

Right infra-axillary mini-thoracotomy for aortic valve replacement

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Introduction

Minimally invasive aortic valve replacement (MICS-AVR) has traditionally been performed through fore-chest approaches, including partial sternotomy, parasternal thoracotomy, or anterior inter-costal thoracotomy (1-3). Proximity to the ascending aorta and aortic valve seems to be advantageous in these approaches. Fore-chest skin incisions are not necessarily ideal, as minimally invasive surgery may be preferred over standard sternotomy for cosmetic reasons. However, fore-chest wounds can easily be recognized and their dimensions determined. Second, incisions in fore-chest skin tend to lead to hypertrophic scarring, as is the case in the shoulder or pubic regions.

Meanwhile in minimally invasive mitral valve surgery, the antero-lateral thoracotomy is now a standard procedure irrespective of its remoteness from the mitral valve. Right antero-lateral or lateral thoracotomy is cosmetically better because the wound can be hidden by the breast or arm, and those areas are not susceptible to scar formation.

We started right infra-axillary mini-thoracotomy for minimally invasive AVR (TAX-AVR) as previously reported (4). Its cosmetic superiority over standard sternotomy was apparent, and remoteness from the ascending aorta was compensated for by using long-shafted minimally invasive instruments and high definition endoscopic assist.

Clinical vignette

Here, we describe the technical detail of this operation in the case of a 62-year-old man with aortic stenosis because of a congenital bicuspid valve. His height and weight were 169 cm and 67 kg respectively, yielding a body surface area of 1.76 m².

Operative technique

Postural setting of the patient is important. After induction of general anesthesia and preparation of differential lung ventilation, the patient was set in a 45 degree left lateral position with a pillow beneath the left chest. The right upper arm was abducted anteriorly, the elbow flexed, and the forearm of the patient was set in front of the face and held by a padded positioner bar. The right scapula and shoulder were moved anteriorly. Axillary skin and the lateral margin of the major pectoral muscle were also deviated anteriorly against the rib cage. This positioning enabled an antero-lateral thoracotomy that is closer to the ascending aorta than a lateral thoracotomy, through an axillary skin incision.

After revealing the right femoral artery and vein for femoro-femoral cardiopulmonary bypass, a 7 cm vertical skin incision was made along the right anterior axillary line. Subcutaneous fat was cut along the lateral margin of the major pectoral muscle to reveal the rib cage. The undersurface of the major pectoral muscle was then dissected anteriorly. A 4th intercostal antero-lateral thoracotomy was performed and a soft tissue protector (Alexis wound protector, Applied Medical, Rancho Santa Margarita, CA, USA) in size S was set. Notably, sometimes the 3rd intercostal space is selected based on findings of a pre-operative chest computed tomography (CT). The intended aortotomy line should ideally be aligned to the center of the thoracotomy opening. Subsequently a small rib spreader was applied.

For insertion of an endoscope, an 11 mm trocar was inserted through the 6th intercostal space. A variable angle endoscope (EndoCAMEleon, Karl Storz, Tuttlingen, Germany) proved useful to look down the aortic valve through this approach. The endoscope was hand-held and controlled by an assistant surgeon. Three L/min of CO₂

insufflation into the thorax was continued throughout the procedure. After right femoral venous cannulation was performed under trans-esophageal echo guidance, the right femoral artery was cannulated and cardiopulmonary bypass was begun. Vacuum assist was used for venous drainage. The patient was cooled to 30 degrees Celsius.

The pericardium was longitudinally opened 3 cm from the phrenic nerve, and pulled up by several stay sutures. Pericardial sutures on the posterior side were pulled out of the thorax by an Endoclose needle. The dorsal surface of the ascending aorta was dissected just distal to the right pulmonary artery for placement of an aortic clamp. A left ventricular venting tube was inserted through a purse string suture placed on the right upper pulmonary vein. An aortic root cannula was placed, and subsequently the ascending aorta was cross clamped with a flexible shaft clamp inserted through the main incision. Antegrade cold blood cardioplegia was given.

After an initial infusion of antegrade cardioplegia, the aortic root cannula was then removed to increase the ease by which the following procedures would be performed. The ascending aorta was opened in an oblique fashion, 3 cm distal to the right coronary ostium. Additional cardioplegia was given directly into each coronary ostium with a soft tip cannula every 30 minutes and retrograde cardioplegia was not used. The aortic wall was retracted by several 4-0 Prolene stay sutures. A small aortic wall retractor was placed in this case, but this is optional. The aortic valve could be observed directly from the wound and also by using the endoscope. The aortic valve was a calcified bicuspid valve with a raphe present between the right and left cusps. The calcified valve was excised from the annulus using long scissors and an ultrasonic aspirator. After washing the left ventricle with saline, sizing of the annulus was performed using standard valve sizers. Carpentier-Edwards Perimount-Magna in size 23 was selected. Simple interrupted 2-0 braided polyester sutures were placed around the annulus in this case, although it should be noted that pledget supported non-everting mattress sutures are typically used. After placing about 20 sutures on the annulus, the sutures were passed through the cuff of the prosthesis and placed back on the suture holder immediately. Note that if we bundle all of the sutures together and set down the valve in position in this surgery, it would be very time consuming to select out correct suture pairs afterwards. After sliding down the valve to the annulus, all sutures were tied with the aid of a knot pusher (ValveGait, Geister, Tuttlingen, Germany).

An endoscope was utilized to confirm that the knots were tied securely. Suture-knots behind the stent posts could also be observed with the variable angle function of EndoCAMEleon and hand-held control of it by an assistant surgeon.

The aortotomy was closed in single or double layers depending on the quality of the aortic wall by continuous 4-0 Prolene. After placing of an aortic root cannula once more, de-airing of the heart was performed by active suction through an aortic root cannula and regulation of venous drainage. After de-clamping the aorta, hemostasis of the aortic suture-line was completed by placing additional sutures during full cardio-pulmonary bypass. After weaning the patient off bypass, the pericardium was loosely closed and the chest was closed in the usual manner. A 24Fr drain was inserted into thoracic cavity through the camera port. The aortic clamp time, CPB time, and operative time were 110, 142 and 232 minutes, respectively.

Comment

A skin incision in the lateral chest wall is cosmetically superior to that in the fore-chest. However, this approach has not been popular for MICS-AVR presumably because of remoteness from the ascending aorta. An axillary approach is not as remote from the ascending aorta as generally pictured, because the width of the rib cage becomes narrow cranially. In addition, the shoulder joint is indirectly connected to the rib cage interposed by the clavicle and can be moved antero-medially against the rib cage. By the postural setting as mentioned above, we can enter the thorax antero-laterally through a lateral axillary skin incision. Nevertheless, we cannot manipulate the ascending aorta and aortic valve manually, and thus utilization of minimally invasive, long-shafted instruments is mandatory. Although we have not experienced peri-valvular leakage in all consecutive 54 cases, the tying technique of annular sutures using a knot pusher is crucial.

EndoCAMEleon is a 10 mm shaft, variable angle (0 to 120 degrees) scope. Endoscopic assist was not mandatory, but very useful in this procedure in order to observe annular suture knots, and to confirm hemostasis of the aortic suture line on the left side.

TAX-AVR with standard prostheses is time-consuming and requires 3 to 4 hours of operative time. If sutureless valves were utilized in this method, operative time can be considerably shortened.

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