Imaging of Prosthetic Heart Valve Dysfunction
Complementary Diagnostic Value of TEE and MDCT?

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PROSTHETIC HEART VALVES ARE INCREASINGLY IMPLANTED WORLDWIDE TO REPLACE
DISEASED NATIVE VALVES. Prosthetic heart valve (PHV) dysfunction is rare but potentially
life-threatening. In clinical practice, transthoracic echocardiography and transesophageal echocardiog-
raphy, and fluoroscopy for mechanical valves, are the routine imaging modalities to evaluate suspected
PHV dysfunction (1). Establishing the exact cause of PHV dysfunction is important to determine the
appropriate treatment strategy but can be difficult. Multidetector computed tomography may have
complementary diagnostic value to the routine imaging modalities in these patients (1,2). In this iPIX,
we present a spectrum of findings with echocardiography, fluoroscopy, and computed tomography for
a variety of PHV dysfunction etiologies that includes endocarditis, thrombus, and pannus formation
(Figures 1 to 11).

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Definite or possible diagnosis of prosthetic heart valve (PHV) endocarditis is based on the modified Duke criteria in which noninvasive imaging plays a key role (2). A low threshold for performing transesophageal echocardiography (TEE) after transthoracic echocardiography (TTE) is advisable because of the low sensitivity of TTE for the detection of signs of PHV endocarditis. In this patient with a Carbomedics (Sorin Group, USA Inc., Arvada, Colorado) bileaflet PHV in the aortic position, TTE demonstrated severe aortic regurgitation. In addition, TEE and multidetector computed tomography (MDCT) revealed a mycotic aortic root aneurysm directly underneath the right coronary artery origin (RCA) (A and C) with diastolic paravalvular leakage as seen on color Doppler imaging (B). Acoustic shadowing on the TEE images (A) hampers complete and accurate assessment of the PHV, but MDCT did not show any vegetations (C). MDCT nicely demonstrated the close relationship of the mycotic aneurysm and the RCA (C and D). The location of the mycotic aneurysm is indicated by an asterisk on the schematic drawing (D). MDCT images can be reconstructed in any desired imaging plane after acquisition and allow for a one-on-one comparison with every echocardiographic view. Ao — aorta; LV — left ventricle; RV — right ventricle.

In the same patient as presented in Figure 1, short-axis TEE images demonstrated the mycotic aneurysm (A) and the diastolic paravalvular leakage on color Doppler (B). MDCT also demonstrated the mycotic aneurysm and allowed for detailed delineation of its contours (C) due to lack of acoustic shadowing present on TEE images (A). However, TEE provides additional hemodynamic information by color Doppler flow demonstrating the diastolic flow paravalvular leakage (B). Although MDCT confirms the paravalvular route by showing contrast outside the valve, it cannot determine the diastolic and systolic flow direction. The illustration (D) shows the partition of the mycotic aneurysm on MDCT images (*) and the close relationship of the aneurysm with the right sinus of Valsalva (arrow). The arrowhead indicates the orifice of the left main branch. LA — left atrium; RVOT — right ventricular outflow tract; other abbreviations as in Figure 1.
In the same patient as in Figures 1 and 2, MDCT images demonstrated the extent of the mycotic aneurysm (*) and the close relationship with the RCA (arrow). This anatomical information is of high clinical importance for the pre-operative surgical guidance in case of reoperation (PHV replacement with or without pericardial patch or homograft implantation with coronary reimplantation). In this case, the extent of the mycotic aneurysm and the close relationship with the RCA resulted in a successful homograft implantation with reimplantation of the coronary arteries. Abbreviations as in Figure 1.

This patient with a St. Jude (St. Jude Medical, St. Paul, Minnesota) bileaflet PHV in the aortic position presented with suspected PHV endocarditis (fever and multiple positive blood cultures with streptococcus). Both TTE and TEE (A) revealed a large (11 × 14 mm) mobile echodense mass indicating the presence of a vegetation. The potential presence of an abscess or mycotic aneurysm on the septal side of the PHV was difficult to assess due to acoustic shadowing (A and B). The illustration demonstrates the relation of the vegetation (*) with the interventricular septum (IVS) and the anterior mitral valve leaflet (AMVL). MDCT confirmed the presence of the vegetation underneath the PHV (C) and definitely excluded the presence of an abscess or mycotic aneurysm. Abbreviations as in Figure 1.

Figure 5. PHV Endocarditis: Simultaneous Coronary and Aortic Dimension Assessment by MDCT

The presence of a large vegetation is an indication for urgent reoperation. For appropriate pre-operative assessment, the cardiothoracic surgeon needs to be informed on the presence of coronary artery disease (CAD). Invasive coronary angiography is the gold standard for coronary assessment. However, the presence of a large vegetation is associated with an increased risk of distal embolization by catheter manipulation. Therefore, noninvasive evaluation of the coronary arteries is preferred. In the same patient as in Figure 4, (A) demonstrates the ability of MDCT to evaluate coronary arteries (i.e., RCA) simultaneously with PHV assessment. MDCT excluded coronary artery disease, and given the high negative predictive value of MDCT for the presence of CAD, invasive coronary angiography was omitted. Although MDCT is a suitable technique to exclude coronary artery disease, in patients with severe coronary calcifications, it is difficult to identify significant coronary stenosis. Proximal aortic assessment is important because of possible therapeutic consequences (aortic root and/or arch replacement). In this case, MDCT (B) revealed an aneurysm of the ascending aorta (diameter 50 mm) which was not visualized with TEE because of focusing on PHV assessment. Although TEE is able to detect aneurysms of the ascending aorta, it is inferior to MDCT for diameter measurements. The presence of a large vegetation and the dilated ascending aorta resulted in the choice for replacement of both the PHV and ascending aorta (Bentall procedure). Surgical inspection confirmed the presence of a large vegetation and the absence of a mycotic aneurysm in the aortic root. Surgery also confirmed the dilated ascending aorta. Abbreviations as in Figure 1.
Patients with PHV obstruction present with an increased pressure gradient and/or decreased prosthetic orifice area on TTE. The exact cause of PHV obstruction is often not detected with TTE. In this patient with a Carbomedics bileaflet PHV (Sorin Group) in the aortic position, additional TEE, fluoroscopy, and MDCT were performed. TEE demonstrates a subvalvular echodense mass located between the septal side of the PHV and the anterior mitral valve leaflet (A, arrow). MDCT confirmed the presence of this mass on the ventricular side of the PHV. Moreover, an additional hypodense mass was seen on the aortic side of the PHV (B, arrows). The irregular shape and the location on both the aortic and ventricular side of the PHV (C) favors the diagnosis of PHV thrombosis over pannus formation. Abbreviations as in Figures 1 and 2.

In the same patient as in Figure 6, diastolic TEE short-axis images demonstrate 2 possible echodense masses on the aortic side at the level of the origin of the aneurysmatic left coronary artery (A). These possible lesions were missed at the initial TEE interpretation. MDCT was performed for determination of the exact cause of the PHV obstruction, and nicely delineated 2 hypodense irregular shaped lesions on the aortic side of the PHV which are compatible with PHV thrombosis (B). After this observation, 2 possible echodense masses were identified on TEE images. The illustration (C) demonstrates the 2 irregular shaped lesions (black areas) and their relationship with the PHV and aneurysmatic left main branch (*). LAA — left atrial appendage; other abbreviations as in Figure 1 and 2.

In the same patient as in Figure 7, both fluoroscopy and MDCT (A) demonstrated restricted leaflet opening, more pronounced on one side but also present on the other side. Asymmetric leaflet restriction is often present in PHV thrombosis and not very common in patients with pannus formation. Comprehensive imaging evaluation resulted in the diagnosis of PHV thrombosis which was treated with additional anticoagulation therapy (warfarin plus low-molecular weight heparins) and antiplatelet therapy (aspirin). After 2 months, TTE showed normalization of maximum pressure gradient over the aortic PHV. MDCT confirmed this by showing normal leaflet opening of both leaflets (B), and the hypodense irregular shaped mass disappeared, which confirmed the successful diagnosis and treatment of PHV thrombosis. Abbreviations as in Figure 1.
This patient presented with a gradual increase of maximum pressure gradient over the aortic PHV (Carbomedics Tophat bileaflet [Sorin Group]) and complaints of dyspnea (New York Heart Association functional class II). TTE did show an increased pressure gradient but could not determine its exact cause. The assessment of the PHV, especially the subvalvular area on TEE images (A), was hampered by acoustic shadowing. No echodense masses were seen on the subvalvular side, but a possible supravalvular echodense mass (*) was identified. This contour is, however, typical for this specific PHV type that is implanted in supra-annular position. MDCT (B) did not show any supravalvular mass. However, MDCT identified a semicircular hypodense mass on the ventricular side of the PHV ring (arrows) which is compatible with pannus formation. Pannus formation is a known cause for PHV obstruction leading to a gradual increase of the pressure gradient over the PHV. Abbreviations as in Figure 1.

PHV leaflet assessment was hampered by acoustic shadowing on TEE. Fluoroscopy was performed to assess leaflet motion. Normal manufacturer leaflet opening angles of this PHV are 78°. Fluoroscopy (A) revealed decreased leaflet opening of both leaflets (49° at posterior side and 54° at septal side, respectively). MDCT confirmed this leaflet restriction (B). Furthermore, notice the presence of a mitral annuloplasty ring. Leaflet restriction is more suggestive for PHV thrombosis than pannus formation. Abbreviations as in Figure 1.

TEE images did not show a subvalvular mass (A). However, MDCT demonstrated a circular hypodense mass in the subvalvular region (B). Hypodense PHV-related artifacts are indicated with arrowheads. The illustration (C) emphasizes the circular pattern on the PHV-related artifacts (black area). This circular hypodense mass is more suggestive for pannus formation. Therefore, thrombolysis was not considered and the patient was referred for surgery. Surgical inspection confirmed pannus formation as the case of PHV dysfunction. Abbreviations as in Figures 1 and 2.
REFERENCE
