# Transseptal puncture facilitated by "reverse tenting" using a left atrial ablation catheter

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## Introduction

Transseptal puncture is a critical procedural step in pursuing left-sided catheter ablations. Most centers use either fluoroscopic and/or intracardiac echocardiographic (ICE) guidance.[1,2] However, not uncommonly, these routinely used approaches may not be sufficient to repeatedly obtain transseptal access in a safe manner.[3] We present a recently described novel approach to transseptal puncture using a concomitant ablation catheter in the left atrium (LA) in 2 challenging cases.

## Case reports

### Case 1

An otherwise healthy 67-year-old man with symptomatic paroxysmal atrial fibrillation refractory to flecainide therapy was referred for LA catheter ablation (pulmonary vein [PV] isolation). He presented to the cardiac electrophysiology laboratory at Johns Hopkins Hospital (Baltimore, MD) in sinus rhythm. Right femoral venous access was obtained, and an 8F SR-0 sheath and two 8F SL-0 sheaths (Abbott, St. Paul, MN) were advanced to the right atrium. A deflectable decapolar electrode catheter was advanced into the coronary sinus through the SR-0 sheath, and a deflectable quadripolar catheter was advanced to the His-bundle position through an SL-0 sheath. Left femoral venous access was obtained, and a 9F 45-cm sheath was advanced into the inferior vena cava to facilitate placement of an 8F ICE catheter (CARTO-Sound, Biosense Webster, Diamond Bar, CA) into the right atrium to image the fossa ovalis.

Biplane fluoroscopy was positioned (right anterior oblique 30° and left anterior oblique 60°), and a bolus of unfractionated heparin was administered (target activated clotting time >350 seconds). A Brockenbrough transseptal needle (71-cm BRK-1, Medtronic, Minneapolis, MN) connected to an arterial pressure transducer line was placed within a SL-0 dilator 1 cm short of the tip at the superior vena cava junction and upon withdrawal was noted to "drop" into the membranous fossa ovalis. This was confirmed by both radiocontrast injection and ICE imaging demonstrating marked tenting within the LA. Considerable manual pressure was required, and the membranous tenting dissipated with an initially low mean atrial pressure observed. However, immediate radiocontrast injection demonstrated extracardiac extravasation into the pericardial space (Figure 1), so the needle was promptly withdrawn. Subsequent pericardial ICE imaging demonstrated a new-onset small circumferential effusion, so the decision was made to reverse the unfractionated heparin with protamine sulfate and abort the procedure. Review of the patient's segmented 3-dimensional cardiac computed tomographic scan confirmed a narrow LA anteroposterior diameter. The patient rapidly convalesced without issues. After discussion of potential alternative strategies for transseptal puncture, he returned 6 weeks later for a repeat LA ablation attempt.

Venous access, catheter placement, and ICE imaging were undertaken in similar fashion. After heparinization, a standard Brockenbrough needle (71-cm BRK XS, Medtronic) was advanced through an SL-0 sheath and dilator, and upon withdrawal from the superior vena cava it was noted to drop into the membranous fossa ovalis with considerable tenting once again. However, manual pressure alone proved unsuccessful in puncturing the membrane when a needle with less curvature than before was used (Figure 2). After 3 such attempts, we chose to use radiofrequency (RF) energy (Stockert RF generator, Freiburg, Germany). RF application initially was started at 10 W, then 15 W, and finally 20 W with significant manual pressure. Upon the third application, the needle was seen to advance considerably into the LA with loss of tenting and a low mean atrial pressure observed. The needle was immediately withdrawn approximately 1 cm. Nevertheless, immediate radiocontrast injection indicated that the LA free wall was only 1 cm away from the needle tip. The SL-0 sheath was advanced over the dilator and into the LA, followed by insertion of a force-sensing 3.5-mm-tip ablation catheter (Bi-directional F-J curve SmartTouch STSF, Biosense Webster). To avoid the use of excessive

**KEYWORDS** Atrial fibrillation; Catheter ablation; Intracardiac echocardiography; Left atrium; Transseptal puncture
(Heart Rhythm Case Reports 2019;5:159–162)

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https://doi.org/10.1016/j.hrcr.2018.12.002

## KEY TEACHING POINTS

- Transseptal puncture, which is widely used for ablation of left-sided arrhythmias, can be challenging.
- Excessive tenting and difficulties in reaching the interatrial septum are among the possible challenges.
- Application of a curled force-sensing ablation catheter upon the fossa ovalis ("reverse tenting") can readily facilitate the second transseptal puncture.

manual pressure, we chose to utilize a technique recently advocated by Dr. Joshua Cooper in a message on Twitter. Specifically, the ablation catheter was deliberately curled so that the tip prolapsed against the membranous fossa ovalis to provide significant counterpressure (9–10*g* of force) resulting in visual evidence of "reverse tenting" (Figure 2). The subsequent transseptal puncture was performed with the same minimal curvature Brockenbrough needle after its drop into the fossa ovalis. While monitoring the ablation tip contact force and its proximity to the needle with ICE and fluoroscopy images, the puncture was successfully performed by using only modest manual pressure and little tenting due to the appositional counterpressure applied from the LA ablation catheter. Immediate radiocontrast injection after the second transseptal puncture confirmed only small advancement of the needle into the LA (Figure 2).

## Case 2

A 63-year-old man with symptomatic persistent atrial fibrillation refractory to medical therapy presented for LA catheter ablation (PV isolation) at Temple University Hospital (Philadelphia, PA). Left and right femoral vein access was obtained, a steerable decapolar catheter (Abbott Medical St Paul, MN) was advanced into the coronary sinus, an ICE catheter was advanced to the right atrium, and a medium curve steerable sheath (Agilis, Abbott Medical, St. Paul, MN) was advanced over a wire to the right atrium for transseptal puncture after therapeutic anticoagulation with intravenous heparin had been achieved (target activated clotting time 350–400 seconds). Because of mild biatrial enlargement as well as an anatomically unfavorable trajectory of the inferior vena cava into the right atrium, the steerable sheath had to be deflected to a considerable degree to achieve good apposition of the dilator to the fossa ovalis. Transseptal puncture was successfully achieved using ICE guidance, brief biplane fluoroscopy, and a SafeSept Needle-Free transseptal guidewire (Pressure Products, San Pedro, CA). An irrigated bidirectional ablation catheter (SmartTouch STSF D-F curve, Biosense Webster) was advanced into the LA via the first transseptal sheath and positioned in the left superior PV. An SL-1 nondeflectable sheath was then advanced over a wire to the right atrium, but because of the anatomic challenges mentioned earlier, the SL-1 curved dilator tip would not reach the interatrial septum. Instead, as the sheath was advanced, the dilator tip simply rose cranially within the right atrial chamber, without adequate septal contact. Rather than switching the SL-1 sheath to a second steerable sheath, the decision was made to use the transseptal ablation catheter to artificially create a more favorable geometry of the interatrial septum. The ablation catheter was fully curved into its "D" configuration within the LA chamber to create an anchor that would not pull back through the transseptal hole, and the sheath–catheter assembly was firmly pulled backward, thereby tenting the interatrial septum into the right atrium. The SL-1 sheath and dilator were then easily apposed to the interatrial septum, below the "reverse tenting" site. A second transseptal puncture was then readily performed with the SL-1 sheath under ICE guidance, brief biplane fluoroscopy, and the SafeSept Needle-Free transseptal guidewire without complication (Figure 3).

## Discussion

Despite the wealth of experience on performing transseptal punctures with fluoroscopic and ICE guidance, certain cases still provide challenges that may entail the risk of catastrophic complication. In particular, a large but strong membrane may result in a large amount of tenting into the LA, raising the possibility of unintended free-wall perforation as seen in our first case. RF transseptal application can be useful in this scenario, but as seen in our second procedure, it may still require considerable manual pressure from the right atrium with subsequent protrusion close to the lateral LA free wall. In addition, in a

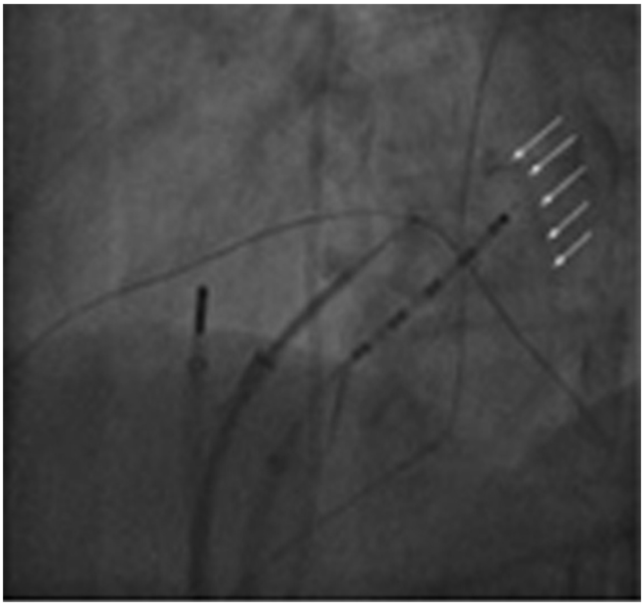

**Figure 1** Left anterior oblique view after transseptal puncture with Brockenbrough needle. Injection of contrast through the needle shows extravasation of contrast into pericardial space (*white arrows*).

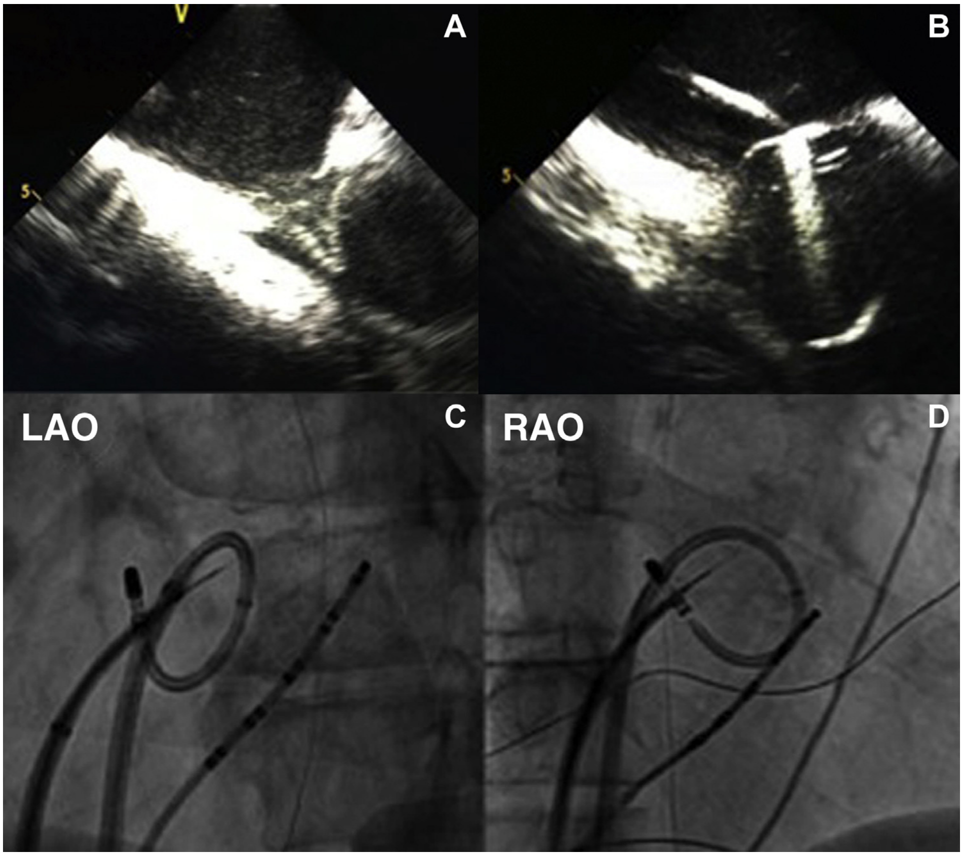


**Figure 2** **A:** Intracardiac echocardiographic image showing marked tenting of the intra-atrial septum against the needle during the first transseptal puncture. **B:** Intracardiac echocardiographic image showing prolapsed ablation catheter tip artifact at the membranous fossa ovalis causing "reverse tenting." Left anterior oblique (LAO) (**C**) and right anterior oblique (RAO) (**D**) images after the second transseptal puncture showing the curved ablation catheter against the intra-atrial septum and injected contrast within the left atrium well away from the free wall.

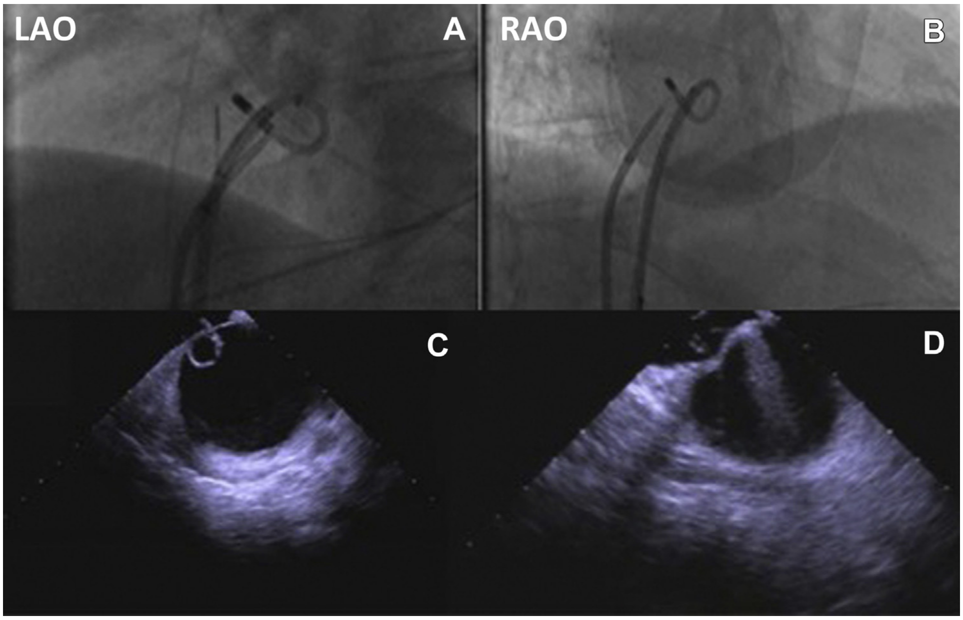


**Figure 3** Left anterior oblique (LAO) (**A**) and right anterior oblique (RAO) (**B**) fluoroscopic images with curled ablation catheter backward traction being applied on the left atrial side of the interatrial septum, thereby enabling an SL-1 introducer and sheath to reach the interatrial septum. Intracardiac echocardiographic images showing the ablation catheter tightly curved in the left atrium and pulled back onto the left side of the interatrial septum (**C**), and a more posterior view of the septum showing reverse tenting of the superior portion of the interatrial septum from backward traction on the curved ablation catheter, while the SL-1 dilator is seen tenting the septum toward the left atrium in a more caudal and posterior location than the first transseptal site (**D**).

scenario such as case 2 with a large RA, simply reaching the septum for the second transseptal puncture using a nonsteerable sheath might be difficult. In these scenarios, some operators may opt to use a single puncture/double transseptal technique by passing 2 sheaths through 1 transseptal puncture. However, using this technique may cause continuous mechanical interactions between the catheters because of their adjacent movements. Therefore, independent repositioning of 1 catheter may displace the other catheter. In addition, because both sheaths are passing through the same transseptal puncture site, a larger defect will be created in the interatrial septum, which will increase the risk of iatrogenic atrial septal defect formation. In a prospective study of 39 patients who underwent a single puncture/double transseptal approach for PV isolation, 9 patients (21%) still had a small iatrogenic atrial septal defect at 6-month follow up.[3] In contrast, as known from studies using 2 separate transseptal punctures, this rate is zero at 6-month follow-up.[4] Using an RF needle for our case 1 or using 2 steerable sheaths for our case 2 would also have been helpful in successfully performing the second transseptal puncture. However, using the ablation catheter for reverse tenting to improve transseptal apposition in both of these scenarios provided an inexpensive and timesaving solution. We found in both cases that use of the Cooper transseptal technique enabled us to safely undertake the second transseptal puncture in instances of excessive tenting or inability to reach the septum using nonsteerable sheaths. We attribute the ease of puncture to the effective counterpressure applied by the opposing force-sensing ablation catheter on the interatrial septum.

Of note, there might be a potential risk for damaging the ablation catheter because of pulling against the septum or physical interaction between the transseptal needle and the catheter itself. Fortunately, we have not observed damage to the ablation catheter in the dozen cases we have performed using this technique to date. We believe that we have intuitively avoided such a scenario by being cognizant of both the ablation catheter tip artifact upon ICE imaging and the real-time ablation tip force data when undertaking transseptal puncture. If the force starts to rise exceedingly high ($>$20–25*g*) upon the pullback, we stop and reconfigure the placement of the ablation tip to avoid direct contact with the puncture needle in the fossa ovalis, usually by rotating it 90° such that the ablation tip becomes *en face* in the left anterior oblique view (the modified Cooper transseptal technique).

Given that atrial fibrillation ablation has become the most common invasive arrhythmia procedure performed at many medical centers,[5] we encourage others to use this approach when a double transseptal puncture is sought in patients with challenging anatomic features.

## Conclusion

This technique is simple and, based on our experience, can be performed safely. However, as discussed, operators encountering difficulties in performing a second transseptal access might be more familiar with alternative techniques and should attempt those first. Accordingly, we believe that the reverse tenting technique can be considered another approach that can be safely used when operators have not been successful with their preferred options.

## Acknowledgments

The authors would like to acknowledge the assistance of Dr Hugh Calkins in advising on the preparation and writing of this manuscript.

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