

Complication prevention in ablation procedures: How to perform transseptal puncture safely in case of atrial septum aneurysm



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Introduction

Transseptal catheterization is routinely used for numerous ablation procedures, including ablation of atrial fibrillation (AF), accessory pathways, focal atrial tachycardias, and ventricular tachycardias. Moreover, transseptal puncture (TSP) is used for the occlusion of left atrial appendages or mitral valve repair. The original technique introduced by Ross¹ in 1959 has evolved into a widely used standard procedure with low complication rates over time.² However, presence of atrial septum aneurysm, thickened interatrial septum (IAS), or previous TSP may result in a challenging task with elevated risk.³ We here present a case report of TSP in a patient with IAS aneurysm, provide a detailed description of the TSP implementation, and recommend on complication prevention.

Case report

A 62-year-old male patient was admitted to our hospital for a redo ablation of persistent AF. The patient suffered from flecainide-refractory recurrent symptomatic AF episodes 2 years after cryoballoon pulmonary vein isolation. The left ventricular ejection fraction was normal and stress echocardiography did not provide any evidence of coronary artery stenosis. Preinterventional transesophageal echocardiography (TEE) was performed to exclude left atrial thrombi. Additionally, this TEE demonstrated an IAS aneurysm with bidirectional movement to both atria of 15 mm (Figure 1).

The ablation procedure was carried out under conscious sedation with propofol and fentanyl. Two diagnostic catheters were advanced from the right femoral vein: a 10-polar coronary sinus catheter that additionally served as an

anatomic landmark for the inferior left atrium and a 4-polar right ventricular catheter. An 8F transseptal sheath with dilator (SL1, Abbott, Chicago, IL) was introduced from the right femoral vein and positioned in the superior vena cava via a 0.035-inch J-tipped guidewire. The 71-cm Brockenbrough needle (BRK1-XS, Abbott) was inserted into the sheath with the tip of the needle not exiting the dilator. The needle was connected to a pressure transducer and the system flushed with saline. Under fluoroscopy guidance the SL1 sheath was retracted from the superior vena cava until the tip of the sheath performed a sudden leftward movement into the fossa ovalis (the second “jump”) above the coronary sinus ostium (Figure 2A). TEE confirmed a correct puncture site at the inferior fossa ovalis not pointing toward the posterior left atrial wall or the aortic root. Advancement of the needle did not result in puncture of the IAS (Figure 2B). Instead, TEE demonstrated a massive tenting of the IAS toward the free left atrial wall on the left side as a result of the IAS aneurysm (Figure 2C). After 3 unsuccessful TSP attempts the pressure toward the left side was reduced without losing contact to the intended puncture site. The pressure transducer was removed and a 0.014-inch nitinol guidewire (SafeSept, Pressure Products, San Pedro, CA) was introduced into the BRK1 needle. The sharp tip of that guidewire passed through the IAS without further tenting (Figure 2D). After entering the left atrium the resumed J-shaped tip of the guidewire was safely positioned in a superior branch of the left inferior pulmonary vein, since the left superior vein could not be reached (Figure 2E and F). Next, the combined transseptal sheath with dilator and BRK needle was advanced into the left atrium (Figure 3A). While a rapid pacing maneuver was performed from the right ventricular catheter, left atrial

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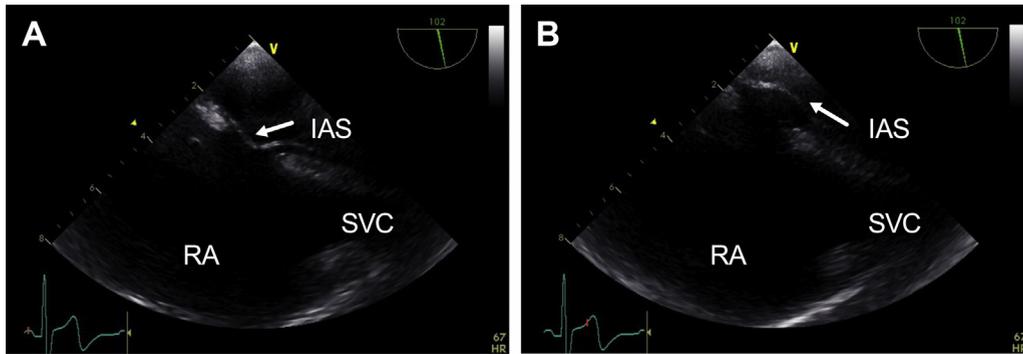


Figure 1 Interatrial septum aneurysm. Transesophageal echocardiography in a bicaval view (here 102°) demonstrated the presence of interatrial septum (IAS) aneurysm. Between ventricular diastole (A) and systole (B) an IAS movement of 15 mm could be measured. RA = right atrium; SVC = superior vena cava.

angiography was performed over the SL1 sheath after removal of dilator, needle, and guidewire (Figure 3B). Further introduction of an 8.5F steerable sheath (Agilis NxT, Abbott) via a stiff guidewire (0.032 inch) positioned in the left superior pulmonary vein was implemented without problems (Figure 3C and D). Placement of the second transseptal sheath was performed in an analogous manner and

the redo pulmonary vein isolation procedure with a 3-dimensional mapping system was undertaken as planned.

Discussion

Nowadays, the transseptal approach is a mandatory access to the left atrium for the interventional electrophysiologist. It is

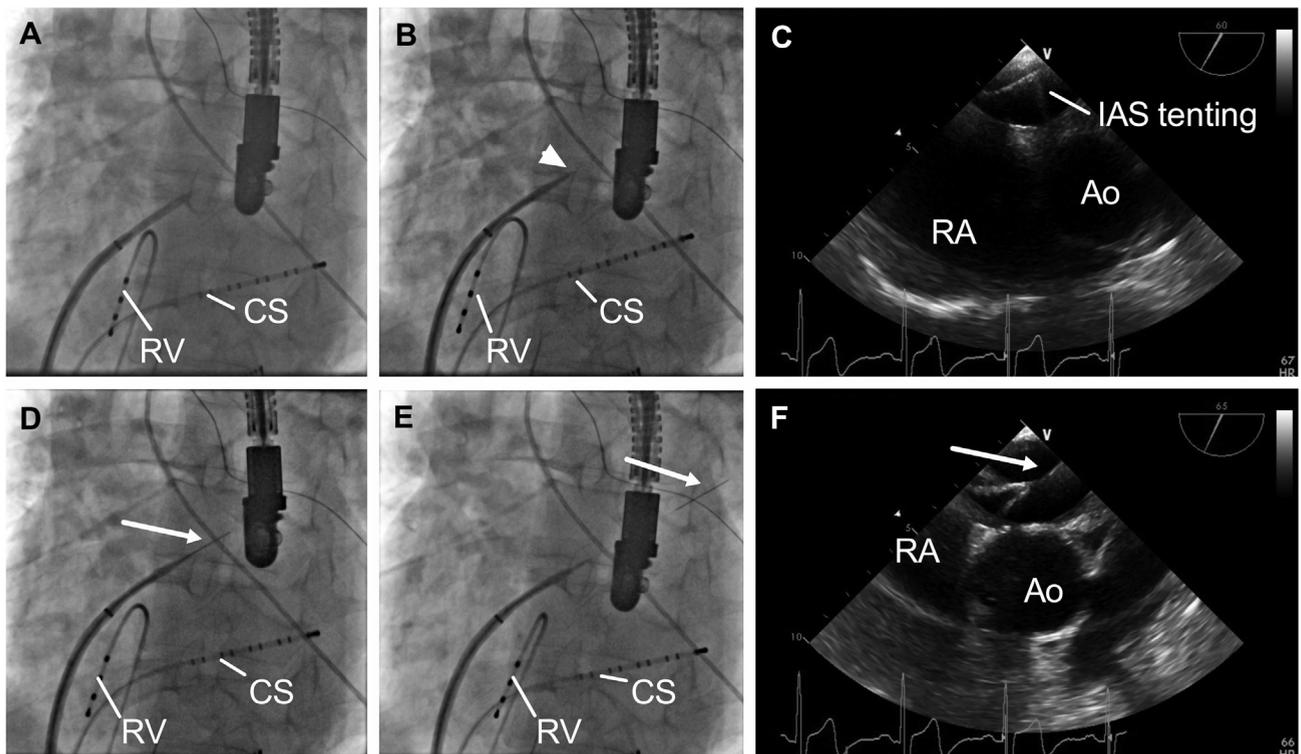


Figure 2 Transseptal puncture. **A:** Fluoroscopic view (left anterior oblique [LAO] 40°) with the tip of the transseptal sheath (SL1, 8F, Abbott, Chicago, IL) in the fossa ovalis. **B:** The Brockenbrough needle (BRK1-XS, Abbott) was advanced and the tip of the needle (arrowhead) produced a marked tenting toward the left atrial lateral wall without passing through the septum. **C:** Transesophageal echocardiography (TEE) demonstrated the excessive interatrial septum (IAS) tenting. Moreover, TEE was used here to verify an optimal septal puncture site, posterior to the aortic root (Ao), anterior to the posterior wall, and in the inferior third of the IAS. **D:** A transseptal puncture wire (SafeSept, Pressure Products, San Pedro, CA) was advanced through the BRK1-XS needle and entered the left atrium. Following transseptal passage the tip of the puncture wire automatically bent back, thereby forming an atraumatic distal tip. The puncture wire showed a radiopaque marker (arrow) directly distal to the atraumatic tip. **E:** The puncture wire (arrow) was carefully advanced into a pulmonary vein (here, upper branch of the left inferior pulmonary vein). **F:** TEE helped guide the puncture wire (arrow) in the left atrium toward the pulmonary veins and away from the left atrial appendage. As long as the transseptal sheath had not crossed the septum a persistent tenting of the IAS could be noticed. All fluoroscopic pictures are shown in LAO 40° view. CS = coronary sinus catheter; RA = right atrium; RV = right ventricular catheter.

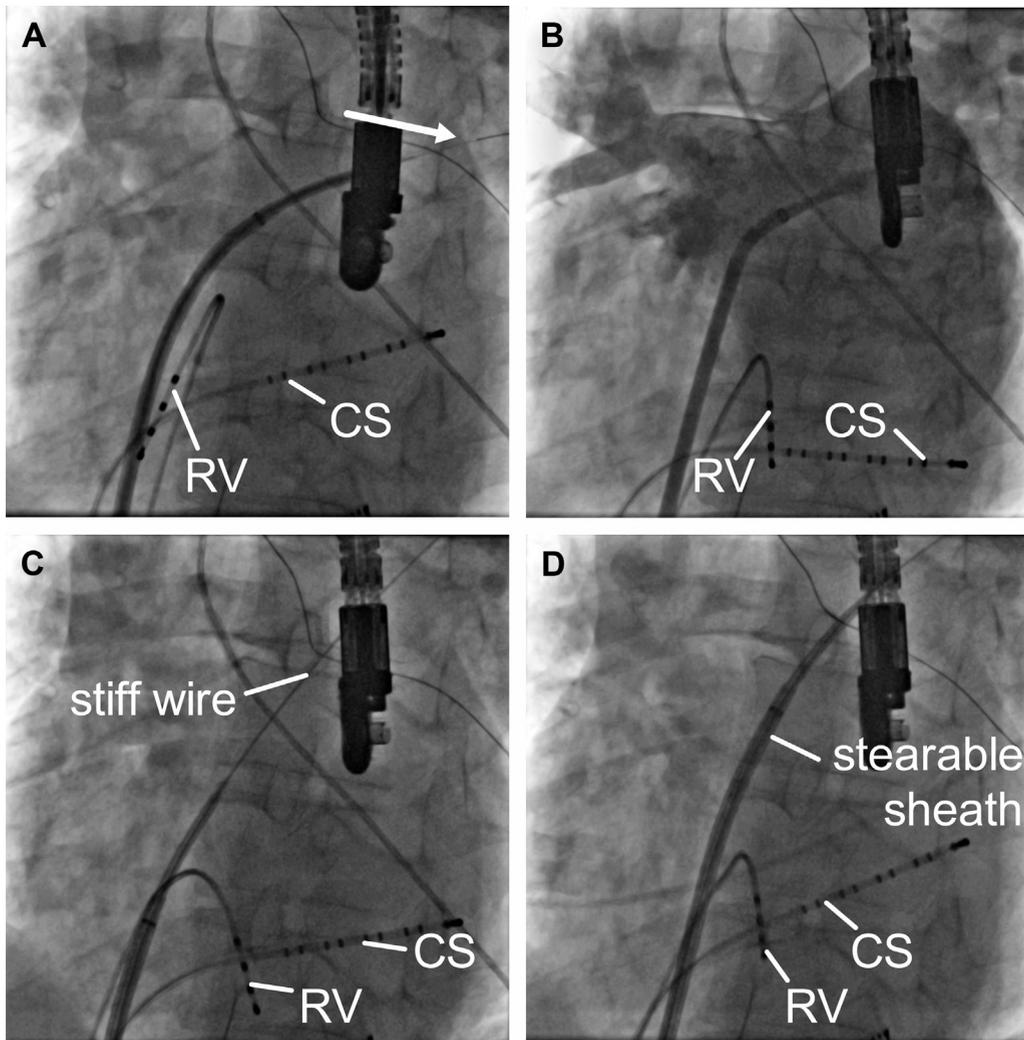


Figure 3 Introducing the sheaths into the left atrium. **A:** With the puncture wire (*arrow*) held in a stable position (here upper branch of left inferior pulmonary vein), the transseptal sheath (SL1, Abbott, Chicago, IL) together with the BRK1 needle (Abbott) was advanced through the septum in a left anterior oblique (LAO) 40° view. **B:** Left atrial angiography was performed under rapid right ventricular pacing maneuver to visualize pulmonary vein anatomy. **C:** A J-tipped stiff guidewire was positioned in the left superior pulmonary vein for optimal backup while exchanging sheaths. **D:** An 8.5F steerable sheath (Agilis NxT, Abbott) was brought forward into the left atrium over the guidewire. All fluoroscopic pictures are shown in LAO 40° view. CS = coronary sinus catheter; RA = right atrium; RV = right ventricular catheter.

a safe procedure when performed by experienced hands with a low complication rate of <1%.⁴ Of these, the most frequent severe complications are inadvertent injury of adjacent structures outside the fossa ovalis, such as free right or left atrial wall resulting in cardiac tamponade, or puncture of the aortic root.⁵ The risk for complications is elevated particularly in cases of abnormal septum anatomy (ie, IAS aneurysm or thickened septum after repeated TSP).⁶ The sole use of biplane fluoroscopy and anatomic landmarks with diagnostic intracardiac catheters has been shown to result in safe and successful TSP procedures.⁷ However, direct visualization of the correct puncture site using TEE or intracardiac echocardiography (ICE) can be successfully applied to minimize risk for cardiac injuries, especially at the beginning of the learning curve.⁸ Ablation of AF using ICE guidance is performed in 87% in the United States and Canada compared

with 13% in Europe, Asia, and Latin America.⁹ ICE provides high-quality images—not only of the IAS but also of the pulmonary veins and the left atrial appendage—and possesses the advantage of being usable without deep sedation or additional echocardiographic personnel compared to TEE. However, it requires additional expertise, it is an invasive procedure, and it may increase the cost of the procedure.¹⁰ Moreover, the routine use of TEE did not reduce the complication rate of TSP per se.¹¹ For these reasons, echocardiographic guidance for transseptal punctures has not yet become standard in countries outside the United States. Since TEE harbors the risk of potentially injuring vocal cords or the esophagus,¹² we do not recommend using this technique routinely in all cases, particularly if a preceding TEE already excluded a challenging anatomy. On the other hand, we recommend using echocardiography in cases in which a

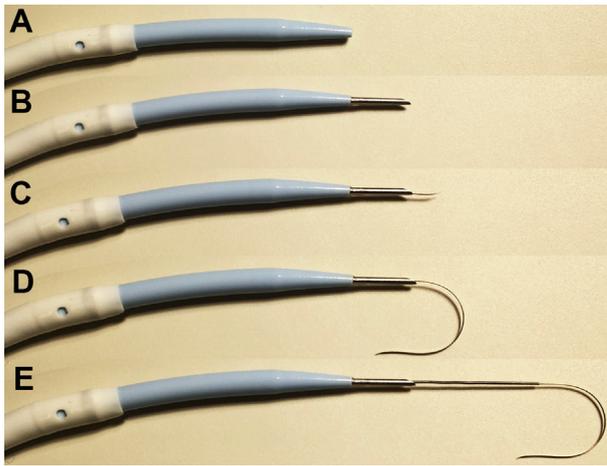


Figure 4 SafeSept guidewire (Pressure Products, San Pedro, CA). **A:** Transseptal sheath SL1 (Abbott, Chicago, IL) with dilator. **B:** The BRK1-XS needle (Abbott) pushed out of the dilator. **C:** The SafeSept guidewire exiting the BRK1-XS needle in the same direction straight on. **D:** After passing through the septum, the guidewire forms an atraumatic J-shaped tip. **E:** The atraumatic tip can be positioned in a pulmonary vein before advancing the transseptal sheath. Directly proximal to the J-shaped tip resides a radiopaque marker coil.

challenging TSP as a result of preceding TEE or medical history (eg, septum aneurysm, repeat TSP, pectus excavatum) might be expected.

We presented a patient with an IAS aneurysm that was diagnosed during echocardiography before the catheter intervention. Therefore, we planned the invasive procedure under TEE guidance in the first place. In the case of IAS aneurysm, the operator must be prepared to direct the needle through the left atrium across a longer distance owing to tenting of the septum. For that reason, it is advisable to use a transseptal needle with a tighter angle like the BRK1 needle (Abbott) or to cautiously apply an additional bend to a standard-curve Brockenbrough needle to prevent reaching the left atrium roof. Moreover, we routinely use a needle with a sharper tip like the BRK1-XS (bevel angle 30° as compared

to a bevel angle of 50° in standard BRK needles) to ease TSP in cases of a septum aneurysm. Using echocardiography it is possible to aim for a puncture site in the inferior part of the fossa ovalis close to the inferior limbus and to help in guiding the needle toward the left superior pulmonary vein and away from the posterior wall, roof, left atrial appendage, or the aortic root. However, this was insufficient in our case and we subsequently used a specially designed nitinol guidewire to facilitate IAS puncture. The use of this guidewire, which promptly reforms to an atraumatic tip after traversing the IAS (Figure 4), has been described in several cases of difficult transseptal punctures with positive results.^{13–15} While using this guidewire, the operator cannot simultaneously monitor left atrial pressure. In this case, TEE helps confirm correct left atrial position of the guidewire tip after TSP, and fluoroscopy is needed to guide the wire into a pulmonary vein. The wire should not be directed too far inside a pulmonary vein to minimize the potential risk of injury in very tight pulmonary veins by the retrograde sharp end of the J-shaped tip.

The second possibility to facilitate puncture of a thickened or aneurysmatic IAS may be the use of a radiofrequency (RF) needle (Baylis Medical, Montreal, Quebec, Canada). Safety and a reduced instrumentation time of the RF transseptal device compared to the standard Brockenbrough needle have been demonstrated¹⁶; however, no study specifically evaluated the superiority of the RF needle with regard to complication prevention. A disadvantage of the RF needle certainly is the necessity of hardware acquisition (ie, energy generator, RF needles, connector cables) with subsequent costs.

In case none of the aforementioned auxiliary material is available, it is possible to mark the IAS with a small amount of contrast agent (Figure 5). As a result, IAS tenting is directly visible using fluoroscopy and the needle passing through the IAS can immediately be recognized. A further option for penetrating the tenting septum in challenging cases without additional resources is the use of the inner stylet of the Brockenbrough needle as a “mosquito,” which has been evaluated in a small study (34 patients in the intervention

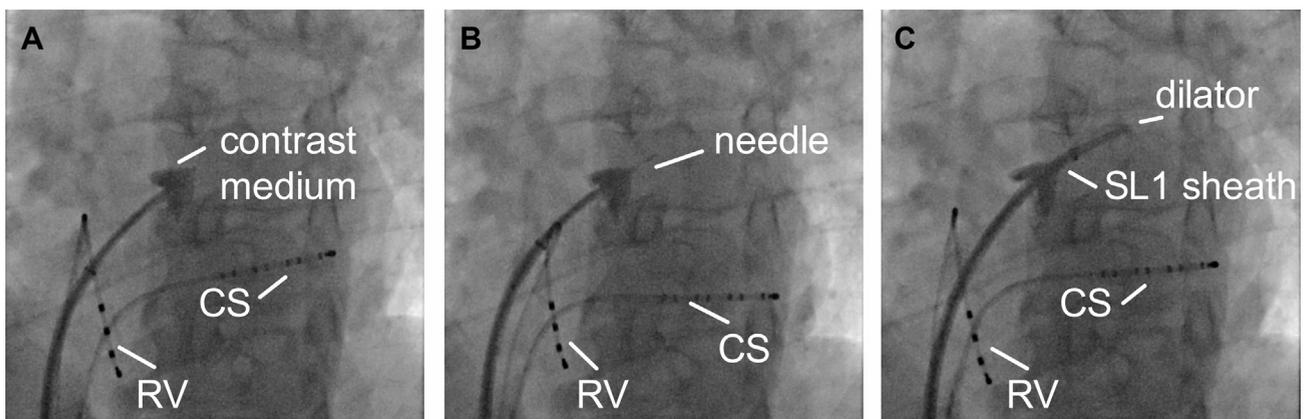


Figure 5 Marking the atrial septum with contrast agent. **A:** A small amount of contrast agent (1–2 mL) is administered from the needle in the fossa ovalis at the intended puncture site. The extent of tenting of the septum can directly be visualized. **B:** The needle (BRK1-XS, Abbott, Chicago, IL) has crossed the septum but tenting remains owing to the dilator still being on the right side of the septum. **C:** The dilator and the transseptal sheath (SL1, Abbott) have crossed the septum and the needle is retracted. All fluoroscopic pictures are shown in left anterior oblique 40° view. CS = coronary sinus catheter; RV = right ventricular catheter.

group) with promising results.¹⁷ Moreover, Aksu and colleagues¹⁸ presented a deep inspiration maneuver to facilitate difficult TSP in a very small series of patients (11 patients in the intervention group).

Once a successful puncture of the aneurysmatic IAS has been performed (either with a needle or with a puncture wire), advancing the transseptal sheath might constitute the next obstacle as a result of persistent tenting. In these cases the use of a pigtail wire that coils in the left atrium (eg, Pro-Track, 0.025 inch, Baylis Medical) can be used to facilitate the introduction of a transseptal sheath.¹⁹ Alternatively, using a different angle of push (eg, toward the right superior pulmonary vein) can help to achieve a difficult transseptal passage with the sheath.

Conclusion

Transseptal punctures can safely be undertaken in most cases with intracardiac catheters as anatomic landmarks, pressure monitoring, and fluoroscopy. However, the presence of IAS aneurysms can result in challenging procedures. The use of TEE or ICE helps in visualizing the optimal puncture site. Utilization of a TSP guidewire or RF needles facilitates passing through a difficult IAS.

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