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Perioperative Challenges of Valvular Replacement in Patients After Mediastinal Radiation Therapy

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MEDIASTINAL RADIATION THERAPY can induce a wide spectrum of cardiovascular pathology, and the potential perioperative risks for patients after radiation therapy who require valvular surgery remain underappreciated. These patients frequently present with symptoms consistent with a deterioration in cardiac function despite optimal medical management, and surgical intervention becomes an option to extend and improve quality of life. Interestingly, some of these patients may appear to have normal left ventricular function based on preoperative workup, which may be deceiving to the unfamiliar practitioner when developing an intraoperative management plan. The authors retrospectively reviewed their experience with this delicate subset of patients to collectively identify intraoperative challenges and outcomes.

Between January 2008 and August 2010, 10 patients who had prior radiation therapy to the chest underwent cardiac surgery for aortic/mitral valve replacement/repair at the authors' institution. The reasons for prior radiotherapy were Hodgkin's or non-Hodgkin's lymphoma (n = 7), breast cancer (n = 2), and lung cancer (n = 1). Because radiotherapy for lymphoma exposes mediastinal structures to maximum radiation, this subset of patients was reviewed further.

At the time of surgery in these patients, cardiac tissues were consistently noted to be friable with significant valvular stenosis and insufficiency, and repair proved to be technically challenging. Patients were weaned successfully from bypass although most required substantial vasoactive medications and/or mechanical circulatory support. In addition, during the postoperative period, cardiac performance continued to decline, leading to significant morbidity and mortality. For discussion purposes, the hospital course of 3 of the authors' most challenging cases is presented.

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CASE REPORTS*

Case 1

A 48-year-old woman presented for mitral and aortic valve replacement because of severe regurgitation of both valves along with mitral stenosis. She received mediastinal radiation therapy for Hodgkin's lymphoma 15 years prior and subsequently was diagnosed with radiation-induced nonischemic cardiomyopathy. A transthoracic echocardiogram (TTE) showed a left ventricular ejection fraction (LVEF) of 20% to 25% and aortic and mitral valve disease. Surgical intervention was recommended in an attempt to improve the patient's quality of life. She had invasive arterial and pulmonary artery catheters placed before anesthetic induction. The patient was hemodynamically stable and strong enough to transfer without assistance to the operating table. After induction with 18 mg of etomidate, 100 μg of fentanyl, and 8 mg of pancuronium, she had cardiovascular collapse with pulseless electrical activity. Using successive doses, a total of 16 μg of epinephrine and 2 U of vasopressin were given, and after several minutes her vital signs normalized. Transesophageal echocardiography (TEE) then showed an LVEF of 25%, severe global myocardial hypokinesis, sclerotic and calcified aortic and mitral valves with severe regurgitation, severe mitral stenosis, and a normal-appearing tricuspid valve with severe insufficiency (Figs 1 and 2). She had an uneventful surgical course, with aortic and mitral bioprosthetic valve replacements and tricuspid valve annuloplasty. With atrioventricular pacing, an intraaortic balloon pump (IABP), and significant doses of inotropic and vasoactive medications, the patient was separated successfully from cardiopulmonary bypass (CPB) despite minimal improvement in her ventricular function. Upon arrival in the intensive care unit, she had an episode of pulseless ventricular tachycardia and was resuscitated successfully. She was extubated on postoperative day 2 without neurologic sequelae. However, despite adequately functioning prosthetic valves, she never displayed myocardial recovery and later developed multiple organ system failure. Care was withdrawn after 3 months.

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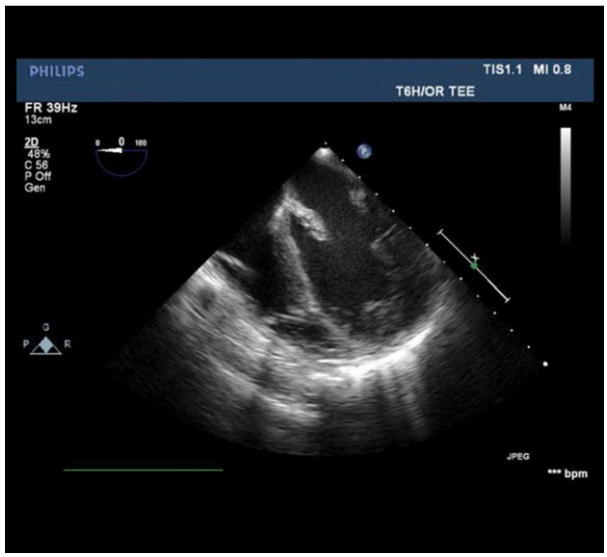

Fig 1. A transesophageal echocardiogram of midesophageal 4-chamber 2-dimensional view showing thickened and sclerotic appearance of the anterior mitral valve leaflet.

Case 2

A 79-year-old woman presented for aortic and mitral valve replacement because of severe aortic (area = 0.7 cm^2) and mitral stenosis with regurgitation. She had a history of both Hodgkin's and non-Hodgkin's lymphoma treated with mediastinal radiation therapy. Additional cardiac history included pulmonary hypertension and pacemaker dependence. She previously had been managed successfully medically; however, because of worsening shortness of breath, she agreed to proceed with operative intervention. Preoperative TTE confirmed severe aortic and mitral valvular disease, severely elevated right ventricular systolic pressure, and an estimated LVEF of 50% to 55%. At the time of surgery, cardiac tissues were noted to be friable with significant calcification and stenosis of valves. After repair, she was weaned successfully from CPB and transferred to the cardiac intensive care unit. Postoperative TEE showed normal left ventricular and right ventricular function and normally functioning bioprosthetic valves. She remained hemodynamically stable and subsequently was discharged home but returned 6 weeks later in severe heart failure. An IABP was placed emergently via the left femoral artery. On further workup, she was found to have severe perivalvular leaks of her prosthetic aortic and mitral valves. The decision was made to return to the operating room for exploration and repair. A friable myocardium was encountered, resulting in a tear in the right ventricle. Despite the immediate initiation of CPB, repair of the wound proved to be futile, and the patient subsequently died in the operating room.

Case 3

A 37-year-old woman with a history of Hodgkin's lymphoma treated with radiotherapy and chemotherapy in 1992 presented to the authors' institution in congestive heart failure with respiratory distress requiring endotracheal intubation. Her surgical history included mitral valve ring placement and atrial ablation. Preoperative TTE showed normal right ventricular and left ventricular systolic function (LVEF = 60%-65%), severe tricuspid regurgitation, moderate pulmonic regurgitation, moderately elevated right ventricular systolic pressure, and moderate mitral stenosis with a mitral valve prosthetic annular ring. The decision was made to proceed with mitral valve replacement, tricuspid ring annuloplasty, and a complete maze operation. The surgical procedure proved technically challenging because of severe fibrosis and scarring from her previous radiation and surgery and required 2 hours of meticulous dissection to free the aorta and atrium. At the conclusion of surgery, the prosthetic mitral valve showed normal function, and the tricuspid insufficiency was greatly reduced. Follow-up postoperative TTE showed normal left ventricular systolic function, a normally functioning mitral valve prosthesis, and mild/moderate tricuspid regurgitation. However, throughout her hospitalization, she required inotropic support, prolonged ventilatory support, and continuous venovenous hemofiltration after the development of acute renal failure. Subsequently, the patient's pulmonary status deteriorated and required prostaglandin therapy and nitric oxide to maintain oxygenation. Despite these measures, the patient's status continued to decline, resulting in cardiac arrest. The patient failed to respond to aggressive resuscitation and was pronounced dead.

Of the 4 remaining patients, 2 were discharged without major complication except for refractory bradycardia, which required permanent pacemaker placement. One patient had a previous history of aortic valve endocarditis and ultimately died of enterococcal bacteremia and multiple organ dysfunction 10 months later. One patient suffered from postoperative stroke and succumbed to respiratory failure 5 months after surgery.

DISCUSSION

In the authors' experience, performing complex valvular surgery in this fragile patient population was associated with many perioperative challenges. In patients with a history of lymphoma, repeated exposure to mediastinal radiation can cause a variety of cardiac diseases, including pericarditis, valvular disease, autonomic dysfunction, and accelerated coronary and peripheral vascular atherosclerosis.[1-4] In fact, radiation-associated cardiac complications have been identified as the leading cause of noncancer mortality among Hodgkin's lymphoma survivors.[1] Because of the myriad of cardiovascular complications associated with radiation therapy, the unfamiliar practitioner easily can overlook the delicate hemodynamic balance of these patients presenting for cardiac surgery. In this report, the authors presented several patients who

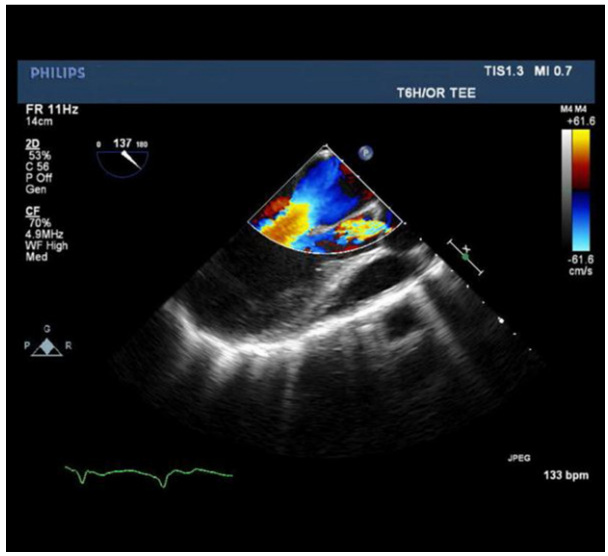

Fig 2. A transesophageal echocardiogram of the midesophageal aortic valve long-axis view showing severe aortic regurgitation with color-flow Doppler.