Destructive Device Removal - Sparks and Deletion of Therapy History From an Implantable Cardioverter Defibrillator

Takashi Kurita,1 MD, Shigeyuki Ueda,2 MD, Hideo Okamura,2 MD, Takashi Noda,2 MD, Kazuhiro Satomi,2 MD, Kazuhiro Suyama,2 MD, Wataru Shimizu,2 MD, Naohiko Aihara,2 MD, Shunichi Miyazaki,1 MD and Shiro Kamakura,2 MD,

SUMMARY

A 74-year-old female with a diagnosis of idiopathic dilated cardiomyopathy and ventricular tachycardia died suddenly 9 years after an implantation of an implantable cardioverter-defibrillator (ICD). The destructive removal of an ICD generator and the leads by an uninformed coroner resulted in the loss of the fragile electrograms during the terminal episodes of VT/VF and caused severe charring on the surface of the ICD generator.

In order to observe the conditions in which the shock deliveries occurred during the noise detection, we programmed the ICD to deliver the maximum shock energy via a programmer while keeping continuous contact between the device surface and shock lead. The maximum shock energy of 31 Joules produced significant sparks from the surface of the ICD.

To avoid the loss of data from an ICD and injury to the patient, widespread notification and education through appropriate scientific societies about the functions of ICDs are highly recommended. (Int Heart J 2009; 50: 823-827)

Key words: Sudden cardiac death, Implantable device, Device removal

This case report describes the destructive removal of an ICD generator and the leads by an unaware person may result in the loss of important information, such as the electrograms during the terminal episodes of VT/VF, and may cause severe charring on the surface of the ICD generator. The publication of this case will hopefully contribute to avoiding the loss of data from an ICD and injury to the person.

Implantable cardioverter defibrillators (ICDs) are well established as the

---

From the 1 Division of Cardiology, Department of Internal Medicine, Kinki University School of Medicine and 2 Division of Cardiology, Department of Internal Medicine, National Cardiovascular Center, Osaka, Japan.

Address for correspondence: Takashi Kurita, MD, Division of Cardiology, Department of Internal Medicine, Kinki University School of Medicine, 377-2, Ohno-Higashi, Osaka-Sayama, Osaka 589-8511, Japan.

Received for publication May 8, 2009.

Revised and accepted August 6, 2009.
most effective antiarrhythmic therapy for patients with ventricular tachycardia (VT) and/or ventricular fibrillation (VF). However, several clinical studies\textsuperscript{1-3} have demonstrated that the annual incidence of sudden death in patients with ICDs is presumed to be approximately 2%. Sudden death cannot be completely avoided even after ICD therapy.

The therapy logs and electrograms at the time of sudden death are very useful for evaluating the mode of death in such clinical settings. However, inappropriate manipulation of an ICD and the leads after death may result in the loss of important fragile information during a fatal event. Therefore, general physicians, police officers, and paramedics, who may encounter unexpected out-of-hospital deaths of ICD patients, should be informed about proper management of the device after the death of an ICD patient. In Japan, almost all deceased persons are cremated. Therefore, removal of the ICD generator is recommended before cremation in order to avoid explosion of the ICD generator under the high temperatures used in cremation. We experienced an out-of-hospital patient who died suddenly and her ICD was removed by a coroner who mistakenly left it in the active state.

**CASE REPORT**

The case was a 74 year-old female with a diagnosis of idiopathic dilated cardiomyopathy and ventricular tachycardia. An ICD was implanted on February 26, 1997. After implantation, she experienced 6 episodes of appropriate antitachycardia pacing or shock therapies during 9 years of follow-up. On January 26, 2007, her husband noted that she had gone to her bedroom at 14:30. At 18:00 pm, he discovered she had collapsed on her bed and showed no response to his calls. An emergency rescue team arrived 20 minutes later but she had already passed away.

A coroner’s inquest was begun at 21:05 on the same day. Because it was the first time the coroner had performed an autopsy on a patient with an ICD, he removed the ICD by cutting the leads forcibly using scissors without inactivating the device beforehand. After extracting the ICD, he placed the generator in a plastic bag with the damaged leads attached, and kept it in his office.

We became aware of her sudden death one month later due to her absence from our out-patient clinic. We contacted the coroner through the police department and requested that he send the device to our hospital. To evaluate the cause of the sudden death, we retrieved data from the ICD using a programmer. Unfortunately, the electrograms during the fatal event were subsequently lost because of the repeated noise events sensed after removal of the device. The remaining log data were retrieved from the ICD. Four VT or VF events were detected
Figure 1. Charring and crater formation on the surface of the ICD.
A: The ICD had been placed in a vinyl bag with the damaged leads still attached.
B: A magnified view of the uncovered ICD surface. Significant craters and charring are observed where the edge of the damaged shock lead came in contact with the ICD can.

Figure 2. A maximum shock of 31 Joules produced significant sparks emanating from the surface of the ICD.
within approximately 20 minutes (from 14:49 to 15:11 on January 26, 2007), and ICD therapies (antitachycardia pacing and defibrillation shocks) in response to each episode were delivered. After the terminal shock therapy, back-up ventricular pacing with a cycle length of 1000 ms was present. From 21:21 on the same day, frequent events were detected during the coroner’s inquest with manipulation of the device during its removal and the ICD delivered many shocks that were triggered by sensing noise. Many events were also recorded on the 26th and 28th of February. Charring and crater formations were observed on the surface of the ICD where the edge of the injured shock lead had come in contact with the can, probably because of the frequent shock deliveries (Figure 1).

In order to observe the conditions in which the shock deliveries occurred during the noise detection, we programmed the ICD to deliver the maximum shock energy via a programmer while keeping continuous contact between the device surface and shock lead. As shown in Figure 2, a maximum shock of 31 Joules produced significant sparks from the surface of the ICD, which resulted in fusion of the lead wire to the ICD surface.

**Discussion**

We report a patient with idiopathic dilated cardiomyopathy and a history of VT/VF in whom an ICD and the leads were destructively removed by an unaware coroner after the sudden cardiac death of the patient. Because the electrograms during the fatal event had disappeared due to successive detections of noise, the exact cause of the sudden death remained unknown. However, the remaining stored data logs and event markers (showing frequent VT/VF episodes followed by continuous back-up pacing) suggested that the terminal defibrillation shock was either unsuccessful in terminating the tachycardia due to degenerating it to fine (undetectable) VF or induced a nonresponsive cardiac electrical standstill. A postmortem ICD extraction by an uninformed person could lead to the loss of important information.

Furthermore, the present case demonstrated that unstable contact between the uncovered edge of a lead and the surface of the ICD may cause dangerous electric discharges. The melting point of titanium (the material on the surface of ICD generators) is reported to be approximately 1600 °C. If a person were to touch anywhere close to the edge of the lead during a shock discharge, it may cause severe injury.

Even in the United States where the deceased are usually buried, inactivation and removal of an ICD for analysis has been recommended by manufacturers.

To avoid both deletion of the therapy history and dangerous electrical dis-
charges from the ICD, the following procedures are recommended. 1) Careful disconnection of the lead from the ICD using a special screwdriver. 2) Inactivation of the device by changing the previous settings using a compatible programmer. 3) When a coroner or pathologist does not have special implements to perform the above procedures, he or she has no choice but to remove the device by cutting the ICD leads after placing insulation between the edges of the injured leads and the surface of the ICD in order to prevent electrical shock. 4) After removal of the device, the coroner or police department should inform the patient’s doctor about the death as soon as possible. 5) The device should be sent to an appropriate medical center or the manufacturer so they can analyze the terminal episode. In order to ensure widespread and consistent notification about the handling of ICDs after death, education through appropriate scientific societies, such as a guideline from the Japanese Heart Rhythm Society, is highly recommended.

ACKNOWLEDGMENT

We would like to thank Mr. Hajime Ideno, Technical Service Manager, Boston Scientific, Guidant Japan, KK for his support in preparing Figure 2 which demonstrates significant sparks from an ICD.

REFERENCES