“Obstruction Alternans”: A Rare Presentation of Mechanical Mitral Valve Obstruction

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INTRODUCTION

Mechanical valves have greater durability compared with bioprosthetic valves but are associated with distinct long-term complications. These complications include bleeding due to required oral anticoagulants, embolic events, and valvular obstruction. We present a case of a dysfunctional Medtronic-Hall tilting-disk mechanical mitral valve demonstrating a unique Doppler pattern of “obstruction alternans.”

CASE PRESENTATION

The patient was a 70-year-old man at the time of presentation to our institution. In 1997 he developed severe mitral regurgitation due to degenerative valvular disease with ruptured chordae tendineae. He underwent placement of a 29-mm Medtronic-Hall tilting-disk valve in the mitral position with concomitant two-vessel bypass surgery. His perioperative course was unremarkable, and he returned to normal functional capacity. His only significant interval history was a small stroke in 2013, which occurred when his anticoagulation was withheld for 9 days before colonoscopy.

In June 2017 he was hospitalized with a soft tissue hematoma after a fall, with a supratherapeutic international normalized ratio of 8.56. Transesophageal echocardiography was ordered during that admission and demonstrated a mean gradient of 8 mm Hg, and pressure halftime was 106 msec at a heart rate of 89 beats/min (Video 1). The patient had no cardiac symptoms at that time, and no additional investigation of the valve was undertaken. He was eventually discharged home on a reduced dose of warfarin with bridging anticoagulation using enoxaparin.

In approximately October 2017 the patient developed exertional dyspnea progressing over several months and leading to admission to our cardiology service with acute decompensated heart failure. At the time of admission, his international normalized ratio was subtherapeutic at 1.47, and he was in normal sinus rhythm on electrocardiography. Unfractionated heparin infusion was started. Auscultation demonstrated abnormal mechanical heart tones. On alternating beats we heard either a single closing click or two closing clicks.

Transesophageal echocardiography showed normal systolic left ventricular function. Both color flow and spectral Doppler imaging of the mitral valve demonstrated higher and lower transmitral flows on alternating beats (Figure 1).

Also demonstrated on the spectral imaging in Figure 1 is a pattern of alternating single and double closing clicks that correlates with auscultatory findings. The double click always followed an interval of normal transmitral flow, whereas the single clicks occurred after an interval of reduced flow. On the beats with the greater degree of flow, the average transmitral gradient was 9 mm Hg, with a peak E velocity of 2.4 m/sec at a heart rate of 67 beats/min (Figure 2).

Cine fluoroscopy was performed confirming abnormal mitral valve motion with partial opening of the valve on alternating beats (Figure 3, Video 2).

Transesophageal echocardiography was performed the next day and showed evidence of pannus formation on three-dimensional imaging and a similar pattern of alternating transmitral flow. The transmural gradient was 12 mm Hg at a heart rate of 93 beats/min. No thrombus was identified on either study (Figure 4, Videos 3, 4, and 5).

After 5 days of heparin infusion and aggressive diuresis, transthoracic echocardiography was repeated. We observed a similar, alternating restricted valve pattern with a further rise in the transmural gradient to 17 mm Hg at a heart rate of 83 beats/min (Figure 5).

The patient had persistent symptoms of dyspnea and a brief episode of atrial fibrillation with spontaneous conversion to normal sinus rhythm during his admission. Given his progressive clinical symptoms, new-onset atrial fibrillation, extensive pannus formation, and rising mitral valve gradients, he was referred for repeat mitral valve replacement. In addition to his valvular disease, preoperative evaluation demonstrated severe coronary artery disease and severe tricuspid regurgitation. He underwent repeat mitral valve replacement with a 29-mm bioprosthetic valve, tricuspid valve annuloplasty, and two-vessel coronary artery bypass grafting (Figure 6).

DISCUSSION

Mechanical mitral valve prosthesis obstruction can be due to pannus ingrowth, thrombus, entrapment of papillary muscles, or valvular endocarditis restricting the occluder’s motion. The most common of these are pannus formation and thrombus, and differentiation of these two entities can be difficult.

Abrupt changes in symptoms or gradient are usually attributed to thrombus formation, whereas gradual symptoms or gradient progression is more typical of pannus formation. Compared with thrombus, pannus is usually less mobile, is typically confined to the area around the sewing ring, and is more dense and echogenic. Transthoracic echocardiography is indicated when clinical symptoms or signs suggest prosthetic valve dysfunction. Frequently, visualization of mechanical valve motion on two-dimensional transthoracic echocardiography is difficult because of artifact. Because of this limitation, Doppler imaging should be performed each time a mechanical valve is assessed. Doppler indicators of a stenotic mitral valve prosthesis include pressure halftime > 200 msec, peak E wave > 1.9 m/sec, or mitral valve velocity-time integral/left ventricular outflow tract velocity-time integral ratio ≥ 2.2. Also, an elevated mean transmitral
gradient may also suggest valve stenosis. A mean gradient > 5 to 6 mm Hg is suggestive of possible obstruction, while a mean gradient > 10 mm Hg suggests severe stenosis. At each assessment, these parameters should be compared with previous values for the individual patient. M-mode imaging may occasionally provide additional insight because of its high temporal resolution.

Valvular obstruction is most commonly consistent from beat to beat but in rare cases may be intermittent. In our case the mitral valve motion changed with every other beat, creating the “obstructive alternans” pattern. Alternatively, intermittent valve obstruction may occur less frequently or in an inconstant pattern. This phenomenon can be missed on Doppler imaging if the image loop duration is too short. Therefore it is important when echocardiography is being performed for suspected prosthetic valve dysfunction that longer image loops be collected.

The physiology behind the alternating obstructive pattern in our case is likely related to the left atrial pressure required to overcome
Figure 3  Cine fluoroscopy of the mechanical single tilting disc mitral valve prosthesis. (A) Diastolic frame showing an open mitral disc (white arrow). (B) The next diastolic frame with incomplete opening of the mitral disc (green arrow).

Figure 4  Three-dimensional (3D) transesophageal echocardiographic image of a single disc mechanical mitral valve, viewed en face from the left atrial perspective, demonstrating pannus formation (red arrows).

Figure 5  Continuous wave (CW) spectral Doppler through the mechanical mitral valve by transthoracic echocardiography after five days of unfractionated heparin infusion. The alternating obstruction is still present (red arrow) and the transmitral gradient has increased to 17 mm Hg at a heart rate of 83 beats/min (green arrow head). 2D, Two-dimensional.
the friction created by the pannus ingrowth onto the prosthetic leaflet. During the first atrial filling interval of the cardiac cycle, the atrial pressure does not rise enough to fully open the single occluder at the beginning of ventricular diastole, and only limited transmitral flow occurs. The residual volume in the left atrium following the restricted motion cycle results in increased left atrial pressure during the next cycle. The higher left atrial pressure during the next cycle is enough to overcome the restriction and fully open the valve, allowing more complete emptying of the left atrium and a normal mitral flow pattern with discrete E and A waves.

In addition, this case highlights the importance of assessing subtle clinical changes of prosthetic valves. The patient had no significant pannus visualized with mildly elevated gradients 4 months before he required mechanical valve replacement. More extensive workup during that admission might have been able to detect more significant prosthetic valvular dysfunction than initially thought by his transthoracic echocardiography.

CONCLUSION

There are very few cases of “obstruction alternans” reported in the literature. To our knowledge, only one other case involved a Medtronic-Hall mechanical mitral valve (also a 29-mm valve), but that patient had intermittent restriction and delayed opening. In patients with mechanical valves who present with dyspnea or evidence of clinical heart failure, although rare, intermittent valvular obstruction should be considered. This presentation can be very difficult to appreciate but when present indicates advanced prosthetic valvular disease.

For this reason, the assessment of prosthetic heart valves should include transthoracic echocardiography, transesophageal echocardiography, and cine fluoroscopy if no other explanation can account for the patient’s symptoms. Urgent diagnosis is recommended because rapid deterioration can occur if treatments for a dysfunctional mechanical valve are delayed.

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SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.case.2018.06.001.

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