ORIGINAL ARTICLE

Appropriate Classification and Filtering of Electromagnetic Interference by the S-ICD Sensing Algorithm During Surgery

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The subcutaneous implantable cardioverter defibrillator (S-ICD) is a new device used for the prevention of sudden cardiac death. Best practices in the perioperative management of the S-ICD are not established; therefore, clinicians typically deactivate the device during surgery, with reinterrogation and activation postoperatively. This could put the patient at risk for being discharged with the device "off." We present two cases where electromagnetic interference was appropriately detected by the S-ICD and filtered. These cases present an important clinical finding that could lead to less deactivation of devices during surgery. Further research will be required to define which surgical procedures require magnet, reprogramming, or no changes.

Keywords: *implantable cardioverter defibrillator, electromagnetic interference, surgery.*

IMPLANTED CARDIOVERTER DEFIBRILLATORS (ICDs) are indicated for prevention of sudden cardiac death (SCD) in patients at risk for SCD. Implantation of ICDs has risen rapidly, with more than 485,000 defibrillators implanted from 2006 to 2009 alone.[1,2] A relatively new type of ICD became available in 2012: the entirely subcutaneous implantable cardioverter defibrillator (S-ICD). To date, more than 19,000 devices have been implanted worldwide.[3] Unlike a transvenous ICD, in which leads are threaded transvenously and attached to the myocardial wall, the electrodes of the S-ICD are placed subcutaneously, proximal to the myocardial wall, leaving the myocardium free from leads. One of the reasons the S-ICD was developed was to reduce the risk of complications associated with transvenous leads including potential infections and breakage of leads.

Management of patients with S-ICDs in the inpatient and outpatient setting is slightly different than that of patients with transvenous ICDs. Because the location of the generator and leads is different, perioperative and postanesthesia nurses may be uncertain how to manage these devices during and after a surgical procedure. Of note, there are no specific recommendations in the guidelines for the perioperative management of S-ICDs.[4-6] Therefore, common practice is to deactivate the device during surgery, with reinterrogation and reactivation postoperatively.

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Disclosures: K. Larimer: consulting—Endotronix, Edward Hospital, PhysIQ; M Saleem: consulting—Boston Scientific; M. Burke: honoraria—Boston Scientific, research grants—Scientific, St Jude Medical and Medtronic, Equity in Atacor Medical, Inc.

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1089-9472/$36.00

http://dx.doi.org/10.1016/j.jopan.2016.12.002

The impact of electrical magnetic interference (EMI) is a unique perioperative consideration for patients with both transvenous ICDs and S-ICDS. Patients with these devices have traditionally been considered at risk for EMI from a variety of sources including electrocautery, which is commonly used in the operating suite. EMI can cause oversensing, which occurs when an electrical signal is inappropriately recognized as cardiac activity. When this happens there is an increased potential for inappropriate ICD therapies (ie, shocks). EMI can also cause pacing inhibition, which puts patients that are pacemaker dependent at risk for bradycardia.[7]

The American Society of Anesthesiologists' practice advisory,[4] the American College of Cardiology/American Heart Association practice guidelines,[5] and Heart Rhythm Society/American Society of Anesthesiologists expert consensus statement[6] advise suspending ICD therapies during use of electrocautery if EMI is likely to occur. Although this is the current recommendation, it is important for nurses to recognize that many patients undergoing surgical procedures are at intermediate risk (1% to 5%) or high risk (>5%) for perioperative cardiac events based on the type of procedure.[5] Although the risk of EMI is low during many procedures, institutions' practice patterns have typically been to routinely program ICD therapies off for all procedures, regardless of the level of risk. Routinely programming ICD therapies off exposes patients to unnecessary cardiac-related risks including (1) arrhythmias with life-saving therapies off when under sedation or general anesthesia, (2) unmonitored transport and holding when awaiting skilled personnel to reprogram ICD therapies "on," and (3) inadvertently leaving ICD therapies off at patient discharge because of miscommunication during multiple communication handoffs. The question of best practice in perioperative management of traditional ICDs and S-ICDs remains controversial.

As an exercise to better understand the potential interaction of EMI and the S-ICD in the operating theater, the S-ICD electrocardiogram (ECG) data in two patients were monitored using the programmer for oversensing of all EMI during and after surgery. The following is a summary of our observations.

Case Reports

Two patients with S-ICDs underwent elective surgical procedures requiring monopolar electrocautery. We sought to evaluate the response of the sensing filters in the S-ICD algorithm during and after the surgery. Sensing filters are algorithms in the device software that allow detection of a potential arrhythmia, verification of the arrhythmia, and appropriate therapy decision making by the device (heart rhythm assessed and therapy delivered).

Patient A was a 64-year-old male with an ischemic cardiomyopathy and an ejection fraction (EF) of 35% who underwent a bilateral parathyroidectomy requiring monopolar electrocautery. Patient B was a 76-year-old male with an ischemic cardiomyopathy and an EF of 32% who underwent laparoscopic cholecystectomy requiring monopolar electrocautery and harmonic scalpel. Both patients met the indications[8] for a defibrillator in the primary prevention of SCD because of low EF and a remote history of myocardial infarction. Both patients were receiving standard medical therapy characteristic of their diagnosis, in other words, beta blockers, angiotensin receptor antagonists, antiplatelet therapy, and diuretics. Both patients were given an S-ICD because of their lack of symptomatic bradycardia or reliably paced terminable ventricular tachycardia.[9]

Before the implantation of the S-ICD, each patient was successfully screened for adequate sensing by surface ECG using the product labeling method.[9] In brief, a preoperative 12-lead ECG screening in the supine position and upright position was obtained across the three chest wall sensing vectors: primary (left parasternal xiphoid to generator); secondary (second intercostal left parasternal to generator); and alternate (second intercostal to xiphoid along left parasternum). The screening discovered the secondary sensing vector posturally adequate in both patients. The two patients had uneventful S-ICD implantations including generator placement in the fourth intercostal space in the midposterior axillary line with the lead tunneled to the left parasternum then superiorly from the xiphoid process to the second intercostal space. The patients had normal follow up and no sensing issues from the implant to the day of surgery.