

CASE REPORT

Revision of subcutaneous implantable cardioverter defibrillator to intermuscular pocket to prevent inappropriate shocks

Jeko M. Madjarov¹  | Svetozar Madzharov^{1,2} | Filip Abedinov³ | Stefanie Chappuis⁴ | John M. Fedor⁵

¹Department of Cardiovascular Surgery, Sanger Heart & Vascular Institute, Atrium Health, Charlotte, North Carolina

²Faculty of Medicine, Sofia Bulgaria Medical University, Sofia, Bulgaria

³St. Ekaterina University Hospital, Sofia, Bulgaria

⁴Boston Scientific, St. Paul, Minnesota

⁵Department of Electrophysiology, Sanger Heart & Vascular Institute, Atrium Health, Charlotte, North Carolina

Correspondence

Jeko M. Madjarov, Sanger Heart & Vascular Institute, 1001 Blythe Blvd Suite 300 Charlotte, NC 28203.
Email: Jeko.Madjarov@atriumhealth.org

Funding information

This work was supported by the Heineman Foundation for Research, Educational, Charitable and Scientific Purposes, Inc.

Abstract

Sensing and defibrillation threshold for a S-ICD are impacted by positioning at implant or revision. The intermuscular pocket prevents device migration and provides appropriate, stable sensing vectors.

KEYWORDS

inappropriate shock, intermuscular, sensing vector, S-ICD

1 | INTRODUCTION

The subcutaneous implantable cardioverter defibrillator (S-ICD; Boston Scientific) is a safe and effective implantable defibrillator option for the prevention of sudden cardiac death (SCD).¹ Implant technique and location of the generator and electrode are critical to ensure appropriate sensing, defibrillation threshold (DFT), and reduction of long-term system complication rates.^{2,3} This report highlights the advantages of the intermuscular S-ICD implant technique and the importance of this procedure as an option in the event of inappropriate shocks due to generator placement.

2 | METHODS

A 57-year-old female patient with a history of cardiomyopathy received a S-ICD model 1010 device implant in April 2014. At the time of implant, the device was programmed to Secondary vector for sensing (distal electrode—Can). During the preimplant screening process, the patient passed screening in Secondary and Primary vectors, but failed in Alternate due to a poor QRS:T-wave ratio. Defibrillation testing was performed at implant with a successful 65J DFT and recorded shock impedance of 125 ohms. Three years post-op, she presented to the office for routine follow-up

This manuscript is original, and no aspect of the case report or images has been published elsewhere.

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2020 The Authors. *Clinical Case Reports* published by John Wiley & Sons Ltd.

and was unaware that she received an inappropriate shock from her S-ICD. This was the first episode noted on her device since implant. Upon evaluation, it was determined she had received a shock due to T-wave oversensing while programmed to Secondary vector. During the episode, the QRS:T-wave ratio appeared degraded when compared to the manually captured Secondary subcutaneous electrocardiogram (S-ECG). After evaluation of the sensing vectors, the device was programmed to Primary vector (xyphoid electrode—Can) which had an appropriate QRS:T-wave ratio.

The following month the patient presented to the office with three inappropriate shocks from the S-ICD. It was determined that the patient had received inappropriate shocks for oversensing of T-waves while programmed to Primary vector (Figure 1). The cause of the T-wave oversensing was attributed to a degradation of the QRS amplitude. All inappropriate shocks occurred while the patient was lying down, primarily on the left side. The patient was further evaluated while performing postural changes, and it was noted that the QRS amplitude varied in real time with these changes to posture (Figure 2). Pocket evaluation was performed, and it was found that the device was in an anterior position, most likely in adipose tissue; and the device tended to migrate with postural changes causing variances in the QRS amplitude. The S-ICD generator is an integral

part of the sensing vector when programmed to Primary or Secondary vector. Alternate vector (distal electrode—xyphoid electrode) was not a programming option due to a poor QRS:T-wave ratio.

X-ray images were obtained and compared to the images from implant (Figure 3A,B), and it was confirmed that the device had been inappropriately placed in an anterior axillary position at implant and that the generator appeared to have slightly migrated in the pocket. (Figure 3C,D) Although the device was sutured to the fascia at implant, it was decided that the sutures were most likely no longer intact and holding the generator in a secured position. After discussing the case details, the decision was made to reposition the generator to the intermuscular pocket as recommended in labeling by Boston Scientific.⁴

The patient was admitted to the hospital in October 2017 to undergo generator pocket revision. Anesthesia evaluated the patient and induced standard general anesthesia. Marking lines were placed on the patient after fluoroscopy-guided images were obtained to verify appropriate generator placement posterior to the midaxillary line. The patient was prepped and draped in sterile surgical fashion. The generator was extracted in routine manner at this point with a new 4-cm incision placed on the left lateral aspect, 4 finger breadths above the latissimus dorsi muscle. Electrocautery was used to dissect the pocket and obtain hemostasis. The incision was deepened through

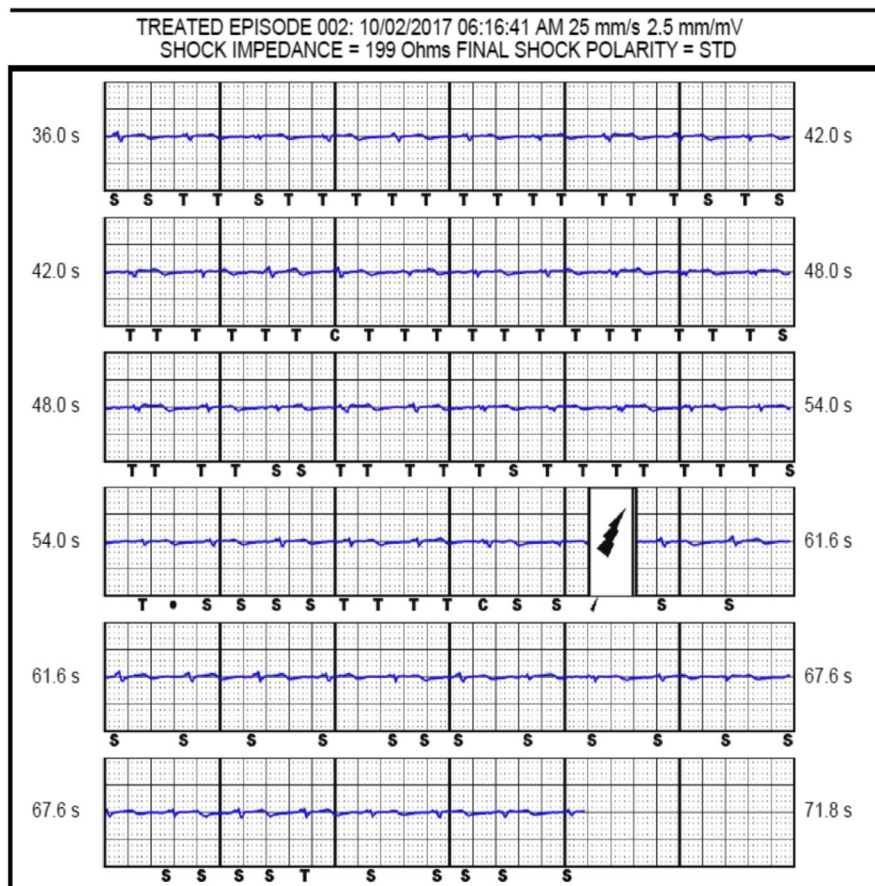


FIGURE 1 Shock in Primary vector due to T-wave oversensing and QRS amplitude degradation

FIGURE 2 Primary vector S-ECG showing QRS amplitude degradation with postural changes

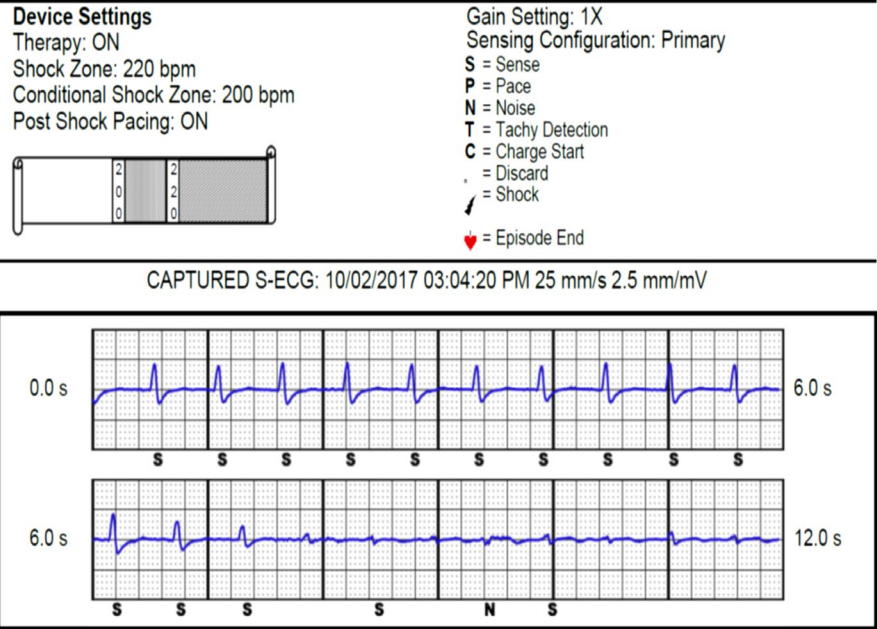
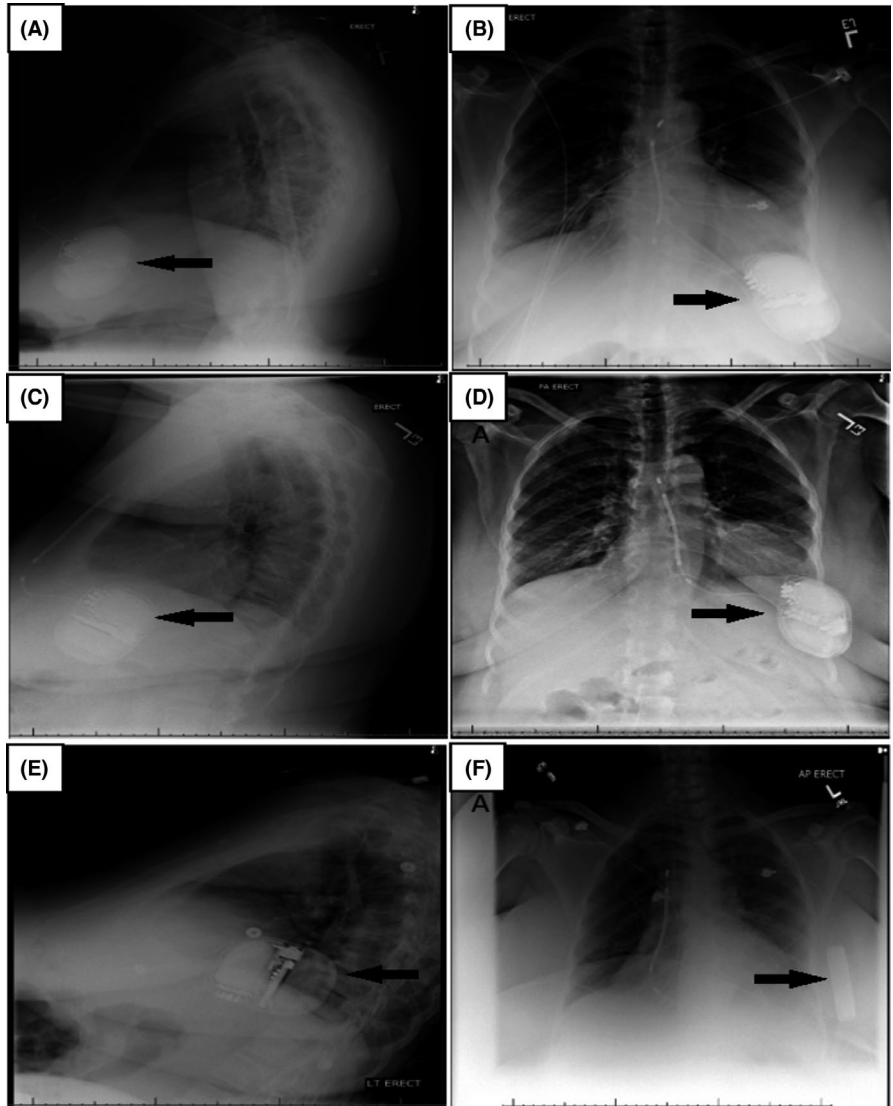


FIGURE 3 Chest x-ray images: A, lateral at implant, B, posteroanterior (PA) at implant, C, lateral post-shock, D, PA post-shock, E, lateral pocket revision, and F, anteroposterior (AP) pocket revision



the subcutaneous layers down to the rib cage. In the avascular plane, we were able to create the intermuscular pocket between the serratus anterior and latissimus dorsi using blunt dissection without any significant bleeding.⁵ After positioning the generator in the intermuscular pocket, the device was secured per instructions for use and successful defibrillation testing was performed with a threshold of 80J. The surgical wound was closed in a multi-layer fashion with a sterile dressing applied upon closure. The patient was taken to recovery without any adverse events.

3 | RESULTS

Postoperative images confirm the generator was appropriately repositioned posterior to the midaxillary line (Figure 3E,F). Postoperative device interrogation showed no changes to the QRS morphology with postural variation or while the patient was in the left lateral recumbent position with the device secured in the intermuscular pocket. There have been no episodes of oversensing or inappropriate shocks after the device was placed in the intermuscular position.

4 | DISCUSSION

In the event of inappropriate shocks with degradation of QRS amplitude, it is important to not only evaluate the captured S-ECG's in one position, but in various positions, especially that in which the patient received therapy. Changes in posture can result in QRS degradation leading to oversensing of T-waves as the sensing algorithm adjusts to detect the low-amplitude QRS signal. It is critical to recognize the role the generator plays in appropriate sensing and ensure at implant that the device is placed in an appropriate midaxillary to posterior axillary position and secured to avoid migration. The sensing vector is not constant if the device is not attached immediately to the chest wall fascia; and when placed in the soft tissue component of the chest wall, namely subcutaneous adipose, it creates the possibility of postural variations, that is, undulating vectors, which can lead to inappropriate therapy.

Another point to note is that the device in its original positioning recorded elevated shock impedances for each of the inappropriate shocks, ranging from 188 to 199 ohms. Data presented in 2018 indicates that impedances greater than 110 ohms have notably lower success rates at 65 Joules and may warrant evaluation of the full system placement, including both the generator and the coil.⁶ At the time of this revision in 2017, the shock impedance decreased by roughly 30%, registering at 137 ohms during DFT testing, with the first shock failing at 65J followed by a successful 80J shock. The

successful 80J DFT is considered safe and appropriate so the coil position was not revised. Based on this new data showing an inverse relationship between shock impedance and DFT conversion success, along with demonstrating that increased subcutaneous fat underneath either the coil or the generator impairs system success, we would have also revised the coil depth to ensure DFT efficacy. With evaluation of the X-ray images, there is a clinically significant amount of subcoil fat that contributed to the elevated shock impedance and failure to convert at 65J even after revision of the generator placement.

5 | CONCLUSION

It has been our experience that placing the generator in an intermuscular position between the serratus anterior and latissimus dorsi appears to be a superior approach to the subcutaneous implant both in terms of DFT efficacy and long-term patient comfort. The intermuscular implant protects against migration of the device during postural changes, especially in patients with increased body mass index. Through other studies, the intermuscular technique has been shown to be a safe and effective alternative approach to the S-ICD implant while providing low complications rates, appropriate sensing vectors, effective and possibly improved defibrillation thresholds, and better cosmetic outcomes.^{5,7,8} In the event of inappropriate therapy with a S-ICD, evaluation of alternative sensing vector S-ECGs should take place while the patient is placed in multiple postural variations as well as consideration given to the evaluation of the full system placement to rule out the possibility of device or coil migration.

ACKNOWLEDGMENTS

Published with written consent of the patient.

CONFLICT OF INTEREST

Stefanie Chappuis is an employee of Boston Scientific. We have no other conflicts of interest to disclose.

AUTHOR CONTRIBUTIONS

Author 1: Jeko M. Madjarov, MD - JM: involved in concept/design, critical revision of the article, and securing funding. Author 2: Svetozar Madzharov, MD - SM and Filip Abedinov, MD - F.A: involved in concept/design and drafting of the article. Author 4: Stefanie Chappuis, BSBm.E - SC: acquired device diagnostics and drafted the article. Author 5: John M. Fedor, MD, FHRS - JF: involved in concept/design and critical revision of the article. All authors approved of the submitted content. All authors are responsible for the content of the case report, have reviewed the manuscript, and have approved the final version for submission to Clinical Case Reports.

ORCID

Jeko M. Madjarov  <https://orcid.org/0000-0001-9241-8567>

REFERENCES

1. Boersma L, Barr C, Knops R, et al. Implant and midterm outcomes of the subcutaneous implantable cardioverter-defibrillator registry: The EFFORTLESS Study. *J Am Coll Cardiol*. 2017;70(7):842-844.
2. Kevin Heist E, Belalcazar A, Stahl W, Brouwer TF, Knops RE. Determinants of subcutaneous implantable cardioverter-defibrillator efficacy: a computer modeling study. *JACC Clin Electrophysiol*. 2017;3(4):405-414.
3. McLeod CJ, Boersma L, Okamura H, Friedman PA. The subcutaneous implantable cardioverter defibrillator: state-of-the-art review. *Eur Heart J*. 2017;38(4):247-257.
4. EMBLEM S-ICD, EMBLEM MRI S-ICD User's Manual. 359481-019 EN Europe 2016-11. Manual.
5. Winter J, Clahsen H, Shin D-I, O'Connor S. Submuscular is Superior to Subcutaneous Implantation for Subcutaneous Implantable Cardioverter Defibrillator. *Circulation*. 2013; 128:A14688. Article.
6. Amin AK, Gold MR, Burke MC, et al. Factors associated with high-voltage impedance and subcutaneous implantable defibrillator ventricular fibrillation conversion success. *Circ Arrhythm Electrophysiol*. 2019;12:e006665.
7. Ferrari P, Giofre F, De Filippo P. Intermuscular pocket for subcutaneous implantable cardioverter defibrillator: single-centre experience. *J Arrhythm*. 2016;32(3):223-226.
8. Winter J, Siekiera M, Shin D-I, et al. Intermuscular technique for implantation of the subcutaneous implantable cardioverter defibrillator: long-term performance and complications. *Europace*. 2017;19(12):2036-2041.

How to cite this article: Madjarov JM, Madzharov S, Abedinov F, Chappuis S, Fedor JM. Revision of subcutaneous implantable cardioverter defibrillator to intermuscular pocket to prevent inappropriate shocks. *Clin Case Rep*. 2020;8:1081–1085. <https://doi.org/10.1002/ccr3.2819>