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Accurate and Rapid Diagnosis of Complex Mitral Valve Aneurysm with Neoplasm via Real-time 3D Transesophageal Echocardiography

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ABSTRACT

Mitral valve leaflet aneurysm (MVA) is a rare and potentially devastating complication of infective endocarditis. Here, we report the case of a 49-year-old man with mitral endocarditis who had an anterior MVA without aortic morphologic change and only mild regurgitation. By real-time 3D transesophageal echocardiography (TOE), we found two perforations and a hard mass in the aneurysm accompanied with severe regurgitation. The patient underwent valve replacement surgery combined with anti-infection treatment and was successfully discharged. In addition to the case report and literature review related to MVA, we also summarize the application value of RT-3D TOE in these cases.

INTRODUCTION

Mitral valve aneurysms (MVAs) without the absence of aortic valve endocarditis are rare, as most MVAs are the secondary result of aortic valve infective endocarditis and severe aortic regurgitation [Gülmez 2009]. The various complications associated with MVAs include perforation with severe mitral regurgitation, thrombus formation, and embolism [Kolluru 2020]. Timely diagnosis and appropriate treatment can prevent catastrophic cardiac complications. The most convenient and efficient imaging methods used to diagnose MVAs and their potential complications are transthoracic echocardiography (TTE) and transesophageal (TOE) echocardiography. These imaging methods are tremendously beneficial for the management of cardiac diseases, including the planning of surgical treatments.

We present a case of MVA in a patient without aortic valve disease. This was a rare and complicated case of an anterior mitral valve aneurysm with an aneurysm in the anterior leaflet. While perforation is relatively rare in cases of MVAs, our case presented an intra-aneurysm abscess with perforation. TTE and real-time three-dimensional (RT3D) TOE were used to diagnose, plan, and manage the clinical treatment in this case.

CASE REPORT

Due to fever, a 49-year-old male patient was hospitalized in another hospital for nine days. Echocardiography during that hospitalization indicated mitral valve growth, and the patient was initially diagnosed with infective endocarditis. Anti-infective treatment consisting of cefuroxime, paracillin, and vancomycin was given successively, but the patient's fever did not improve. Following nine days of antibiotic treatment, a cardiac neoplasm was identified, and the patient was transferred to the Cardiology Department of our hospital for further treatment. According to the results of routine blood tests, a blood biochemical panel, brain magnetic resonance plain scanning plus time-of-flight angiography, and pulmonary computed tomography (CT) examination, infective endocarditis and bilateral pneumonia were preliminarily considered as the causes of fever. However, the blood culture subsequently showed no pathogenic bacteria, and cerebral embolism was considered possible. First, the presence of brain embolism was ruled out. During this process, the patient was treated with ceftriaxone, and his fever remained unchanged. Under the guidance of the pharmacy physician, the patient's fever persisted for four weeks with ceftriaxone treatment, and his white blood cell count and C-reactive protein level remained high. (Figure 1) Despite consistently negative results from blood culture, vancomycin and amikacin were added. TTE and TOE were performed to confirm the cardiac neoplasm and guide treatment planning.

TTE showed thickening, roughness, restricted opening, and poor closure of the mitral valve tip, with an anatomical valve orifice area of 1.4 cm2. The TTE images also showed an anterior valve aneurysm that protruded into the left atrium and was accompanied by severe mitral regurgitation. Thickening and abnormal mass attachment were not found in other parts of the anterior and posterior leaflets or the chordae tendineae under the valve. Due to the severe degree of valve regurgitation, the relationship between the valve aneurysm and regurgitation could not be established with TTE.

TOE was then performed to evaluate and delineate the aneurysm and the cause of severe mitral regurgitation of the MVA. Phillips EPIC 7C and XB-2T probes were used for exploration. The mitral valve opening was limited on the two-dimensional (2D) and RT-3D True Vue model of TOE, and a valve aneurysm was observed in the A2 area (Figure

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2A). (Figure 2) A hard mass had formed within the aneurysm with slight activity on TOE, and this mass protruded from the aneurysm and entered the left ventricle with the heart beating in diastole. Two perforations were visible on the aneurysm (Figure 2B). Exploration of the aortic valve revealed that the valve leaflet was only slightly thickened with a small lesion. There was no neoplasm attached to the aortic valve. Stenosis also was not seen when the valve opened, and only mild regurgitation was observed. The RT-3D True Vue model of TOE confirmed the diagnosis of mitral stenosis, anterior valve aneurysm with perforation, and abnormal parenchymal echo shadow formation with severe mitral regurgitation. Images of the valvular aneurysm on 2D and RT-3D TOE are presented in Figure 2A–2D.

Based on the images from both TTE and TOE, the patient was diagnosed with an aneurysm in the anterior leaflet of the mitral valve. Further, abscess formation and perforation were suspected in the aneurysm. Considering together the symptoms, signs, and related examination results, subacute endocarditis was confirmed in this patient. The anterior MVA formed an abscess and perforated the left atrium. The aneurysm was not accompanied by typical aortic valve lesions. In this case, TTE and TOE proved to be very important for early detection and timely surgical intervention (repair or replacement) to prevent fatal consequences.

The risks of infection and embolism were carefully managed during the treatment of this patient. Physicians from the Cardiology Department, Cardiac Surgery Department, Pharmacy Department, and Anesthesiology Department collaborated to consider the patient's high inflammatory indexes and his poor response to antibiotic treatment, as the patient continued to experience intermittent fever even with vancomycin treatment. Thus, surgical clearance of the infection area was indicated. Because the risk of perioperative septic shock was high, timely adjustment of antibiotic treatment was achieved via careful collaboration with the Pharmacy Department. After four weeks of antibiotic treatment, mitral valve replacement surgery was performed. During surgery, the existence of an MVA was confirmed under the surgical field of vision. A solid abscess was found in the aneurysm, and a breach was visible on this mass (Figure 3A, 3B). (Figure 3) The mitral annulus was completely removed and replaced with an ATS artificial Shuang Ye mechanical valve No. 27 (Medtronic, Floor 6-17, Block B, Qiantan World Trade Center (Phase I), No. 5, Lane 255, Dongyu Road, Pudong New Area, Shanghai). A pathological examination was carried out on the aneurysm and intra-aneurysm mass to confirm the MVA and abscess formation (Figure 3C). The patient's temperature dropped to normal three days after surgery, and his vital signs remained good. The indexes of infection and inflammation gradually decreased to normal levels within 15 days after surgery (Figure 1). After four weeks of standard antibiotic treatment, all indexes had reached normal levels, and the patient was discharged from the hospital.

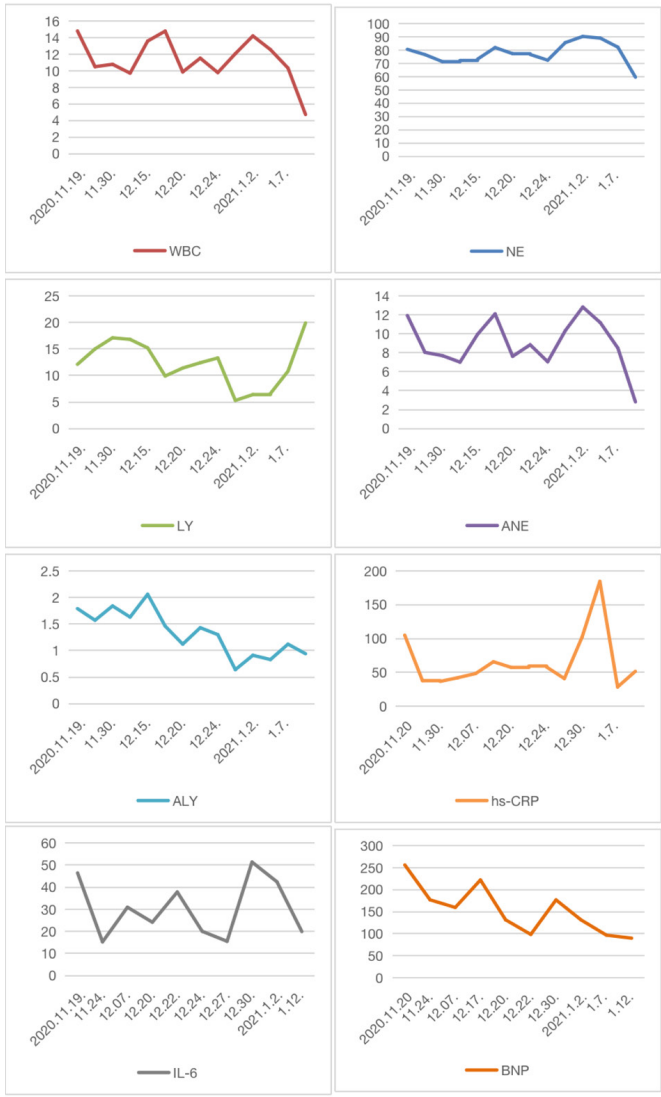

Figure 1. Fluctuations in main infection indexes during hospitalization.

DISCUSSION

The first case of MVA was reported in 1729 [Tariq 2019]. Although MVAs are clinically rare, the relevant literature has provided a comprehensive understanding of MVAs. MVAs are closely related to aortic valve infection, and in most cases, MVAs result from infective endocarditis [Kolluru 2020; Werner 2020; Moretti 2018; Tomsic 2016]. However, a few individual cases of MVA without infective endocarditis have been reported [Kim 2012]. Degeneration is also considered one of the causes of MVA formation. The optimal treatment of an MVA is dependent on the size, formation mechanism, complications associated with the valvular aneurysm, and embolization risk. TTE and TOE provide valuable insight for selecting the treatment scheme for an MVA. These imaging methods facilitate the exploration of valve morphology and function and the diagnosis of complications associated with the MVA. Echocardiography also supports the determination of the best treatment mode [Guler 2014]. An echocardiography window close to the imaged human tissue provides more concrete and multi-faceted information about the

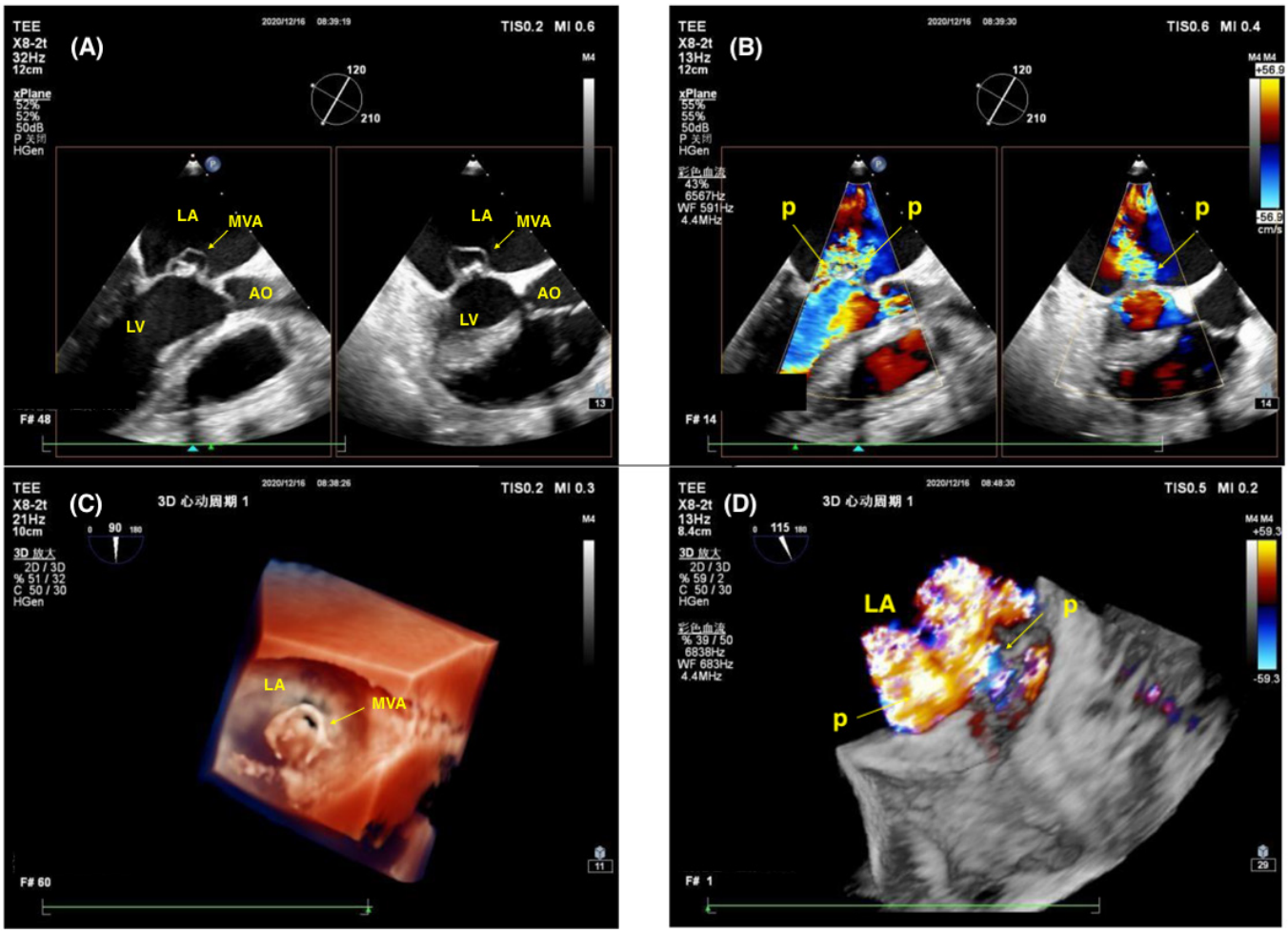

Figure 2. (A) 2D-TOE xPlane showing the anterior leaflet of mitral valve aneurysm with abnormal mass formation. (B) 2D-TOE xPlane color images show a perforation in the MVA, and blood flow entering the left atrium through the rupture of the aneurysm. (C) Anterior MVA in the anterior leaflet, with abnormal mass shadow and rupture on 3D-TOE TrueVue mode. (D) 3D-TOE color image showing that blood flow enters the left atrium through the rupture of the MVA.

anatomy of a valve aneurysm before surgery. This enables surgeons to make a practical preoperative evaluation, select appropriate surgical methods, judge surgical risks, and predict surgical results. In our case, TTE proved to be a useful, non-invasive method for rapid judgment of the need for clinical treatment, determining the direction of the treatment plan, and diagnostic considerations necessary in clinical practice. However, due to the limitation of air interference and angle, TTE cannot provide the most accurate display of an aneurysm or the situation of the rupture. Thus, the function and morphology of the valve cannot be wholly and accurately evaluated. In the present case, the combination of 2D and RT3D TOE exploration was applied to evaluate the presence of infective endocarditis complicated with MVA. The biplane images with an intersecting angle of 90 degrees provided real-time 2D images showing an abnormal space occupying the valve aneurysm. The abnormal activity and connection between the aneurysm and mitral valve were also clearly visible on X-plane echocardiography simultaneously. Two perforations were observed on the left atrial surface of the aneurysm, which caused severe mitral regurgitation. RT 3D+TrueVue technology helped visualize the shape and texture of the MVA, its relationship with the anterior leaflet of the mitral valve, the location of the perforation, and the relationship between the abnormal space within the aneurysm and the aneurysm body. By adjusting the frame rate, the activities of the MVA and foreign bodies in the aneurysm during cardiac contraction and relaxation were concretely displayed. Based on the echocardiography reports and joint discussion among members of multiple departments led by the cardiac surgery, treatment with mitral valve replacement after the achievement of infection control was decided.

With continued advancements in imaging technology, TTE and TOE now play a dominant role in diagnosing and anatomical display of infective endocarditis. These imaging methods also provide a rapid and efficient technique for guiding the choice of treatment methods and treatment opportunities.

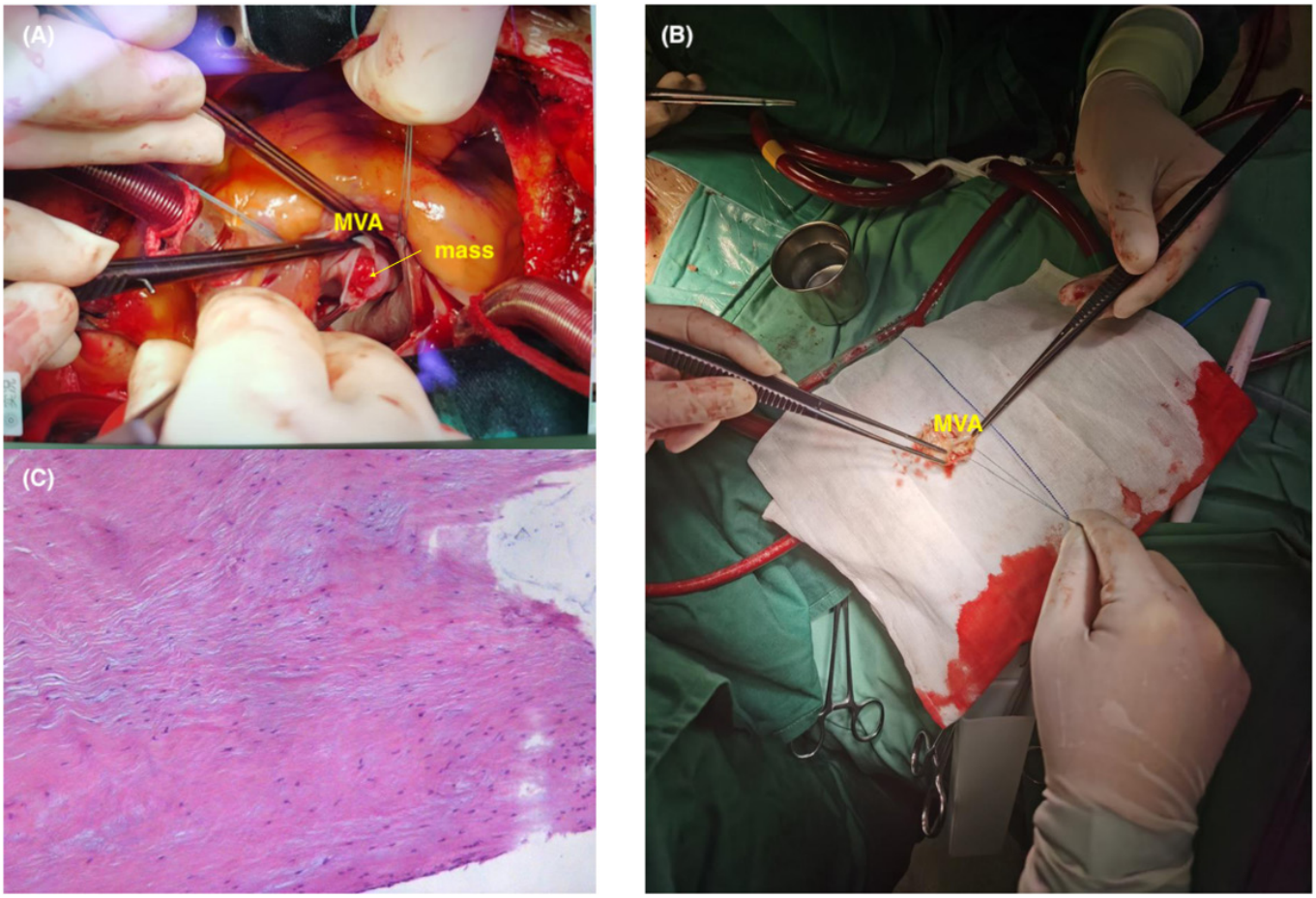

Figure 3. (A) Photograph of the surgical field of view showing the MVA with rupture and abscess. (B) Image of the mitral valve during resection, with rupture of the supra-valvular aneurysm and the abscess within it. (C) Pathological staining shows hyaline and myxoid degeneration of valve tissue and fibrous tissue hyperplasia in the valve, with acute and chronic inflammatory cell infiltration in the capsule wall.

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