

Percutaneous Epicardial Catheter Ablation Opens Another Chapter in the Catheter-Based Ablation for Atrial Fibrillation

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Editorial Comment

Over the past two decades, no other story in cardiology has received as much attention as the nonpharmacological treatment of cardiac arrhythmias, catheter-based ablation. The story began to unfold with the development of the catheter-based radiofrequency (RF) ablation of accessory pathways, proven to be the first nonsurgical curative treatment in cardiology.^{1,2} Shortly thereafter, electrophysiologists realized they could perform ablations to cure a variety of supraventricular tachycardia (SVT) easily and effectively, yielding spectacular outcomes that had rarely been witnessed with other treatment modalities. What followed is quite remarkable.

Professionals from several disciplines (i.e., basic and clinical scientists, engineers, and health care providers)—from various industries to academia—formed the vanguard of interventional electrophysiology. The ensemble of new talents and intellects helped create new catheters, mapping systems, and a variety of tools and technologies that facilitated ablation procedures. These advances dramatically transformed the field of clinical electrophysiology—from the sedate specialty that merely carried out diagnostic electrophysiologic studies or antiarrhythmic drug testing—to an exciting and dynamic discipline that provided effective treatment for SVT via its interventional approach. Fortunately, the story did not end with SVT ablation, but continued for all types of cardiac arrhythmias.

At present, most tachyarrhythmias can be reproducibly ablated with great success. For example, patients with typical cavotricuspid isthmus-dependent atrial flutter can now be ablated in 1 hour or less with a success rate of over 95% and a very low likelihood of complications. One by one, many arrhythmias joined the long list of tachycardias that use catheter ablation as the first-line treatment. However, finding the best way to ablate atrial fibrillation (AF), “the mother of all arrhythmias,” remains a major challenge—the Holy Grail for the electrophysiologist!

Just as the Knight Templar faced daunting tasks when searching for the grail, so has the electrophysiologist dealt with many obstacles when ablating AF. First, the electrophysiologic mechanisms underlying human AF remain unclear and are likely to be somewhat different from patient to patient (i.e., paroxysmal to persistent). The seminal work by Haissaguerre *et al.*³ clearly establishes the important role of pulmonary veins (PVs) as triggering and perpetuating AF. As

a result, the vast majority of AF approaches rely largely on aiming to isolate electrically the PVs, especially for paroxysmal AF. The weakness of this strategy, however, is the assumption that AF is homogeneous with a universal underlying mechanism.

Also, this strategy does not address the increasing number of patients with longstanding persistent AF. Recently, more supplemental linear ablations are being added to the PV isolation, with a significantly improved success rate for such AF patients. Why and how this combined approach works remains unclear.

Second, it is well established that many AF recurrences may be due to reconnections of PV electrical conduction to the atrium. Hence, even when clear targets such as PVs are identified, lesion creations may not be reliably effective all the time.

Third, AF ablations have to be done in multiple areas of the left atrium (also sometimes in the right atrium) and coronary sinus, regardless of the technique.^{3,4} Inevitably, certain areas of the left atrium in some patients may not be easily accessible or achieve good contact for delivery of RF energy and, in turn, create a permanent lesion.

Although electrophysiologists are still struggling to understand human AF and to find the best ablation approach, they are getting better at finding a way to deliver effective lesions or to navigate into various chambers of the heart. Electrophysiologists now routinely perform trans-septal puncture to gain access into the left atrium for AF ablation and they are adapting more and more to newer techniques. Also, using new catheters, sheaths, and upcoming robotic catheter control (e.g., Stereotaxis Niobe Magnetic Navigation, Biosense Webster Inc. and Hansen’s technologies, Hansen Medical Inc. Mountain View, CA, USA), electrophysiologists will be able to navigate confidently in the left atrium and reliably make contact with the endocardial sites. However, not all lesions can be created effectively on the endocardial sites. Thanks to the pioneering work by Sosa *et al.*,⁵ the epicardial sites may be approached via pericardial space. While the pericardial approach was originally designed for ablations of epicardial VT, it is only a matter of time before this approach is utilized for AF ablation.

Indeed, in this issue of the *Journal*, Pak and co-workers⁶ present a compelling study demonstrating the usefulness of an epicardial approach as an adjunctive modality for a hybrid catheter-based AF ablation. The investigators performed percutaneous epicardial catheter ablation (PECA) in four patients with persistent AF who had failed previous ablation and had PV stenosis, as well as in one patient with permanent AF. They performed PECA as supplemental ablations to the endocardial ablations at the following sites: roof of the left atrium, between left atrial appendage and left superior PV, perimitral annulus, and ligament of Marshall. By ablating these areas in addition to the endocardial ablations,

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Pak *et al.* successfully isolated PVs and/or terminated AF in all five patients with good immediate outcomes. They were quite efficient in successfully performing epicardial ablation in a relatively short period of time and in demonstrating that PECA is effective and feasible.

Pak *et al.*'s study also demonstrated that in left atrial chambers, some specific target sites in the left atrium, such as the ridge between left atrial appendage and left superior PV or ligament of Marshall, may not be easily ablated by the endocardial ablative approach, but are much more amenable to the epicardial approach. Interestingly, three of the five patients (cases 3–5) had recurrent left-sided PV electrical connections after the endocardial approach. Pak and colleagues found that the left-sided PV potential in these patients was very difficult to eliminate by endocardial ablation, but was quite easy to abolish with epicardial ablation at the junction between left atrial appendage and left-sided PVs.

These observations highlight the stark reality of the limitations of the current endocardial ablative approach at some specific target sites in the left atrium. Fortunately, Pak and his colleagues have nicely shown that some of these limitations can be overcome by the epicardial approach.

However, before electrophysiologists can fully embrace this epicardial approach and incorporate it into their AF ablation protocol, they must weigh risks and benefits of this approach. Obviously, Pak *et al.*'s study consisted of a very small number of patients. A more systematic study with a much larger patient sample must be conducted to confirm the benefit of the epicardial approach for AF ablation.

In addition, four of the five patients had PV stenosis from their previous endocardial ablations, suggesting that the investigators ablated very close to the PV ostia or inside of the veins. Perhaps using the wider PV antrum isolation approach would not only avoid PV stenosis, but also attain similar results as combining with the epicardial approach.⁷

Likewise, some of the roofline and perimitral area ablation could have been accomplished with the different sheaths or tools. It is intriguing to speculate that a magnetic control automated catheter advancer system such as Stereotaxis could allow electrophysiologists to navigate the ablation catheter to these difficult sites with excellent contact. This would enable effective RF applications resulting in transmural lesions and could in turn eliminate the need to use the epicardial approach. If this speculation is correct, the risks and shortcomings of the epicardial approach could be avoided.

Certainly, the PECA requires a skilled and experienced operator to perform safely pericardial puncture and to advance the sheath into the pericardial space to avoid damaging the bowels or causing pericardial tamponade. Furthermore, some areas of the left atrium (i.e., septum and part of the right PV) are not accessible by the epicardial approach.

In addition, one out of five (20%) patients from Pak *et al.*'s study had hemopericardium. While this complication was successfully treated, it could potentially affect anticoagulation after AF ablation; one may be concerned

about anticoagulation in such a patient who could have more bleeding into the pericardium. If anticoagulation was withheld, the patient could run a high risk of stroke because concomitant endocardial ablation was performed in the left atrium.

Furthermore, during epicardial ablations, one has to be cognizant of potential collateral damage to the esophagus, coronary arteries, or phrenic nerves. Epicardial ablations have to be done with an irrigated-tip catheter and therefore, one has to be careful with fluid overload in the pericardium that again may compromise patient hemodynamics. Last, the long-term effect of epicardial ablation is unknown. The following questions need to be answered: Could chronic pericarditis develop and cause unpleasant symptoms for patients in the future? Could there be any risk of infection to the pericardium in these patients?

The concerns raised in this editorial do not deny the fact that the epicardial approach offers an alternative for electrophysiologists to ablate effectively the AF substrate or triggering foci. However, one must not fall into the trap of the old saying that "it is the journey that is worthwhile and not the grail." While many enjoy the challenge of searching for the best AF ablation approach, we must consider our patients, who have so much to gain if we succeed and so much to lose if we cause unwanted complications. I, for one, sincerely hope that one day I can schedule an ablation for my AF patients with the same attitude and conviction that I do for my atrial flutter patients. Thus, the search is not over and PECA is merely another chapter in the catheter-based ablation story, which does not have an end in sight any time soon.

References

1. Jackman WM, Wang X, Friday KJ, McClelland JH, Twindale N, Hazlitt HA, Prior MI, Margolis PD, Calame JD, Overhold ED, Lazzara R: Catheter ablation of accessory atrioventricular pathways (Wolff-Parkinson-White syndrome) by radiofrequency current. *N Engl J Med* 1991;324:1605-1611.
2. Calkins H, Sousa J, El-Atassi R, Rosenheck S, de Buitelir M, Kou H, AH Kadish AH, Langberg JJ, Morady F: Diagnosis and cure of the Wolff Parkinson White Syndrome or paroxysmal supraventricular tachycardias during a single electrophysiologic test. *N Engl J Med* 1991;324:1612-1618.
3. Haissaguerre M, Sanders P, Hocini M, Takahashi Y, Rotter M, Sacher F, Rostock T, Hsu LF, Bordachar P, Reuter S, Raudaut R, Clementy J, Jais P: Catheter ablation of long-lasting persistent atrial fibrillation: Critical structures for termination. *J Cardiovasc Electrophysiol* 2005;16:1125-1137.
4. Nademanee K, McKenzie J, Kosar E, Schwab M, Witayakul B, Vasavakul, Khunnawat C, Ngarmukos T: A new approach for catheter ablation of atrial fibrillation: Mapping of electrophysiologic substrate. *J Am Coll Cardiol* 2004;43:2044-2053.
5. Sosa E, Scanavacca M, d'Avila A, Pilleggi F: A new technique to perform epicardial mapping in the electrophysiology laboratory. *J Cardiovasc Electrophysiol* 1996;7:531-536.
6. Pak HN, Hwang C, Lim HE, Kim JS, Kim YH: Hybrid epicardial and endocardial ablation of persistent or permanent atrial fibrillation: New approach for difficult cases. *J Cardiovasc Electrophysiol* 2007; DOI: 10.1111/j.1540-8167.2007.00882.x.
7. Verma A, Marrouche NF, Natale A: Pulmonary vein antrum isolation: Intracardiac echocardiography-guided technique. *J Cardiovasc Electrophysiol* 2004;15:1335-1340.