Masters of Cardiothoracic Surgery

Complex robotic correction for complex degenerative mitral valve disease

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Clinical vignette

The gold standard treatment of degenerative mitral valve disease remains surgical repair. The classic repair described by Dr. Carpentier (1) with leaflet resection and annuloplasty remains the primary technique for mitral repair. Other techniques such as the "American correction" (2) or artificial chordae have been introduced with similar success rates. Innovations in surgical approach over the past 20 years have led to the development of minimally invasive access to the mitral valve. Fifteen years ago, Dr. Chitwood pioneered the use of the da Vinci Robotic Surgical System (Intuitive Surgical, Inc., Sunny Vale, California, USA) for mitral valve repair (3,4). His excellent outcomes and those of others led to an increased utilization of the robotic approach to the mitral valve (1-10). Robotic correction of mitral regurgitation was initially limited to less complex mitral valve pathologies. However, with improvement in technologies and experience, complex repair of degenerative mitral regurgitation is possible.

A 44-year-old gentleman was referred with asymptomatic severe mitral regurgitation. His past medical history was unremarkable except for osteoarthritis of the hip. Physical examination was normal except for a grade V holosystolic murmur in the left fifth intercostal space (ICS) radiating to the axilla. Transthoracic echocardiography (TTE) demonstrated severe mitral regurgitation, severe bileaflet prolapse, predominantly involving the posterior leaflet with flail of the anterior leaflet and evidence of ruptured chordae. Left and right ventricular function were normal. The rest of the cardiac work-up was normal, demonstrating no coronary artery disease and absence of peripheral vascular disease.

Surgical techniques

Pre-operative assessment

The patient was positioned in slight left lateral decubitus position after induction of general anesthesia and placement of the double lumen endotracheal tube, routine monitoring lines and a TEE probe. All patients undergo three-dimensional reconstructed transesophageal echocardiography (TEE) imaging, and this patient's images demonstrated a severe 4+ mitral regurgitation jet resulting from bileaflet prolapse and anterior leaflet flail, as well as excessive leaflet motion of all leaflet segments.

Operative technique

Our current standard practice has been previously described (5) (*Video 1*). After the patient is positioned supine with the right side of the chest elevated, the right lung is deflated, and a 3- to 4-cm right inframammary incision through the fourth or fifth ICS is used as the working port. Trocars for the robotic instrument arms, 14-gauge angiocatheters for traction sutures, and a 20-F DLP (Medtronic, Inc., Minneapolis, Minn, USA) intracardiac sump drain are inserted through a separate stab-wound incision.

The patient is heparinized and the femoral vessels are cannulated for cardiopulmonary bypass. A two-stage venous cannula is placed through the femoral vein under TEE guidance to ensure proper placement for venous drainage with vacuum assistance. The pericardium is incised ventral to the phrenic nerve. A transthoracic aortic clamp (Scanlan International, Minneapolis, Minn, USA) is positioned through the third ICS in the midaxillary line. An ascending aortic root vent (DLP 14-gauage 7 F; Medtronic, Inc.) is

placed under direct vision. The da Vinci robot is positioned to the patient's left side, and the instrument arms are placed endoscopically. Bypass is established, and the patient is cooled to 32 ℃. Once cold, the cross-clamp is positioned and clamped under endoscopic vision followed by 1.2 L of Del Nido cardiopleagia. No redosing necessary was during the case. Once asystole is achieved, a standard left interatrial incision is made using the robot, and the left atrial roof retractor is positioned for mitral valve exposure.

The repair consisted of a large triangular resection of P2. The resultant cleft was then closed with several figure-of-eight sutures of 4-0 Cardionyl. Two sets of chordae were then inserted at the level of A2, one from the anterolateral papillary muscle, one from the posteromedial papillary muscle. There was a flail chord at A2, which was resected. There was prolapse of P3-A3, and this was repaired using an advancement of the medial commissure with figure-of-eight sutures of 4-0 Cardionyl, effectively resulting in a commissural closure. Two of these sutures were employed. The valve was then tested and found to be competent. The repair was then completed using a #39 ATS band (Medtronic, Inc., Minneapolis, MN, USA) which was implanted using interrupted 2-0 Ethibond (Ethicon Inc., Somerville, NJ, USA) sutures. After all the sutures were inserted into the band and tied and cut, the left atriotomy incision was closed using a running suture technique of 4-0 Gore-Tex. Before completing the closure, the left ventricle and aorta were allowed to fill up with blood in order to evacuate as much air as possible from the heart. The crossclamp was then removed and the patient was rewarmed. The patient was weaned off bypass without requiring any inotropic support. Intraoperative TEE confirmed the presence of a good repair with no residual MR. Venous and arterial cannulae were removed, the right femoral artery and vein were repaired, and the right groin incision was closed. Two temporary ventricular pacemaker wires were inserted in the usual fashion as well as three chest tubes, one in the pericardium and two in the right side of the chest. The minithoracotomy incision was then closed anatomically using pericostal sutures in layers. The patient tolerated the procedure well and left the operating room in a satisfactory condition. The post-operative course was uncomplicated and the patient was transferred to the floor the following morning and discharged on post-operative day 4. His one month follow-up TTE showed trivial MR.

Comments

Since October 2000, the use of robotic mitral repair has steadily grown. Our institutional experience dates back to 2005. All patients with MR considered to be reparable, including all degenerative and endocarditic etiologies, were approached using the da Vinci system. With increasing experience and improved outcomes compared to the standard sternotomy approach, we found an increase in referral of more complex mitral pathology leading to a greater proportion of patients with bileaflet pathology and Barlow's disease. Robotic mitral valve repair is safe and associated with low mortality of less than 1% in our hands. Our experience shows that all complex valve repairs previously approached through a sternotomy can be performed robotically. We would argue that the robotic approach leads to greater and better repair rates than the standard approach. We exclusively follow an echo-guided approach to valve repair and not all abnormalities seen on valve inspection are repaired, such as clefts that are not causing regurgitation. The reason for this approach is that valve sutures inevitably cause some leaflet scarring which can reduce long-term durability, especially in complex valve repairs. In summary, complex mitral valve repair can be performed robotically and should not be a deterring factor when considering whether a patient can undergo robotic repair of their mitral valve.

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None.

Footnote

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

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