Masters of Cardiothoracic Surgery

Annular stabilization in remodelling technique

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Clinical vignette

Case 1 is a 52-year-old patient with New York Heart Association (NYHA) III dyspnea. Echocardiography demonstrated a tricuspid aortic valve with grade 4 aortic insufficiency (AI), preserved ejection fraction (50%) and a dilated left ventricle with end-diastolic and end-systolic diameters of 63 and 42 mm, respectively. Gated computed tomography (CT) revealed sinuses of Valsalva measuring 57 mm and ascending aorta 44 mm in diameter.

Case 2 is a 69-year-old patient with NYHA III dyspnea. Echocardiography demonstrated a bicuspid aortic valve with grade 4 AI, preserved ejection fraction (54%) and a dilated left ventricle with end-diastolic and end-systolic diameters of 59 and 45 mm, respectively. Gated CT revealed sinuses of Valsalva measuring 52 mm and ascending aorta 47 mm in diameter.

Surgical techniques

Preparation

After performing a median sternotomy and opening the pericardium, heparinization is undertaken. To maximize the excised ascending aorta length, aorta cannulation is performed high in the arch. Direct antegrade Custodial cardioplegia is used to induce diastolic arrest.

Operation

The ascending aorta is opened and excised down to the sinotubular junction. To reach below the level of the annulus, the aortic root must first be dissected around to the subvalvular plane. The non-coronary sinus is separated from the left atrial roof and then removed. Next, the plane between the pulmonary artery and left-coronary sinus is divided. The left-coronary button is prepared, and the left sinus is excised. Dissection continues all the way to the subvalvular plane. Finally, the right-coronary sinus is removed, and the right-coronary button is prepared. The plane between the right sinus and the right ventricle outflow tract/infundibulum must be dissected. Dissection must remain parallel and near the aortic wall to prevent damaging the infundibulum and entering the right ventricle. A 3 mm rim of aortic tissue is kept around each sinus, 3–5 mm above each commissure, and from the cusp's hinge point.

Next, a complete valve assessment is performed. The mobility, tissue quality, calcification, and leaflets fenestration are all analyzed. Raphes are checked for thickness and restriction of leaflet mobility.

A ruler is used to measure geometric height of each cusp. In the case of tricuspid aortic valve, a cusp is judged to have retracted if the geometric height is 16 mm, and 19 mm in the case of bicuspid aortic valve (in the non-fused cusp). A Hegar dilator is used to measure the annulus size. This measurement determines the size of the expansile external annuloplasty ring (Extra-Aortic, Coroneo Inc., Montreal, Canada) and the synthetic graft.

In the subvalvular plane, six "U" sutures (Ethicon 3/8 25 mm) are positioned circumferentially, one beneath the nadir of each cusp and one beneath each commissure. The sutures are inserted as pledgetted mattress sutures 1–2 mm beneath the nadir of each cusp into the aorta. The needle

should exit the aorta from the outside at the lowest point of the dissection plane, guaranteeing that the ring that is implanted thereafter lies at the subvalvular plane.

The "U" sutures should be inserted at the same depth as those at the nadirs of the cusps, underneath the commissures at the base of the interleaflet triangles. The sixth suture is not inserted internally. Instead, it is positioned at the deepest plane of dissection on the left atrium exterior wall (non-pledgetted) to prevent harm to the conduction system below the right-non commissure.

Then, alignment of cusp free edge is established. In the case of tricuspid aortic valve, each hemi-cusp is compared to its neighbour in a systematic way. Polypropylene 5/0 sutures are placed through the nodules of Arantius and used to retract two adjacent hemi-cusps away from their corresponding commissure to assess if there is excess length on any cusp. All cusps are compared to their neighbouring cusp in this manner. Central plication of the free margin is carried out if there is excess length. In case of bicuspid aortic valve, the aim is to use the non-fused cusp as the reference, and to align the free edge length of the fused cusp with the non-fused cusp. A 5/0 polypropylene suture is placed in the nodule of Arantius of both cusps. One commissure is grasped and retracted whilst the sutures in the nodules of Arantius of both cusps are pulled in the opposite direction thereby, showing any excess of length in the free edge of the fused cusp. If this is present, central plicating 5/0 sutures are used to achieve symmetry.

Then, remodelling is undertaken using a synthetic graft as previously described (1). After root reconstruction, cusp repair is carried out by measuring the cusp effective height using a special cusp caliper. Each cusp is examined to check for prolapse (residual or induced). To obtain a 9 mm effective height, plaiting 5/0 polypropylene sutures are put in the centre of cusps free edge with an effective height of less than 9 mm.

Completion

The expansile annuloplasty ring is positioned at the subvalvular level as the last stage. Each of the previously placed subvalvular "U" sutures is passed around the ring. The sutures are tied after the ring has been dropped by parachute. The coronary buttons are anastomosed to the Valsalva graft. The distal aortic anastomosis is performed. The patient is then taken off cardiopulmonary bypass, and the competency of the repair is evaluated via transesophageal echocardiogram.

Comments

Clinical results

Although the remodelling technique provides physiologic cusp movement within the three reconstructed neo-sinuses, thus preserving root expansibility through the interleaflet triangles, an untreated dilated aortic annulus (>25–28 mm) has been identified as a risk factor for failure. As a result, aortic valve repair using the re-implantation technique or remodelling with aortic annuloplasty, is recommended in young patients with aortic root dilatation and tricuspid aortic valve (Class IC indication) since 2014 ESC/EACTS guidelines (2). However, most aortic valves are still replaced (3). The multicentric CAVIAAR study comparing aortic valve repair versus mechanical valve replacement for root aneurysm showed that standardized aortic valve repair with external annuloplasty significantly reduced valve-related deaths and major bleeding rates without increasing the risk of reoperation (4).

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Footnote

Conflicts of Interest: EL has consultant agreements with CORONEO, Inc. (www.coroneo.com). The other authors have no conflicts of interest to declare.

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