A new approach for implantation of a cardiac resynchronization therapy–defibrillator in a patient with bilateral pectoral neurostimulation devices

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Introduction

Neurostimulation devices (NSDs), such as deep brain stimulators for Parkinson disease, are an essential treatment for patients with medically refractory neurological disease.[1] Patients with NSDs for neurological indication rarely require cardiovascular implantable electronic devices (CIEDs). However, when a CIED, especially a defibrillator, is implanted in a patient with bilateral pectoral NSDs, device interferences can occur. Interference between devices could result in detection of the high-frequency impulses of the NSDs, followed by inappropriate implantable cardioverter-defibrillator (ICD) shock, which may conversely lead to malfunction of the NSDs.

We report a successful case of cardiac resynchronization therapy–defibrillator (CRT-D) implantation in the usual way after repositioning of the NSD in a patient who suffered from medically refractory Parkinson disease having bilateral pectoral NSDs. With this method, device interference could be avoided.

KEY TEACHING POINTS

- The subsequent implantation of a cardiovascular implantable electronic device (CIED), especially a cardiac resynchronization therapy–defibrillator (CRT-D), is challenging in a patient with bilateral pectoral neurostimulation devices (NSDs), as device interference can occur.
- In order to place the generators apart, implantation of the pulse generator in the abdomen has been reported, with long leads used in the case of an implantable cardioverter-defibrillator; the leads were placed on the epicardium in the case of CRT-D.
- Our method of implantation of the CRT-D in the usual way after repositioning of the NSD is simple and minimally invasive. Using this method, device interference could be avoided. This method should be considered when implantation of a CIED is planned for a patient with bilateral pectoral NSDs.

Case report

A 76-year-old man with dilated cardiomyopathy and advanced parkinsonism fainted owing to sustained ventricular tachycardia. Electrocardiography showed non–left bundle branch block with a QRS duration of 150 ms, and echocardiography showed a left ventricular ejection fraction of 32% with left ventricular dyssynchrony. CRT-D implantation was recommended. The patient had a long-standing history of drug-refractory parkinsonism, which was ultimately managed with deep brain stimulation via implanted bilateral pectoral NSDs (Activa SC, Medtronic, Minneapolis, MN) (Figure 1). In order to avoid electromagnetic interference between the NSDs and the CRT-D, we planned to perform CRT-D implantation after repositioning of the left pectoral NSD to the left lateral side. We obtained informed consent from the patient for treatment.

Cooperative surgery with neurosurgeons was performed under local anesthesia. First, the NSD was refixed. After

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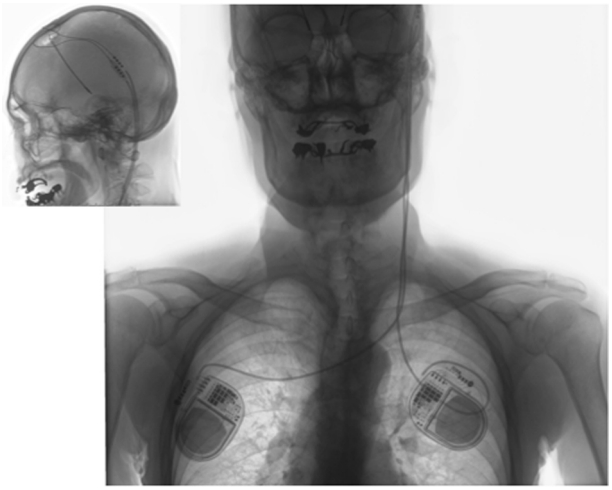

Figure 1 Chest and skull radiographs showing the neurostimulation devices with their electrodes.

removal of the NSD pulse generator from the left pectoral pocket, the lead was passed subcutaneously to the new pocket on the left lateral side by using a tunneler. Next, the CRT-D (Claria MRI Quad, Medtronic) was implanted in the usual way. After this, the CRT-D pulse generator was placed in the pocket where the prior NSD was placed (Figure 2). The lead configurations were as follows: (1) atrial lead: sensed P-wave amplitude of 5.4 mV, pacing threshold of 0.5 V at 0.4 ms, impedance of 612 Ω; (2) ICD lead: sensed R-wave amplitude of 8.2 mV, pacing threshold of 0.7 V at 0.4 ms, impedance of 604 Ω; (3) left ventricular lead: pacing threshold of 1.9 V at 0.4 ms, impedance of 884 Ω. We then tested for interference between the devices. Optimal programming of the NSDs for this patient was as follows: (1) right stimulation: bipolar setting, contact 1 cathode, contact 3 anode, frequency of 130 Hz, amplitude of 2.6 mA, pulse width of 60 μs; (2) left stimulation: bipolar setting, contact 1 cathode, contact 3 anode, frequency of 130 Hz, amplitude of 1.6 mA, pulse width of 60 μs. The outputs from both NSDs were maximized to tolerable output for this patient, with both unipolar and bipolar settings under the sensitivity of 0.15 mV in the CRT-D. However, there was no oversensing of the pulse of the NSDs in the CRT-D. In addition, defibrillation threshold testing was performed and ventricular fibrillation was induced with an R-on-T shock, which was appropriately sensed and defibrillated. Resetting of the NSDs after shock deliveries did not occur (Table 1). Finally, both NSDs were reprogrammed to the bipolar setting. The patient tolerated the operation well and was discharged 1 week later without any complications.

Discussion

Our case suggests important findings. For patients with bilateral pectoral NSDs, CRT-D implantation after repositioning of the left pectoral NSD to the left lateral side is less invasive and useful. There was no interference between the CRT-D and the NSDs in this method.

It is recommended that the NSD and the CIED pulse generator be separated by 8 in as a precautionary measure to minimize interference between the 2 devices.[2] For separation, 2 kinds of methods are available: (1) CRT-D implantation after repositioning of the left pectoral NSD, as was in this case; and (2) CRT-D implantation 8 in apart, without moving the NSD. It has been reported that long leads are used for implantation of the pulse generator in the abdomen in the case of ICD.[3,4] A subcutaneous ICD can also be a therapeutic option.[5] However, in the case of CRT-D leads placed intravenously, there is no available long left ventricular lead that can be used for abdominal or lateral site implantation. A case of CRT-D was reported in which the leads were placed on the epicardium, and the pulse generator was implanted in the abdomen.[2] When placing leads on the epicardium, the procedure would become more invasive.

To our knowledge, this is the first case report of successful implantation of a CRT-D in a minimally invasive way after repositioning of the left NSD. Our method could be applicable for all types of CIED implantation.

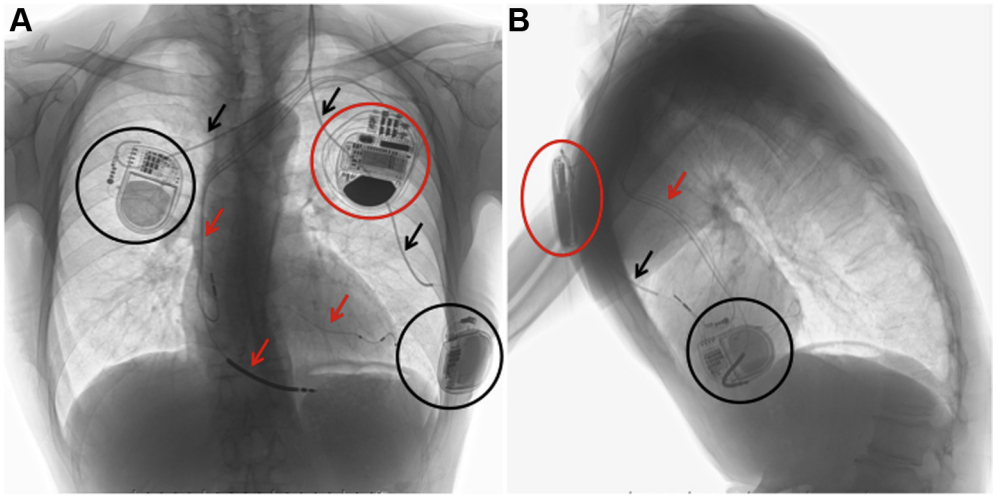

Figure 2 Postoperative frontal (**A**) and lateral (**B**) radiographs showing the leads of the cardiac resynchronization therapy–defibrillator (CRT-D) (*black arrows*), leads of the neurostimulation devices (NSDs) (*black circles*), pulse generator of the NSDs (*red arrows*), and pulse generator of the CRT-D (*red circles*).

Table 1 Sensing test and defibrillation test

Variable	NSDs		CRT-D	
	Left device	Right device	RA lead	RV lead
Sensing test of the CRT-D at any output of the NSDs	60 μs, 130 Hz	60 μs, 130 Hz	Sensitivity 0.15 ms	Sensitivity 0.15 ms
	OFF	Bi 2.4 mA	Oversensing (−)	Oversensing (−)
	OFF	Bi 3.0 mA	Oversensing (−)	Oversensing (−)
	Bi 1.5 mA	OFF	Oversensing (−)	Oversensing (−)
	Bi 2.5 mA	OFF	Oversensing (−)	Oversensing (−)
	Uni 1.0 mA	Bi 3.0 mA	Oversensing (−)	Oversensing (−)
	Uni 2.0 mA	Bi 3.0 mA	Oversensing (−)	Oversensing (−)
	Uni 2.5 mA	Bi 3.0 mA	Oversensing (−)	Oversensing (−)
	Uni 2.5 mA	Uni 2.0 mA	Oversensing (−)	Oversensing (−)
	Uni 2.5 mA	Uni 2.5 mA	Oversensing (−)	Oversensing (−)
	Uni 2.5 mA	Uni 3.0 mA	Oversensing (−)	Oversensing (−)
Defibrillation test of the CRT-D	Reset (−)*	Reset (−)		

When the amplitude of the neurostimulation device (NSD) was set > 3.0 mA on the right stimulator > 2.5 mA on the left stimulator, dyskinesia developed in this patient. Thus, this setting was taken as the maximum tolerable output.

Bi = bipolar setting; CRT-D = cardiac resynchronization therapy–defibrillator; RA = right atrial; RV = right ventricular; Uni = unipolar setting.

*No resetting of the NSDs occurred after shock delivery with 20J or 30J.

In our case, no interference between devices occurred after CRT-D implantation. Some interference between devices has been reported. Romanó et al[6] reported intermittent inhibition of a pacemaker with increased NSD amplitude. Tavernier et al[4] demonstrated resetting of the generator resetting of the NSDs after shock delivery by an ICD. NSDs are typically first programmed to the unipolar setting, since this requires less stimulation intensity to achieve the same clinical benefit and allows longer battery life. In contrast, Ooi et al[7] reported that the unipolar setting is associated with a higher risk of device interaction with CIEDs. After CIED implantation, NSDs are recommended to be programmed to the bipolar setting. In our case, even though the NSD amplitude was increased to the maximum tolerated level for this patient, the NSDs did not affect the CRT-D in both the unipolar and bipolar settings. In addition, no problems with the NSDs occurred after defibrillation threshold testing of the CRT-D. However, in order to minimize the risk of device interference, the NSDs were programmed to the bipolar setting.

With the use of this device, electromagnetic device interference can be detected as high ventricular rate episodes via remote monitoring. We subsequently followed the patient via remote monitoring. However, neither high ventricular rate nor shock episodes have been transmitted so far.

Conclusion

We report a case of successful CRT-D implantation after repositioning of an NSD. There was no interference between devices. It is difficult to determine whether patients with bilateral deep brain stimulators who undergo CRT-D implantation using our method are generally free from device interference. Regardless, our method was less invasive than other reported methods and would be worth performing as the first choice. It is important to confirm whether any device interference occurred during the implantation procedure. Further investigation is required to assess whether our method can be applied to other patients.

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