Minimally invasive pulmonary valve replacement via left anterior minithoracotomy

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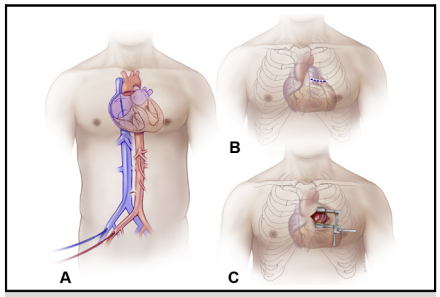


Left anterior minithoracotomy for minimally invasive pulmonary valve replacement.

CENTRAL MESSAGE

Minimally invasive pulmonary valve replacement is feasible through a left anterior minithoracotomy and can be performed in both primary and reoperative settings.

See Commentaries on pages 130 and 132.

Video clip is available online.

SURGICAL TECHNIQUE

Preoperative Workup

Cross-sectional imaging, such as cardiac computed tomography (CT) or magnetic resonance imaging, is performed preoperatively as a part of the surgical planning. Doppler ultrasound of the groin is performed to evaluate the patency of the femoral vessels, and intraoperative transesophageal echocardiography (TEE) is performed to rule out the presence of intracardiac shunts.

Anesthetic Considerations

Standard monitoring lines with a single-lumen are placed. A double-lumen endotracheal tube is an option.

Operative Technique

The patient is positioned supine, prepped, and draped as for standard median sternotomy (Figure 1, *A*). A 6-cm horizontal incision is performed through the left third or fourth intercostal space (Figure 1, *B*). In primary operative settings, the left lung is gently retracted to expose the pericardium, which is then incised anterior to the left phrenic nerve to expose the right ventricular outflow tract and the main pulmonary artery. In reoperative settings (Video 1), the left lung is usually adherent to the right ventricular outflow tract and/or the previously placed transannular patch if the pericardium was not closed after the first procedure, and will need to be dissected off the main pulmonary artery and right ventricular outflow tract (Figure 1, *C*). A 3- to 4-cm right suprainguinal groin incision is performed, and both the common femoral vein and artery are exposed (percutaneous cannulation with ultrasound guidance is an alternative). Heparin (400 U/kg) is administered systemically, and the femoral vessels are cannulated in a standard fashion using a modified Seldinger technique and under TEE guidance.

It is important to achieve adequate right heart decompression during this procedure owing to the limited exposure. Along with routine use of vacuum-assisted venous drainage, we prefer to use a multistage venous cannula that is inserted via the common femoral vein and advanced all the way up to the superior vena cava. Once activated clotting time (ACT) is satisfactory, cardiopulmonary bypass is initiated in the standard fashion, and ventilation is discontinued.

A vertical incision is made along the previous transannular patch (Figure 2, *A* and *B*), and remnants of pulmonary valve leaflets are excised (Figure 2, *C*). An appropriate-

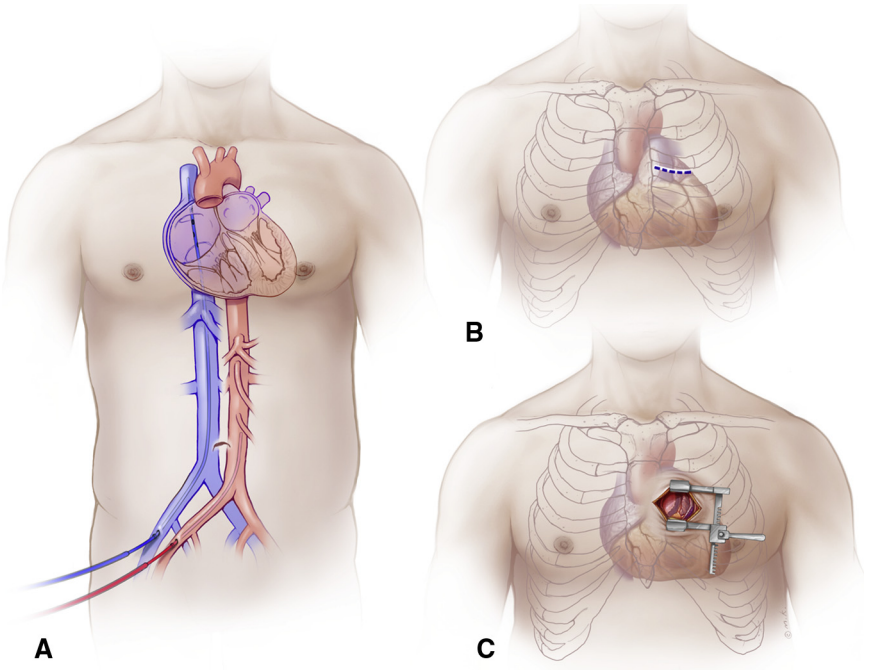
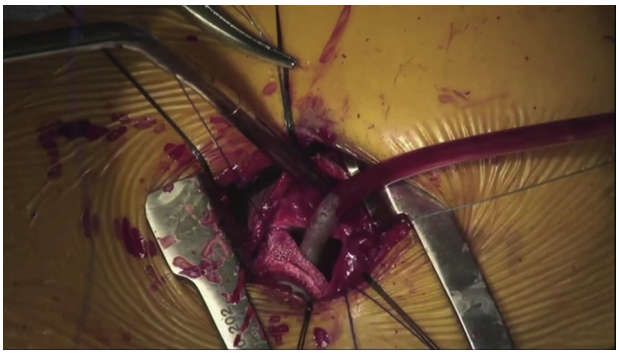


FIGURE 1. A, Groin cannulation for cardiopulmonary bypass. B, A transverse skin incision of approximately 6 cm is made parallel to the left third or fourth intercostal space. C, The left chest is entered, and the left lung is retracted to expose the pericardium.

sized bovine pericardial patch is used to augment the main pulmonary artery and is sewn in using running 4/0 Prolene suture up to the level of proposed position of the pulmonary prosthesis (Figure 2, *D* and *E*). The pulmonary bioprosthesis is chosen and is sewn in along the native pulmonary annulus using running 3/0 Prolene suture (Figure 2, *F*). The anterior portion of the prosthesis sewing ring is then sewn to the undersurface of the pericardial patch using a separate Prolene stitch (Figure 2, *G*). The rest of the patch is then trimmed and sewn to the right ventricular outflow tract (Figure 2, *H*). The right side of the heart is then deaired, and the patient is weaned off cardiopulmonary bypass. Once TEE is satisfactory, the groin is decannulated and femoral vessels are repaired. A single chest drain is placed and both groin and chest incisions are then closed in layers. The patient is typically extubated in the operating room at the end of the procedure.



VIDEO 1. Operative video showing the technique of pulmonary valve replacement via a left anterior minithoracotomy approach. The patient underwent previous tetralogy of Fallot repair with placement of a transannular patch. A 25-mm bioprosthesis was placed, and he was extubated in the operating room, and received no transfusions. He was discharged 2 days after the procedure. Video available at: https://www.jtcvs.org/article/S2666-2507(20)30721-5/fulltext.

COMMENTS AND EARLY EXPERIENCE

The resultant free pulmonary regurgitation after previous repair of tetralogy of Fallot with a transannular patch leads to progressive right ventricular enlargement and may necessitate reoperation for pulmonary valve replacement.[1] Repeat median sternotomy is not without its own risks and difficulties,[2] and a search for alternative strategies is needed. Left anterior minithoracotomy is an alternative technique that provides adequate exposure to the right ventricular outflow tract[3] and may result in faster recovery and shorter hospital stay.[4] Our experience with this technique is in its early phase, but we have performed the procedure in 6 patients (the youngest at age 13 years; 4 with previous tetralogy of Fallot repair). The procedure was feasible, with no conversion to open sternotomy in any. There was no early or late mortality. One patient developed a femoral artery pseudoaneurysm during follow-up due to percutaneous cannulation and required late repair. The length of stay averaged 2 days. We believe that weight >30 kg is necessary for satisfactory groin vessel cannulation. The mere presence of calcifications in the transannular patch is not a

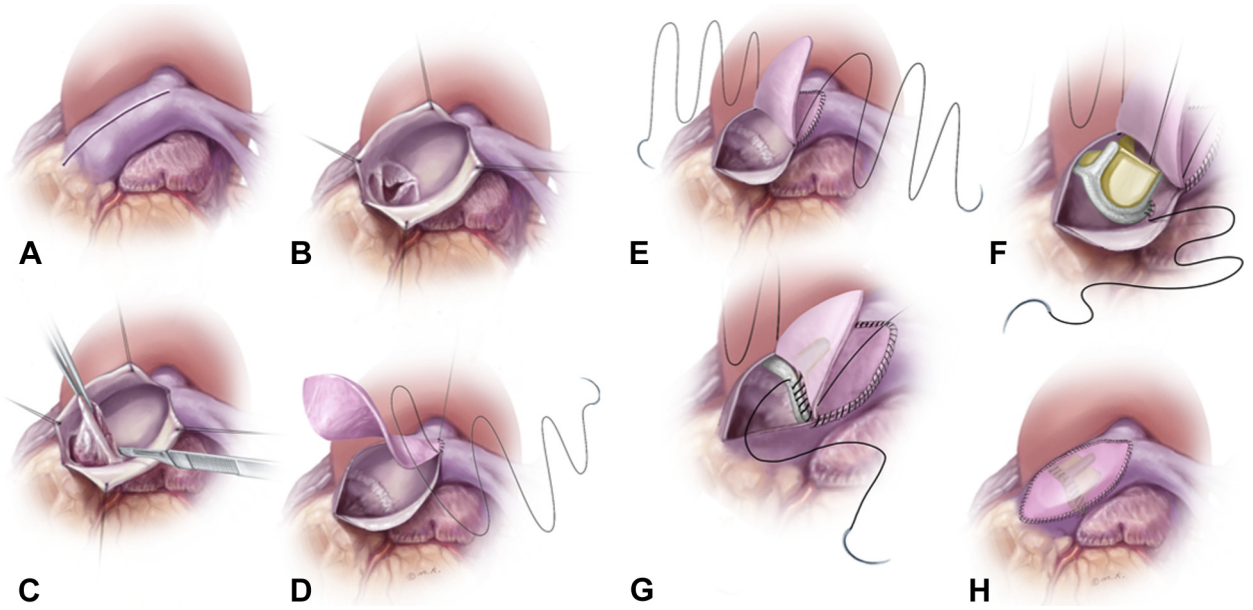


FIGURE 2. Steps of pulmonary valve replacement. A, An incision is made along the main pulmonary artery or the previous transannular patch. B, Stay sutures are placed to expose the pulmonary valve annulus and the right ventricular outflow tract. C, Remnants of pulmonary valve leaflet are excised if present. D, An appropriate-sized bovine pericardial patch is used to augment the main pulmonary artery and is being sewn to the distal main pulmonary artery. E, The patch is sewn to the proposed level of the prosthesis. F, The pulmonary prosthesis is then sewn with a running polypropylene suture along the posterior annulus. G, The anterior part of the prosthesis sewing ring is then secured to the undersurface of the pericardial patch. H, Completion of the right ventricular outflow tract and main pulmonary artery reconstruction.

contraindication to the technique, but it is important to note that we do not recommend using this technique in the presence of previous right ventricular-to-pulmonary conduits, and we have not performed this technique in this subgroup of patients. We are also not aware that it has been performed elsewhere. Most of these conduits are extra-anatomic in position (anatomic landmarks might not be clear, and the conduits may be closer to the midline), and they are not uncommonly calcified and very adherent to the aorta, making their exposure via a left minithoracotomy relatively unsafe. Some of these conduits must be entirely removed to achieve satisfactory placement for a new conduit/pulmonary prosthesis, which is not feasible through the limited left minithoracotomy exposure. It is also important to rule out any intracardiac shunts by TEE before committing to the procedure, because it is not possible to place a standard vent or to deair the heart properly, similar to sternotomy cases. We do not think that the procedure will be cosmetically acceptable to women, given the incision in the third or fourth intercostal space, which has the potential to cause breast disfigurement.

Long-term data and larger studies will be needed to prove the safety and effectiveness of this technique.

References

1. Geva T. Repaired tetralogy of Fallot: the roles of cardiovascular magnetic resonance in evaluating pathophysiology and for pulmonary valve replacement decision support. *J Cardiovasc Magn Reson*. 2011;13:9.
2. Holst KA, Dearani JA, Burkhart HM, Connolly HM, Warnes CA, Li Z, et al. Risk factors and early outcomes of multiple reoperations in adults with congenital heart disease. *Ann Thorac Surg*. 2011;92:122-8; discussion 129-30.
3. Cheema FH, Heng EE, Rehman A. Pulmonary valve replacement through a left minithoracotomy: an alternate approach. *Ann Thorac Surg*. 2014;98:1827-9.
4. Nellis JR, Vekstein AM, Meza JM, Andersen ND, Haney JC, Turek JW. Left anterior mini-incision for pulmonary valve replacement following tetralogy of Fallot repair. *Innovations (Phila)*. 2020;15:106-10.