**Title: ICD shock below the detection rate therapy zone. When appropriate is inadequate.**

Short title: **Shock therapy in the monitor zone**

Category: Device rounds

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**Case Presentation**

We present the case of a 39-year-old man referred for evaluation of dyspnea on exertion, documenting a 2:1 atrio-ventricular block (AVB) during a treadmill exercise stress test. An electrophysiological study demonstrated an infrahisian block, and a dual-chamber pacemaker was implanted (Enitra 8 DR-T, Biotronik, Germany). Two years later the patient developed symptoms of heart failure, documenting complete AVB and severe left ventricular systolic dysfunction. An upgrade to an implantable cardioverter-defibrillator with cardiac resynchronization therapy (Gallant TM CDHFA500Q, Abbott, US) was performed. One month after implantation, recurrent episodes of non-sustained slow ventricular tachycardia (VT) with a cycle length (CL) of 550 ms (110 bpm), and left bundle branch block (LBBB) with left-superior axis morphology were recorded. The patient was admitted to the hospital and antiarrhythmic medication (amiodarone) was initiated. The lower rate limit (LRL) was increased to 95 bpm due to the persistence of those episodes despite medication. Device settings are summarized in Table 1. The evening following admission the patient presented an episode of asymptomatic monomorphic VT at 160 bpm (figure 1) falling in the VT-1 zone, programmed as monitor-only, without therapies. Unexpectedly, this VT episode was treated with an ICD shock. The stored EGMs of the episode are shown in Figure 2. What is the explanation of this therapy?

**Discussion**

ICD shocks can be delivered for arrhythmias detected in monitor-only zones under certain conditions. In Abbott devices, previously St Jude Medical (St. Paul, MN, USA), ICD shocks in “monitor zones” have been described in the following situations: 1) slowing of an ongoing arrhythmia from an active zone to a monitor zone either spontaneously or after therapy, and 2) irregular arrhythmias with a variable cycle length that alternates between two zones (a monitor zone and an active zone). 1, 2 However, in our case both causes can be ruled out since there was no slowing of a rapid tachycardia nor alternance of cycle lengths between two programmed zones.

The *Ventricular fibrillation therapy assurance* (VFTA) feature is a new algorithm implemented in the Abbott Gallant ICD. It is intended to identify the occurrence of polymorphic VT or ventricular fibrillation (VF), arrhythmias at risk of underdetection.2 Detailed information about this algorithm is not provided in Abbot help manual. This algorithm has two criteria to recognize undersensing on far-field (FF) channel during a tachycardia detection on near field (NF) channel: 1) two consecutive ventricular signals with an amplitude between 0.3-0.6mV in the FF channel, and 2) an interval between any 2 sensed events in FF channel longer than 2 seconds. The VFTA feature is triggered If any of these 2 conditions is met. Once the algorithm is activated, tachycardia detection is automatically changed to a single therapy zone (VF only). The settings of this new single therapy zone are: 1) “VF zone” detection rate decreases to the rate of the previous lowest programmed zone (including the monitor zone) plus 100 ms, to a maximum of 400 ms; 2) the number of intervals to detection (NID) is decreased to six; 3) ATP is switched off; and 4) the end of episode is increased to seven intervals.3

In our case, once the episode is detected in the VT-1 zone, the device analyzes the ventricular signals in the FF channel. An intermittent absence of VS2 markers on the discrimination channel, lasting more than 2 seconds, is observed (solid rectangle in figure 2), denoting RV undersensing that triggers the VFTA feature. Algorithm activation is noted by the switch in the detection markers, from T1 to VF, even though the CL remains unchanged. The VF detection rate is automatically switched to 400 ms (150 bpm), therefore leaving the clinical VT within this new VF zone. When the NID is fulfilled (six intervals), the device starts capacitator charging and finally delivers a shock therapy. Atrial and biventricular paced rhythm is observed after the effective shock therapy.

We report an undescribed cause of a shock therapy in a monitor zone. It emphasizes that new algorithms designed to avoid underdetection/undertreatment of life-threatening arrhythmias may also expose patients to inappropriate therapies. Despite its potential benefits, the use of VFTA feature (which is nominally activated ON) should be individualized.

**References**

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2. Tachycardia Devices Help manual, Abbott. <https://manuals.sjm.com/~/media/manuals/product-manual-pdfs/0/2/024dc7ff-b18f-444e-8164-d8e3e86cb44e.pdf>
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**Figure Legends**

Figure 1: 12-lead ECG showing clinical ventricular tachycardia at 160 bpm with left bundle branch block morphology and left-superior axis.

Figure 2: From top to bottom: RA: Right atrial electrogram, LV: unipolar left ventricular electrogram (distal ring to can), RV NF: Right ventricular near-field (sense amplitude electrogram), RV FF: Right ventricular far field channel (electrogram discrimination; right ventricular coil to can) and markers. The initial rhythm is ventricular tachycardia with a cycle length (CL) between 350-380ms. After 40 consecutive fast intervals a VT-1 episode is triggered. Intermitent absence of VS2 markers (black rectangles) denotes undersensing on the discrimination channel, which lasts for >2 seconds in the solid black rectangle. Thus, VFTA is triggered. This fact is noted by the change of the markers from T1 to VF despite the CL remaining unchanged. A new single therapy zone is then programmed at 400ms (see text for detailed description). After 6 beats in this new zone (bold numbers), VF is declared and charging of capacitors begin. After successful redetection shock therapy is delivered and atrial and biventricular paced rhythm is restored.

**Tables**

Table 1. Device’s programmed parameters.

Pace Mode DDD

Ventricular Paced Simultaneous

LRL (Lower Rate Limit) - URL (Upper Rate Limit) 95 - 130 bpm

Paced –Sensed AV delay 200 - 150 msec

PVARP 275 msec

VT-1 Detection Rate (Monitor Only Rate Zone) 150 min-1/ 400 msec

VT-1 Number of Intervals 40 intervals

VT-2 Detection Rate (Therapy Zone) 190 min-1 / 315 msec

VT-2 Number of Intervals 30 intervals

VT-2 Therapy ATPx4; CVRTx 3

VF Detection Rate (Therapy Zone) 214 min-1 /280 msec

VF Number of Intervals 24 intervals

VF Therapy ATP Prior Charging; Defib x 6

Therapy after Timeout OFF

Abbreviations: AV, atrioventricular; PVARP, post ventricular atrial refractory period; VT, ventricular tachycardia; VF, ventricular fibrillation; ATP, anti-tachycardia pacing; CVRT, cardioversion therapy; Defib, defibrillation therapy; RV, right ventricle.