Masters of Cardiothoracic Surgery

Robotic-assisted double valve surgery

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In this report we highlight two examples of robotic double valve repair/replacement. The first is a mitral and tricuspid valve repair, and the second is an aortic valve replacement (AVR) with mitral valve repair. Both patients also underwent concomitant biatrial Cox-Maze procedures.

Clinical vignettes

The first patient was a 61-year-old male that presented to our institution initially with cardiogenic shock, flail posterior mitral leaflet, severe mitral regurgitation (MR), severe tricuspid regurgitation (TR), and persistent atrial fibrillation (AF) with an ejection fraction (EF) of 20%. He was medically optimized and eventually discharged for a short interval prior to semi-elective surgery. His preoperative parameters included an EF of 35%, severe MR, moderate-severe TR with an annular diameter of 43 mm, and persistent AF (*Video 1*).

The second patient was a very robust 76-year-old male with severe symptomatic aortic insufficiency, moderate-severe primary MR due to a flail posterior leaflet. He also had a patent foramen ovale, persistent AF, but only trace TR with annular diameter 37 mm, and an EF of 45%. Both patients were referred for robotic double valve operations following thorough multidisciplinary heart team evaluation.

Surgical techniques

Our robotic surgical approach, including double or multi-valve operations, involves preoperative computed tomography (CT) angiographic screening, peripheral bicaval cannulation, and a 3–4 cm mini lateral thoracotomy working incision at the level of the fourth intercostal space at the anterior axillary line for all patients. We find that with bicaval cannulation facilitated by vacuum assistance and an 19- or 20-French French cannula via the right internal jugular, snaring for right atrial procedures is not necessary.

Following pericardial exposure and commencement of cardiopulmonary bypass, an aortic root vent and a left ventricular vent via right superior pulmonary vein are placed in all patients. Antegrade cardioplegic arrest either via the aortic root, or selective coronary ostial delivery in some cases of robotic AVR (RAVR), is performed following application of a transthoracic cross-clamp.

The DaVinci Xi (Intuitive Surgical, Sunnyvale, California, USA) is used. Instrument use is as follows: arm 1, or left hand, is placed in the third intercostal space and controls a DeBakey forceps; arm 2 is the camera port that is either placed through the working incision or a separate insertion in the fourth intercostal space; arm 3 controls the dual blade retractor for mitral and tricuspid procedures or the long tip forceps for RAVR procedures, via the fifth intercostal space; and arm 4 controls the Metzenbaum scissors and needle driver.

Principles of mitral valve repair are applied utilizing either resection or non-resection techniques and flexible or remodeling annuloplasty rings are implanted utilizing interrupted 2-0 braided sutures as indicated and tailored to the pathoanatomy. Tricuspid valve repair is performed using interrupted sutures and remodeling annuloplasty hemi-rings. Suturing the mitral and tricuspid annuloplasty devices are performed intracorporeally and secured with suture fasteners (Cor-knot, LSI solutions, Victor, NY, USA). RAVR is performed via an aortotomy that is extended to the non-coronary sinus, with complete debridement performed with scissors and tableside suction aspiration, and interrupted 2-0 braided sutures placed from the ventricular side without pledgets. Suturing the aortic mechanical or bioprostheses is performed extracorporeally and secured

with suture fasteners. The aortotomy is closed in two layers with 4-0 polypropylene suture. The full biatrial Cox-Maze is performed with cryothermy (Atricure, Mason, OH, USA) applied in defined and consistent lesions and the left atrial appendage is endocardially obliterated in all cases (1).

Comments

As robotic-assisted cardiac surgery continues to evolve, cases of increased pathoanatomic complexity and the need for multiple concomitant procedures has become safe and effective. Operative experience and team building is essential for the safe introduction of these added procedures. Robotic cardiac surgery, starting predominantly with mitral valve repair, has been well established in our program, with over 1,000 cases performed by our team. Excellence in preoperative imaging, anesthesia, perfusion, and seamless coordination between console and tableside surgery has been instrumental to permit the relatively standardized additions of concomitant procedures, including our development of RAVR in early 2020 (2,3). The same platform is used for all robotic valve cases and the vast majority of our patients are extubated in the operating room, thus enhancing our ability to perform these operations in a timely manner, often with two operations by the same team in a day, and in a cost-neutral manner to sternotomy (4). One must stay vigilant to the basic tenets of peripheral cardiopulmonary bypass, myocardial protection, and valve analysis. After overcoming the learning curve for robotic mitral surgery, additional concomitant procedures such as AVR, root enlargement, complex bileaflet mitral repair, endocarditis repair, biatrial Cox-Maze, and TV repair are all possible with the identical platform. As long as a patient is suitable for peripheral cardiopulmonary bypass, a relative all-comer strategy is employed at our institution. Every patient is evaluated by the heart team, which now considers RAVR as the preferred approach for low-risk and even intermediate-risk patients with isolated aortic valve disease as well as when concomitant procedures are required.

In conclusion, robotic double valve operations may be performed safely via the standard robotic platform used for robotic mitral surgery. Additional concomitant procedures and combinations to include full biatrial cryothermic Cox-Maze may also be effectively performed with team experience.

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Footnote

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