RF/MICROWAVE APPLICATIONS IN MEDICINE WITH EMPHASIS ON RF ABLATION FOR THE TREATMENT OF CARDIAC ARRHYTHMIAS

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ABSTRACT

RF/microwaves are used in the treatment of cancer, arrhythmias, tachycardia, benign prostatic hyperplasia, and sleep apnea. This paper addresses the advances in RF catheter ablation for the treatment of cardiac arrhythmias.

INTRODUCTION

The use of RF/microwaves in thera-peutic medicine has increased dramatically in the last few years. RF and microwave therapies for cancer in humans are well documented, and are presently used in many cancer centers. RF treatments for supraventricular arrhythmias, and more recently for ventricular tachycardia (VT) are currently employed by major hospitals (fig.1). RF/microwaves are also used in human subjects for the treatment of benign prostatic hyperplasia (BPH). In the last year, several otolaryngological centers in the United States have been utilizing RF to treat upper airway obstruction and alleviate sleep apnea. Furthermore, new modalities such as microwave enhanced liposuction, microwave ablation and microwave septic wound treatment are continually being researched.

ABLATION OF CARDIAC ARRHYTHMIAS

Ablation of cardiac arrhythmias is based on the concept that removal of cardiac tissue that is either the focus or critical portion of an arrhythmic circuit will abolish the arrhythmia. In 1969, Sealy and colleagues demonstrated that patients with Wolff-Parkinson-White syndrome could be cured of their cardiac arrhythmias once their accessory pathway was surgically interrupted. These observations lead to the development of arrhythmia surgery. If the arrhythmic substrate could be identified, the surgeon could remove tissue that was critical for maintenance of the arrhythmia. Unfortunately, few arrhythmias could be treated in this manner. This was because open-heart surgery with cardiopulmonary bypass was required to complete the procedure.

Radio frequency catheter ablation has now become the nonpharmacological treatment of

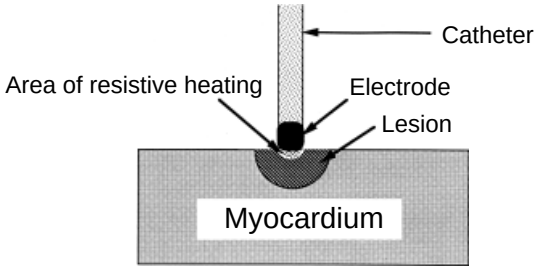

Figure 1. Mechanism of lesion formation with radiofrequency catheter ablation: delivery of RF current to tip of electrode catheter results in an area of resistive heating. Conduction of heat to the myocardium results in cell death and lesion formation. Appropriately placed RF lesions result in the successful ablation of cardiac arrhythmias.

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choice for patients with a variety of cardiac arrhythmias (fig. 2). The target sites for ablation are determined by the results of careful endocardial catheter mapping of cardiac electrical activity. During such studies, called cardiac electrophysiological studies, catheter electrodes are percutaneously inserted and fluoroscopically advanced to a variety of cardiac sites. Using programmed electrical stimulation, the clinical arrhythmia can be induced and studied in the laboratory. Once the mechanism of the arrhythmia has been identified, catheter ablation may be attempted. More than 90% of patients with supraventricular tachycardias can be successfully treated with a minimum of complications. The promising results of catheter ablation for the treatment of atrial arrhythmias have lead to the study of RF for the treatment of ventricular tachycardia, a more life-threatening arrhythmia.

FUTURE DEVELOPMENTS

Catheter ablation developments are likely to include new catheter designs for RF delivery to create linear lesions and possibly alternative energy sources such as microwaves. Patients with atrial fibrillation and possibly more patients with ventricular tachycardia may be treated with this technique. Catheter ablation, using radio frequency energy, has truly revolutionized the treatment of patients with cardiac arrhythmias. Many patients who were previously relegated to lifelong drug therapy may now be cured with a simple and safe procedure.

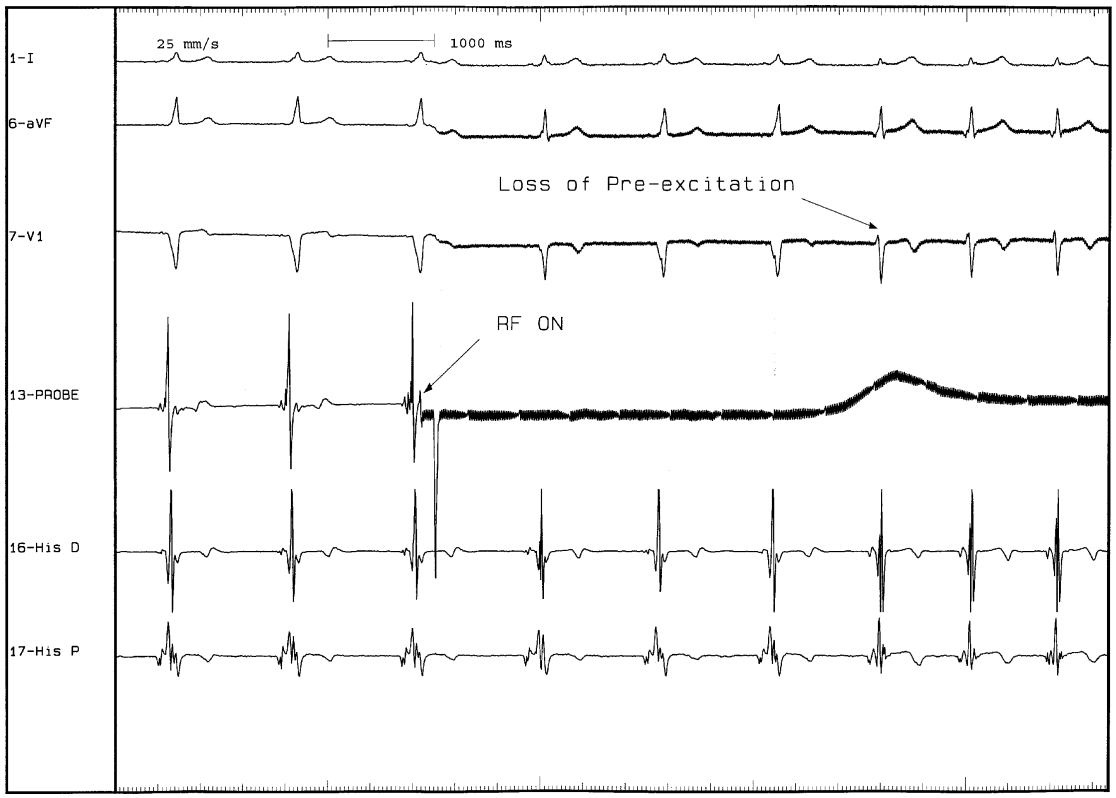

Figure 2. Recordings obtained during RF delivery in a patient with Wolff-Parkinson-White Syndrome (pre-excita-tion) and recurrent supraventricular tachycardia. Delivery of RF to an elect-rode catheter placed on the anteroseptal aspect of the tricuspid valve annulus results in loss of pre-excitation and cure of recurrent supraventricular tachy-cardia. Abreviations: surface electro-cardiographic (ECG) leads I, avF, and V1, Probe = endocardial recordings obtained from ablation catheter, His D, His P = endocardial recordings obtained from catheter located at distal and proximal AV junction for His bundle electrogram recordings.

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