# Lateral (left–right commissural) root enlargement may reduce risk of coronary artery obstruction from transcatheter aortic valve-in-valve implantation



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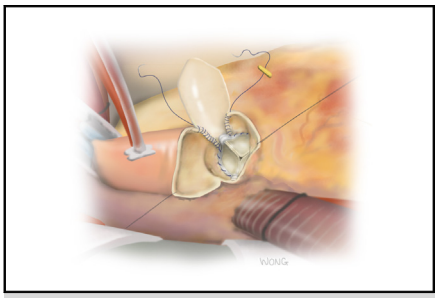

Lateral aortic root enlargement through the left–right (LR) commissure.

### CENTRAL MESSAGE

Lateral root enlargement at the left–right commissure may reduce risk of transcatheter aortic valve-in-valve implantation-induced coronary artery obstruction via sinus sequestration.

We propose a novel surgical technique for lateral root enlargement, wherein a patch splits the left–right (LR) commissure. This technique borrows heavily from root enlargement techniques described by Nicks and colleagues,[1] Vouhé and colleagues,[2] and Yamaguchi and colleagues.[3] In addition to enlarging the annulus, this technique modifies the shape of the root in ways that may reduce risk of coronary artery obstruction and sinus sequestration during future transcatheter aortic valve implantation (TAVI).

## TECHNIQUE

The aorta is opened anteriorly 1 cm above the sinotubular junction (STJ), and extended leftward, to curve down through the STJ, to the top of the LR commissure. The aortic leaflets are excised. After separating the aorta from the pulmonary artery behind the LR commissure, the aortotomy is extended further, splitting the LR commissure along its length, into the subcommissural triangle, stopping 3 mm before entering septal myocardium (Figure 1).

A patch is sewn into the divided LR commissure, using 4–0 polypropylene suture, similar to a Nicks root enlargement. The patch suture lines are continued past the STJ, before sewing in the valve. The valve sutures should traverse the patch well above its nadir, where the patch is at least 6 mm wide to upsize the valve. Once seated, there should be a few millimeters of space behind the tip of the LR strut and the patch. The aortotomy is closed, incorporating the patch whilst permitting it to bulge outward slightly when the aorta is pressurized.

## COMPUTED TOMOGRAPHY ANALYSIS

To simulate future valve-in-valve TAVI and assess risk for coronary obstruction, a virtual TAVI valve was superimposed on 3-dimensional multiplanar reconstructed postoperative computed tomography images with Horos version 4.0.0 DICOM image viewer for MacOSX (Horos Project). Risk of TAVI-induced coronary artery obstruction is considered high if the virtual transcatheter valve to STJ distance over a coronary ostium is <2 mm and if virtual transcatheter valve to coronary distance is <4 mm.[1] As shown in Figure 2, *D*, the virtual transcatheter valve to STJ distance over the left main and right coronary arteries were 1 mm and 9 mm, respectively. The billowing patch material provides

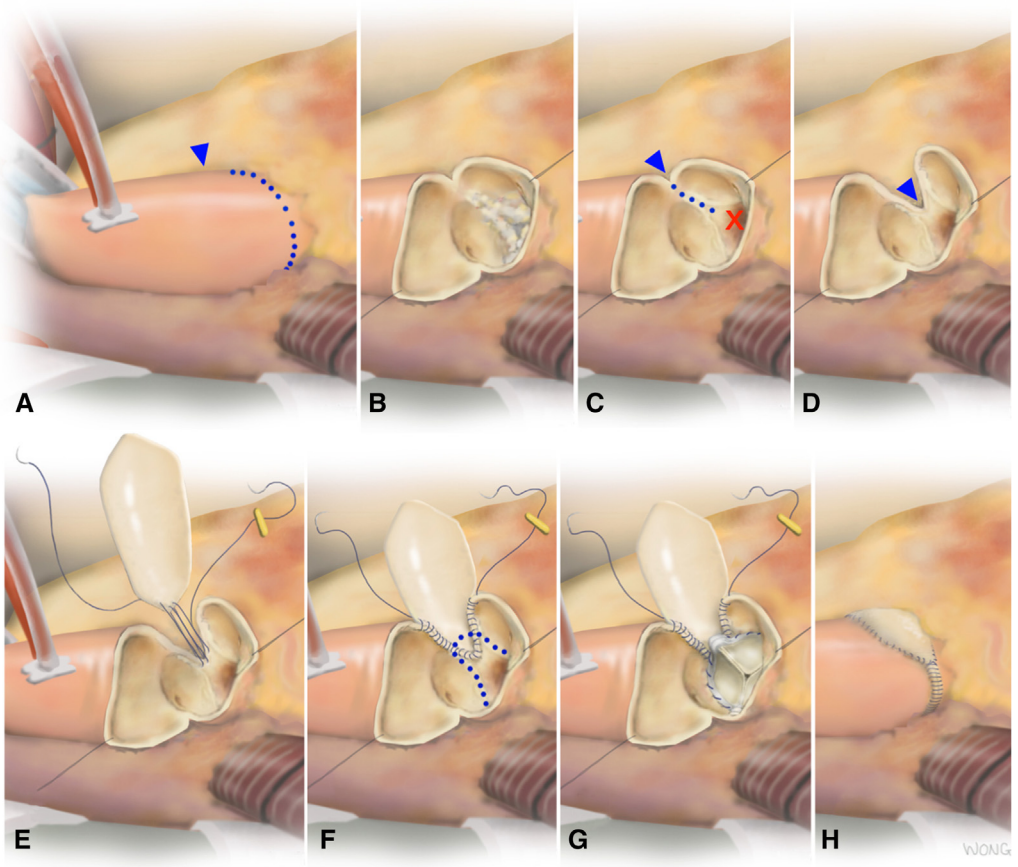


**FIGURE 1.** Operative technique illustrated. A, After cardioplegic arrest, the main pulmonary artery (PA) and proximal ascending aorta are separated (*blue arrowhead*); an aortotomy is made starting 1 cm above the sinotubular junction (STJ) anteriorly above the right coronary artery, and curved toward the top of the left-right (LR) commissure laterally, and transversely in a medial direction. B, Retraction sutures are placed, and the diseased aortic valve is inspected and excised. C, Using cautery and scissors, the plane between the aorta and PA behind the LR commissure is developed (*blue arrowhead*), and then the aortotomy is extended 1 to 1.5 cm further down the middle of the LR commissure (*blue dotted line*), remaining within aortic tissue (in the subcommissural triangle) and avoiding septal myocardium (*red X*). D, This opens a *V*-shaped cleft through the commissure. The plane between aorta and PA (*blue arrowhead*) may need to be developed more thoroughly to mobilize the cut aortic edges. E, A 4 × 4 cm piece of bovine pericardium or 5 cm length of 8 mm polyethylene terephthalate tube graft split open down its length (Boston Scientific Corporation) is then fashioned into a 5- to 6-cm long and 2- to 2.5-cm wide patch with 45° diamond-shaped short ends, and is sewn smooth side facing inward, to the cleft in the LR commissure using a 4–0 polypropylene continuous suture line with small, closely-spaced bites. After parachuting the valve down into place, care is taken to invert the edges of the patch, especially for the portion of the suture line above the annulus, so that the rough side of the patch meets the adventitia of the aorta; this encourages the patch to bulge outward from the aorta. F, It is best if the suture line is continued on both sides of the patch beyond the STJ, before implanting the valve. The surgical aortic valve suture line (*blue dotted line*) should pass through the patch; and the patch should have been fashioned so it is at least 6-mm wide at the level where the annulus and valve suture line intersect it. G, Once the valve is seated and tied down, there will be a few millimeters of separation behind the LR strut of the surgical bioprosthesis in front of the patch. H, Finally, the remainder of the patch is incorporated into the closure and billows outward when pressurized after completion of the closure.

ample room (9 mm) for blood flow from the tubular aorta into the right sinus. Critically, it also establishes a new route (up to 6 mm measured between the LR strut and patch) for flow behind the LR strut into the left sinus, thus mitigating risk of left main coronary obstruction. Virtual transcatheter valve to coronary distance was 5 mm for both coronary ostia. As shown in Figure 2, a balloon-expandable TAVI valve, a tall self-expandable TAVI valve, and even a TAVI-in-TAVI implant would be predicted to be safe for valve-in-valve implant, with flow into the left and right sinuses supplied almost exclusively via the billowing patch.

## DISCUSSION

There are several advantages to this novel technique. First, a surgeon can easily visualize the LR commissure and suture high at the commissure rather than deep within the nadir of

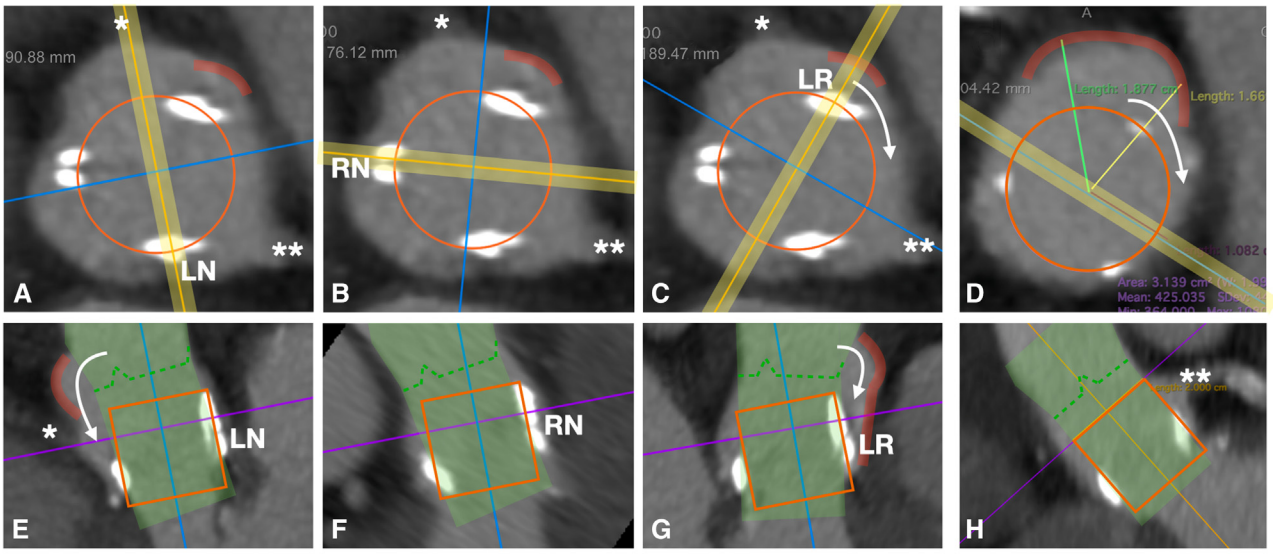


**FIGURE 2.** Postoperative computed tomography of the aortic root with 3-dimensional multiplanar reconstruction. The 4 upper images (A through D) show a plane (parallel to the annular plane through the surgical bioprosthesis) at the level of the coronary ostia (A through C) and at the level of the sinotubular junction and tops of the surgical valve struts (D); the 4 lower images (E through H) show orthogonal side view planes corresponding to the thick yellow lines in the image above each 1 respectively (*purple lines* in the lower images mark the height of the planes corresponding to the upper images). Virtual transcatheter valves (as a valve-in-valve within the surgical bioprosthesis) appear as superimposed 20 mm orange circles in A through D, and as orange box outlines (to illustrate a balloon-expandable valve with 20 mm width) and green solids (to illustrate a self-expandable valve with 20 mm width inflow and 45 mm height) in E through H. Flow of blood (*white arrows*) into the sinuses of Valsalva and coronary arteries is facilitated by the extra space created by the billowing patch (*curved red lines*); coronary flow is likely to be preserved even if a self-expandable transcatheter aortic valve implantation (TAVI) valve were to require subsequent TAVI-in-TAVI implant, which would extend the chimney of leaflet tissue up to the dotted green line. Panel G corresponds to a 2-cusp overlap fluoroscopy view, and conveniently demonstrates well the area of enlargement behind the left–right (*LR*) strut. *LN*, Left-non; *RN*, right-non. *Right coronary artery. **Left main coronary artery.

the posterior annulus. Second, this technique may lend itself to younger patients in whom a future valve-in-valve TAVI (and even subsequent TAVI-in-TAVI procedures) may otherwise lead to sinus sequestration. Compared with other root enlargement techniques,[1-5] there is little risk of distorting the mitral valve and inducing mitral regurgitation as with the Manouguian technique; rotation of any of the coronary arteries, as with the Y incision technique, is not necessary; and it does not require patching of the ventricular septum and is easier to perform than the Konno, Vouhé, and Yamaguchi techniques. Unlike root replacement, there is no need to reattach coronary buttons, and the elastic properties of the root are maintained. Finally, for concomitant mitral and aortic valve surgery, there is no interference from the mitral prosthesis, another potential limitation of posterior techniques.

Potential pitfalls include extension of the enlargement into septal myocardium, which risks bleeding from friable tissue. Second, it is unlikely that this technique will permit upsizing by more than 1 to 2 valve sizes, although it may be possible to perform concurrent lateral and posterior (bilateral) root enlargements.[3] Finally, this technique is not advisable in the presence of anomalous coronaries between the great vessels, or in patients with pulmonary hypertension, pulmonary artery dilatation, or existing or planned surgical or percutaneous pulmonic valve replacements which can compress the patch.

With increasing use of TAVI to treat failing surgical bioprostheses, technical considerations at the initial operation play a role in the lifetime management of aortic valve disease. Lateral (LR-commissural) root enlargement is a simple method for enlarging the aortic annulus and modifying the risk of future TAVI-induced coronary artery obstruction and sinus sequestration.

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