

V-A-A-V Activation Sequence at the Onset of a Long RP Tachycardia: What is the Mechanism?

YOSHIAKI KANEKO, M.D., PH.D., TADASHI NAKAJIMA, M.D., PH.D., TADANOBU IRIE, M.D., PH.D., MASAKI OTA, M.D., TAKAFUMI IJIMA, M.D., PH.D., and MASAHIKO KURABAYASHI, M.D., PH.D.

From the Department of Medicine and Biological Science, Gunma University Graduate School of Medicine, Maebashi, Gunma, Japan

atrial tachycardia, atrioventricular nodal reentrant tachycardia, electrophysiological study, double atrial response

Case Presentation

A 52-year-old woman with a history of multiple episodes of paroxysmal supraventricular tachycardia underwent electrophysiologic studies and a catheter ablation procedure. The 12-lead electrocardiogram during tachycardia showed a long RP tachycardia with negative P waves in leads II, III, and aVF. At baseline, dual atrioventricular (AV) and ventriculoatrial (VA) nodal conduction was elicited by atrial and ventricular premature stimulation. During intravenous administration of isoproterenol, the earliest site of atrial activation during ventricular pacing was observed near the His bundle, and a previously recorded narrow QRS tachycardia was reproducibly induced by premature or rapid ventricular apical pacing, with an initial V-A-A-V activation sequence (Fig. 1). During tachycardia, the HA and AH intervals measured 71 and 342 milliseconds, respectively, and the earliest atrial activation was recorded at the ostium of the coronary sinus (CS). The earliest first "A" of the initial "V-A-A-V" activation sequence was recorded in the His bundle region, reflecting conduction over a fast pathway (FP), as was observed during ventricular pacing, while the second "A" was recorded near the CS ostium, as was observed during the tachycardia. The interval between the first and second "A" was often shorter than the subsequent tachycardia cycle length. Premature ventricular stimuli delivered during tachycardia while the His bundle was refractory did not reset the atrial cycle. From these observations, what is the mechanism of tachycardia?

Commentary

The differential diagnosis of a long RP tachycardia with the site of earliest atrial activation at the CS ostium (Fig. 1) includes: (a) a fast-slow type AV nodal reentrant tachycardia (AVNRT), (b) AV reentrant tachycardia (AVRT) using a slowly conducting posteroseptal accessory pathway as the retrograde limb, and (c) a septal atrial tachycardia (AT). The absence of atrial resetting by premature ventricular stimuli delivered during His-bundle refractoriness was consistent with the absence of retrograde atrial activation over an AP, though did not rule out its concealed presence. This case illustrates an important observation in the differential diagnosis of supraventricular tachycardia with an initial "V-A-A-V" sequence upon cessation of ventricular pacing. The atrial response (V-A-A-V or V-A-V) following cessation of entrainment or induction of the tachycardia by ventricular pacing provides useful diagnostic information to distinguish AT from AVNRT.¹ A "V-A-A-V" sequence is typically diagnostic of AT, whereas a "V-A-V" response excludes this diagnosis.¹ However, the study population upon which this criterion was defined¹ may have been biased by not including atypical AVNRT (which cannot be excluded on the basis of the "V-A-A-V" sequence), whereas typical AV nodal reentry, which was included in that study,¹ is unlikely to explain the second "A" of the "V-A-A-V" sequence, which occurs immediately after the first "A," caused by retrograde conduction through the AV node. Therefore, it is important to identify the origin of both "A" of an initial "V-A-A-V" activation sequence to distinguish atypical AVNRT from AT. In the case of AT, its induction by ventricular stimulation, though not inconceivable, is unlikely. Furthermore, because of the different sites of earliest activation of the first versus second "A," one can readily exclude a pseudo V-A-A-V response after the cessation of ventricular entrainment of atypical AVNRT, where the first and second "A" are produced by the penultimate and the last paced cycles, respectively, resulting in a long interval due to slow conduction over a slow pathway.² It is noteworthy that another initial "V-A-V" activation sequence, with the earliest "A" recorded at the CS ostium, was reproducibly observed when the tachycardia was induced by premature ventricular stimulation or by rapid pacing

J Cardiovasc Electrophysiol, Vol. 26, pp. 101–103

No disclosures.

Address for correspondence: Yoshiaki Kaneko, M.D., Ph.D., Department of Medicine and Biological Science, Gunma University Graduate School of Medicine, 3-39-22 Showa, Maebashi, Gunma 371-8511, Japan. Fax: +81-27-220-8158; E-mail: kanekoy@gunma-u.ac.jp

Manuscript received 14 August 2014; Revised manuscript received 20 August 2014; Accepted for publication 25 August 2014.

doi: 10.1111/jce.12534



Figure 1. Right ventricular apical (RVA) pacing at an S-S cycle length of 380 milliseconds induced a long RP tachycardia, with the earliest site of atrial activation at the ostium of the coronary sinus (A5-6), following an initial “V-A-A-V” electrogram sequence. The numbers between the atrial electrograms on the A 5-6 channel indicate the cycle length in milliseconds. See text for further explanations. I, II, and V₁ = surface electrocardiogram; HBE 1-2 and 3-4 = distal to proximal His bundle region; a 9-10 to 1-2 = proximal to distal CS recording.

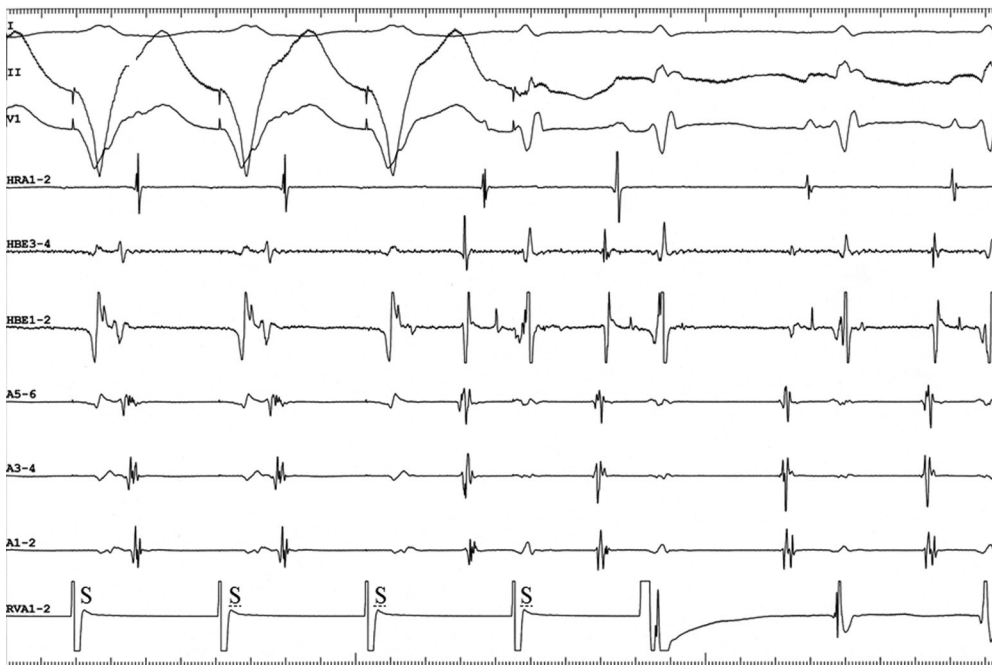


Figure 2. “V-A-V” activation sequence at the onset of supraventricular tachycardia induced by RV apical pacing at an S-S cycle length of 420 milliseconds. The first 2 paced cycles capture the atria with a short VA interval and the earliest site of atrial activation is recorded in the His-bundle region, consistent with retrograde conduction over a fast pathway. The 3rd paced cycle is blocked over the fast pathway, though activates the atrium near the ostium of the CS (A5-6) after a long VA interval, consistent with retrograde conduction over a slow pathway, followed by the onset of the tachycardia. The 4th pacing stimulus does not capture the RV apex. See text for further explanations. The abbreviations are the same as in Figure 1.

(Fig. 2), confirming the diagnosis of AVNRT. The “V-A-V” sequence was caused by atrial capture over a slow pathway, and conduction block over a refractory fast pathway. Thus, the initial “V-A-A-V” sequence is explained by dual atrial activation from the last ventricular paced cycle, where the

first “A” was produced by retrograde conduction over a fast pathway, and the second “A” by retrograde conduction over a slow pathway.^{3,4} To our knowledge, the induction of atypical AVNRT by an initial “V-A-A-V” or “V-A-V” in the same patient is probably rare.⁵⁻⁷ This case shows that a “V-A-A-V”

response observed upon cessation of ventricular pacing is not an electrophysiological proof of diagnosis of AT.

Presuming a diagnosis of atypical AVNRT, we proceeded with the ablation of a slow pathway in the posteroseptal right atrium, near the CS ostium, at the site of earliest retrograde atrial activation. This was associated with a junctional rhythm during delivery of radiofrequency energy and eliminated the inducible tachycardia.

References

1. Knight B, Zivin A, Souza J, Flemming M, Pelosi F, Goyal R, Man C, Strickberger A, Morady F: A technique for the rapid diagnosis of atrial tachycardia in the electrophysiology laboratory. *J Am Coll Cardiol* 1999; 33:775-781.
2. Vijayaraman P1, Lee BP, Kalahasty G, Wood MA, Ellenbogen KA: Reanalysis of the "pseudo A-A-V" response to ventricular entrainment of supraventricular tachycardia: Importance of his-bundle timing. *J Cardiovasc Electrophysiol* 2006;17:25-28.
3. Yamabe H, Okumura K, Tabuchi T, Tsuchiya T, Yasue H: Double atrial responses to a single ventricular impulse in long RP' tachycardia. *Pacing Clin Electrophysiol* 1996;19(4 Pt 1):403-410.
4. Lin FC, Yeh SJ, Wu D: Double atrial responses to a single ventricular impulse due to simultaneous conduction via two retrograde pathways. *J Am Coll Cardiol* 1985;5:168-175.
5. Yeh SJ, Yamamoto T, Lin FC, Wu D: Atrioventricular block in the atypical form of junctional reciprocating tachycardia: Evidence supporting the atrioventricular node as the site of reentry. *J Am Coll Cardiol* 1990; 15:385-392.
6. Man KC, Brinkman K, Bogun F, Knight B, Bahu M, Weiss R, Goyal R, Harvey M, Daoud EG, Strickberger SA, Morady F: 2:1 atrioventricular block during atrioventricular node reentrant tachycardia. *J Am Coll Cardiol* 1996;28:1770-1774.
7. Lee PC, Hwang B, Tai CT, Hsieh MH, Chen YJ, Chiang CE, Chen SA: The electrophysiological characteristics in patients with ventricular stimulation inducible fast-slow form atrioventricular nodal reentrant tachycardia. *Pacing Clin Electrophysiol* 2006;29:1105-1111.