Postablation-acquired short atrioventricular Mahaim-type fibers: Observations on their clinical, electrocardiographic, and electrophysiologic profile

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BACKGROUND The electrophysiologic characteristics of decrementally conducting accessory pathways (APs) are well described; however, little is known about decrementally conducting APs caused by the radiofrequency ablation of a rapidly conducting AP.

OBJECTIVE To report the clinical, electrocardiographic, and electrophysiologic characteristics of 6 patients who developed a decremental AP after an attempt at ablation.

METHODS We compared the clinical and electrophysiologic characteristics of 295 consecutive patients with the Wolff-Parkinson-White syndrome who underwent radiofrequency ablation of 311 manifest APs (group A) with those of 6 patients with the Wolff-Parkinson-White syndrome in whom a decrementally conducting AP was detected after an attempt at ablation.

RESULTS The AP ablation site in group B patients was at the coronary sinus ostium region in 3 patients, middle cardiac vein in 2 patients, and left posteroseptal region in 1 patient. Sixty-two bypass tracts in group A patients and all 6 in group B patients were ablated at these locations, while 249 bypass tracts in group A patients and none in group B patients were ablated elsewhere ($P = .0001$). Five of the 6 patients (83%) with acquired Mahaim physiology had an AP located in the venous system. The odds for developing an acquired decremental antegrade atrioventricular AP when it was located inside the venous system were 1 in 6. All group B decremental APs were sensitive to adenosine, but none in 85 group A patients ($P < .0001$).

CONCLUSIONS The risk for developing decremental conduction after the ablation of a rapidly conducting AP is greater for APs inside the coronary venous system. Acquired decremental antegrade atrioventricular APs are electrophysiologically similar to de novo ones. They are capable of being part of an arrhythmia circuit and, therefore, should be targeted for ablation.

KEYWORDS Decrementally conducting accessory pathways; Mahaim fibers; acquired Mahaim fibers; Radiofrequency catheter ablation; Accessory pathways; Wolff-Parkinson-White syndrome; Adenosine

ABBREVIATIONS AP = accessory pathway; **AV** = atrioventricular; **ECG** = electrocardiogram; **RF** = radiofrequency; **VA** = ventriculoatrial

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Introduction

The electrocardiogram (ECG) during sinus rhythm in patients having both atrioventricular (AV) conduction over a manifest AV bypass tract and a decrementally conducting AP shows ventricular depolarization through the rapidly conducting AP. The presence of a Mahaim fiber is usually diagnosed after catheter ablation of the rapidly conducting AP, either because a minimal preexcitation pattern appears during sinus rhythm[1] or because it is brought out during atrial pacing at increasing rates. However, one should be suspicious of an iatrogenic slow and decrementally conducting AP when the preexcited QRS complex resembles the one recorded before ablation particularly when it is associated with a prolonged P-delta interval. Radiofrequency (RF) slow and decremental conduction in 1 patient with a previous rapidly conducting AP was first reported by Haissaguerre et al,[2] but there has been no systematic study about acquired decremental antegrade AV APs caused by the injury of a rapidly conducting AP.[3] The aim of our study was to describe the clinical and electrophysiologic characteristics of a cohort of 6 patients having a decrementally conducting AP following RF catheter ablation attempt in patients with AV conduction over a rapidly conducting AP, and to discuss the likely mechanisms for its occurrence.

Methods

Study population

A cohort of 301 consecutive patients with the Wolff-Parkinson-White syndrome who were referred for RF catheter ablation between January 2005 and December 2011 was

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Table 1 Comparative characterization of group A and group B patients

	Group A	Group B	*P*
n	295	6	
Male gender	172 (58%)	3 (50%)	ns
Age (y)	30 ± 15	26 ± 10	ns
APs			
Manifest	311	6	
Concealed	8	0	
Multiple APs			
2 APs	18	0	
3 APs	3	0	
AP site (manifest AP)			
Left free wall	95	0	
Anteroseptal	34	0	
Right free wall	36	0	
Right posteroseptal	69	0	
Coronary sinus ostium	15	3	<.0001
Middle cardiac vein	10	2	
Left posteroseptal	36	1	
Midseptal	16	0	
Conduction block with intravenous adenosine	0 of 85	6 of 6	<.0001
Additional heart disease			
Ebstein	3	0	
Reversible left ventricle dysfunction	2	0	
Hypertrophic cardiomyopathy	1	0	

AP = accessory pathway; ns = not significant.

retrospectively analyzed. Informed and written consent was obtained from study subjects. The study was approved by the Ethics Committee of Biocor Institute.

Group A had 295 patients with 311 rapidly antegrade conducting AV accessory pathways (APs) who underwent a successful RF ablation procedure. The group had 172 men (53%), with a mean age of 30 ± 15 years (range 8–81 years) (Table 1).

Group B had 6 patients with a single fast bidirectional conducting AV AP (except case 1 who had unidirectional anterograde conduction through the AP) developing slow AV conduction with decremental properties after an attempt at ablation (Figure 1 and Table 2). Three of the 6 patients were men (50%), with a mean age of 26 ± 10 years.

Exclusion criteria

Sixteen patients with variants of preexcitation—7 atriofascicular pathways, 6 fasciculoventricular pathways, and 3 short decrementally conducting AV APs—were excluded because decremental conduction was already present before ablation (6 of 7 atriofascicular fibers and 2 of 3 short AV fibers) or because they were diagnosed after the ablation of a rapidly conducting AP from a different site. The fasciculoventricular pathways were excluded because in them catheter ablation is not indicated.

Definition of terms

Decremental conduction

Decremental conduction is defined as cycle length–dependent prolongation of the impulse conduction time ≥ 30 ms through the AP.

Acquired decremental antegrade AV AP

Following the ablation attempt, each one of the 6 group B patients showed electrophysiologic criteria for a decrementally conducting bypass tract during atrial pacing, with progressive AH and AV interval prolongation coupled with a decreasing HV interval leading to a greater degree of ventricular preexcitation. These electrophysiologic properties are similar to decrementally conducting de novo AV AP.

Electrophysiologic study

Programmed electrical stimulation and recordings of the 12-lead surface ECG and intracardiac electrograms were made by using the EP Tracer (CardioTek BV, Maastricht, The Netherlands). Programmed electrical stimulation included atrial and ventricular pacing at increasing rates and extrastimuli during sinus rhythm and during atrial and ventricular pacing. The ventricular stimulation protocol with up to 3 extra stimuli was repeated during isoproterenol infusion. Group B patients underwent electrophysiologic assessment including pharmacologic testing with adenosine and isoproterenol when it became clear that the electrophysiologic properties of the AP changed after the ablation attempt. Programmed electrical stimulation was also repeated in all group A patients after the ablation of the AP. All group A patients were challenged with adenosine after ablation, but only 85 patients were challenged before ablation. Patients challenged with intravenous adenosine received a bolus of 6 μg followed by 12 μg, and up to 18 μg, until a significant effect on the AV nodal conduction was seen.

Statistical analysis

Values are given as mean ± standard deviation. The significance of differences ($P < .05$) in clinical, electrocardiographic, or electrophysiologic parameters between groups was assessed by using the Student *t* test or the Fisher exact test, using Stata 11 software.

Results

RF catheter ablation

Group A

We used a regular 4-mm-tip ablation catheter (DAIG, SJM, Minnetonka, Minnesota) in 285 patients. A 3.5-mm cool-tip (Biosense-Webster, Diamond Bar, California) ablation catheter (open-irrigated tip) was used in 8 of the 36 patients with a right free wall bypass tract and in 2 of the 10 patients with APs located in the middle cardiac vein.

Group B

We used an open-irrigated tip catheter in 3 of the 6 patients (case numbers 1, 2, and 6) in whom high impedance occurred, with a regular 4-mm-tip ablation catheter being used while ablating in the middle cardiac vein, the coronary sinus, and the origin of a posterior vein, respectively (20–25 W, 17 mL/min). The mean number of RF pulses was 2.5 ± 1.6 as compared with 5.6 ± 3.4 in group A (P = ns). Successful ablation was accomplished in 5 of the 6 patients using the same procedure.