic and mitral valves were no longer in direct continuity and there was loss of support of the anterior mitral valve leaflet and mitral annulus. Functional abnormalities of the mitral valve occurred as a consequence of loss of normal support. Systolic closure of the anterior mitral valve leaflet was delayed and restricted resulting in mal-co-aptation of the leaflets and severe mitral regurgitation (MR) (Figures 5 and 6). In systole, the aneurysm expanded toward the left atrium which appeared to further undermine anterior leaflet support. The coronary ostia were not well seen on echocardiography.

There was evidence of mild left ventricular remodeling; left ventricular mass index 158 g/m² (normal ≤115 g/m²),¹ indexed LVEDV 75 mL/m² (normal range 35–75 mL/m²)¹ (Figure 7), mitral co-aptation height 1.2 cm and mitral

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**Figure 1** Transesophageal echocardiogram, long axis view, showing dehiscence of the aortic valve prosthesis and aortic conduit (yellow arrows) from the native aortic annulus (red arrows) and wrapped native aortic wall. A large periconduit space is visible (white arrow) surrounding the prosthesis that represents the aortic aneurysm and contained rupture.

**Figure 2** Transesophageal echocardiogram, short axis view, showing the aortic conduit (yellow arrow) and the circumferential periconduit space (white arrow).

**Figure 3** Transesophageal echocardiogram, long axis view, showing color in the periconduit space (white arrow) and para valvular regurgitation. Appearances are consistent with dehiscence at the proximal suture line and contained rupture.

**Figure 4** Transesophageal echocardiogram, at 0 degrees, showing the aneurysmal mitral–aortic intervalvular fibrosa forming part of the wall of the aortic aneurysm (yellow arrow).
tented area 1.4 cm² (parasternal long axis view). The mitral annular measurements at end diastole were mediolateral 36 mm and anterolateral 38 mm. Left ventricular systolic function was normal. Left atrial volume was increased at 70 mL and indexed 33 mL/m² (normal, 29 mL/m²). There was no evidence of endocarditis. Computed tomography confirmed echocardiographic findings.

Cardiac surgery identified the ascending aortic aneurysm and periconduct space and confirmed dehiscence at the level of the proximal suture site (Figure 8). The reimplanted coronary arteries and distal conduit anastomosis were intact. A composite aortic graft was inserted with a bileaflet mechanical aortic prosthesis and a Dacron tubular graft. The post pump intra-operative TEE images showed marked improvement in the mitral valve and aortic root architecture with significant reduction in MR severity. Anterior mitral valve leaflet motion had improved significantly but remained mildly restricted. Persisting MR was graded moderate but thought not to be an acceptable result in the clinical context. Mitral repair with an undersized ring annuloplasty was considered but extensive scarring at the atrial aspect of the mitral annulus appeared likely to inhibit the surgeon’s ability to significantly reduce the mitral annular dimension. Ultimately, the mitral valve was replaced with a bileaflet mechanical prosthesis. Echocardiographic evaluation of the mechanical valve prostheses revealed normal function. No valvular regurgitation was seen. Histopathology of the native mitral valve showed no significant structural abnormality. There was no evidence of endocarditis.

Discussion

Proximal dehiscence of a valved aortic conduit with periconduct cavity and ascending aortic aneurysm has been infrequently reported in the literature in patients post aortic root surgery where the native aortic wall is retained around the conduit. This can occur due to a mechanical problem with or without secondary infection and in the setting of aortitis.

Mitral regurgitation as a complication of proximal dehiscence of a prosthetic aortic valve and conduit with aneurysm of the mitral intervalvular fibrosa has not been previously reported as far as the authors could ascertain. Mitral regurgitation has, however, been reported in association with an aortic pseudoaneurysm on one previous occasion. Espinoza-Caliani et al. describe an aortic pseudoaneurysm with mitral regurgitation, where the MR was attributed to displacement of the anterior mitral valve

Figure 5 (A) Transesophageal echocardiogram, modified long axis view, at end diastole showing the mitral valve leaflets with delayed anterior mitral leaflet motion and incomplete closure. (B) Transesophageal echocardiogram, modified long axis view, at mid systole showing incomplete leaflet coaptation.

Figure 6 (A) and (B) Transesophageal echocardiogram, long axis view, showing severe mitral regurgitation.
annulus toward the aortic annulus in systole by the aneurysm and resultant anterior leaflet prolapse above the annular plane. In our case we believe the MR to be also due to displacement of the anterior leaflet annulus by systolic expansion of the aortic aneurysm with resultant loss of anatomical and functional support, but in this patient this resulted in anterior mitral leaflet restriction and not prolapse.

The common element in both cases is involvement of the anterior mitral leaflet annulus and intervalvular fibrosa and, in particular, its function in supporting the anterior mitral leaflet. In contrast to the report of Espinosa-Caliani et al., we showed that distortion of the mitral valve architecture caused abnormal restriction and tethering of the mitral leaflet with subsequent impairment of co-apation and severe MR. In particular, systolic expansion of the intervalvular fibrosa aneurysm and movement of the unsupported base of the anterior mitral valve leaflet appeared to alter mitral annular dynamics and anterior mitral leaflet function. The anterior mitral valve leaflet, although of normal echocardiographic appearance, showed restricted and delayed motion resulting in incomplete systolic co-apation. The differences in anterior mitral leaflet motion between the two cases may reflect differences in size and shape of the aortic aneurysm and pseudoaneurysm, the extent of prosthetic dehiscence, differences in chamber pressure and left atrial and ventricular remodeling.

In the case reported by Espinosa-Caliani et al. the mitral valve did not need surgery post resection of the aortic pseudoaneurysm and aortic valve replacement. In our case, despite correction of the mitral intervalvular fibrosa aneurysm and aortic valve replacement, the anterior mitral valve leaflet motion did not completely return to normal. The anterior mitral leaflet remained mildly restricted and the mitral regurgitation, although reduced, was still moderate. Persistence of the mitral regurgitation in this case most likely reflects the fact that the intervalvular fibrosa structure and function and adjacent anterior mitral leaflet base was not completely normalized following corrective aortic root surgery and due to leaflet tethering from apical displacement in the setting of left ventricular remodeling. Real time 3D echocardiographic imaging may have provided additional insights into the mechanism of the residual MR and potentially guided additional efforts to repair the valve. Recurrent valvular regurgitation in this patient is striking and although the exact etiology is unclear, it most likely reflects bicuspid aortopathy. Cystic medial necrosis associated with this congenital cardiac malformation is thought to be secondary to apoptosis of medial smooth muscle cells. Other less likely possibilities include aortitis, persistent infection and surgical technique.

Aortic valve and conduit proximal dehiscence and contained rupture is a potentially life-threatening complication of aortic root surgery with several potentially serious complications, which can contribute to severe mitral regurgitation. This case describes a new mechanism for severe mitral regurgitation in the context of a large mitral intervalvular fibrosa aneurysm due to structural and functional abnormalities of the anterior mitral valve leaflet and left ventricular remodeling.

Supplementary material

Supplementary material associated with this article can be found in the online version.

References

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