CASE REPORT

Complementary role of different imaging modalities in the diagnosis of concurrent obstructive aortic and mitral prosthetic valve thrombosis

Eşzamanlı obstrüktif aortik ve mitral prostetik kapak trombozları tanısında farklı görüntüleme yöntemlerinin tamamlayıcı rolü

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Summary– Prosthetic valve thrombosis (PVT) is a life-threatening valve dysfunction. In asymptomatic cases, as well as certain symptomatic patients with PVT, the results of the first-line imaging tool, transthoracic echocardiography, may be inconclusive in terms of illustrating the thrombus, which is necessary in order to select the proper treatment option. Hence, a differential diagnosis based on clinical presentation may be challenging, and multimodality imaging, including echocardiography, cine fluoroscopy, and cardiac computed tomography, is usually required to distinguish between PVT and other prosthesis-related pathologies, such as pannus, vegetation, and prosthesis-patient mismatch.

Özet– Protez kapak trombozu (PKT) hayati tehlike arz eden bir kapak işlev bozukluğudur. Semptomsuz olgularda ve PKT'li bazı semptomlu hastalarda, birinci basamak görüntüleme aracı olan transtorasik ekokardiyografi, uygun tedavi seçeneğini seçmek için zorunlu olan trombüs gösterimi açısından yetersiz kalabilir. Bu nedenle, klinik prezentasyona dayalı ayırıcı tanı zordur ve ekokardiyografi, sine floroskopi ve multimodalite görüntüleme, ekokardiyografi, sine floroskopi ve kardiyak bilgisayarlı tomografi dahil olmak üzere genellikle PKT ile pannus, vejetasyon ve hasta-protez uyumsuzluğu gibi protezle ilgili patolojiler arasındaki ayrım için gereklidir.

Prosthetic valve thrombosis (PVT) is a life-threatening valve dysfunction.[1,2] Multimodality imaging tools are crucial in the diagnosis and treatment of challenging cases. This case report presents multimodality and intraoperative images of simultaneous obstructive mitral and aortic valve thrombosis and provides a brief discussion of the diagnosis and treatment of PVT.

CASE REPORT

A 49-year-old female patient with a history of aortic and mitral valve replacement surgery (Bicarbon bileaflet valves; Sorin Biomedica, Saluggia, Italy) 9 years earlier due to rheumatic valve disease presented at the clinic with progressive shortness of breath ongoing for 2 weeks (New York Heart Association functional class IV). The patient's medical history included type 2 diabetes mellitus, hypertension, and an ischemic cerebrovascular event. Upon admission, the patient's blood pressure was low and she was in a state of hypotensive pulmonary edema. The heart rate recorded was 114 bpm. A 12-lead electrocardiogram indicated sinus tachycardia. The arterial blood gas interpretation was mild metabolic acidosis (pH 7.33, bicarbonate 17.5 mmol/L, potassium 4.1 mmol/L), her international normalized ratio was 1.48, and her time in therapeutic range for the last 6 months was 35%. Bedside

Abbreviations:

2D	*Two-dimensional*
CF	*Cine fluoroscopy*
HU	*Hounsfield unit*
MDCT	*Multidetector cardiac computed tomography*
PHV	*Prosthetic heart valve*
PHVT	*Prosthetic heart valve thrombosis*
PVT	*Prosthetic valve thrombosis*
RT-3D	*Real-time 3-dimensional*
TEE	*Transesophageal echocardiography*
TT	*Thrombolytic therapy*
TTE	*Transthoracic echocardiography*

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transthoracic echocardiography (TTE) demonstrated transaortic gradients of 103 mmHg (peak)/58 mmHg (mean) [baseline gradients: 24 mmHg (peak)/15 mmHg (mean)], restricted mitral prosthetic heart valve (PHV) motion with a mean diastolic gradient of 22 mmHg [baseline gradients: 11 mmHg (peak)/5 mmHg (mean)], (Fig. 1a, b), normal left and right ventricular dimensions and function, and moderate-severe intravalvular aortic regurgitation (Fig. 1c, Video 1*). After achieving hemodynamic stabilization, transesophageal echocardiography (TEE) was performed for a more detailed evaluation and demonstrated a large, immobile thrombus in both the atrial and ventricular sides of the mitral PHV (Fig. 1d, Video 2*). Real-time 3-dimensional (RT-3D) TEE also detected thrombus formation in the left atrial side of the mitral PHV with an area of 0.71 cm^2 (Fig. 2a, Video 3*). Due to the inability to assess the aortic PHV in terms of valve dysfunction, cine fluoroscopy (CF) was performed, which revealed that only 1 leaflet had motion; the other leaflet was stuck and immobile (Fig. 2b, Video 4*). The cardiovascular surgery and cardiology departments conferred and made an evaluation. An urgent surgical intervention consisting of thrombectomy and redo mitral valve replacement was performed for the aortic and mitral valves. Intraoperative images were taken and a histopathological examination was performed. It was reported that the surgical material (including thrombectomy specimen) was a thrombus (Fig. 2c-e). Subsequently, the patient was discharged and was doing well at 4 months after surgery.

DISCUSSION

Although PVT is most often asymptomatic, it may present with pulmonary edema and cardiogenic shock

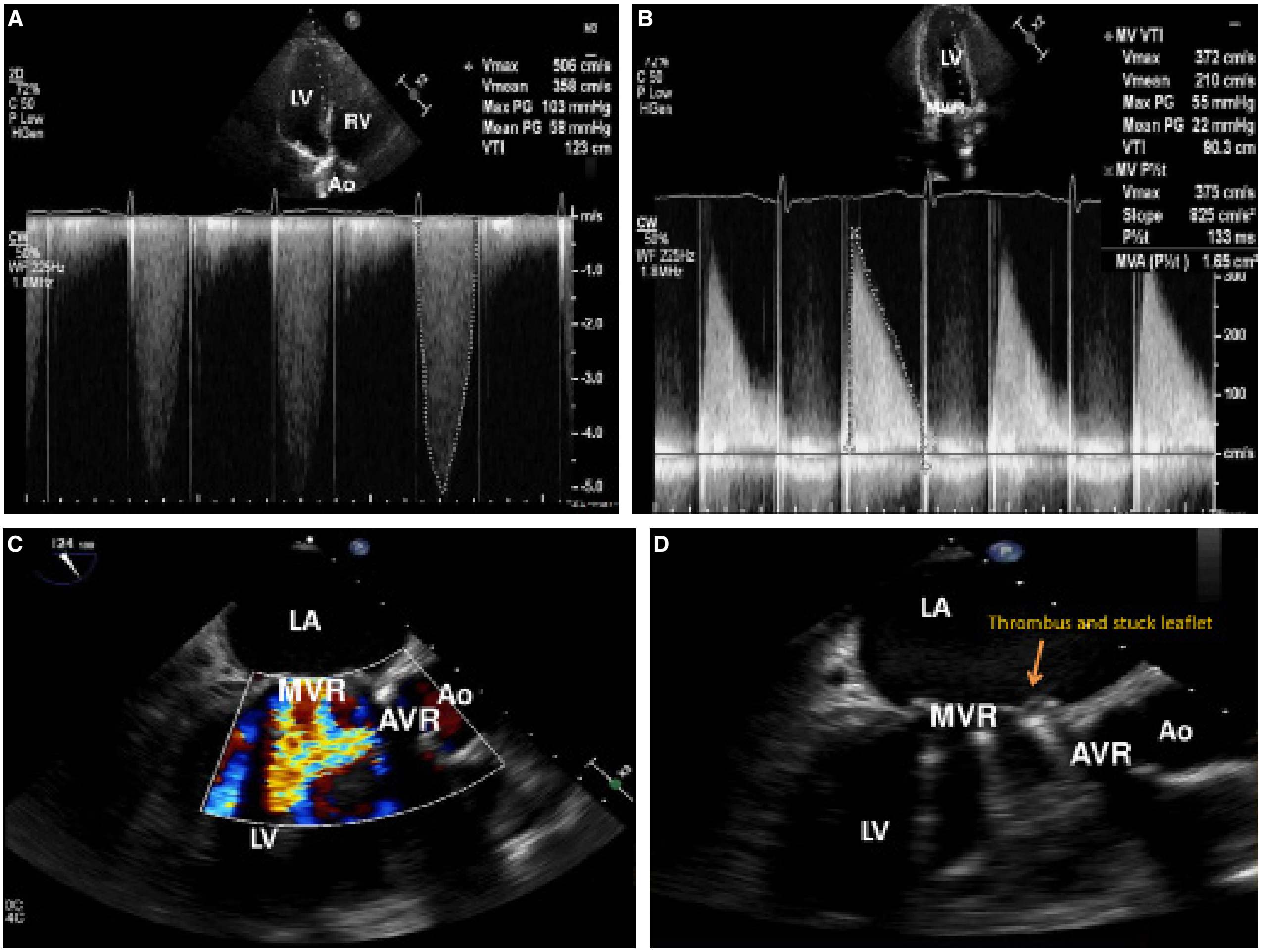

Figure 1. **(A, B)** Transthoracic echocardiography shows the gradient and effective orifice area of the prosthetic valve and **(C)** moderate-severe intravalvular aortic regurgitation. **(D)** Transesophageal echocardiography demonstrates a large, immobile thrombus on both the atrial and ventricular sides of the mitral prosthetic heart valve (yellow arrow).

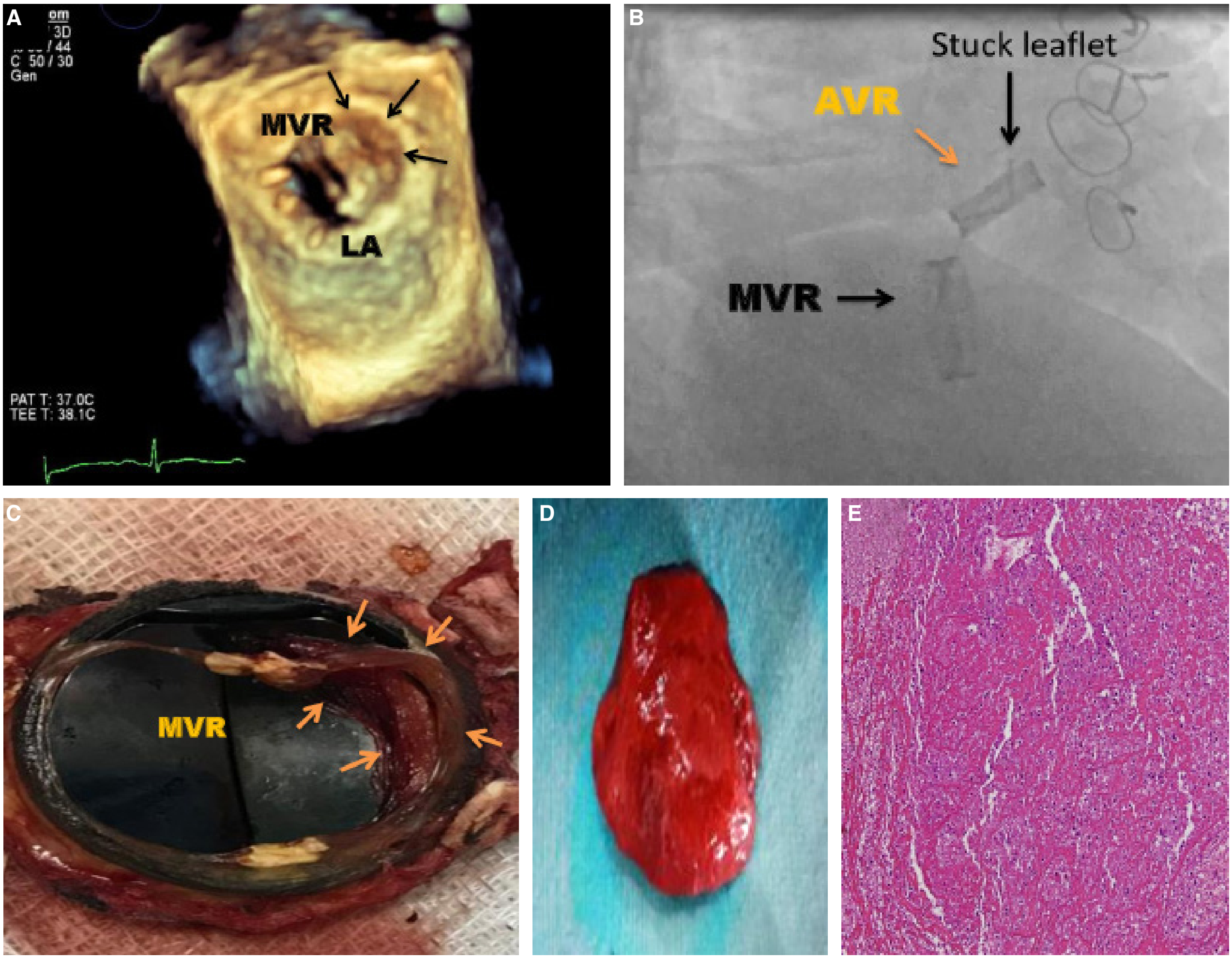

Figure 2. (A) Real-time 3-dimensional transesophageal echocardiography displays the thrombus formation in the left atrial side of the mitral prosthetic heart valve (MPHV) (black arrows). **(B)** Cine fluoroscopic imaging of the aortic prosthetic valve shows that only one leaflet had motion; the other leaflet was stuck and had no motion. **(C, D)** A large, immobile thrombus from the atrial side of the MPHV (yellow arrows) and the mass excised from the aortic valve prosthetic valve are seen macroscopically. **(E)** Histopathological examination reveals that the mass excised from the aortic prosthetic valve was a thrombus.

due to valve obstruction.[3–7] Diagnosis of PVT requires clinical suspicion along with diagnostic investigations; the findings of the first-line imaging tool, TTE, may be inconclusive in terms of demonstrating the thrombus, which is mandatory in order to select the proper treatment option. Hence, in cases where there is a suspicion of PVT, either symptomatic or clinically silent, a multimodality imaging approach is recommended with a class 1 indication in the most recent guidelines.[8]

TTE is readily available in most centers and highly reproducible when performed by experienced hands. Although a TTE examination is an essential part of the diagnostic assessment of a patient with PVT, the value of TTE is usually limited because of a certain degree of acoustic shadowing and characteristic reverberations caused by the prosthetic material. Montorsi et al.[9] reported that the sensitivity and specificity for the diagnosis of PVT in the mitral or aortic position using TTE was 75% and 57%, respectively. The limited role of TTE in the evaluation of PVT almost always necessitates the use of additional imaging tools, such as CF and TEE examination.[9]

Evaluation of structural abnormalities of prosthetic valves is limited with 2-dimensional (2D) TEE due to attenuation and acoustic shadowing; therefore, further TEE examination is usually required.[1,2,4,7] Detailed imaging of the atrial side of the mitral valve prosthesis can be obtained because of the proximity of the esophagus to the heart and the absence of interference with the lungs and ribs.[4] Nonetheless, a thrombus may not be clearly visualized with TEE in all aortic PVT cases. Acoustic shadowing from the prosthetic material may often obscure the anterior part of the aortic prosthesis. This is also true for a prosthesis in the tricuspid position.[10] TEE has an indispensable value in the assessment of thrombus size, mobility, and location, which may help in various treatment decisions, such as thrombolysis, anticoagulation, and surgery.[1–3,8,10] Moreover, TEE provides direct imaging of a thrombus in the body or the appendage of the left atrium, which usually cannot be detected with TTE. The presence of a left atrial thrombus is accepted as a contraindication for thrombolysis and should be ruled out by TEE before initiating thrombolytic therapy (TT).[1–5]

RT-3D TEE provides a more comprehensive delineation of PVT compared with conventional 2D TEE, which may underestimate or even miss thrombi, particularly when it is ring-located and nonobstructive and "Doppler silent." It may inform the clinician about the total thrombus burden in detail, helping to organize a more precise anticoagulation therapy.[4,5,7] Therefore, patients may benefit from accurate diagnosis and the correct course of therapy with RT-3D TEE. This also avoids unnecessary further diagnostic work-up. It must be acknowledged that RT-3D TEE is a complementary diagnostic tool; the accuracy depends on the quality of the original 2D images. It has several limitations, including reduced temporal resolution; poor visualization of the anterior structures of the heart, such as the aortic and tricuspid valves; and poor image quality due to poor electrocardiography gating in patients with arrhythmias.[7] Furthermore, it has the problem of acoustic shadowing, like 2D imaging, for instance, it may be difficult to visualize pathologies (thrombus, pannus, etc.) located on the ventricular side of the mitral prosthesis.[4,7,10]

CF was the first noninvasive imaging technique to evaluate PHVs.[4,10,11] Previously reported sensitivity, specificity, and positive and negative predictive values for the diagnosis of PVT in the mitral or aortic position with CF were 87%, 78%, 80%, and 91%, respectively.[12] In cases of bileaflet valves, the disks can be directly visualized, and the opening and closing angles can be measured using a tangential view. CF, however, also has limitations. First of all, it is not useful in distinguishing pannus from thrombus, since neither pannus nor thrombus can be visualized with this modality. Therefore, TEE is required to clarify the underlying pathology blocking the leaflet excursion. Second, CF will most likely miss a nonobstructive PVT where occluder motion is not hampered (2D and 3D TEE can be very helpful in this respect). Third, X-ray exposure limits its use in pregnancy. Lastly, although CF is a very useful tool in the functional evaluation of prostheses with radiopaque disks, it provides no functional information in cases of the various prostheses with radiolucent disks.[13]

Improvements in multidetector cardiac computed tomography (MDCT) have led to increased use of this modality in the evaluation of PHVs. It provides good image quality for the assessment of newer generation bileaflet mechanical PHVs, whereas older generation monoleaflet mechanical valves tend to be associated with significant artifacts, which limits evaluation of the leaflets.[14] Gündüz et al.[14] found that 64-slice MDCT efficiently provided reliable, quantitative data for the diagnosis and differentiation of pannus and thrombus in patients with prosthetic valve dysfunction. A thrombus was diagnosed when the Hounsfield unit (HU) value of the mass was <90, whereas pannus demonstrated a high HU with a high sensitivity and specificity. TEE is still the most reliable method in the diagnosis of prosthetic heart valve thrombosis (PHVT), but MDCT can be used as a complementary diagnostic method for a definitive diagnosis in challenging cases. It may be especially helpful in patients with double left-sided mechanical valves because acoustic shadowing can occur even during a TEE study and make the interpretation difficult. Multimodality imaging is now recommended with a class I-B indication in patients with suspected mechanical PHVT to assess the thrombus and valve function.

Treatment options for PHVT include intensified anticoagulation, TT, and surgery.[1,2,4,5,10] In certain high-risk patients, watchful waiting may be a last option. The effectiveness of anticoagulation in the resolution of PHVT is based on data from a limited number of publications. Recently, Bayam et al.[15] demonstrated that unfractionated heparin treatment was successful in 46.8% of PHVT patients who had relative contraindications for both TT and surgery. In the current literature, the use of low-molecular-weight heparin in left-sided PHVT is not yet clear. Until the 1990s, the treatment of choice for mechanical PHV obstruction was surgery; however, TT has been increasingly used in recent decades.[1–5,8] Currently, TT has become an alternative to surgery as a first-line therapy in patients with PVT.[1,2,8] In a meta-analysis authored by Castilho et al.[16] that evaluated 27 studies with 1107 patients treated with TT and 26 studies with 1132 patients operated on for PHVT, it was revealed that there was a higher mortality rate with surgery compared with TT (18.1% vs. 6.6%). However, we are aware that it may be misleading to compare mortality rates of TT and surgery without a head-to-head randomized trial. The 2017 American Heart Association/American College of Cardiology (AHA/ACC) Focused Update of the 2014 AHA/ACC Guideline for the Management of Patients with Valvular Heart Disease now suggests immediate initial treatment with either slow-infusion low-dose TT or emergency surgery for obstructive PVT as first-line treatment strategies with a class 1-B indication.[8] However, surgery should be considered as a first-line treatment in patients with cardiogenic shock. Other indications for surgical treatment include a contraindication for fibrinolysis, presence of left atrial thrombus, and possible pannus formation.[1,2,5]

In conclusion, despite technological advances, the hemodynamic and physical properties of mechanical valves remain thrombogenic, and therefore, the development of valve thrombosis will not be surprising. The accurate diagnosis of PVT and other types of prosthetic valve dysfunction is now easier with the capabilities of multimodality imaging, including RT-3D TEE, CF, and MDCT.

*Supplementary video file associated with this article can be found in the online version of the journal.

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