Clinical Case Reports

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CASE REPORT

Bipolar irrigated radiofrequency ablation of resistant ventricular tachycardia with a septal intramural origin: the initial experience and a description of the method

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Funding Information
No sources of funding were declared for this study.

Received: 24 March 2016; Accepted: 20 June 2016

Clinical Case Reports **2016; 4(10): 957–961**

doi: 10.1002/ccr3.648

Key Clinical Message

Bipolar radiofrequency (RF) ablation is effective in treatment of ventricular tachycardia originating from thick interventricular septum. The RF generator and CARTO system can be used to precisely and safely perform ablation. Standard ablation catheter can be used with indifferent ablation electrode connected to the electrode receptacle in RF generator with custom-made cable.

Keywords

Bipolar RF ablation, electroanatomical mapping, nonischemic cardiomyopathy, ventricular tachycardia.

Introduction

The importance of radiofrequency (RF) ablation increases in patients with recurrent ventricular tachycardia (VT) [1]. The three-dimensional scar visualization based on magnetic resonance imaging and electroanatomic techniques has led to a better understanding of the mechanisms of tachycardia [2, 3]. However, some patients with VT have a reentrant circuit located deep in the myocardium, with most in the interventricular septum [4, 5]. This arrhythmia is always challenging to ablate, as the thickness of the muscle does not allow to achieve transmurality with unipolar approach. Recently, there have been a few reports on bipolar ablation [6, 7] We describe our initial experience with bipolar ablation of septal ventricular arrhythmia.

A 75-year-old hypertensive man with DDD-ICD (Maximo II DR) and recurrent VT of LBBB morphology resistant to medical therapy was admitted for RF ablation. Echocardiography showed a dilated left ventricle (65 mm) with a thick interventricular septum (17 mm) and low EF (35%). Coronary angiography was normal. The first ablations were performed in April 2015. At electrophysiological study, VT was easily induced (Fig. 1). Three-dimensional endocardial and epicardial mapping with CARTO 3 (Biosense-Webster, Inc.) showed only small scarring in the septal region which was consistent with propagation and pace-mapping. Several RF applications on both sides of interventricular septum with NaviStar Thermocool electrode (Biosense-Webster, Inc.) resulted in termination of the VT, which remained inducible but self-terminating. The patient was well on amiodarone and β-blocker for 3 months when repeated episodes of VT occurred. Two unsuccessful ablations including endocardial and epicardial approaches were performed in the other EP center. Thereafter, the number of ICD interventions increased drastically to more than 50 interventions per day, including high-output therapies.

At this stage, bipolar ablation was planned and connector was constructed to connect second ablation electrode

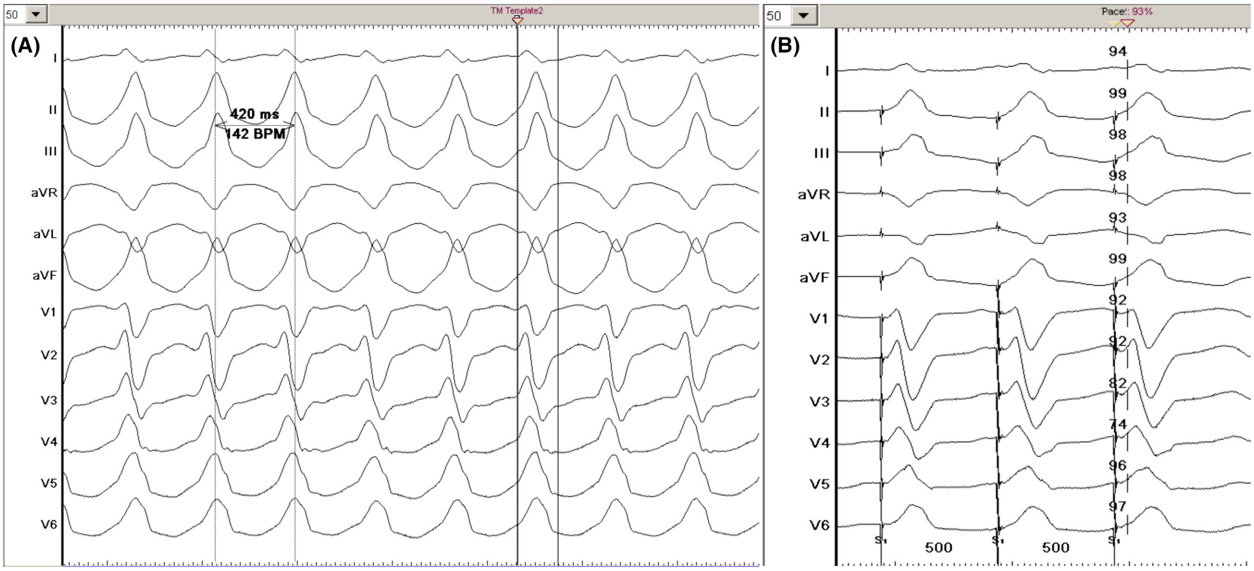

Figure 1. Clinical ventricular tachycardia (VT) and the best pacing map from the right side aspect of the interventricular septum. (A) The VT morphology had a left bundle branch block pattern, normal axis, and transition zone in V3. (B) Pacing from the right interventricular septum reproduced the morphology of VT (11/12 agreement).

to indifferent receptacle. Informed consent for the experimental procedure was obtained. Under deep sedation, VT was easily induced with one extrastimulus. Electroanatomical mapping using CARTO and NaviStar Thermocool SF catheter (Biosense-Webster, Inc.) of the RV, LV and aorta was performed in sinus rhythm and during VT (Fig. 2). The zones of low-amplitude signals on both sides of the septum were identified, which were almost unexcitable probably due to the prior extensive ablations. Standard 30W applications delivered from the right side of the septum transiently slowed down VT from 140/min to 120/min. The left-sided applications were unsuccessful. At this point, the ablation electrode was retrogradely positioned at the superior aspect of the septum below the aorta. The 4-mm tip Celsius electrode (Biosense-Webster, Inc.) was positioned on the opposite site of the septum and connected to CARTO. The distance between the electrodes was assessed in various projections on X-ray and CARTO (Fig. 3). Thereafter, it was connected with the indifferent electrode receptacle of the RF generator using a custom-made connector, and NaviStar electrode was connected to CARTO. The 30W application with saline flow of 25 mL/min was delivered between both electrodes, which were closely monitored for position and impedance. The VT rate slowed down from 142/min to 113/min and subsequently terminated in 72 sec. The line between the superior and inferior aspect of the septum was created as two other septal VT were induced (application time 482 sec; change of impedance -12 Ohm). After 30 min, only nonsustained apical VT was induced, but it was not targeted. After ablation, preexisting 1st degree of atrioventricular block increased to 3rd degree. The total procedure was 153 min, fluoroscopy time was 35 min, and radiation dose 193 mGy.

The patient had uneventful recovery and was discharged after 7 days. He did not present with any significant VT on CareLink (Medtronic Inc.) monitoring at 3 months follow-up, but later developed heart failure symptoms with runs of nonsustained VT. After 6 months, the ICD was upgraded to CRT-D. The resynchronization therapy resulted in substantial clinical improvement and complete resolution of ventricular tachycardia.

Discussion

During standard ablation, RF energy is delivered between the tip of the electrode and the dispersive pad located underneath the patient. The electrical alternating current flowing through the tissue encounters resistance, and the energy is converted into heat. This energy, resistive heat, destroys the tissue close to the electrode. Heat is then transmitted to the surrounding tissue by conduction and radiation leading to lesion formation. Scar formation is related to the electrode size, power of the energy, the contact force between the electrode and the tissue and the cooling effect of the surrounding fluid, even though only a small amount of the energy is delivered to the tissue [8]. By cooling the electrode, we prevent overheating the tissue, which enables us to create a deeper lesion. The decrease of the distance between the tip electrode and the

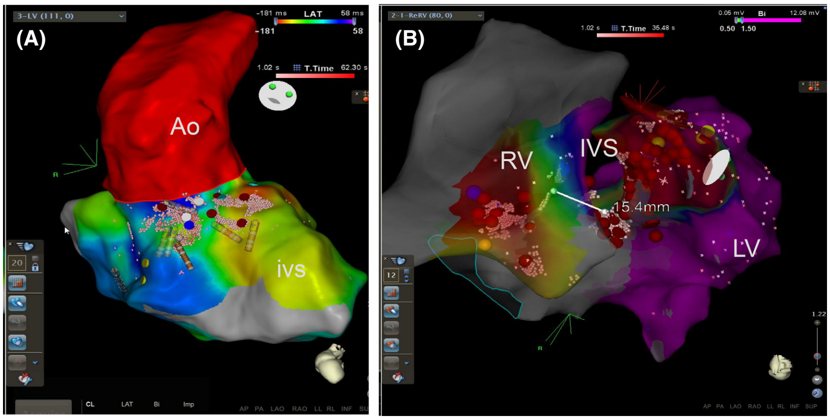

Figure 2. (A) The bipolar map of ventricles during sinus rhythm. Ablation lines on the CARTO activation map of the left ventricle (LV). The red dots represent the sites of radiofrequency applications. The blue dot indicates the site where VT was terminated. (B) The bipolar CARTO map of the right ventricle (RV) and LV with several measurements of the septum.

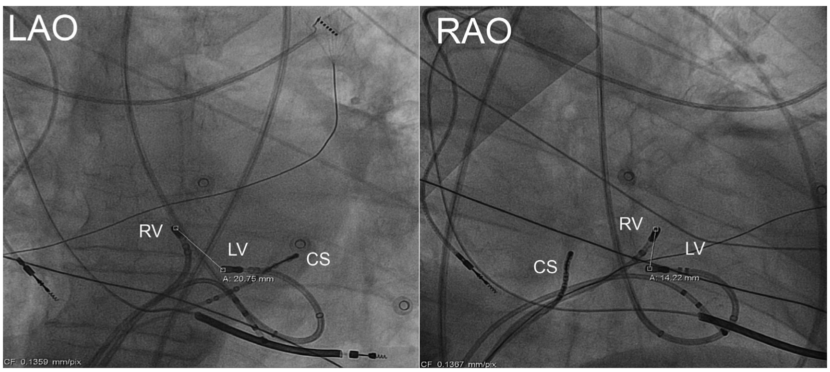

Figure 3. The LAO and RAO projections of ablation electrodes. Several positions for the electrodes were examined before ablation. The right ventricle (RV) electrode was connected to the indifferent electrode receptacle of the radiofrequency (RF) generator. The left ventricle (LV) electrode was connected to MAP socket of the CARTO 3 system and RF generator. LAO, left anterior oblique; RAO, right anterior oblique (CS – coronary sinus). IVS, interventricular septum; Ao, aorta.

dispersive pad will result in a bigger current density with more resistive heating, which leads to deeper lesion formation. Bipolar ablation is when the RF current flows between two closely located rings [9]. Lesions created by bipolar ablation are narrower and deeper, resulting in a transmural scar in the tissue as thick as 25 mm [7]. With good control of the impedance and contact pressure, the bipolar source of RF energy seems safe, and this has confirmed by another study [10].

Njeim et al. reported a high proportion of septal late enhancement on MRI in 20 patients with unsuccessful ablation of VT [11]. Haqqui et al. reported that 11% of patients who underwent VT ablation had only a septal substrate [4]. Ablation of the septal VT is always challenging. The most commonly used approach is to apply unipolar RF energy to both side of the septum [12]. In cases of failed ablation, there are three different options. First is an alcohol septal ablation. A unipolar signal is recorded from an angioplastic wire inserted into the septal branch of the left anterior descending artery. After selecting the proper vessel, alcohol infusion is administered. The efficacy of this method has been proven by several reports [13, 14]. Second, a needle sliding out form ablation catheter can be used to deliver RF energy to the myocardium, although this technique is associated with a relatively high number of complications [15]. Third, experimental phase bipolar ablation using two ablation electrodes positioned on the opposite side of the wall. There are no commercially available tools and connectors used during the procedure need to be custom-made. Merino et al. delivered RF energy between two nonirrigated electrodes located in the aortic sinus of the Valsalva and the LV to treat idiopathic VT [16]. In the series of nine patients, Koruth et al. performed bipolar ablation in four patients with septal and two with LV free wall VT [7]. Similar to our findings, they found only a small septal scar without late potentials in this group of patients. There were also different VT induced, which were all associated with the septal region.

Septal ablation gives the risk for atrioventricular (AV) block. It occurred in one of four patients as well as in our case. The risk of AV block is probably related to underlying conduction abnormalities and the site of application in the septum. The injury to the conduction system is, however, not associated with technique of ablation. In a larger group of 30 patients with isolated septal substrate for VT, standard unipolar ablation with an irrigation electrode resulted in a new atrio-ventricular block in five patients and LBBB in two [4].

We conclude that in patients with a documented septal substrate for VT, bipolar ablation can be safely used if standard unipolar ablation is ineffective. The bipolar technique should be used during the earlier stages of patients' treatment, as the scarring caused by numerous unipolar applications may make the mapping procedure more difficult. As there is a high proportion in ablation-related atrioventricular block the resynchronisation therapy should be considered on early postablation period. This, however, should be evaluated in larger patient populations prospectively.

Acknowledgment

We would like to acknowledge Michał Śliwka, Senior Clinical Support Specialist, Biosense Webster, Poland, for his valuable engineering support.

Conflict of Interest

None declared.

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