Mobile subcutaneous implantable cardioverter-defibrillator leads to oversensing and inappropriate shocks

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Introduction

The implantable cardioverter-defibrillator (ICD) offers a reduction in mortality to persons at risk and survivors of cardiac arrest.[1] The subcutaneous ICD (S-ICD) is an alternative to the traditional transvenous ICD (TV-ICD) without the risk of endovascular lead complications.[2] Inappropriate S-ICD shocks are uncommon.[3] We describe a case of an inappropriate S-ICD shock 4 years after implant owing to hypermobility of the S-ICD generator resulting in abnormal sensing.

Case report

A 48-year-old woman presented with an awake shock from her S-ICD without any preceding symptoms while lying in bed. Her medical history includes familial idiopathic dilated cardiomyopathy with a left ventricular ejection fraction of 20% despite left ventricular enhancement therapy, for which she received a primary prevention dual-chamber TV-ICD (Fortify DR pulse generator model CD2233-40, St. Jude Medical, St. Paul, MN; right ventricular lead model 6935, Medtronic, Minneapolis, MN) in 2012. Owing to a fractured right ventricular high-voltage lead, the system was explanted and replaced by an S-ICD (SQ-RX Pulse Generator Model 1010 and Q-TRAK Subcutaneous Electrode Model 3010, Cameron Health/Boston Scientific, San Clemente, CA) in 2014. The generator pocket was created in the midaxillary line superficial to the latissimus dorsi between the fifth and sixth intercostal spaces and electrode along the left parasternal border. Chest radiographs postimplantation show the generator positioned anterior to the midaxillary line (Supplemental Figure 1). Device testing at the time of implant showed adequate R-wave sensing, which remained stable in follow-up.

The patient presented to hospital following a first and unprovoked shock 4 years after implant. Device interrogation showed low-amplitude cardiac signals (R wave < 0.1 mV) and poor QRS discrimination, resulting in intermittent double counting (T-wave oversensing) and triple counting (P-wave and T-wave oversensing) (Figure 1). This caused inappropriate ventricular tachycardia detection and a shock. Following the shock, she changed position, which led to restoration of the R wave amplitude to 0.6 mV and correct QRS discrimination (Figure 1). The patient reported lying in bed in the left lateral decubitus position before receiving a shock, which jolted her into the supine position.

Chest radiographs were obtained and showed that the device position was unchanged from implantation when the patient was seated upright (Supplemental Figure 2). However, the patient could manually and freely move the device anteriorly and superiorly in the subcutaneous tissue. The patient reported that the device was in a stable position for years. It became dislodged following mechanical trauma

KEY TEACHING POINTS

- Inadequate fixation or distorted anatomy may lead to hypermobility of the subcutaneous implantable cardioverter-defibrillator (S-ICD) generator.
- Malposition of the S-ICD generator may compromise R-wave sensing, leading to P-wave oversensing and/or T-wave oversensing. Oversensing is the commonest cause of inappropriate shocks by the S-ICD.
- The durability of device positioning may be ensured by placing the generator deep to the latissimus dorsi muscle with sutures to secure it in place.

KEYWORDS ICD; Implantable cardioverter-defibrillator; Inappropriate shocks; S-ICD; Subcutaneous; Subcutaneous defibrillator
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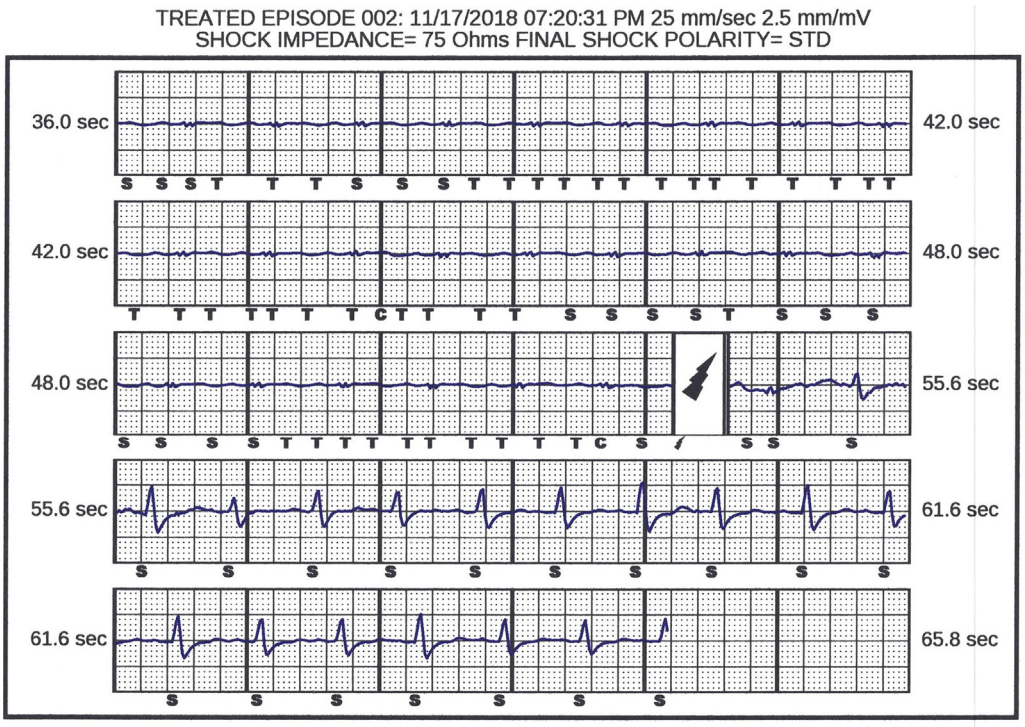

Figure 1 Poor QRS discrimination resulting in T-wave oversensing and a shock followed by an increase in QRS voltage and restoration of QRS discrimination. This electrogram is explained by a change in patient position. C = charging; S = sensed beat; T = tachy detection.

to the pocket while she was doing laundry the week prior, and was freely mobile thereafter. When the device was interrogated with the patient in the supine position, it showed normal sensing in the primary and secondary vectors (Figure 2), but not the alternate vector. When interrogated in the left lateral decubitus position, there was poor R-wave sensing in all vectors (Figure 2). This was likely due to further anterior positioning of the pulse generator (Supplemental Video). Programming changes could not resolve the problem.

At surgical exploration, the device was hypermobile and sitting anterior to the latissimus dorsi muscle. The patient had abnormal anatomy owing to two previous lateral chest wall surgeries (including a breast reduction) and there was a significant distortion of the latissimus dorsi muscle insertion onto the serratus muscle. A 0-0 silk retention suture

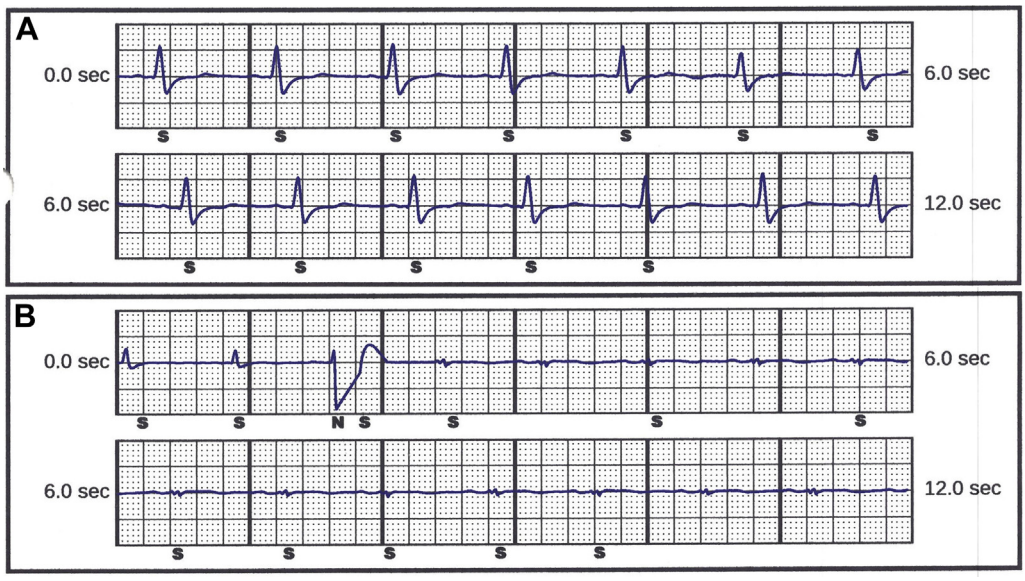

Figure 2 Electrogram demonstrating adequate QRS discrimination while in the supine position (**A**) and low voltages and poor QRS discrimination while in the left lateral decubitus position (**B**). N = noisy beat; S = sensed beat.

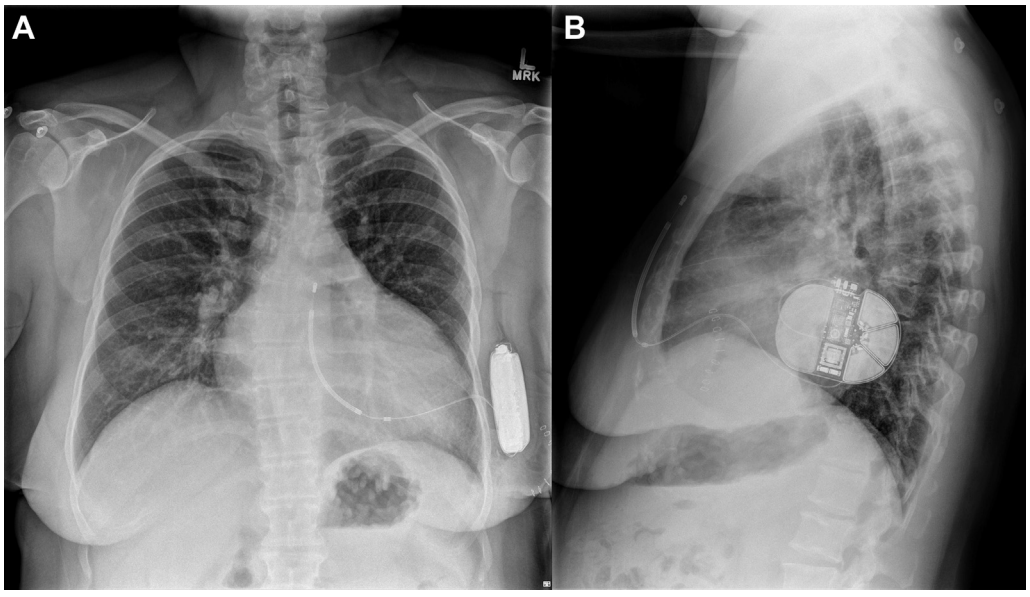

Figure 3 Posterior-anterior (**A**) and lateral (**B**) chest radiographs demonstrating appropriate positioning of the subcutaneous implantable cardioverter-defibrillator generator along the midaxillary line following reimplantation of the device.

that had been used to stabilize the device appeared frayed and had broken. The latissimus dorsi was dissected free of the chest wall and a pocket made between it and the serratus very posteriorly. The new generator was redundantly sutured to muscle fascia and interrupted sutures were placed to keep the device from moving into the old pocket. The electrode remained in situ. Follow-up chest radiography demonstrated stable position of the electrode and optimal repositioning of the new S-ICD generator along the midaxillary line (Figure 3).

Discussion

The S-ICD is considered to be less invasive than the conventional TV-ICD. Inappropriate shocks are uncommon but are still the most frequent complication of the S-ICD system, especially in the setting of low-amplitude cardiac signals and resultant T-wave oversensing.[2–4] Inappropriate shocks may cause significant physical and psychological stress and, in some cases, lethal arrhythmias.[5]

We present a case of late mechanical dislodgment of the S-ICD generator owing to mechanical trauma, resulting in breakage of a silk retention suture and hypermobility of the device at 4 years postimplantation. The consequent positional variability in sensing of cardiac signals resulted in intermittent P- and T-wave oversensing followed by an inappropriate shock. Implanters should take appropriate steps to secure the device in a stable position at the time of implantation.

Conclusion

In some S-ICD patients, dynamic device positioning may result in low-amplitude cardiac signals and resultant T-wave oversensing with inappropriate shocks. Device positioning may be stabilized by creating the pocket deep to the latissimus dorsi muscle with sutures to secure it in place. This may mitigate the risk of future inappropriate or failed device therapy.

Appendix

Supplementary data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.hrcr.2019.04.001.

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