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# Left atrial appendage occlusion techniques for open heart surgery and for minimally invasive thoracotomy

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## Introduction

Atrial fibrillation (AF) is the most common type of persistent cardiac arrhythmia and a leading cause of cardioembolic stroke (1). In patients affected by AF, up to 90% of thrombi originate from the left atrial appendage (LAA) (1). Thus, surgical LAA occlusion (LAAO) or exclusion procedures aim to reduce cardioembolic events in AF patients. LAAO techniques include excisions, suture closures and clip based procedures (2,3).

## Clinical vignette

Here we present three patients with AF that were admitted to cardiac surgery to address their structural cardiac condition and perform LAAO.

The first patient, a 73-year-old symptomatic [New York Heart Association (NYHA) II–III] slightly obese [body mass index (BMI) 26.3 kg/m$^2$, body surface area (BSA) 2.1 m$^2$] male presented with severe aortic valve stenosis (AVS) {bicuspid aortic valve (AV) type 1 [non-coronary cusp (NCC)/right coronary cusp (RCC)], mean pressure gradient (MPG) 67 mmHg}, aorta ascendens dilatation (51 mm) and persistent AF addressed by edoxaban therapy [$CHA_2DS_2$-VASc-score >2, HAS-BLED-score 1, European Heart Rhythm Association (EHRA) 1]. The operation included conventional aortic valve replacement (AVR) (Magna Ease 23 mm) and supracoronary ascending aortic replacement (Hemashield 30 mm) followed by bilateral pulmonary vein isolation [bipolar radiofrequency (RF) ablation clamp] and surgical amputation of the LAA.

The second patient was a 78-year-old symptomatic (NYHA III) severely obese (BMI 34 kg/m$^2$, BSA 2.29 m$^2$) male with severe AVS [aortic valve area (AVA) 0.5 cm$^2$], coronary artery disease (CAD) and persistent AF on rivaroxaban therapy ($CHA_2DS_2$-VASc-score 2, HAS-BLED-score 1, EHRA 1). The operation consisted of conventional AVR (Magna Ease 23 mm) with coronary artery bypass grafting (CABG) [left internal mammary artery (LIMA)-left anterior descending (LAD), radial artery-first obtuse marginal artery (OM1)], bilateral pulmonary vein isolation (bipolar RF ablation clamp) and LAAO using an epicardial clipping device.

The third patient was a 61-year-old symptomatic (NYHA II) male of normal weight (BMI 23.8 kg/m$^2$, BSA 1.96 m$^2$) with severe mitral valve regurgitation and paroxysmal AF ($CHA_2DS_2$-VASc-score 1, HAS-BLED-score 1, EHRA 1). This patient was selected for minimally invasive mitral valve repair (MIMVR) (PhysioFlex 36 mm annuloplasty, P1/P2 cleft closure, ChordaeX 3×16 mm Loops P2/P3), cryoablation (Cox MAZE IV left atrial lesion set) and intra-atrial surgical LAA closure.

 

## Surgical techniques

### Preparation

All patients underwent general anesthesia for cardiac surgery. Routine invasive monitoring and transesophageal echocardiography (TEE) was used.

### Exposition

Median sternotomy was performed in patient one and two between the sternal notch and the xiphoid process. Patient three underwent periareolar minimally invasive right lateral mini-thoracotomy. For the latter, cardiopulmonary bypass was implemented peripherally through femoral artery and vein cannulation. Antegrade cardioplegia was administered and mild hypothermia (34 ℃) was pursued. TEE and doppler imaging were performed to confirm optimal cannulation and to examine the LAA for the presence of thrombi.

### Operation

***Patient one: surgical LAA excision***

The arrested heart was positioned to the right side and rotated counterclockwise exposing the LAA base. LAA excision at the base was performed followed by inspection for thrombi. The left atrial wall was closed in double-layer mattress technique using 4-0 Prolene suture armed with Teflon pledgets.

***Patient two: epicardial clipping (AtriClip)***

The LAA base was exposed in similar fashion as described above and the LAA was held in place using two wide-shaped forceps by the assistant. An AtriClip device (AtriCure, Mason, OH, USA) of a proper size (40 mm) was positioned with its open clip surrounding the base of the LAA. The clip was closed and released from the deployment device, disconnecting the LAA lumen from the left atrium.

***Patient three: intra-atrial endocardial suture***

The lumen of the LAA was identified through a left atriotomy and suction was applied to remove potential thrombi. In order to fully exclude the LAA at the base, the LAA was turned inside out. A running purse-string suture (4-0 Proline) was applied disconnecting the LAA lumen from the left atrium. The LAA was pushed back outside the left atrium and the suture was tightened.

### Completion

Inspection of sutures and resectate was performed. TEE (doppler) was used to examine valve and ventricular function and thrombi-free LAA exclusion or closure in the dry situs. The surgical access was closed by standard procedure. Extubation was performed 14, 5 and 4 h post-operation for patients one, two and three, respectively.

## Comments

### Clinical results

LAAO is considered a standard surgical procedure to lower the risk of ischemic stroke in patients with AF (2). As such, the three patients benefitted from their individual surgery procedures, living on with a reduced cardioembolic risk and without definite long-term anticoagulation pharmacotherapy. Patients were discharged 9 and 7 days after surgery for the open-heart surgery and the minimally invasive surgery respectively.

### Advantages

Large-scale analyses such as Left Atrial Appendage Occlusion Study (LAAOS) III demonstrate that surgical LAAO can benefit the outcome for patients with AF [stroke hazard ratio (HR), 0.67; 95% confidence interval (CI): 0.53–0.85; P=0.001, occlusion *vs.* no-occlusion] (2). However, to this date there is no consensus on a gold-standard procedure (3). In the three cases above, we demonstrate the advantage of choosing from a portfolio of LAAO methods when operating on a patient within the setting of independent primary heart surgery.

### Caveats

The performance of different LAAO techniques are subject to discussion in current literature, including putative negative effects of increased embolic risk through incomplete LAAO, a phenomenon found in up to 40% of cases in one study at Cleveland Clinic (3). Notably, the same study demonstrates that successful LAA closure after surgery was observed significantly more often following excision-based methods than by endocardial suture or stapler exclusion (73%, 23%, and 0%, respectively, P<0.001) (3). Clip-based methods seek to address this issue by allowing for easy handling, lowering the risk of surgical

 

dehiscence, but may not be suitable for all patients (relative risk reduction for ischemic strokes: 87.5%, ischemic stroke-rate: 0.5/100 patient-years) (4). While LAA clipping is routinely performed on the open heart, minimally invasive surgery may offer an alternative for certain settings requiring use of an LAA clip (5). One caveat for deciding on a procedure may result from the interindividual anatomical differences of the LAA, ranging from patients whose LAA tip rests in the transverse pericardial sinus to patients whose tip is located close to their left coronary circumflex. Importantly, the chosen surgery technique should allow for proper exclusion of the LAA base, leaving a remnant LAA stub of approximately below 1cm to avoid introducing ectopic AF foci (6).

These individual requirements for the technical set-up should be pondered together with drawbacks of certain methods, such as the higher leak rate of suture-based techniques compared to clipping methods (4).

Finally, further case series and quantitative studies comparing the outcome of routine LAAO methods and alternative technical approaches are required to facilitate the choice of the appropriate LAA exclusion technique on a patient-by-patient basis.

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## Footnote

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



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