

## CASE OF THE MONTH

### A 70-Year-Old Woman with Acute Dyspnea and Mechanical Aortic Valve

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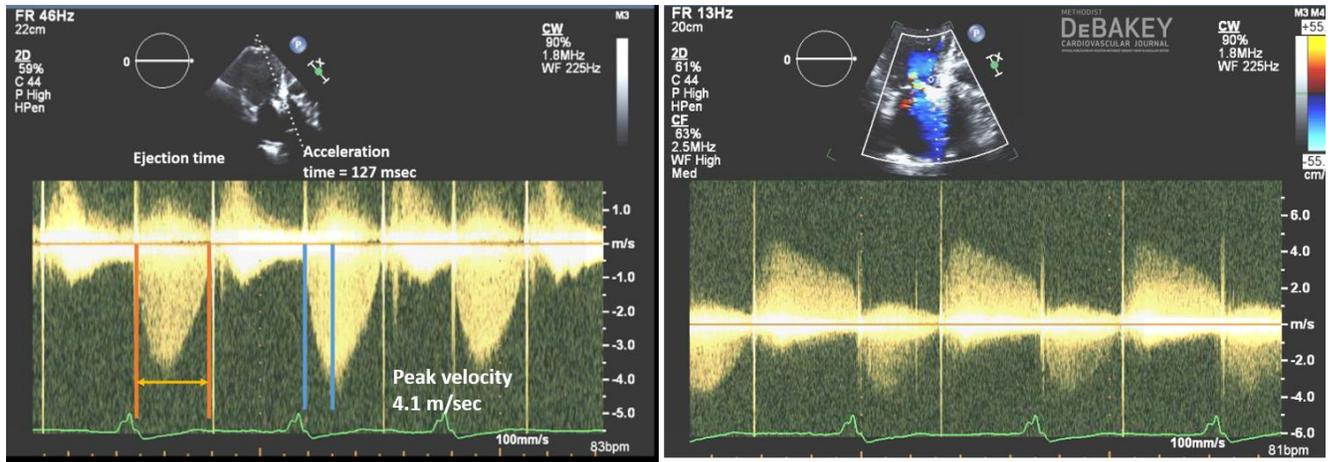
### CLINICAL PRESENTATION

A 70-year-old, retired female nurse presented to an outside hospital with 2 days' history of shortness of breath (NYHA class III) and lower-extremity edema. Her history was relevant for 40-pack-year smoking, diabetes, hypertension, two mechanical aortic valve replacements (2006 and 2011) for aortic stenosis (last replacement with 21 mm SJM Regent™), peripheral and carotid artery diseases with previous bilateral carotid endarterectomy, and aortofemoral bypass. The patient was compliant with her medical regimen and had no history of hospitalization since her surgery.

On physical examination, she was tachypneic (respiratory rate 30 breaths/min) with a pulse rate of 130 bpm, an oxygen saturation of 89%, and a blood pressure of 121/82 mm Hg. Cardiopulmonary examination showed elevated jugular venous pressure, bilateral crackles, and a harsh grade III/VI systolic ejection murmur heard over the precordium. Lower extremities showed pitting edema. Her electrocardiogram demonstrated atrial fibrillation with rapid ventricular response and chest X-ray showed bilateral pulmonary venous congestion. Laboratory workup revealed a white cell count 12.9 k/ $\mu$ l, hemoglobin 10.5 g/dl, creatinine 1.12 mg/dl, brain natriuretic peptide of 1960 pg/ml and international normalized ratio (INR) of 3.0. The patient was given IV diltiazem, Lasix, and positive airway pressure support, then transferred to Houston Methodist for further management.

On arrival to our institution, she had a regular pulse at 86 bpm, respiratory rate of 20 breaths/min, blood pressure of 140/62 mm Hg, and O<sub>2</sub> saturation of 97% on 4L nasal cannula. A transthoracic echocardiogram (TTE) was performed (Video 1). Other findings not shown on the video included: a left ventricular (LV) internal diameter in diastole (LVIDd) of 5.2 cm, dilated left atrium, and spectral Doppler findings that were consistent with a pulmonary artery systolic pressure of > 50 mm Hg (Figure 1). The prosthetic aortic valve dimensionless index was 0.26 with an effective aortic orifice area of 0.9 cm<sup>2</sup>.

**Video 1.** [https://youtu.be/\\_AomY2JWw48](https://youtu.be/_AomY2JWw48)



**Figure 1.** Spectral Doppler.

**QUESTION 1:** What is the most likely diagnosis?

- Patient-prosthesis mismatch with aortic regurgitation
- Obstructed mechanical aortic valve
- High-flow state with aortic regurgitation
- Significant paravalvular leak

**ANSWER**

*B: Obstructed mechanical aortic valve*

TTE showed mildly dilated LV with preserved systolic function (estimated LV ejection fraction of 65-69%). The mechanical aortic valve leaflet discs were poorly visualized on short axis view; however, on color Doppler at least moderate aortic regurgitation was noted (note the short pressure-half time on the CW tracing in Figure 1). In addition, transaortic velocities and gradients were significantly elevated (mean gradient of 36 mm Hg, peak velocity of 4.1 m/sec), acceleration time (AT) was prolonged at 127 msec with an acceleration time/ejection time (AT/ET) of 0.4, (values  $\geq 0.4$  considered significant for prosthetic valve obstruction<sup>1</sup>), and the dimensionless index was 0.26 (normal  $> 0.30$ ). Effective orifice area was 0.9 cm<sup>2</sup>. These findings were all consistent with prosthetic aortic valve obstruction.

**QUESTION 2:** Which of the following diagnostic tests is recommended?

- Cinefluoroscopy
- Transesophageal echocardiogram (TEE)
- Cardiac MRI
- Cardiac Multidetector Computed Tomography (MDCT)

**ANSWER**

*B: Transesophageal echocardiogram (TEE)*

Given TTE findings consistent with mechanical prosthetic aortic valve obstruction, the next set of tests are directed at determining the cause of the obstruction, which usually consists of either a thrombus within the prosthesis or pannus formation behind the prosthesis that limits disc motion. Although any of the choices given above could be used, TEE is the procedure most frequently selected for these cases.

According to the 2017 AHA/ACC Guidelines for the Management of Patients with Valvular Heart Disease, TEE is recommended (Class I level of evidence A) in patients with suspicion for prosthetic valve thrombosis.<sup>2</sup> In comparison to MRI, TEE has higher spatial resolution, and mechanical valves will create artifacts in MRI that may hinder the assessment of prosthesis difficult.

TEE was performed (Video 2); 4 quadrants are shown. The prosthetic valve appeared well seated with no evidence of dehiscence. No gross masses were seen but there was limited disc mobility visualization. Central transvalvular aortic regurgitation was noted. Given the non-diagnostic findings by TEE, the attending cardiologist elected to start patient empirically on heparin and requested a surgical consultation.

**Video 2.** <https://youtu.be/XqMTx2Q-KgM>

**QUESTION 3:** What other test would be helpful to evaluate leaflet motion?

- a) Cardiac Multidetector Computed Tomography (MDCT)
- b) Cinefluoroscopy
- c) Either B or B

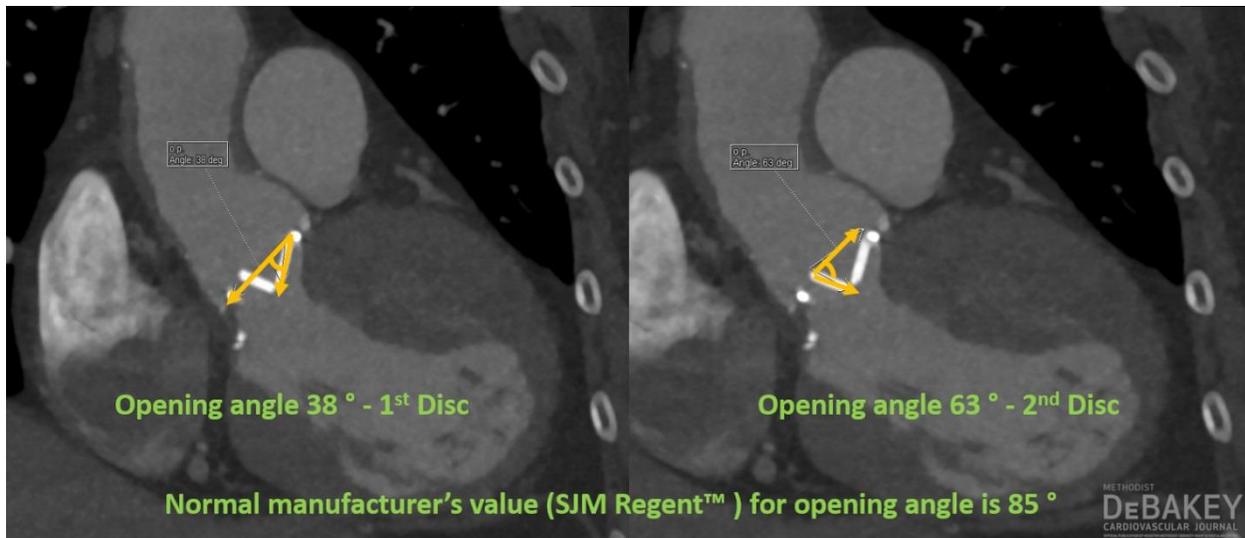
**ANSWER**

*C: Either A or B*

In this case, the new onset of central regurgitation is likely related to interference with closure of leaflet discs, whether due to thrombus or pannus. Historically, cinefluoroscopy has been used for assessment of leaflet discs due to superior temporal and spatial resolution. Recent advances in cardiac MDCT has allowed dynamic leaflet/disc evaluation, and at times visualization of pannus or thrombotic overgrowth<sup>3</sup> Cinefluoroscopy was performed (Video 3) showing complete immobilization of one of the discs. In trying to discern pannus ingrowth versus thrombus, a cardiac MDCT was done on the fifth hospital day; this test demonstrated a frozen disc and restricted opening angle of the other disc (Video 4A; Figure 2). However, no gross evidence of valve thrombosis or pannus overgrowth was noted (Video 4B).

**Video 3.** <https://youtu.be/pnnimdMmb1c>

**Video 4a.** <https://youtu.be/GA1AXxHv1VQ>



**Figure 2.** Cardiac multidetector computed tomography.

**Video 4b.** <https://youtu.be/TPC-8gbuE1Q>

**Question 4: What would be the best next step in management?**

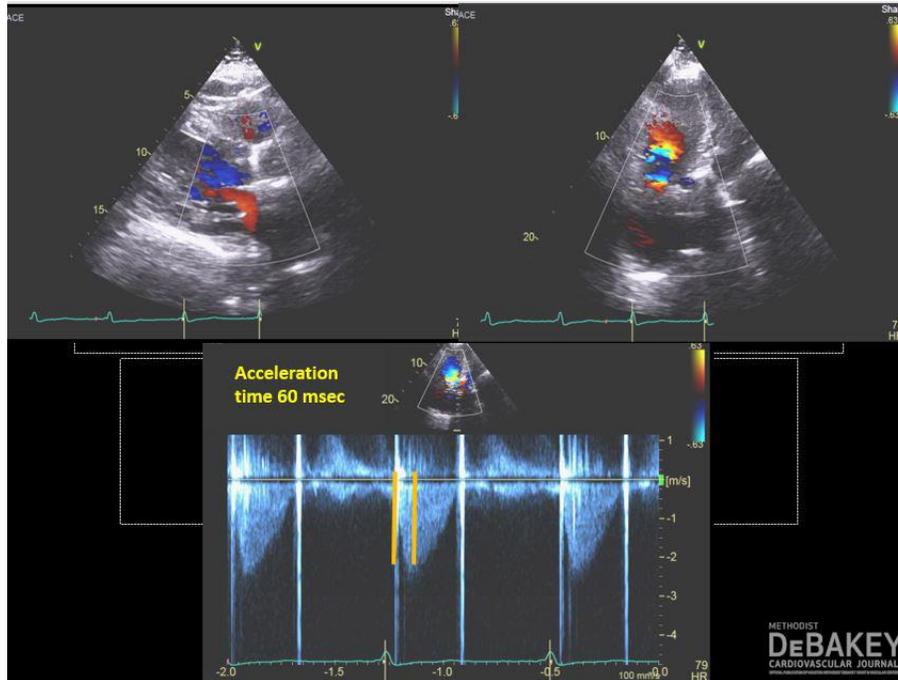
- a) Recommend redo aortic valve surgery
- b) Systemic thrombolysis
- c) Continue medical management with anticoagulation

**ANSWER**

*B: Systemic thrombolysis*

At this point, the clinical decision making was challenging due to the lack of a precise mechanism of valve obstruction (i.e., thrombus versus pannus). The acute presentation with heart failure increased the likelihood of a thrombus whereas the normal INR favored the diagnosis of a pannus.<sup>4</sup> After consultation with the surgical team, the patient was deemed a high surgical risk given two prior open heart surgeries. Thus, a decision was made to proceed with fibrinolytic therapy on the premise that the acute presentation was indicative of prosthetic valve thrombosis. Her INR was allowed to go down to 1.7 and the patient started on alteplase on a low-dose, slow infusion protocol at a rate of 1 mg/hr for a total dose of 48 mg. At 48 hours, repeat cinefluoroscopy showed restoration of normal leaflet motion with normal opening and closing angles of both discs (Video 5). A repeat TTE (hospitalization day 9) revealed a normal sized LV (LVIDd of 4.3 cm) with normal systolic function. There was dramatic reduction in prosthetic valve peak velocity to 2.45 m/sec (Figure 3), mean gradient to 12 mm Hg (from 36 mm Hg), acceleration time to 60 msec (from 120 msec) without evidence of aortic regurgitation, and an improved calculated aortic valve area of 1.5 cm<sup>2</sup>.

**Video 5.** [https://youtu.be/xOE8vj\\_Et-8](https://youtu.be/xOE8vj_Et-8)



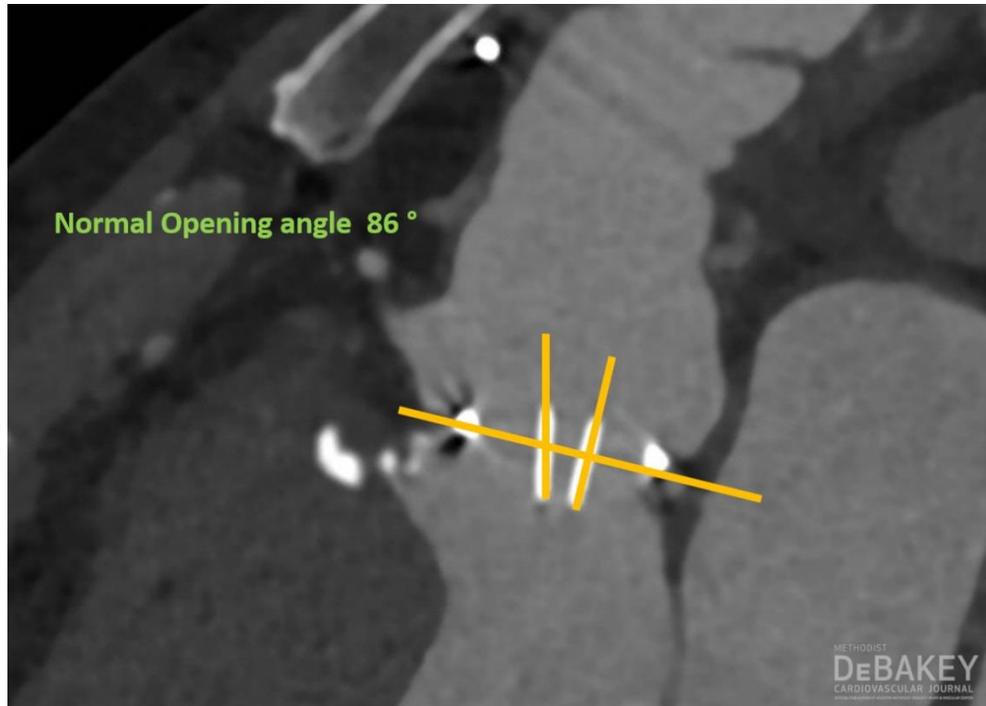
**Figure 3.** Repeat transthoracic echocardiogram.

## OUTCOMES AND FOLLOW-UP

The patient experienced no bleeding or thrombotic complications after the administration of low-dose alteplase. She was bridged from heparin to Coumadin and discharged home after achieving two therapeutic INR values with a target INR of 3-3.5. A TTE prior to discharge showed normal prosthetic velocities and gradients and no evidence of aortic regurgitation.

## DISCUSSION

We report a unique case where multimodality imaging was used in evaluating prosthetic valve obstruction. Differentiating thrombus from pannus in our case was challenging, as both can cause restriction of leaflet motions (though almost always present in patients with valve thrombosis). Although echocardiography (TTE and TEE) plays a major role in the diagnosis of an obstructed mechanical prosthetic valves, cinefluoroscopy and dynamic CT can be extremely helpful in documenting which disc is affected and, at times, giving clues as to the presence of thrombus versus pannus.<sup>4</sup> Cinefluoroscopy, however, requires proper patient positioning with the X-ray beam parallel to both the valve ring and the tilting axis of the leaflets, which is not the case in cardiac CT. Measurement of opening and closing angles reported on MDCT have closely correlated with manufacturer's values.<sup>5</sup> Figure 4 illustrates a normally functioning bileaflet aortic valve with normal opening angles per manufacturer.



**Figure 4.** Cardiac multidetector computed tomography.

In our case, no definitive thrombus or pannus was visualized to explain the prosthetic valve obstruction on Doppler echocardiography and the frozen disc on cinefluoroscopy/MDCT. The patient had also been compliant with anticoagulation and had a therapeutic INR on admission. However, new onset heart failure and central transvalvular regurgitation was more in favor of prosthetic valve thrombosis rather than pannus formation.<sup>6,7</sup> Furthermore, although infrequent (< 10%), a therapeutic INR has been reported in patients with prosthetic valve thrombosis.<sup>8</sup>

Left-sided prosthetic valve thrombosis is rare but life threatening, with a reported incidence of 0.5 to 6% per patient-year.<sup>9</sup> The standard treatment has been surgery, but more cases over the past two decades have demonstrated feasibility of thrombolytic treatment as first line agent, with a recent meta-analysis analyzing 48 studies demonstrating lower mortality rate with thrombolysis compared to surgery (6.6% vs 18.1%), higher rates of thromboembolic events (12.8% vs 4.6%), but similar risk of stroke (5.6% vs 4.3%), respectively.<sup>10</sup> According to the AHA/ACC Guidelines for the Management of Patients with Valvular Heart Disease, emergent surgery or low-dose slow-infusion thrombolytic therapy is recommended to correct severe valvular obstruction (Class I level of evidence B).<sup>2</sup> However, there is no consensus on the type or dosage of thrombolytics in this setting.

In the largest cohort to date of prosthetic valve thrombosis, Ozkan<sup>11</sup> reported an 85% success rate with no mortality and only 4.8% risk of major complications (embolization or hemorrhage) in patients treated with slow (6 hr) infusion of low-dose alteplase (25 mg) for prosthetic valve obstruction. More recently, the low-dose, slow (25 hr) infusion protocol of alteplase was studied in a single center setting in 114 patients and showed remarkable success rate of 90% with 1 reported mortality and 3.3% risk of non-fatal major complications.<sup>8</sup>

#### **TAKE-HOME MESSAGES**

- The differentiation between pannus and thrombus as the cause of mechanical prosthetic obstruction remains challenging, and multimodality imaging is highly recommended.
- Mechanical valve thrombosis is rare but serious. A high index of suspicion is required in patients with elevated prosthetic valve velocities and lack of disc motion even in the absence of demonstrating thrombotic mass.
- Newer regimen of low-dose, slow infusion of alteplase therapy proved safe and effective in patients considered extremely high risk for surgical reintervention.

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