Masters of Cardiothoracic Surgery

Direct transcatheter mitral valve implantation in severe mitral annular calcification: technique and evidence

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Clinical vignette

A 66-year-old woman was referred to our institution's heart team for evaluation of severe mitral annular calcification (MAC) leading to symptomatic mitral stenosis (MS). The patient had a history of hypertension and insulin-dependent diabetes mellitus, as well as end-stage renal disease for which she underwent a deceased donor renal transplant two years prior to presentation. Despite normal renal allograft function, the patient developed symptomatic atrial fibrillation and New York Heart Association class III heart failure symptoms, prompting hospitalization for acutely decompensated heart failure. Echocardiography demonstrated preserved bi-ventricular function as well as severe MAC that was encroaching on both mitral valve (MV) leaflets and producing severe MS. At a heart rate of 54 beats per minute, the mean gradient across the MV was 7.2 mmHg, and the valve area measured 0.9 cm^2 by planimetry. The patient's Society of Thoracic Surgeons (STS) risk score for valve replacement was 9.0%. Given the patient's age and comorbidities, as well as the technical difficulties associated with intervening on such a calcified valve, the patient was offered direct transcatheter, transatrial implantation of an Edwards Sapien 3 bioprosthesis (Edwards Lifesciences, Irvine, CA, USA).

Surgical technique

Preparation

Pre-procedural echocardiography, as well as coronary angiography and cardiac-gated multi-detector computed tomography are essential (1). The latter is particularly important, in order to appropriately size the transcatheter heart valve (THV) and assess post-implantation risk of left ventricular outflow tract (LVOT) obstruction.

Exposition

A median sternotomy or right thoracotomy are performed first, followed by aortic and bi-caval cannulation, to facilitate cardiopulmonary bypass. Standard diastolic arrest with antegrade cardioplegia are induced. The left atrium is subsequently exposed through an opening in Waterson's groove.

Operation

To facilitate placement of the THV, the anterior MV leaflet is resected along with the supporting chordal structures. The posterior leaflet is typically left intact. If the risk of LVOT obstruction is high, a septal myectomy can be performed through a transverse aortotomy, prior to opening the left atrium. An Edwards Sapien S3 delivery system balloon is first used to size the annulus after leaflet resection, using the valve size predicted by CT reconstruction. Once the size is confirmed, the valve is prepared as follows: our technique, described elsewhere, involves sewing a felt strip around the sealing cuff of the THV with 5-0 Prolene sutures (1). The commissures are marked with a marking pen on the felt skirt. The valve is subsequently crimped onto the transcatheter delivery system. Prior to implantation, the atrial surface of the MV annulus circumference is lined with pledgeted 2-0 Ethibond sutures taken into leaflet tissue only. The THV is seated

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into the MV annulus and the valve balloon is inflated slowly, taking care to maintain proper orthogonal alignment with the annular plane, and orientation of the commissures at 2, 6 and 10 o'clock. The pledgeted 2-0 Ethibond sutures are then passed through the sealing skirt and tied. Saline testing and later, transesophageal echocardiography are used to ensure the valve leaflets appropriately coapt and that there is minimal paravalvular leak (PVL) and no LVOT obstruction.

Completion

The left atrium is closed and de-aired, and the patient is weaned from cardiopulmonary bypass and decannulated in standard fashion. The chest is closed with sternal wires and chest tubes placed in the pleural space. A medication regimen involving lifelong Aspirin and a minimum of three months of anticoagulation with Warfarin, in order to achieve an International Normalized Ratio between 2.0 and 3.0, are recommended.

Comments

Clinical results

Patients who develop severe MAC are often elderly and poor surgical candidates on account of multiple comorbidities. Accordingly, outcomes with traditional valve replacement, with or without calcium debulking, are poor and the procedure is associated with a rare, but potentially fatal complication of posterior annular rupture (2,3). Growing familiarity and experience with THVs has led to their use in valvulopathies other than aortic stenosis, including calcific MS. Percutaneous implantation of THVs in patients with severe MAC is feasible, but is associated with higher rates of complications, such as LVOT obstruction, severe PVL, and even embolization (4). Our group has previously reported the largest registry to date of patients undergoing transatrial TMVR, which uses the technique described above to secure the THV into the mitral annulus (5). Twenty-six patients enrolled across six sites were included in the analysis, which demonstrated a 100% technical success rate according to the Mitral Valve Academic Research Consortium criteria. Only one patient experienced mild PVL, which led to hemolysis and necessitated a follow-up procedure to dilate the THV and eliminate the PVL. All-cause mortality at 30 days occurred in 27% of patients, but the risk of LVOT obstruction was eliminated and implantation was achievable despite the patients' complex anatomy.

Advantages

Transatrial TMVR mitigates some of the risks associated with open surgical MV replacement in severe MAC. The procedure is shortened, limiting time on cardiopulmonary bypass, and the risks of posterior annular rupture and left circumflex artery injury are minimized. Relative to entirely percutaneous TMVR techniques, transatrial TMVR also reduces the likelihood of LVOT obstruction, severe PVL and device embolization.

Caveats

Patients with severe MAC remain at high risk for poor outcomes following any intervention because of accumulated comorbidities: transatrial TMVR is no different, and the short-term mortality remains high in the early experiences documented with this procedure. Patients with concomitant valvular heart disease requiring intervention represent a particularly high-risk group of patients for whom transatrial TMVR should be evaluated with caution. Specific anatomic considerations, which influence the risk of LVOT obstruction for example, also need to be considered for optimal patient selection. Finally, valve durability and hemodynamic performance relative to traditional surgical valves may be inferior, emphasizing the need for long-term follow-up with patients undergoing transatrial TMVR.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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