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A Supraventricular Tachycardia: What is the Mechanism?

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Keywords

V-A-V; AVNRT; atrial tachycardia; supraventricular tachycardia; pacing maneuvers

Case Presentation

A 93 year old female presented for an electrophysiology study and possible catheter ablation for two syncopal episodes, one associated with facial injury. Previously, she had undergone placement of a dual chamber permanent pacemaker for sinus bradycardia, and subsequent interrogation of the device revealed several episodes of tachycardia with a one to one V-A relationship. Holter monitoring confirmed that these episodes represented a supraventricular tachycardia (SVT).

Quadrupolar catheters were positioned in the His-Bundle and the right ventricular apex. A decapolar catheter was positioned in the coronary sinus (CS). Her baseline rhythm was atrial paced. Dual AV node physiology was observed with atrial pacing, manifest by a reproducible “jump” in the atrial-His interval of greater than 50ms with a decrement in the atrial extrastimuli by 10ms. Supraventricular tachycardia was initiated with atrial or ventricular overdrive pacing and with single extrastimuli from the atrium. The cycle length was approximately 340ms. The response to ventricular overdrive pacing is shown in Figure 1. What is the mechanism?

Commentary

With the cessation of ventricular pacing during tachycardia, a single atrial electrogram is seen between the final pacing stimulus and the first intrinsic return ventricular beat. As the A-A cycle length at the end of the drive train is identical to the pacing cycle length and as the tachycardia continues after the pacing has stopped, capture of the atrium with entrainment of the tachycardia appears to be successful. The apparent V-A-V response suggests that the tachycardia mechanism involves a reentrant circuit that includes the AV node, essentially excluding atrial tachycardia. Examination of the CS activation sequence during both ventricular pacing and tachycardia reveals a concentric activation pattern, with the earliest atrial activation > 70 ms, consistent with either AV nodal reentrant tachycardia or atrioventricular reciprocating tachycardia (AVRT).¹ The post-pacing interval minus the tachycardia cycle length is 50 ms, and the time from the ventricular pacing stimulus to the proximal CS atrial electrogram minus the time from QRS onset to the proximal CS electrogram

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during tachycardia is 45 ms, both differences strongly favoring AVRT as the underlying mechanism.² However, careful inspection of the final 3 beats of tachycardia shown demonstrates that the tachycardia cycle length varies from approximately 330ms to 350ms, with intervals that nearly match the pacing cycle length. In addition, changes in the A-A pacing cycle length precede changes in the His-His pacing cycle length, strongly favoring atrial tachycardia.³

Of note, the QRS that follows the first pacing stimulus exhibits a different QRS morphology than the other paced beats and is most consistent with a fusion between right ventricular pacing and conduction down the His-Purkinje system. Indeed, a subtle deflection in the distal His channel just after the pacing artifact may represent anterograde conduction of the His (with an A-H time consistent with the subsequent tachycardia beats).

Subsequent overdrive ventricular pacing during tachycardia demonstrated definitive V-A dissociation for greater than 10 consecutive dissociated beats, essentially excluding AVRT,¹ leaving a pseudo-V-A-V response and atrial tachycardia as the most likely mechanism. Ultimately, the patient was found to have a focal atrial tachycardia originating in the low right atrial septum.

Therefore, this pseudo-V-A-V response occurred due to failure to capture the atrium and a variable tachycardia cycle length that fortuitously corresponded to the pacing cycle length at the end of the drive train. While entrainment of an SVT from the ventricle can provide rich information regarding the arrhythmia mechanism, careful attention must first be directed to whether or not the tachycardia has been, in fact, entrained.

Abbreviation

AVRT, atrioventricular reciprocating tachycardia; V-A, ventricular-atrial; V-A-V, ventricular-atrial-ventricular; CS, coronary sinus.

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Figure 1.

Overdrive ventricular pacing from the right ventricular apex at a cycle length of 330 ms is performed during the supraventricular tachycardia. HIS d and HIS p = distal and proximal His-bundle electrogram, respectively; CS p, CS d, CS 3-4, CS 5-6, and CS 7-8 = proximal, distal, bipole 3-4, bipole 5-6, bipole 7-8 coronary sinus electrogram, respectively; RVA p = proximal right ventricular electrogram.