

Pulmonary Vein Orifice Isolation for Eliminating Paroxysmal Atrial Fibrillation after ICD Implantation

Taijiro Sueda, MD, PhD, Kazumasa Orihashi, MD, Masanobu Watari, MD, Kenji Okada, MD, and Osamu Ishii, MD

We treated a patient with dilated cardiomyopathy (DCM) and sustained ventricular tachycardia by an implantable cardioverter defibrillator (ICD). He then suffered from inappropriate ICD shocks triggered by paroxysmal atrial fibrillation (AF). We successfully performed pulmonary vein orifice isolation to eliminate paroxysmal AF. The pulmonary vein orifice isolation was a simple and useful procedure for eliminating paroxysmal AF in patient with decreased left ventricular (LV) function after ICD implantation. (Ann Thorac Cardiovasc Surg 2001; 7: 119–21)

Key words: implantable cardioverter defibrillator, pulmonary vein isolation, paroxysmal atrial fibrillation

Introduction

Inappropriate shocks delivered by implantable cardioverter-defibrillators (ICDs) occur in approximately 20% (15–40%) of the patients treated with these devices.^{1–3} The most frequent causes for these inappropriate shocks include paroxysmal atrial fibrillation (AF) with a rapid ventricular response and other supraventricular arrhythmias. Nowadays, dual chamber ICDs can prevent an inappropriate shock for supraventricular tachycardia.

This paper describes a patient who underwent ICD (single chamber ICD) implantation, and then began to suffer inappropriate shocks because of paroxysmal AF. He received a simple pulmonary vein orifice isolation, which was successful in eliminating the paroxysmal AF.

Case Report

The patient was a 30 year-old-male with dilated cardiomyopathy and syncope. He had experienced sustained ventricular tachycardia triggered by supraventricular tachycardia. Echocardiography revealed poor left ventricu-

lar function [ejection fraction 30%, left ventricular diastolic diameter 72 mm on ultrasound cardiography (UCG) study]. Electrophysiological study revealed sustained ventricular tachycardia (VT) induced by rapid stimulation to the upper right atrium (Fig. 1). Paroxysmal AF occurred spontaneously with non-sustained ventricular tachycardia during exercise.

He received defibrillator implantation surgery in May 1997, with a Ventak Mini (Cardiac Pacemakers, Inc, St. Paul, MN, USA) device and an Endotak C-0125 transvenous lead (Cardiac Pacemakers, Inc, St. Paul, MN, USA). Implant and post implant testing revealed normal defibrillation function. The defibrillation detection interval, duration and shock energy for ventricular fibrillation were programmed at 300 ms, 10 sec and 29 joules, respectively. The first shock was delivered 8 days after the ICD implantation. An evaluation of the stored electrogram from his device revealed that this shock was delivered for rapid AF at a cycle length ranging from 137 to 359 ms. Paroxysmal AF occurred frequently, and inappropriate shocks were delivered for the rapid AF. Antiarrhythmic drugs and digitalis were not sufficient to eliminate these arrhythmias. Following these shocks, the defibrillation detection interval was changed to two zones, a ventricular fibrillation (VF) zone at a cycle length under 273 ms, and a VT zone at a cycle length from 273 to 300 ms. However, the inappropriate shocks were frequently delivered after the change in the defibrillation

From the Department of Surgery, Hiroshima University School of Medicine, Hiroshima, Japan

Received July 24, 2000; accepted for publication October 20, 2000. Address reprint requests to Taijiro Sueda, MD, PhD: Department of Surgery, Hiroshima University School of Medicine, 1-2-3 Kasumi, Minami-ku, Hiroshima 734-8551, Japan.

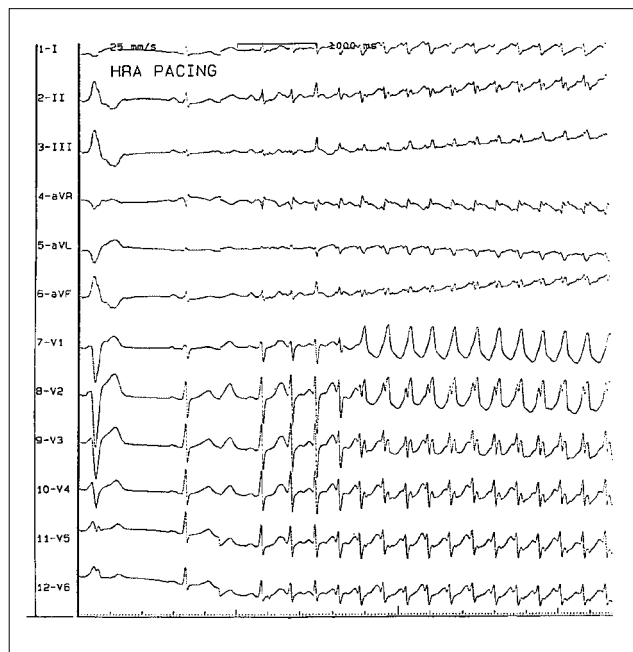


Fig. 1. Electrocardiograms recorded during the induced ventricular tachycardia.

An electrophysiological study revealed rapid ventricular tachycardia induced by rapid stimulation to the upper right atrium.

detection intervals. His left ventricular function was severely depressed and catheter ablation for pulmonary vein orifices is not carried out in our institute. We therefore performed a simple pulmonary vein orifice isolation to eliminate the paroxysmal AF, instead of a complicated Maze procedure.

Under extracorporeal circulation and cardioplegic arrest, the left upper atriotomy was extended toward the left pulmonary vein orifices. Additional cryoablation was performed on the atrial wall remnant between the left upper and lower pulmonary vein orifice (Fig. 2). The left atriotomy was sutured completely using a running suture. The aortic cross clamping time and extracorporeal circulation time were 23 min and 46 min, respectively. After the completion of the procedure, a sinus rhythm was restored and left ventricular function was improved without any circulatory support. During the postoperative period, two episodes of paroxysmal AF occurred, but terminated spontaneously without inappropriate shocks by his device. The exercise stress test did not induce any paroxysmal AF. He was discharged from the hospital 21 days after the surgery and did not suffer from paroxysmal AF or any inappropriate shocks after discharge.

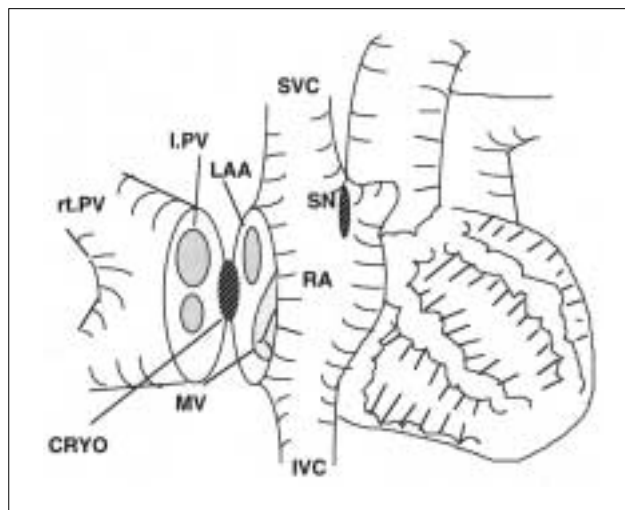


Fig. 2. Schema of pulmonary vein orifice isolation.

A right sided vertical atriotomy on the left atrium was extended to the left margin of the left pulmonary vein orifices and complementary cryoablation (-60°C , 3 min) was applied to the remnant of the left atrial wall between the left upper pulmonary vein orifice and the left lower pulmonary vein orifice.

SN: sinus node, RA: right atrium, MV: mitral valve, LAA: left atrial appendage, I.PV: left pulmonary vein, rt.PV: right pulmonary vein, SVC: superior vena cava, IVC: inferior vena cava, CRYO: cryoablation.

Discussion

The incidence of inappropriate shocks ranges between 15-40%¹⁻³⁾ of ICD patients. The etiology of these shocks is supraventricular arrhythmias, such as AF and other atrial tachycardias. The differentiation of these supraventricular tachycardias from ventricular tachycardias has been facilitated by the development of adjunctive algorithms mechanisms. These algorithms include the ventricular activation interval stability criteria and sudden onset criteria.⁴⁾ This report describes one etiology of inappropriate shocks; AF with a rapid ventricular response. Most of these cases can be treated by antiarrhythmic drugs and digitalis. However, these drugs did not work effectively in this patient. This clinical situation reoccurs frequently and causes further inappropriate shocks. The solution for these inappropriate shocks can be achieved by flexibility in programming and the use of a dual chamber ICD with atrial sensing. Unfortunately, we could not use a dual chamber ICD at that time, and catheter ablation for eliminating paroxysmal AF could not be performed in our hospital. We therefore selected surgical interruption of the paroxysmal AF in this case.

Recently, Haissaguere reported spontaneous initiation

of AF due to ectopic beats originating in the left pulmonary veins and reported successful application of radiofrequency ablation at these focal sources.⁵⁾ He also reported over 90 % of ectopic beats originated from the pulmonary veins.⁶⁾ Although we could perform an electrical interruption of atrio-ventricular conduction by catheter ablation, an atrial transport function disappeared after atrio-ventricular nodal interruption. Therefore, we performed a simple isolation of all pulmonary vein orifices and successfully eliminated paroxysmal AF. We could also restore atrial systolic function following this surgery. Although more experience is mandatory, this simple method is useful for eliminating paroxysmal AF in patients with severe left ventricular dysfunction.

References

1. Goldberger J, Horvath G, Inbar S, et al. Utility of pre-discharge and one month transvenous implantable defibrillator tests. *Am J Cardiol* 1997; **79**: 822–5.
2. Grimm W, Flores B, Marchlinski F. Electrocardiographically documented unnecessary, spontaneous shocks in 241 patients with implantable cardioverter defibrillators. *PACE* 1992; **15**: 1667–73.
3. Grimm W, Flores BF, Marchlinski F. Symptoms and electrocardiographically documented rhythm preceding spontaneous shocks in patients with implantable cardioverter-defibrillator. *Am J Cardiol* 1993; **71**: 1415–8.
4. Hook B, Callans D, Kleinman R, et al. Implantable cardioverter-defibrillator therapy in the absence of significant symptoms. *Circulation* 1993; **87**: 1897–906.
5. Haissaguerre M, Jais P, Shah DC, et al. Spontaneous initiation of atrial fibrillation by ectopic beats originating in the pulmonary veins. *N Engl J Med* 1998; **339**: 659–66.
6. Jais P, Haissaguerre M, Shah DC, et al. A focal source of atrial fibrillation treated by discrete radiofrequency ablation. *Circulation* 1997; **95**: 572–6.