Prosthetic valve obstruction is a condition associated with significant morbidity and mortality. The most common causes of obstruction include valve thrombosis or pannus formation. Thrombosis is more likely to occur early after valve implantation, in the setting of inadequate anticoagulation, and is more common in mechanical prostheses. However, it can occur with bioprostheses and may develop long after implantation. Pannus is a more chronic process associated with ingrowth of tissue, causing obstruction. Distinguishing between thrombus and pannus as a cause of obstruction is important because thrombus can potentially be treated with fibrinolysis, whereas pannus requires surgical intervention to relieve the obstruction. Fibrinolysis is associated with potentially serious adverse outcomes including intracranial bleeding or embolic events, particularly when used for left-sided prosthetic valve thrombosis. Unsuccessful fibrinolysis may delay surgical intervention; this delay can be associated with increased mortality. Hence, correctly identifying the cause of prosthetic valve obstruction is critically important for management.

The evaluation of obstructed prosthetic valves has traditionally used both transthoracic and transesophageal echocardiography (TEE), as well as fluoroscopy. Transthoracic echocardiography serves well as the standard for evaluation of the hemodynamic performance of prosthetic heart valves; an increase in gradient and decrease in orifice area can signal development of obstruction. Gradual rotation of the imaging plane is required to appreciate occluder motion. However, the ability to visualize thrombus or pannus may be compromised by acoustic shadowing from the mechanical prosthesis or by limited acoustic windows because of patient size or lung disease. Fluoroscopy is good at determining whether leaflet motion is normal or abnormal, but cannot provide additional information about the presence or the absence of the thrombus. TEE provides a better assessment of the prosthesis, and the presence of mobile masses with decreased ultrasound intensity suggests the presence of thrombus. TEE provides information that is complementary to transthoracic echocardiography, as the left atrial side of a mitral prosthesis and posterior aspect of an aortic prosthesis are better visualized. Findings at TEE can predict outcomes with fibrinolytic therapy, as the presence of a thrombus area <0.8 cm2 at TEE is associated with a lower risk of complications with fibrinolytic therapy.

This finding is the basis for the recommendations for management of prosthetic valve thrombosis outlined in the 2014 American Heart Association/American College of Cardiology Guidelines for the Management of Valvular Disease. This document provides a class I recommendation that the initial evaluation for suspected prosthetic valve thrombosis includes transthoracic echocardiography to evaluate hemodynamic severity. If findings on thrombosis are present, TEE is recommended to assess thrombus burden for left-sided valves. Fluoroscopy or computed tomography (CT) to evaluate leaflet motion are also considered reasonable (class IIa), particularly in patients with mechanical prosthetic aortic valves, which are particularly challenging to visualize with echocardiography. Emergency surgery is recommended for patients with mobile or large thrombus (>0.8 cm2) and patients with New York Heart Association class III to IV symptoms. Fibrinolytic therapy is recommended for small thrombi, class I to II symptoms, and recent onset of symptoms, as well as for right-sided valve thrombosis. Recent studies have suggested that thrombolytic therapy is safe, particularly when a low-dose infusion is used, and should be considered as a first-line therapy for prosthetic valve thrombosis. For stable patients with milder degrees of obstruction, reassessment after several days of intravenous administration of unfractionated heparin may be considered as an alternative approach.

Improvements in multidetector CT technology (MDCT) have led to increasing use of this modality in the evaluation of prosthetic valves. MDCT provides good image quality for assessment of newer generation mechanical prostheses and bioprosthetic valves, whereas older generation mechanical valves tend to be associated with significant artifact that limits its evaluation of the leaflets. Previous small studies and case reports have demonstrated the utility of MDCT to detect the presence of masses and abnormal leaflet motion and the ability to discriminate thrombus from pannus in obstructed prosthetic valves using differences in attenuation as measured in Hounsfield units (HU).

In this issue of Circulation: Cardiovascular Imaging, Gündüz et al report their findings in a study designed to assess the ability of MDCT to differentiate between thrombus and pannus in patients with prosthetic valve obstruction. In 37 patients with periprosthetic masses in whom a diagnosis
was possible, the 64-slice MDCT attenuation value of the periprosthetic mass was useful in differentiating between thrombus and pannus. If the HU value of the mass was ≥145, pannus was diagnosed with a high sensitivity and specificity. Response to thrombolysis could also be predicted using the HU value, with complete lysis obtained in all masses with a value <90. The authors suggest that these values could be used clinically to guide treatment, with masses with a HU value ≥145 going directly to surgery and masses with a HU value <90 receiving thrombolytics. These findings are encouraging and should be confirmed in larger prospective studies.

Further information about the group of patients studied would be of interest. Was imaging performed as a part of routine surveillance or was prosthetic valve dysfunction suspected? If it was suspected, what was the basis for suspicion? Did the patients have cardiac symptoms, murmurs, embolic events, or low international normalized ratios? Were all receiving low-dose aspirin, which is recommended in addition to vitamin K antagonists in patients with mechanical heart valves?20

All patients in the study also had a TEE, and the authors appropriately point out that TEE is good at detecting masses likely to be thrombus, including in this study. They suggest that the addition of MDCT may be clinically useful in patients where TEE does not show a mass or if there is suspicion for pannus on TEE. If echocardiography clearly shows evidence of thrombus in the appropriate clinical setting, MDCT is likely unnecessary and exposes the patient to additional risks including iodinated contrast and radiation exposure. However, if echocardiography reveals obstruction of the valve but the mechanism is unclear, the additional information obtained by MDCT may save the patient from an operation if fibrinolysis can be performed for thrombus or may save the patient from the risks of fibrinolysis in the case of pannus. Three-dimensional TEE has the potential to provide additive information to that obtained by standard TEE imaging and may play a useful role in the evaluation of possible prosthetic valve thrombosis, but was not evaluated in the current study.

Diagnostic images could not be obtained in 4 patients. Older generation mechanical valves are particularly known to cause significant artifact.22 Because artifact is also a problem for echocardiography, which is also currently used to guide many interventional procedures, manufacturers of prosthetic valves and devices would benefit patients by using materials that are more suitable for imaging.

With multiple imaging modalities now available, it is critical to understand the strengths and weaknesses of each modality to select the most appropriate test that provides the necessary information to answer the clinical question in a cost-effective manner and expose the patient to the least amount of risk. MDCT holds potential to provide additional information about the mechanism of prosthetic valve obstruction, which may impact management, but it is critical that providers with expertise and knowledge in image acquisition and interpretation perform these studies. The authors appropriately outline the importance of appropriate patient preparation (β-blockers for heart rate control and instructions on breath holding), image acquisition (adequate amount and timing of contrast, appropriate field of view to optimize image quality, software to eliminate irregularities in the R-R cycle), and image interpretation (reformatting in the phase with the least amount of artifact and avoiding evaluation when artifact is present). These points cannot be overemphasized. If not performed appropriately, CT has the potential to expose the patient to risk and radiation without providing useful information. The authors also point out that the use of newer generation CT scanners may result in better image quality and hence better evaluation of prosthetic valves because dual-source scanners with 256- or 320-detector rows have better temporal resolution and fewer artifacts.17

Thrombosis of bioprosthetic valves is increasingly recognized as a cause of obstruction, and findings at echocardiography that suggest thrombosis have been proposed.4,18 MDCT seems promising for evaluation of cases of suspected thrombosis of bioprosthetic valves because image quality is generally good with fewer artifacts. Comparison of these modalities is an appropriate area for future study.

In the evaluation of patients with prosthetic valve obstruction, it should be remembered that pannus and thrombus not uncommonly coexist. Both were observed in a few patients in the current study. By pathological examination, both have been present in as many as 45% of obstructed mitral mechanical prostheses.20

In summary, the detection, evaluation, and treatment of prosthetic valve obstruction are challenging. The current study suggests that MDCT may serve as an adjunct to trans-thoracic echocardiography and TEE, and in patients with periprosthetic masses, may provide additional information to guide treatment.

Disclosures

None.

References


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Prosthetic Valve Thrombus Versus Pannus: Progress With Imaging
Crystal R. Bonnichsen and Patricia A. Pellikka

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