

# A novel technique to repair circumflex coronary artery–coronary sinus arteriovenous fistulas



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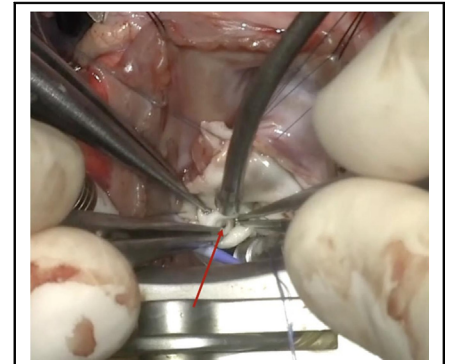
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Exposure of fistula orifice (arrow) with eversion technique.



Video clip is available online.

## CASE REPORT

A 3.9-kg term female was born with a normal exam. On the second day of life, a murmur was detected. Echocardiography showed normal biventricular function, severely dilated left main and circumflex arteries, and a fistulous connection between the distal circumflex artery and the coronary sinus (CS) (Figure 1). The CS ostium appeared stenotic at its termination into the right atrium and decompressed via a persistent left superior vena cava (LSVC) flowing retrograde toward a medium-sized bridging vein. The patient was clinically stable, and workup showed no signs of myocardial ischemia.

The patient was discharged to home and returned for elective repair at age 9 months at a weight of 9.2 kg. A median sternotomy was performed with aortic and bicaval cannulation. The LSVC was clamped to allow uniform delivery of antegrade cardioplegia. The right atrium was opened, revealing a pinpoint CS ostium. A ring of fibrotic tissue around the os was carefully debrided, and the sinusotomy was extended posteriorly to avoid the conduction system. Additional antegrade cardioplegia was provided to localize the fistula, but no tract was seen. Thus, the atrial septum was opened, and the sinusotomy was continued into the left atrium as far laterally as was surgically accessible. Nonetheless, brisk cardioplegia flow emanated from deeper in the sinus, and consequently an eversion technique was used (Video 1).

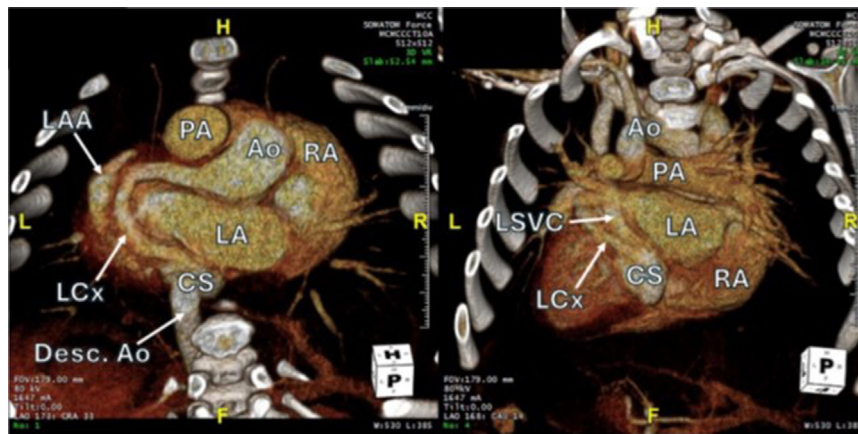
Using 2 pickups, the endocardium was gradually pulled into the operative field, invaginating the CS and exposing

the orifice of the fistula in the lateral lumen (Figures 2 and 3). The fistula had a distinctly circumscribed os created by the media of the coronary artery that helped differentiate it from other venous tributaries. Importantly, it emitted pressurized, bright-red cardioplegia at the onset of antegrade delivery, confirming the fistulous connection. Several interrupted sutures with 7-0 Prolene were used to ligate this tract, with small bites to prevent inadvertent kinking or distortion of the coronary artery. Subsequent administration of cardioplegia confirmed cessation of anomalous flow. The CS was internalized to its native position and closed with a running stitch. The atrial septum was reconstructed with an autologous pericardial patch to enlarge the ostium of the CS, ensuring that it drained into the right atrium. Given the inherent risk of restricting of this abnormal os, the LSVC was left intact to allow for potential decompression.

The patient weaned from cardiopulmonary bypass uneventfully. Transesophageal echocardiography confirmed ligation of the fistula with appropriate flow reversal in the LSVC to normal antegrade flow. Biventricular function was normal without wall motion abnormalities. The patient was discharged on postoperative day 8. Oral

## CENTRAL MESSAGE

The eversion technique is safe and efficient and provides excellent exposure of coronary arteriovenous fistulas deep in the lateral coronary sinus.



**FIGURE 1.** Three-dimensional computed tomography scan reconstruction demonstrating aneurysmal left circumflex coronary artery–coronary sinus fistula (posterior view).

anticoagulation was initiated to prevent thrombosis in her aneurysmal coronary arteries.

At the most recent follow-up at 18 months after surgery, echocardiography demonstrated normal biventricular function, remodeling of the previously dilated left ventricle, and uniform coronary sinus flow without any acceleration jets.

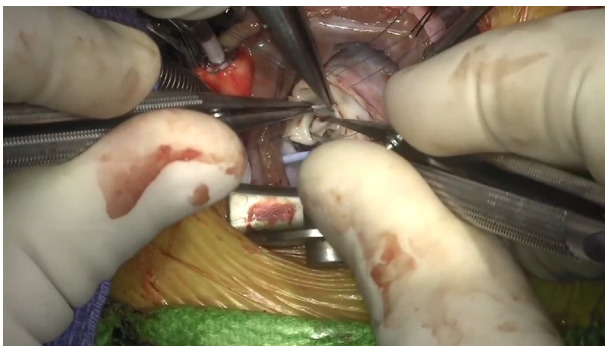
## DISCUSSION

Coronary arteriovenous fistulas (CAVFs) are rare congenital lesions resulting from persistence of the embryonic sinusoids during development of the epicardial vasculature. Clinical signs include coronary ischemia, ectasia of the affected vessels, and high-output heart failure. Diagnosis in the pediatric population is made by echocardiography, with further anatomic delineation done via contrast computed tomography scan, magnetic resonance imaging, or coronary catheterization.

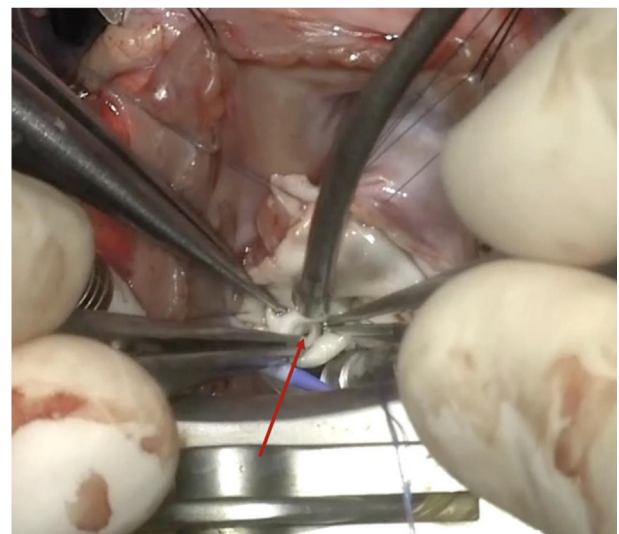
The management of CAVF depends on patient anatomy, symptoms, and flow through the fistula.<sup>1,2</sup> In this young patient with a tortuous, dilated left circumflex artery and distal

CAVF, endovascular options carried a prohibitively high risk of coronary intimal trauma, thromboembolism, and device migration.<sup>3</sup> Even with an open approach, however, exposure remained a significant challenge owing to the lateral location of the fistula orifice. Optimal exposure was essential to prevent inadvertent stenosis or occlusion of the coronary artery.

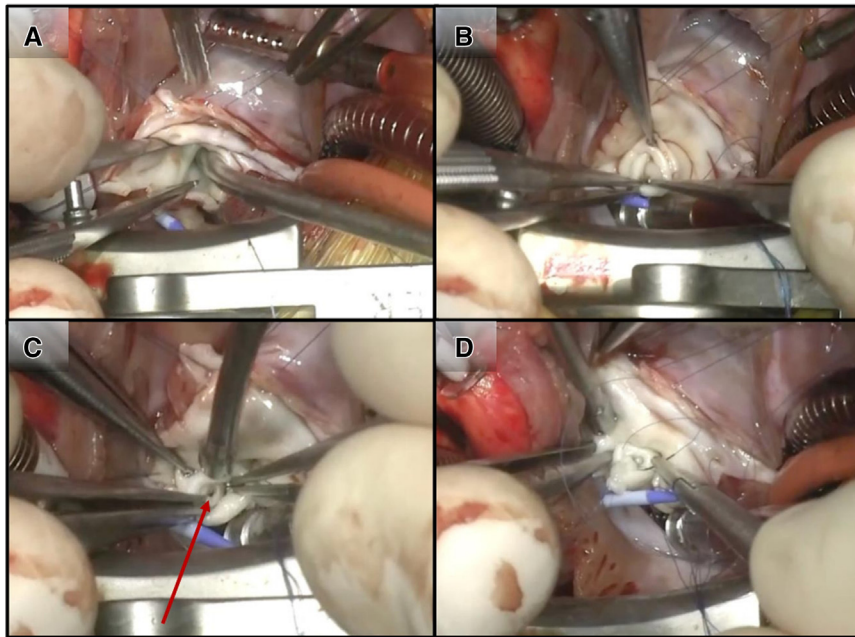
DeBakey published what later became known as the eversion technique in 1959.<sup>4</sup> This method allowed for exposure of the distal internal carotid artery with minimal trauma, thereby reducing the risk of restenosis. The present report is the first description of the use of an eversion technique to access the proximal CS. This technique is particularly advantageous in the infant population, in which exposure is limited by very small cardiac chambers. Importantly, this



**VIDEO 1.** Operative recording demonstrating the eversion technique to repair a coronary arteriovenous fistula. Video available at: [https://www.jtcvs.org/article/S2666-2507\(24\)00511-X/fulltext](https://www.jtcvs.org/article/S2666-2507(24)00511-X/fulltext).



**FIGURE 2.** Exposure of fistula orifice (arrow) with the eversion technique.



**FIGURE 3.** A, Instrument cannulating unroofed coronary sinus. B, Eversion of proximal coronary sinus. C, Orifice of coronary arteriovenous fistula at the tip of the red arrow. D, Suture ligation.

maneuver reduced the suture burden in the CS, which was structurally abnormal because of its aberrant embryologic development and thus prone to thromboembolism. By preserving the integrity of the CS, the reconstruction time was greatly reduced.

## CONCLUSIONS

CAVFs are low-prevalence but high-impact congenital lesions that demand a comprehensive understanding of relevant anatomy for effective management. The eversion technique can be safely applied to the CS to access deep lesions that otherwise are surgically inaccessible in small hearts.

## Conflict of Interest Statement

The 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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