Korean J Thorac Cardiovasc Surg 2016;49:489-492 □ HOW-TO-DO IT □
ISSN: 2233-601X (Print) ISSN: 2093-6516 (Online) https://doi.org/10.5090/kjtcs.2016.49.6.489

Valve-Sparing Root Replacement: Aortic Root Remodeling with External Subvalvular Ring Annuloplasty

Sang-Ho Cho, M.D., Ph.D., Dae Hyun Kim, M.D., Ph.D., Young Tae Kwak, M.D., Ph.D.

Department of Thoracic and Cardiovascular Surgery, Kyung Hee University Hospital at Gangdong, Kyung Hee University School of Medicine

The original valve-sparing procedures for aortic root aneurysms were remodeling and reimplantation of the aortic root. The remodeling technique provides more physiologic movement of the cusps within 3 reconstructed neo-sinuses, thus preserving root expansibility through the interleaflet triangles. However, the durability of remodeling has been a matter of concern due to the high rate of aortic insufficiency when annular dilation is not addressed. Therefore, a modified approach was developed, combining a physiologic remodeling of the root with a subvalvular annuloplasty. This case report highlights the first case of successful aortic root remodeling with external subvalvular ring annuloplasty in Korea.

Key words: 1. Aortic root
2. Aortic aneurysm
3. Aortic valve, surgery
4. Cardiac valve annuloplasty

Case report

A 69-year-old man was referred for the surgical management of an aortic root aneurysm found by echocardiography during a preoperative work-up for spinal surgery. He did not have a family history or cardinal features of any heritable disorder of the connective tissue. A transthoracic echocardiographic examination showed an enlarged sinus of Valsalva (55 mm in diameter) with moderate aortic regurgitation (Fig. 1A, B). The maximal diameters of the sinotubular junction and ascending aortic tubular portion were 44 and 40 mm, respectively (Fig. 1C). The left ventricular ejection fraction was 65% with no regional wall motion abnormalities. A transesophageal echocardiographic examination showed aortic valve cusp coaptation at a level close to the middle of the sinuses of Valsalva (Fig. 1D). The patient was scheduled for aortic root remodeling with concomitant external subvalvular ring annuloplasty.

After establishing cardiopulmonary bypass (CPB) and aortic clamping, the ascending aorta was transected above the sinotubular junction. After external dissection down to the base of the aortic annulus, the wall of the aortic sinus was completely removed, leaving a fringe of the aortic wall, and the coronary artery buttons were individualized. The diameters of the Valsalva graft and the flexible ring were determined to be 26 and 25 mm, respectively, based on the internal aortic annular base diameter measured with a 28-mm Hegar dilator (Video 1). Five sutures of 2-0 polyester fiber with pledgets were passed from the inside out as U stitches in the subvalvular plane. A sixth suture without pledgeting was

Received: May 19, 2016, Revised: July 5, 2016, Accepted: July 6, 2016, Published online: December 5, 2016

Corresponding author: Sang-Ho Cho, Department of Thoracic and Cardiovascular Surgery, Kyung Hee University Hospital at Gangdong, 892 Dongnam-ro, Gangdong-gu, Seoul 05278, Korea
(Tel) 82-2-440-6158 (Fax) 82-2-440-8004 (E-mail) sinan75@khnmc.or.kr

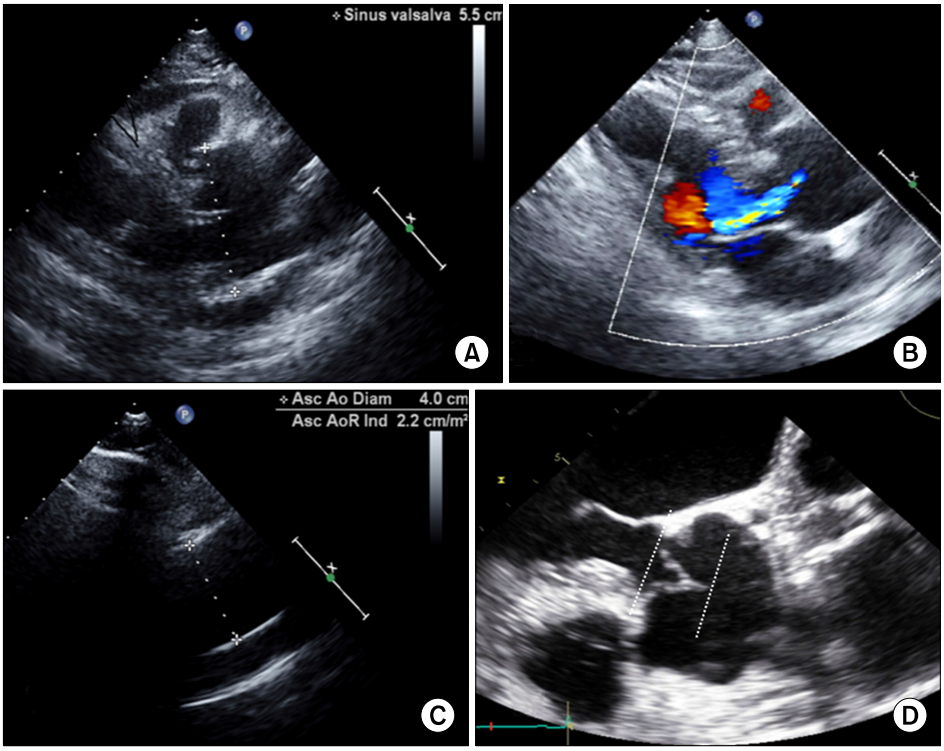

Fig. 1. Preoperative echocardiography. (A) Transthoracic echocardiography shows an enlarged sinus of Valsalva (55 mm in diameter). (B) A parasternal long axis view shows moderate aortic regurgitation. (C) The maximal diameter of the ascending aortic tubular portion was 40 mm. (D) Transesophageal echocardiography shows cusp coaptation at a level close to the middle of the sinuses of Valsalva.

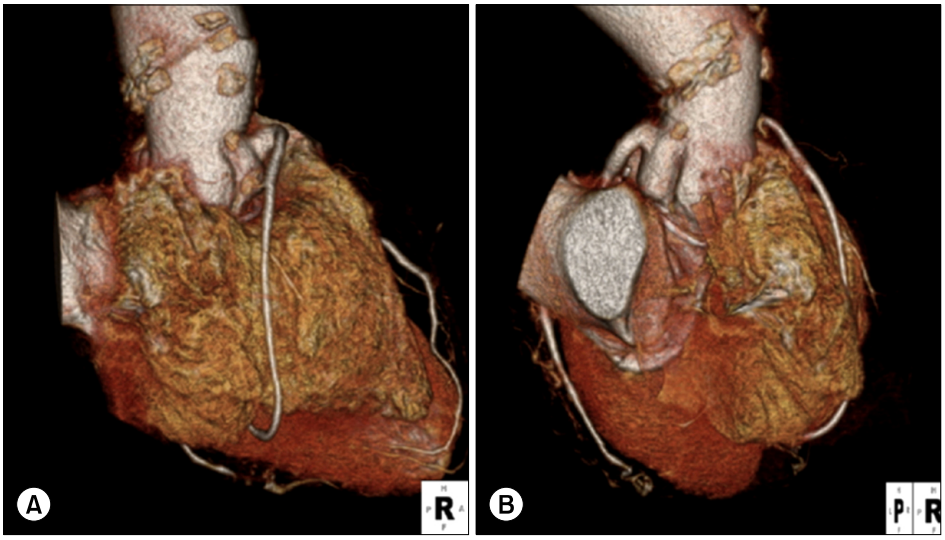

Fig. 2. (A, B) Postoperative computed tomographic images (3-dimensional reconstruction) show reconstructed neo-sinuses, interleaflet triangles, and patent coronary artery button anastomoses.

placed externally at the level of the interleaflet triangle between the right and noncoronary sinus due to a lesion at the bundle of His (Video 2). The first step of aortic cusp repair for the alignment of the coaptation margin was the placement of a central plication stitch on the extended noncoronary cusp. The length of each hemi-cusp free edge between the right and noncoronary cusp was equalized (Video 3). The remodeling technique was performed, using a 26 mm Gelweave Valsalva graft (Vascutek, Renfrewshire, Scotland), allowing a bulging aspect of the neo-sinuses of Valsalva and preserving the interleaflet triangles. After remodeling the aortic root, the second step of aortic cusp repair was performed, involving the resuspension of an effective height. Three plication stitches on the right coronary cusp and 1 plication

stitch on the noncoronary cusp were added on the free edge until any residual or induced cusp prolapse was resolved and an effective height greater than 9 mm was obtained (Video 4). After reducing the ring length to 8 cm with a diameter of 25 mm, the six anchoring U stitches were passed through the inner aspect of the SJM Tailor flexible ring (St. Jude Medical, St. Paul, MN, USA). The ring was then brought downward around the remodeled aortic root and the U stitches were tied to fix the ring in a subvalvular position (Video 5). The coronary ostia were reimplanted following the usual technique with a 6-0 prolene suture, and distal anastomosis was performed with the use of running 4-0 prolene sutures. The total cross-clamp time was 210 minutes, and the patient was successfully weaned from CPB.

The patient had an uneventful postoperative course with regard to hemodynamic performance. Echocardiography on postoperative day 7 revealed a competent aortic valve with no regurgitation (Video 6) and a computed tomography scan showed a well-reconstructed aortic root (Fig. 2). He was discharged from the hospital on postoperative day 13 and followed up at an outpatient clinic for 9 months. Follow-up echocardiography at 8 months was performed and showed no significant aortic regurgitation.

Discussion

In the past 2 decades, valve-sparing root replacements (VSRRs) have been developed as alternatives to the Bentall procedure for dystrophic aortic root aneurysms combined with aortic valve regurgitation. The two most widely used techniques are the remodeling technique, developed by Yacoub, and the reimplantation technique, developed by David [1]. Aortic root remodeling does not correct the dilation of the aortic annulus that can lead to the failure of the procedure and the recurrence of aortic insufficiency. As a result, many surgeons prefer the reimplantation technique. David et al. [2] recommended the reimplantation technique when the aortic annulus is >27 mm in men and >25 mm in women, while the remodeling technique is suitable for older patients with a normal aortic annulus. When selecting a technique, Hanke et al. suggested an annular diameter of 28–30 mm as a cutoff value, recommending the Yacoub technique for annuli with narrower diameters and the David technique for wider diameters [3]. However, the classic remodeling technique provides more physiologic movements of the cusps within the three reconstructed neo-sinuses. This preserves root expansibility through the interleaflet triangles during the cardiac cycle. Recent dynamic studies have suggested that cusp motion and flow patterns across the reconstructed aortic root are more physiologic after remodeling of the aortic root than after reimplantation of the aortic valve [1,4]. As a result, recent research has focused on modified remodeling techniques, such as a remodeling root reconstruction in association with an aortic annuloplasty to combine the advantages of both the remodeling and reimplantation techniques. In this case, we performed an approach standardized by Lansac that restored normal aortic cusp geometry (valve repair) and reduced the dilated aortic annulus using an external subvalvular ring annuloplasty device [1,5]. Valve repair is achieved in two steps. First, before root reconstruction to realign adjacent cusp free edges, the excess length of the cusp is corrected with central plication stitches along the nodule of Arantius or by triangular resection of this area. Second, after root reconstruction, residual or induced cusp prolapse is resuspended with central plication stitches in order to obtain an equivalent effective height of all cusps (distance between the free edge of the cusp to the aortic annular base) [1,5]. Prolapse frequently occurs after VSRR irrespective of the preoperative degree of aortic regurgitation. An effective height of less than 9 mm indicates prolapse, which in most instances should be corrected [5]. In addition to valve repair, Lansac et al. [1] advocated an external subvalvular annuloplasty using an expansible flexible ring when the aortic annular base diameter is ≥ 25 mm. Compared with other techniques such as plication stitches, partial annuloplasty, and internal annuloplasty, an external ring annuloplasty may ensure optimal reduction in the aortic annular base diameter, cusp mobility, and the preservation of the conduction system. Moreover, subvalvular annuloplasty through an aortic ring partially increases the coaptation height and compensates for the induced symmetric prolapse that usually occurs after root replacement [1,5]. Six anchoring stitches are needed to implant the ring. Five sutures of 2-0 polyester fiber with pledgets are placed from the inside out as U stitches circumferentially in the sub-

valvular plane, below the nadirs of each cusp, and at the base of each interleaflet triangle except for one. A sixth stitch is passed externally at the level of the interleaflet triangle between the right and noncoronary sinus in order to preserve the membranous septum or the bundle of His lesion [1].

This is a case report describing a standardized approach to VSRR. We suggest that physiologic remodeling of the aortic root can be safely combined with aortic valve repair and subvalvular annuloplasty using an external ring for dystrophic aortic root aneurysms.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Supplementary materials

Supplementary materials can be found via https://doi.org/10.5090/kjtcs.2016.49.6.489. Video 1. Dissection of the subvalvular plane.

Supplementary materials can be found via https://doi.org/10.5090/kjtcs.2016.49.6.489. Video 2. Placement of six anchoring sutures for ring annuloplasty. Five sutures with pledgets were passed from the inside out as U stitches circumferentially in the subvalvular plane, below the nadirs of each cusp, and at the base of each interleaflet triangle except for one. A sixth stitch without pledgeting was placed externally at the level of the interleaflet triangle between the right and noncoronary sinus.

Supplementary materials can be found via https://doi.org/10.5090/kjtcs.2016.49.6.489. Video 3. The first step of aortic cusp repair for the alignment of the coaptation margin. A polypropylene 6-0 stay suture was passed through each nodule of Arantius. The distance between the two stitches determined the area for the central plication stitches to equalize each hemi-cusp.

Supplementary materials can be found via https://doi.org/10.5090/kjtcs.2016.49.6.489. Video 4. The second step of aortic cusp repair for the resuspension of an effective height. Central plication stitches were placed to obtain an equivalent effective height for all cusps. The effective height of all cusps should be greater than 9 mm.

Supplementary materials can be found via https://doi.org/10.5090/kjtcs.2016.49.6.489. Video 5. Aortic annuloplasty using an external subvalvular ring.

Supplementary materials can be found via https://doi.org/10.5090/kjtcs.2016.49.6.489. Video 6. Postoperative echocardiography shows a competent aortic valve with no regurgitation.

References

1. Lansac E, Di Centa I, Vojacek J, et al. *Valve sparing root replacement: the remodeling technique with external ring annuloplasty*. Ann Cardiothorac Surg 2013;2:117-23.
2. David TE, Maganti M, Armstrong S. *Aortic root aneurysm: principles of repair and long-term follow-up*. J Thorac Cardiovasc Surg 2010;140(6 Suppl):S14-9.
3. Hanke T, Charitos EI, Stierle U, et al. *Factors associated with the development of aortic valve regurgitation over time after two different techniques of valve-sparing aortic root surgery*. J Thorac Cardiovasc Surg 2009;137:314-9.
4. Soncini M, Votta E, Zinicchino S, et al. *Aortic root performance after valve sparing procedure: a comparative finite element analysis*. Med Eng Phys 2009;31:234-43.
5. Schafers HJ, Aicher D. *Root remodeling for aortic root dilatation*. Ann Cardiothorac Surg 2013;2:113-6.