Interference From a Hand Held Radiofrequency Remote Control Causing Discharge of an Implantable Defibrillator

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MAN, K.C., ET AL.: Interference From a Hand Held Radiofrequency Remote Control Causing Discharge of an Implantable Defibrillator. *A 46-year-old man with a history of sustained monomorphic ventricular tachycardia underwent an implantation of a third generation multiprogrammable implantable cardioverter defibrillator. One year post implant, while manipulating a remote control to a radiofrequency modulated toy car, the patient experienced a defibrillator discharge not preceded by an arrhythmia prodrome. Subsequent interrogation of the defibrillator revealed that a 34-joule shock had been delivered and had been preceded by RR intervals ranging from 141–406 msec, consistent with sensing lead noise. The remote control utilizes a 12-volt battery and has a carrier frequency of 75.95 MHz and a modulating frequency of 50 Hz. Evaluation of the remote control and defibrillator interaction revealed that the remote control was able to trigger tachyarrhythmia sensing and reproduce the clinical episode. Interference was present only when the remote control was within 8 cm of the pulse generator and at specific angles relative to the device and only when the antenna length was > 45 cm. Interference was eliminated when a ground wire was attached to the antenna and when an aluminium shield was placed between the pulse generator and the remote control. This case report suggests that patients with third generation multiprogrammable defibrillators should be cautioned against close contact with potential sources of electromagnetic interference, such as remote control units. (PACE, Vol. 16, August 1993)*

electromagnetic interference, implantable cardioverter defibrillator

Introduction

Electromagnetic interference (EMI) generated from various sources can interfere with normal implantable cardioverter defibrillator (ICD) function.[1–3] High frequency EMI can prevent an ICD from sensing a patient's intrinsic rhythm, thereby resulting in the inhibition of therapy.[4] It has been reported that low frequency EMI from a transcutaneous electrical nerve stimulator (TENS) device theoretically could cause oversensing and the delivery of inappropriate therapy.[4] To date, EMI causing oversensing of an ICD has not been documented clinically. In the following case report radiofrequency transmission from a toy car remote control was implicated as the cause of oversensing and inappropriate therapy from a third generation multiprogrammable ICD.

Case Report

A 46-year-old man with a history of ischemic heart disease and drug refractory sustained monomorphic ventricular tachycardia underwent implantation of a third generation multiprogrammable ICD (PRx Model #1705, Cardiac Pacemaker Inc., St. Paul, MN, USA) with epicardial defibrillating patches and sensing leads. The device was programmed to have two zones of therapy for tach-

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Patient Therapy History

Date: 09/17/92 Episode—11 Attempt—1 of 1

Time of detection	19:07:18
Device State	Monitor and Therapy
Pre-attempt R-R mean	219 msec. 274 BPM
Detection criteria met	Duration
Zone of Therapy	2
Therapy Used	Defib Shock #1 @ 34 joules
Conversion Successful	Yes
Therapy Aborted	No
Arrhthymia Accelerated	No
Post-attempt monitoring	11 cycles
Post-attempt R-R mean	633 msec. 95 BPM

Pre and Post Episode R-R intervals

Pre: 367, 156, 203, 359, 141, 156, 164, 406, 180, 375, 188, 156 msec.
Post: 664, 844, 953, 633, 695, 664, 648, 641, 633, 648, 641, 633 msec.

Figure 1. *Therapy history demonstrating R-R intervals pre and post 34-joule discharge.*

yarrhythmia detection. Zone 1 was programmed to deliver therapy for heart rates between 165–200 beats/min and consisted of a 10-joule shock followed by up to four 34-joule shocks if the arrhythmia did not terminate. Zone 2 was programmed to deliver therapy for heart rates > 200 beats/min and consisted of up to five 34-joule shocks. One year after implantation, the patient reported an episode of defibrillator discharge while operating a hand held remote control to a radiofrequency modulated toy car (2-Channel Transmitter, Model #FP-2PBKA, Futaba Corporation of America, Irvine, CA, USA, frequency 75.950 MHz, 12-volt battery source). The patient did not experience any symptoms prior to the defibrillator discharge. Interrogation of the ICD therapy history revealed that he had experienced a single 34-joule shock for a tachyarrhythmia detected to be in zone 2. The preshock RR intervals were irregular, ranging from 141–406 msec, suggesting possible sensing lead noise (Fig. 1). The pacing and sensing thresholds remained unchanged compared to 2 months earlier and there was no evidence of the epicardial sensing leads fracture.

When the remote control was turned on and placed next to the pulse generator in the left upper quadrant of the abdomen, oversensing occurred (Fig. 2). This oversensing was dependent on the

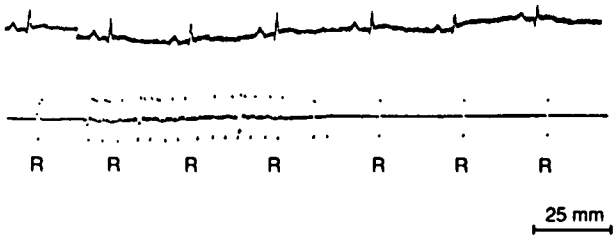

Figure 2. *ECG tracing of sinus rhythm (top). Sensing markers (bottom) demonstrating the detection of intrinsic QRS complexes (R) and noise interference during sinus rhythm after the remote control was turned on (bottom).*

distance between the remote control and the device, the orientation of the remote control in the frontal plane, and the length of the remote control antenna. Oversensing occurred only when the remote control was within 8 cm of the ICD. Interference was observed only when the antenna was angled between 60–120° in the frontal plane and when the antenna was extended > 45 cm. Noise detection was eliminated when a ground wire was attached to the antenna and when the antenna was detached from the remote control. The various features of the remote control transmitter such as the steering and speed did not affect the level of signal interference. Finally, no signal interference was detected when an aluminium shield was placed between the pulse generator and the remote control.

Discussion

This case report demonstrates that nontraditional sources of EMI must be considered when patients experience inappropriats ICD discharges. In this particular case, the explanation for the source of interference was the modulating pulse frequency emitted from the remote control. The 2-channel remote control consists of a low power 12-volt transmitter that transmits a carrier frequency of 75.95 MHz. The carrier frequency is pulse modulated at 50 Hz. This ICD can detect electromagnetic frequencies up to 90–100 Hz depending on the amplitude of the signals and signals > 90–100 Hz are filtered as noise. The observation that the oversensing only occurred when the device was in close proximity to the remote control indicates that the amplitude of the signal as well as the frequency was important for noise

detection. To our knowledge this is the first report of EMI causing oversensing and inappropiate discharge of an ICD.

Clinical Implications

Current FDA approved ICDs have a frequency detection cutoff of approximately 38 Hz. In this particular case, the remote control modulated frequency of 50 Hz would have been outside the detection limit of the device. The higher frequency detection limit of 90–100 Hz in this investigational device allows for a greater potential for oversensing of EMI. Therefore, a greater awareness of potential EMI sources may be necessary for some of the newer ICD devices.

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