Incidence of Tissue Coring During Transseptal Catheterization When Using Electrocautery and a Standard Transseptal Needle

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Background—The application of radiofrequency electrocautery to a standard, open-ended transseptal needle has been used to facilitate transseptal puncture (TSP). The purpose of this study was to determine the incidence of cardiac tissue coring when this technique is used.

Methods and Results—A model using excised swine hearts submerged in a saline-filled basin was developed to simulate TSP with electrocautery and a standard transseptal needle. Punctures were performed without the use of electrocautery and by delivering radiofrequency energy to the transseptal needle using a standard electrocautery pen at 3 target sites (fossa ovalis, non–fossa ovalis septum, and aorta). The tissue of the submerged heart was gently tented, and the needle was advanced on delivery of radiofrequency. The devices were retracted, and the needle was flushed in a collection basin. None of the TSPs without cautery caused tissue coring. For TSPs using electrocautery, the frequency of coring was at least 21% for any puncture permutation used in the study and averaged 37% at septal sites (P<0.001 compared with punctures without cautery). Tissue coring occurred in 33 of 96 (35%) punctures through the fossa ovalis and in 38 of 96 (40%) punctures through non–fossa ovalis septum. The frequency of tissue coring at aortic sites was 62 of 96 (65%), which was significantly higher than at the septal sites (P<0.001).

Conclusions—In an animal preparation, TSP at the level of the fossa ovalis using electrocautery and a standard open-ended Brockenbrough needle resulted in coring of the septal tissue in 35% of cases (33 of 96 punctures). (Circ Arrhythm Electrophysiol. 2012;5:341-344.)

Key Words: transseptal catheterization ■ embolism ■ electrocautery ■ fossa ovalis

Transseptal puncture (TSP) using standard techniques can be difficult when the interatrial septum is thick or when the septum is difficult to puncture because of prior transseptal catheterization. Previous studies have demonstrated that radiofrequency energy can be delivered to a standard Brockenbrough transseptal needle to facilitate TSP.1–3 However, a potential complication of the technique is coring of cardiac tissue into the tip of the open-ended needle, which could lead to systemic embolization. Coring refers to the creation of a small plug of cardiac tissue by the open-ended tip of the Brockenbrough needle. The purpose of this study was to determine the incidence of tissue coring when radiofrequency energy is delivered to a standard Brockenbrough needle during TSP.

Methods

To quantify the incidence of tissue coring when the electrocautery TSP technique is used, radiofrequency-assisted punctures were simulated using a benchtop model. Replicate, randomized experiments were completed with permutations of different needle models, levels of radiofrequency power, heart sizes, and puncture sites. Punctures were performed from the right atrium to left atrium, either through the fossa ovalis (FO) or other locations of the interatrial septum (non-FO). Complication scenarios were also analyzed by performing punctures from the right atrium into the aorta. Needles were inspected and flushed into collection basins after each puncture to determine if tissue coring had occurred. Coring was defined as the presence of any visible material in the collection basin when the puncture experiments. The punctures were completed the same day the hearts were harvested. To study size dependence, heart samples were procured from swine populations with live weights either under 50 kg, or over 65 kg. Seven hearts were used from each group, and average heart weights from these “small” and “large” heart populations were 273 g and 376 g, respectively. Immediately before testing, anterior atrium walls were cut away to reveal the septum and simplify device access. Septa were supported from above during punctures using a clip. Surrounding heart tissue was excised in the in vitro preparation so as to facilitate the needle positioning and puncture. It was possible to verify that the septal punctures were

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completed in a consistent manner and did not engage the posterior wall of the left atrium or other surrounding tissue. Aortic punctures in the complication scenarios were also performed while taking care to avoid contact with the opposing vessel wall. The size of the FO was a limiting factor in the number of punctures that could be performed on a single sample. All in vitro experiments were performed at room temperature in a noncirculating saline bath.

**Puncture Procedure and Coring Assessment**

Adult Brockenbrough needles from Cook Medical (Bloomington, IN), TZ Medical (Portland, OR), and St Jude Medical (BRK-1 and BRK-1 XS models; St Paul, MN) were used in this study. Needles were 71 cm long and were placed within a transseptal sheath and dilator (SL-1, St Jude Medical, St Paul MN) that had been preflushed with saline. Radiofrequency energy was delivered using an electrosurgical generator (Valleylab Force FX, Valleylab, CT). The output of the generator was connected to the handle of the needles with an alligator clip, and a grounding pad was submerged in the saline-filled test basin to complete the monopolar radiofrequency circuit. Con...

**Figure 1.** Experimental procedure for transseptal punctures using in vitro swine hearts. **A,** The septum was revealed with the transseptal needle approaching the fossa ovalis from the right atrium. **B,** The transseptal needle is shown tented against the fossa ovalis, while the septum is gently supported from above using a clip. On application of radiofrequency energy, the needle was advanced through the fossa, followed by the dilator. The needle was flushed after each puncture to determine if coring occurred. **C,** Successive punctures were performed. Note: Transseptal punctures were performed with the heart submerged in a grounded saline basin. These images were taken outside of the solution for clarity. The scale bars indicate 5 mm.

**Statistical Analysis**

Continuous variables are expressed as a mean ± SD (95% confidence interval range). The incidence of tissue coring at the various sites was compared using χ² analysis and Fisher exact test. A probability value < 0.05 was considered statistically significant.

**Results**

**Influence of Electrocautery**

A total of 108 TSPs were performed without electrocautery and a total of 288 TSPs were performed with electrocautery, with triplicate punctures for each permutation of radiofrequency power level, needle type, heart size, and puncture site. None of the TSPs without cautery caused tissue coring. For TSPs using electrocautery, the frequency of coring was at least 21% for any puncture permutation used in the study and averaged 37% at septal sites (P < 0.001 compared with punctures without cautery). Tissue coring occurred in 33 of 96 (35%) punctures through the FO and 38 of 96 (40%) punctures through non-FO septum (Figure 3A). The frequency of tissue coring at aortic sites was 62 of 96 (65%), which was significantly higher than at the septal sites (P < 0.001).

**Influence of Heart Size, Needle Model, and Radiofrequency Modes**

For a given puncture location, coring was observed 2–9% more often in the larger hearts with electrocautery, regardless of other parameters, although this difference was not statistically significant (Figure 3B).

For TSPs using electrocautery, there was no statistical difference in the frequency of coring between different needle models (Figure 3C) and radiofrequency power or type (Figure 3D).

**Discussion**

**Main Findings**

This study demonstrates that tissue coring occurs 37% of the time on average (with a minimum of 21% for any settings tested) when radiofrequency energy is delivered to a standard Brockenbrough needle during TSP in a bench model, regardless of
needle type, puncture location, heart size, or power delivered. In these cases of coring, embolic material was captured in the Brockenbrough needle lumen, which was released when the needle was flushed. Every combination of needle brand and power settings tested was prone to coring, and the tendency to generate embolic material generally increased with the thickness of the target tissue. Coring did not occur when TSP was performed without electrocautery. These results suggest that the tissue coring may occur when using the electrocautery technique with open-ended energized needles in clinical settings.

Cerebral Embolism During Catheter Ablation for Atrial Fibrillation

Left atrial catheter ablation has become a routine therapy for medically refractory atrial fibrillation. However, the incidence of symptomatic thromboembolic complications related to left-sided ablation for atrial fibrillation may be nearly 1%.4 According to one large, multicenter study, ischemic brain lesions were the third most common cause of death.5 Emerging data indicate that asymptomatic embolization rates can be upward of 14%,6 with some data indicating neuropsychological decline as a consequence of left-sided ablation.7

Previously identified sources of periprocedural cerebrovascular accidents include left atrial thrombus present before the procedure, char formation on radiofrequency catheters or ablated tissue, thrombus formation on catheters or sheaths, air embolism, shaving of dilator particulate by Brockenbrough needles,8 or postprocedural development of new atrial thrombus after conversion of atrial fibrillation to sinus rhythm.9,10 Efforts to minimize this risk include periprocedural left atrial imaging, anticoagulation before the procedure, continuation of warfarin during the procedure, intravenous heparin during the procedure, continuous flushing of sheaths, and the use of irrigated-tip catheters. The present study identifies a potential novel mechanism of systemic embolism when electrocautery is used to achieve left atrial access during catheter ablation procedures for atrial fibrillation, which is not mitigated by current measures used to minimize the risk of stroke. This study did not draw conclusions on the clinical relevance of tissue cores that were created. It is widely regarded however, that the release of emboli in the bloodstream should be avoided. Other studies have discussed the potential clinical implications of microembolic events after ablation, cardiac surgery and carotid stenting.6,11

Alternatives to Using Electrocautery and a Standard Transseptal Needle

There are times when TSP can be difficult, or not achievable, using a standard transseptal needle and mechanical pressure. Therefore, alternatives should be considered.
There are 2 methods that are available as alternatives to conventional TSP and are not associated with tissue coring. One alternative is a unique radiofrequency-powered transseptal needle that is specifically designed with side holes, rather than an end-hole to prevent coring. Recent publications suggest that using this powered needle to perform TSP is as safe and effective as using a standard needle without radiofrequency. A second available alternative is the use of a needle wire. This wire is a small-caliber, sharp-tipped, J-shaped guide wire that can be safely advanced across the interatrial septum into the left atrium through the lumen of a standard transseptal needle.

Limitations
A limitation of this study was the lack of histological examination of the material that was flushed from the needle after TSP. It is therefore not clear how much of the cores represent cardiac tissue. The dark appearance of the material suggests that at least some of the material could be char. Although the model used in this study was developed to simulate TSP in humans, it is important to emphasize that this was an in vitro experiment. Caution must be used when making clinical decisions based on the results of benchtop models. For example, the animal preparation was kept at room temperature. The texture of the FO may be different during room temperature compared with body temperature, which may affect the likelihood of tissue coring when using radiofrequency and a standard needle. Further in vivo studies are needed.

Conclusion
In an animal preparation, TSP at the level of the FO using electrocautery and a standard open-ended Brockenbrough transseptal needle resulted in coring of the septal tissue in 35% of cases (33 of 96 punctures). These results raise concern about the risk of systemic embolism of cardiac tissue when this approach is used in humans. The dark appearance of the material that was flushed from the needle after TSP. It is therefore not clear how much of the cores represent cardiac tissue. The dark appearance of the material suggests that at least some of the material could be char. Although the model used in this study was developed to simulate TSP in humans, it is important to emphasize that this was an in vitro experiment. Caution must be used when making clinical decisions based on the results of benchtop models. For example, the animal preparation was kept at room temperature. The texture of the FO may be different during room temperature compared with body temperature, which may affect the likelihood of tissue coring when using radiofrequency and a standard needle. Further in vivo studies are needed.

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Disclosures
None.

References
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