

Long-standing persistent atrial fibrillation ablation without use of fluoroscopy in a patient with cor triatriatum



Saumil R. Shah, MD, Guru P. Mohanty, MD, David M. Gilligan, MD, FHRS,
C. Mark Newton, MD

From the Virginia Cardiovascular Specialists, Chippenham Hospital, Richmond, Virginia.

Introduction

Symptomatic persistent atrial fibrillation refractory to medication is commonly treated with catheter ablation. These procedures have historically relied on fluoroscopic guidance for catheter delivery. Typical catheter ablation procedures for atrial fibrillation expose patients to the equivalent of 150 chest radiographs, translating to 1% excess lifetime cancer risk per procedure.¹ Electrophysiologists, interventional cardiologists, and other cardiac catheterization laboratory staff are exposed to the equivalent of 250 chest radiographs annually, presenting a 1% excess cancer risk.² Spine, hip, knee, and ankle pain have been reported by up to 60% of these staff owing to the use of heavy protective lead apparel, leading to limited work functions in up to one third of physicians.³ Efforts to reduce fluoroscopy in catheter ablation procedures fall short of describing fluoroless transseptal puncture or rely on dexterity for positional confirmation.^{4–8} Therefore, fluoroscopy continues to be used routinely owing to uncertainty regarding efficacy and the ability to do complex mapping. In our experience of a large number of nonfluoroscopic atrial fibrillation ablations, including in patients with challenging anatomy, we have been successful in routinely applying a nonfluoroscopic transseptal technique. In patients with cor triatriatum, for example, a fenestrated membrane dividing 1 of the atria into 2 compartments makes navigating catheters toward target sites more challenging, and requires precise guidance. Where the membrane presents a challenge in accessing the target pulmonary vein, transseptal catheterization into the appropriate subdivision of the left atrium may be necessary and requires precise imaging to position the transseptal assembly at the desired location on the interatrial septum.^{9,10} This report describes the application of our center's

nonfluoroscopic transseptal and catheter ablation technique in a cor triatriatum patient with persistent atrial fibrillation.

Case report

A 75-year-old woman presented with a history of atrial fibrillation for more than 16 years. Symptoms were initially paroxysmal. She was treated with amiodarone and maintained sinus rhythm; however, the patient self-discontinued the medication owing to fatigue and concerns of long-term side effects. Transesophageal echocardiogram (TEE) noted mild left ventricular (LV) systolic dysfunction with estimated LV ejection fraction of 45%, mild-to-moderate mitral regurgitation, and a membrane in the left atrium. Fenestrations were noted within the membrane, with flow detected across it on color Doppler. High-resolution chest computed tomography confirmed anterior-posterior separation of the left atrium, consistent with cor triatriatum sinister (Figure 1). All 4 pulmonary veins originated in the right subdivision of the left atrium.

After restarting on amiodarone and undergoing cardioversion, the patient maintained sinus rhythm and, in follow-up, reported improvement in symptoms of fatigue. However, concern remained about long-term amiodarone use, and the decision was made to undergo catheter ablation.

Procedural description

Fluoroless image guidance setup

The EnSite Velocity Cardiac Mapping System (St. Jude Medical, St. Paul, MN) was used for 3-dimensional (3D) electroanatomic mapping (EAM) and visualization of the transseptal needle. The radiofrequency (RF) transseptal needle (NRG Transseptal Needle, Baylis Medical Company, Montreal, Canada) and 0.032" guidewire were set up on the mapping system as 2 15F single-electrode catheters with no electrode spacing, and were assigned to corresponding locations in the recording system pin box. The guidewire was connected to the pin box using a disposable pacing system analyzer alligator cable (St. Jude Medical) (Figure 2A). The RF needle was connected to the Baylis RF Puncture Generator through the DuoMode extension

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Dr Shah is a consultant for Abbott and Medtronic. All other authors have no disclosures to report. **Address reprint requests and correspondence:** Dr Saumil R. Shah, Virginia Cardiovascular Specialists, 7611 Forest Ave #100, Richmond, VA 23229. E-mail address: srshah@vacardio.com.

KEY TEACHING POINTS

- With increasing awareness of the health risks associated with radiation exposure and orthopedic implications of heavy protective equipment, extra efforts should be implemented to eliminate fluoroscopy from the electrophysiology lab.
- The use of a blunt radiofrequency transseptal needle allows exposure and visualization of the needle on 3-dimensional electroanatomic mapping during drop-down and positioning on the interatrial septum.
- Even in the case of complex cardiac anatomy, such as cor triatriatum, with care, catheters can be navigated successfully toward target ablation sites without the use of fluoroscopy.

cable (Baylis Medical Company), allowing a direct connection to the recording system pin box (Figure 2B). Intracardiac echocardiography (ICE) was used for guidance and anatomic verification throughout the procedure.

Transseptal puncture

The procedure was performed in the electrophysiology lab under general anesthesia. The patient received heparin bolus at baseline with additional boluses and infusion to maintain activated clotting time above 300 seconds. Right and left femoral vein access was obtained using the Seldinger technique. Catheters were inserted under EnSite Velocity guidance. Inferior vena cava, superior vena cava (SVC), right atrial, and coronary sinus geometries were created at baseline using a duodecapolar catheter. A quadripolar CRD-2 catheter (St. Jude Medical) was placed across the tricuspid annulus to mark the His location.

EnSite Velocity was used to track the location and movement of the 0.032" guidewire toward the SVC; however, tip location accuracy could not be assessed on the map, as the guidewire was not electrically insulated. To avoid trauma, the SL1 sheath and dilator were advanced after verifying location in the SVC on the 3D map. After removal of the guidewire, the RF needle was inserted into the assembly and advanced beyond the distal end of the dilator to visualize the active needle tip. With the tip still exposed, the transseptal assembly was dropped down to the level of the interatrial septum. This was evidenced by a sudden leftward jump of the needle on the left anterior oblique image on EnSite. Needle placement and septal tenting were verified on ICE before marking the needle tip position on the 3D map. Transseptal puncture was performed by applying RF energy (pulse mode) under ICE guidance and pressure monitoring. The needle tip was visualized on ICE to confirm left atrial access without significant further needle advancement. A ProTrack

Pigtail Wire (Baylis Medical Company) was then used to replace the transseptal sheath with an Agilis steerable sheath (St. Jude Medical). A second transseptal puncture was performed in the same manner, using the first transseptal site marked on EnSite as a positioning guide (Figure 3A–C) and ICE for verification (Figure 3D).

Catheter ablation

After transseptal catheterization, the left atrial geometry was created using the Reflexion Spiral mapping catheter (St. Jude Medical). Circumferential wide-area ablation was performed outside all 4 pulmonary veins using a TactiCath ablation catheter (St. Jude Medical) to achieve pulmonary vein electrical isolation. Esophageal temperature was monitored using a CIRCA probe (CIRCA Scientific, Englewood, CO). After 30 minutes from initial pulmonary vein isolation (PVI), 12 mg adenosine was administered to check for dormant conduction; atrioventricular block was induced, and all 4 veins were mapped. Pacing during adenosine was performed to verify entrance block and exit block in all 4 pulmonary veins. Given persistent atrial fibrillation, a left atrial roof line was also created. Block across this line was verified with differential pacing and measured 140 ms. After completion of PVI and left atrial roof line (Figure 3E), the catheter was tracked back in the right atrium, and right atrial flutter ablation was performed to create a bidirectional block.

Both transseptal puncture and catheter ablation were completed without the use of fluoroscopy and with no immediate complications. Catheter movement and sheath position were monitored using ICE, given the complex anatomy. Attention was given to ensure free catheter movement and to avoid potential catheter entrapment in the membrane dividing the left atrium.

Follow-up

The patient was seen in follow-up at 2 weeks, 3 months, and 12 months postablation. Amiodarone was discontinued at the 2-week visit, while warfarin was continued. Sinus rhythm was maintained and the patient showed improved symptoms of fatigue continuing at 12 months postprocedure.

Discussion

To our knowledge, this report is the first to describe a technique for entirely fluorless RF catheter ablation, including the critical step of transseptal catheterization, in a patient with cor triatriatum sinister. The transseptal needle and guidewire were imaged on 3D EAM and ICE to safely navigate toward target sites and effectively perform catheter ablation in the presence of complex cardiac anatomy, while eliminating radiation exposure to both patient and staff.

Atrial fibrillation ablation is routinely performed with fluoroscopy, with fluoroscopy times often exceeding 30 minutes.¹¹ A previous report of fluoroscopy-guided transseptal puncture and atrial fibrillation ablation in a patient with cor triatriatum sinister indicated difficulty with sheath manipulation and accessing all 4 pulmonary veins, highlighting the

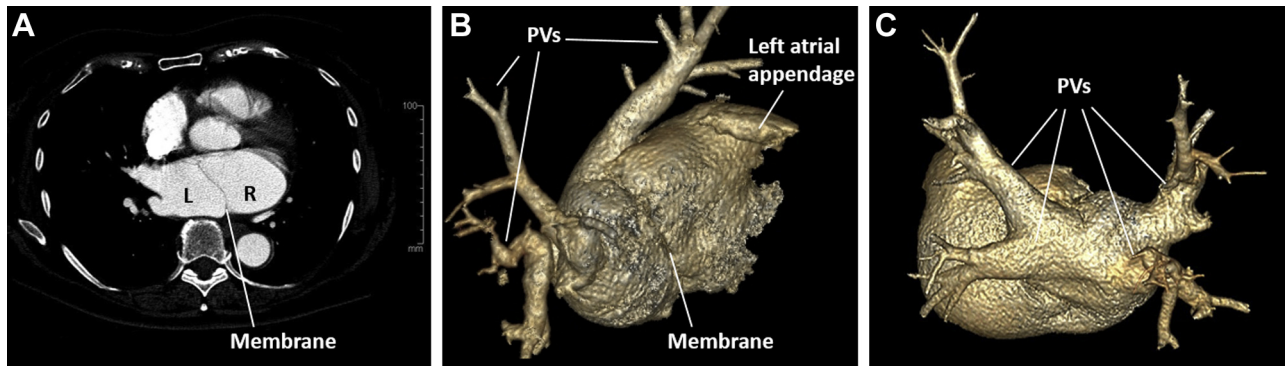


Figure 1 **A:** High-resolution chest computed tomography (CT) during preprocedure work-up indicated an anterior-posterior membrane separating the left atrium into 2 subdivisions. **B, C:** Three-dimensional CT reconstructions (**B:** cranial view; **C:** posterior view) show that all 4 pulmonary veins (PVs) drained into the right subdivision of the atrium. L = left; R = right.

importance of image guidance in such cases,⁹ and the potentially longer fluoroscopy times and radiation exposure.

Furthermore, as the volume of atrial fibrillation procedures rises, concern over patient and staff radiation exposure continues to increase.^{2,12,13} While nonfluoroscopic guidance systems, such as ICE, TEE, and 3D EAM, have been increasingly used in catheter ablation procedures to reduce or completely eliminate fluoroscopy,^{4–8,14} transseptal access is often regarded as the main challenge in completely nonfluoroscopic catheter ablation.¹⁵ This step requires visualization of the drop-down of the device tip from the brachiocephalic vein or SVC to the fossa ovalis, which is traditionally performed under fluoroscopic guidance. In our practice, as illustrated in this case, the RF

needle was visualized on EAM as a discrete dot owing to its electrode tip and electrically insulated shaft. Unlike conventional sharp mechanical needles, it was possible to expose the round atraumatic RF needle tip while visualizing the anterior or posterior location in the SVC and down onto the fossa ovalis. The use of EAM with a blunt RF needle enabled direct visualization of the needle position in 3 dimensions, which, combined with ICE imaging at the time of puncture, eliminated any uncertainty associated with 2-dimensional fluoroscopy. In this case where a fenestrated membrane subdivided the left atrium, we were able to achieve transseptal access with little difficulty, as well as map and ablate around all 4 pulmonary veins and the left atrial roof without membrane entrapment or intraoperative

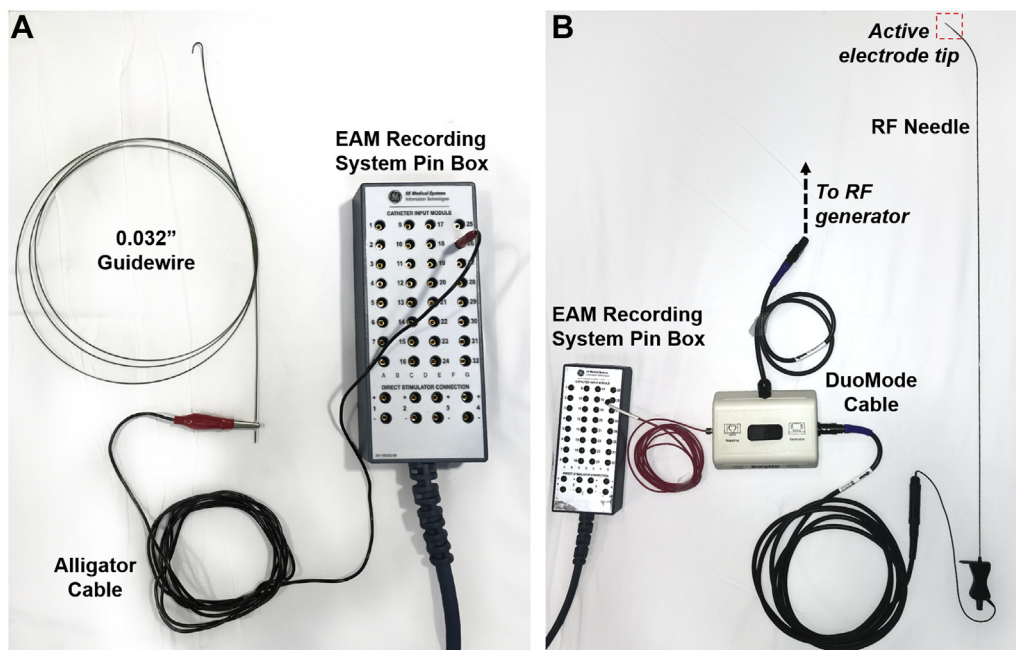


Figure 2 Setup to visualize the 0.032" guidewire and NRG Transseptal Needle (Baylis Medical Company, Montreal, Canada) on the EnSite Velocity Cardiac Mapping System (St. Jude Medical, St. Paul, MN). **A:** The guidewire was connected to the pin box using an alligator cable for tracking up the superior vena cava. **B:** A DuoMode extension cable (Baylis Medical Company) was used to connect the radiofrequency (RF) needle to the recording system pin box to enable visualization during drop-down to the fossa ovalis. EAM = electroanatomic mapping.

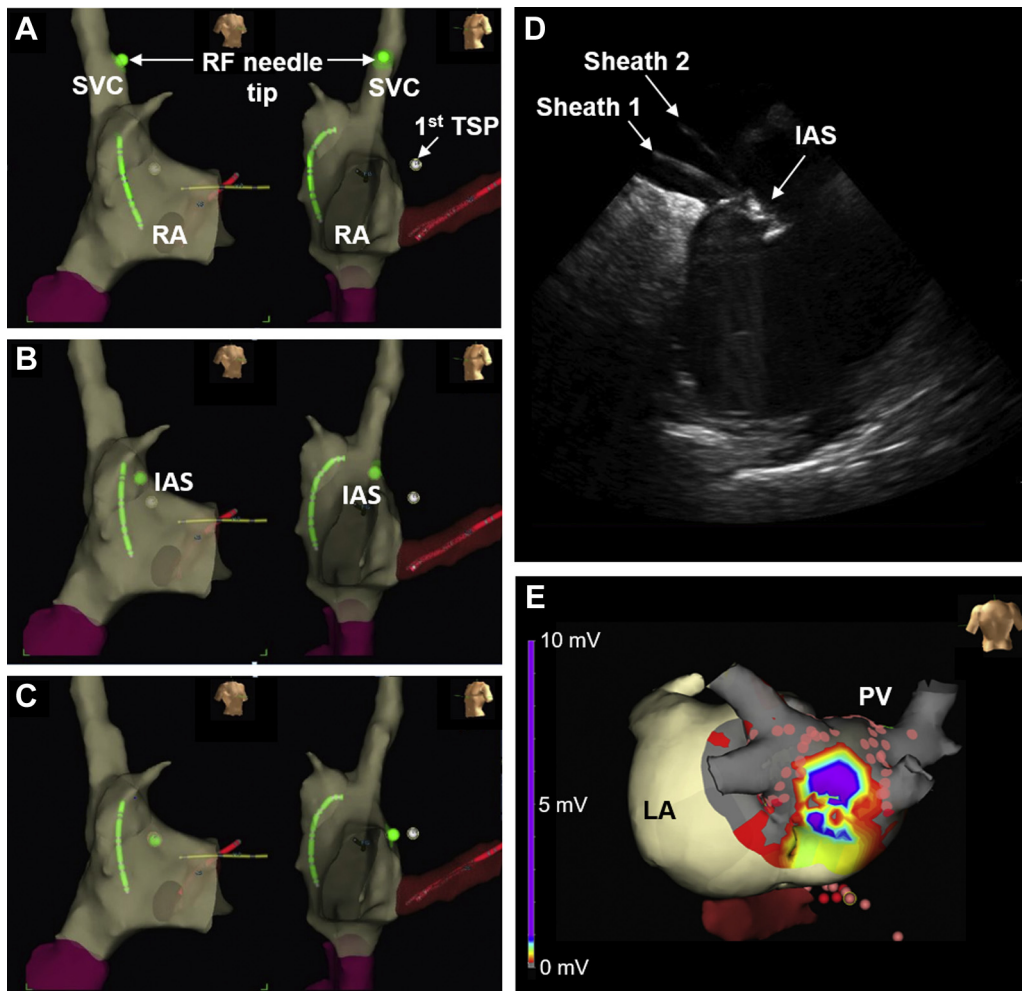


Figure 3 A, B: Radiofrequency (RF) needle movement (green dot) was tracked using 3-dimensional mapping from the superior vena cava (SVC) (A) toward the interatrial septum (IAS) (B). The white dot indicated the location of the first transseptal puncture (TSP). C: The needle was positioned on the IAS relative to the location of the first TSP before applying RF energy for the second TSP. D: Intracardiac echocardiography image indicating 1 sheath across the septum, as well as tenting by a second sheath and needle assembly prior to the second TSP. E: EnSite Velocity (St. Jude Medical, St. Paul, MN) voltage map showing individual ablation lesions (pink) and pulmonary vein isolation (gray). LA = left atrium; PV = pulmonary vein; RA = right atrium.

complications. Patient symptoms were significantly improved, with no recurrence of atrial fibrillation at 12-month follow-up. Our findings suggest that even patients with challenging anatomies can benefit from nonfluoroscopic procedures and the lower radiation risk that they present. The elimination of fluoroscopy would also help electrophysiology lab staff and provide relief from lead fatigue, as use of heavy protective lead apparel was not necessary during any parts of the procedure.

Conclusion

This paper describes a completely nonfluoroscopic transseptal puncture and catheter ablation procedure to treat atrial fibrillation in a cor triatriatum patient. PVI was achieved with no intraoperative complications. Patient symptoms were improved, with no recurrence of cardiac arrhythmia 12 months after the ablation procedure. This case highlights that a nonfluoroscopic image-guidance technique using 3D

EAM and ICE provides a safe and effective alternative to fluoroscopy that can be utilized even in complex anatomies, thereby reducing radiation exposure to both patients and staff.

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