Intracardiac Echocardiography in Premature Ventricular Complex/Ventricular Tachycardia Ablation

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ABSTRACT
Although fluoroscopy is the most commonly used imaging tool for guiding catheter ablation, there are several associated limitations, including radiation exposure, poor resolution of soft-tissue structures, and the use of iodinated contrast agents. In contrast, intracardiac echocardiography (ICE) can provide excellent real-time and detailed images, thus facilitating a more efficient catheter ablation. Moreover, ICE is useful in premature ventricular complex/ventricular tachycardia ablation because it can provide information on catheter contact and complicated anatomical structures, such as the papillary muscle.

Key words: arrhythmia, catheter ablation, intracardiac echocardiography

Introduction

The miniaturization of ultrasound transducers that can be advanced and maneuvered through the vessels and intracardiac chambers has enabled the development of intracardiac echocardiography (ICE). Two modalities of ICE are currently available. One modality involves the use of a mechanical nonsteerable catheter with a 360° rotating ultrasound transducer at the tip (Boston Scientific Co.) that provides circumferential real-time imaging.1 The other modality involves the use of a steerable catheter with a phased array transducer and variable frequency (Acuson, Siemens). This ultrasound system supports color, pulsed, and continuous wave Doppler imaging. The safety and the effectiveness of mapping and ablation of premature ventricular complex (PVC)/ventricular tachycardia (VT) may be enhanced by ICE.2,3 In patients with outflow tract VT, ICE is an excellent tool to visualize the great arteries and outflow tracts. Another advantage of ICE is the ability to visualize the coronary arteries in relation to the location of the mapping catheter.3,4
Case #1

A 64-year-old man presented with a frequent occurrence of monomorphic PVC and nonsustained VT, which caused palpitations and dyspnea for 6 months after he had undergone coronary artery bypass grafting following myocardial infarction. Oral administration of amiodarone (200 mg) was not effective. Surface electrocardiography (ECG) showed very narrow QRS, positive V1, and a superior axis (Figure 1).

The ablation procedure was performed with the

![Figure 1. Surface electrocardiogram of Case #1.](image)

![Figure 2. Ablation around the left ventricular scar with the CARTO® mapping system.](image)
patient in a conscious sedative state. Intracardiac ECG from the high right atrium, His–bundle site, coronary sinus, and right ventricular apex region was simultaneously recorded and displayed using a surface ECG on a multichannel recorder (Cardiolab, Prucka Engineering, USA). Voltage mapping revealed ventricular myocardial scarring in the inferoseptal wall (Figure 2). The earliest ventricular activation site during PVC was noted at the border of the scar at 48 ms before the inscription of surface QRS waves. ICE clearly showed the location of the papillary muscle, and papillary muscle origin PVC was excluded (Figure 3). During ablation, the PVC morphology was altered. The ablation line was achieved along the scar border line and no PVC was observed.

**Case #2**

A 52-year-old woman presented with frequent PVC, which had caused dizziness and palpitation for 1 year (Figure 4). Given the symptomatic and drug-refractory (β-blocker) nature of the arrhythmia, radiofrequency (RF) ablation was indicated for this patient. During an electrophysiological study of the patient under local anesthesia, frequent PVCs were observed. The ICE catheter was inserted into the left femoral vein through an 8-F introducer sheath and passed into the right ventricular outflow tract (RVOT). A clockwise rotational maneuver was performed, and a short-axis view of the aortic root level was reached to visualize the RVOT and pulmonic valve (Figure 5). The ablation catheter did not touch the cardiac wall (Figure 6), although ECG earlier than QRS was observed. The earliest ventricular activation site was noted at 52 ms before the inscription of surface R-waves, and the ICE confirmed good contact of the ablation catheter (Figure 7). Following application of RF energy, the PVC was not detected. Several additional radiofrequency catheter ablation procedures were performed on contiguous lesions circumferentially surrounding the successfully ablated site. PVC was not clinically detected after RF ablation during 30 minutes of observation. The patient remained free of symptoms for 3 months.
Discussion

With the constant increase in the number of individuals experiencing heart failure and the increased longevity of individuals with coronary artery disease, ventricular arrhythmias have become a common clinical problem. Catheter ablation can be offered as an alternative to antiarrhythmic drug therapy as a first-line therapy to patients with symptomatic ventricular arrhythmias. Ventricular arrhythmias are associated with complex cardiac structures, for which the ablation approach depends on the associated anatomy. The development of ICE was facilitated by the miniaturization of ultrasound transducers that are mounted on flexible and relatively thin catheters, which can be advanced and
maneuvered through the vessels and intracardiac chambers, ICE is an excellent imaging tool to visualize the great arteries, outflow tracts, and the coronary arteries in relation to the location of the mapping catheter. Thus, ICE has led to a significant improvement in the precision and safety associated with complex catheter–based ablation procedures. Decreased radiation exposure, guidance during critical steps in the procedure, visual and real-time support for precise catheter placement, troubleshooting, and monitoring of complications are some of the benefits of real-time continuous ultrasound imaging. Newer technologies, including ICE, have enabled the development of more accurate and safer ablation procedures for patients with increasingly complex arrhythmia substrates.

Figure 6. Intracardiac echocardiography showing noncontact of the ablation catheter.

Figure 7. Intracardiac echocardiography showing good contact of the ablation catheter.
References


