Left Ventricular Outflow Tract Obstruction After Bioprosthetic Mitral Valve Replacement With Preservation of the Anterior Leaflet

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A 79-year-old woman with a history of bioprosthetic aortic and mitral valve replacement with coronary artery bypass graft surgery presented with pulmonary edema 4 years after surgery. Transthoracic echocardiography and transesophageal echocardiography revealed an obstruction of the left ventricular outflow tract caused by the bioprosthetic mitral valve. We present this case, accompanied by a review of the literature.

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Key words: Left ventricular outflow tract obstruction • Mitral valve replacement • Anterior leaflet preservation

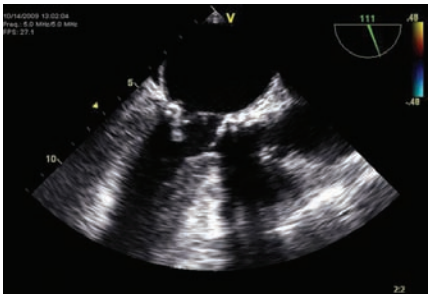
A 79-year-old woman with a history of a Carpentier-Edwards (Edwards Lifesciences, Irvine, CA) bioprosthetic 23-mm aortic valve replacement, Carpentier-Edwards porcine 27-mm mitral valve replacement with anterior leaflet preservation, and coronary artery bypass grafting presented with shortness of breath and palpitations. Postoperatively, she stated that she never "felt well," and continued to have symptoms of dyspnea on exertion. She was never hospitalized for heart failure and failed to follow up with her cardiologist.

Physical examination revealed a blood pressure of 140/80 mm Hg, bibasilar inspiratory rales, and a grade 2/6 systolic ejection murmur at the left sternal

border. A chest radiograph revealed mild bilateral interstitial edema. Her B-type natriuretic peptide level was 1500 pg/mL. Troponin levels were within the normal range. She was treated with intravenous diuretics.

A transthoracic echocardiogram (TTE) demonstrated normal left ventricular (LV) systolic function, a small LV cavity with severe LV hypertrophy, and normal-appearing bioprosthetic aortic and mitral valves; however, there was obstruction of the LV outflow tract (LVOT) from the bioprosthetic mitral valve. Pulmonary artery systolic pressure was estimated to be 65 mm Hg, and LV ejection fraction was 65%. An electrocardiogram showed normal sinus rhythm, intra-atrial conduction delay, and LV hypertrophy, with more significant ST-T segment changes in the lateral leads. On a transesophageal echocardiogram (TEE), systolic narrowing of the LVOT was confirmed between the septum and the struts of the bioprosthesis (Figure 1). Turbulent flow was observed in the same region (Figure 2). The peak gradient across the LVOT was 113 mm Hg. It should be noted that when lining up the continuous-wave Doppler cursor across the LVOT, care was taken to avoid measuring the flow across the aortic valve.

Figure 1. *Transesophageal echocardiogram showing the struts of a bioprosthetic mitral valve obstructing flow in the left ventricular outflow tract.*



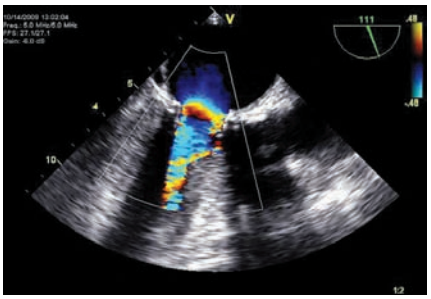


Figure 2. *Transesophageal echocardiogram showing turbulent flow across the left ventricular outflow tract.*

The patient was treated medically and had improvement of the pulmonary edema and symptoms; however, she declined a second mitral valve replacement with a mechanical valve after it was offered in an attempt to correct the obstruction.

Discussion

In patients who undergo mitral valve replacement with high- or low-profile prosthesis, LVOT obstruction is a well-recognized postoperative complication. The usual presentations are signs of low-output heart failure, hypotension with reflex tachycardia, increasing dyspnea following surgery, arrhythmias that may lead to syncope, atrial fibrillation, and pulmonary edema. A gradient can be seen across the LVOT on TTE, and Doppler techniques can provide additional information regarding the site, mechanism, and severity of the obstruction. A smaller ventricular cavity increases the chances of obstruction; however, no studies directly relating sex to the risk of developing LVOT obstruction have been performed.[1-4]

Preservation of the subvalvular apparatus during mitral valve replacement has been shown to be superior to mitral valve replacement alone.[5] With this technique, there is better preservation of LV function and improvement in long-term survival; however, there is an associated increased risk of developing LVOT obstruction. Mitral valve replacement has been shown to decrease the mitral-tricuspid angle, which can contribute to anterior displacement of the mitral apparatus. This may obstruct the outflow of the left ventricle, aggravated by a thickened interventricular septum, LV hypertrophy, a small ventricular cavity, or reduced preload (if the patient is on diuretics or has atrial fibrillation).[1,3,6]

Elevated LVOT gradients after mitral valve replacement can occur for many reasons, and the obstruction may be fixed or dynamic. The incidence ranges from 2% to 16%.[7] It can be managed with medications; however, surgery is indicated if signs and symptoms of obstruction emerge. Fixed LVOT obstruction is at times found with high-profile bioprosthetic valves because of incorrect orientation, resulting in the strut impinging on the LVOT.[4] Dynamic obstruction of the LVOT has been reported in patients with a reduced LV cavity size, small hypercontractile left ventricle, redundant mitral valve leaflets, anteriorly placed chordal apparatus, narrowed mitral-aortic angle, thickened septum, or systolic anterior motion of the preserved anterior mitral leaflet.[4,8,9] Relief of symptoms due to dynamic obstruction can be successful with the use of rapid infusion of intravenous fluids, β-blockers, or calcium channel blockers. Phenylephrine has been used if afterload is reduced. Studies have shown that systolic anterior motion with LVOT obstruction resolves with

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conservative therapeutic measures, with no need for late reoperation. However, when a severe LVOT obstruction develops, a more aggressive approach is generally needed.[10,11]

TTE is the image modality of choice to differentiate fixed from dynamic obstruction. The continuous wave Doppler flow profile may show a characteristic dagger shape for dynamic obstruction (Figure 3).[6,9,12] TEE is an important tool before mitral valve replacement with anterior leaflet preservation because it can help predict postprocedural LVOT obstruction.[13] There are distinct factors predisposing the LVOT to obstruction, such as a myxomatous mitral valve with redundant leaflets, a nondilated hyperdynamic left ventricle, and a thick interventricular septum, all of which can be evaluated using TEE. The use of a low-profile bioprosthetic valve and proper valve orientation reduce the risk of developing LVOT obstruction after mitral valve replacement.[9] Currently, new low-profile valves on the market in the mitral position include the Carpentier-Edwards PERIMOUNT Magna Mitral Ease valve (Edwards Lifesciences) and the St. Jude Biocor® valve (St. Jude Medical, St. Paul, MN). These valves may eliminate LVOT obstruction because of their design.

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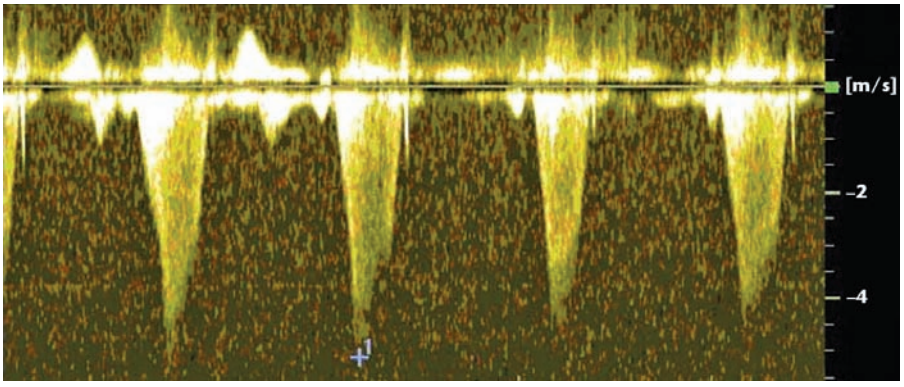
The clinical course of LVOT obstruction after mitral valve replacement varies significantly. Patients may be asymptomatic, and the timing of presentation of symptoms can also vary. Mortality can be high, as demonstrated by Waggoner and colleagues.[14] Six out of seven patients died within 2 months of their operation. Systolic anterior motion of the native anterior mitral leaflet was observed in all six patients. Mitral prosthetic function was normal in five patients.[14] Bortolotti and associates[2] also presented and discussed two fatal cases of LVOT obstruction after mitral valve replacement.

We recommend routine intraoperative TEE to assess the LVOT after mitral valve replacement, especially when the subvalvular apparatus is preserved.[3] If late LVOT obstruction develops after using a bioprosthetic valve, depending on symptoms and the status of the patient, repeat mitral valve replacement with a mechanical valve, or replacement with one of the new low-profile valves, are surgical options. ■

Figure 3. *Doppler profile of the left ventricular outflow tract demonstrating the characteristic dagger shape appearance for dynamic obstruction.*



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Main Points

- Left ventricular outflow tract (LVOT) obstruction after mitral valve replacement is a well-recognized postoperative complication.
- Intraoperative transesophageal echocardiography should be used to assess the LVOT after mitral valve replacement.
- Medical therapy is used initially for relief of symptoms.
- Repeat surgery may be needed with a mechanical valve or a low-profile bioprosthetic valve.

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