

CASES AND TRACES

Supraventricular Tachycardia With Something Missing

ECG CHALLENGE

A 7-year-old girl was referred for electrophysiological study and catheter ablation for incessant supraventricular tachycardia that was terminated with intravenous adenosine but was refractory to oral metoprolol and sotalol (Figure 1). There were cycles in which no atrial activation could be observed in leads I and V₁ without a change in the R-R interval (Figure 2). For this supraventricular tachycardia (SVT) with intermittently missing P waves, can you determine the mechanism?

Please turn the page to read the diagnosis.

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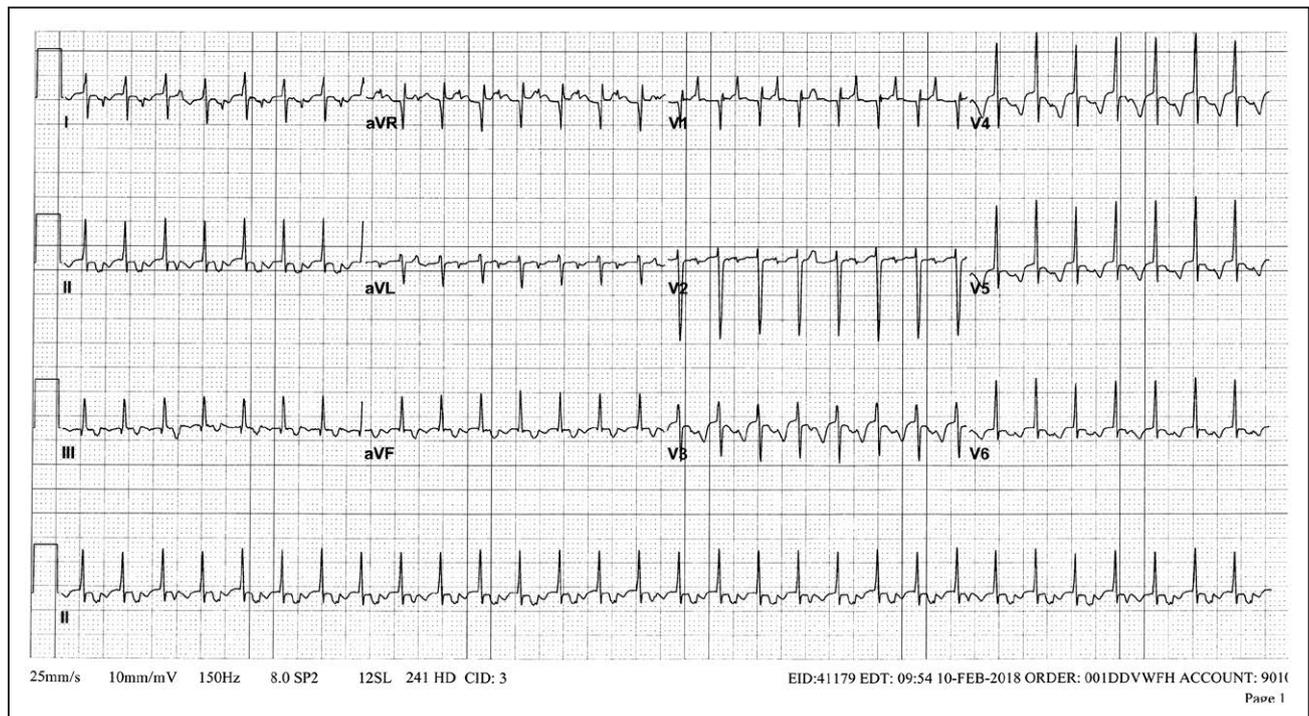


Figure 1. Twelve-lead ECG demonstrating a regular, narrow complex supraventricular tachycardia at a rate of 183 bpm.

The RP interval measures 125 ms and the PR interval measures 195 ms.

RESPONSE TO ECG CHALLENGE

The ECG demonstrates a regular SVT with an RP interval of 125 ms and a PR interval of 195 ms. Note that the P waves have a very short duration and are markedly upright in lead V₁ and inverted in leads II, III, and aVF. These features suggest atrial activation near the region of the crux. The missing P waves indicate retrograde block to the atria and exclude arrhythmias that are dependent on atrial activation such as atrial tachycardia or orthodromic atrioventricular reciprocating tachycardia utilizing a retrograde conducting accessory pathway, including the permanent form of junctional reciprocating tachycardia (Figure 3). Therefore, the differential diagnosis is limited to an accelerated junctional rhythm, atrioventricular nodal reciprocating tachycardia (AVNRT), or a concealed nodofascicular tachycardia.¹ This ECG is not typical of AVNRT (antegrade slow pathway [SP] and retrograde fast-pathway conduction) because the long RP interval (125 ms) exceeds the usual interval of <70 ms. In addition, atyp-

ical AVNRT (antegrade fast-pathway and retrograde SP conduction) has a long RP and a short PR interval. These features suggest slow-slow AVNRT using the SP for antegrade conduction and a left-sided, slowly conducting atrioventricular nodal pathway as the retrograde limb (Figure 4).¹⁻³

Antegrade dual atrioventricular nodal pathways were demonstrated during programmed atrial stimulation with induction of SVT dependent on antegrade SP conduction. Ventricular extrastimuli delivered during His bundle refractoriness had no effect on atrial activation. Spontaneous ventricular-atrial block was observed during SVT without affecting the ventricular cycle length. During programmed ventricular stimulation, there was a decremental pattern of retrograde conduction with earliest atrial activation 1 cm inside the coronary sinus. Rapid ventricular pacing during SVT did not entrain the tachycardia with orthodromic His bundle activation, excluding a concealed nodofascicular pathway. Radiofrequency current was applied within the coronary sinus at the site of earliest retrograde atrial activation. This

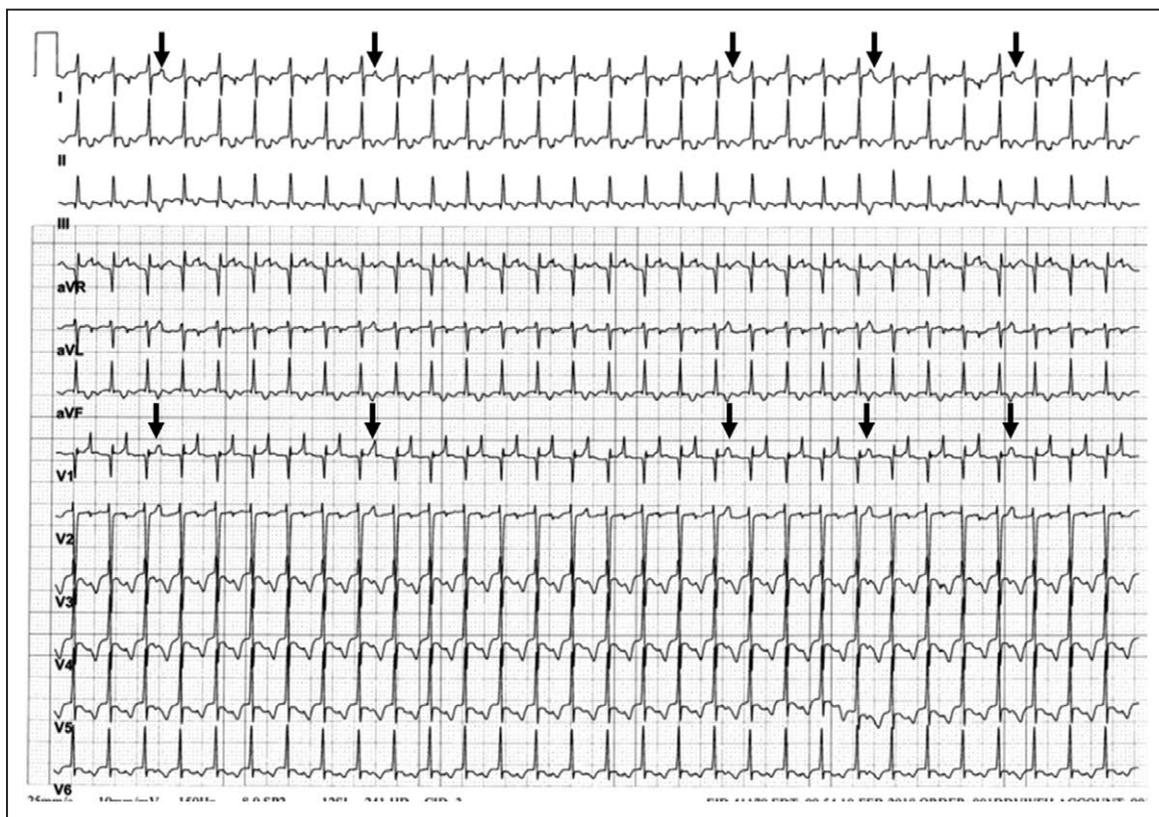


Figure 2. Twelve-lead ECG demonstrating the occasional absence of retrograde P waves (arrows).

Note that the R-R interval remains constant despite the lack of retrograde P waves (arrows). The presence of persistent tachycardia with fewer P waves than QRS complexes rules out atrial tachycardia or orthodromic atrioventricular reciprocating tachycardia, because these arrhythmias are dependent on atrial activation. The differential diagnosis of a regular, narrow QRS tachycardia with VA block includes an accelerated junctional tachycardia or AV nodal reentrant tachycardia (AVNRT). The RP interval of 125 ms is not typical of slow antegrade-fast retrograde AVNRT, which usually has an RP interval of ≤ 70 ms. Neither is this tachycardia typical of fast antegrade-slow retrograde AVNRT, because the PR interval is considerably longer than the RP interval. These features are consistent with slow-slow AVNRT using the slow pathway as the antegrade limb and left atrial AV nodal fibers that insert near the ostium of the coronary sinus as the retrograde limb. AV indicates atrioventricular; and VA, ventriculo-atrial.

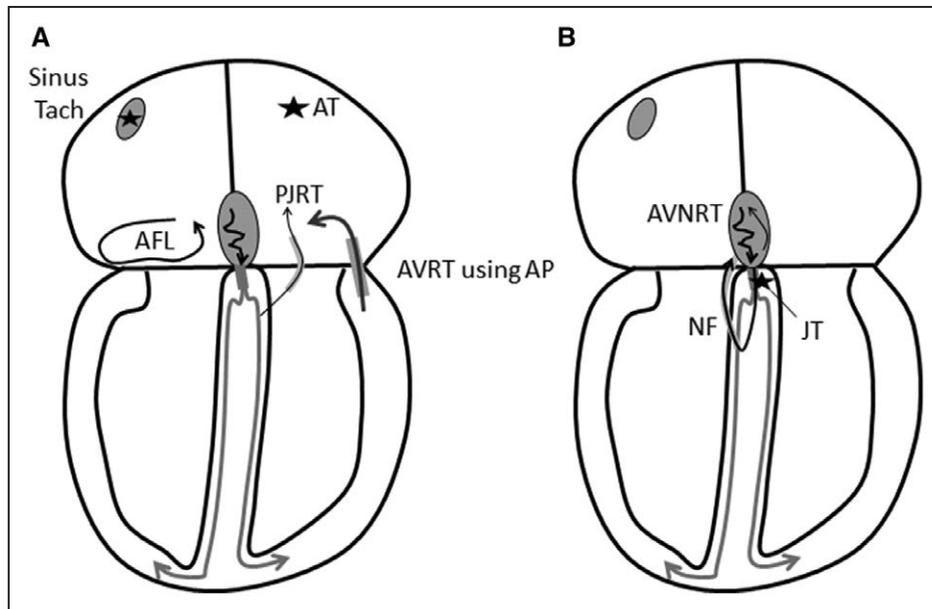


Figure 3. Illustration of the differential diagnosis of a regular SVT and clues to the mechanism from the 12-lead ECG.

A, Mechanisms excluded by missing P waves such that the number of QRS complexes exceeds the number of P waves: sinus tachycardia, atrial tachycardia, atrial flutter, atrioventricular tachycardia (AVRT) using a retrograde accessory pathway (AP), and the permanent form of junctional reciprocating tachycardia (PJRT) using a slowly conducting AP with decremental conduction properties. **B**, Possible mechanisms to consider in the presence of retrograde block to the atria. Because the RP interval is relatively long (125 ms) with a longer PR (195 ms) than RP interval, typical slow-pathway antegrade and fast-pathway retrograde AVNRT is excluded where the RP interval would be expected to be <70 ms. Atypical AVNRT using the fast pathway as the antegrade limb and the slow pathway as the retrograde limb would also be excluded because the PR interval is longer than the RP interval. A concealed nodofascicular tachycardia was excluded by premature ventricular extrastimuli during His bundle refractoriness and lack of entrainment with orthodromic capture of the His bundle during rapid ventricular pacing. An accelerated junctional tachycardia was excluded by entrainment of the SVT by rapid atrial pacing and the fact that induction of tachycardia was dependent on antegrade slow-pathway conduction. AFL indicates atrial flutter; AT, atrial tachycardia; AVNRT, atrioventricular nodal reentrant tachycardia; JT, junctional tachycardia; NF, nodofascicular tachycardia; Sinus Tach, sinus tachycardia; and SVT, supraventricular tachycardia.

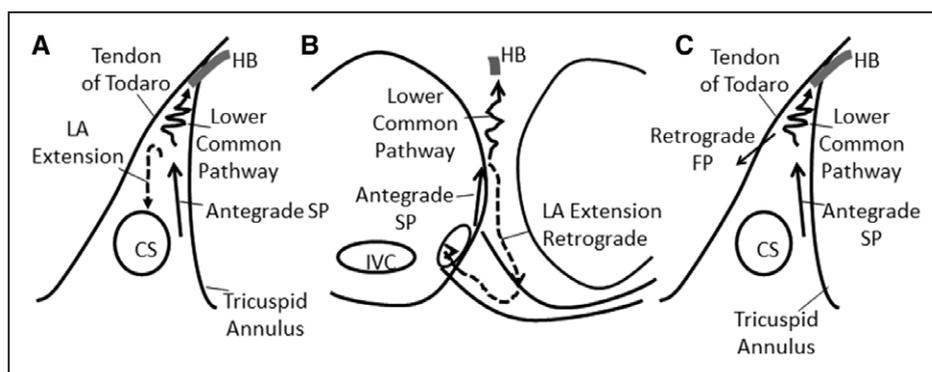


Figure 4. Diagram of slow-slow and slow-fast AVNRT.

A, Right anterior oblique projection. Antegrade conduction during SVT is over the right atrial extensions that form the slow pathway. Fibers conduct the impulse from right to left (dashed line) to the left atrial side of the AV node. The impulse conducts to the His bundle via a lower common pathway. **B**, Left anterior oblique projection. The retrograde limb is over fibers that conduct toward the left side of the septum and exit to the coronary sinus musculature (dashed line). Because both the antegrade and retrograde limbs of this circuit have slow conduction, the RP interval is longer than for typical AVNRT that uses fast-pathway fibers along the tendon of Todaro. **C**, Typical AVNRT uses an antegrade slow pathway consisting of fibers parallel to the tricuspid annulus and a retrograde fast pathway exiting along the tendon of Todaro. AV indicates atrioventricular; AVNRT, atrioventricular nodal reentrant tachycardia; CS, coronary sinus; FP, fast pathway; HB, His bundle; IVC, inferior vena cava; LA, left anterior; SP, slow pathway; and SVT, supraventricular tachycardia.

eliminated the slow-slow form of AVNRT, but typical slow-fast AVNRT could be induced with a ventricular-atrial interval of 40 ms and earliest atrial activation at the apex of the Koch triangle. A single radiofrequency application along the tricuspid annulus eliminated all SP conduction, and AVNRT was no longer inducible at baseline and during isoproterenol infusion.

This case demonstrates the value of the ECG to accurately predict possible mechanisms of an SVT. Slow-slow AVNRT can be successfully treated by ablation of the slow antegrade atrioventricular nodal pathway, the retrograde pathway within the coronary sinus, or both SPs.³ However, elimination of the left atrial inputs (the retrograde SP) may still allow typical slow-fast AVNRT to be induced.

ARTICLE INFORMATION

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Disclosures

None.

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