Review Article

Epicardial Ventricular Tachycardia Ablation: The Last Frontier in Interventional Electrophysiology?

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Mapping and radiofrequency (RF) catheter ablation of ventricular tachycardia (VT) remains a challenging task, with low success rates.[1] The presence of epicardial circuits has been considered one of the reasons for the failure of endocardial ablation, and these circuits have been described in several types of cardiac disease in which surgical and non-surgical techniques have been used. Coronary veins can be used to perform epicardial mapping, but the manipulation of the catheter is limited by the anatomical distribution of these vessels. The subxiphoid percutaneous approach to the epicardial space is the only technique currently available that allows extensive and unrestricted mapping of the epicardial surface of both ventricles. The importance of epicardial VT circuits was first highlighted in Chagas' disease, which classically results in epicardial involvement in approximately 70% of patients.[2] The technique of percutaneous access to the pericardial space was initially described by Sosa et al.[3]

Selection criteria/parameters

The epicardial approach could be an option in patients who have thrombus in the left ventricular cavity or in patients with metallic prostheses in either the aortic or mitral valve. It is not clear whether one should use this approach only after an endocardial failure or only when the ECG (QRS duration >200 ms, intrinsicoid deflection time >85 ms, and pseudo-delta wave >34 ms) of clinical VT suggests an epicardial origin.[4] Magnetic resonance imaging may also help identify an epicardial substrate in cardiomyopathies.[5]

The epicardial procedure

Once in the pericardial space, atrial and ventricular surface mapping can be performed. Atrial surface mapping can be limited by the normal pericardial reflections and by the irregular atrial anatomy (left and right atrial appendage). Ventricular surface mapping, however, can be performed more easily. In patients with epicardial VT, the target for ablation is selected exactly as the endocardial target is selected.

The percutaneous approach to the pericardial space can be difficult in patients who have undergone cardiac surgery in the past or after myocarditis. In post-surgical patients, the adhesions are mostly concentrated in the anterior portion of the heart; therefore, the puncture must be directed toward the diaphragmatic area. Previous coronary angiography analysis must be done to select a safer area for RF applications. It is considered that the base, the anterior and posterior septum areas are the more dangerous zones. In case of doubt, coronary angiography can be performed before RF application, keeping the ablation catheter in the target site position.

Relevant studies

The largest study to date on epicardial catheter mapping and ablation consisted of a referral patient population with a variety of diagnoses who underwent VT ablation at 3 tertiary centers between 2001 and 2007.[6] This retrospective, multicenter analysis included 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 achieved 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. A surgical subxiphoid window or open-heart thoracotomy was used in the remaining patients. The highest prevalence of epicardial VT was observed in patients with the diagnoses of arrhythmogenic right ventricular cardiomyopathy/dysplasia (41%) and non-ischemic cardiomyopathy (35%), followed by patients with ischemic heart disease (16%).

Overall, these findings are consistent with prior observations. Soejima et al[7] found epicardial ablation necessary in 28% of patients with dilated cardiomyopathies, and Sosa et al[8] 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 in different cardiomyopathies, especially when a prior endocardial approach has failed. Schmidt et al demonstrated that an epicardial ventricular substrate is present in three fourths of patients who have previously undergone failed endocardial ablation attempts.[9]

In non-ischemic cardiomyopathy, larger confluent low-voltage areas compared with the endocardial surface, often located over the basal lateral left ventricle near the valve annulus, are usually identified.[9] The low-amplitude electrograms recorded in these areas are typically wide, split, and/or late, which help distinguish scar from epicardial fat.[10] In contrast to those with non-ischemic cardiomyopathy, patients with ischemic heart disease tend to have a 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.[8] In patients with arrhythmogenic right ventricular cardiomyopathy/dysplasia, the presence of extensive epicardial low-voltage areas, often with fractionated and late electrographic recordings, has 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.[11] Catheter ablation has been shown to be an effective therapy for patients with an idiopathic ventricular arrhythmia. However, occasional patients have been reported in whom such an arrhythmia could not be ablated from the ventricular endocardium or from the aortic cusps. Often under-recognized, the incidence of an epicardial origin in idiopathic VT may be as high as 9%.[4]

Complications

Epicardial mapping and ablation is associated with major and minor complications: death, epicardial bleeding, hepatic bleeding, coronary stenosis, phrenic nerve paralysis, inadvertent entry of the guidewire into the pleural space, chest pain after almost all procedures (related to pericardial inflammation), usually requiring treatment with a non-steroidal anti-inflammatory drug.[6,9]

Indications

Based on the aforementioned data and our experience from only a few patients with non-ischemic cardiomyopathy (Figure 1), patients should be selected for epicardial mapping and ablation taking into account the following remarks:

a. The substrate of the cardiomyopathy. The highest prevalence of epicardial VT is observed in patients with arrhythmogenic right ventricular cardiomyopathy and non-ischemic dilated cardiomyopathy.
b. The ECG of clinical VT suggests an epicardial origin of VT.
c. Failure of endocardial ablation could reflect the presence of an epicardial origin.
d. Epicardial access is successfully achieved in the majority of patients via a percutaneous subxiphoid approach. The majority of the failures of percutaneous subxiphoid punctures are observed in patients with previous cardiac surgery.
e. High-output pacing and coronary angiography should be performed to define the course of the phrenic nerve and to confirm the absence of coronary arteries near the ablation site.

In conclusion, further 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 technol-

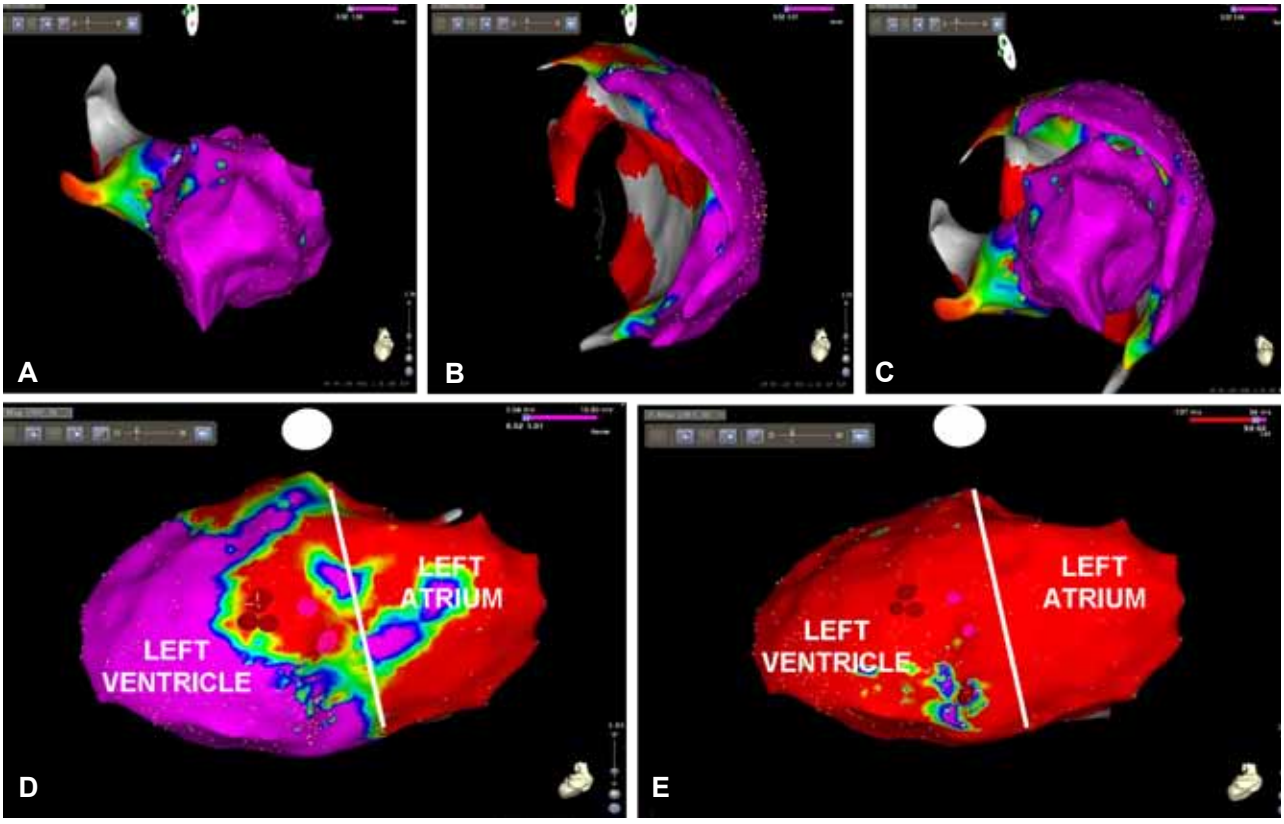

Figure 1. A) Endocardial mapping in a 62-year-old female patient, with non-ischemic cardiomyopathy, without a low voltage area. B) Epicardial mapping of the left ventricle. C) "Fusion" image: epicardial and endocardial mapping. D) Epicardial voltage mapping of the left ventricle depicts a low voltage area at the base of the lateral wall. E) Late potential mapping: in the same area late potentials were identified. Red dots depict radiofrequency applications.

ogies and refinement of ablation techniques might allow us to better image the ventricular substrate, and minimize the risks of the procedure.

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