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Editorial Comment

Epicardial Ventricular Tachycardia Ablation

An Evolution of Needs*

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Referral for epicardial ablation frequently represents a "last ditch" effort in uniquely difficult patients. Epicardial mapping was the cornerstone that guided our early experience in the surgical ablation of arrhythmias (1). However, epicardial mapping alone was insufficient to identify the site of origin of ventricular tachycardias (VTs), particularly in patients with coronary artery disease and myocardial infarctions (2,3).

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In contrast to the surgical approach, catheter ablation has evolved from the endocardium to the epicardium. Despite the advent of electroanatomical mapping systems, irrigated catheters, and substrate mapping strategies, the long-term efficacy of endocardial ablation is only modest (4,5). Failure of endocardial ablation could reflect the presence of an epicardial or intramyocardial arrhythmia focus and the inaccessibility from the endovascular approach.

Epicardial Substrate for Ventricular Arrhythmia

The importance of epicardial VT circuits was first highlighted in Chagas' disease, which classically results in an epicardial involvement in approximately 70% of patients (6). The technique of percutaneous access to the pericardial space was initially described by Sosa et al. (7). Case reports have shown that epicardial instrumentation in the electrophysiology laboratory is feasible and provides an alternative treatment strategy in selected patients.

Nonendocardial substrates in scar-related as well as in idiopathic VTs have recently been increasingly recognized (6,8–13). In patients with left ventricular nonischemic cardiomyopathy, endocardial VT ablation is associated with a lower success rate compared with patients with ischemic heart disease (10,14,15). The initial attempt to characterize the electrophysiological substrate in nonischemic cardiomyopathy demonstrated only modest-sized endocardial electrographic abnormalities (15). Detailed epicardial mapping has identified larger confluent low-voltage areas compared with the endocardial surface, often located over the basal lateral left ventricle near the valve annulus (9,10,12). The low-amplitude electrograms recorded in these areas are typically wide, split, and/or late, which help distinguish scar from epicardial fat (12). In contrast to those with nonischemic cardiomyopathy, patients with ischemic heart disease tend to have larger endocardial than epicardial scar, usually confined to a specific coronary vascular territory. Although there is a predilection for a subendocardial location of the VT substrate, the prevalence of epicardial circuits may be high, particularly in patients with old inferior infarctions (16).

In patients with arrhythmogenic right ventricular cardiomyopathy/dysplasia, sizable low-voltage areas often involve the infundibulum, free wall, and basal perivalvular regions, constituting the endocardial substrate (17). However, despite short-term success with endocardial catheter ablation, recurrences become increasingly common during long-term follow-up (18). More recently, the presence of extensive epicardial low-voltage areas, often with fractionated and late electrographic recordings, have been identified. The epicardial scar is consistently larger than that on the endocardial surface. The epicardial foci targeted for successful catheter ablation are also frequently located beyond the endocardial defined scar (13).

Catheter ablation has been shown to be an effective therapy for patients with idiopathic ventricular arrhythmia. However, occasional patients have been reported in whom such arrhythmia could not be ablated from the ventricular endocardium or from the aortic cusps. Often underrecognized, the incidence of an epicardial origin in idiopathic VT may be as high as 9% (11). The mechanism of these catecholamine-sensitive arrhythmias is consistent with triggered activity, commonly arising from areas adjacent to epicardial coronary vasculature (8,11).

This Study

Despite the increasing recognition that ventricular arrhythmias may originate from epicardial foci, epicardial VT ablation remains a specialized procedure and is performed at

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few centers. In this issue of the *Journal*, Sacher et al. (19) report their experiences with epicardial VT mapping and ablation, focusing on safety and complications. The study cohort consisted of a referral patient population with a variety of diagnoses who underwent VT ablation at 3 tertiary centers between 2001 and 2007. This retrospective, multicenter analysis is the largest study to date on epicardial catheter mapping and ablation. Of 913 VT ablations, 156 procedures (17%) in 134 patients involved epicardial instrumentation. The majority of the patients (86%) had prior endocardial ablation attempts. Epicardial access was obtained in 136 procedures (about 90%) via subxiphoid punctures. Failures of such a percutaneous approach (n = 15) were mostly associated with histories of prior cardiac surgery (n = 11) or pericarditis. Surgical subxiphoid window (20) or open-heart thoracotomy was used in the remaining patients.

A total of 14 procedure-related major complications (9%) were observed acutely or before discharge. Complications related to the epicardial approach (5%) included 7 episodes of epicardial bleeding as well as 1 coronary stenosis, despite the use of cryoablation in the vicinity of the right coronary artery. It is important to note that almost one-half of the procedure-related complications were related to the "conventional" endocardial approach. There were 3 delayed complications (2%) related to pericardial access. These consisted of a pericardial inflammatory reaction, late tamponade, and a late coronary occlusion with myocardial infarction. Constrictive pericarditis or phrenic nerve injuries were not observed in this study.

Epicardial access was successfully obtained in the majority of the patients via a percutaneous subxiphoid approach, even in those who required repeated epicardial procedures. However, up to a 20% right ventricular perforation rate was observed, and major pericardial bleeding was the most common complication (4.5%). Care must be taken to ensure correct guidewire position in the pericardial space before the insertion of a sheath. Patient selection is also important, as 85% of the failures of percutaneous subxiphoid punctures were in patients with previous cardiac surgery. In addition, high-output pacing and coronary angiography should be performed to define the course of the phrenic nerve (21) and to confirm the absence of coronary arteries near the ablation site (22,23).

In addition to the safety data, Sacher et al. (19) also report the percent of epicardial VTs in the global population. The highest prevalence of epicardial VT was observed in patients with the diagnoses of arrhythmogenic right ventricular cardiomyopathy/dysplasia (41%) and nonischemic cardiomyopathy (35%), followed by patients with ischemic heart disease (16%). Overall, these findings are consistent with prior observations. Soejima et al. (9) found epicardial ablation necessary in 28% of patients with dilated cardiomyopathies, and Sosa et al. (16) found epicardial VTs in 23% of patients with VT late after myocardial infarction. It appears that epicardial involvement may be present to various degrees in a significant minority of patients with VT with different cardiomyopathies, especially in whom prior endocardial approach has failed.

After a mean follow-up period of 23 ± 21 months, freedom from VT recurrence was observed in 71% of the patients. This result is also similar to other published reports, with rates of arrhythmia control ranging from 63% to 78% among different patient populations (8,9,12,13). Considering that these studies included patients with significant structural heart disease, the long-term efficacy of the epicardial VT ablation strategy appears quite respectable.

However, the endocardium was ultimately thought to be a better target than the epicardium in a significant minority of the patients (up to 21%), and ablation was not performed after obtaining epicardial access. This highlights the importance of pre-operative evaluations and procedure planning. Careful analysis of the electrocardiogram during VT or premature ventricular contraction is essential. Different electrocardiographic criteria for recognizing epicardial origin of arrhythmia have been proposed (11,24,25). Magnetic resonance imaging may also help identify epicardial substrate in cardiomyopathies (26,27). Thorough pre-procedural assessment can facilitate an efficient mapping strategy and improve ablation outcomes.

An Evolution of Needs

Analogous to the evolution of transseptal catheterization, the technique was well established but was embraced by electrophysiologists only after recognizing its potential in arrhythmia interventions. The importance of epicardial substrate for VT has only now been appreciated, and the efficacy of epicardial VT ablation is encouraging, with an acceptable complication rate. It is important to note that these findings reflect practices at centers that specialize in arrhythmia management and may not be applicable to less experienced operators or centers. With up to a 20% risk for ventricular perforation, careful patient selection is important, and the procedure should be performed by experienced operators with surgical backup.

Reference criteria for electrographic recordings have recently been established to allow better characterization of electroanatomical substrate on the epicardium (12). Future studies are needed to define the role of epicardial ablation as patient populations and technologies continue to evolve. The development of dedicated equipment for percutaneous pericardial access as well as epicardial mapping and ablation is also necessary. Other advances in technologies and refinement in ablation techniques might allow us to better image the ventricular substrate, track online lesion formation, and minimize the risk for phrenic nerve or coronary vasculature damage.

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