

MINI-FOCUS ISSUE: COMPLICATIONS

INTERMEDIATE

CASE REPORT: CLINICAL CASE

An Unexpected Complication of Subcutaneous ICD Implantation and its Successful Management



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ABSTRACT

Subcutaneous implantable cardioverter-defibrillator implantation is known to be a safe procedure. However, inappropriate lead insertion can lead to serious complications. We present a case where an inappropriate lead placement resulted in puncturing the lung parenchyma, and successful management of the lead-related pneumothorax through thoracoscopic lead removal and partial lung resection. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2020;2:889-93) © 2020 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

HISTORY OF PRESENTATION

A 78-year-old man (body mass index 19.6 kg/m²) presented with a nonsustained ventricular

tachycardia during a routine electrocardiogram check-up. Echocardiography showed diffuse left ventricular hypomotility and a left ventricular ejection fraction of 17.5%. The patient was classified as New York Heart Association functional class II heart failure despite proper medications. According to the 2017 American Heart Association/American College of Cardiology/Heart Rhythm Society guidelines, the patient exhibited a Class I indication for implantable cardioverter-defibrillator (ICD), and was admitted for subcutaneous ICD (S-ICD) implantation as primary prevention of sudden cardiac death (1).

The patient underwent general anesthesia and was put on positive-pressure mechanical ventilation for the procedure. While closing the insertion site after S-ICD implantation, we noticed a respiratory fluctuation of the wound, at which point, we suspected a pneumothorax caused by the misplacement of the S-ICD lead.

LEARNING OBJECTIVES

- To understand the importance of tunneling in the correct plane during S-ICD implantation.
- To recognize respiratory fluctuation of the incision site and suspect a pneumothorax.
- To recognize the kinking of the lead in fluoroscopic images, which may suggest the lead entering the chest cavity.
- In cases where pneumothorax is suspected or found in fluoroscopic images, especially if kinking of the lead is observed along the course of tunneling, a chest CT is suggested in order to identify the detailed course of the lead.

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the *JACC: Case Reports* [author instructions page](#).

Manuscript received November 15, 2019; revised manuscript received April 15, 2020, accepted April 21, 2020.

ABBREVIATIONS AND ACRONYMS

CT = computed tomography

ICD = implantable
cardioverter-defibrillator

S-ICD = subcutaneous
implantable cardioverter-
defibrillator

PAST MEDICAL HISTORY

The patient had a history of old myocardial infarction and underwent coronary artery bypass grafting 16 years ago. The patient, a past smoker, also had chronic obstructive pulmonary disease with forced expiratory volume/forced vital capacity ratio of 49.8%.

His chest computed tomography (CT) scan showed severe emphysema.

DIFFERENTIAL DIAGNOSIS

Regarding pneumothorax, the question of whether the tip of the lead remained in the thoracic cavity, or had penetrated the lung parenchyma, was raised.

INVESTIGATIONS

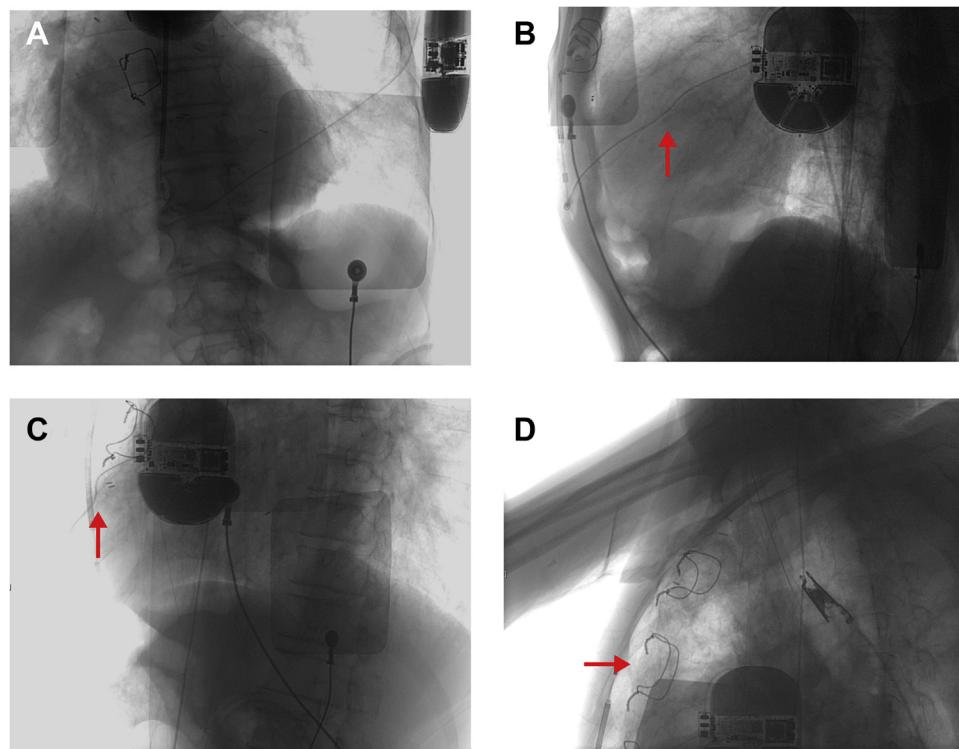
The S-ICD was implanted using the 2-incision technique. The pulse generator was placed between the anterior surface of the serratus anterior muscle and the posterior surface of the latissimus dorsi, whereas

the S-ICD lead was intended to be positioned through a subcutaneous tunnel.

After closing the subcutaneous layer of the lateral incision after lead placement, we observed a respiratory fluctuation, where the wound inflated during the inspiratory phase of mechanical ventilation and deflated during the expiratory phase. We suspected a pneumothorax and immediately performed a fluoroscopic exam. The fluoroscopic images revealed a pneumothorax, as well as kinking of the lead between the 2 incision sites, suggesting that the lead may have transected the muscular layer into the thoracic cavity (**Figure 1**). However, the exact course of the lead was unclear. As the fluoroscope in our operating room is also capable of performing a CT scan, we proceeded to perform a chest CT.

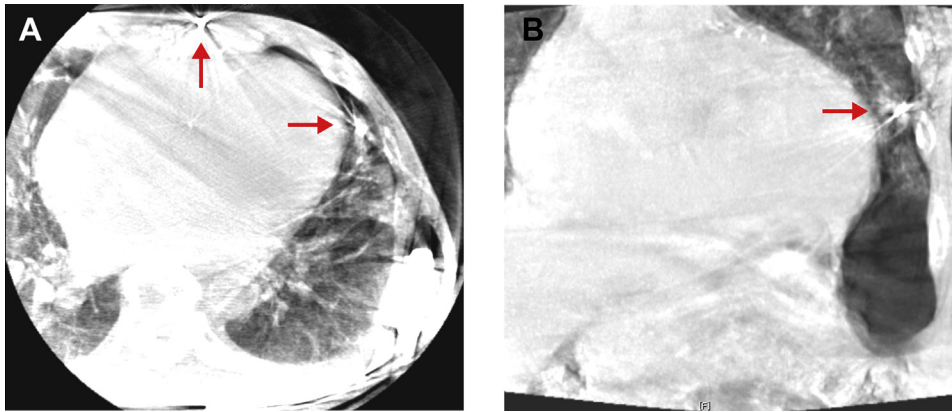
The CT images revealed the S-ICD lead passing through the thoracic cavity, and collapsing of the left lung (**Figure 2**). From the CT images, we were unable to distinguish whether the lead had only penetrated the chest cavity or it had also penetrated the lung parenchyma.

FIGURE 1 Fluoroscopy



(A) Posteroanterior chest view: Detailed course of the lead is unclear. (B) Left lateral view showing slight kinking of the S-ICD lead (arrow). (C) Posterolateral view of the chest showing the kinking of the S-ICD lead (arrow). (D) Lateral view of the chest showing the pneumothorax (arrow). S-ICD = subcutaneous implantable cardioverter-defibrillator.

FIGURE 2 CT Scan of Chest



(A) Horizontal view: The arrows show the S-ICD lead passing through the thoracic cavity from the xiphoid incision. (B) Coronal view: The arrow shows the S-ICD lead inside the thoracic cavity. CT = computed tomography; S-ICD = subcutaneous implantable cardioverter-defibrillator.

An emergency thoracoscopy was performed, which revealed the lead penetrating the lung parenchyma, confirming our diagnosis of pneumothorax (Figure 3). The S-ICD lead had penetrated the intercostal into the chest cavity while tunneling between the sternal and the lateral incisions.

MANAGEMENT

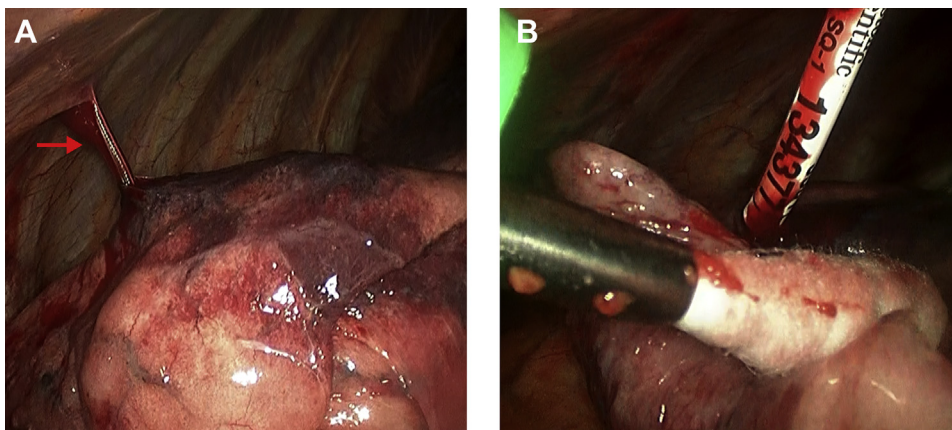
Upon discussion with the thoracic surgeons, we decided a partial resection of the lung was necessary

in order to prevent infections. Using thoracoscopy, we extracted the lead from the xiphoid incision, and a thoracoscopic lung resection was performed (Figure 4). We then reimplemented the S-ICD.

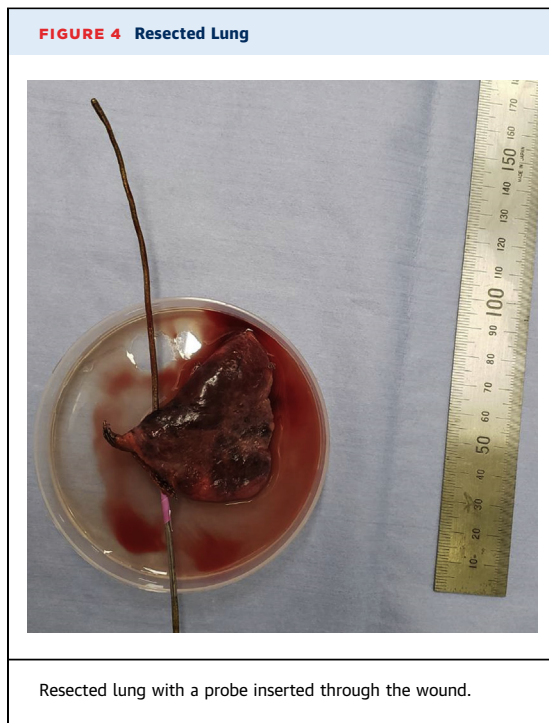
DISCUSSION

The S-ICD system has been reported to have a significantly lower number of lead-related complications compared with the transvenous ICD (2). Furthermore, there have only been a few reports

FIGURE 3 Thoracoscopy



(A) The arrow indicates the S-ICD lead penetrating the lung parenchyma. (B) The image shows the lead being extracted from the xiphoid incision. S-ICD = subcutaneous implantable cardioverter-defibrillator.



associated with complications of lead insertion during implantation. Lambiase et al. (3) and Gold et al. (4) have reported pneumothorax as one of the complications of S-ICD, though details of the complications were not described. Kaufmann et al. (5) reported a case in which the lead was inserted into the peritoneal cavity, causing a lead infection. In another case, reported by Arias et al. (6), the lead passed through the intercostal space into the mediastinum during parasternal tunneling in a patient with chest deformation.

Identifying the appropriate anatomic landmark, tunneling in the recommended direction, and tunneling in the correct plane are essential for a correct lead placement. Furthermore, limited blunt dissection between the fascia and subcutaneous adipose tissue between the incisions could help delineate the appropriate tunneling plane, and may have prevented this complication. In our case, the lead was inserted into the thoracic cavity from an appropriate insertion site at the xiphoid process, but failed to tunnel in the correct plane.

This is the first report of a S-ICD lead penetrating the lung parenchyma, and the successful management of lead-related pneumothorax by collaborating

with thoracic surgeons. We were also able to successfully reinsert the S-ICD. We suspect that failing to tunnel in the correct plane, in addition to weakening of the fascia due to aging, was the cause of our complication. This complication may happen more often with increasing popularity of submuscular S-ICD implantation.

Inappropriate lead insertion can lead to serious complications. If respiratory fluctuation of the incision site is observed at the time of closure, it may be a sign of pneumothorax. Furthermore, if kinking is observed in fluoroscopic images, it is most likely that the lead had entered the chest cavity. Lateral or posterolateral fluoroscopic view is recommended when identifying a pneumothorax. In cases where pneumothorax is suspected or found in fluoroscopic images, especially if kinking of the lead is observed along the course of tunneling, a chest CT is suggested in order to identify the detailed course of the lead. The chest imaging should be performed immediately for diagnosis, as well as consulting with thoracic surgeons on a treatment plan.

FOLLOW-UP

Thoracostomy tube was removed 11 days post-surgery, with the patient's breathing remaining stable after tube removal. We observed no issues during the final post-implantation device interrogation. The patient was discharged 19 days later without any further complications or worsening of activities of daily living.

CONCLUSIONS

S-ICD implantation is known to be a safe procedure, but inappropriate lead insertion can lead to severe complications. If abnormal fluctuation of the incision site is observed after lead placement, it may be a sign of pneumothorax, and fluoroscopy should be performed immediately. A chest CT is recommended for diagnosis, as well as identifying the course of the lead; and when appropriate, a consultation with thoracic surgeons is necessary in order to avoid further complications and a fatal outcome.

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KEY WORDS lead complication, pneumothorax, subcutaneous implantable cardioverter