CASE REPORT

Detection of refrigerator-associated 60 Hz alternating current as ventricular fibrillation by an implantable defibrillator

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This report describes a patient with an implantable defibrillator who suffered an inappropriate defibrillation shock upon retrieving some food items from his inadequately earthed refrigerator. Noise typical of electrical interference can be observed in the stored electrogram of the episode. The patient was instructed to earth his home appliances, but he decided to avoid his refrigerator altogether, and has had no subsequent shocks.

KEYWORDS
Implantable defibrillator; Electromagnetic interference; Inappropriate shock

Introduction

Electromagnetic interference (EMI), such as that generated by handheld radiofrequency remote controls, 1 electric razors, 2 electronic article surveillance systems, 3–5 power drills and washing machines, 6 or slot machines, 7 may rarely result in false triggering of implantable cardioverter defibrillators (ICDs) discharge, triggering of noise-reversion mode, inadvertent reprogramming of the device, or damage to the circuitry. This type of interference may result in delivery of inappropriate detection and therapy discharge to the patient. A common source of EMI is electrical leakage from unearthed electrical appliances at home or work. 8 Usually such interference is easy to recognize in the stored intracardiac electrograms (EGMs) of ICDs because of the typical pattern of electrical noise.

Case report

The patient is a 77-year-old male with a history of coronary artery disease and previous myocardial infarction, with depressed left ventricular function, who suffered from recurrent symptomatic ventricular tachycardia (VT). He had a Medtronic single chamber ICD (GEM II VR, model 7229) and bipolar Sprint lead implanted. ICD detection and treatment were programmed for two zones, ventricular fibrillation (VF) zone [290 ms, number of intervals detected (NID) 18/24] and VT zone (400 ms, NID 16). Antitachycardia pacing (ATP) algorithms were programmed on. Ventricular sensitivity was 0.3 mV. During the 20 months follow-up after ICD implant, the patient was followed regularly and had several appropriate ATP treatments due to VT and shocks due to VF. The episodes were typically characterized by dizziness, followed by palpitations and then resolution of symptoms.

The patient presented to the pacemaker clinic complaining of a single shock without warning symptoms of any kind. The patient explained that the shock was received when he was at home taking food items from his refrigerator. He felt the shock at the moment he was touching the inside of the appliance, and the shock threw him to the floor. No further shocks were felt subsequently. Interrogation of his ICD showed a single episode of detected VF, for which a 19.4 J (20 J stored) shock was delivered (Figure 1). This is the first programmed shock in the VF zone. Impedance of the high voltage lead was within the normal range (49 ohm) and the episode lasted for 9 s. Examination of the stored EGM in Figure 1 shows regular and normal appearance of R-waves at an interval of ~840 ms. However, there is undulating high-frequency noise distorting the baseline. This noise disappeared after delivery of the shock. Closer examination of the detected noise reveals that it is being detected in a regular pattern, but following every normal R-wave, there is cessation of detection of the noise for just over 400 ms. Arm movement as well as positional changes did not reproduce this noise on the EGM. Combined with delivered shock impedance of 49 ohm, this is evidence inconsistent with conductor fracture.

Given the history, the fact that the refrigerator was not earthed, the appearance of EMI on the intracardiac EGM, and the characteristic grouped ventricular sensed
events, an electrical leak from the refrigerator causing 60 Hz interference was inferred (alternating current in Saudi Arabia has a voltage of 120 or 220 V at 60 Hz).

Discussion

This case illustrates a typical example of potential environmental hazards to patients who have implantable defibrillators, particularly when electrical appliances and instruments are not sufficiently earthed. Because household appliances are typically not earthed in Saudi Arabia, the potential for electrical leak, particularly for refrigerators and other kitchen appliances is very high.

The history and examination of stored EGMs are typical of electrical current leak with detection by the implanted defibrillator. The ICD detected this current leak while the patient was touching the inside of the refrigerator and responded with a defibrillation shock. Review of the intracardiac EGM (Figure 2) reveals the onset of high frequency noise (120 ms) detected by the ICD as VF, superimposed on normal R-waves marching through the noise. The noise seen on the stored EGM is typical of this type of EMI, and the intermittent lack of detection following a normal sensed R-wave is due to automatic adjustment of sensitivity. For this particular Medtronic device, the sensitivity is reduced to 75% of the EGM peak following the sensed (but not paced) event. The ICD recognized the noise as EMI and
responded with a pacing spike coupled at 500 ms to the last detected impulse. Pacing terminates the under-sensing period 500 ms following the native R-wave. Following the paced beat, however, detection of noise as VF resumes. After VF detection criteria are satisfied, and during capacitor charge, ventricular pacing ceases and typical grouped detection of the noise is evident (three sensed and three missed). Under-sensing of R-waves is due to the auto-adjusting sensitivity threshold mechanism, discussed earlier. This pattern is not seen with actual VF, where nearly all the waves are sensed because the difference between the waves is not as significant as it is in this example. Following shock delivery, which resulted in the patient moving away from the source of EMI, the EGM no longer shows the EMI noise.

The patient was reassured about the function of the device and was educated thoroughly on EMI and ways to avoid it. He was instructed on appropriate earthing of his household appliances and has not returned with any further inappropriate shocks.

Conclusions

This patient has suffered an inappropriate ICD discharge due to an electrical leak from the refrigerator. The most important protection from such incidents is patient awareness including education about the possibility of EMI-triggered ICD discharge and avoidance of situations where electrical leaks may exist. They should be urged to have their electrical appliances and instruments appropriately earthed.

References