Masters of Cardiothoracic Surgery

Robotic aortic valve replacement with simultaneous ventricular septal myectomy: a minimally invasive solution

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Clinical vignette

A 67-year-old female with a history of hypertension (HTN), hyperlipidemia (HLD), chronic obstructive pulmonary disease (COPD), stage III chronic kidney disease (CKD), Sjögren's syndrome, rheumatoid arthritis, and hypertrophic cardiomyopathy (HCM) presented with severe symptomatic left ventricular outflow tract (LVOT) obstruction, moderate aortic stenosis, moderate-to-severe aortic insufficiency, and a small aortic annulus (19 mm). She underwent robotic aortic valve replacement (RAVR) with a 21 mm bioprosthesis, modified Nicks root enlargement with a Dacron patch, and concomitant robotic-assisted septal myectomy. She was discharged home on postoperative day 4. At one month, she achieved New York Heart Association (NYHA) Class I status, with a mean LVOT gradient of 5 mmHg. At one year, she remained asymptomatic with a normally functioning prosthetic aortic valve and an LVOT gradient of 4 mmHg.

Surgical technique

Preparation

Patients eligible for RAVR undergo comprehensive computed tomography angiography (CTA) of the chest, abdomen, and pelvis to confirm favorable anatomy for the surgical approach and assess adequate peripheral vascular anatomy for cardiopulmonary bypass (CPB) cannulation. The patient is positioned supine under general anesthesia and preoperative monitoring lines, including arterial and central venous catheters, are established. A transesophageal echocardiography (TEE) probe is inserted to confirm the pathology and guide intraoperative management. Peripheral cannulation is established using the common femoral artery and vein with a superior vena caval cannula placed via the right internal jugular vein for bicaval drainage.

Exposition

A 3 to 4 cm lateral thoracotomy is performed in the fourth intercostal space at the anterior axillary line, through which the pericardial fat pad is mobilized and pericardiotomy is performed. Pericardial stay sutures as well as a diaphragmatic retraction suture are placed to improve visualization. Following initiation of CPB, the aorta is mobilized, and a transthoracic aortic cross-clamp is introduced via the second intercostal space and positioned high on the distal ascending aorta. An aortic root vent is placed through the working incision followed by a left ventricular vent via a separate chest wall stab incision, through the right superior pulmonary vein under TEE guidance. The DaVinci Xi robot (Intuitive Surgical, Sunnyvale, CA, USA) ports are then placed with the camera via the working incision and three additional ports in the second, fifth, and sixth intercostal spaces.

Operation

Antegrade cardioplegia is administered via the aortic root or directly through the coronary ostia as needed, achieving cardiac arrest. An aortotomy is performed at or above the sinotubular junction and extended into the noncoronary sinus to provide adequate exposure of the aortic valve and subvalvular apparatus. The native valve leaflets are excised, and annular debridement is performed to remove calcific deposits. Beginning approximately 5–8 mm below the nadir of the right coronary cusp, the septal myectomy is then performed using the robotic Metzenbaum scissors and long-tip grasping forceps. Care is taken to avoid injuring the conduction system and membranous septum. The myectomy is carried apically to the level of the antero-septal papillary muscle with care to avoid injury to the papillary muscles or chordae. The base of the papillary muscles and ventricular apex should be easily visible following excision. Interrupted 2-0 braided polyester sutures are robotically placed circumferentially from the ventricular side, starting at the left non-coronary commissure and proceeding clockwise. In a case of aortic root enlargement, a pericardial or Dacron patch is used to augment the non-coronary sinus in a modified Nicks fashion, as previously described (1). Either a mechanical or bioprosthetic valve is sized and seated using robotic instrumentation, with suture knots secured using suture fasteners (Cor-Knot; LSI Solutions, Victor, NY, USA).

Completion

The aortotomy is closed with a double-layered 4-0 polypropylene suture technique, employing a horizontal mattress stitch followed by a running whipstitch. Multiple de-airing maneuvers are performed, the cross-clamp is removed, and the patient is reperfused. Atrial and ventricular pacing wires are robotically placed, and chest drains are introduced through the inferior port site. After undocking the robotic system, the patient is weaned from CPB, decannulated, and fully rewarmed. The cannulation sites are secured, and all incisions are closed in layers. Intraoperative TEE is performed to confirm prosthetic valve function, ensure the absence of paravalvular leaks, and evaluate post-myectomy LVOT gradients. The patient is extubated in the OR and transferred to the intensive care unit.

Comments

Clinical results

Surgical septal myectomy is considered the standard of care for patients with obstructive HCM with symptoms that are refractory to medical therapy (2,3). Traditionally performed via median or hemisternotomy transaortic approaches, or rarely through mitral valve, the procedure presents technical challenges due to limited visualization and an associated risk of injury to surrounding structures. When performed via the mitral valve, detachment and reimplantation of the anterior mitral leaflet with or without patch reconstruction is often required. RAVR has emerged as a promising alternative with superior visualization to access LVOT, which allows for performing septal myectomy, either as a standalone procedure or in combination with valve repair or replacement.

RAVR with concomitant septal myectomy is feasible and demonstrates favorable clinical outcomes in addressing both aortic valve disease and HCM (4). Initial multicenter studies of RAVR report low rates of morbidity, no conversions to sternotomy, and minimal paravalvular leak, even in complex cases involving concomitant procedures (4). Additionally, robotic septal myectomy aligns with contemporary best practices by offering precise resection of hypertrophic myocardium, effectively relieving LVOT obstruction and improving symptoms (3).

Advantages

The robotic platform provides exceptional visualization, improved dexterity, and superior instrumentation—such as robotic Metzenbaum scissors with its strong, fine tips—enabling complex procedures like valve replacement and septal myectomy to be performed with precision through a minimally invasive approach. Additionally, RAVR preserves the advantages of using standard surgical prostheses while enabling concomitant procedures, including aortic or mitral valve repair or replacement, root enlargement, maze procedures, and, as in this case, septal myectomy, while avoiding a sternotomy (1,3-5). This approach also allows for a standalone septal myectomy in the absence of concomitant valvular disease.

Caveats

Robotic-assisted cardiac surgery requires significant technical expertise and institutional investment in specialized equipment and training. The learning curve for surgeons and operative teams can be steep, which may limit broader adoption (4,5). Additionally, patient selection is critical, as certain anatomical or comorbid factors may preclude the robotic approach.

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Footnote

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