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An Echocardiographic Evaluation of Valvular Function and Ventricular Patch Repair During Surgical Exclusion of Left Ventricular Pseudoaneurysm

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Case Presentation

A 23-year-old African male presented with recurrent fevers, chest pain, and hypotension to an outside institution. After a transthoracic echocardiogram revealed a left ventricular (LV) pseudoaneurysm, he was transferred to our institution for possible surgical intervention. The Cleveland Clinic IRB waived the requirement for patient consent for this report.

His clinical presentation and a subsequent coronary angiogram without evidence of coronary artery disease, suggested a nonischemic, presumably infectious, etiology of the pseudoaneurysm. He was brought to the operating room for repair of the pseudoaneurysm, where a transesophageal echocardiogram (TEE) midesophageal (ME) four-chamber view demonstrated moderate LV dysfunction with a pseudoaneurysm originating from the inferolateral wall below the mitral annulus. (Figure 1) Apical displacement of the point of mitral leaflet coaptation was noted. A modified transgastric short-axis view confirmed the defect in the inferolateral myocardial wall with continuous bi-directional flow on color flow Doppler (CFD) imaging (see Supplemental Digital Content, Video 1, Loops 1 and 2). A modified ME long-axis view demonstrated restricted systolic closing of the posterior mitral

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leaflet. ME two-chamber view with CFD demonstrated a severe, posteriorly directed jet of mitral regurgitation (MR). (Supplemental Digital Content, Video 1, Loops 3 and 4)

The surgical procedure included exclusion of the pseudoaneurysm with a 5-cm pericardial patch, mitral commissure plication, and annuloplasty ring placement. Postcardiopulmonary bypass TEE evaluation revealed a moderately echogenic, noncontractile patch in the mid- and basal inferolateral wall. (Figure 2) The ME four-chamber view demonstrated severe LV dysfunction without an echo-free space lateral to the LV and absence of color Doppler flow, confirming exclusion of the pseudoaneurysm. (Supplemental Digital Content, Video 1, Loop 5) Adequate mitral valve repair without residual MR was confirmed with CFD. After a complicated postoperative course, he was discharged to a local hospital several weeks later.

Nine months later he presented with recurrent fevers. Preoperative echocardiography documented LV patch dehiscence and mitral valve vegetations. He was brought to the operating room for patch repair and mitral debridement. Intraoperative TEE documented a large echo-free space lateral to the LV confirming re-expansion of the pseudoaneurysm. CFD revealed communication between the LV and pseudoaneurysm at the inferior border of the patch. (Figure 3) A large, mobile vegetation was observed on the posterior mitral leaflet (Supplemental Digital Content, Video 2, loop 1–2). Surgical repair consisted of replacement of *in situ* pericardial patch, valve debridement, and a new annuloplasty ring. Postbypass TEE documented successful pseudoaneurysm exclusion and mitral valve repair. (Supplemental Digital Content, Video 2, Loop 3) He was subsequently discharged to a long-term care facility.

Discussion

Two-dimensional echocardiography is the preferred diagnostic imaging modality for diagnosis of a ventricular pseudoaneurysm.(1) It is also useful to assess the impact of the pseudoaneurysm on valvular function. A recent Echo Rounds described the distinction between a pseudoaneurysm and true aneurysm.(2) Our report illustrates the impact of a pseudoaneurysm on the mitral valve resulting in severe MR and the evaluation of dehiscence of an exclusion patch.

Severe MR may occur as a direct result of a LV pseudoaneurysm and contribute to the complexity of the surgical repair. The echocardiographic approach to evaluation of MR in the presence of a pseudoaneurysm must include a comprehensive interrogation of the myocardial defect in relation to the mitral valve apparatus. The borders of the defect and their proximity to the papillary muscles and mitral annulus should be defined. Other causes of severe MR in a patient with an LV pseudoaneurysm must be eliminated (Table 1).

In this patient, severe MR occurred as a consequence of ventricular pathology. Similar to conditions such as “functional” MR, in which severe MR is a consequence of underlying ventricular disease despite normal mitral leaflets,(3) the inferolateral myocardial wall defect, which bordered the posterior mitral annulus and papillary muscle insertion, distorted the geometry of the mitral apparatus. Mitral valve dysfunction consistent with a Carpentier type IIIB classification (restricted systolic motion of the posterior mitral valve leaflet relative to the annular plane) was documented.(4,5) A severe, posteriorly directed MR jet was the result. Proper LV reconstruction with preservation of normal LV and mitral apparatus geometry, corrected mitral valve function. The mitral annuloplasty ring effectively decreased the antero-posterior diameter of the annulus, improved leaflet apposition, and thus improved the MR.

A patch is usually required to surgically repair the defect and exclude the pseudoaneurysm. A double-patch technique may be used, with one patch applied inside and a second patch

outside the ventricular wall.(6) In-hospital mortality after repair ranges from 20 to 40%.(1,7) Recurrence of the pseudoaneurysm occurs in 8% of patients within two years.(1)

TEE evaluation after bypass should assess the integrity of the ventricular patch for signs of dehiscence. The patch often appears as a nonmobile membrane with increased echogenicity, shadowing, or reverberations, separating the LV from the pseudoaneurysm. Spectral and color Doppler imaging may identify patch dehiscence via turbulent flow in the LV or pseudoaneurysm. Flow between the LV and pseudoaneurysm will be directed towards the pseudoaneurysm during systole with reversal during diastole. Flow is typically turbulent through a narrow orifice in a pseudoaneurysm due to high ventricular pressure. However, ambiguity may occur if a large communication is present with little pressure difference between the LV and pseudoaneurysm. Other imaging modalities, including pulsed and continuous wave Doppler, confirm timing and velocity of shunt flow. Three-dimensional imaging can further describe the size and location of the myocardial defect and visualize abnormal motion of the exclusion patch. Contrast injection may enhance visualization of patch dehiscence. If patch dehiscence presents acutely, cardiac tamponade may occur.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Clinicians Key Teaching Points

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- In contrast to a true left ventricular (LV) aneurysm, a pseudoaneurysm does not contain all layers of the ventricular wall and thus is more prone to expansion or rupture over time. Pseudoaneurysm formation, which may result from ischemia or less commonly infection, can significantly alter LV geometry, leading to inefficient contraction and distortion of the mitral valve apparatus causing functional mitral regurgitation (MR).
- A pre- or intraoperative transesophageal echocardiogram can confirm the location and size of a pseudoaneurysm as well as define the mechanism and severity of any associated MR. Color flow and spectral Doppler imaging can demonstrate systolic flow of blood from the LV into the pseudoaneurysm cavity. Surgical repair with a pericardial patch may appear as a membrane with increased echogenicity causing shadowing or reverberation artifact; color flow Doppler interrogation should confirm that the pseudoaneurysm is no longer in communication with the LV cavity.
- In this complex case, a large pseudoaneurysm altered the geometry of the LV and subvalvular mitral apparatus leading to significant functional MR necessitating both patch exclusion of the pseudoaneurysm and mitral valve repair. Months later, with associated mitral endocarditis, the patch dehisced. Color flow Doppler imaging demonstrated return of flow between the pseudoaneurysm and LV cavity necessitating additional surgical intervention.
- It is important for the echocardiographer to be able to identify an LV pseudoaneurysm and characterize any contribution to MR that may be present. Functional MR, which results from alterations in LV geometry in the setting of normal mitral leaflets, may necessitate valve repair in addition to patch exclusion of the pseudoaneurysm.

Figure 1.

Midesophageal four-chamber view demonstrating a large pseudoaneurysm originating from the inferolateral wall of the left ventricle (LV). Note the point of mitral leaflet coaptation is significantly displaced toward the apex. ** = pseudoaneurysm; RV = right ventricle; LA = left atrium; LV = left ventricle.

Figure 2. Midesophageal four-chamber view demonstrating the exclusion patch seen as a curved, moderately echogenic membrane positioned in the inferolateral myocardial wall. Shadowing from the mitral valve annuloplasty ring is noted. ** = pseudoaneurysm; Patch = Pericardial exclusion patch; LV = left ventricle.

Figure 3.

Panel A. Four-chamber midesophageal view at re-operation demonstrating dehiscence of the ventricular pericardial patch. **Panel B.** Four-chamber midesophageal view demonstrating the communication between the left ventricle and the pseudoaneurysm with color flow Doppler.

LV = left ventricle, Defect = site of patch dehiscence, ** = pseudoaneurysm.

Table 1

Evaluation of mitral regurgitation (MR) in a patient with a ventricular pseudoaneurysm

Source of MR	Mechanism	Echocardiographic Findings
Mitral valve leaflet abnormalities	Prolapsed or flail mitral valve leaflets.	Increased motion of the free edge of leaflet relative to the annular plane. Eccentric MR jet.
Papillary muscle infarction/rupture	Recent myocardial infarction or ischemia causing dysfunction or rupture of papillary muscle.	Severe eccentric jet of MR. Ruptured papillary muscle head may be seen in the left atrium or ventricle during systole.
Functional MR	Annular dilation or tethering of the posterior leaflet related to regional left ventricular dysfunction.	Structurally normal mitral valve apparatus with annular dilation or tethering of mitral leaflets and a central MR jet.
Ventricular pseudoaneurysm	Distortion of left ventricular and papillary muscle geometry by pseudoaneurysm.	Myocardial defect from a ventricular pseudoaneurysm in proximity to papillary muscles/mitral annulus with alteration of normal ventricular and papillary muscle geometry.