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Response to His-refractory premature atrial complex with antegrade and retrograde septal depolarization: What is the mechanism?

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1 | EPS FOR RESIDENT PHYSICIANS

A 38-year-old woman was evaluated for a 2-year history of intermittent palpitations. She had previously presented to the emergency room with wide complex SVT, which was terminated by intravenous adenosine. In the electrophysiology laboratory, during the introduction of the venous sheaths and catheters, the patient had spontaneous sustained wide complex tachycardia with left bundle brunch block (LBBB) morphology. Responses to two different His-refractory premature atrial complexes (PAC) from the lateral right atrium are given in Figure 1 (arrows in A and B). What is the mechanism of the tachycardia?

2 | DISCUSSION

The differential diagnosis of a regular wide QRS tachycardia with 1:1 atrioventricular (AV) association includes (a) orthodromic reentrant tachycardia (ORT) with aberrancy; (b) atrial flutter or atrial tachycardia with ventricular preexcitation; (c) antidromic reentrant tachycardia (ART) with retrograde conduction through bundle branch–His–AV node axis; (d) preexcited tachycardia due to pathway-to-pathway (duodromic) conduction (e) atrioventricular nodal reentrant tachycardia (AVNRT) with bystander accessory pathway conduction; (f) ORT with bystander activation of ventricles using another pathway; (g) ventricular tachycardia (VT) or bundle brunch reentry tachycardia (BBRT); (h) junctional tachycardia (JT) with aberrancy or fasciculoventricular (FV) connection; and (i) antidromic atriofascicular (AF), nodofascicular (NF) or nodoventricular (NV) reentrant tachycardia (NFRT/NVRT).[1,2]

Several clinical characteristics are useful for the appropriate diagnosis of a wide-QRS tachycardia. In 1988, when Tchou et al. reported the role of a late APC in differentiating AF from NF fiber in a single patient.[3] Advancement of ventricular activation by an APC at a time when the septal atrium (proximal CS) has been already (retrogradely) depolarized followed by resetting of the tachycardia in patients with decrementally conducting accessory pathway is a helpful maneuver to prove pathway existence and participation in the circuit.[3,4] Whereas the failure of an APC to advance ventricular activation is usually regarded as an argument favoring the presence of an AF or NF fiber, the ventricular advancement response to APC is a diagnostic feature of an AF pathway (Mahaim pathway)[3] and also rules out a myocardial VT. However, it is difficult to differentiate the AF pathway from the manifest NFRT/NVRT or even AVRT with bystander AF/NF/NV pathways. Since both right-sided AF Mahaim pathway and NFRT have same electrophysiological exit into the right bundle, both tachycardias have same morphology of LBBB tachycardia involving anterograde conduction over an AF or NF pathway and retrograde conduction over the His bundle and AV node. Therefore, whether there is septal (proximal CS) refractoriness

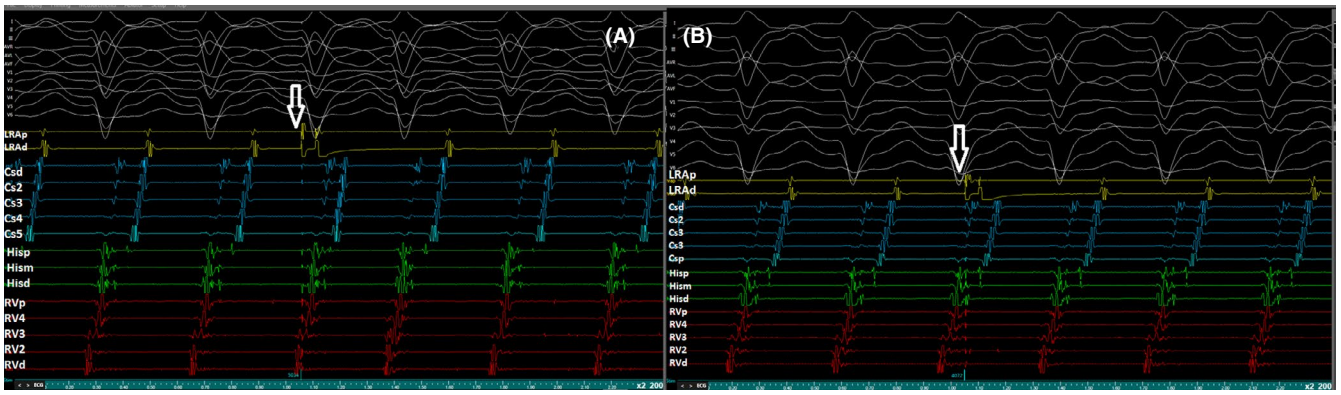

FIGURE 1 (A) A His-refractory PAC advances the ventricular electrogram by 60 ms without changing the QRS morphology. The advanced ventricular electrogram, in turn, advances the retrograde His and septal (proximal CS) atrial electrogram without changing the atrial activation sequence. The ventricular advancement following the early PAC was preceded by the advancement of atrial electrogram in the His region suggesting that antegrade conduction has happened through the AV node (Early PAC cause anterogradely *septal activation*). This response excludes the VT but not differentiate the atriofascicular ART from the NF/NVRT or AVNRT with bystander Mahaim fiber. (B) A His-refractory PAC advances the ventricular electrogram by 20 ms without changing the QRS morphology. The advanced ventricular electrogram, in turn, advances the retrograde His and septal (proximal CS) atrial electrogram without changing the atrial activation sequence. Late PAC during already retrogradely activated *septal/AV node region* advances ventricular activity indicating antegrade conduction via an active AF rather than a bystander AF or NF accessory pathway. Therefore, the classical response of antidromic AF Mahaim tachycardia to PAC delivered during septal refractoriness is an advancement of the QRS, without a change in QRS morphology and septal A-A interval. LRA, low right atrium; Cs, coronary sinus; RV, right ventricle

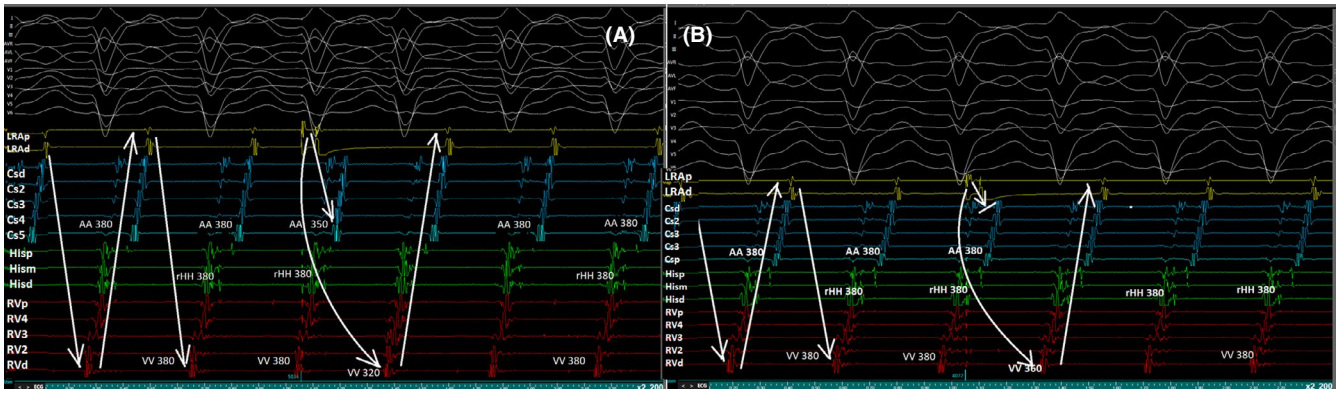

FIGURE 2 (A) A His-refractory PAC advances the ventricular electrogram by 60 ms without changing the QRS morphology. The advanced ventricular electrogram, in turn, advances the retrograde His and septal (proximal CS) atrial electrogram without changing the atrial activation sequence. The ventricular advancement following the early PAC was preceded by the advancement of atrial electrogram in the His region suggesting that antegrade conduction has happened through the AV node (Early PAC cause anterogradely *septal activation*). This response excludes the VT but not differentiate the atriofascicular ART from the NF/NVRT or AVNRT with bystander Mahaim fiber. (B) A His-refractory PAC advances the ventricular electrogram by 20 ms without changing the QRS morphology. The advanced ventricular electrogram, in turn, advances the retrograde His and septal (proximal CS) atrial electrogram without changing the atrial activation sequence. Late PAC during already retrogradely activated *septal/AV node region* advances ventricular activity indicating antegrade conduction via an active AF rather than a bystander AF or NF accessory pathway. Therefore, the classical response of antidromic AF Mahaim tachycardia to PAC delivered during septal refractoriness is an advancement of the QRS, without a change in QRS morphology and septal A-A interval. LRA, low right atrium; Cs, coronary sinus; RV, right ventricle

via retrograde depolarization is utmost important for the evaluation of His-refractory PAC response.[2,4,5] Considering that normal intra-atrial conduction time takes 20-50 ms, atrial stimulation from the lateral wall affords a wider window of stimulation than stimulating from the septum because of the time interval that the excitation wavefront takes to depolarize the atrial septal region.[4] Therefore, showing the antegrade or retrograde depolarization/refractoriness of the AV node by septal/proximal CS electrocardiogram is essential, and this maneuver also rules out other forms of AVNRT with bystander preexcitation (such as NV or NFRT) because these tachycardias would also require a PAC to penetrate the septal atrium for termination.[4]

In current case, both His-refractory APCs (Figures 1 and 2) placed at the right atrial free wall advance the ventricular electrogram

without changing the QRS morphology (which excludes the VT) and reset the tachycardia without changing the VH or VA interval and the retrograde atrial activation sequence (which excludes the bystander pathway-to-pathway connection) remaining the possibilities of active or passive (bystander) AF or NF/NV pathways. However, whereas the first His-refractory APC (Figures 1A and 2A) captured the septal (proximal CS) atrial electrocardiogram anterogradely, the second His-refractory APC (Figures 1B and 2B) could not capture the septal atrial region anterogradely making the AV node was refractoriness by retrograde activation, and confirms the diagnosis was AF pathway (Mahaim) tachycardia. Whereas the only one His-refractory APC is not enough in differentiating the Mahaim pathway from Kent pathway; however, a series of progressively tighter His-refractory PACs to reveal to pathway's decrementality is also discriminative between them.[3] There was a Mahaim potential at the successful ablation point of lateral tricuspid annulus (Figure S1). Distinguishing between an antegrade His (proximal to distal activation sequence on His catheter) and the retrograde His (distal to proximal activation sequence on His catheter) is critical in the interpretation of pacing maneuvers or complex cases involving wide QRS tachycardia. The retrograde His activation is compatible with ART or VT and excludes the supraventricular tachycardia with aberrancy. However, in the current case, both His-refractory PAC causes the retrograde His (distal to proximal)-activation sequence (Figures 1 and 2), and excludes the AVNRT with LBBB. This case highlights the importance of the early vs late His-refractory APC response in differentiating AF pathway ART from AV node-linked NF/NVRTs.

CONFLICT OF INTEREST

Authors declare no conflict of interests for this article.

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REFERENCES

1. Topaloglu S, Ozeke O, Cay S, Ozcan F, Koca S, Aras D. Wide QRS complex supraventricular tachycardia with negative precordial concordance: Electrocardiographic clues for Mahaim pathway with Ebstein anomaly. J Electrocardiol. 2018;51:663–6.
2. Thajudeen A, Namboodiri N, Choudhary D, Valaparambil AK, Tharakan JA. "Classical" response in a pre-excited tachycardia: what are the pathways involved? Circ Arrhythm Electrophysiol. 2013;6:e11–e16.
3. Tchou P, Lehmann MH, Jazayeri M, Akhtar M. Atriofascicular connection or a nodoventricular Mahaim fiber? Electrophysiologic elucidation of the pathway and associated reentrant circuit. Circulation. 1988;77:837–48.
4. Sternick EB, Lokhandwala Y, Timmermans C, Gerken L, Soares F, Dias L, et al. Atrial premature beats during decrementally conducting antidromic tachycardia. Circ Arrhythm Electrophysiol. 2013;6:357–63.
5. Mohanan Nair KK, Namboodiri N, Abhilash SP, Prabhu M, Das D, Valaparambil A. Classical response of antidromic atriofascicular tachycardia to premature atrial extrastimulus delivered during septal refractoriness. J Cardiovasc Electrophysiol. 2019. https://doi.org/10.1111/jce.13931 [Epub ahead of print].

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