

Transaxillary aortic valve replacement with a sutured valve

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Keywords: Transaxillary approach; minimally invasive; aortic valve surgery; tailored-surgery approach



Submitted Aug 25, 2026. Accepted for publication Sep 22, 2026. Published online Sep 24, 2026.

doi: 10.21037/acs-2026-0336-tdv

View this article at: <https://dx.doi.org/10.21037/acs-2026-0336-tdv>

Clinical vignette

A 52-year-old male patient attended the local emergency department due to a 3-week history of progressive dyspnea, intermittent chest tightness and cough, initially treated with an antibiotic course but with no improvement. During initial assessment, there was evidence of heart failure due to severe aortic stenosis. Past medical history was significant for hypertension and type 2 diabetes, and he was a smoker. Transthoracic echocardiography demonstrated evidence of impaired left ventricular (LV) systolic function (ejection fraction ~39%) and a mildly dilated LV. Coronary angiogram demonstrated no coronary artery disease. Following surgical assessment and computed tomography (CT) review, anatomical features were favorable for a minimally invasive transaxillary surgical approach to address the aortic valve pathology.

Surgical techniques

Preparation

The patient is positioned supine. The right arm is flexed posteriorly to allow access to the right side of the chest to facilitate the transaxillary incision, placement of the aortic cross-clamp, and positioning of the cardiopulmonary bypass sump sucker (this port is then used for chest drainage). The mid and anterior axillary lines are fully visible and accessible. A transvenous ventricular pacing wire is sited during the anesthetic preparation, as well as an intercostal nerve block, to facilitate perioperative management and allow for enhanced recovery of the patient. Surgery can be performed with lung isolation or with a single lumen endotracheal tube with short, limited periods of intermittent apnoea until cardiopulmonary bypass is established.

Exposure

A 4- to 5-cm longitudinal skin incision in the right anterior axillary line is made, followed by a pectoralis muscle-sparing anterolateral mini thoracotomy following the rib to approach the 3rd or in certain cases, the 4th intercostal space. A soft tissue retractor

is placed. A rib spreader may be used to increase the width of the working incision but is not routinely used.

Operation

Cardiopulmonary bypass is established through the femoral vessels, exposed via a minimal groin incision with exposure of only the anterior wall of each vessel. The femoral vessels are cannulated after placing two 5-0 polypropylene sutures in the adventitia of each vessel's anterior wall. Then, cardiopulmonary bypass is established using a dual/multistage venous cannula and vacuum-assisted drainage (-40 mmHg). Mild hypothermia to 34 °C is reached and carbon dioxide is used to flood the surgical field to minimize the risks of air embolism. Then, a longitudinal asymmetrical pericardiotomy is performed to expose the aorta, the right atrium and the right superior pulmonary vein. Once the pericardiotomy is completed, pericardial stay sutures are used to retract the pericardium laterally on the chest wall. Additional pericardial stay sutures are placed anteriorly, providing exposure of the aorta to facilitate cross-clamping and aortotomy. A LV vent is placed through the right superior pulmonary vein and snared with a pledgeted 4-0 polypropylene suture. After bluntly dissecting the pulmonary artery from the posterior wall of the aorta, the aortic cross-clamp (Chitwood clamp) is introduced into the right chest via an incision one level above the working thoracotomy and the clamp is applied as distally as possible, taking care to avoid injury to the left atrial appendage in the transverse sinus. Cold crystalloid cardioplegia (Custodiol HTK) is administered via the aortic root using an antegrade cannula. In cases of severe aortic regurgitation, the cardioplegia is administered directly via the coronary ostia. In order to provide further exposure of the aorta, the tip of the right atrial appendage can be encircled, snared, and retracted through the utility port, as demonstrated in the video. The aortic valve is exposed via an oblique aortotomy. Retraction sutures are placed at the apex of each commissure to further retract the aortic valve and annulus toward the thoracotomy. After valvectomy and decalcification are performed, non-everting 2-0 polyester sutures with pledgets are placed around the aortic annulus, beginning first with the right coronary sinus, then the non-coronary sinus and finally the left coronary sinus. Valve sizing is then confirmed, and the valve is tied in position with an automatic knotting device.

Completion

The aortotomy is closed in one layer, and after de-airing and removing the cross-clamp, the patient is weaned from cardiopulmonary bypass. Systemic heparinization is reversed, femoral vessels are decannulated and hemostasis is secured. The pericardium is loosely approximated with 2 to 3 interrupted stitches over a flexible pericardial drain and the chest wall is closed, approximating the intercostal muscles and soft tissue is closed in layers over a basally placed right pleural drain.

Comments

Transcatheter valve replacement has progressed in recent years, achieving excellent outcomes even in patients with challenging anatomy and in progressively younger

cohorts. The gold standard treatment for patients with aortic valve pathology remains surgery. However, in order to provide a less invasive alternative to full sternotomy approach aortic valve replacement (AVR), minimally invasive AVR has evolved from hemi-sternotomy to sternal-sparing techniques with the aim of minimizing operative trauma and accelerating postoperative recovery. The transaxillary approach to AVR offers a reproducible, minimal access alternative that has demonstrated safety and effectiveness comparable to conventional surgical access (1).

Since 2020, 87 patients at our center have undergone surgical AVR through a mini-thoracotomy approach. Of these, 15 underwent multivalve procedures including AVR. The transaxillary approach was introduced in 2023 and has since been used in 40% of cases, while a right anterior thoracotomy was performed in 60%. The mean patient age was 66 years. In the transaxillary group, there were no conversions to sternotomy and no re-explorations for bleeding. In comparison, the right anterior thoracotomy group had a 1.4% conversion rate to full sternotomy and a 3.4% rate of re-exploration for bleeding.

Preoperative imaging can help replace subjective judgement to allow for reproducible anatomy-based selection for patients being considered for minimal access surgical approaches. Contrast-enhanced CT is the key investigation for defining thoracic geometry, peripheral vascular access, and a tailored minimal access route for each valve procedure. At our center, radiographic selection criteria for the transaxillary approach are applied systematically and include: (I) an ascending aorta located predominantly within the right hemithorax, with at least two-thirds of its course lying to the right of the sternum; and (II) a coronal CT-measured distance of ≤ 15 cm between the planned thoracotomy site and the aortic valve. To determine the optimal intercostal space for entry during a transaxillary approach, a line is drawn between the midpoint of the aortic valve annulus and the junction of the superior vena cava with the right atrium. This line, projected onto the chest wall, is used to identify the most favorable intercostal space for the thoracotomy.

A standardized and systematic preoperative approach to minimal access aortic valve procedures can minimize adverse events and avoid intraoperative unexpected hazards that can lead to further complications. Preoperative CT should be considered a mandatory component of the preoperative assessment. Our center's experience demonstrates that a standardized protocol based on detailed anatomical analysis using a limited number of readily reproducible parameters can substantially reduce the incidence of conversion to median sternotomy. These findings confirm that a multivariable CT-based assessment protocol may represent an important next step in further refining patient selection, surgical planning, and the overall safety and efficacy of minimally invasive surgery (2).

The versatility of the transaxillary approach makes it a valuable strategy, even in the management of multiple valve pathology, and it has become the default minimal access approach for valve pathology in our centre (3). Additional benefits of this approach include the ability to perform the procedure under direct vision, without reliance on endoscopic technology. This makes it particularly suitable for challenging anatomies in which a totally endoscopic approach may be technically demanding.

The main challenge associated with the transaxillary approach is its learning curve. Although we believe that the technique described provides a reproducible framework, careful patient selection remains paramount, particularly during the early stages of establishing a transaxillary program. We also advocate a stepwise approach in

progression from full sternotomy AVR to minimal access, thoracotomy approach AVR, which also mandates some experience in AVR via partial sternotomy approach.

A key advantage of the transaxillary approach is that it allows implantation of a conventional sutured prosthesis using standard annular suturing techniques under direct surgical vision. This approach may remain feasible despite additional technical challenges, extending its applicability to carefully selected patients with more complex anatomy or operative requirements. Nevertheless, anatomical features identified during preoperative assessment may favor alternative minimally invasive strategies, including upper hemi-sternotomy or right anterior thoracotomy. Familiarity with different minimally invasive approaches is therefore important, allowing the surgical access to be tailored to the individual patient rather than adopting a single approach for all cases. Comprehensive preoperative CT assessment remains central to this strategy, facilitating appropriate patient selection and procedural planning.

Acknowledgments

None.

Footnote

Funding: None.

Conflicts of Interest: The authors have no conflicts of interest to declare.

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Cite this article as: Lucchese G, Bilkhu R, Gardellini J. Transaxillary aortic valve replacement with a sutured valve. *Ann Cardiothorac Surg* 2026;15(5):71. doi: 10.21037/acs-2026-0336-tdv