Cardiovascular Imaging In-a-Month

Significant Congestive Heart Failure Despite Mild Mitral Stenosis

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CASE

   A 61-year-old woman with mitral stenosis was admitted to control congestive heart failure and to determine the indication for surgery. She had a history of surgical commissurotomy to the mitral valve 27 years previously. Despite full medication, she was in New York Heart Association functional class . Left ventricular and aortic valve functions were normal. Mitral regurgitation was mild by Doppler echocardiography and absent by left ventriculography. Two-dimensional 2D echocardiography demonstrated relatively mild mitral stenosis with a mitral valve area of 1.6 cm^2 **Figs. 1 A, B** and the cause of the significant congestive heart failure was not clear.
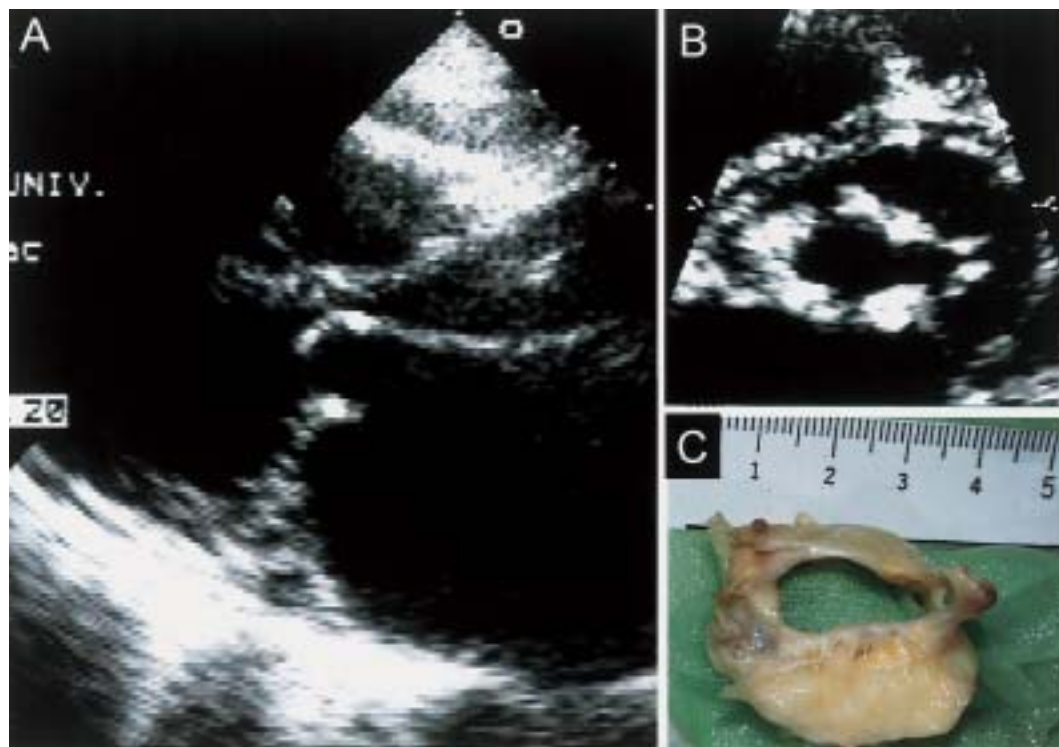

Fig. 1

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Points for Diagnosis

The anatomic and functional valve areas are different. 2D echocardiography basically measures the anatomic valve area. In contrast to the 2D echocardiographic study, mitral stenosis was estimated as severe with a valve area of $0.75\,cm^2$ by the continuity equation, which measures the functional valve area. Mitral stenosis was also estimated as severe mitral valve area $1.0\,cm^2$ by catheterization with Gorlin's method, which basically measures the functional valve area and subsequently calculates the anatomic area by multiplying the functional area by a constant anatomic area $\times 0.85$ functional area, indicating the functional area of $0.85\,cm^2$ in this patient [1]. Therefore, the functional mitral valve area was estimated as severely stenotic by both the continuity equation and Gorlin's method, whereas the anatomic area was assessed as only mildly stenotic by 2D echocardiography. Mitral valve area is often difficult to measure by 2D echocardiography, especially in patients with the valve orifice oblique to the left ventricular long axis, but direct observation at the time of surgery confirmed the preserved anatomic mitral leaflet orifice area $1.5\,cm^2$ and the accuracy of 2D echocardiographic measurement in this patient **Fig. 1 C** . Functional area is usually only modestly decreased compared to anatomic area, so the discrepancy between them may not be carefully evaluated in routine clinical practice. However, this patient demonstrated strikingly decreased functional area relative to anatomic area anatomic area $\times$ 0.50 to 0.56 functional area .

We speculate that the unique diastolic mitral leaflet morphology proximal to the orifice in this patient, characterized with a posterior leaflet tip highly superiorly displaced relative to the anterior tip as well as to the posterior leaflet base **Figs. 1 A, 2 A** , may require a major change in blood flow direction to pass through the anatomic orifice and promote significant flow convergence beyond the anatomic orifice, resulting in a discrepancy between the anatomic and functional mitral valve areas **Fig. 2 B** [2]. Transvenous contrast echocardiography Levovist™, Agilent Technologies Sonos 5500, real time second harmonic imaging demonstrated converging flow beyond the anatomic orifice to the functional orifice vena contracta , consistent with the discrepancy between the anatomic and functional valve areas. Therefore, this patient had anatomically mild but functionally severe mitral stenosis. In addition to reduction in the mitral valve anatomic area, leaflet morphology proximal to the orifice can significantly contribute to valve stenosis, requiring careful estimation of both anatomic and functional valve areas in patients with mitral stenosis.

Diagnosis: Anatomically mild but functionally severe mitral stenosis

References

1 Cohen MV, Gorlin R: Modified orifice equation for the calculation of mitral valve area. Am Heart J 1972; **84**: 839 840

2 Gilon D, Cape EG, Handschumacher MD, Jiang L, Sears C, Solheim J, Morris E, Strobel JT, Miller-Jones SM, Weyman AE, Levine RA: Insights from three-dimensional echocardiographic laser stereolithography: Effect of leaflet funnel geometry on the coefficient of orifice contraction, pressure loss, and the Gorlin formula in mitral stenosis. Circulation 1996; **94**: 452 459
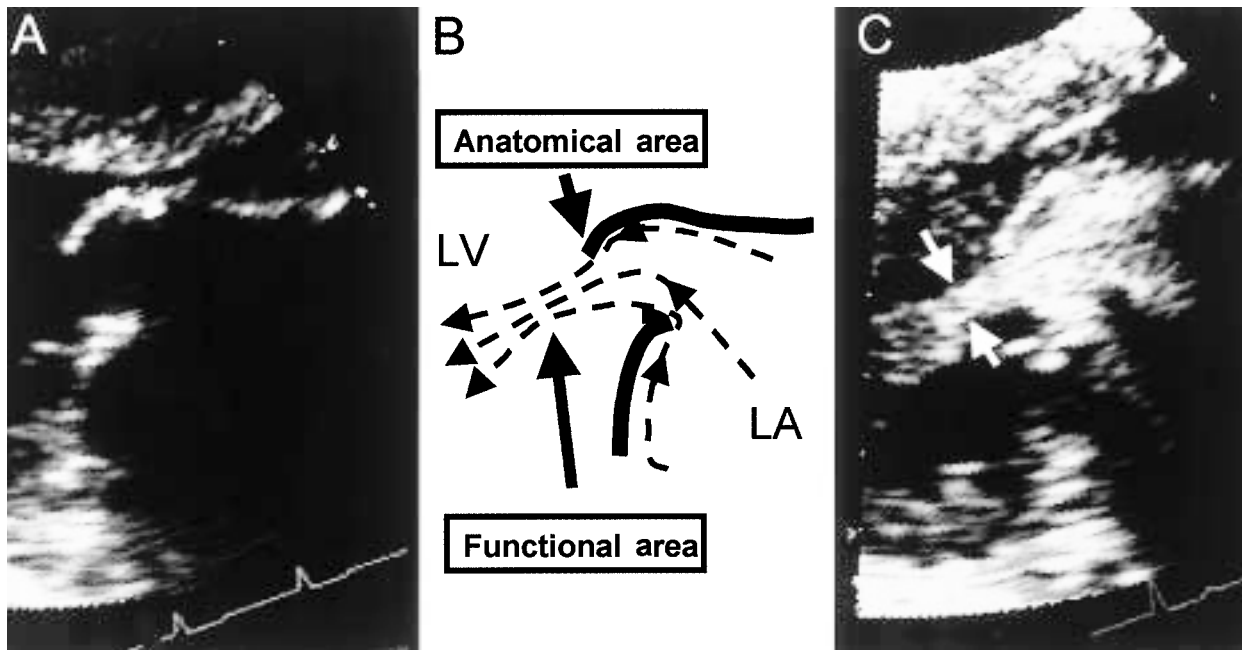
Fig. 2

Fig. 1 Two-dimensional echocardiograms *A*, *B* and photograph of the surgical specimen *C*
Anatomic mitral valve area was estimated as 1.5 to 1.6 cm² mild mitral stenosis by both methods.

Fig. 2 Echocardiograms and scheme
A: Two-dimensional echocardiogram showing a posterior mitral leaflet tip superiorly displaced relative to the anterior tip and also to the posterior leaflet base.

B: Scheme of the speculated mechanism accounting for the discrepancy between the anatomic and functional mitral valve areas due to flow convergence beyond the anatomic orifice.

C: Contrast echocardiogram showing significant flow convergence *white arrows* beyond the anatomic orifice.

LV   left ventricle; LA   left atrium.