Echocardiographic Demonstration of Outlet Strut Fracture of a Björk-Shiley Mitral Prosthesis

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Fracture of the outlet strut of the Björk-Shiley mitral valve prosthesis has been recognized with increasing frequency, prompting recall of unimplanted valves manufactured before March 1982. Presenting dramatically with acute severe pulmonary edema and low cardiac output, strut fracture is frequently a fatal complication.

The Björk-Shiley valve is a widely used prosthetic device with attractive hemodynamic characteristics and durability. The present valve is a 60° convexo-concave valve consisting of two struts on either side of a Pyrolite carbon occluder disc. Since its inception in 1969, the valve has undergone several modifications, including machining of the inlet strut from the plate stock used for the valve ring with the minor outlet strut welded on later (1). Although the early series of valves were relatively free of mechanical failure, a recall was instituted between February 1981 and March 1982 because of an incidence of frequently fatal outlet strut fracture three times that of previous years (1–5). We present the first reported case of echocardiographic documentation of outlet strut fracture with disc dislodgment.

Case Report

Clinical presentation. A 36 year old Marfanoid white man underwent aortic and mitral valve replacement with Björk-Shiley prosthetic valves for valve incompetence resulting from infective endocarditis on intrinsic "floppy valves." The patient did well postoperatively. Seven months later, he presented to our emergency room with an 8 hour history of severe shortness of breath and hemoptysis. He was in severe respiratory distress and complained of cough and dyspnea. Physical examination revealed a tachypneic, cyanotic man in severe respiratory stress, coughing up copious amounts of blood-tinged sputum. The blood pressure was 70 mm Hg systolic, heart rate 160 beats/min and regular and respiratory rate 56 breaths/min and labored. The skin was cool, clammy and mottled. Auscultation of the chest revealed diffuse rales and wheezes. The peripheral pulses were diminished, the neck veins were flat and the carotid artery upstrokes were brisk but with a reduced volume. There was a precordial impulse in the area of the left ventricle, and asynchronous mechanical events could be palpated. Auscultation of the heart revealed a clattering of sounds with an indistinguishable relation to the cardiac cycle and no demonstrable murmurs. The electrocardiogram revealed left ventricular hypertrophy with ST-T wave changes and sinus tachycardia. The chest X-ray film revealed pulmonary edema. The patient was immediately treated with intravenous dopamine and furosemide (Lasix) and intubation with 100% forced inspiratory oxygen and 10 cm of positive end-expiratory pressure.

Echocardiographic findings. It was believed that the patient had acute valvular insufficiency, although which valve was involved was not clear. A decision for emergency exploratory cardiac surgery was made. While readying the support services of the operating room, perfusionist and cardiac surgeon, a limited two-dimensional echocardiographic study was obtained (Fig. 1 and 2). Doppler ultrasound recording was not available. Figure 1A is an apical four chamber view that demonstrates a slightly dilated left ventricle and left atrium with the presence of a prosthetic device in the mitral position. Figure 1B demonstrates a bright echo-dense object in the middle of the left ventricle which is absent in the previous frame. On real time display, this echo-dense object, which at surgery proved to be the
Figure 1. A, Two-dimensional echocardiogram, four chamber view, demonstrating a minimally dilated left ventricle (LV) that was shown to be contracting vigorously on real time scanning. The left atrium (LA) is moderately enlarged and the mitral prosthetic device (M, arrow) was not rocking excessively. B, The same view several frames later demonstrates a large, bright echodense object (arrow), proved at surgery to be the dislodged disc from the mitral valve, which was flying in and about the left ventricle, colliding with the chamber walls with each contraction and moving in and out of the ultrasound beam on subsequent frames.

Figure 2. A, Two-dimensional echocardiogram, long-axis view, demonstrating a clear and clean left ventricle (LV) without demonstrable echogenic densities or masses. The left atrium (LA) is moderately enlarged. A portion of the prosthetic mitral device (M) is demonstrated, although the bright redundant echogenic densities often seen in association with a tilting disc prosthesis are conspicuous by their absence. B, The same view several frames later demonstrates a large mass of echogenic densities (arrow) generated by the escaped mitral prosthetic disc. This mass nearly completely occupies the left ventricular cavity, which can be identified by the ventricular septum (vs).
dislodged mitral occluder disc, could be seen flipping in and about the left ventricle with each contraction. The mitral valve ring itself appeared to be well seated without excessive rocking, although the mitral prosthetic disc was not visualized. Overall, left ventricular contractility was intact. Figures 2A and B are long-axis views demonstrating the diffuse, bright, echo-dense occluder disc as it flips around in the ventricle, absent in one frame and echogeneric prominent in the next. A stable prosthetic ring was identified in the aortic position, although technical limitations precluded resolution of disc motion.

Clinical course. The patient was rushed to the operating room, where cardiopulmonary bypass was achieved through the femoral approach. The aorta was cross clamped and incised and the prosthetic aortic valve ring inspected; there was no mechanical valve defect, only a small perivalvular rent that was repaired with a pledgeted suture. The left atrium was incised and the prosthetic mitral valve visualized; the occluder disc was dislodged from the mechanical valve and was sitting in the apex of the left ventricle and the outlet strut of the mitral valve was missing. The mitral valve was excised and replaced with a St. Jude bileaflet prosthesis. The patient was weaned from cardiopulmonary bypass without difficulty and had an uneventful postoperative course. The outlet strut was never recovered and presumably escaped through the aortic prosthesis. Embolization of the occluder disc was prevented by the aortic prosthesis. Computed tomographic scanning, to locate the escaped strut, was planned after hospital discharge, but the patient was lost to follow-up.

Pathology. Figure 3 shows a pathologic specimen of the excised 29 mm Björk-Shiley mitral valve ring demonstrating the conspicuous absence of the minor outlet strut from the points to which it was welded on the valve ring. To the left of the valve ring is the occluder disc, which was found floating free in the left ventricular apex.

Discussion

Mechanical valve failure. The Björk-Shiley tilting disc mechanical prosthesis is widely used because of its attractive hemodynamic characteristics and proved durability. However, since a modification in the manufacturing process in 1976, there has been a disturbing number of cases of fracture of the outlet strut in the mitral valve prosthesis in sizes 29 to 33 mm (1–4). The estimated incidence of strut fracture in models of this valve manufactured between February 1982 and March 1982 was approximately 0.3 percent, which is three times greater than that of previously inserted valves of this type (2). Recognizing this increased incidence of outlet strut fracture at the welding point, the Shiley Company recalled all unimplanted valves manufactured before February 28, 1982 (5). Subsequent reports (2,3) of outlet strut fracture in patients with valves manufactured after that date have raised the question of whether the problem with the outlet strut weld has persisted. In addition to potential manufacturing defects, possible contributing factors to outlet strut fracture include deformation of the outlet strut from improper storage, improper sterilization in nonrigid containers and utilization of an improperly sized holder set for valve insertion or rotation (1). The outlet strut fractures have occurred only in the mitral prostheses of sizes 29 to 33 mm, usually within 12 months of implantation (2,3). These prostheses may be prone to fracture because of greater stress across the orifice area (3), or perhaps because the outlet strut is longer in these larger valves, with coincident greater stress in the fulcrum area stressing the welding point (4).

Evaluation of mechanical valve failure. When this patient presented with acute hemodynamic decompensation, which by clinical evaluation appeared to be related to severe valvular regurgitation, it was not initially clear whether the dysfunction was from the aortic or mitral valve or precisely what the mechanism of this valve incompetence was. The differential diagnosis for decompensation in such patients would include valve dehiscence from infection or suture dislodgment, improper seating of the tilting disc secondary to thrombus or vegetation or mechanical failure from fracture of the struts or disc. Clinical signs of mechanical valve failure may include asynchronous and clattering mechanical events related to the displaced disc. A prominent murmur is telling, although the absence of a murmur does not exclude valve incompetence in a patient with low cardiac output and a wide open leak. Prompt treatment is essential when such patients are in dire hemodynamic straits and cardiac catheterization is inappropriate. The clinical presentation of precipitous hemodynamic compromise characterized by acute severe pulmonary edema and low cardiac
output may, in and of itself, be enough to warrant exploratory cardiac surgery. This case demonstrates that two-dimensional echocardiographic examination can be a useful tool in evaluating acute severe mechanical prosthetic failure. Mechanical valve failure may appear on echocardiography as excessive valve rocking reflecting valve dehiscence, chamber enlargement from valve insufficiency or lack of motion of a disc, ball or tissue leaflets that may be obstructed, dislodged or otherwise dysfunctional. Doppler ultrasound recording, if available, should successfully localize the incompetent valve and may define the mechanism of dysfunction.

References