Successful implantation of a subcutaneous cardiac defibrillator in a patient with a preexisting deep brain stimulator

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Introduction

In September 2012, the United Stated Food and Drug Administration approved the use of a fully subcutaneous implantable cardiac defibrillator (S-ICD, Boston Scientific Inc). The device is implanted in the left midaxillary space and attached to a single lead that is tunneled subcutaneously from the xyphoid process in 2 directions, superiorly to the sternal manubrium joint to the left of the sternum and laterally to the pulse generator. The lead consists of a single coil in the portion of lead along the sternum and 2 sensing electrodes, 1 at the tip of the lead at the upper portion of the sternum and 1 at the xyphoid process. Sensing is achieved via 1 of 3 potential configurations: between the device and the lower electrode, between the device and the upper electrode, or between the 3 electrodes. The sensing vector is automatically chosen by the device to minimize the chance of T-wave oversensing, but it can be manually overriden.[1]

A deep brain stimulator (DBS) is an electronic device consisting of a pulse generator and 1 or more electrodes implanted in the brain. It can be programmed to operate in a bipolar or unipolar stimulation mode. It is used for the treatment of Parkinson disease, among other neurologic conditions.[2] Manufacturer's recommendations for concomitant use of a transvenous implantable cardiac defibrillator (ICD) and DBS include setting the ICD to bipolar sensing. Sensing in an S-ICD is achieved via much wider bipoles than in a transvenous ICD, raising the concern of adverse interaction between the 2 devices. To our knowledge, we present the first case report of successful implantation of an S-ICD in a patient with a previously implanted DBS.

KEYWORDS Subcutaneous defibrillator; Deep brain stimulator; Defibrillation threshold testing; Implantable cardiac defibrillator; Cardiac device interaction

ABBREVIATIONS **DBS** = deep brain stimulator; **DFT** = defibrillation threshold; **ECG** = electrocardiogram; **ICD** = transvenous implantable cardiac defibrillator; **S-ICD** = subcutaneous implantable cardiac defibrillator (Heart Rhythm Case Reports 2015;1:241–244)

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Case report

A 51-year-old man presented as an outpatient to our institution for consideration of an S-ICD implantation. His past medical history consisted of coronary artery disease, for which he had undergone placement of multiple coronary stents, and early-onset Parkinson disease, for which he had undergone implantation of a Medtronic Activa DBS in the right prepectoral area. In 1996, he had an episode of polymorphic ventricular tachycardia, which resulted in cardiac arrest. At that time, a single-chamber ICD was implanted in the left prepectoral area for secondary prevention of sudden cardiac death. His left ventricular ejection fraction was and remains normal. Between 1996 and 2005, he underwent 4 ICD generator replacements. His initial right ventricular lead was a Ventritex Cadence single-coil lead, which failed and was replaced by a dual-coil St. Jude Medical Riata lead in 2005. In view of the recent Food and Drug Administration recommendation,[3] the patient underwent routine surveillance imaging of the lead at another institution and was found to have externalization of a conductor on fluoroscopy. In addition, an acute rise in the right ventricular threshold from 1 to 3.5 V was noted.

Because of a lack of confidence in the reliability of the Riata lead and the patient's desire to continue to have protection from sudden cardiac death, the patient was given multiple options, including extraction of the transvenous lead and implantation of new transvenous lead, or abandonment of the leads and implantation of an S-ICD. The decision-making was complicated by the presence of the Medtronic Activa DBS, which had provided him with significant relief from parkinsonian symptoms.

In patients with Parkinson disease, the DBS works by bilateral stimulation of the internal globus pallidus or the subthalamic nucleus. Our patient had a single unit with 2 leads, 1 to each cerebral hemisphere. Each lead has 4 electrodes, and the device can be programmed to stimulate in either a unipolar or bipolar fashion. The device can be

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KEY TEACHING POINTS

- The subcutaneous cardiac defibrillator (S-ICD) represents a major advance in ICD technology with the ability to provide sudden death prevention without transvenous leads. Because of its wide sensing bipole, interaction with other implanted electronic devices is a concern. This includes patients with a deep brain stimulator (DBS), which is used for treatment of neurologic disorders such as Parkinson disease.
- Implantation of an S-ICD in patients with a preexisting DBS requires a multidisciplinary approach with the patient's neurologist for programming the DBS to a bipolar mode if possible to limit the possibility of interaction with the S-ICD. In addition, technical support should be available during S-ICD implantation to test sensing with different DBS settings and for interrogation of the DBS after defibrillation threshold testing.
- This case report outlines an approach that was successful when both devices coexisted in the same patient without any adverse effect on the S-ICD or the patient's neurologic symptoms.

programmed to a voltage mode or a current mode, and it can deliver 2 to 250 Hz at a pulse width of 60 to 450 μs and up 10.5 V (voltage mode) or 25.5 mA (current mode).

The patient's DBS had been chronically programmed to unipolar stimulation between the DBS pulse generator and the lead(s). As a first step to facilitate S-ICD implantation, we requested that the DBS be changed to a bipolar mode. Symptom relief from parkinsonian symptoms persisted in bipolar mode.

The 2 DBS leads in the patient's DBS can be programmed independently. The left hemisphere lead was programmed to an output of 3.V, and the right hemisphere lead was programmed to 2.1 V. The pulse width and frequency of both leads were the same at 90 μs and 180 Hz, respectively. During implantation of the S-ICD and defibrillation threshold (DFT) testing, these settings were not manipulated.

Avoidance of T-wave oversensing by an S-ICD requires screening surface ECG recordings simulating the sensing vectors of the S-ICD. Application of a template provided by the manufacturer determines eligibility, which was adequate in this patient.

The patient was taken to the electrophysiology laboratory for implantation of the S-ICD. A programmer and a technician were available to alter the programming of the DBS as needed. The procedure was performed with the patient under general anesthesia. The S-ICD implantation technique has been described elsewhere.[4] We performed the standard technique with a modification: we used a sheath in conjunction with the tunneling tool to place the lead along the left side of the sternum, which avoids the superior third incision.

After implantation, we tested for interaction of the S-ICD and the DBS. Changing between unipolar and bipolar stimulation on the DBS was immediately apparent on the surface ECG (Figure 1).

The S-ICD sensing vectors were recorded with the DBS in both unipolar and bipolar configurations. There was no oversensing of DBS activity (in both bipolar and unipolar modes) by the S-ICD (Figure 2). DFT testing was performed with successful sensing and termination of induced ventricular fibrillation at 65, 50, and 35 J. The DBS was active in bipolar

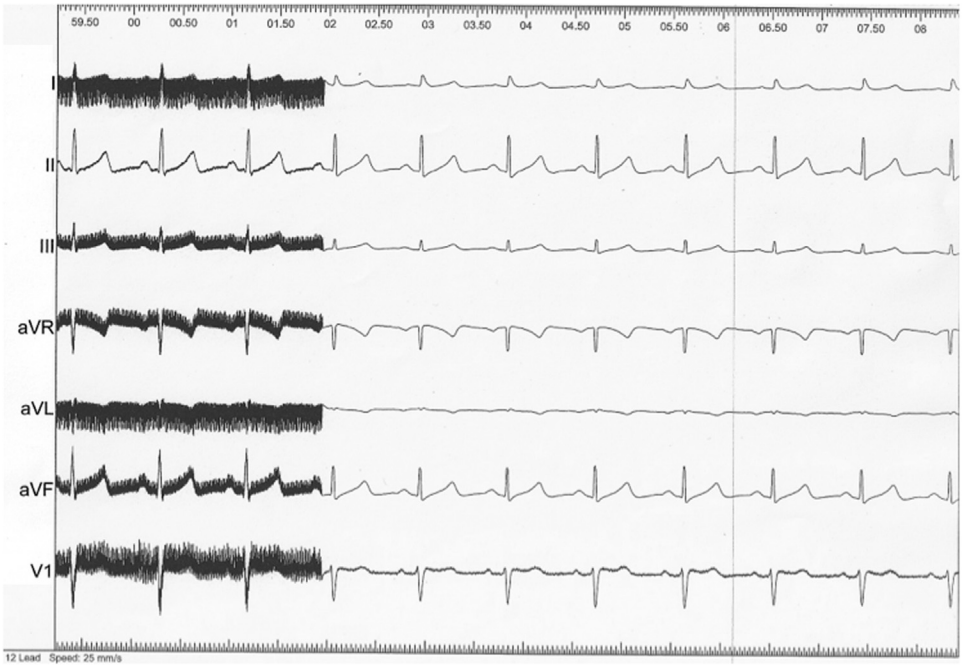

Figure 1 Surface ECG tracing showing transition of DBS stimulation from unipolar to bipolar mode. The artifact created by the DBS in unipolar mode is clearly appreciated in the first third of the tracing. DBS = deep brain stimulator.