Masters of Cardiothoracic Surgery

The Ross procedure for bicuspid aortic valve: total root implantation technique

Maroun Yammine, Elbert Williams, Ismail El-Hamamsy

Department of Cardiovascular Surgery, Mount Sinai Health System, New York, NY, USA

Correspondence to: Ismail El-Hamamsy, MD, PhD. Department of Cardiovascular Surgery, Mount Sinai Health System, 1190 fifth Avenue, Box 1028, New York, NY 10029, USA. Email: Ismail.El-Hamamsy@mountsinai.org.

Submitted Jul 16, 2021. Accepted for publication May 28, 2022.
doi: 10.21037/acs-2022-bav-23
View this article at: https://dx.doi.org/10.21037/acs-2022-bav-23

Clinical vignette

An otherwise healthy 55-year-old patient was referred for symptomatic severe bicuspid aortic valve stenosis (AS). Preoperative evaluation showed normal biventricular function, no evidence of coronary artery disease and an ascending aorta of 3.5 cm. Elective Ross procedure using a total root technique was therefore scheduled (1).

Echocardiographic evaluation

The aortic valve, aortic root and pulmonary valve (PV) are evaluated by transesophageal echocardiogram (TEE). Bicuspid valve anatomy is assessed with a specific focus on commissural orientation and the presence and location of raphe. Aortic root dimensions are also measured. While central mild pulmonary regurgitation is common and benign, eccentric or more significant regurgitation mandates direct valve inspection.

Setup and cannulation

The aortic cannula is inserted in the aortic arch using the Seldinger technique. Bicaval cannulation is preferred for venous drainage. The distal ascending aorta is freed circumferentially to avoid tethering the pulmonary artery (PA) with the cross-clamp, which subsequently facilitates distal homograft anastomosis. Cold Del-Nido cardioplegia is used antegrade through the aortic root and selectively into the coronary ostia thereafter (2).

Aortic valve resection and root mobilization

The aorta is clamped at the base of the innominate artery with particular attention to exclude the PA from the clamp. A transverse aortotomy is then performed. The valve, in this case, was bicuspid and heavily calcified. The leaflets are excised, and the annulus debrided. The root is inspected for annular size and commissural symmetry: angles and heights, as both will need to be symmetrical at the time of autograft implantation. In cases of gross asymmetry, three points are identified that are 120° apart, representing neo-commissures. The coronary buttons are then mobilized. In this case, the annulus was not dilated, and the primary presentation was isolated AS; therefore, no annuloplasty was required.

Pulmonary autograft harvest and preparation

The main PA is transected anteriorly, 3–5 mm proximal to the takeoff of the right PA. The PV is inspected to rule out large fenestrations or bicuspid anatomy. The autograft is then lifted off the plane of the heart by dissecting posteriorly, using low-power electrocautery, down to the level of the interventricular septum. Care is taken to not injure the left anterior descending coronary artery (LAD) posteriorly by staying close to the PA wall. Using a right-angled clamp, a full-thickness puncture is then performed to the anterior right ventricular free wall 5 mm below the nadir of the non-facing cusp. Pulmonary autograft harvesting is then completed using a combination of scissors and cautery, leaving 3–5 mm of infundibular muscle below

cusp insertion. Once the autograft is resected, a small dose of cardioplegia is administered to identify bleeders in the septal bed, which should be controlled at this stage.

The autograft is then trimmed proximally, leaving ≤3 mm of infundibular muscle. This devascularized myocardium provides no structural support to the autograft. Slight scalloping of the commissures is also performed. In AS, PV annular diameter closely matches that of the aortic valve. However, cusp symmetry should be examined carefully prior to implantation in the aortic annulus, ensuring that pulmonary valve (PV) commissures are at ~120°.

Aortic root preparation

If the native aortic root commissures were symmetric, autograft implantation can be carried in a standard fashion with no further root modifications. However, if there is commissural asymmetry, care is needed to avoid autograft distortion at implantation. In this case, the commissures were at ~160°. A tool with markers at 120° is therefore used to identify three neo-commissures 120° apart, ensuring that the left main button sits between two of the neo-commissures. Similarly, we examine commissure/raphe height. When the commissures and raphe are at different heights, the raphe becomes the reference. We close both commissures with figure of eight sutures to equalize their heights, which lowers the implantation plane. We recommend adopting the same strategy for a type 0 bicuspid aortic valve annulus.

Autograft implantation

We use single interrupted 4-0 prolene sutures. The fundamental principle is to ensure the autograft sits in a subvalvular position, by implanting it within the left ventricular outflow tract (LVOT) so that the native aortic annulus provides structural support to the PV. Sutures enter 1 mm above the aortic annulus and exit 2–3 mm below the annulus. On the autograft side, the suture is taken inside-out right at the hinge point of the pulmonary cusps and passed tangentially to exclude all infundibular muscle. The sutures are then tied, and three retraction sutures are placed 2 mm above each of the commissures.

Both coronary arteries are then reimplanted in the body of the autograft sinuses. There is no need to reimplant the right coronary button high in the Ross procedure, provided it was not over-mobilized.

Pulmonary homograft implantation

Pulmonary homograft implantation is performed prior to the autograft distal suture line. A decellularized oversized (≥28 mm) pulmonary homograft is used (3). We start with the distal anastomosis using a running 5-0 prolene, which is interrupted at three different locations to avoid purse-stringing. The proximal anastomosis is completed using a running 4-0 Prolene suture. Care is taken to keep the bites partial thickness through the interventricular septum, especially in its lateral portion, to avoid injury to the first septal perforator.

Proximal ascending aorta

All supra-commissural PA tissue is trimmed leaving ≤2 mm above the commissures. In case of size mismatch between the autograft sinotubular junction (STJ) and native ascending aorta (≥3–5 mm), a short Dacron interposition graft (typically 26 or 28 mm) is used to prevent autograft STJ dilatation. Commissural symmetry is also critical for this anastomosis to avoid any distortion of the autograft at the STJ. The clamp is then removed, and the patient weaned off bypass prior to hemostasis.

Postoperative care

Strict blood pressure control from the moment the clamp is removed and extending six to twelve months after surgery is fundamental. Systolic blood pressure is maintained ≤110–115 mmHg. Beta blockers are used as first-line therapy to decrease dp/dt (the change in pressure inside the left ventricle cavity during isovolemic contraction).

Acknowledgments

Funding: None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

References

1. El-Hamamsy I, Toyoda N, Itagaki S, et al. Propensity-Matched Comparison of the Ross Procedure and Prosthetic Aortic Valve Replacement in Adults. J Am Coll Cardiol 2022;79:805-15.
2. Williams EE, EL-Hamamsy I. The Ross Procedure. Operative Techniques in Thoracic and Cardiovascular Surgery 2021;26:189-209.
3. Chauvette V, Bouhout I, Tarabzoni M, et al. Pulmonary homograft dysfunction after the Ross procedure using decellularized homografts-a multicenter study. J Thorac Cardiovasc Surg 2022;163:1296-1305.e3.

Cite this article as: Yammine M, Williams E, El-Hamamsy I. The Ross procedure for bicuspid aortic valve: total root implantation technique. Ann Cardiothorac Surg 2022;11(4):484-486. doi: 10.21037/acs-2022-bav-23