



Original article

Atrial pacing during radiofrequency deliveries for catheter ablation of para-Hisian arrhythmias



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ABSTRACT

Background: Atrial pacing during radiofrequency (RF) deliveries is a technique to facilitate rapid recognition of impaired atrioventricular (AV) conduction during slow pathway ablation of AV nodal reentrant tachycardia. The objective of our study was to report this technique in the catheter ablation of para-Hisian arrhythmias.

Methods: The study included a total of 48 patients who underwent ablation of para-Hisian arrhythmias including accessory pathways (APs), atrial tachycardias (ATs), and ventricular arrhythmias (VAs) in 6, 9, and 33 patients, respectively.

Results: AT was successfully eliminated in all cases without any accelerated junctional rhythm (JR) occurring. JR appeared during RF deliveries in 20 patients (3 with APs, 17 with VAs). In 11 of 20 patients, RF deliveries were terminated when JR appeared and restarted during atrial pacing at a faster rate than the JR. No transient complete AV block was observed in the 11 patients, however it occurred in 1 of the remaining 9 without atrial pacing ($p = 0.25$). Small His bundle potentials were recorded at the effective ablation site before the RF delivery in 11 (55%) patients. No patients had any AV conduction disturbances at the end of and after the procedure. APs were successfully eliminated in 2 of 3 patients. VAs were completely and partially eliminated in 10 and 4 of 17 patients, respectively.

Conclusions: Atrial pacing during RF applications might be helpful to avoid AV conduction disturbances during catheter ablation of APs close to the His bundle and idiopathic VAs originating in the vicinity of the His bundle.

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Introduction

Radiofrequency (RF) catheter ablation has been widely accepted as a safe and curative therapy for various atrial and ventricular arrhythmias with a high success rate. However, it is well known that arrhythmias originating from the vicinity of the His bundle are often difficult to eliminate by RF ablation due to the high risk of inducing atrioventricular (AV) conduction block. Actually, the probability of inducing AV block, which could result in a lifelong pacemaker-dependent patient, renders these arrhythmias “high risk” during RF catheter ablation in the electrophysiology laboratory. RF applications in the vicinity of the His bundle and AV node often cause accelerated junctional rhythm by a heating effect, which is considered as an early warning of injury

[1,2]. Although atrial pacing has been reported as one of the techniques to facilitate the rapid recognition of impaired AV conduction during slow pathway ablation during the RF catheter ablation of AV nodal reentrant tachycardia, the technique has not been extended to the other arrhythmias originating from the vicinity of the His bundle. The purpose of the present study was to report the clinical utility of atrial pacing during RF applications in the catheter ablation of arrhythmias originating from the vicinity of the His bundle.

Methods

Study population

We retrospectively reviewed 3433 consecutive RF catheter ablation procedures undertaken at our institute between February 2009 and March 2014. Among them, RF energy was applied at the vicinity of the His bundle in 48 patients with para-Hisian arrhythmias. The cases with AV nodal reentrant tachycardia were

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excluded from the study. All the electrophysiological data were retrospectively analyzed, and we investigated the procedural complications and clinical outcome.

Electrophysiological study

The surface electrocardiogram (ECG) and bipolar intracardiac electrograms were continuously monitored and stored on a computer-based digital recording system (LabSystem PRO, Bard Electrophysiology, Lowell, MA, USA). Bipolar electrograms were filtered from 30 to 500 Hz. For the patients with supraventricular tachycardia, venous access was obtained under local anesthesia from the right femoral and subclavian veins. Three quadripolar catheters were positioned in the right atrium, His bundle region, and right ventricle, respectively. A decapolar catheter was introduced from the right subclavian vein and positioned within the coronary sinus (CS). For the patients with ventricular premature contractions (PVCs) and ventricular tachycardia (VT), two quadripolar catheters were positioned in the His bundle region, and right ventricle (RV) or right atrium.

Catheter ablation protocol

A 5000 U bolus of heparin was administered before the catheters were introduced. Mapping and ablation were performed using a 4-mm non-irrigated ablation catheter (Fantasista or Ablaze, Japan Lifeline, Tokyo, Japan) introduced from the right femoral vein for the RV or from the right femoral artery for the aortic sinus cusps and left ventricle (LV), under bilateral fluoroscopic guidance. In cases with accessory pathways, the selection of the target site was based on the presence of either continuous AV activity during sinus rhythm or closely coupled local ventriculoatrial activity during orthodromic AV reentrant tachycardia or ventricular pacing. In cases with atrial tachycardia (AT), the earliest atrial activity during the AT was targeted. In cases with ventricular arrhythmias (VAs), activation and pace mapping were performed in all cases to identify the origin. If an appropriate ablation site was not identified on the RV septum or successful ablation was not obtained by a right-sided approach, we also mapped the coronary cusps and LV septum. RF energy was delivered using a temperature control mode with a temperature setting of 50–55 °C and maximum power output of 30–50 W for up to 60 s at the presumed ablation site. Because the earliest activation was close to the His bundle region in all patients, RF energy was delivered starting with an initial power setting of 10 W under bilateral fluoroscopic imaging. In the cases in which the atrial pacing technique was used, once an accelerated junctional rhythm was present during the RF application, we immediately stopped the RF delivery and restarted it during right atrial pacing at a rate faster than the junctional beats. If the RF application was considered to be effective without any effect on the AV conduction, the RF energy was gradually titrated up to the target output. Successful ablation was defined as the elimination of the accessory pathway, no inducibility of AT, and the absence of any spontaneous or induced clinical VAs with or without an isoproterenol infusion after the RF energy application, respectively. We did not deliver RF energy at the sites where an apparent His bundle potential of more than 0.1 mV was recorded in the distal bipolar electrogram recording. If a faster junctional tachycardia (<350 ms) appeared during the RF delivery or any findings of a conduction disturbance such as prolongation of the AV conduction or AV block, we immediately discontinued the RF delivery and abandoned the RF application at that site.

After the ablation, ECG monitoring was performed for 24–48 h in all patients. All antiarrhythmic drugs were discontinued after the ablation procedure. The first outpatient clinic visit was 1 month

after the procedure and 24-hour Holter monitoring was undertaken. The patients then underwent post-procedure follow-up including a clinical interview, ECG, and 24-hour Holter monitoring at our cardiology clinic.

Statistical analysis

Continuous variables are expressed as the mean \pm standard deviation. Continuous and categorical variables are compared using a Student's *t* test and chi-square test, respectively. A probability value of $p < 0.05$ indicated statistical significance.

Results

Patient characteristics

RF energy delivery in the para-Hisian area was required in a total of 48 procedures (patients). The mean age was 61.7 ± 16.7 years, and 31 of the patients were men. The mean left atrial diameter and LV ejection fraction was 39.4 ± 7.8 mm and $64.8 \pm 8.0\%$, respectively. Among them, 6 (12.5%), 9 (18.8%) and 33 (68.8%) patients had orthodromic AV reentrant tachycardia using an accessory pathway close to His bundle [3,4], AT originating from the para-Hisian area [5], and idiopathic VAs originating from the vicinity of the His bundle [6–8], respectively. No patients had any structural heart disease.

Catheter ablation

In 6 cases with accessory pathways close to the His bundle, orthodromic AV reentrant tachycardia was induced by programmed stimulation in all cases. Persistent and intermittent antegrade conduction via an accessory pathway was observed in 2 and 1 patient, respectively. Para-Hisian accessory pathways were successfully eliminated from the RV septum and LV septum in 3 and 2 patients, respectively. In one case, we abandoned the procedure because the appropriate ablation site (right side) was a site where a large His bundle potential was recorded, and RF applications at the non-coronary cusp where the His bundle potential was not recorded failed to eliminate it. Accelerated junctional rhythm was observed during the RF delivery in 3 (50%) patients. Among the 3 cases, accessory pathways were successfully eliminated by an RF delivery during atrial pacing with careful observation of the AV conduction time in 2 cases (Fig. 1). In 3 cases with antegrade conduction, an accessory pathway was eliminated on the ventricular side, and it was eliminated on the atrial side in the remaining 2 cases. None of the patients in whom an accessory pathway was successfully eliminated had any recurrent atrial tachyarrhythmias after the procedure.

In 9 cases with AT originating from the para-Hisian area, the earliest atrial activation site was searched from both the RA septum and non-coronary cusp during the tachycardia. An intravenous administration of a small dose of adenosine triphosphate (2–6 mg) terminated the AT with a gradual prolongation of the AA interval in all cases. AT was terminated by RF applications on the RA septum and non-coronary cusp in 6 (66.7%) and 3 (33.3%) patients, respectively. No further AT was inducible after the applications without any AV conduction disturbances in all patients. Accelerated junctional rhythm did not appear during the RF delivery in any cases. Therefore, no atrial pacing during the RF application was undertaken in any of those patients. No patients had any arrhythmia recurrences.

In 33 cases with VAs originating in the vicinity of the His bundle, the VAs were completely eliminated in 20 (60.6%) patients, the VAs significantly decreased in 6 (18.2%) patients, and the VAs remained

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