Dissociation of right and left AV conduction: What is the mechanism?

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Introduction

Atrioventricular septal defect (AVSD) can be associated with supraventricular arrhythmias and atrial fibrillation (AF).[1] The position of the conduction system differs from the normal heart: the atrioventricular (AV) node is more posterior and inferior compared with the normal position in the triangle of Koch, in close relation with coronary sinus (CS) ostium.[2,3] We present a case of AF and atrioventricular nodal reentrant tachycardia (typical AVNRT) in a 43-year-old patient with a repaired AVSD, with a dissociation of the right atrium (RA) from the left atrium (LA) and coexistent sinus rhythm with junctional escape and typical AVNRT alternated, after ablation of the Bachmann bundle (BB).

Case report

A 43-year-old woman was referred to our hospital with symptomatic persistent AF unresponsive to antiarrhythmic drugs. She had a history of surgical repair for AVSD, closure of patent ductus arteriosus, and replacement of the mitral valve with a mechanical prosthesis and resection of subvalvular aortic stenosis. At admission to our hospital, the echocardiogram showed left atrial enlargement with normal right atrial dimension (RA area 12 cm^2; LA area 23 cm^2) and normal left ventricular ejection fraction (65%). In accordance with the patient's wishes, a catheter ablation was attempted. To aid navigation, preprocedural magnetic resonance imaging was performed. Two quadripolar and decapolar catheters (Supreme and Inquiry, St. Jude Medical, St. Paul, MN) were positioned in the right ventricular apex and in the CS. Following an uncomplicated transseptal puncture, a 3-D left atrial geometry was created with an irrigated ablation catheter (Thermocool-F, Biosense Webster Inc, Diamond Bar, CA) and then integrated with the magnetic resonance image using a 3-D mapping system (Carto-3, Biosense-Webster Inc). At the beginning of the procedure, we observed that the sinus wave reached the AV node with a distal-to-proximal CS activation and a delayed AV conduction (P-Q 280 ms) (Figure 1A–C). A circumferential pulmonary vein (PV) ablation was delivered until complete PV isolation. A voltage map showed low-voltage signals in the septum, roof, and posterior walls; thus additional ablation lines and substrate modification were made in these regions. During ablation, a nonsustained typical AVNRT (cycle length 580 ms, VA <70 ms, dual AV node conduction, ventricular pacing at a cycle length 20 ms shorter than supraventricular tachycardia with a V-A-V response, post-pacing interval–tachycardia cycle length >114 ms) was induced. After radiofrequency delivery in the anterosuperior septum (BB area, close to the right superior PV) (Figure 2B), sinus rhythm was recorded in the RA but not conducted to the LA and ventricular activation was induced by junctional rhythm (40–50 min) with 1:1 retrograde conduction to the LA (Figure 2) or by AVNRT (Figure 3). In this place, the length of the lesions required to transect the BB was 28 mm. Moreover, when no electrical impulse from the LA or directly from the AV node arose, we also observed an asystole, coexisting with sinus rhythm. At the end of the procedure, we recorded, with the ablation catheter placed in the RA, sinus signals dissociated from the left side (Figure 2). This dissociation was confirmed with pacing maneuvers in which the stimulus from CS 1/2 captured the LA but not the RA. By pacing from the ablation catheter, located not only in the triangle of Koch but in different regions of the RA, the stimuli were not able to capture the atrium in the CS, determining RA-LA dissociation (Figure 3C and D). The next day the patient received a dual-chamber pacemaker and 6 months later underwent a successful typical AVNRT ablation.

Discussion

Partial and intermediate AVSD constitute approximately 20%–40% of all AVSD.[4] Electrocardiogram abnormalities such as right bundle branch block, first-degree AV block, and, more rarely, second- and third-degree AV block are described in patients with AVSD even before surgical correction.[5,6] Moreover, previous studies [2-7] demonstrated a high incidence of AV nodal dysfunction, often revealed by

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KEY TEACHING POINTS

- The conduction system in patients with repaired atrioventricular septal defect (AVSD) differs from the normal heart.
- The AV node is often located more posteriorly and inferiorly in close relation to the coronary sinus ostium.
- After AVSD repair, the Bachmann bundle (BB) represents the only connection between the right and the left atrium.
- In these patients interruption of the BB results in a dissociation between the left atrium and the right atrium, leading to AV dissociation.

AV nodal tachycardia with uncommon properties. The cardiac conduction system differs from normal hearts, and several studies [2,3] in human hearts have described the His bundle morphology and position in AVSD. The AV node is located more posteriorly and inferiorly compared with the normal position in the triangle of Koch, in close relation to the CS ostium. Repair of an AVSD could be performed, as in our case, with the 2-patch technique, in which the atrial defect is closed with autologous pericardial patch or with the atrial component of the single patch. The CS could be maintained on the RA side or it is leaved on the left side. Aims of surgical repair of an AVSD are thus closing the interatrial communication and the interventricular communication by avoiding AV block induction. It is possible to avoid damage to the AV node and/or His bundle by staying on the right side of the septum and leave these structures in the LA. We supposed that the patch used to close the AV defect isolated the AV node and the CS ostium from the connections usually located in areas near the fossa ovalis. This hypothesis was also supported by the evidence of the first atrial activation recorded in CS distal (CS 1-2), during sinus rhythm achieved after electrical cardioversion before ablation. In this case the sinus wave propagated to the left side only via BB because the other connections between the RA and LA, usually located in areas near the fossa ovalis and the CS ostium,[8] were blocked by the patch used to replace the absent myocardium. For this reason, the ablation in the BB area determined a disconnection between right and left atrium in our patient and, therefore, the sinus wave could not reach the AV node and the ventricle could be activated only with impulses that arose from the left side or directly from the AV node (junctional rhythm or AVNRT). This results in complete right and left atrial AV dissociation.

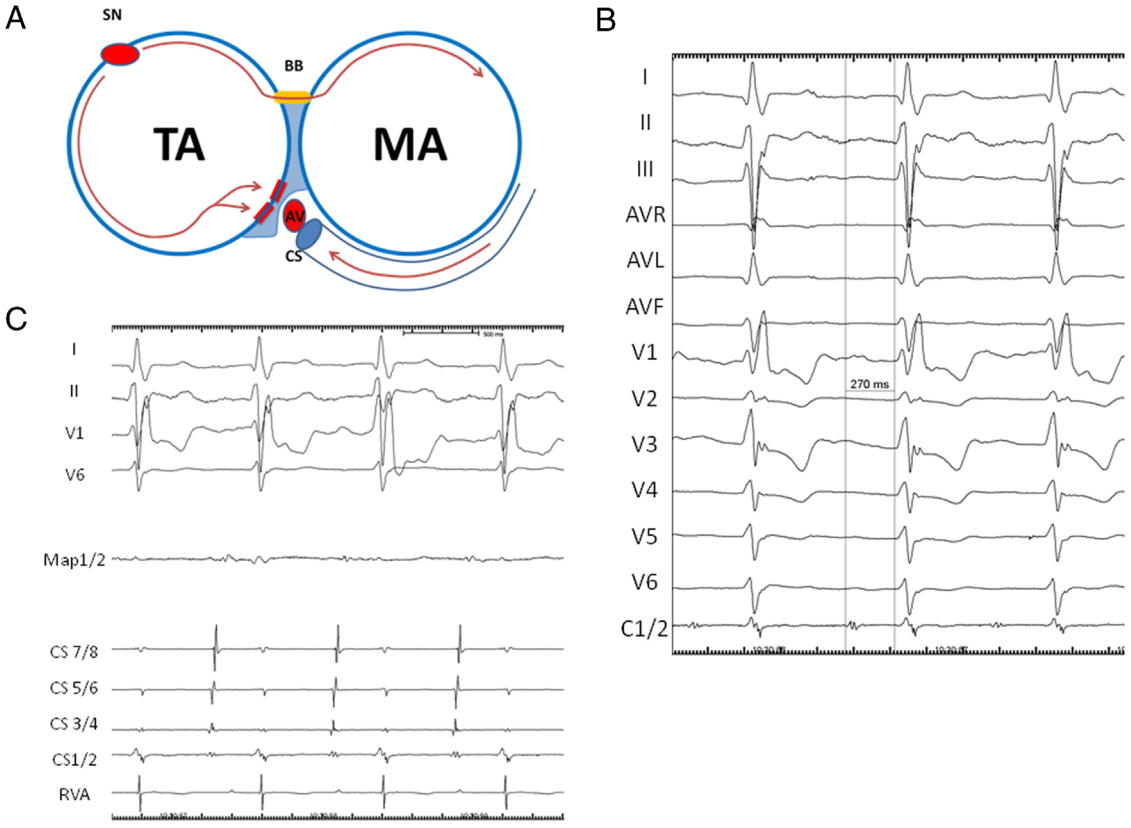

Figure 1 **A:** Schematic representation of the activation of the left atrium (LA) via the Bachmann bundle (BB). **B:** Corresponding 12-lead electrocardiogram with prolonged atrioventricular node (AV) (270 ms). **C:** During sinus rhythm after electrical cardioversion, the first atrial activation was recorded in coronary sinus (CS) distal (CS 1-2); map 1/2 was located in LA. MA = mitral annulus; SN = sinus node; TA = tricuspid annulus.

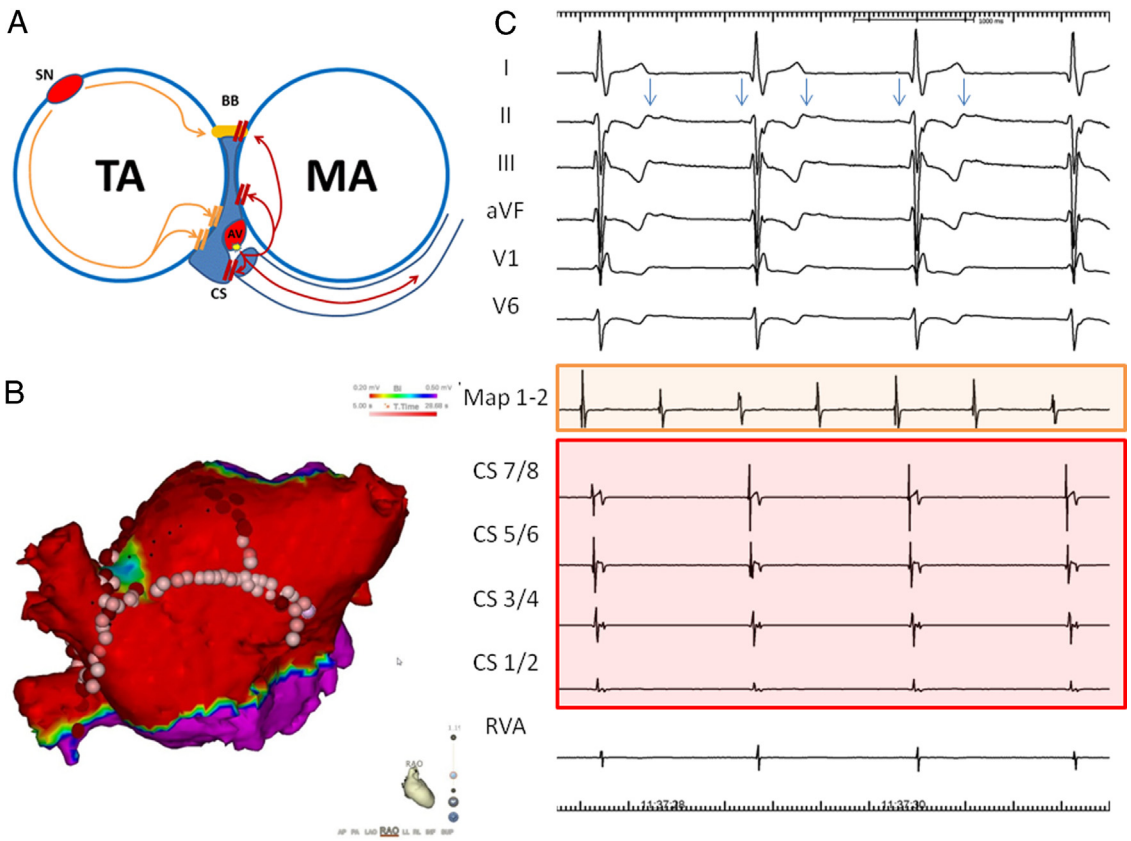

Figure 2 **A:** Schematic representation of sinus rhythm with Bachmann bundle (BB) block and a junctional escape rhythm conducted to the left atrium (LA). **B:** LA voltage map generated by Carto-3 in right anterior oblique view; red and rose dots represent the ablation points. **C:** Corresponding electrocardiogram shows a junctional escape rhythm and a sinus rhythm (*blue arrows*) dissociated; below the coronary sinus (CS) catheter recorded a junctional escape rhythm with 1:1 retrograde conduction to LA while Map 1-2, placed in right atrium (RA), recorded the sinus rhythm. In the transparent orange box, signal recorded from a catheter in RA; in the transparent red box, signal recorded from CS in LA. AV = atrioventricular node; MA = mitral annulus; SN = sinus node; TA = tricuspid annulus.

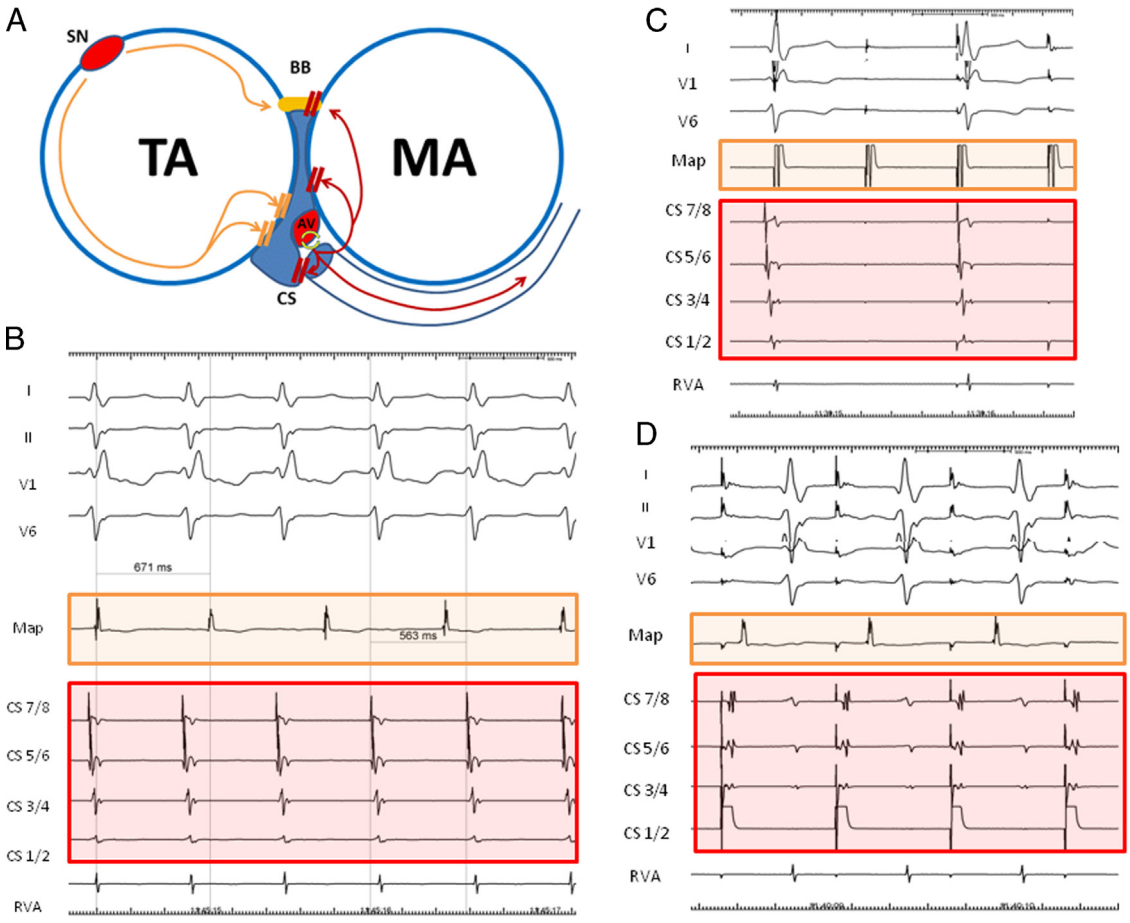

Figure 3 **A:** Schematic representation of sinus rhythm with Bachmann bundle (BB) block and atrioventricular nodal reentrant tachycardia (AVNRT). **B:** Coronary sinus (CS) catheter recorded typical AVNRT dissociated from the sinus signal recorded from the right atrium (RA), placed in RA. **C,D:** Pacing from RA (**C**) and CS 1/2 (**D**) shows an RA-left atrium dissociation. AV = atrioventricular node; MA = mitral annulus; SN = sinus node; TA = tricuspid annulus.

Conclusion

In a patient with repaired AVSD, ablation of the BB during catheter ablation of AF resulted in complete right and left atrial AV dissociation. To the best of our knowledge, this is the first reported patient.

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