Assessment of Mitral Valve Leaflet Perforation as a Result of Infective Endocarditis by 3-dimensional Real-time Echocardiography

Stephanie A. Schwalm, MD, Lissa Sugeng, MD, Jai Raman, MD, Valluvan Jeevanandum, MD, and Roberto M. Lang, MD, Chicago, Illinois

Since the introduction of the Duke criteria, echocardiography has played an essential role in the diagnosis of infective endocarditis. For a variety of reasons, such as poor acoustic windows and low resolution imaging, transthoracic echocardiography (TTE) has a sensitivity of only 55% to 69% for the detection of endocarditic lesions. Imaging from the transesophageal echocardiographic (TEE) approach overcomes many of these limitations, having higher resolution to delineate smaller lesions occurring earlier in the disease, detect vegetations on atypical sites, evaluate prosthetic valve endocarditis, and identify complications such as leaflet perforation and abscess.

Recent advances in computer and ultrasound technology have resulted in the development of 3-dimensional (3D) echocardiography, which has enabled the visualization of valvular pathology from a surgical perspective in the beating heart. To our knowledge, there have been no reports on the use of 3D echocardiography for the diagnosis of mitral valve perforation or tear caused by infective endocarditis. We hereby describe 3 patients with perforated or torn mitral valve leaflets because of infective endocarditis, in which 3D echocardiography aided in the diagnosis and guided treatment.

CASE NO. 1

A 52-year-old man who had been admitted 3 months previously with a protracted course of infective endocarditis complicated by mitral regurgitation (MR) presented with fever, increasing shortness of breath, and lower extremity edema. Cardiac examination disclosed a grade 3/6 pansystolic murmur at the lower sternal border, which radiated to the axilla. Blood cultures were positive for coagulase negative Staphylococcus. TTE revealed a small mobile echodensity on the ventricular surface of the anterior mitral valve leaflet. The regurgitant jet appeared to traverse the leaflet, instead of originating at the leaflet coaptation point, raising the suggestion of perforation (Figure 1 A and B). Differential diagnosis included a small vegetation, perforation of the anterior mitral valve leaflet, and the presence of a flail scallop because of ruptured chordae. A 3D TTE diagnosed the exact location in the anterior leaflet, and size of the perforation, with an estimated area of 0.7 cm² (Figure 1, C). In Figure 1, D, surgical inspection confirmed the echocardiographic diagnosis of an anterior mitral valve perforation. On pathologic examination focal neovascularization and myxoid degeneration were found without evidence for a vegetation. The patient successfully underwent mitral valve replacement.

CASE NO. 2

A 53-year-old man presented with shortness of breath. Medical history included end-stage renal disease requiring hemodialysis. Physical examination revealed bibasilar lung crackles and elevated JVP. On cardiac auscultation, a normal S1, S2, and S3 were present, and a 4/6 systolic ejection murmur at the left ventricular apex was heard radiating to the axilla. Blood cultures were positive for methicillin-resistant S aureus. The echocardiogram revealed a small echodensity attached to the atrial surface of the mitral valve leaflet, and severe MR. TEE revealed a small perforation of the posterior mitral leaflet (Figure 2, A) causing significant eccentric regurgitation (Figure 2, B). A 3D TEE study was performed using a rotational method of acquisition, gated to the electrocardiogram and respiration, which confirmed the perforation site on the P3 segment of the posterior leaflet, measuring 0.1 cm² (Figure 2, D). A color 3D reconstruction confirmed that the MR jet originated in the perforation site and was directed anteriorly (Figure 2, C). An intraoperative image of this lesion is shown (Figure 2, E), corroborating the 3D findings, by demonstrating a perforation in the P3 segment. The patient underwent curettage and repair of perforation with a pericardial patch and a 31-mm St Jude annuloplasty ring.
CASE NO. 3

A 64-year-old man presented with multiple strokes, presumably caused by embolism from mitral valve endocarditis. Blood cultures were positive for *Streptococcus bovis*. TTE revealed thickening of the posterior mitral leaflet with a mobile echodensity (Figure 3, A), the differential diagnosis of which included a vegetation, ruptured chordae, or torn leaflet. An eccentric jet of moderate to severe MR hugging the posterior wall and a smaller jet of MR were clearly noted (Figure 3, B). A 3D TTE of the mitral valve (as viewed from the left atrium), was obtained using a matrix-array transducer depicting a large vegetation on the mitral leaflet P2 segment, and a tear between the P1 and P2 segments of the posterior leaflet (Figure 3, C). Intraoperative images confirmed a large vegetation on the mitral valve and confirmed the presence of a tear in the P1 segment (Figure 3, D). Both the P2 segment of the posterior leaflet and the vegetation were excised. The P2-P1 cleft was repaired. A 29-mm St Jude annuloplasty ring was also implanted.

DISCUSSION

Mitral valve perforation is a rare complication of bacterial endocarditis; however, with the use of newer imaging tools such as TEE and 3D imaging, the incidence may be higher than previously reported. Prior autopsy studies reported perforation rates of 8% to 20%, whereas current studies using TEE imaging estimate the frequency to be as high as 34% to 61%. Patients with a history of endocarditis, or involvement of the aortic valve, and poor New York Heart Association functional class are at higher risk for leaflet perforation. TEE has shown that the mechanisms resulting in mitral leaflet perforation include; primary leaflet destruction caused by the infectious agent; direct extension from aortic valve endocarditis; continuous impingement of an aortic regurgitation jet on the mitral valve leaflet causing disruption; and altered leaflet anatomic structure as a result of prior infective endocarditis.
Figure 2 A, Transesophageal long-axis view of mitral valve (MV) demonstrating disruption of P3 segment of posterior mitral leaflet. B, Color Doppler image of A showing severe mitral regurgitation traversing posterior mitral leaflet through site of perforation. C, Three-dimensional (3D) reconstruction of MV as seen from left atrium with color Doppler regurgitant jet directed anteriorly. D, Three-dimensional reconstruction and en-face view of MV as seen in C, revealing site of perforation in P3 segment. E, Intraoperative images of MV confirming presence of posterior leaflet perforation seen on 3D echocardiography.

Figure 3 A, Transthoracic apical 4-chamber view showing large mitral valve vegetation on posterior mitral leaflet and possible perforation (arrow). B, Two jets of mitral regurgitation, one severe eccentric posteriorly directed regurgitant jet and a smaller jet (arrow). C, Three-dimensional echocardiographic image revealing posterior leaflet tear. D, Intraoperative images of large mitral leaflet vegetations and tear in P1 segment of posterior leaflet.
On physical examination, valvular regurgitation caused by perforation is indistinguishable from MR caused by abnormal leaflet coaptation. Identification of the cause of MR is important for management and subsequent surgical approach. Two-dimensional echocardiography with color flow mapping may raise the suggestion of leaflet perforation when the mosaic-colored flow acceleration appears to traverse the mitral leaflet rather than originating from the leaflet coaptation site. Visualization of the frame with the maximal MR jet, with and without color Doppler, may reveal the discontinuity in the leaflet tissue at the site of the perforation. As previously stated, TEE is superior to TTE for the diagnosis of perforation, with higher sensitivity (95%) and specificity (98%) rates because of the ability of TEE to visualize leaflet discontinuities down to a resolution of 1 mm.2,9,11

Within the last decade, the addition of 3D capability to TEE imaging has provided unique views of the mitral valve from both the left atrial and left ventricular perspective. Three-dimensional imaging from the TEE approach in endocarditis has been reported to have sensitivity and specificity that range between 67% to 100% and 78% to 100% for the anterior leaflet and 100% sensitivity and specificity for the posterior leaflet. The diagnostic capability of this technique varies depending on the leaflet segment or scallop involved. In the same study, the correspondence between 3D TEE images and operative findings was excellent.2 Aside from confirming the site of valvular perforation, 3D imaging can accurately estimate the size of the disruption, allowing a surgeon to attempt valve repair. Repair as a valve-sparing treatment for MR caused by infective endocarditis complicated by perforation minimizes insertion of prosthetic material in the setting of acute or healed infection and has been shown to have excellent long-term outcomes.10,14,15 The capability of the surgeon to review the 3D images before operation allows assessment of the feasibility of repair.

Two of the patients herein reported with mitral valve perforation underwent mitral valve repair, after preoperative review of the 3D images by the surgeon depicted the anatomy of the perforation and suggested the feasibility of repair. Both patients have done well, with resolution of heart failure symptoms, clearance of blood cultures, and no recurrent episodes of endocarditis to date. The third patient had valvular involvement deemed too extensive for repair by preoperative review of the 3D images and, thus, underwent valve replacement. He has done well postoperatively, with resolution of heart failure symptoms and no recurrent endocarditis to date.3,4,8

REFERENCES