

Transaxillary triple valve surgery and left atrium appendage occlusion

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Clinical vignette

We present the case of a 66-year-old female presenting with severe rheumatic mitral valve stenosis, moderate aortic regurgitation and moderate tricuspid regurgitation. She presented with exertional dyspnea [New York Heart Association (NYHA) functional class II], with a history of previous mitral commissurotomy in 1995; in addition, she had previous episodes of paroxysmal atrial fibrillation.

Preoperative evaluation and surgical planning

Preoperative transesophageal echocardiography (TEE) demonstrated a preserved left ventricular ejection fraction (LVEF) of 60%, severe mitral stenosis (mean gradient 16 mmHg), moderate aortic regurgitation (vena contracta 5 mm), moderate tricuspid regurgitation with a tricuspid annular diameter of approximately 41 mm, and a dilated left atrium (left atrial volume index 83 mL/m²). A contrast-enhanced computed tomography (CT) angiography confirmed adequate iliofemoral vessel diameters (>6 mm) without severe calcification or tortuosity, making peripheral cannulation safe. CT also confirmed favorable chest wall anatomy and an ascending aorta free from calcifications.

After meticulous preoperative imaging evaluation, a minimally invasive approach through a right transaxillary incision was selected to perform triple valve surgery and left atrial appendage occlusion. Based on valvular orientation and distance from the access, the fourth intercostal space was chosen as the best access site.

Given the rheumatic morphology of the mitral valve and the history of previous commissurotomy, mitral valve replacement was favored over repair. For the associated aortic and tricuspid valve disease, we planned an aortic valve replacement and tricuspid annuloplasty, due to the presence of moderate tricuspid regurgitation and annular

dilatation, while left atrial appendage occlusion was added in view of the patient's history of paroxysmal atrial fibrillation.

Surgical techniques

Preparation

After intubation, a right jugular venous cannula was placed under TEE guidance as the first part of bicaval venous cannulation. The patient was positioned supine with the right hemithorax slightly elevated and rotated toward the left. The right arm was brought cephalad alongside the head, with the elbow flexed and shoulder abduction maintained below 90°. The arm and pressure points were carefully padded to minimize the risk of brachial plexus injury. This positioning widens the intercostal space while flattening the subcutaneous tissues, mimicking the patient's position during the preoperative angio-CT scan, which is a crucial element for accurate procedural planning. Ultrasound-guided serratus anterior plane block was performed by the anesthesiologist.

Following a 2 cm skin incision above the inguinal fold, peripheral cannulation of the femoral vessels for cardiopulmonary bypass (CPB) was established using the Seldinger technique under TEE guidance; considering the routine CPB times at our institution, our femoral cannulation protocol does not routinely include a dedicated distal limb perfusion catheter.

Exposure

A 5-cm skin incision was made at the level of the fourth intercostal space along the anterior axillary line. After dissection of the subcutaneous tissue in the same direction, the thoracic cavity was entered along the intercostal space line, and a soft-tissue retractor was positioned. Continuous CO₂ insufflation was then initiated to reduce the risk of air embolism. An additional retractor at this stage is generally used: an intercostal rib spreader is gradually opened to loosen the intercostal space, ease the muscular tension, and enlarge the operating field. Once CPB was started, the pericardium was opened and the rib spreader removed.

The pericardium was opened longitudinally, and seven pericardial stay sutures (three anterior and four posterior) were placed; of note, these sutures were fixed to the skin close to the incision to improve visualization and strongly pull the heart closer to the operator. In addition, the posterior ones will help keep the lung away from the operative field during weaning from CPB and subsequent hemostasis, since single-lung ventilation is not used.

The superior vena cava was prepared with scissors, and the oblique sinus was opened to help mobilize, open, and close the left atrium. The superior and inferior vena cavae were snared with tapes and tourniquets. The fat pad on the interatrial groove was prepared with the electrocautery, and a stay suture was placed and exteriorized through the thorax to displace the right atrium while working on the mitral valve. A left ventricular vent was introduced through the right superior pulmonary vein. Finally, a line for cardioplegia and aortic venting was placed above the sinotubular junction. Exposure of the aortic root was optimized by placing a traction suture on the tip of the

right atrial appendage, exteriorized through the thoracic wall. The ascending aorta was prepared by gently dissecting the surrounding structures.

Operation

The ascending aorta was cross-clamped using a flexible clamp through the same incision; a second clamp can occasionally be used to pull the aorta and reach a more distal clamping site. Antegrade cold crystalloid Custodiol cardioplegia was administered into the aortic root.

Mitral valve replacement

The left atrium was opened, and an atrial retractor was inserted to expose the mitral valve. Without the need for an external camera or endoscope, a natural and perpendicular view of the valve was obtained. The mitral valve leaflets were excised, leaving just a small portion of the posterior leaflet, as the valve appeared calcified and partially fused due to rheumatic degeneration. A biological 29 mm Epic Plus valve was anchored using interrupted non-absorbable sutures with pledgets. An automatic knotting device was used to secure the sutures. The left atrium was then closed with a running polypropylene suture.

Aortic valve replacement

An aortotomy was performed in a hockey-stick fashion. Three aortic stay sutures were placed to improve exposure and ensure a perfectly perpendicular view of the valve. The native calcified valve cusps were excised. Careful annular decalcification was performed. Everting interrupted pledgeted sutures were placed to secure a biological 21 mm Perimount Magna valve. The aortotomy was then closed using a double-layer Prolene running suture.

Tricuspid valve repair

The right atrium was opened horizontally and retracted using stay sutures exteriorized through the chest wall. Interrupted sutures were placed along the tricuspid annulus, paying particular attention to avoid injury to the atrioventricular node. An incomplete tricuspid annuloplasty ring (28 mm Contour Ring) was implanted and secured with an automatic knotting device. The right atrium was closed using a running suture.

Left atrial appendage occlusion

The left atrial appendage was visualized through the transverse sinus with the aid of a small retractor.

A traction suture was placed at the tip of the appendage to facilitate manipulation.

An external clipping device (AtriClip 35 mm) was positioned at the base of the appendage and deployed to achieve complete exclusion, ensuring no residual stump and no interference with the circumflex artery.

Completion

After careful de-airing under TEE guidance, aided by continuous CO₂ insufflation and aortic root/left ventricular venting, the aortic cross-clamp was removed, and the patient was gradually weaned from CPB.

Intraoperative TEE confirmed correct positioning and optimal function of the prosthetic valves, and satisfactory tricuspid repair. A pericardial drain was placed into the oblique sinus, and a larger drain was placed in the right pleural space. The pericardium was partially closed, and ribs were stabilized and approximated with a single non-absorbable stitch. During chest closure, a local analgesic catheter was positioned to improve postoperative pain control (1).

Comments

Clinical results

CPB and cross-clamp times were 146 and 103 minutes, respectively. Echocardiographic evaluation confirmed optimal prosthetic function without paravalvular leaks, with transprosthetic gradients consistent with the implanted valves (mean gradient of 12 mmHg for the aortic prosthesis and 5 mmHg for the mitral prosthesis). Tricuspid valve repair demonstrated no residual regurgitation, and LVEF was 55%. Complete left atrial appendage exclusion was verified by direct visual inspection and confirmed on color flow Doppler by the absence of residual flow or intra-appendage turbulence. The postoperative course was uneventful, with an intensive care unit stay of two days and discharge on postoperative day seven (1).

In the setting of triple-valve surgery, these operative times are particularly informative. Cross-clamp and CPB durations are robust surrogate markers of technical complexity in minimally invasive valve surgery (2). Their relative containment, despite addressing three valves and the left atrial appendage through a single small access, demonstrates the technical feasibility of the transaxillary direct-view approach for selected highly complex combined procedures, and it supports the concept that this approach may effectively simplify these procedures.

Advantages

The principal strength of the transaxillary approach lies in its versatility. Through a single lateral incision and a standardized direct-vision setup, all cardiac valves and adjunctive procedures such as left atrial appendage occlusion can be performed without changing access or operative strategy. This is particularly relevant in multivalve surgery, where complexity often limits minimally invasive adoption.

Triple-valve surgery with left atrial appendage occlusion represents the upper limit of minimally invasive feasibility. Within this context, the association of aortic with mitral and tricuspid procedures is the main technical challenge. The transaxillary route uniquely facilitates this combination by providing direct and perpendicular exposure of all valvular planes, including the aortic root. While endoscopic and robotic approaches are well established for single and double valve procedures (3), their application to complex multi-valve or triple-valve surgery is technically demanding and requires

prolonged operative times. The direct-vision transaxillary approach offers a familiar line of sight without fully relying on video-assisted instrumentation.

This advantage derives from ergonomic simplification. The lateral access ensures a short working distance, a wider intercostal space, and natural eye-hand alignment under direct vision (4). Pericardial stay sutures further reduce operative depth, enabling a consistent and intuitive workflow across all valves. This translates into procedural efficiency. By lowering complexity, the transaxillary approach has the potential to expand the applicability of minimally invasive surgery to more advanced clinical scenarios.

Overall, this experience illustrates that the transaxillary direct-vision technique can serve as a feasible minimally invasive option for selected patients requiring complex multi-valve and adjunctive procedures, though cohort-level studies are needed to evaluate generalizability and comparative outcomes (4).

Caveats

Multivalve surgery through a transaxillary minithoracotomy requires meticulous preoperative planning and strict adherence to a standardized technique. Preoperative CT angiography is mandatory to assess vascular access, define the optimal intercostal space, evaluate valve orientation, and identify the aortic clamping site.

Adequate exposure is the key determinant of safety and depends on precise positioning, optimal placement of pericardial stay sutures, and disciplined execution. Predefined criteria for conversion to full sternotomy should include uncontrollable bleeding, dense adhesions causing inadequate exposure, or refractory hemodynamic instability.

Although this approach simplifies minimally invasive multivalve surgery compared with other thoracotomy-based techniques, it still requires familiarity with minimally invasive principles and a structured learning pathway (5). Its reproducibility relies on planning, exposure, and consistency rather than advanced technology.

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Footnote

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

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