CARDIAC IMAGING QUIZ

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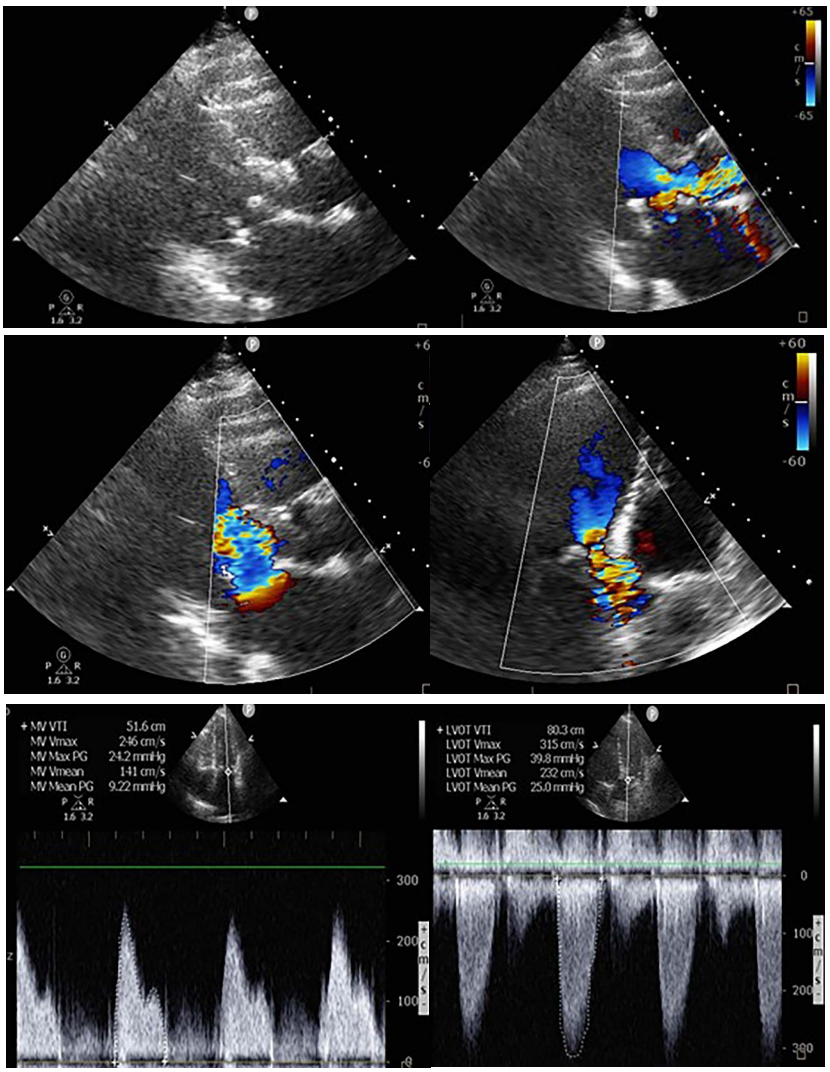

QUESTION: What is the diagnosis?

A. Hypertrophic cardiomyopathy.

B. Aortic valve degenerative stenosis and mitral valve stenosis.

C. Subaortic membrane.

D. Patient-prosthesis mismatch and left ventricular outflow tract obstruction.

ANSWER

(D) Patient-prosthesis mismatch and left ventricular outflow tract obstruction.

These images belong to a 70-year-old overweight female who underwent mitral valve replacement for severe rheumatic mitral valve stenosis. A month after mitral valve replacement, she presented with fatigue and shortness of breath. She was not anaemic, her septic markers were not elevated, and a thyroid function test was normal.

Transthoracic echocardiographic images show a bioprosthetic mitral valve implant, identified by the echogenic struts, abutting the left ventricular outflow tract (LVOT) (top panel). On colour images, turbulence can be noted in the LVOT (top panel, long axis view), with flow convergence at the level of the valve strut basal interventricular septum (middle panel, apical 3 chamber view, right image) and across the mitral valve prosthesis (middle panel, long axis view, left image). The aortic valve leaflets, though poorly delineated, are thin (top and middle panels), implying the gradient is not at the level of the valve. There is a high mean gradient of 9 mmHg and increased E wave velocity > 2 m/s across the mitral valve bioprosthesis, suggestive of patient-prosthesis mismatch (PPM) (bottom panel, left image). The gradient across the LVOT is also elevated at 25 mmHg (bottom panel, right image) and results from the protrusion of the mitral valve prosthesis into the LVOT. The mitral valve effective orifice area (EOA) measured 1.1 cm^2/m^2.

PPM occurs when the EOA of a valve prosthesis is disproportionately small relative to the patient's body size, leading to an abnormally elevated post-operative pressure gradient.[1] In the mitral position, PPM is defined by an effective orifice area index (EOAI) ranging from ≤ 1.2 to 1.25 cm^2/m^2, with severe PPM characterised by an EOAI ≤ 0.9 cm^2/m^2.[2] This mismatch is associated with adverse outcomes, including elevated transvalvular gradients, pulmonary hypertension, heart failure, and atrial fibrillation.[2] Older patients are particularly vulnerable due to smaller mitral annuli and the presence of comorbidities. Therefore, a patient's body size must be carefully considered before valve replacement.[3]

In some cases, the struts of a bioprosthetic mitral valve may extend into the LVOT.[4,5] The degree of protrusion is influenced by the aortomitral annular angle (AMA) – the angle between the mitral and aortic valve annuli.[5] A narrower AMA, closer to 90 degrees, increases the likelihood of LVOT obstruction, which impairs blood flow from the left ventricle to the aorta, resulting in a pressure gradient and reduced cardiac output.[4,5] Risk factors for LVOT obstruction include a small LVOT, high-profile prosthesis, improper valve sizing or orientation, septal hypertrophy, and a narrow AMA.[4,5]

Fixed LVOT obstruction needs to be differentiated from dynamic LVOT obstruction, which is due to systolic anterior motion of the mitral valve and occurs in approximately 1–2% of patients undergoing mitral valve repair.[5] Mechanical valves, being low-profile, typically do not interfere with LVOT flow.[6] Conversely, bioprosthetic valves have a higher profile and are more likely to cause obstruction, especially when the native mitral valve apparatus is preserved – a practice associated with better post-operative left ventricular function.[6]

Echocardiography serves as an important imaging modality for assessing the structure of the valve prosthesis, measuring gradients, EOA, and LVOT area, especially on three-dimensional (3D) imaging.[4,5,7] It also serves as an effective tool for assessing and identifying high-risk features on echocardiography for PPM and LVOT obstruction.[5,7]

Conflict of interest: none declared.

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