Right anterior minithoracotomy for aortic valve replacement

Antonio Miceli, Matteo Ferrarini, Mattia Glauber

Cardiac Surgery and Great Vessels Department, Istituto Clinico Sant'Ambrogio, Gruppo Ospedaliero San Donato, Milan, Italy

Correspondence to: Antonio Miceli, MD., PhD. Cardiac Surgery and Great Vessels Department, Istituto Clinico Sant'Ambrogio, Gruppo Ospedaliero San Donato, Via Favarelli 16, 20149, Milan, Italy. Email: antoniomiceli79@alice.it.

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Clinical vignette

We present the case of a 78-year-old lady with severe aortic stenosis who underwent cardiovascular investigations for ingravescent dyspnea [New York Heart Association (NYHA) functional class III] undergoing minimally invasive aortic valve replacement (MIAVR) through right anterior minithoracotomy (RT).

The patient's height and weight were 170 cm and 62 kg, respectively. Risk factors included hypertension, diabetes, hypercholesterolemia and chronic obstructive pulmonary disease. Transthoracic echocardiography showed a mean aortic transvalvular gradient of 52 mmHg and peak gradient of 88 mmHg. Left ventricular ejection fraction was 45% and systolic pulmonary artery pressure was 50 mmHg.

Preoperative planning

In addition to routine preoperative exams such as chest X-ray, coronary angiogram and echocardiogram, all patients scheduled for an MIAVR undergo thoracic computed tomography (CT) without contrast enhancement to evaluate the relationship among the sternum, intercostal space, ascending aorta and aortic annulus. Dedicated open free software is available to reconstruct three dimensional (3D) images of the chest. This information is very important for operative planning. RT is suitable if the following criteria are met: (I) at the level of main pulmonary artery, the ascending aorta is rightward (more than one half of ascending aorta is located on the right side in respect to the right sternal border); (II) the distance from the ascending aorta to the sternum should be <10 cm; (III) the α angle (angle between the midline and the inclination of ascending aorta) should be >45°. Regarding our patient, echocardiogram confirmed the severity of aortic stenosis, angiogram excluded the presence of coronary disease and the CT scan showed that our patient was suitable for a RT approach.

Surgical technique

Anesthesia is provided according to the standard protocol used for conventional aortic valve replacement (AVR). A single lumen tube for intubation is used. Two defibrillator pads are accurately placed across the chest wall to guarantee effective electric conduction.

It is very important to underline that our philosophy regarding MIAVR is to reproduce all the surgical steps we usually perform through full median sternotomy, in order to make these procedures safe and reproducible.

RT is performed through a 5 to 6 cm skin incision placed at the level of the second intercostal space, starting from the border of the sternum. The right internal mammary artery is often sacrificed in order to have better surgical vision and avoid bleeding complications. A soft tissue retractor is inserted into the minithoracotomy exposure and the ribs are spread. With the lungs off, we always identify the pathway of the phenic nerve and the residual thymic tissue is removed taking care not to injury the phrenic nerve and the left innominate vein. The pericardium is opened at the level of ascending aorta, and aorta is exposed up to the left innominate vein. Three pericardial stay sutures are placed at the top, middle and the bottom of the right pericardial ridge, and passed percutaneously close to the right side of the minithoracotomy. This maneuver allows having a better view and identifying the right upper pulmonary vein for insertion of ventricular vent. Once the ascending aorta is exposed, two concentric polyester purse-string sutures for direct aortic cannulation are placed in a standard

fashion. We usually reinforce the second purse-string with two pledgets. The cannulation site should be near the pericardial reflection, usually below the innominate vein. Once the purse-strings on the ascending aorta are ready, the groin is accessed for percutaneous vein cannulation. Using the Seldinger technique, a guidewire is passed through the introducer sheath and is inserted into the superior vena cava under echotransesophageal guidance using a bicaval view. Dedicated venous dilators are used in tunnelling the cannula path. Finally, a percutaneous cannula is inserted through the femoral vein and advanced into the right atrium and superior vena cava. Afterward, direct ascending aorta cannulation is performed under direct vision using a flexible cannula. It is very important in this phase to keep down the pressure. Once the cannula is into aorta, the cannula is secured with two tourniquets using a silk suture. After vacuum-assisted cardiopulmonary bypass (CPB) (–60 to –40 mmHg) is established, a left ventricular vent is placed trough the right superior pulmonary vein and patient is cooled to 34 ℃. Subsequently, a combined Y shape cardioplegia/vent catheter is placed into the ascending aorta and aorta is directly clamped using a dedicated minimally invasive detachable clamp (Glauber Clamp). Antegrade warm blood cardioplegia is given into the aortic root or selectively into the coronary ostia. The surgical field is flooded with carbon dioxide at a flow of 0.5 L/min until closure of aorta. Afterward, an aortotomy is performed. In our department, sutureless aortic valves are the first treatment option for the treatment of aortic stenosis for those patients candidate for a biological prosthesis, and this video demonstrates the implantation of a Perceval S (Sorin, Sallugia, Italy) sutureless valve. The transverse aortotomy is usually performed approximately 1.5 to 2 cm higher than ordinary aortotomy for a stented valve. The diseased native valve is completely removed and the aortic annulus thoroughly decalcified. This is a crucial part of this procedure, and decalcification should be performed in standard fashion similar to implantation of stented valves. We use two forceps for debridement, taking care not to injury the aortic wall especially at the level of the mitro-aortic continuity.

Despite company recommendations for removal of only the eccentric and bulky intra-annular calcifications, we strongly believe that an incomplete decalcification is responsible for paravalvular leakages and central aortic regurgitation due to leaflet mal-coaptation. Once the decalcification is complete, the aortic annulus is sized with appropriate valve sizers. For Perceval S, four sizers are available: small (21 mm), medium (23 mm), large (25 mm) and extra-large (27 mm). The valve sizer is designed so that the intra-annular head of the sizer (yellow) has the same external diameter as the supra-annular head (white) of the smaller size. For the appropriate sizing, the native annulus should allow the passage of the intra-annular head but not the supra-annular head of the same sizer. In this patient, the size of aortic annulus was large.

Afterward, three guiding 4-0 Prolene sutures are placed at the nadir point of each valve sinuses to act as a reference for accurate alignment of the inflow portion of the prosthesis into the aortic annulus. The valve is collapsed using a specific device system and connected to the guiding sutures through three bottom holes placed on the midpart of the inflow ring. The valve is parachuted down into the aortic root and the valve released into the aortic annulus. The co-aptation of the three leaflets is checked and the three guiding sutures are removed. The valve is again checked for the correct position, and the aortotomy is closed using 4-0 or 5-0 running sutures. After rewarming, CPB is stopped and the arterial cannula is removed. CPB and cross-clamp times were 53 and 36 minutes, respectively. The patient is filled with residual blood via the venous cannula and after protamine, the venous femoral cannula is removed. A slight compression at level of the cannula site (5-10 minutes) is required to secure hemostasis.

Comments

MIAVR has been shown to reduce mortality, morbidity while allowing faster recovery, less pain and blood transfusions, shorter hospital stay and better cosmetic results (1,2). The majority of these studies have focused on ministernotomy, which represents the most common minimally invasive technique for isolated AVR. Since 2005 we developed our program for the minithoracotomy, reporting excellent results in terms of mortality morbidity and patient satisfaction (3).

Patients undergoing MIAVR through RT had better outcomes when compared to patients undergoing conventional surgery or ministernotomy approach (4,5). However, the prolonged CPB and cross-clamp time associated with RT approach are the Achilles' heel of this procedure. This has raised some concerns on its safety on very old fragile patients, as it has been demonstrated the prolonged operative times are risk factors for postoperative mortality and morbidity (6). In this setting, the introduction of sutureless valve has drastically reduced the operative times

by a mean of 35-40%, making this procedure easier and safer (7). The mean CPB and cross-clamp time reported in our previous studies using RT and stented valves were 123 and 89 minutes, respectively (3,4). In this case, we observed a 50% operative time reduction as the CPB and cross-clamp times were 53 and 36 minutes, respectively. In light of these results, we strongly believe that MIAVR by a way of RT using sutureless valve is the ideal combination for the treatment of high risk patients.

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