Unique Technique to Relieve Left Ventricular Assist Device Electromagnetic Interference with an Implantable Cardioverter Defibrillator

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Abstract

We introduced a simple technique to eliminate electromagnetic interference between a left ventricular assist device (LVAD) and an implantable cardioverter-defibrillator (ICD). A 43-year-old male with heart failure and a reduced ejection fraction (HFrEF) who had an ICD presented with decompensated heart failure and received an LVAD as a bridge to transplant. Remote monitoring showed persistent atrial fibrillation causing an inappropriate ICD shock leading to a decision to disable shock therapies. However, an in-office interrogation was unsuccessful due to electromagnetic interference. Patient was instructed to extend his arm above his head on the ipsilateral side of the ICD, thus increasing the distance between LVAD and ICD, eliminating the interaction to allow reprogramming of the device.

Introduction

Progressive pump failure and malignant ventricular arrhythmias are the leading causes of death in patients with advanced heart failure with HFrEF. In patients with refractory HFrEF despite optimal guideline-directed medical therapy, an LVAD, may be implanted as either a bridge to heart transplantation or destination therapy for non-candidates of heart transplant. These patients often meet recommended indications for an ICD as primary prevention of sudden cardiac death[1]. Therefore, many patients with HFrEF have both devices implanted. Electromagnetic interference (EMI) between LVAD and ICD may result in an inability to make a telemetric link for interrogation, or cause an inappropriate shock, or fail to deliver an appropriate shock. We describe a unique and convenient technique to increase the distance between LVAD and ICD, eliminating their interaction to allow successful interrogation of the ICD.

Case Report

The patient is a 43-year-old male with non-ischemic cardiomyopathy, left ventricular ejection fraction of 15%, and paroxysmal atrial fibrillation who had an ICD implanted (Biotronik Intica 7 VRT DX). The patient presented with decompensated heart failure complicated by cardiogenic shock approximately 6 weeks post-implant. The patient was managed with inotropic therapy, an intra-aortic balloon pump, and evaluated for advanced therapies. A HeartMate III LVAD was placed as a bridge to transplant. Eleven months later, remote ICD monitoring reported persistent atrial fibrillation with periods of rapid ventricular rates resulting in inappropriate anti-tachycardia pacing and ICD shocks. With shared decision-making, it was decided to deactivate the tachyarrhythmia therapies. However, in-office interrogation of the ICD was unsuccessful. A pseudo-Faraday cage created by a cast-iron pan was placed on top of the ICD and failed. Successful interrogation and reprogramming were only achieved when the patient was instructed to extend his arm (on

the ipsilateral side of the ICD) above his head, thus increasing the distance between LVAD and ICD from 4 cm (Fig 1) to over 10 cm, eliminating the interaction.

Discussion

To date, there is a paucity of reported cases of EMI interaction between ICDs and LVADs, with the first case reported in 2006.[2]Six cases have reported an interaction between ICDs and the HeartMate II, resulting in the inability to interrogate and program the ICD, inappropriate shocks, and pacing inhibition (St. Jude Medical and Sorin being the most commonly affected ICDs).[2-7] Five other case reports show interactions between HeartWare and ICDs presenting as pacing inhibition or inappropriate shocks.[8-12] With HeartMate III, 7 cases of ICD EMI have been reported, resulting in communication failure in 6 cases and over-sensing LVAD noise signal in one case. [13-15]

Several strategies have been proposed to enable successful communication, interrogation, and reprogramming of an ICD in the setting of EMI with an LVAD:

1. The HeartMate III user's manual recommends that prior to implanting an ICD or pacemaker into a HeartMate III patient, the device to be implanted be placed in close proximity to the LVAD pump (approximately 10 cm) and assure that telemetry communication is established. This approach may be the easiest to confirm the safe distance between the ICD and the LVAD without requiring special equipment and can be performed in office settings. However, this is only a screening technique and its effectiveness may be limited after device implant. If a patient receives a HeartMate III pump and has a previously implanted device that is found to be susceptible to electromagnetic interference, the ICD or pacemaker device should be replaced with one that is not prone to programming interference.
2. A Faraday cage is an enclosure used to block electromagnetic fields that can be created temporarily with conductive material such as metal sheets, mesh or more conveniently, a cast iron pan/sheet externally positioned to isolate the ICD device from the field created by the LVAD motor. Creating a Faraday cage has been shown to be useful in isolating both devices and thus eliminating potential communication interference.[3]
3. Altering the operating frequency of the LVAD or ICD may theoretically eliminate EMI between the two devices. The operating frequency of an ICD is fixed and only altered by changing to another manufacture's pulse generator. This comes with procedural risks, most notably pocket infection. LVAD generated EMI, determined by motor speed, can be adjusted to below 1300 rpm or above 11,000 rpm to establish ICD communication.[4] However, extreme alterations to the LVAD motor may cause hemodynamic compromise and therefore, is not a viable option, in general.

Currently, there are no optimal solutions eliminating EMI interactions between LVADs and ICDs after device implantation. Therefore, selection of the combination of available LVAD and ICD devices must be carefully considered before implantation of either device. Further research is needed to assess, interpret and prevent EMI interaction between ICDs and third-generation, magnetically driven LVADs.

Conclusion

EMI interaction between LVADs and ICDs can potentially interfere with ICD interrogation. This case illustrates a simple, yet effective technique to allow unhindered ICD interrogation and reprogramming as needed with current technology. Further studies are warranted to assess and resolve the interactions between ICDs and LVADs.

Key Teaching Points

- Electromagnetic interference between LVAD and ICD may result in an inability to make a telemetric link for interrogation, or cause an inappropriate shock, or fail to deliver an appropriate shock.
- ICD should be ideally at least 10 cm away from LVAD device to decrease the risk of electromagnetic interference.
- Extending patient's arm above the head (on the ipsilateral side of the ICD) can increase the distance between LVAD and ICD, which is a simple, yet effective technique to allow unhindered ICD

interrogation and reprogramming.

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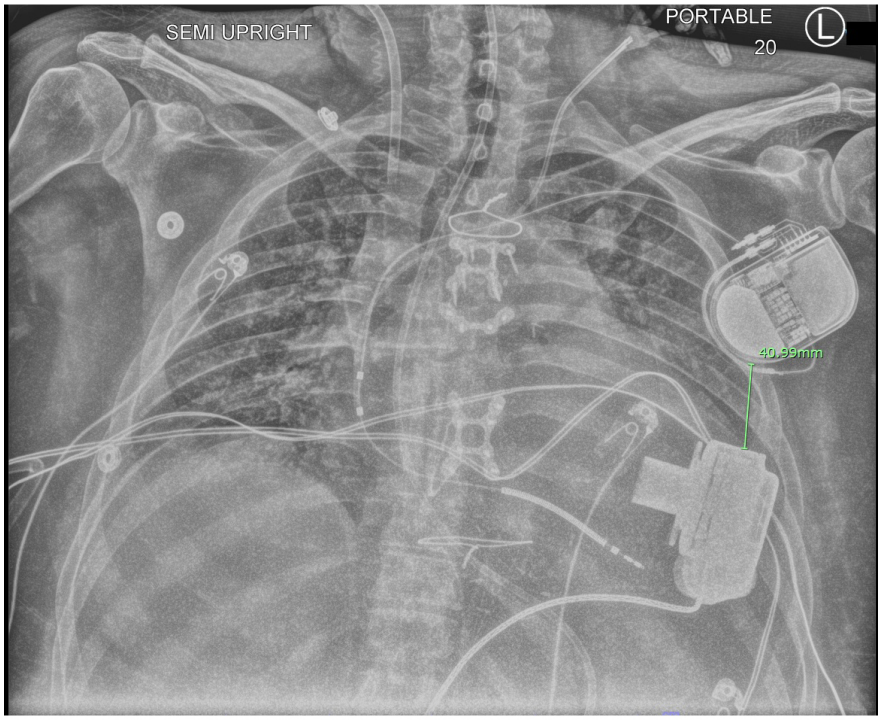

Figure 1. Chest X-Ray showing the distance between Left Ventricular Assist Device and Implantable Cardioverter Defibrillator before extending patient's left arm.

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