Subcutaneous implantable cardioverter-defibrillator implantation in a patient with an axillary bifemoral bypass and past sternectomy

Masafumi Sugawara, MD,* Kajiyama Takatsugu, MD, PhD,† Yusuke Kondo, MD, PhD,* Michiko Watanabe, MD, PhD,‡ Goro Matsumiya, MD, PhD,‡ Yoshio Kobayashi, MD, PhD*

*From the *Department of Cardiovascular Medicine, Chiba University Graduate School of Medicine, Chiba, Japan, †Department of Advanced Cardiorhythm Therapeutics, Chiba University Graduate School of Medicine, Chiba, Japan, and ‡Department of Cardiovascular Surgery, Chiba University Graduate School of Medicine, Chiba, Japan.*

Introduction

Subcutaneous implantable cardioverter-defibrillators (S-ICDs) are clinically superior to conventional transvenous ICDs (TV-ICDs) in terms of reducing lead-related complications.[1,2] Moreover, S-ICDs are an effective alternative to TV-ICDs in patients with difficulty in obtaining venous access and a high risk of infection. Here we present a case of a secondary prophylactic S-ICD implantation that was passed under an axillary femoral (A-F) bypass vessel and a successful subcutaneous lead placement in a patient after a sternectomy.

Case report

A 70-year-old Japanese man visited a previous hospital because of symptomatic sustained monomorphic ventricular tachycardia (VT) (Figure 1A). The tachycardia cycle length was 280 ms, which resulted in a low blood pressure of 90/60. The patient also complained of chest pain, and the VT was then terminated by cardioversion. Because the VT recurred soon after admission to the intensive care unit, an intravenous administration of amiodarone was initiated. Although a 12-lead electrocardiogram of the VT was lacking, its initiation was polymorphic, as shown in Figure 1A.

The patient had a history of chronic kidney disease on dialysis for 23 years with a right brachial vein transposition arteriovenous fistula, coronary and peripheral artery disease revascularized by percutaneous coronary intervention, and left axillary bifemoral bypass, respectively. Furthermore, 4 years prior, he underwent a surgical aortic valve replacement for severe aortic valve stenosis and sternectomy with an omental flap transposition because of postoperative mediastinitis (Figure 1B). His left ventricular ejection fraction was 40%. Antithrombotic therapy with clopidogrel sulfate and warfarin was ongoing. After being discharged from the previous hospital, he was introduced to our department. Considering his past history and reduced left ventricular ejection fraction, his VT was treated as nonidiopathic. The VT incessantly recurred over a short term at the previous hospital. Based on the latest guidelines in Japan,[3] we determined that prevention of sudden cardiac death had top priority and an ICD implantation was desirable. However, computed tomography revealed that the left A-F prosthetic bypass appeared under the skin between the subclavian site and first rib (Figure 1C). This made it difficult to perform a left-

KEY TEACHING POINTS

- Subcutaneous implantable cardioverter-defibrillator (S-ICD) is an effective alternative to transvenous ICD in patients with high risk for infection or absence of vascular access.
- Patients having higher cardiovascular risks are often complicated with peripheral arterial disease and ventricular arrhythmias requiring defibrillator. Axillary femoral (A-F) bypass is one of the effective techniques but makes it difficult to implant cardiac devices.
- In addition, in this report, S-ICD lead locating and appropriate R-wave sensing was achieved successfully without acute complications such as infection and bleeding, even in patients after sternectomy owing to past infection following surgical aortic valve replacement.

KEYWORDS Subcutaneous implantable cardioverter-defibrillator; S-ICD; Secondary prophylaxis; Axillary femoral bypass; Prosthetic graft; Sternectomy
(Heart Rhythm Case Reports 2023;9:80–83)

Funding Sources: None. Disclosures: The authors have no conflicts of interest to report. **Address reprint requests and correspondence:** Dr Masafumi Sugawara, Department of Cardiovascular Medicine, Chiba University Graduate School of Medicine, 1-8-1 Inohana, Chuo-ku, Chiba, 260-8670, Japan. E-mail address: masafumi0817@gmail.com.

https://doi.org/10.1016/j.hrcr.2022.10.019

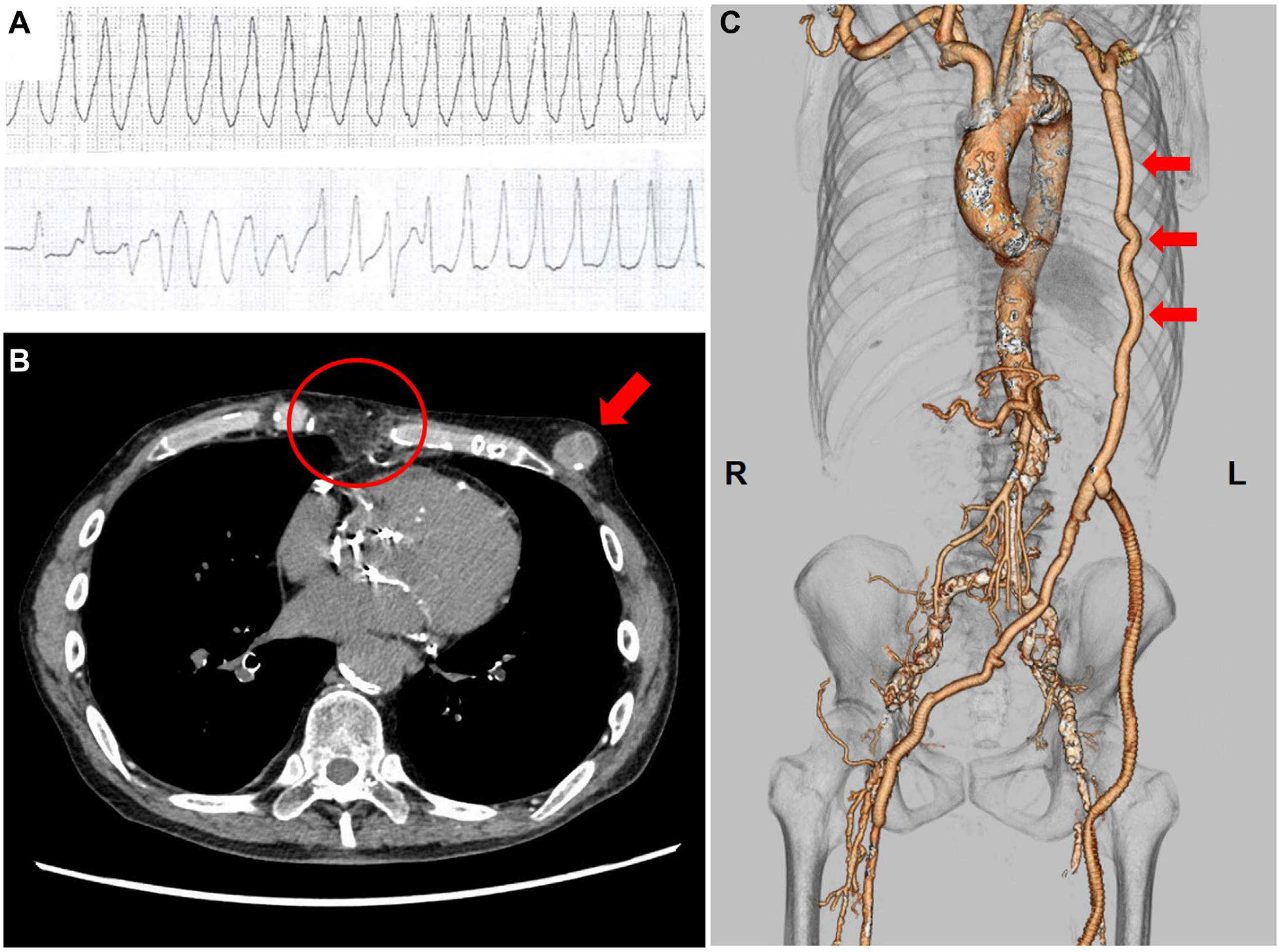

Figure 1 **A:** Upper panel: ventricular tachycardia recorded by an ambulatory monitor. Lower panel: the initiation of a recurrence after admission. **B:** Postoperative computed tomography scan in the short-axis view depicting the defective sternum refilled by the omental flap, as highlighted by the red circle, and prosthetic graft, shown by the red arrow. **C:** Three-dimensional reconstruction of the major arteries revealing the axillary femoral bypass graft appearing in the left first intercostal space and located along the midclavicular line (*red arrows*).

sided extrathoracic subclavian venipuncture because of the higher risk. As mentioned above, the presence of an upper arm arteriovenous fistula also prevented the transvenous leads from being implanted on the right side. Given the lack of an appropriate superior venous access and no indication for permanent cardiac pacing, we decided to implant an S-ICD after confirming favorable signals in all 3 vectors through a surface electrocardiogram evaluation.

Under general anesthesia, the pocket for the pulse generator was made in the submuscular space in a midaxillary position (Figure 2A). Two-incision techniques were performed to create the route for the shock lead on the left side to the cavity of the sternectomy to avoid the site of the omental flap transposition. In coordination with vascular surgeons, we dissected the subcutaneous tissue from the lateral pocket and the so-called parasternal incision toward the A-F bypass vessel. To penetrate the adhesion between the conduit and chest wall, we first used straight pean forceps to gently create a tunnel and then held the tip of an 11F peel-away sheath in order to pull it through toward the middle (Figure 2B). Although the bypass surgery was performed 10 years prior, we could dissect the artificial vessel without any difficulty at this time and the solid core of the lead insertion tool was not used. The sheath was peeled off after the shock lead was inserted through it. Then a tunnel was created beneath the skin just lateral to the left sternocostal joint. In order to avoid any migration of the shock lead into the mediastinum, a short lead insertion tool with a core stylet was carefully advanced under fluoroscopic guidance. As a result, the distal portion of the lead was fixated onto the left edge of the anterior ribs using the 2-incision technique (Figure 2C). Finally, the lead was connected to the pulse generator and the pocket was closed by the usual technique. The induced ventricular fibrillation did not sustain long enough to perform defibrillation threshold (DFT) testing. The lead and generator were appropriately located, as shown by the postoperative computed tomography (Figure 3A). In the follow-up, a subsequent S-ICD interrogation revealed no evidence of any malfunction. The R-wave amplitude was adequate in all 3 vectors (Figure 3B). After discharge, DFT testing was

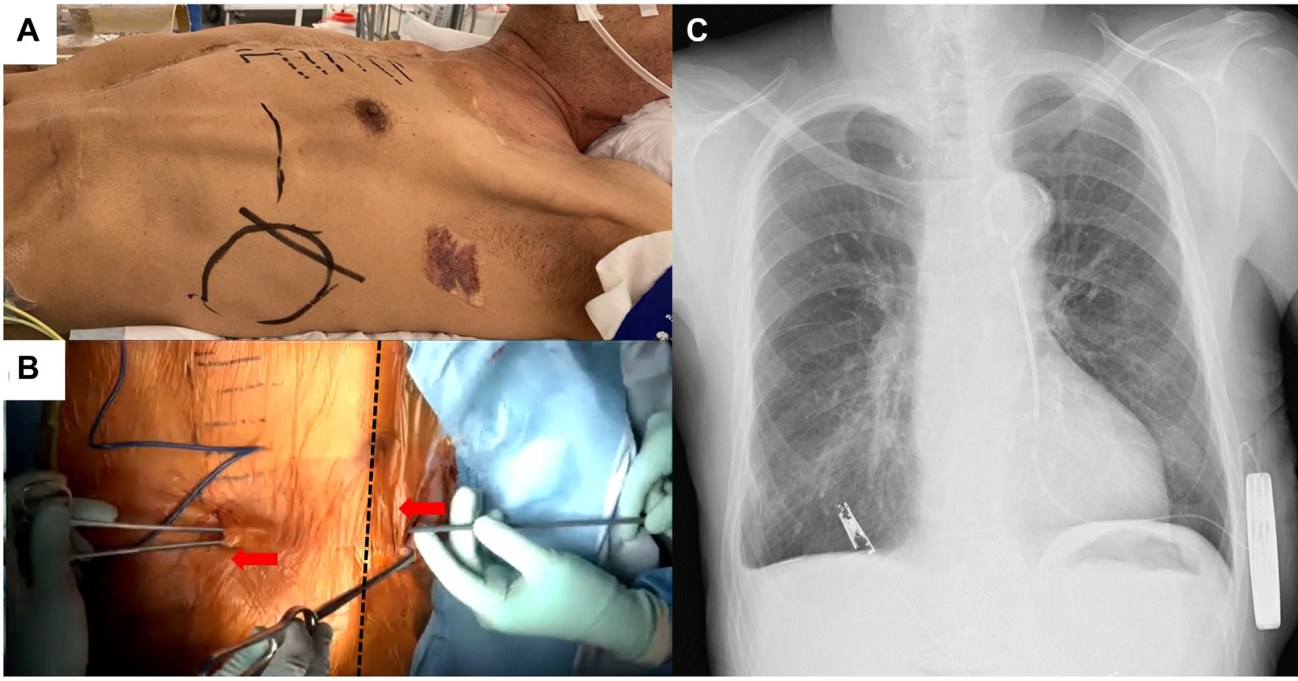

Figure 2 **A:** Preoperative marking showing the predetermined location of the pulse generator and lead. **B:** Picture of the insertion of an 11F peel-away sheath under the prosthetic graft (*dotted line*) using straight pean forceps in the direction of the red arrow, which is in the direction from the generator pocket to the mid-incisional line. **C:** Posteroanterior chest radiograph after implanting the subcutaneous cardioverter-defibrillator with the lead located in the left parasternal position.

successful, with a single 65 J shock after induction of ventricular fibrillation with a 50 Hz stimulation (Figure 3C). The shock impedance was 46 Ω. There were no remote complications related to the procedure.

Discussion

To the best of our knowledge, this is the first case report of an S-ICD implantation in a patient with an A-F bypass and sternectomy. Patients with an axillary femoral bypass sometimes

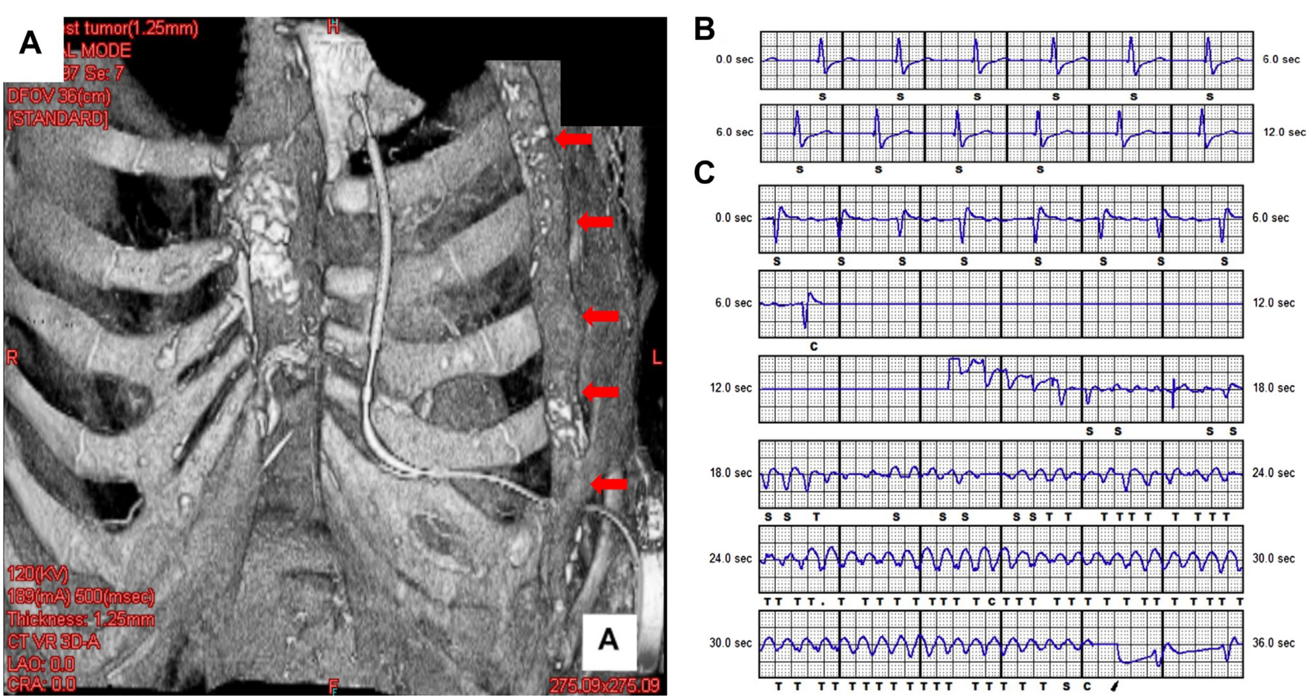

Figure 3 **A:** Postoperative plain computed tomography scan image confirming the lead placed on the edge of the ribs without sticking into the omental flap as shown by the red arrow. **B:** Electrogram tracing from the substernal lead showing an appropriate R-wave amplitude in all of the 3 vectors. **C:** Successful defibrillation test performed with a single 65 J shock after ventricular fibrillation induction with a 50 Hz stimulation.

are indicated for prevention against sudden cardiac death consequently owing to their higher cardiovascular risk, and this case report highlighted the potential feasibility and safety of an S-ICD implantation coexisting with a prosthetic graft. A sternectomy is also seen in daily cardiovascular practice, even in the electrophysiology field. By avoiding the place where the sternum originally existed, we could prevent any acute complications related to the S-ICD lead implantation; nevertheless, we achieved an acceptable defibrillation threshold.

The S-ICD is already recognized as an effective substitute for a TV-ICD, especially in patients with difficult venous access and a high risk of lead-related complications.[1,2,4] In this case, the patient had an arteriovenous fistula for dialysis on the right arm as well as an A-F bypass graft located on the left anterior chest. We considered that a transvenous lead implantation would impose a higher risk of a device-related infection and injury to the prosthetic graft as compared to an implantation of an S-ICD. Even if it is implanted in dialysis patients, an S-ICD is associated with an equivalent rate of adverse events as that in non–dialysis patients, including mortality, bleeding, and infections.[5] Although S-ICDs are also related to a higher incidence of inappropriate ICD therapies, careful programming could avoid shock deliveries to previous atrial tachyarrhythmias and T-wave oversensing.

Regarding the A-F bypass, we discussed it with the vascular surgeons in advance, and finally, a lead insertion under the prosthetic graft was deemed to be technically feasible. Because an infection of a prosthetic A-F bypass may lead to a difficult situation to manage—including, in the worst scenario, a peripheral amputation[6,7]—we did not expose the prosthesis and passed the sheath under the prosthetic graft using the blind technique.

A sternectomy is one of the surgical options for sternal tumors, osteomyelitis, and infections of deep sternal wounds after surgery.[8] As a treatment of an infection, the sternum will be partially or totally excised depending on the clinical condition, usually followed by a chest wall reconstruction with the omental flap, a muscle flap, or prosthetic equipment.[9] As the omental flap is highly vascularized, in this case, we placed the shock lead on the left side to avoid it passing over the omental flap transposition in order to decrease the risk of bleeding. Moreover, to avoid any lead migration, the distal segment of the lead was placed lateral to the defect of the sternum. Up to the present, no symptoms of infection have been observed. Nonetheless, careful long-term follow-up will be required, because deep chest surgical site infections can be related to lethal adverse events.[10,11] In a prior report of an S-ICD case undergoing a sternectomy,[12] the existing lead of the S-ICD was repositioned from the right parasternal to the left parasternal region during the surgery, which was a similar position as in our case. In that report, the DFT testing was postponed because of the instability of the chest wall just after the sternectomy. From the point of view concerning the DFT, an increased threshold was a major concern because the lead position was unusually distant from the midline and close to the pulse generator. The distance between the coil and pulse generator could have a significant impact on the subsequent DFT.[13] Fortunately, in our present case there was no difficulty in achieving a successful defibrillation, and furthermore, our case demonstrated a favorable clinical course.

Conclusion

In conclusion, S-ICDs are an effective alternative to TV-ICDs in patients with multiple anatomical complications, as in this present case. The implantation of an S-ICD was feasible in a patient harboring an A-F bypass on the left anterior chest and sternectomy. Careful preprocedural planning is vital for such an unusual setting.

Acknowledgments

We thank Mr. John Martin for his linguistic assistance regarding this report.

References

1. Basu-Ray I, Liu J, Jia X, et al. Subcutaneous versus transvenous implantable defibrillator therapy: a meta-analysis of case-control studies. JACC Clin Electrophysiol 2017;3:1475–1483.
2. Fong KY, Ng CJ, Wang Y, Yeo CJ, Tan VH. Subcutaneous versus transvenous implantable defibrillator therapy: a systematic review and meta-analysis of randomized trials and propensity score-matched studies. J Am Heart Assoc 2022; 11:e024756.
3. Nogami A, Kurita T, Abe H, et al. JCS/JHRS 2019 guideline on non-pharmacotherapy of cardiac arrhythmias. Circ J 2021;85:1104–1244.
4. Knops RE, Olde Nordkamp LRA, Delnoy PHM, et al. Subcutaneous or transvenous defibrillator therapy. N Engl J Med 2020;383:526–536.
5. El-Chami MF, Burke MC, Herre JM, et al. Outcomes of subcutaneous implantable cardioverter-defibrillator in dialysis patients: results from the S-ICD post-approval study. Heart Rhythm 2020;17:1566–1574.
6. Mertens RA, O'Hara PJ, Hertzer NR, Krajewski LP, Beven EG. Surgical management of infrainguinal arterial prosthetic graft infections: review of a thirty-five-year experience. J Vasc Surg 1995;21:782–791.
7. Siracuse JJ, Nandivada P, Giles KA, et al. Ten year experience with prosthetic graft infections involving the femoral artery. J Vasc Surg 2013;57:700–705.
8. Bongiolatti S, Voltolini L, Gonfiotti A, et al. Short and long-term results of sternectomy for sternal tumours. J Thorac Dis 2017;9:4336–4346.
9. Abu-Omar Y, Kocher GJ, Bosco P, et al. European Association for Cardio-Thoracic Surgery expert consensus statement on the prevention and management of mediastinitis. Eur J Cardiothorac Surg 2017;51:10–29.
10. Hollenbeak CS, Murphy DM, Koenig S, Woodward RS, Dunagan WC, Fraser VJ. The clinical and economic impact of deep chest surgical site infections following coronary artery bypass graft surgery. Chest 2000;118:397–402.
11. Kobayashi T, Mikamo A, Kurazumi H, Suzuki R, Shirasawa B, Hamano K. Secondary omental and pectoralis major double flap reconstruction following aggressive sternectomy for deep sternal wound infections after cardiac surgery. J Cardiothorac Surg 2011;6:56.
12. Saour B, Kaplan R, Ward A, Churyla A, Kim S, Knight B. Management of S-ICD lead in a patient requiring sternotomy. Clin Case Rep 2019;7:1309–1311.
13. Heist EK, Belalcazar A, Stahl W, Brouwer TF, Knops RE. Determinants of subcutaneous implantable cardioverter-defibrillator efficacy: a computer modeling study. JACC Clin Electrophysiol 2017;3:405–414.