

Atrial anti-tachycardia pacing resulting in termination of atrial flutter: intracardiac electrograms providing insight into the mechanism of arrhythmia termination

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Abstract

The “MINimizE Right Ventricular pacing to prevent Atrial fibrillation and heart failure” (MINERVA) multicenter randomized study demonstrated that atrial anti-tachycardia pacing (A-ATP) can effectively decrease the burden of atrial fibrillation (AF) in patients with bradycardia and atrial tachyarrhythmias. We herein describe the unique electrophysiological results of AF ablation in a patient for whom atrial flutter (AFL) was terminated by A-ATP from a Medtronic dual-chamber pacemaker. In this case, the atrial activation sequence indicated that the tachycardia was a right atrial typical flutter and that A-ATP from the right atrial appendage would thus be more likely to terminate the tachycardia. This is a novel case involving documented intracardiac electrograms captured during an AF ablation study in a patient in whom AFL was successfully terminated by A-ATP. These findings provide insight into the mechanisms by which A-ATP can terminate atrial arrhythmias.

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Keywords

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Introduction

The atrial fibrillation (AF) burden has been shown to be an independent predictor of ischemic stroke, and device-detected AF is associated with an increased risk of cerebral ischemic events.¹ The “MINimizE Right Ventricular pacing to prevent Atrial fibrillation and heart failure” (MINERVA) multicenter randomized study demonstrated that atrial anti-tachycardia pacing (A-ATP) can effectively decrease the burden of AF in patients with bradycardia and atrial tachyarrhythmias.² We herein describe the unique electrophysiological results from a case involving a patient with AF ablation in whom atrial flutter (AFL) was terminated by A-ATP. This case is being reported to provide insight into the mechanisms by which A-ATP can terminate atrial arrhythmias.

Case report

A 75-year-old man with symptomatic AF refractory to antiarrhythmic medications was referred for catheter ablation. He had previously undergone implantation of a Medtronic dual-chamber pacemaker for treatment of sinus node dysfunction with complete atrioventricular block and symptomatic tachycardia-bradycardia syndrome. The initial rhythm during the AF ablation procedure was sinus rhythm, but AF occurred spontaneously during mapping, eventually organizing to AFL. Our standard practice has been to disable the A-ATP function and program devices to

VVI 60 ppm before AF ablation; however, the A-ATP function was inadvertently left enabled on this patient's device. Thus, A-ATP with ramp pacing was delivered by the pacemaker (Figure 1). Interestingly, intracardiac electrograms revealed that A-ATP delivered from the right atrial appendage (RAA) captured the right atrium for four beats (Figure 2) prior to termination of AFL. The A-ATP drive train did not affect the left atrial electrograms recorded at the coronary sinus. Figure 3 shows the fluoroscopic position of the pacemaker lead and mapping catheters. This study was approved by the Tokyo Medical and Dental University Institutional Review Board and was conducted in conformity with ethical and humane principles of research (M2018-003). Written informed consent was obtained from the patient before treatment.

Discussion

The MINERVA study demonstrated that A-ATP can decrease the burden of AF (DDDR vs. MVP vs. DDDRP + MVP = 17 vs. 9 vs. 4 minutes/day, respectively).² In addition, from this study, this new feature of A-ATP (reactive ATP) may not only attempt atrial tachyarrhythmia termination after detection, but it may also watch for any change in the rate or regularity and then opportunistically apply A-ATP therapy when the episode is most vulnerable to pace termination. However, the mechanism of AF termination by



Figure 1. Twelve-lead electrocardiogram of atrial flutter termination by atrial anti-tachycardia pacing.

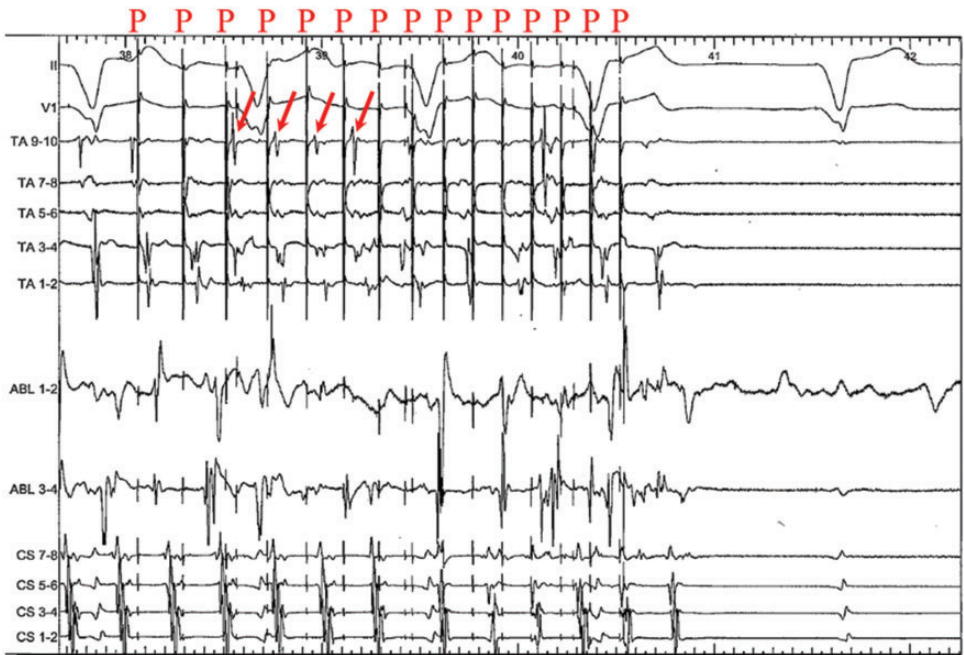


Figure 2. Intracardiac electrogram during atrial anti-tachycardia pacing. The red arrows indicate where the atrial anti-tachycardia pacing delivered from the right atrial appendage captured the right atrium for four beats prior to termination of atrial flutter. P = pacing.

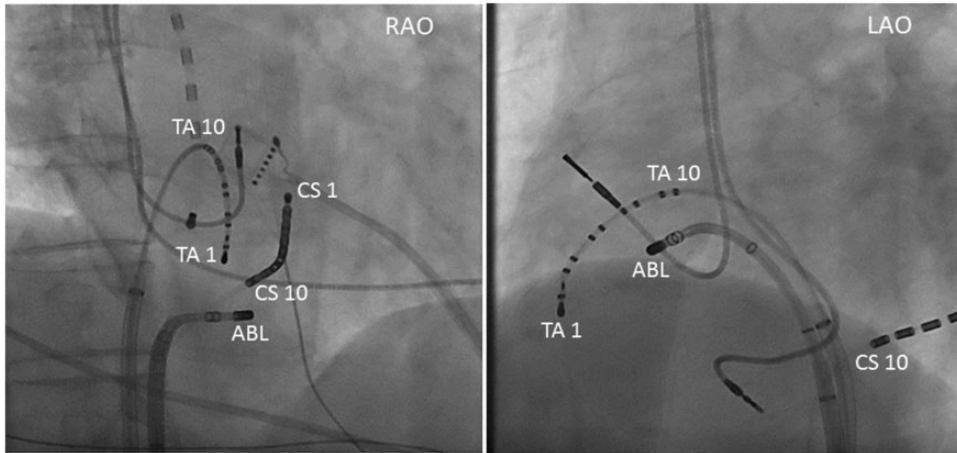


Figure 3. Position of right atrial pacemaker lead and mapping catheters. ABL = ablation (mapping) catheter; CS = coronary sinus; LAO = left anterior oblique; RAO = right anterior oblique; TA = tricuspid annulus.

A-ATP remains unclear. In this case, we serendipitously captured a unique electrophysiological finding obtained from intracardiac electrograms during a case of AF ablation in which AFL was terminated by A-ATP. Figure 2 shows that the third to sixth paced beats captured the right atrium and altered the atrial activation sequence of the catheter along the tricuspid annulus. This phenomenon indicates that the pacing first entrained the tachycardia circuit, then caused the rhythm to degenerate briefly into AF before spontaneous conversion to sinus rhythm. Induced AF might be unstable at first, and tachycardia could not maintain AF. The seventh paced beat captured neither the right atrial or coronary sinus catheter. The atrial activation sequence indicated that the tachycardia was a typical right AFL; thus, A-ATP from the RAA would be more likely to affect the tachycardia. Interestingly, only four beats affected termination of tachycardia during AFL. Higher-output pacing may capture larger portions of the atria, possibly increasing the efficacy of A-ATP. The reason that A-ATP is effective for terminating AF (as opposed to AFL) remains

unclear. Pacing may affect the excitable gap of spiral waves of reentry³ and/or collide with rotors⁴ or multiple wavelets.⁵ We hypothesize that the proximity of the pacing site to the AFL circuit affects the likelihood of terminating the tachycardia. As such, while pacing from the RAA in this case effectively terminated the typical right AFL, theoretically, A-ATP from the right atrial septum may be more effective in terminating left AFL. Further studies are warranted to clarify the mechanisms of AF termination with A-ATP.

In conclusion, although typical AFL can be easily entrained and terminated with overdrive pacing from the right atrium, we have herein reported the first case of documented intracardiac electrograms captured during an AF ablation study in a patient in whom AFL was successfully terminated by A-ATP from a dual-chamber pacemaker. These findings provide insight into the mechanisms by which A-ATP can terminate atrial arrhythmias.

Declaration of conflicting interest

Dr. Maeda and Dr. Takahashi received endowments from Medtronic, Win International,

Japan Lifeline, and Boston Scientific. The other authors report no conflicts of interest.

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