Reoperative aortic valve replacement through upper hemisternotomy

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Clinical vignette

Reoperative aortic valve replacement (AVR) has become increasingly common (1). In patients with previous coronary artery bypass grafting (CABG), minimally invasive reoperative AVR is the preferred approach since it allows the performance of no-touch technique for left internal mammary artery (LIMA) and minimal dissection around the vein grafts (2,3). Here, we present an 83-year-old man with symptomatic severe aortic stenosis and a positive history of coronary artery disease (CAD), hypertension, dyslipidemia, chronic renal disease, peripheral vascular disease and carotid stenosis. He has had a CABG and carotid endarterectomy and was found to be ineligible for transcatheter aortic valve replacement (TAVR) due to severe iliofemoral calcification. Coronary grafts were proven patent by angiography, while left ventricular function and wall motion were proven normal by echocardiography. The patient was scheduled for a minimally invasive isolated AVR reoperation through upper hemisternotomy.

Surgical techniques

Preparation and exposition

A preoperative chest computed tomography (CT) scan was first obtained to assess the safety of resternotomy. In the surgical theater, external defibrillator pads, pulmonary arterial catheter with pacing port and transesophageal echosonography (TEE) probes were appropriately positioned prior to incision. Peripheral cannulation was then instituted, since this is the preferred approach. The right axillary artery was cannulated and a long venous cannula was advanced toward the inferior vena cava/right atrium after gaining access through a femoral vein. The skin was then incised and the sternum divided down to the fourth intercostal space and then transversely to the right, with great care taken to avoid injuring the right internal thoracic artery or vein.

Operation

Mediastinal dissection was limited to the upper mediastinum, including the peri-aortic area and parts of the right atrium. Precise dissection was also performed on the left side of the sternum, paying close attention to avoid manipulating the patent LIMA to LAD graft. Previous venous, radial, or right internal thoracic artery grafts were mobilized as necessary to safely approach the aortic valve. When needed, retrograde cardioplegic cannulae and left ventricular (LV) vents were placed with TEE guidance.

Patients without a patent LIMA graft are systemically cooled to 34 ℃, and those with a patent LIMA graft down to moderate hypothermia of 28 ℃. Cardiac arrest was induced using a combination of cold antegrade and retrograde cardioplegia. Additional systemic hyperkalemia was induced by instilling potassium chloride into the cardiopulmonary bypass circuit, maintained at the level of 6.0 to 7.0 mEq/L. Ultrafiltration was used to clear high levels of potassium following the release of the aortic crossclamp.

Size of the left ventricle (LV) was continuously monitored intraoperatively by TEE imaging. Left ventricular venting was accomplished through the aortic annulus after aortotomy. In order to minimize air trapping in the left side of the heart, CO_2 was applied to the field at the end of the procedure. The aortic valve operation was then performed with standard techniques according to patient indications. When backflow from the patent LIMA-LAD graft through the left main ostium obscured the operative field, pump flows were temporarily turned down to improve the surgical field of view. After the aortic valve was seated, rewarming was started and the aortotomy closed, and then the aortic cross clamp was released.

Completion

Defibrillation was achieved through external pads. In addition to standard deairing maneuvers, external compressions and table positioning helped in removal of intracardiac air, which was confirmed by TEE. Temporary pacing wires are placed on the surface of the right ventricle if the right ventricle has been dissected, and the pacing port of the PA line is proposed as an alternative. Chest tubes were then placed through the right pleural space. Cardiopulmonary bypass weaning, decannulation, and chest closure were done in a standard fashion.

Comments

Mini-AVR through upper hemisternotomy has been a well established technique with excellent long term results (4). It promotes expeditious healing and accelerated return to baseline physical health (4-9). Some studies suggest that minimally invasive surgery reduces blood loss (10-14), surgical trauma and pain (11-14), time on the ventilator (10,13,14), and postoperative length of hospital stay (5,15,16). The benefits of reoperative mini AVR include decreased surgical trauma, fewer injuries of the right ventricle and the aorta, minimal dissection of the patent grafts, fewer packed red blood cells (pRBC) transfusions, and shorter intubation and intensive care unit (ICU) times (2,4,17-19). These benefits have been described in the general reoperative AVR population as well as in patients over 80 years of age (18).

Full sternotomy reoperations often include extensive mobilization of previously performed grafts, which increases the potential for injury and embolization of partially calcified conduits (20-22). The standard operating procedure is to use the no-touch technique for the LIMA to LAD graft and only minimal mobilization of proximal portion of venous grafts. This allows for preservation of previously performed grafts without the need for repeat revascularization, which likely contributed to only one observed injury of a previously repaired LIMA graft. Myocardial preservation in patients with open LIMA to LAD consisted of initial anterograde and retrograde cardioplegia, moderate systemic hypothermia, and systemic hyperkalemia. Systemic hyperkalemia was induced with initial bolus of 40-60 mEq of potassium chloride and subsequent boluses as needed to maintain systemic hyperkalemia of 6-8 mEq/L. Upon completion of the procedure and removal of the cross clamp, the excess potassium was ultra-filtrated while reperfusing and rewarming the patient. As previously described with this technique (2), we were able to have minimal enzyme leak with no new Q waves on electrocardiogram and no new segmental wall motion abnormalities on the echocardiogram.

In our 17 years of experience, there were no injuries to the innominate vein, aorta, or the right ventricle with reentry. This was achieved by detailed analysis of the preoperative imaging, pump initiation when the aorta was very close to the posterior sternal plate, and surgical technique involving attention to detail. During this period, the majority of the patients were moderate to high risk, of which 70% had Society of Thoracic Surgeons (STS) predicted scores between 4% and 8%, while 32% of them were octogenarians. These are the patients for whom standard full sternotomy presented elevated operative risks, but who may not be considered eligible for TAVR procedure. We find that a minimally-invasive sternotomy remains a viable surgical approach to reoperative AVR.

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