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Committed function for the first delivered shock of an uncommitted implantable cardioverter-defibrillator

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A 75 year-old man with a Biotronik Lumax VR-T540 uncommitted implantable cardioverter--defibrillator (ICD) received a shock during general anesthesia for the resection of a basal cell carcinoma on the nose. The surgeon who was unaware of the ICD, used unipolar electrocautery during the procedure. No ICD parameters were reprogrammed preoperatively and the device remained programmed as follows: Low rate = 40 ppm, ventricular tachycardia — 1, rate = 167–222 bpm, antitachycardia pacing (ATP) followed by 40 J shocks, ventricular fibrillation (VF) zone 12/16 and > 222 bpm, ATP, followed by 40 J shocks. ATP in this device is only activated by tachycardia with relatively stable cycle lengths which was not the case in our patient because the interference from electrocautery produced sensed signals with marked irregularity of rate or detected intervals. Figure 1 shows how interference from electrocautery was detected as VF by the device which then initiated capacitor charging. ATP was not delivered. The capacitor charge was then aborted when the interference abated based on the uncommitted function of the ICD (Fig. 2). The subsequent recurrence of another bout of interference failed to produce enough "sinus" intervals between the aborted shock and VF redetection (interference) to fulfill detection of a normal termination (Fig. 2). Instead the ICD redetected or reconfirmed the presence of a continuing tachyarrhythmia. The ICD again began to charge its capacitor

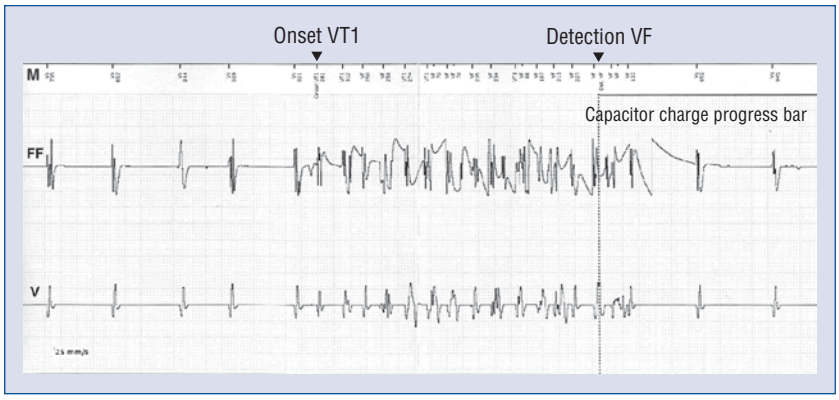

Figure 1. The ICD senses interference from electrocautery. The markers on top show that the ICD interprets the signals as ventricular fibrillation (VF) according to 12 out of 16 VF intervals. The cycles labeled VT in the marker channel (M) are not counted for VF diagnosis. The interference subsides as the capacitor is charging. The underlying rhythm is atrial fibrillation; V — near-field ventricular electrogram; FF — far-field ventricular electrogram; VT — ventricular tachycardia; VS — ventricular sensed event outside the tachyarrhythmia zones; (see text for details).

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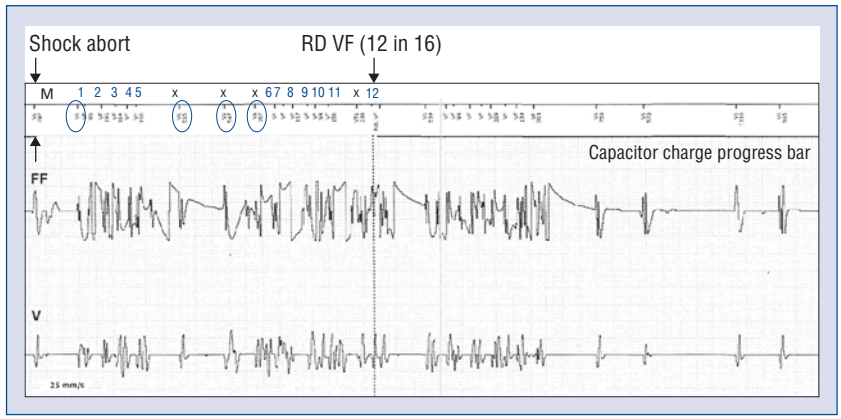

Figure 2. The shock is aborted indicated by the capacitor charge progress bar on the top left side (vertical arrow). This occurred because 3 of 4 intervals were classified as "sinus" intervals during charging. Repeated electrocautery occurs soon after the capacitor has aborted its charge. Tachyarrhythmia termination requires 12 out of 16 "sinus" intervals. As there are only four "sinus" intervals, there are not enough "sinus" cycles to fulfill a termination detection. The ICD re-detects VF (RD VF 12/16) and again charges its capacitor. The interference stops during capacitor charging. Same arrangement as in Figure 1 (see text for details).

Figure 3. Although the interference has stopped, the ICD charges its capacitor and the full 40 J charge is delivered in a committed fashion during a supraventricular rhythm (atrial fibrillation). The finding of 3/4 "sinus" intervals during capacitor charging did not abort the shock. The shock impedance was 46 Ohms. The termination detection was fulfilled 24 s after the initial detection. Same arrangement as in Figures 1 and 2 (see text for details).

(Fig. 2). The interference terminated again during capacitor charging (Fig. 3) but this time the shock was not aborted and the ICD eventually fired (committed ICD function) during a relatively stable supraventricular rhythm (Fig. 3). Subsequent ICD evaluation revealed normal shock and pacing impedances and no evidence of lead malfunction.

As far as the shocks are concerned, most ICDs function in an uncommitted mode for the first shock but in the committed mode for all subsequent shocks if the reconfirmation phase detects a continuing tachyarrhythmia. Yet, in our case, it was the first delivered shock that was committed.

If an uncommitted device aborts tachyarrhythmia therapy, it reverts immediately to the programmed parameters. It then resumes monitoring for ventricular tachyarrhythmias or their equivalent usually starting at the first paced or sensed ventricular event after the capacitor has stopped charging. If the device redetects the tachyarrhythmia before the ICD is able to declare termination of the episode (criteria according to design), it will then de-

liver the programmed shock that was previously aborted [1]. This time, the ICD functioned as a committed device (for the first delivered shock to the patient) so that spontaneous termination of the detected tachyarrhythmia (or its equivalent) as in our case no longer aborted the shock. The rationale for this behavior is based on the assumption that the first shock might have been aborted because of intermittent undersensing of VF. In fact, the ICD sees two episodes of VF in this situation. Consequently in virtually all ICDs (except the recently released Medtronic Protecta ICD + cardiac resynchronization) [2] capacitor discharge cannot be aborted twice in succession when reconfirmation (after the capacitor has stopped charging) suggests an ongoing tachyarrhythmia and the device fails to detect the return to "sinus rhythm" according to criteria based on its design. The committed function for the first delivered shock after an aborted one therefore provides a therapeutic safeguard.

Disclosures

The authors do not report any conflict of interest regarding this work.

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