Case reports

Facilitation of atrioventricular reentrant tachycardia by iatrogenic right bundle branch block

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The present case report describes the diagnosis of a concealed bypass tract in the right lateral wall revealed by electrophysiologic evaluation performed in a patient with rare palpitations. A iatrogenic right bundle branch block (RBBB) caused the occurrence of an incessant atrioventricular reentrant tachycardia. The disappearance of the RBBB determined a very difficult induction of the tachycardia that, when induced, showed a shorter cycle length and ventriculoatrial interval than those observed during RBBB tachycardia. The presence of a RBBB ipsilateral to the right free wall accessory pathway provided a critical delay within the circuit thus allowing the bypass tract to recover excitability. This relevant delay also allows the sinus beat to initiate and stabilize the tachycardia thus rendering it incessant.

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Introduction

In the Wolff-Parkinson-White syndrome and in the presence of concealed accessory pathways, the onset of atrioventricular orthodromic reentrant tachycardia is generally due to spontaneous or induced atrial or ventricular premature beats. When the blocked branch and the accessory pathway are ipsilateral, the appearance of a bundle branch block during tachycardia prolongs the cycle length[1-7].

We present a case of supraventricular tachycardia attributable to a concealed accessory pathway in which the appearance of a bundle branch block affected not only the tachycardia cycle length but also the modality of induction of the tachycardia.

Case report

A 24-year-old male athlete with a 6-month history of rare short lasting episodes of palpitations was referred to our institution for investigation. An ECG recording during symptoms was not available. An ECG performed in sinus rhythm showed a normal axis and intervals and there was no evidence of preexcitation. Physical examination was normal and echocardiography revealed no evidence of structural heart disease.

Having obtained the patient's informed consent, he was submitted to electrophysiological evaluation. Quadripolar diagnostic catheters were placed in the high right atrium, His bundle region and right ventricular apex; a decapolar diagnostic catheter was inserted into the coronary sinus. Complete right bundle branch block (RBBB) occurred during catheter placement. Soon after the occurrence of the RBBB a supraventricular tachycardia with a cycle length of 430 ms was induced by a sinus beat. This arrhythmia was incessant: in fact, following interruption by ventricular pacing or spontaneous ventricular extrasystoles, the tachycardia was immediately and continuously reinduced by sinus beats (Fig. 1). Figure 2 shows the endocavitary recordings of the spontaneous initiation of the tachycardia. The ventriculoatrial (VA) interval measured on the proximal His bundle recording was 246 ms and the earliest atrial activation was observed in the high right atrium. This suggested a diagnosis of atrioventricular orthodromic reentrant tachycardia (Fig. 3). In order to exclude a decremental slow-conducting anomalous pathway, ventricular extrastimuli with increasing degrees of prematurity were de-

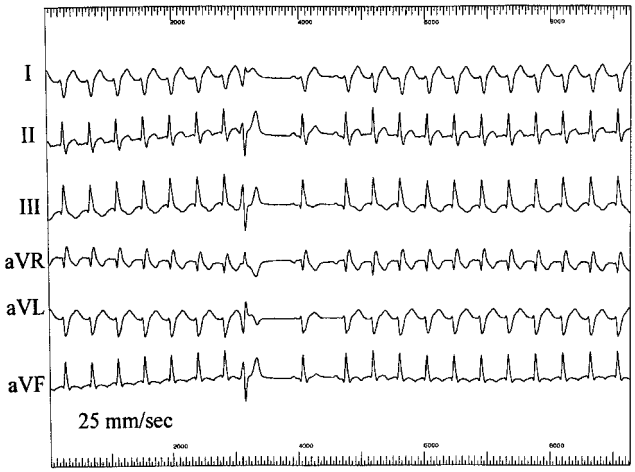

Figure 1. *The surface ECG shows the termination of the right bundle branch block tachycardia by a spontaneous ventricular extrasystole and the immediate reactivation of the tachycardia by a sinus beat. Paper speed of 25 mm/s.*

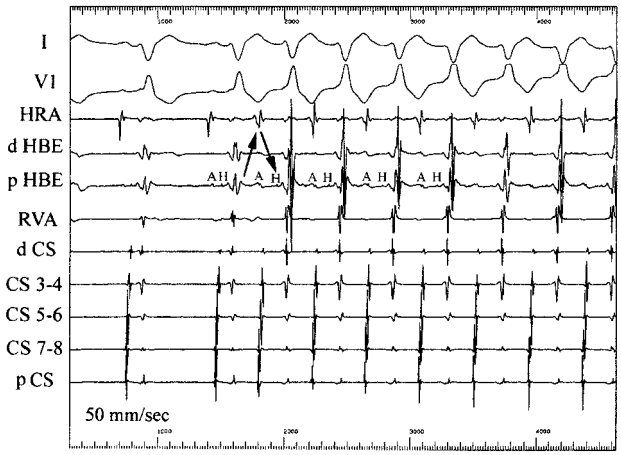

Figure 2. *Endocardial recordings and surface ECG.* From above: *D1, V1, high right atrium (HRA), distal (d HBE) and proximal His bundle (p HBE), right ventricular apex (RVA), distal coronary sinus (d CS); proceeding from the distal to the proximal coronary sinus: CS 3-4, CS 5-6, CS 7-8 and p CS. Activation of an atrioventricular reentrant tachycardia by a sinus beat. No AH delay is present. However, the right bundle branch block provides enough delay to allow the accessory pathway and the surrounding atrium to recover excitability. The first retrograde atrial activation was recorded in the HRA. Paper speed of 50 mm/s.*

livered during tachycardia. The VA interval did not show any significant variations (< 5 ms).

After some minutes, the RBBB disappeared. In sinus rhythm, the baseline intervals were normal. The VA conduction during ventricular pacing showed that the earliest atrial activation occurred in the high right atrium. Block of accessory pathway conduction occurred at a paced cycle length of 310 ms. The atrioventricular orthodromic reentrant tachycardia was not inducible by ventricular extrastimuli and induced only with difficulty by atrial extrastimuli or spontaneous atrial extrasystoles (Fig. 4). In comparison with the previous RBBB tachycardia, the cycle length and the VA interval were shorter (350 and 176 ms, respectively) while the atrial activation sequence was identical (Fig. 5).

During the tachycardia, a steerable mapping/ablation catheter was inserted. The earliest atrial activation was recorded on the tricuspid annulus at approximately the 9:00 o'clock position (Fig. 6). Radiofrequency energy was delivered at this site during the tachycardia and the arrhythmia was interrupted. Blockage of retrograde pathway conduction was achieved in less than 2 s.

The patient was then resubmitted to electrophysiological evaluation. There was no evidence of conduction over the accessory pathway: in fact, ventricular pacing showed decremental VA conduction with the concentric earliest atrial activation being recorded in the His bundle region. It was not possible to induce tachycardia by programmed atrial and ventricular stimulation.

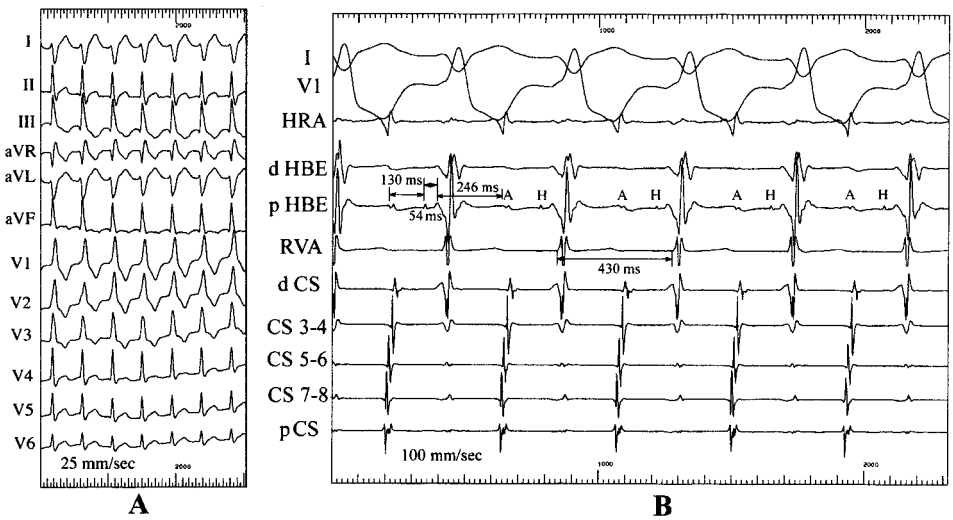

Figure 3. A: *12-lead ECG during right bundle branch block tachycardia. Paper speed of 25 mm/s.* B: *endocardial recordings and surface ECG during right bundle branch block atrioventricular reentrant tachycardia (the cycle length was 430 ms). The first retrograde atrial activation was recorded in the HRA. Paper speed of 100 mm/s. Abbreviations as in figure 2.*

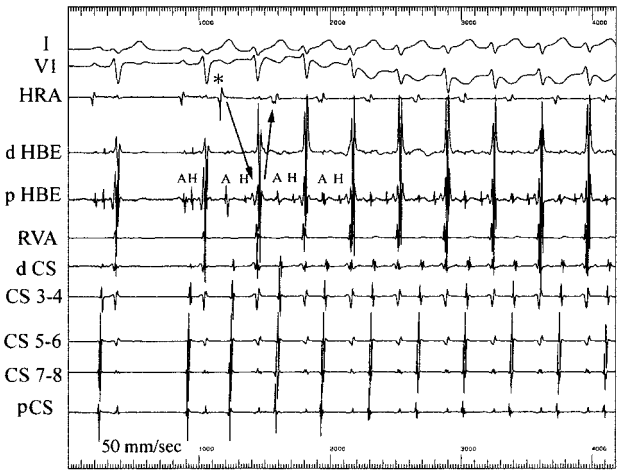

Figure 4. *Endocardial recordings and surface ECG. Activation of an atrioventricular reentrant tachycardia by a spontaneous atrial extrasystole (*) that produces enough AH delay to allow the accessory pathway to be successfully activated retrogradely. Paper speed of 50 mm/s. Abbreviations as in figure 2.*

Discussion

Atrioventricular reentrant tachycardia is the second most common form of supraventricular tachycardia[1]. In case of a concealed accessory pathway, the reentry circuit utilizes the normal atrioventricular conduction system as the anterograde limb and the anomalous pathway as the retrograde limb. During sinus rhythm the retrograde circuit cannot be completed because a concealed anterograde depolarization of the accessory pathway occurs and the activation of the normal conduction system is too rapid to allow recovery of excitability by the accessory pathway and the surrounding atrium (Fig. 7A).

Transient bundle branch block may spontaneously occur at the beginning of the tachycardia[1,2] or may be produced by catheter manipulation. The role of functional bundle branch block during tachycardia in determining the site of the anomalous pathway is well-known[3-7]. When the site of the anomalous pathway is ipsilateral to the bundle branch block, prolongation of the tachycardia cycle length is observed. This is due to an increase in the VA interval[4]. In fact, the bundle branch block produces a delay in the conduction of the impulse from the ventricle to the atrium because of the increased length of the ventricular part of the circuit. During atrioventricular reentrant tachycardia and bundle branch block, an increase in the VA interval equivalent to 30-35 ms or more indicates a free wall pathway location, ipsilateral to the side of the bundle branch block[5-7]. Left bundle branch block and RBBB, respectively in posteroseptal and anteroseptal accessory pathways, produce a shorter degree of VA prolongation[7]. In our patient the occurrence of RBBB caused a prolongation of the tachycardia cycle length with a 70 ms increase in the VA interval. Thus, it has been supposed that the accessory pathway was within the right free wall. This was confirmed by the atrial activation sequence on the endocardial recordings and by the site of successful ablation.

Interestingly, the occurrence of a iatrogenic RBBB determined a significant influence on the mode of tachycardia initiation. As well known, an atrioventricular reentrant tachycardia can be induced by either atrial or ventricular premature beats. The presence of a conduction delay in the circuit is always necessary for the activation of the tachycardia by an atrial premature beat. Such a delay must be long enough to permit full recovery of the excitability of the accessory pathway and the surrounding atrium. The delay may be localized in different sites of the circuit, most commonly in the atrio-

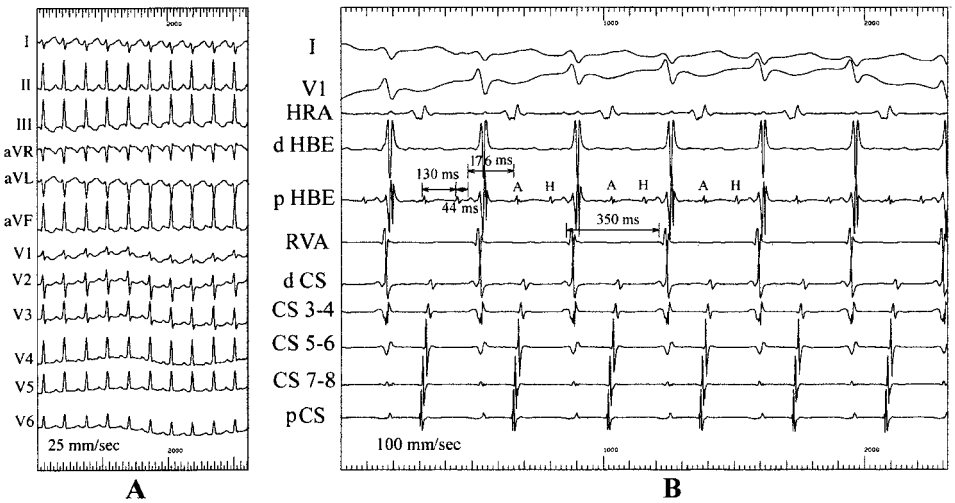

Figure 5. A: *12-lead ECG during a narrow QRS complex tachycardia. Paper speed of 25 mm/s.* B: *endocardial recordings and surface ECG during atrioventricular reentrant tachycardia without right bundle branch block (the cycle length was 350 ms). Note that the ventriculoatrial interval (measured on the p HBE) was 70 ms shorter than the corresponding ventriculoatrial interval during right bundle branch block tachycardia. Paper speed of 100 mm/s. The retrograde atrial activation sequence was the same as during the right bundle branch block atrioventricular tachycardia. Abbreviations as in figure 2.*

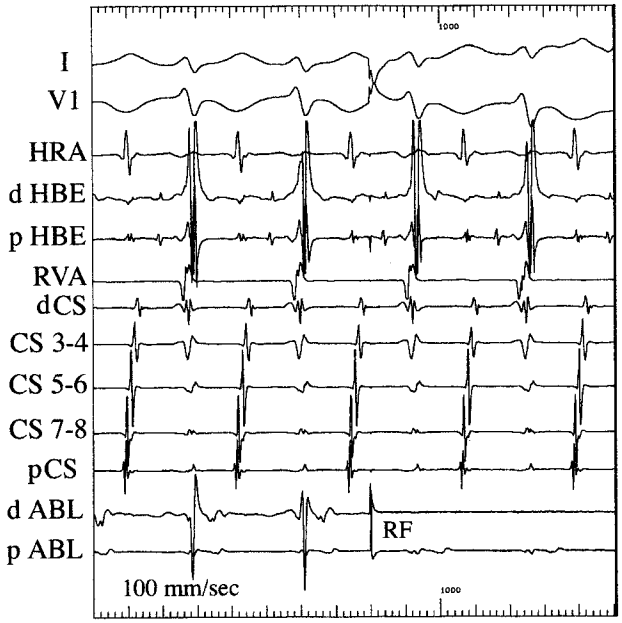

Figure 6. *Endocardial recordings at the site of successful radiofrequency (RF) ablation during atrioventricular reentrant tachycardia. d ABL and p ABL indicate the distal and proximal ablation catheter respectively. Other abbreviations as in figure 2.*

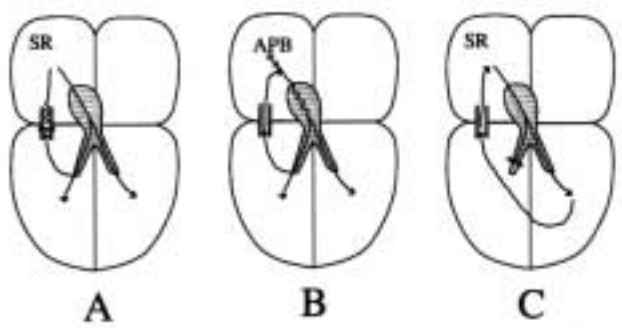

Figure 7. *Schematic representation of the effect of bundle branch block ipsilateral to the accessory pathway in the activation and maintenance of atrioventricular reentrant tachycardia.* A: *during sinus rhythm (SR) the accessory pathway and/or its atrial insertions are not capable of retrograde conduction because they are in the refractory period.* B: *an atrial premature beat (APB) can determine a critical intranodal delay thus allowing the accessory pathway to be activated retrogradely.* C: *the presence of a right bundle branch block ipsilateral to the right free wall accessory pathway provided a critical delay within the circuit allowing the bypass tract to recover excitability and thus the sinus beat to activate the tachycardia.*

ventricular node (Fig. 7B). This was the case when the narrow QRS atrioventricular reentrant tachycardia of our patient was induced by an atrial extrasystole. We observed, when the RBBB was present, a repeated onset of the tachycardia following sinus beats; in such cases the delay is not present in the atrioventricular node but it is due to the RBBB itself. In fact, since the bundle branch block produces a significant lengthening of the reentrant circuit localized in the ventricles, the anomalous pathway has more time to recover its excitability completely. Therefore, similar to permanent junctional reentrant tachycardia, this relevant intraventricular delay also allows the sinus beat to initiate and stabilize the tachycardia thus rendering it incessant[8] (Fig. 7C).

In conclusion, the bundle branch block ipsilateral to the accessory pathway was, in the present case report, important for the initiation and maintenance of the atrioventricular reentrant tachycardia. The *de novo* appearance of a bundle branch block ipsilateral to a known or unknown accessory pathway may cause a critical delay in the circuit such that the episodes of atrioventricular reentrant tachycardia become more frequent or incessant even if they had never or only rarely occurred previously.

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