

## Three-Dimensional Transesophageal Echocardiography to Facilitate Transseptal Puncture and Left Atrial Appendage Occlusion via Upper Extremity Venous Access

Anthony Aizer, MD, MSc; Wilson Young, MD, PhD; Muhamed Saric, MD, PhD; Douglas Holmes, MD; Steven Fowler, MD; Larry Chinitz, MD

Left atrial appendage closure devices are increasingly used in patients with atrial fibrillation at high risk of bleeding and a high thromboembolic risk. The Lariat device (Sentreheart, Redwood City, CA) is an option for those patients who cannot tolerate anticoagulation.<sup>1</sup> There are no published data on either transseptal puncture and left atrial procedural manipulation to achieve percutaneous left atrial appendage closure using upper extremity venous access or the use of 3-dimensional transesophageal echocardiography (3D TEE) to guide upper extremity-based percutaneous procedures.

### Case

A 68-year-old man with a long standing history of persistent atrial fibrillation and a CHA<sub>2</sub>DS<sub>2</sub>-VASc (congestive heart failure or left ventricular dysfunction, hypertension, age > 75 years old, diabetes mellitus, stroke or transient ischemic attack or thromboembolic event, vascular disease [prior myocardial infarction, peripheral artery disease, or aortic plaque], age 65-74 years old, sex category [female gender]) of 3 was unable to tolerate oral anticoagulants because of gastrointestinal bleeding and a history of a fall with consequent subdural hematoma requiring evacuation. Other significant medical history included placement of an infrarenal inferior vena cava filter because of totally occlusive bilateral common femoral deep venous thromboses.

Because of his significant cardioembolic risk and hemorrhagic risk, as well as his inaccessible lower extremity venous system, we attempted percutaneous left atrial appendage closure using upper extremity venous access. Using an 8 Fr sheath, the right internal jugular vein was cannulated and then exchanged over a guidewire for a 61-cm 8.5 Fr inner diameter Agilis sheath (St. Jude Medical, St. Paul, MN). As we expected to use equipment not specifically designed for manipulation from the upper torso, we used 3D TEE to guide catheter orientation and direction. Two-dimensional and 3D TEE was performed using an X7-2 matrix probe and IE33 ultrasound system (Philips Medical Systems, Andover, MA).

Before attempting transseptal puncture, 3D TEE was used to visualize the dimensions and orientation of the left atrial appendage (Figure 1A). The 3D TEE guidance was then used to orient left atrial access via the posterior interatrial septum, thus ensuring subsequent coaxial entry into the left atrial appendage (Figure 1B).

The left atrium was accessed via puncture with a 71-cm Brokenbrough needle that was manually curved at the distal end to provide a sufficient angle to engage the interatrial septum (Figure 1C). Contrast-based imaging of the left atrial appendage with fluoroscopy was then performed for a roadmap for positioning of the Lariat device (Figure 1A-1C in the Data Supplement). Using 3D TEE and fluoroscopy a Sentreheart EndoWire and EndoCATH were advanced into the left appendage (Figure 2A-2C). After obtaining pericardial access via a subxiphoid approach, the Sentreheart EpiWIRE was advanced into the pericardial space via the 14 Fr Sheath and connected magnetically to the EndoWIRE. The Lariat was then positioned over the left atrial appendage and successfully deployed (Figure 3A). The 3D TEE and color Doppler confirmed that the left atrial appendage was closed without leak (Figure 3B).

### Discussion

This is the first case demonstrating feasibility and detailing technique for left atrial appendage closure using upper extremity venous access. We demonstrate that access for the Lariat-based left atrial appendage exclusion via the right internal jugular vein is feasible in patients with contraindications to lower extremity access.

Critical to the procedure was 3D TEE, which allowed for precise visualization of the location and orientation of the transseptal equipment relative to the additional cardiac structures (interatrial septum, tricuspid valve, left atrium) in multiple planes simultaneously. To visualize the interatrial septum in the proper anatomic orientation on 3D TEE, we used the previously published TUPLE (tilt image up then left) maneuver.<sup>2</sup> As a result, engaging the left atrial appendage after transseptal puncture was relatively simple,

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as it was coaxial with the transseptal sheath and thus required minimal equipment adjustment in additional planes. We think that integration of 3D TEE with this transseptal technique can be applied as an alternative method of left atrial access in other situations such as deployment of the Watchman device (Boston Scientific, Marlborough, MA) or left sided ablation.

Previous case reports have been published on transseptal access from the right internal jugular vein for atrial fibrillation ablation and left ventricular lead placement. One of the first reports of transseptal access from the right internal jugular vein was in 1999 when it was used to place a lead in the left ventricle.<sup>3</sup> Transseptal puncture in this case was also achieved with a Brockenbrough needle that was curved more than the standard curve to reach the septum. More recently a case series demonstrated that ablation of atrial fibrillation via the right internal jugular vein was successful in 3 patients who had interruption of the inferior vena cava.<sup>4</sup> The difficulties of the upper extremity approach primarily involve effective engagement of the interatrial septum for transseptal access. Equipment used was designed primarily for manipulation from the lower extremities. Transseptal was performed by unfurling the deflectable sheath to apply pressure to the interatrial septum. Because the equipment is not specifically designed to engage the septum from above, the use of 3D TEE with deflectable sheath technology is critical to ensure optimal equipment orientation, to

safely and optimally obtain left atrial access. These technologies may ultimately result in more left atrial procedures being pursued from the upper extremities.

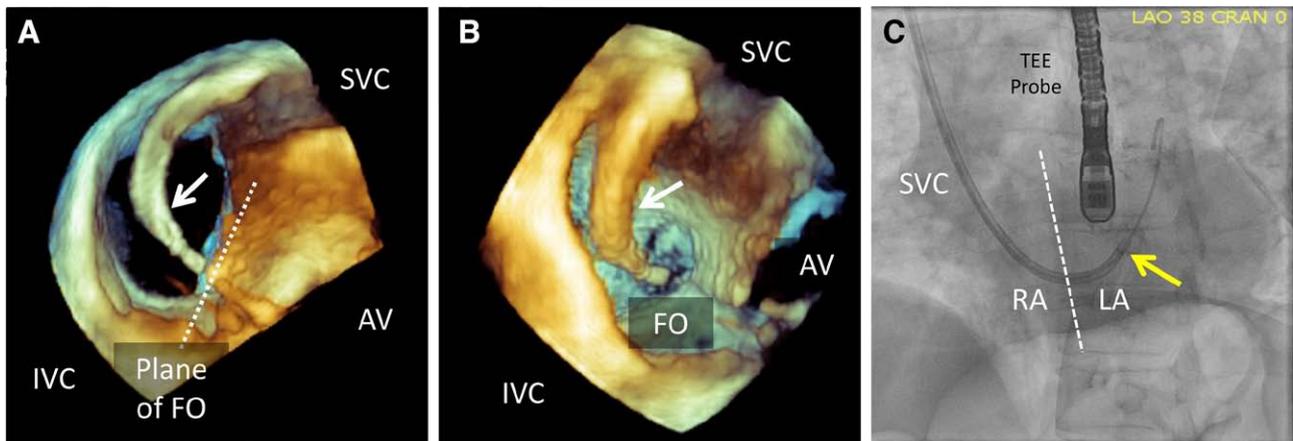
## Disclosures

A. Aizer serves as a consultant to Sentreheart.

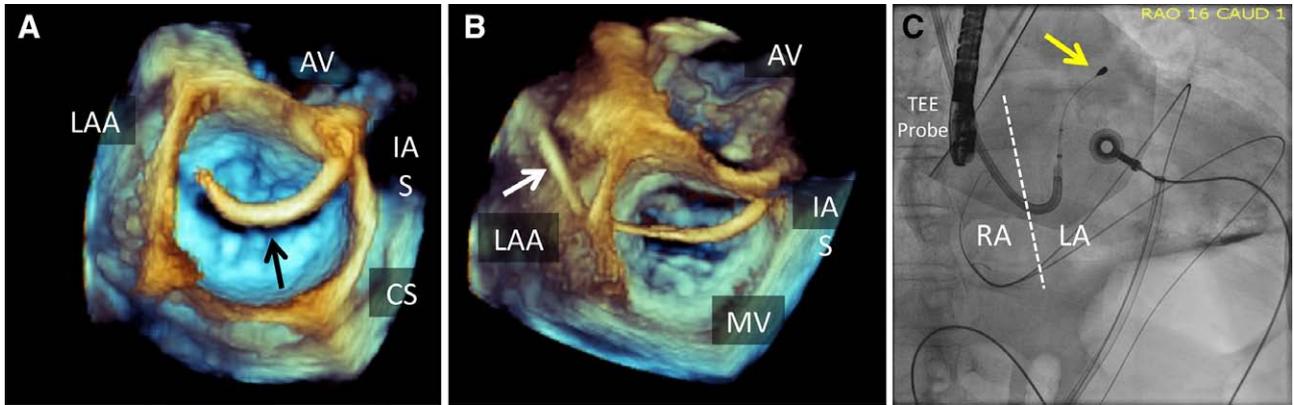
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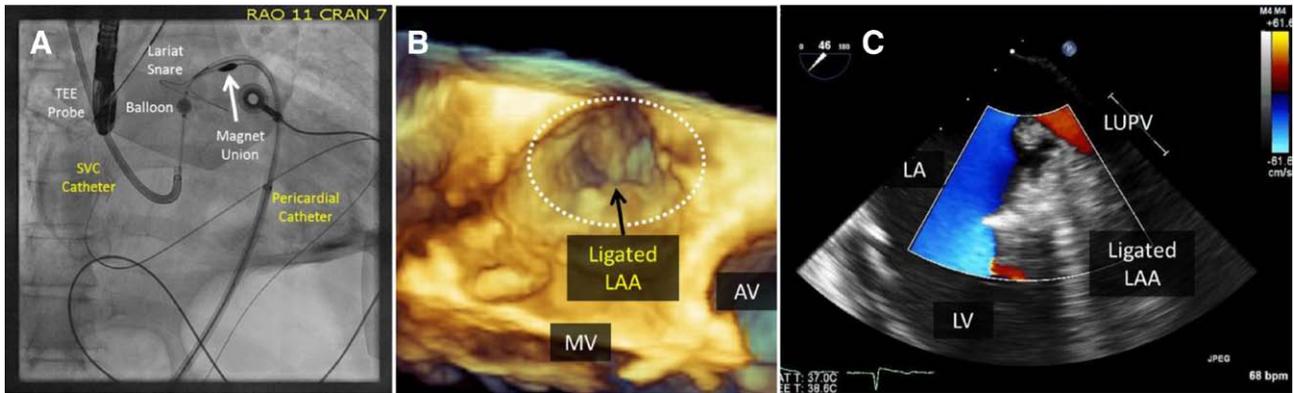
KEY WORDS: atrial fibrillation ■ echocardiography, transesophageal ■ punctures



**Figure 1.** Transseptal puncture guided by 3-dimensional transesophageal echocardiography (3D TEE) and fluoroscopy. **A** and **B**, Three-dimensional TEE allowed real-time orientation of the transseptal apparatus in all dimensions simultaneously. The 3D TEE zoom images of the right atrium demonstrate guidance of the transseptal apparatus (arrow) entering the right atrium from the superior vena cava (SVC) as it curves toward a caudal and posterior aspect of the fossa ovalis (FO) which is visualized in a lateral (**A**) and an en face view (**B**). **C**, Fluoroscopy confirms that transseptal puncture was successfully performed with upward deflection of the transseptal apparatus (arrow), facilitated by a manually curved Brockenbrough apparatus, resulting in orientation toward the left atrial appendage. AV indicates aortic valve; IVC, inferior vena cava; LA, left atrium; LAO CRAN, left anterior oblique cranial; and RA, right atrium.



**Figure 2.** Three-dimensional transesophageal echocardiography (3D TEE) and fluoroscopic guidance of initial steps of Lariat procedure. **A** and **B**, The 3D TEE zoomed image of the mitral valve (MV) in the so-called surgical view demonstrates placement of the endocardial hardware used during Lariat procedure. **A**, The guide catheter (arrow) is seen entering the left atrium through the interatrial septum (IAS) and its tip is oriented toward the orifice of the left atrial appendage (LAA). **B**, The next step during which a magnet tipped endocardial wire (arrow) is placed in LAA. **C**, Fluoroscopy confirms the placement of the magnet-tipped endocardial wire (arrow) in LAA. AV indicates aortic valve; CS, coronary sinus; LA, left atrium; RA, right atrium; RAO CAUD, right anterior oblique caudal; and SVC, superior vena cava.



**Figure 3.** Three-dimensional transesophageal echocardiography (3D TEE) and fluoroscopic guidance of final steps of Lariat procedure. **A**, Fluoroscopy demonstrates the union between endocardial and epicardial magnet-tipped wires (arrow) and the placement of the Lariat snare over the left atrial appendage. Direct Lariat suture placement over the left atrial appendage was performed with minimal trans-septal sheath manipulation because of 3D TEE use ensuring coaxial puncture of the atrial septum with direction toward the left atrial appendage. **B**, The 3D TEE zoomed image shows an en face view of the ligated orifice of the left atrial appendage (LAA) on completion of the Lariat procedure. Note the characteristic bowtie appearance of the ligated LAA orifice. **C**, Color Doppler 2D TEE demonstrates complete obliteration of LAA with no residual leak. AV indicates aortic valve; LA, left atrium; LUPV, left upper pulmonary vein; LV, left ventricle; MV, mitral valve; RAO CRAN, right anterior oblique cranial; and SVC, superior vena cava.

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