

Surgical and electrophysiological considerations in the management of a patient with a subcutaneous implantable cardioverter-defibrillator undergoing coronary artery bypass surgery

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Introduction

The use of the implantable cardioverter-defibrillator (ICD) has been the standard of care in the management of patients who have experienced sudden cardiac death and also for those patients at risk for life-threatening ventricular arrhythmias.¹ These transvenous systems carry a substantial risk of periprocedural complications including pneumothorax, cardiac perforation, pericardial effusion or tamponade, hemothorax, venous thrombosis, lead failure or fracture, and infection.^{2,3} In 2010, Bardy et al reported the first successful use of a completely subcutaneous ICD (S-ICD) that is expected to obviate these risks.⁴ The U.S. Food and Drug Administration has approved the S-ICD for use in indicated patients without the need for ventricular pacing or cardiac resynchronization therapy.⁵ The S-ICD has been effective in the management of at-risk patients; however, its use in surgical patients has been limited. Temporary pacing and sternal wires have interfered with normal S-ICD device function; hence, careful placement of the subcutaneous lead in candidates for cardiac surgery requiring a median sternotomy is of utmost importance.^{6,7} We present the first reported case of a patient with an existing S-ICD system who underwent a median sternotomy for coronary artery bypass graft (CABG) surgery in which removal and repositioning of the S-ICD lead was performed.

KEYWORDS Ventricular tachycardia; Coronary artery bypass surgery; Implantable cardioverter-defibrillator; Sudden cardiac arrest; Cardiomyopathy (Heart Rhythm Case Reports 2016;0:1–5)

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Case report

In February 2016, a 34-year-old man with a history of idiopathic dilated cardiomyopathy for many years and a left ventricular ejection fraction of 20% was referred to the electrophysiology service for ICD implantation. He had a history of nonsustained ventricular tachycardia and unexplained syncope. His electrocardiogram revealed normal sinus rhythm without conduction abnormalities and a narrow QRS duration. He was considered to have NYHA functional class II heart failure symptoms on optimum medical therapy. He underwent successful S-ICD placement and his post-procedure course was uneventful. A chest radiograph revealed normal S-ICD lead and generator positions and the electrogram recording from the S-ICD lead demonstrated normal sensing function (Figure 1). Ventricular fibrillation was induced at implantation utilizing 50 Hz stimulation from the device and defibrillation was successful with a 65 J shock. No evidence of oversensing or undersensing was evident.

Approximately 2 months following S-ICD implantation, he presented to the emergency room at our institution with acute substernal chest discomfort and shortness of breath with new reversible anterior wall ischemia on pharmacologic stress testing, despite the absence of a previous history of chest pain, and despite prior negative stress test for myocardial ischemia a few years earlier. Coronary angiography revealed evidence of severe triple vessel coronary artery disease and bypass surgery was recommended. The patient underwent planned coronary artery bypass grafting with specific provision for handling of the S-ICD lead that was lying in the field of a standard median sternotomy incision. S-ICD lead positioning was undertaken to assure that the distal or proximal sensing electrode was not in contact with any sternal wires (Figure 2).

There is to date no clear guideline for managing a patient with an existing S-ICD lead during median sternotomy, and

KEY TEACHING POINTS

- The subcutaneous implantable cardioverter-defibrillator (S-ICD) is useful in the prevention and treatment of patients with life-threatening ventricular arrhythmias and the lead system may be repositioned safely in patients undergoing coronary artery bypass graft surgery.
- Repositioning of the S-ICD lead in association with the performance of a median sternotomy must be carefully undertaken to avoid contact with sternal wires.
- S-ICD lead testing to discriminate QRS and T-wave amplitude ratio must be undertaken to insure appropriate sensing to enable effective detection and treatment of ventricular tachyarrhythmias.

so we aim to demonstrate our effective treatment of this clinical scenario. In anticipation that thoracic surgery in patients with an existing S-ICD is likely to become more frequent, given the increasing number of implanted S-ICDs, we believe that it is essential to address an approach to prevent potential complications related to sternal wires, as well as other technical and electrophysiological considerations.

Surgical technique

In the cardiothoracic surgery operating room, the patient was prepped and draped in the standard way for CABG surgery. Following a small paraxiphoid incision over the preexisting incision, the anchoring sleeve of the sternal lead was located, the suture sleeve was exposed but not freed from its anchoring sutures, and the lead was pulled back through this small incision to be kept outside of the body between antibiotic-infused packing mesh. The lead was kept protected in this manner while a standard sternotomy proceeded and bypass surgery was performed without complication. Following successful bypass grafting and standard closure of the sternum with sternal wires, the subcutaneous defibrillator lead was reirrigated with antibiotic-infused saline and replaced on top of the fascial plain overlying the sternum, consistent with the original lead position. The lead was nested into a central position (Figure 3) above which the subcutaneous and skin layers were closed in the standard fashion. Care was taken to avoid any contact between the electrode and sternal wires to avoid oversensing.⁶

Postsurgical management and device testing

Pre- and post-vector analysis of the QRS and T-wave amplitudes was measured from the S-ICD lead and the results met acceptable criteria along all measured vectors for effective QRS and T-wave discrimination (Figures 1 and 2). During postoperative in-hospital follow-up this effective

QRS and T-wave complex discrimination remained consistent with the preoperative measurements. The patient had an uneventful postoperative course and was discharged from the hospital after 7 days, in good condition. He returned to the electrophysiology clinic after 1 week for an incision check, and routinely 2 months later. All the incision sites were well healed and the S-ICD was functioning normally, with adequate QRS and T-wave discrimination.

Discussion

To our knowledge, this is the first detailed description of the perioperative management of a patient with an existing S-ICD lead who underwent CABG surgery via median sternotomy in which explantation and reimplantation of the same lead was performed. Additional considerations to address involve the assessment of QRS voltage in the immediate postoperative period, as it has been reported that the QRS amplitude is often diminished following open chest surgical procedures and this may interfere with QRS and T-wave discrimination, an essential parameter that allows accurate arrhythmia detection and minimizes the risk of oversensing the T wave and inappropriate shocks.^{6–8}

To avoid spurious recordings, artifacts, and oversensing, caution should be taken to avoid placing the rate sensing electrodes of the S-ICD lead in close proximity to sternal wires, as this may impact sensing, particularly in the secondary and alternate sensing vector of the device. Infusino et al cited oversensing of epicardial pacing spikes by the S-ICD resulting in inappropriate shocks in a patient undergoing aortic and mitral valve replacement.⁷ Their experience should serve as a caveat to clinicians when managing patients who are at risk for bradyarrhythmias in the perioperative period.

The S-ICD has been effective and safe in patients at risk for sudden cardiac death who do not require antitachycardia pacing, bradycardia support, or cardiac resynchronization therapy.^{4,9–11} Traditional transvenous ICDs are associated with an approximately 5% complication rate within 30 days of implantation, a 16%–20% chance of lead failure over 10 years, and a 2.4% annual incidence of infection.^{2,3,12–14} Systemic infections and endocarditis remain a concern in the use of these traditional devices. In addition, the risk of infection has risen along with the increasing numbers of invasive procedures, including generator replacement.¹⁴ Device-associated infections may have high morbidity and mortality rates and can be fatal when associated with bacteremia and evidence of endocarditis. Accordingly, the extravascular nature of the S-ICD lead is expected to reduce the potential for life-threatening infectious sequelae in these patients.

S-ICDs can sense the QRS complex in 3 vectors, using 2 elements on the electrode—the distal tip and proximal ring—as well as the pulse generator.¹⁰ It has been demonstrated in this case that there was no significant change in the sensed QRS vector amplitude and QRS/T-wave amplitude ratio after the median sternotomy and reimplantation of the S-ICD

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