Journal of Arrhythmia 30 (2014) 262–271

Contents lists available at ScienceDirect

Journal of Arrhythmia

journal homepage: www.elsevier.com/locate/joa

Review

Catheter ablation of epicardial ventricular tachycardia

Takumi Yamada, MD, PhD*

Division of Cardiovascular Disease, University of Alabama at Birmingham, FOT 930A, 510 20th Street South, 1530 3rd AVE S., Birmingham, AL 35294-0019, USA

ARTICLE INFO

Article history:
Received 17 March 2014
Accepted 11 April 2014
Available online 7 June 2014

Keywords:
Epicardial
Ventricular tachycardia
Catheter ablation
Transvenous
Transthoracic
Complications

ABSTRACT

Ventricular tachycardias (VTs) can usually be treated by endocardial catheter ablation. However, some VTs can arise from the epicardial surface, and their substrate can be altered only by epicardial catheter ablation. There are two approaches to epicardial catheter ablation: transvenous and transthoracic. The transvenous approach through the coronary venous system (CVS) has been commonly used because it is easily accessible. However, this approach may be limited by the distribution of the CVS and insufficient radiofrequency energy delivery. Transthoracic epicardial catheter ablation has been developed to overcome these limitations of the transvenous approach. It is a useful supplemental or even preferred strategy to eliminate epicardial VTs in the electrophysiology laboratory. This technique has been applied for scar-related VTs secondary to often non-ischemic cardiomyopathy and sometimes ischemic cardiomyopathy, and idiopathic VTs as the epicardial substrates of these VTs have become increasingly recognized. When endocardial ablation and epicardial ablation through the CVS are unsuccessful, transthoracic epicardial ablation should be the next option. Intrapericardial access is usually obtained through a subxiphoidal pericardial puncture. This approach might not be possible in patients with pericardial adhesions caused by prior cardiac surgery or pericarditis. In such cases, a hybrid procedure involving surgical access with a subxiphoid pericardial window and a limited anterior or lateral thoracotomy might be a feasible and safe method of performing an epicardial catheter ablation in the electrophysiology laboratory. Potential complications associated with this technique include bleeding and collateral damage to the coronary arteries and phrenic nerve. Although the risk of these complications is low, electrophysiologists who attempt epicardial catheter ablation should know the complications associated with this technique, how to minimize their occurrence, and how to rapidly recognize and treat the complications that they encounter. This review discusses the indications, techniques, and complications of the transvenous and transthoracic epicardial catheter ablation of VTs.

Contents

* Tel.: +1 205 975 2404; fax: +1 205 996 5857.
E-mail address: takumi-y@fb4.so-net.ne.jp

http://dx.doi.org/10.1016/j.joa.2014.04.011
1880-4276/

1. Introduction

Catheter ablation is an effective treatment that can cure ventricular tachycardias (VTs). VTs secondary to structural heart diseases are usually first treated by antiarrhythmic drugs and implantable cardioverter-defibrillators. When patients cannot tolerate antiarrhythmic drugs or antiarrhythmic drugs cannot control VTs, resulting in multiple shocks from the defibrillator, catheter ablation of the VTs should be considered [1]. On the other hand, catheter ablation may currently be a first line treatment for idiopathic VTs because of its high success rate and low risk of complications [2].

VTs can usually be treated by endocardial catheter ablation. However, some VTs can arise from the epicardial surface, and their substrate can be altered only by epicardial catheter ablation [2,3]. There are two approaches in epicardial catheter ablation: transvenous and transthoracic [2,3]. The transvenous approach through the coronary venous system (CVS) has been commonly used because it is easily accessible. However, this approach may be limited by the distribution of the CVS and insufficient radiofrequency energy delivery. Pioneering work on transthoracic epicardial catheter ablation to treat VT via a transpericardial approach was first reported by Sosa and his colleagues in 1996 [4]. Since then, epicardial substrates of VTs have been increasingly recognized and transthoracic epicardial mapping and catheter ablation have been proven to enhance the success rate of catheter ablation of VTs and to help the patients avoid a surgical procedure [4–6]. This review discusses how to recognize, map and ablate epicardial VTs and how to prevent, recognize, and manage the complications associated with epicardial VT ablation.

2. How to recognize epicardial VT?

Electrophysiologists should make a decision regarding the indications for epicardial mapping and ablation, based on the electrocardiographic and electrophysiological findings during any phase of the procedure.

2.1. Electrocardiographic recognition of epicardial VT

Twelve-lead electrocardiogram (ECG) tracings are very helpful for determining the likely epicardial VT origin prior to the electrophysiological study. In human hearts, the Purkinje network is located only in the subendocardium. Because of this anatomical background, ventricular activation from an epicardial origin requires more time to reach the Purkinje network, resulting in a slow onset of the QRS during epicardial VTs. Based on this mechanism, several parameters predicting epicardial VT origins have been proposed: a “pseudo-delta” wave duration >34 ms, QRS complex duration >200 ms, delayed intrinsicoid deflection of >85 ms, RS complex duration >121 ms, and maximum deflection index (MDI) (calculated by dividing the shortest time from the QRS onset to the maximum deflection in any of the precordial leads by the total QRS duration) >0.54 [7,8]. When the ventricular activation propagates from the epicardial origin in the left ventricular free wall or ventricular posterior wall, the total activation vector should go from lateral toward medial, or from inferior toward superior, resulting in a QS pattern in lead I or aVF. On the other hand, when the ventricular activation propagates from an endocardial origin on the left ventricular free wall or ventricular posterior wall, a part of the activation vector should go toward the lateral or inferior direction, which reflects the activation conducting through the wall of ventricular muscle toward the epicardium, resulting in the presence of an initial R wave in lead I or aVF. Therefore, a QS pattern in lead I or aVF suggests an epicardial origin in the left ventricular free wall [9] or the ventricular posterior wall, respectively (Fig. 1).

2.2. Electrophysiological findings

Endocardial mapping, as well as transvenous epicardial mapping within the CVS, may provide useful electrophysiological findings suggesting epicardial VT origins before a decision is made to proceed with a transthoracic pericardial approach. These are discussed in the next section.

3. How to map epicardial VT?

3.1. Endocardial and transvenous epicardial mapping

During the electrophysiological study, a multipolar mapping catheter placed in the coronary sinus (CS) is very helpful for predicting an epicardial origin of VTs. If the tachycardia is thought

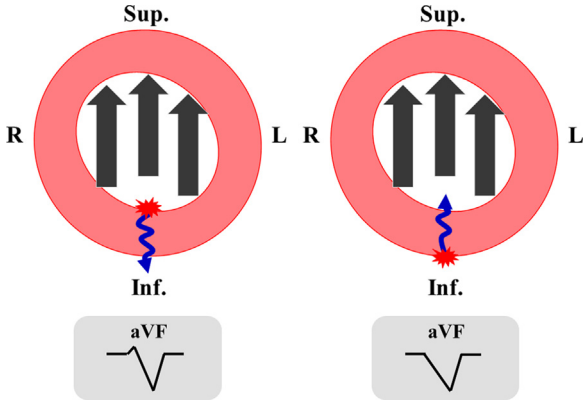

Fig. 1. Schema showing the mechanism to explain the difference in the QRS morphology in lead aVF during ventricular tachycardias with endocardial (left) and epicardial (right) foci. Inf.=inferior; L=left; R=right; and Sup.=superior.