

Challenging decision-making in small aortic annulus with recurrent left ventricular outflow tract obstruction: Ross and hybrid arch frozen elephant trunk repair



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Computed 3D tomography of Ross reconstruction and hybrid arch repair.

CENTRAL MESSAGE

A pulmonary autograft provides superior hemodynamics, especially in patients with small aortic annuli, and can be a useful alternative with recurrent left ventricular outflow tract obstruction.

▶ Video clip is available online.

We describe a 61-year-old patient (height: 170 cm, weight: 75 kg, body surface area: 1.88 m²) who previously underwent an aortic valve commissurotomy and subaortic resection for congenital aortic valvopathy 50 years ago. The patient presented with New York Heart Association class III dyspnea secondary to recurrent left ventricular outflow tract obstruction (LVOTO; peak gradient: 28 mm Hg), significant mixed aortic valvulopathy, and an aneurysmal ascending aorta and arch. Echocardiography findings demonstrated normal left ventricular function and moderate-to-severe aortic regurgitation with severe aortic stenosis (mean/peak gradients: 42/70 mm Hg). Furthermore, a concerning small left ventricular outflow tract (LVOT) of 16 mm and a basal interventricular septum diameter 17 mm were noted. Computed tomography demonstrated an aortic annulus of 17 × 14 mm, an ascending aorta of 52 mm, and an aortic arch of 47 mm.

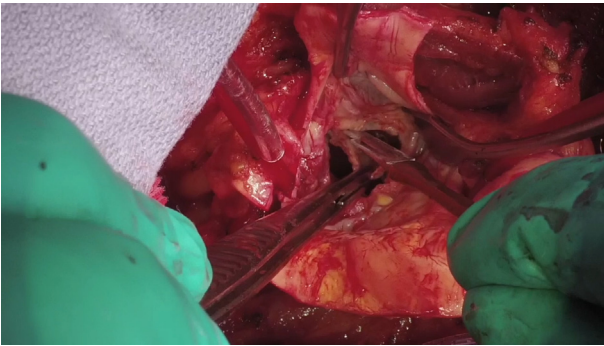
Considering the aortic valvular pathology and recurrent LVOTO, we planned for aortic valve replacement with posterior or anterior aortic root enlargement¹ and believed that a pulmonary autograft would best meet the patient's quality of life and survival expectations. In addition, we planned to perform a hybrid arch frozen elephant trunk repair for his arch aneurysm (Video 1). Written informed consent for

publication of data was provided by the patient. Institutional review board approval was not required.

CASE PRESENTATION

At operation, a 3-cm right neck incision was used to sew an 8-mm Dacron side graft onto the right common carotid artery for systemic and antegrade cerebral perfusion (ACP). A redo midline sternotomy was performed, adhesions were lysed, and cardiopulmonary bypass was initiated with central cooling. Myocardial protection included multi-dose, antegrade del Nido cardioplegia delivered via ostial catheters.

After opening the root, we discovered that the aortic valve appeared stenotic, dysplastic, restricted, and unrepairable; thus, it was excised en bloc. On careful inspection of the LVOT, we could appreciate a tight subaortic ring and prominent interventricular septum. The LVOT measured smaller than a 19-mm sizer. First, we circumferentially excised the recurrent subaortic ring, then we performed a septal myectomy (approximately 2 × 0.5 × 3 cm). We contemplated performing a Konno enlargement but thought



VIDEO 1. Narrated case report video. Video available at: [https://www.jtcvs.org/article/S2666-2507\(24\)00230-X/fulltext](https://www.jtcvs.org/article/S2666-2507(24)00230-X/fulltext).

that current maneuvers provided an acceptably enlarged LVOT and good annular stabilization for the pulmonary autograft. In addition, we had concerns that a Konno could risk too large of a neo-aortic annulus, potentially compromising pulmonary autograft competence.

After reaching a nadir temperature of 28°C, circulatory arrest was initiated with continuous ACP. We resected the ascending aorta and arch and advanced a femorally placed guidewire into the mediastinum for “through-and-through control.” We implanted a 28 × 30 × 100-mm Thoraflex Hybrid graft (Terumo Aortic) with a two-layered, zone 2 anastomosis. Central rewarming was initiated via the perfusion side limb and the left carotid limb was anastomosed to enable bilateral ACP.

We transected the pulmonary artery distally at the bifurcation and scalloped the pulmonary autograft out of the right ventricular outflow tract. The autograft had a diameter

of 23 mm with an initial LVOT less than 19 mm. The sub-aortic ring resection and septal myectomy further enlarged the LVOT and aortic annulus to 21 mm. Excess pulmonary autograft infundibular muscle was trimmed, and the autograft was implanted symmetrically deep into the LVOT, with interrupted 4-0 Prolene sutures. The distal end of the autograft was transected above the sinotubular junction (STJ) and the coronary buttons were reimplemented in the anatomic positions. The STJ was stabilized with a 26-mm Dacron graft. A 32-mm SynerGraft pulmonary homograft (Artivion) was trimmed and implanted. The STJ graft was anastomosed to the arch graft and the crossclamp was removed. Finally, the innominate limb of the hybrid arch graft was anastomosed to the innominate artery to complete the aortic reconstruction.

The patient was weaned from cardiopulmonary bypass with moderate inotropic support and protamine was administered. During closing, the patient suddenly developed ventricular tachycardia and was cardioverted but placed on temporary extracorporeal membrane oxygenation (1-2 L/min) for precautionary measures for less than 48 hours, where it was successfully decannulated. Postoperative transesophageal echocardiography demonstrated a normally functioning homograft and autograft (mean/peak gradients: 6/10 mm Hg) and no residual LVOTO (Figure 1). The patient had a slow, progressive recovery in hospital. PredischARGE echocardiography confirmed excellent autograft and homograft function, with left ventricular ejection fraction of 45% to 50%. Computed tomography (Figure 2) scan confirmed a widely patent hybrid arch and frozen elephant trunk reconstruction, without signs of graft

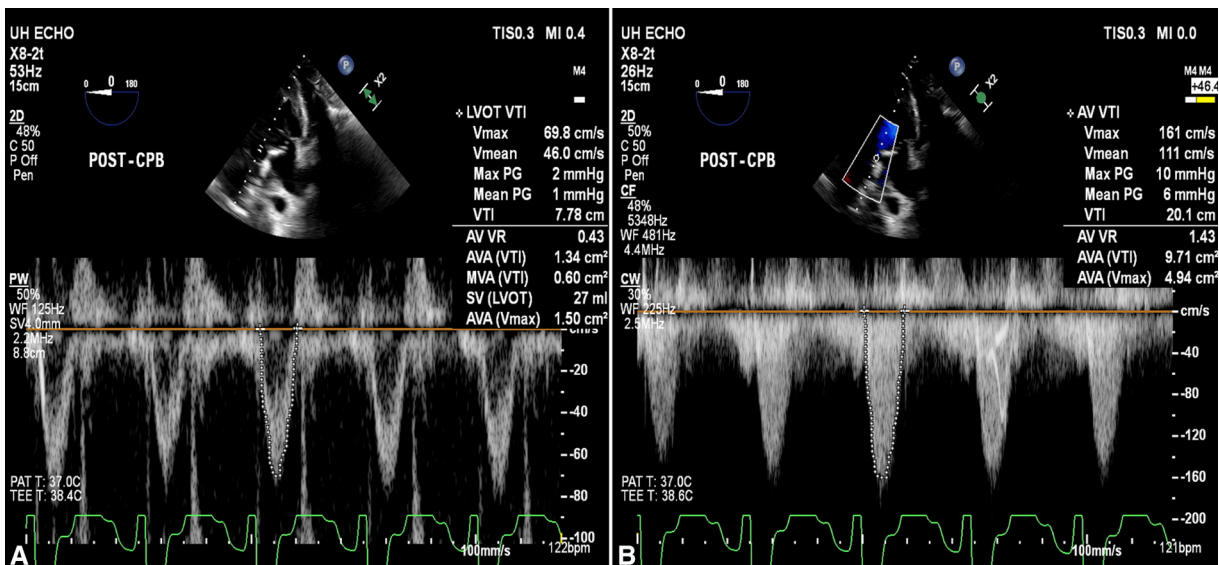


FIGURE 1. Postoperative echo demonstrating (A) left ventricular outflow tract mean and peak gradients of 1 and 2 mm Hg and (B) pulmonary autograft mean and peak gradients of 6 and 10 mm Hg.

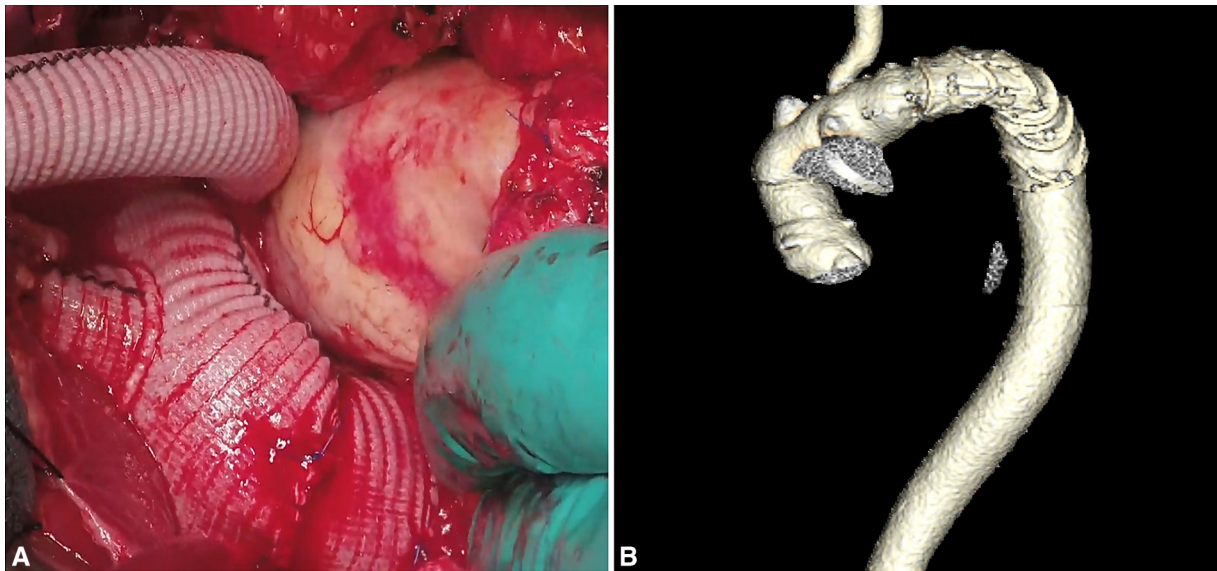


FIGURE 2. A, Intraoperative completed arch and Ross reconstruction. B, Pre-discharge computed tomography, with a 3-dimensional reconstruction showing the Ross, a sinotubular junction stabilization graft, hybrid arch repair with a Thoraflex graft.

complications. At 9 months of follow-up, the patient was doing well, with a normal valvular and left ventricular function (60%-65%).

DISCUSSION

We highlight the challenging decision-making around a small aortic annulus with recurrent LVOTO. Aortic root enlargement remains an option when performing standard aortic valve replacement with conventional prostheses. However, the Ross operation in patients with small aortic annulus offers a living aortic valve substitute with dynamic motion that provides superior hemodynamics, survivability, and lower valve complications/reintervention rates compared with conventional valve prostheses (including stentless bioprosthesis),^{2,3} thus often negating the need for more aggressive aortic root enlargement options, particularly in adults.

In our patient, after resecting the subaortic membrane and performing a septal myectomy, we abandoned the idea of performing a Konno,⁴ as we believed that we had achieved an acceptably enlarged LVOT, particularly for a 23-mm autograft. Moreover, the principle of annular stabilization is of the utmost importance for the durability of the autograft. In conclusion, the Ross operation should

still be considered a viable option in complex aortic reoperations.

Conflict of Interest Statement

M. W. A. Chu reported speaker's honorarium from Medtronic, Edwards Lifesciences, Terumo Aortic, and Artivion. All other authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

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