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SPOTLIGHT

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Discrepant results of the total pacing prematurity in orthodromic reciprocating tachycardia with right bundle branch block

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Ventricular overdrive pacing (VOP) during supraventricular tachycardia (SVT) is an important technique for differentiating the mechanisms of SVTs. The difference between the postpacing interval (PPI) and tachycardia cycle length (TCL) is a representative tool to distinguish orthodromic reciprocating tachycardia (ORT) using accessory pathways (APs) from atrioventricular nodal re-entrant tachycardia (AVNRT).[5,6] The total pacing prematurity (TPP) is a valuable alternative to the PPI–TCL when the SVT terminates during VOP.[1,2] The TPP is defined as the sum of the prematurity of each stimulus (tachycardia cycle length [TCL]–pacing cycle length [PCL]) until the first atrial resetting or tachycardia termination, calculated by the TCL–PCL multiplied by the number (n) of stimuli needed to reset the atrium or terminate the tachycardia. A previous study proved that a TPP <125 ms had a good diagnostic value for diagnosing ORT with a sensitivity of 75% and specificity of 100%.[2] Those with false negative results had left anterolateral or left lateral APs, which has little problem in diagnosing SVTs. However, we encountered a case of an ORT via a left posterior AP that exhibited a TPP ≥125 ms.

An 88-year-old woman with persistent right bundle branch block (RBBB) was referred to our hospital for catheter ablation of a symptomatic regular tachycardia (Figure 1). After obtaining informed consent, four multi-electrode catheters were placed in the high right atrium (HRA), His bundle, coronary sinus (CS), and right ventricular apex (RVA). At baseline, the atrio-His (AH) and His-ventricular intervals were 92 and 37 ms, respectively. The His-RVA interval was 127 ms, probably because of the RBBB, whereas the difference between the QRS onset and the local RVA electrograms was 90 ms. On the other hand, the earliest retrograde atrial activation site during RVA pacing was at the CS ostium. The ventriculo-atrial (VA) conduction time was 132 ms, and it did not have a decremental property. Atrial extra-stimuli from the HRA exhibited decremental conduction, and it reproducibly induced the clinical tachycardia without evidence of jump-up (basic cycle length [BCL] 500 ms, S1S2 275 ms) with a V-A-V sequence.

During the tachycardia, the AH and His-atrial intervals were 150 and 205 ms, respectively. The tachycardia exhibited 1:1 atrioventricular conduction, and the atrial activation sequence during the tachycardia was identical to that during the RVA pacing. After adjusting the position of the CS catheter to record the ostial electrograms, we performed pacing maneuvers during the tachycardia. A ventricular stimulus delivered when the His bundle was refractory successfully reset the tachycardia (Figure 2A). VOP with a cycle length of 340 ms from the RVA repeatedly terminated the tachycardia, but the atrium was electrically captured during the fusion period and transitional zone.[3] These findings supported that the tachycardia was that of an ORT using a posterior AP. However, an analysis when terminating the tachycardia revealed that the TPP needed to reset or terminate the tachycardia was 144 ms, which was not compatible with ORT (Figure 3).

After the transseptal puncture, we inserted an Agilis NxT Steerable Sheath (Abbott, Chicago, IL) into the left atrium. The earliest atrial activation site was mapped during the ORT using a mapping catheter (Thermocool ST SF, Biosense Webster, Irvine, CA), which was located on the 6–7 o'clock position of the mitral valve annulus. Radiofrequency energy applications with 40 W successfully terminated the ORT, which could no longer be induced thereafter (Figure 2B). At the time of this writing, 12 months after the procedure, there has been no recurrence of the tachycardia.

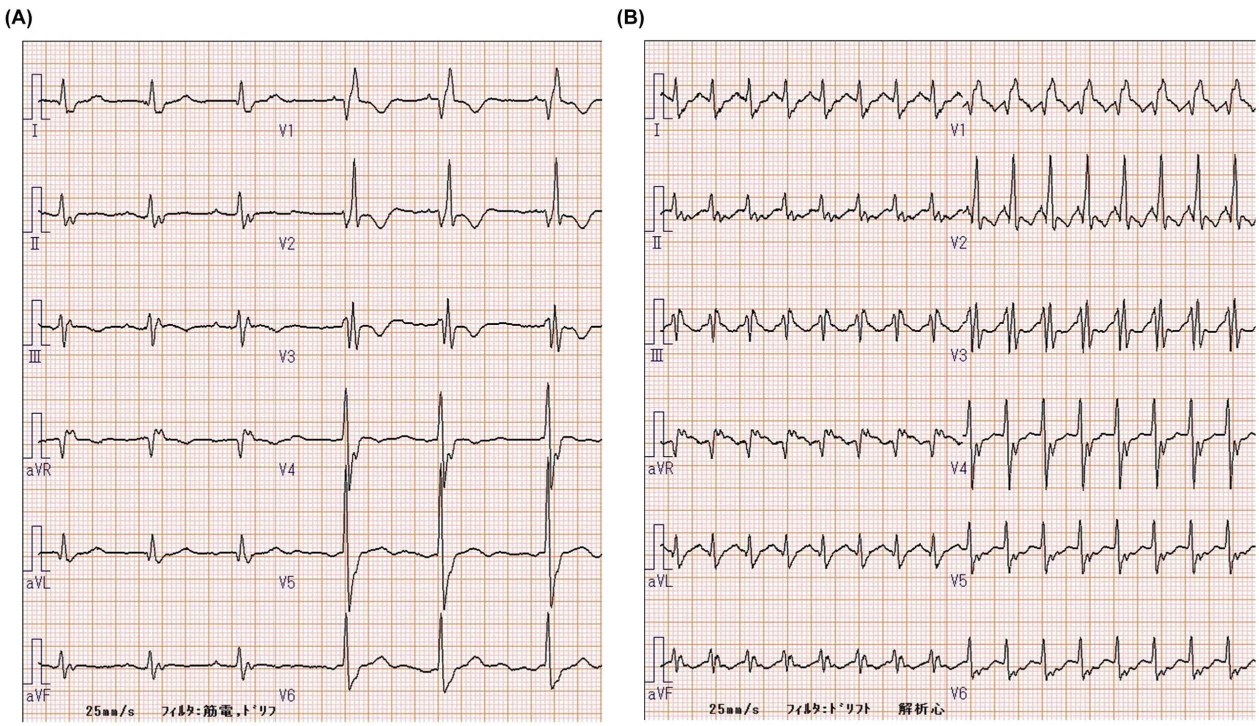

FIGURE 1 The 12-lead electrocardiograms during sinus rhythm (A) and the tachycardia (B).

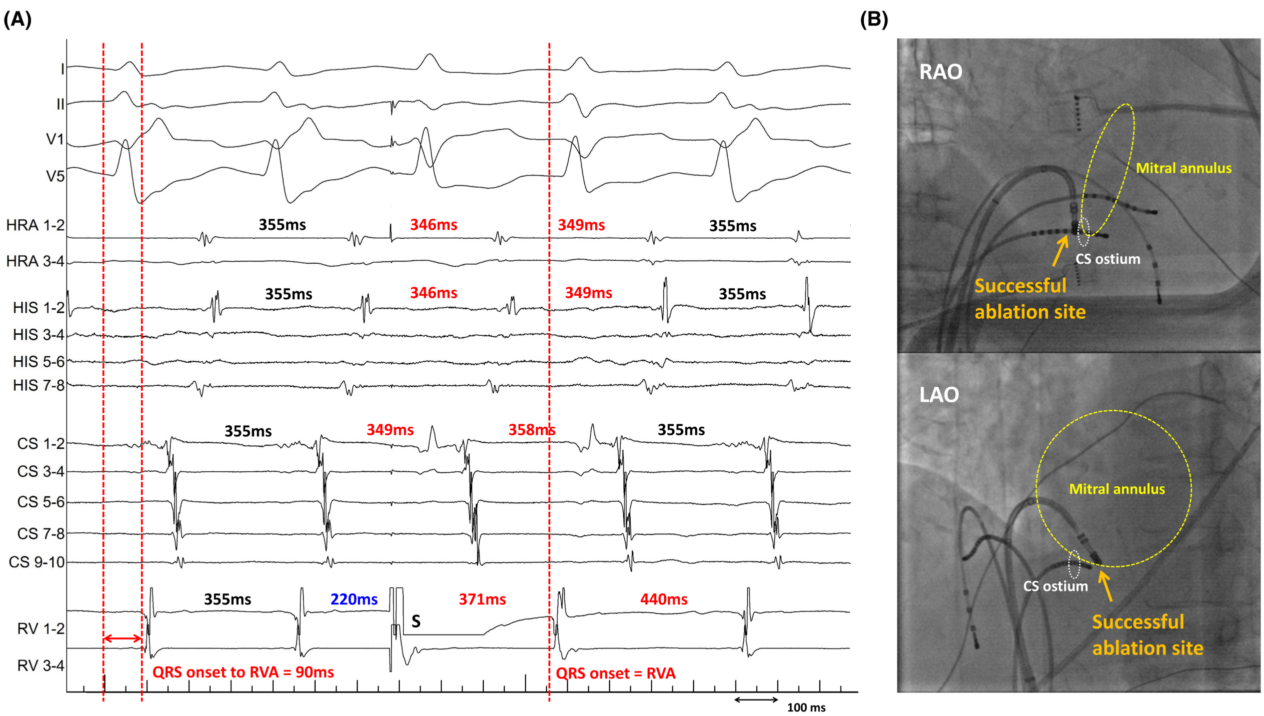

FIGURE 2 (A) Intracardiac electrograms that show the resetting phenomenon by a ventricular extra-stimulus. Because of the unrecordable His bundle electrograms, right ventricular extra-stimulus pacing was performed during the estimated His bundle refractory period (40 ms prior to the QRS onset). The extra-stimulus advanced the subsequent atrial electrograms with an identical activation sequence, suggesting the presence of an accessory pathway. The QRS onset to the RVA interval was 90 ms (equal to the baseline) and 0 ms during the RBBB morphology and narrow QRS complex (the subsequent beat of the His refractory pacing), probably because of the recovered right bundle branch conduction (i.e., "peeling back" of refractoriness). (B) Fluoroscopic image of the successful ablation site. The CS catheter was placed from the CS ostium toward the major cardiac vein to record both atrial and ventricular potentials near the earliest atrial activation site. Radiofrequency energy applications to the left posterior accessory pathway successfully terminated the tachycardia. CS, coronary sinus; His, His bundle; HRA, high right atrium; RBBB, right bundle branch block; RV, right ventricle; TCL, tachycardia cycle length.

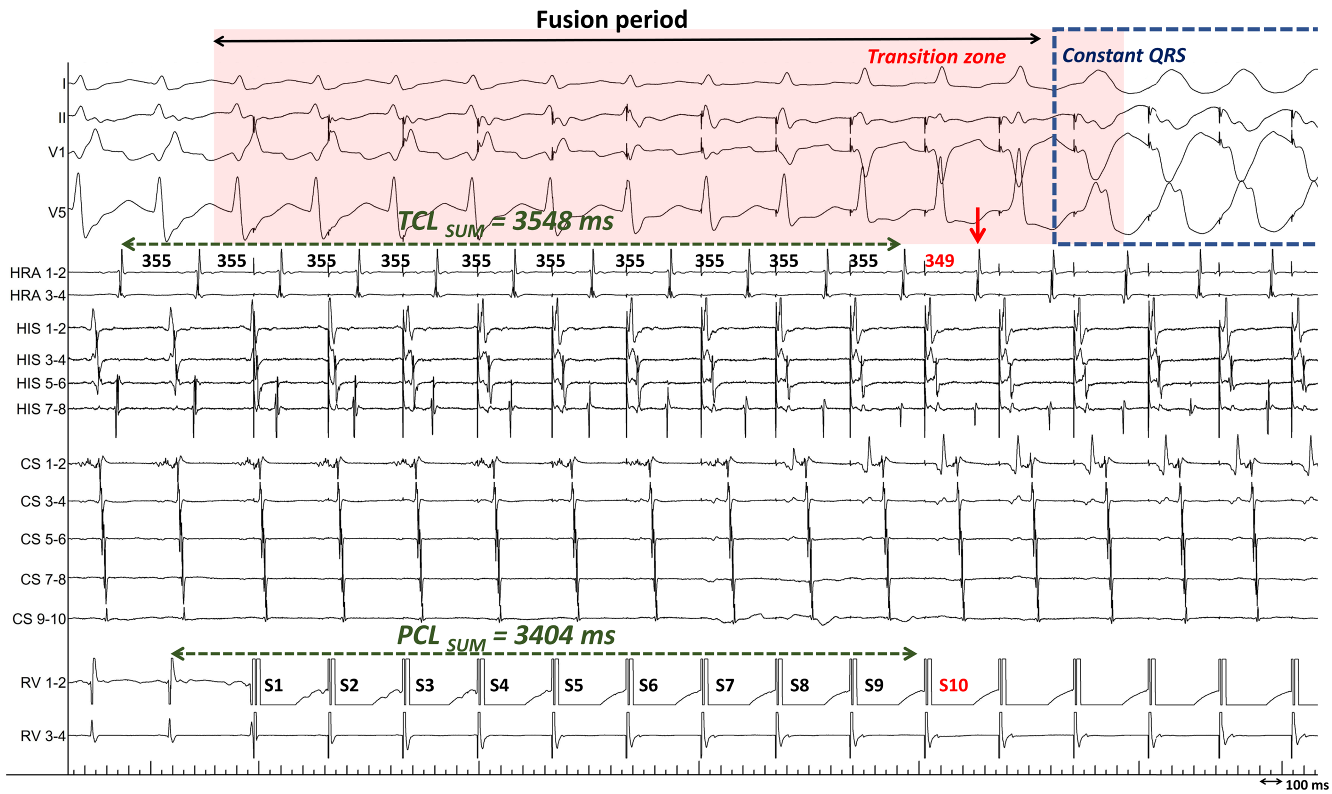

FIGURE 3 Intracardiac electrograms during VOP from the RV apex. The tachycardia was terminated after the atrium was reset with the 10th ventricular stimulus (S10). The TCL_{SUM} was measured with a digital caliper as 10 atrial cycle lengths immediately before atrial resetting, whereas the PCL_{SUM} was measured as 10 pacing intervals (the interval from the ventricular electrogram just before the initiation of pacing to the resetting stimulus [S10]). The TPP was simply calculated by subtracting the PCL_{SUM} from the TCL_{SUM} (3548–3404 ms = 144 ms). The amount of tachycardia advancement during the first atrial reset was 6 ms. The predicted PPI–TCL was calculated as the TPP minus the tachycardia advancement (144–6 ms = 138 ms). PCL, pacing cycle length; PPI, postpacing interval; TPP, total pacing prematurity; VOP, ventricular overdrive pacing; the other abbreviations are as in Figure 2.

This case highlights the importance of considering RBBB and a transseptal conduction delay when performing VOP from the RVA. A previous study showed that there is a longer PPI–TCL in patients with ORT using a left-sided AP than in ORT using a right-sided AP.[4] The PPI–TCL is the sum of the time that the last pacing wavefront enters the tachycardia circuit and returns back to the pacing site from the circuit.[5,6] Thus, the transseptal conduction time from the RVA to the left-sided ORT circuit may explain the longer PPI–TCL in patients with ORT using a left-sided AP. Therefore, it can be inferred that RBBB and a transseptal conduction delay would further increase the PPI–TCL when evaluating an ORT via a left-sided AP. Conversely, the TPP represents the time that the RVA pacing wavefront collides with the tachycardia wavefront and proceeds to enter the tachycardia circuit.[1,2] Similar to the PPI–TCL, the transseptal conduction time would affect the results when the re-entrant circuit is located on the left side of the heart. Therefore, RBBB and the resulting prolonged transseptal conduction would further increase the TPP, and the conventional diagnostic criteria of 125 ms may not be optimal. Certainly, the degree of the transseptal conduction delay would vary even among patients with RBBB according to the presence of retrograde RBBB or intrinsic myocardial conduction. However, unrecordable His recordings made it difficult to draw a definitive conclusion. In addition, it is important to acknowledge various modifying factors that could also affect the results of the TPP (e.g., the right ventricular pacing location, pacing cycle length, and AP locations). Nevertheless, we believe that this case provides an important notion that the optimal cutoff value of the TTP can differ between patients with and without RBBB.

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CONFLICT OF INTEREST STATEMENT

The authors have nothing to disclose.

DATA AVAILABILITY STATEMENT

All the necessary data supporting the findings of this case report are included within the article.

ETHICS STATEMENT

Approval was obtained from the local ethics committee.

DECLARATIONS

Approval of the research protocol: Approval was obtained from the local ethics committee.

Informed consent: Patient consent for publication was obtained.

Registry and registration no. of the study/trial: Not applicable.

Animal studies: Not applicable.

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