ICD Lead Malfunction

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ABSTRACT

In this article, a case with oversensing problem due to ICD lead malfunction and troubleshooting was presented.

KEYWORDS
Implantable cardioverter defibrillator, oversense, electrode

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ÖZET

Bu yazıda ICD elektronunda bozulmaya bağlı aşırı duyarlılık problemi olan bir de vaka sunumu ve sorunu çözmeye yönelik bilgiler verilmiştir.

Anahtar Kelimeler
Implante edilen kardiyoverter defribilatör, aşırı duyum, elektrod

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The “make and break” or false signals of a defective lead or a connection problem often become manifest intermittently (Fig 1). Contact of the sensing lead with an abandoned lead creates another source of false signals leading to intermittent oversensing. The most common site of a fracture (or insulation break) is between the first rib and clavicle or around the site of the anchoring sleeve. A suspected lead failure requires evaluation of all stored (related to episodes) and real-time electrograms, pacing threshold, pacing impedance, and painless shocking (high-voltage) impedance; chest X ray, data logs etc. A normal chest X ray does not rule out lead discontinuity especially an insulation defect.

Ventricular lead problems usually present as oversensing by the ICD that may result in inappropriate shocks, or as abnormal diagnostic measurements (impedance) at follow-up. Stored electrogram in asymptomatic patients may reveal nonsustained interference interpreted and recorded by the ICD as nonsustained ventricular tachycardia (Fig 1). A lead problem may also present less commonly as undersensing of ventricular fibrillation or unsuccessful therapy often fatal. Finally, a lead problem (prior measurements within normal limits) may become manifest for the first time during ICD replacement when false signals become evident after the first test shock.

A low pacing impedance indicates an insulation defect, while a high pacing impedance indicates a complete or partial interruption of the sensing/pacing lead, a loose set screw or a defective adapter. The measured pacing impedance is compared to the chronic baseline value. Decreases of 30% or more or pacing impedances below 200-250 ohms may be indicative of insulation failure. Sudden and significant increases in pacing impedance may be indicative of conductor fracture. Intermittent lead discontinuity may be associated with a normal pacing impedance if the lead was functioning properly at the time of the measurement.

Repeated shocks associated with motion of the ipsilateral arm or certain body positions should raise the suspicion of lead fracture or lead instability. Deep respiration, coughing or a Valsalva maneuver while monitoring the ventricular electrogram at follow-up may differentiate myopotentials from false signals but both may coexist. Manipulation of the device pocket may elicit electrical noise artifacts consistent with lead conductor fracture/insulation defect or a loose connection of the setscrew in the ICD header.

It is important to also record the shocking electrogram. Noise only on the shocking (far-field) electrogram but sparing the sensing (near-field) electrogram indicates a defect in the shocking lead. High-voltage impedance measured by painless weak pulses correlates well with values measured by high-energy shocks. Shocking impedance normally measures 25–75 Ω. A high shocking impedance indicates a fracture, a low value an insulation defect in the shocking circuit. Some ICDs require the delivery of a 12V shock (felt by most patients) for shocking lead measurement rather than the painless system described above.

Some ICDs record the number of extremely short nonphysiologic ventricular intervals (120-140 ms) labeled as RR interval by the ICD. Such data suggests an occult lead problem barring double R wave counting of ventricular extrasystoles. In other ICDs, heart rate intervals can be evaluated for possible nonphysiologic intervals.

Wireless remote monitoring of leads offers great potential for the early detection of abnormal lead function and enhanced patient safety. Alert features that monitor lead impedance can enhance the early detection of ICD lead failure.
Such devices deliver sub-threshold impulses on a daily basis to determine the impedance within the pace-sense or high voltage circuit of the ICD. The upper and lower alert boundaries may be programmable. A value outside the programmed range will trigger an audible alarm.

Medtronic’s new software feature, called the Lead Integrity Alert (LIA), issues an audible alert once it detects signals that could indicate that the lead has fractured, and then repeats the alert every four hours until a physician can reset the ICD. LIA is triggered if both of the following criteria are met in the past 60 days: 1. Two high-rate non-sustained VT episodes with average RR interval <220 ms (273 bpm). 2. Ventricular Sensing Integrity Counter shows >30 within a period of three or fewer consecutive days.

LIA software upgrade is available for ICDs and cardiac resynchronization therapy defibrillators (CRT-Ds) for nearly all (98 percent) of the Medtronic devices implanted in the United States, and for 93 percent of those implanted worldwide. The system appears highly specific but its sensitivity is presently unknown.

Figure 1

**Stored electrograms from a patient with a St Jude ICD (DDI mode) associated with a lead insulation defect.** There is simultaneous recording the atrial electrogram (AEGM) on top and the ventricular electrogram (VEGM) below the atrial electrogram. The marker channel is below the VEGM. Top panel: The VEGM displays obvious interference of the baseline by false signals sensed by the ICD as ventricular fibrillation (VF). A particular short cycle is binned or counted as VF (depicted as F by the marker channel) only if the average cycle duration (of 4 intervals: 3 cycles plus the current cycle) falls outside the sinus zone. A VF cycle will be binned as F if both the average cycle duration and the current cycle detect VF or if one records VF and the other ventricular tachycardia. Note that the ICD fails to bin or count some of the short cycles induced by false signals on the left of the vertical line labeled DDI because the above requirements are not met. The x depicts the mismatch of the signal with the baseline pattern stored in the template. The capacitor then begins charging as shown by the black dots above the VEGM. Bottom pane (continuous with top panel): The shock is aborted because the ICD senses 5 consecutive sinus cycles (VS) without intervening F cycles. The AEGM shows regular atrial sensing (AS) in sinus rhythm but there appears to be sensed interference on the AEGM (top recording) occurring coincidentally with VEGM interference (top tracing on the left of the DDI notation). This may represent a far-field phenomenon or an associated problem with the atrial lead.

**REFERENCES**