E-CHALLENGES & CLINICAL DECISIONS

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Severe Mitral Regurgitation Complicating Minimally Invasive Aortic Valve Replacement: Is It Functional or Organic?

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COSGROVE AND SABIK reported the first series of minimally invasive aortic valve replacements (mini-AVR) through a right parasternal incision in 1996, which was met with excellent outcomes.[1] Over the past 2 decades, various minimally invasive approaches have been utilized for aortic valve replacement (AVR) and have resulted in similar success.[2–9] Irrespective of the surgical technique employed, AVR may lead to mitral regurgitation (MR) when iatrogenic injury to the anterior mitral valve (MV) leaflet occurs. The mechanism of MR is caused predominantly by either anterior MV leaflet needle perforation or aortic valve (AV) periannular suture-induced anterior MV leaflet restriction, causing central or anteriorly directed MR, respectively. Although not well described, severe MR also can develop intraoperatively from reversible myocardial ischemia after AVR. The risk of developing ischemic MR is especially high after mini-AVR surgery, due to the difficulty in achieving optimal myocardial preservation, and is compounded by the difficulty encountered de-airing the left ventricle (LV) before weaning from cardiopulmonary bypass (CPB).

The occurrence of hemodynamically significant new-onset MR after mini-AVR thus requires a detailed intraoperative transesophageal echocardiography (TEE) examination to determine the etiology of the MR (functional or organic) and to help formulate an appropriate treatment plan. This is essential because of the high morbidity and mortality associated with moderate-severe MR, such as secondary pulmonary hypertension and biventricular remodeling. The authors present a case of new-onset severe MR after mini-AVR and describe the benefits of 3-dimensional (3D) TEE for intraoperative diagnosis and management.

CASE REPORT

A 71-year-old female with a complaint of dyspnea on exertion and near-syncope was referred to the authors' institution for cardiovascular evaluation. The patient's past medical history was significant for hypertension, hyperlipidemia, and hypothyroidism. Due to the presence of a systolic ejection murmur and accompanying symptoms, a transthoracic echocardiogram was performed. The results of the transthoracic echocardiogram revealed multiple findings: severe aortic stenosis (mean gradient = 50 mmHg), mild-to-moderate aortic insufficiency, trace-mild MR, moderate concentric left ventricular hypertrophy (LVH) (posterior wall thickness = 1.5 cm; normal < 1.1 cm), and a normal ejection fraction of 60% to 65%. A cardiac catheterization also was performed and demonstrated severe aortic stenosis, right dominant coronary circulation, and mild non-obstructive coronary artery disease. Secondary to the severity of these symptoms and the echocardiographic findings, the patient was scheduled for mini-AVR under CPB.

Clinical Challenges

(1) Is this patient a candidate for mini-AVR? (2) Does mini-AVR provide any major benefits over conventional AVR performed through a median sternotomy? (3) Is myocardial protection adequate during a mini-AVR?

Minimally invasive aortic valve replacement has gained acceptance since the first series by Cosgrove and Sabik.[1–7,10] Elderly patients and patients with significant pulmonary disease with aortic stenosis, without the need for additional cardiac surgery, are excellent candidates for mini-AVR. Partial upper sternotomy minimizes the mediastinal dissection size and avoids the pleural cavities, which are major advantages of this operative approach. Multiple studies have proven the benefits of mini-AVR, which include: less blood loss, lower transfusion requirements, reduced postoperative pain, decreased cosmetic concern, early extubation times, shorter hospital stay, and lower overall cost.[1–8] However, mini-AVR has been associated with suboptimal myocardial preservation irrespective of the myocardial protection strategy utilized.[5] Even though mini-AVR only requires a small incision and provides adequate surgical exposure, it can lead to difficulties with retrograde cardioplegia cannula insertion, inability to use topical hypothermia, difficulty with LV de-airing, and increased LV warming. These issues can result in poor myocardial protection despite the appropriate administration of antegrade cardioplegia, an optimally decompressed LV, and the presence of an isoelectric electrocardiogram during the cross-clamp period.

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In a study of 907 patients by Tabata et al, severe ventricular dysfunction was reported as the second most common reason for converting from hemisternotomy to full sternotomy during a mini-AVR or minimally invasive aortic root replacement (n = 5).[3] This study further demonstrated that ventricular failure occured despite using an excellent myocardial protection strategy. In all of these patients, myocardial protection was achieved by using both antegrade and retrograde cardioplegia, and maintenance cardioplegia was administered every 20 minutes. In addition, the LV was vented and de-aired under TEE guidance prior to weaning from CPB. This clearly indicated that procedure-related risk factors for ventricular failure not only existed but also were not clearly identified. Of particular note, 80% of the patients with ventricular failure who were converted to full sternotomy died perioperatively. Patient A required additional reperfusing on CPB and placement of an intra-aortic balloon pump; Patient B needed a left ventricular assist device; Patient C required a biventricular assist device; and Patients D and E both had right heart failure and needed bypass grafting to the right coronary artery. These individual cases highlight the importance of adequate myocardial protection and de-airing during mini-AVR in order to improve patient outcomes.

Intraoperative Course

Prior to the induction of general anesthesia, a radial arterial catheter was placed for hemodynamic monitoring. After the placement of standard ASA monitors and external defibrillator pads, general anesthesia was induced, and the patient's trachea was intubated uneventfully. A right internal jugular vein introducer and pulmonary arterial catheter also were placed. Intraoperative TEE evaluation (X7-2t transducer; Philips Healthcare, Andover, MA) confirmed findings identical to the preoperative TTE (Figs 1–3; Video clips 1-4). An 8-cm J-shaped hemisternotomy was then performed, which spanned from the sternal notch to the fourth intercostal space. After heparinization, the ascending aorta and right atrial appendage were cannulated. A cardioplegia catheter was then inserted into the aortic root. Normothermic CPB subsequently was initiated. Following cross-clamp application, myocardial preservation was achieved with cold blood antegrade cardioplegia. Maintenance cardioplegia was administered directly into the coronary ostia in 20-minute intervals to maintain electrical silence after the aortotomy. Retrograde cardioplegia was deferred due to the limited surgical exposure. In addition, the LV was vented with a cannula placed directly through the aortic valve. A size 21-mm Trifecta bioprosthetic valve (St. Jude Medical, St. Paul, MN) was used to replace the stenotic aortic valve. After the AVR, the LV was de-aired appropriately through the aortic root vent under TEE guidance prior to weaning the patient from CPB. The total CPB and aortic cross-clamp times were 98 minutes and 84 minutes, respectively. Immediate post-CPB TEE examination revealed a normal functioning AV prosthesis without any regurgitation or stenosis (mean gradient of 14 mmHg). Furthermore, the TEE examination also demonstrated severe central-to-posterolaterally-directed eccentric MR (Fig 4; Video clip 5).

Echocardiographic and Clinical Challenges

(1) What is the mechanism of the baseline mild MR? (2) Why did the baseline MR increase in severity? (3) What is the mechanism/classification of the new MR? (4) Should MV surgery be performed due to the TEE finding of severe MR? (5) How useful is the electrocardiogram in diagnosing acute myocardial ischemia during ventricular pacing?

Severe aortic stenosis can be associated with MR and has an incidence as high as 67%.[11–13] The etiology of MR in

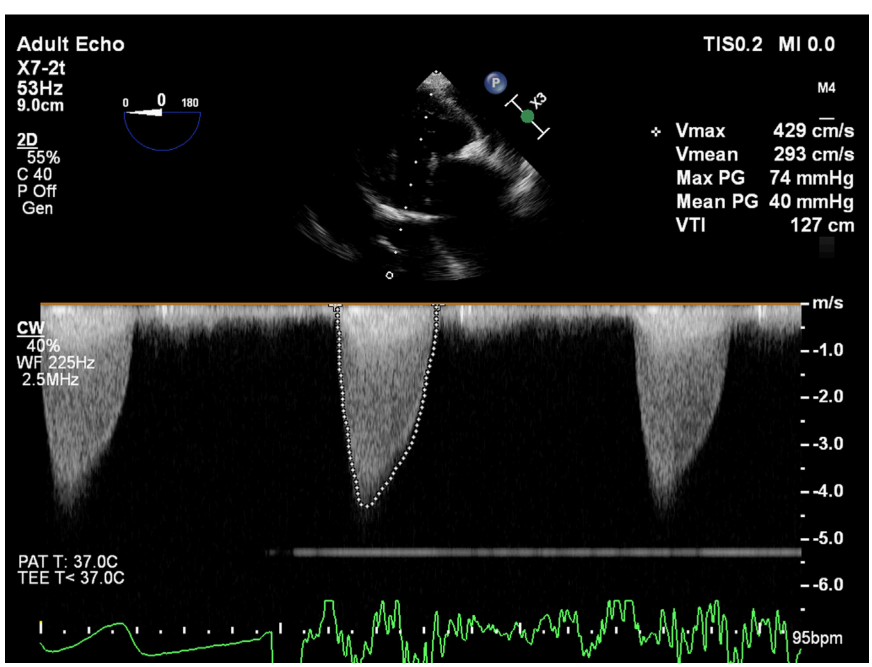

Fig 1. 2D TEE deep transgastric view continuous wave Doppler indicating severe aortic stenosis.