Real-Time 3D TEE for Diagnosis of Subvalvular Pannus Formation in Mechanical Aortic Valves

Comparison With Multidetector CT and Surgical Findings

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Subvalvular pannus formation is a rare but clinically important complication that can be missed in patients with prosthetic valves (1). The only definite treatment for patients with prosthetic valve obstruction as a result of pannus ingrowth is reoperation. However, currently available methodologies are not sufficient to diagnose subvalvular pannus formation especially in mechanical aortic valves (2). We explored a series of experiences with 3-dimensional transesophageal echocardiography (3D-TEE) for the visualization and accurate assessment of subvalvular pannus in patients with mechanical aortic valve (Figures 1 to 4, Online Videos 1A, 1B, 2A, and 2B). We prospectively enrolled 11 patients (mean age 64.0 ± 8.6 years, 10 patients with either double or triple valve replacement) who had previously implanted mechanical aortic valve, with transaortic mean pressure gradient >40 mm Hg or transaortic maximal velocity >4 m/s despite normal occluder motion. All patients underwent 3D-TEE examination to rule out pannus formation and these findings were compared with multidetector computed tomography images and/or surgical findings.

Real-time 3D-TEE can be useful for visualizing subaortic pannus in mechanical aortic valves. Using 3D planimetry, quantitative measurement of geometric subvalvular area at the level of the pannus is feasible and has good correlation with the area measured by multidetector computed tomography and also with the Doppler measurement by transthoracic echocardiography.
Using continuous-wave Doppler measurement by 2-dimensional (2D) transthoracic echocardiography, we evaluated the transvalvular flow across the mechanical aortic valves. All patients had either mean transaortic pressure gradient (PG) >40 mm Hg or maximal transaortic velocity (Vmax) >4.0 m/s. Color Doppler imaging in the parasternal long-axis view showed post-stenotic flow disturbance suggesting the site of obstruction at the subvalvular level, as indicated by the white arrowheads. Flow acceleration occurred proximal to the valve. However, subvalvular pannus formation was not visualized on these 2D transthoracic echocardiography images because of the posterior shadowing by the metallic leaflets (Online Videos 1A and 1B, both videos from the same patient). In 6 patients, 2D echocardiography showed normal opening motion of mechanical occluder. In 5 patients whose occluder motion was unidentifiable by conventional 2D echocardiography, further fluoroscopic evaluation was performed and no patient had evidence of frozen valve on fluoroscopy. In all patients, the normal opening angle of the leaflets was identified again by multidetector computed tomography. Ao = aorta; LA = left atrium; LV = left ventricle.

The conventional 2D transesophageal echocardiography (TEE) images also were not satisfactory for evaluation of the subaortic area (Online Video 2A). However, in 10 patients (91% of total study patients), 3-dimensional (3D)-TEE allowed good visualization of subaortic pannus formation. In the multiplanar reformatting mode, putting the x-y-z crop box just beneath the mechanical aortic valve and avoiding the posterior shadowing, we reconstructed the most optimized 3D images of subvalvular pannus formation as the en face view seen at the aorta-to-LV direction (Online Video 2B). Through cropping of the full-volume 3D images, subvalvular area with pannus could be visualized well in the en face view. For all cases, cardiac multidetector computed tomography (MDCT) images confirmed the 3D-TEE diagnosis of subaortic pannus lesions in the same patients. The shape of the pannus also matched that of the intraoperative findings. A total of 7 patients (64%) were referred for surgical intervention, mainly for symptoms of heart failure. Abbreviations as in Figure 1.
For all patients, we measured the geometric subvalvular area of the mechanical aortic valve prosthesis using 3D-TEE planimetry. All 3D full-volume data sets were stored digitally and transferred to an off-line analysis software (3D-QLAB 10, Philips, Amsterdam, the Netherlands) for post-processing and planimetric analysis. (A and B) Using this software, images were cropped by the multiplanar reformatting mode, which allows them to be displayed as an x-y-z box plane. Putting the crop box just beneath the mechanical aortic valve and avoiding posterior shadowing, we were able to reconstruct the most optimized images of subvalvular area at the level of pannus formation. (C and D) Finally, the smallest subvalvular area beneath the mechanical aortic valve was obtained. (C) The yellow line indicates the geometric subvalvular area at the subvalvular pannus level. Abbreviations as in Figure 2.

FIGURE 4 Correlation Between the 3D-TEE-Derived Subvalvular Area and MDCT-Derived Subvalvular Area or Transaortic Mean PG

(A and B) The geometric subvalvular area (GSA) measured by 3D planimetry (GSA on 3D-TEE) was compared with the area obtained by MDCT images (GSA on MDCT) and with the transaortic mean PG. The degree of correlation was good with both parameters (Spearman $\rho = 0.761$, $p = 0.007$ for GSA by MDCT; Spearman $\rho = -0.726$, $p = 0.011$ for transaortic mean PG). (C) Pannus area was quantitated in 10 patients who had a good visualization of subaortic pannus formation on 3D-TEE. It was calculated by the difference between the GSA on 3D-TEE and the expected subvalvular area of a normal mechanical aortic valve. Transaortic mean PG was well correlated with the measurement of pannus area (Spearman $\rho = 0.695$, $p = 0.026$). Abbreviations as in Figures 1 and 2.
REFERENCES


KEY WORDS  mechanical aortic valves, pannus formation, real-time three-dimensional transesophageal echocardiography

APPENDIX For supplemental videos, please see the online version of this article.