A-V Search Hysteresis in Dual-Chamber Pacemakers

SUMMARY

This article provides an overview of the A-V Search Hysteresis (AVSH) feature available in many Boston Scientific pacemakers. This overview includes:

- How AVSH works
- How AVSH can encourage AV conduction and help reduce RV pacing
- Parameters associated with AVSH
- Considerations for programming an extended AV Delay

A-V Search Hysteresis (AVSH) is a feature available in dual-chamber pacemakers designed to allow intrinsic conduction that might otherwise be masked by continuous pacing (i.e., pacing at an AV Delay that is shorter than the patient's P-R interval). AVSH may be useful for patients with exercise-dependent or intermittent AV nodal block. During normal AV nodal function, this feature temporarily allows intrinsic AV conduction to exceed the programmed AV Delay, thereby encouraging intrinsic AV conduction and reducing ventricular pacing. This may improve hemodynamic performance and increase device longevity due to a reduced number of ventricular paces. Reducing the amount of RV pacing in pacemaker patients: 1) moderately reduces the risk of developing persistent atrial fibrillation,[1] and 2) may reduce the progression to heart failure.[2]

How AVSH Works

Programmable parameters associated with AV Delay and AVSH are described in Table 1. When the AVSH feature is enabled, the AV Delay (either fixed or Dynamic) is periodically lengthened for up to 8 consecutive cardiac cycles to search for intrinsic P-R intervals that are longer than the programmed AV Delay. The AV Delay is lengthened by the programmed percentage AV Increase, and once increased, will remain extended as long as ventricular sensing is occurring. The pacemaker will revert to the programmed paced AV Delay following the first ventricular pace at the Hysteresis AV Delay, or when the 8-cycle search window expires without sensing intrinsic ventricular activity.

Figure 1 illustrates the operation of AVSH. In this example, the device meets the programmed AVSH Search Interval criteria by consecutively pacing in the ventricle for 32 cycles. At this point, the AV Delay is lengthened by 100% (the programmed AV Increase) in search of intrinsic P-R activity. During the 1st cycle, the intrinsic P-R interval is longer than the Hysteresis AV Delay of 400 ms, so the ventricle remains paced. During cycles 2-17, because the intrinsic P-R interval is less than the Hysteresis AV Delay, ventricular pacing is inhibited to allow for intrinsic conduction. Pacing resumes on the 18th cycle because the P-R interval is once again longer than the Hysteresis AV Delay. At this point, the AV Delay returns to its programmed value, and a new Search Interval count begins.

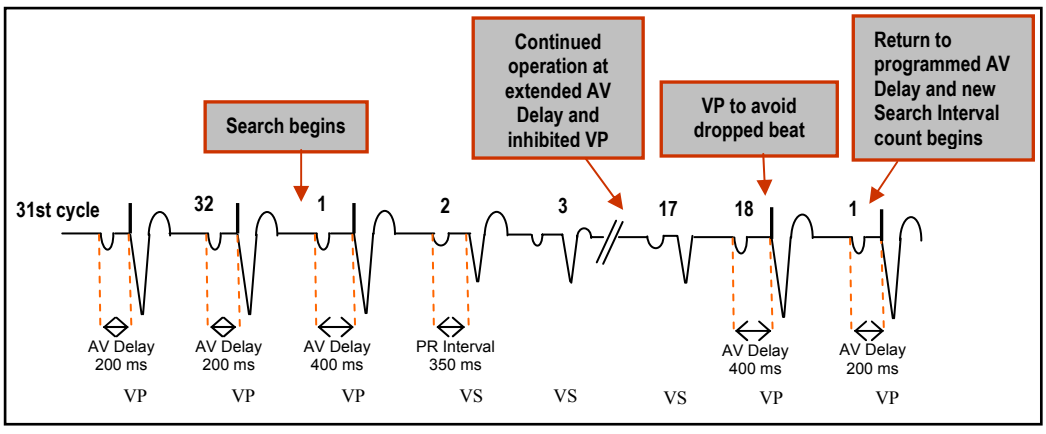

Figure 1. Example of A-V Search Hysteresis operation.

CRM PRODUCTS REFERENCED

The following are trademarks of Cardiac Pacemakers Inc., a Boston Scientific company: ALTRUA, INSIGNIA I Plus/, INSIGNIA AVT, INSIGNIA Ultra, PULSAR MAX II, PULSAR MAX, PULSAR.

Products referenced herein may not be approved in all geographies. For comprehensive information regarding device operation, please reference the appropriate product labeling.

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Activating AVSH

Although significant ventricular pacing would be expected for patients with more severe AV block, AVSH may provide an opportunity to encourage AV conduction and thereby reduce ventricular pacing for some patients with 1st degree or 2nd degree AV block.

Figure 2 displays the ZOOM® LATITUDE® programmer screen used to activate AVSH in an ALTRUA® pacemaker. With this programming, the device will allow the AV Delay to reach, but never exceed the maximum of 400 ms.

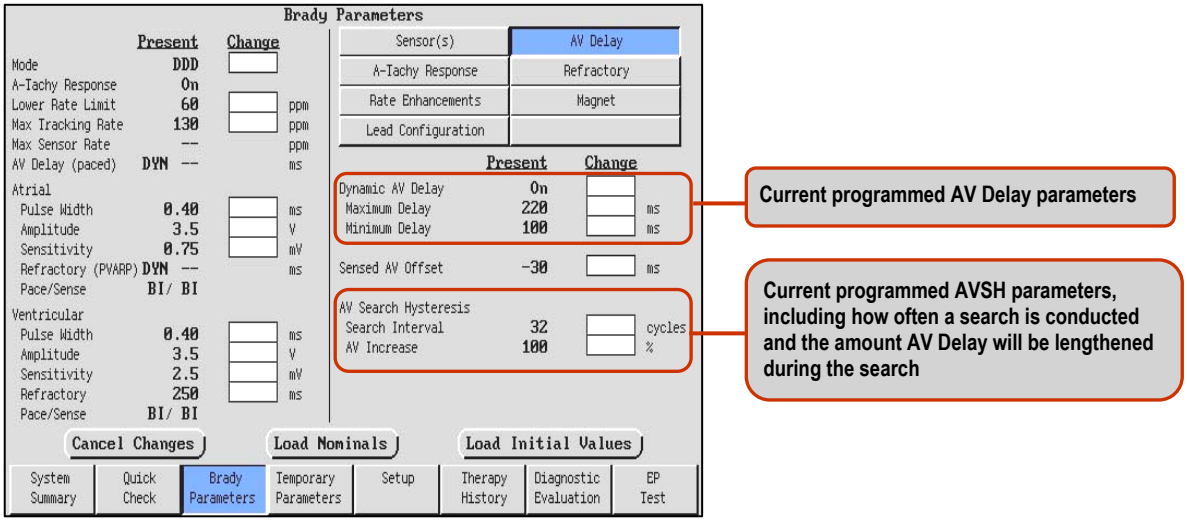

Figure 2. ALTRUA Brady Parameters programmer screen.

An ALTRUA Counters report is shown in Figure 3. Since the previous follow-up visit, the device has paced in the ventricle 40% of the time, and has conducted 35 successful searches out of 39 search attempts.

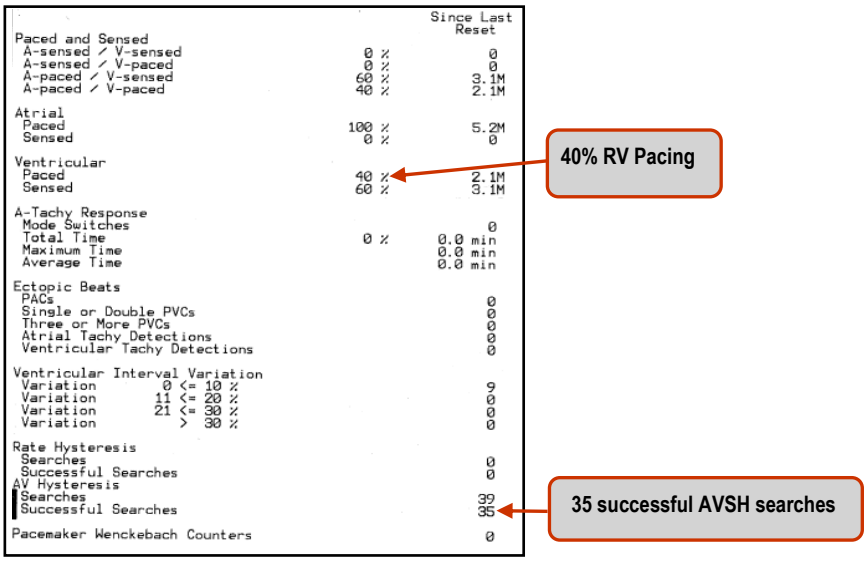

Figure 3. Counters report from an ALTRUA pacemaker with AVSH On.*

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* Individual symptoms, situations, circumstances, and results may vary.

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Table 1. Programmable Parameters Associated with A-V Search Hysteresis

Programmable Parameters of Interest	Description	Programmable Values
AV Delay	Period from the beginning of an atrial event (either intrinsic or paced) to the paced ventricular event	10–300 ms in 10 ms increments for ALTRUA 20/ 40 series, INSIGNIA I Plus/ AVT/Ultra, PULSAR MAX II, PULSAR MAX, and PULSAR pacemakers 10–400 ms in 10 ms increments for ALTRUA 50/60 series pacemakers Nominal = 150 ms
Dynamic AV Delay	Mimics normal AV nodal function by adjusting AV Delay in response to rate changes	Off, On ➢ Nominal = On (ALTRUA™, and INSIGNIA® pacemakers) ➢ Nominal = Off (PULSAR® MAX II, PULSAR MAX, and PULSAR pacemakers)
Maximum Delay	Longest Dynamic AV Delay allowed; will be applied at the lower rate limit	➢ 20–300 ms in 10 ms increments for ALTRUA 20/40 series, INSIGNIA I Plus/ AVT/Ultra, PULSAR MAX II, PULSAR MAX, and PULSAR pacemakers ➢ 20–400 ms in 10 ms increments for ALTRUA 50/60 series pacemakers Nominal = 150 ms
Minimum Delay	Shortest Dynamic AV Delay allowed; will be applied at the maximum tracking rate	10–290 ms in 10 ms increments Nominal = 80 ms
AV Search Interval	Activates AV Search Hysteresis and controls how often an AV search (up to 8 cycles long) will be conducted	OFF, 32, 64, 128, 256, 512, 1024 cycles Nominal = Off
AV Increase	Determines how much the AV Delay (either standard or dynamic) will be lengthened during a search cycle.	10%–100% in 10% increments Nominal = 30%

Considerations for Extending AV Delay

While the use of AVSH may be beneficial in reducing unnecessary RV pacing for some patients, long AV intervals (≥ 250 ms) should be used with caution. Physicians should evaluate the patient and weigh the potential benefit of promoting intrinsic conduction against the potential risk of hemodynamic compromise, such as pacemaker syndrome and diastolic mitral regurgitation.

[1]Sweeney, MO, Bank, AJ, Nsah, E, et. al. Minimizing ventricular pacing to reduce atrial fibrillation in sinus node disease. *N Engl J Med*. 2007; 357: 1000-1008.

[2]Sweeney, MO, Hellkamp AS, Ellenbogen KA, et. al. Adverse effect of ventricular pacing on heart failure and atrial fibrillation among patients with normal baseline QRS duration in a clinical trial of pacemaker therapy for sinus node dysfunction. *Circulation*. 2003;107: 2932-2937.