# Minimally Invasive Repair of Subarterial Ventricular Septal Defect via Left Anterior Thoracotomy and Periareolar Incision

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## Introduction

Minimally invasive cardiac surgery (MICS) is becoming an indispensable option for cardiac surgeons, who must compete against the ever-expanding realm of transcatheter procedures. The commonly used right thoracotomy approach provides a clear view of both the mitral and tricuspid valves as well as the atrial septum. Ventricular septal defects (VSD) near the inlet area can also be repaired without much difficulty. However, subarterial (SA) VSD are located in the right ventricular outflow tract (RVOT) area, which makes it challenging to approach from the right side. Therefore, many centers still perform sternotomy to repair this type of defect. Taking inspiration from the right anterior thoracotomy approach for aortic valve replacement,[1] we devised a novel MICS approach that combines a left anterior thoracotomy (LAT) with a periareolar incision for SA VSD repair (Supplemental Video).

## Case Series

### *Surgical Technique*

The patient was positioned supine and placed on the left side of the bed. To expose the left axillary area, the left arm was dropped down over the edge to be retroflexed at a 45° angle. A double-lumen endotracheal tube was not mandatory, as single-lung ventilation was needed only briefly. The surgeon performed all procedures from the patient's left side. The site for thoracotomy was determined based on the preoperative computed tomography images. Usually, the second intercostal space was the ideal entrance point as it provides good access to both the ascending aorta and the RVOT.

A linear incision was made along the superior border of the left areola, starting from the 9 o'clock position (Fig. 1). About two-thirds of the areola's circumference was incised to create an approximately 3 to 4 cm long incision. The subcutaneous fat layer was carefully dissected from the pectoralis muscle to create a fanwise tunnel between the areola and the second intercostal space. In female patients, we were extra careful to preserve the mammary capsule and avoid harming the mammary glands during the dissection. Once the subcutaneous layer was sufficiently relieved, a small LAT was created at the second intercostal space. The left internal mammary vessels were divided, and the second rib was cut at the sternocostal joint to widen the opening. Cardiopulmonary bypass (CPB) was initiated via femoral artery and vein cannulation. A root cannula and a left atrial venting cannula were placed at the aortic root and the left atrial auricle, respectively. A Chitwood clamp was introduced through a separate incision in the

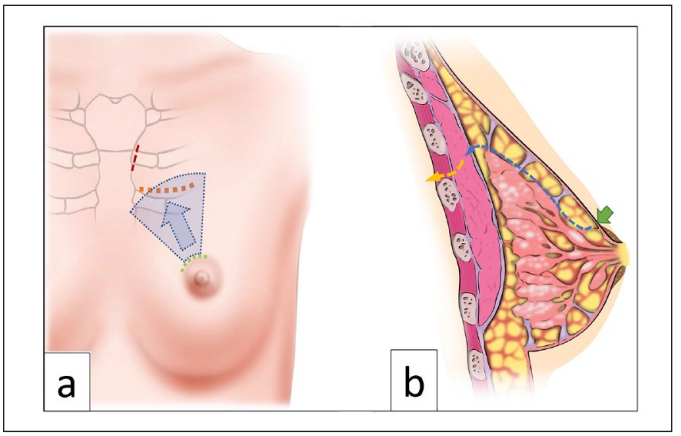


**Fig. 1.** Schematic drawing of the surgical procedure. (a) The subcutaneous fat layer between the periareolar incision (green line) and the second intercostal space (orange line) was extensively dissected (blue area), while the second rib was cut (red line) at the sternocostal joint. (b) In female patients, the subcutaneous fat layer was dissected around the mammary gland before entering the pleural cavity.

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axillary area to clamp the ascending aorta, and the heart was stopped with an antegrade infusion of cardioplegic solution.

An incision at the main pulmonary artery provided a clear view of the outlet portion of the right ventricle, the pulmonary valve, and the main pulmonary artery. The VSD was identified, and a bovine pericardial patch was sutured along the margin of the original defect. After repairing the pulmonary artery, deairing was performed through the root and left atrial cannulas under the guidance of transesophageal echocardiography. CPB was weaned off, and a pleural drainage tube was inserted through the axillary incision.

### *Results*

Patient characteristics and operative details are shown in the Supplemental Table. All 5 procedures were successfully completed without the need for additional incision or sternotomy conversion. All patients were extubated on the same day in the intensive care unit and transferred to our surgical ward the following day. Postoperative echocardiograms showed no significant changes in aortic regurgitation and confirmed complete closure of the VSD. One patient experienced temporary left vocal cord paralysis after the surgery, which was resolved after 3 weeks. There were no other complications.

## Discussion

Periareolar incisions are commonly used in breast surgery and robotic thyroidectomy.[2] With the advancement of thoracoscopic-assisted MICS, cardiac surgeons have adopted the periareolar incision for various intracardiac procedures.[3–5] Multiple reports have shown excellent results with low rates of complications and excellent esthetic outcomes.

The periareolar incision follows the natural line between the pigmented skin of the areola and the lighter skin of the breast. Generally, the resulting scar is well camouflaged in an imperceptible fine-line fashion (Fig. 2). However, there are some downsides. The most obvious one is that the length of the incision is limited by the size of the areola. While all our cases were performed with a linear incision, some reports have suggested using a periareolar zigzag incision can increase the length of the incision while maintaining good cosmetic results.[6] Another concern is the potential injury to the nerves of the nipples or the mammary glands, which can lead to loss of sensation in that area or difficulties with breastfeeding. Limiting the incision length and performing meticulous dissection should reduce the risk of unintended injuries.

In our experience, trying to clamp the ascending aorta through the small periareolar incision was not easy. In most cases, the ascending aorta is positioned on the right side and obscured under the sternum. Depending on the geometric relationship between the ascending aorta and the sternum, the aortic clamp might cause injury to the surrounding structures. It also limits visibility and clashes with other instruments. Therefore, we introduced the aorta clamp from the left axillary area, which significantly freed up the small main opening and made the operation much more straightforward.

One of the major downsides of our approach is the sacrifice of the left internal mammary artery (LIMA). Although this procedure reduces the risk of unintended vessel injury, it eliminates the possibility of using a LIMA graft in future coronary artery bypass operations. To address this issue, we are considering dissecting a segment of LIMA from the chest wall and preserving the vessel before cutting the rib.

Like all MICS, precise evaluation and thorough planning are crucial to a smooth operation. Patients who have significant

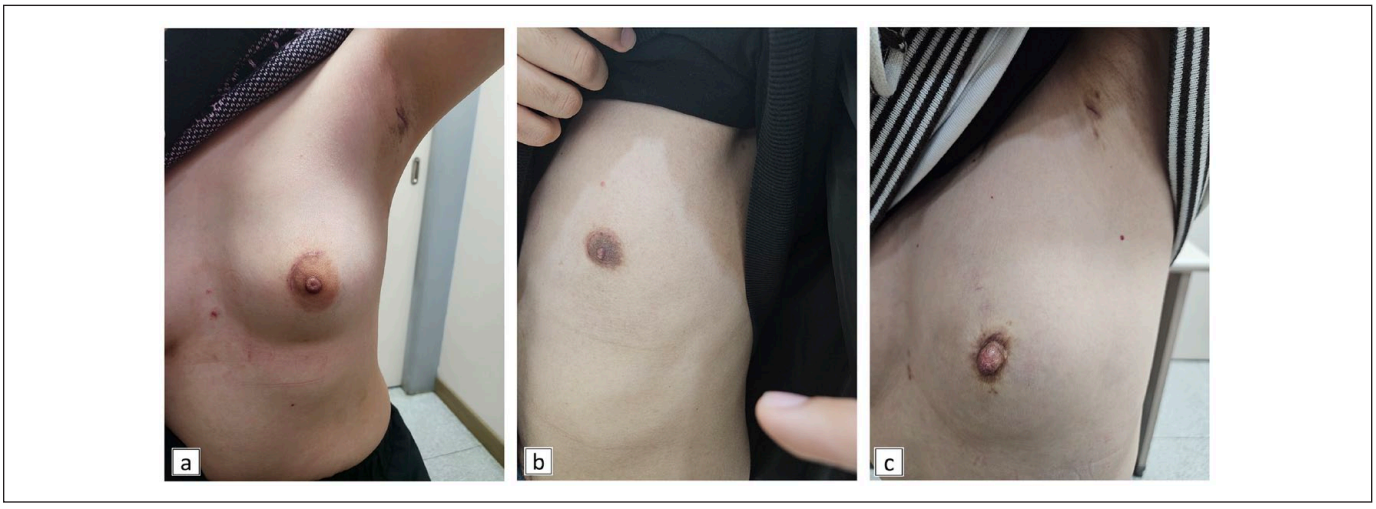


**Fig. 2.** Pictures of surgical scar taken at the outpatient clinic (a) 4 weeks after surgery, (b) 6 weeks after surgery, and (c) 7 weeks after surgery.

mediastinal adhesions or are unsafe for peripheral cannulation should be avoided. Mild adhesions or funnel chests can be managed with thoracoscopic assistance. For cases involving large breast sizes or implants, personalized decisions and surgical modifications may be needed.

In conclusion, the periareolar LAT approach for MICS is safe, efficient, and yields excellent cosmetic results. This approach is simple and reproducible. The periareolar LAT approach can be used for repairing SA VSDs or performing simple RVOT procedures in adult patients.

## Declaration of Conflicting Interests

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## Supplemental Material

Supplemental material for this article is available online.

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