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SPOTLIGHT

Successful repositioning of the subcutaneous implantable cardioverter-defibrillator lead to avoid inappropriate shock

Hiroshi Fukunaga MD | Kanki Inoue MD | Yukio Sekiguchi MD, PhD | Junichi Nitta MD, PhD | Mitsuaki Isobe MD, PhD

Department of Cardiology, Sakakibara Heart Institute, Tokyo, Japan

Correspondence
Hiroshi Fukunaga, Department of Cardiology, Sakakibara Heart Institute, 3-16-1 Asahi-cho, Tokyo 183-0003, Japan.
Email: hfukuna@shi.heart.or.jp

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Treatment of Brugada syndrome (BrS) with an implantable cardioverter-defibrillator (ICD) has been proven to result in a lower mortality rate for sudden cardiac death.[1] The subcutaneous ICD (S-ICD) is an alternative device to transvenous ICD (TV-ICD) for the prevention of sudden cardiac death.[2] It is the first-line therapeutic device, especially for young patients, without the need for pacing at the ventricles because there is a lower risk of complications associated with the leads, including vascular injury, lead fracture, or lead infection, than with the TV-ICD system. S-ICD has more oversensing than TV-ICD, but recent reports have shown that S-ICD has similar or even lower rates of inappropriate shocks compared to TV-ICD.[3] In our case, changing the sensing vector was not sufficient to avoid inappropriate shock, but it was successfully prevented by repositioning the S-ICD lead downward.

A 38-year-old man with BrS was admitted to our hospital for S-ICD implantation. He neither had any symptoms nor previous episodes of syncope or cardiac arrest but had a familial history of sudden cardiac death. His 12-lead electrocardiogram at rest showed fragmented QRS in leads V1 and V2, and a type I Brugada pattern following a drug provocation test using a sodium channel blocker (Figure 1). His ventricular late potentials were abnormal. During the electrophysiological study, ventricular fibrillation was induced by double extra stimulation from the right ventricle. Although risk assessment with an electrophysiological study is controversial, S-ICD implantation was scheduled after the patient and his family provided appropriate informed consent.

Before implantation, two of the sensing vectors were applied for a screening test of the S-ICD system (Figure 2A). During the pre-implantation screening test, two of the three sensing vectors were adequate. The S-ICD (EMBLEM™ S-ICD, Boston Scientific) was successfully implanted on the left side of the thorax between the serratus anterior muscle and the latissimus dorsi muscle, and the S-ICD lead electrode was implanted using the three-incision implant technique. The alternate sensing vector was selected because it was appropriate for immediate postoperative evaluation and the other vectors could not be used for myopotential oversensing during immediate postoperative assessment. One month later, the patient was taken to another hospital with an inappropriate ICD shock due to oversensing of P and T waves (Figure 3). Therefore, we shifted from alternate sensing vector to primary sensing vector to confirm that the effect of myopotential oversensing was reduced after 1 month postoperatively. However, after another month, an inappropriate shock occurred again due to myopotential oversensing, and upon rechecking for S-ICD sensing, none of the three sensing vectors was adequate (Figure 2B). Given that both primary and secondary vectors were deemed unsuitable due to myopotential oversensing, a solution to avoid inappropriate shocks was discussed. The right lead position of the sternum had not been suitable for sensing during the preoperative screening test. The patient's slender body habitus might have caused the coiling of the S-ICD lead located as high as the pulmonary artery. Our primary focus was sensing compliance, but we should have considered lead location more carefully using x-rays. Invasive procedures were considered inevitable, and the strategy was switched to lead repositioning. Downward repositioning of the lead by 4 cm along the left costal arch was performed, which improved alternate vector sensing and reduced the risk of further inappropriate shocks. After carefully repeating the screening, we confirmed that two of the three sensing vectors were compatible at the position where the lead was moved downward (Figure 2C). The only way to obtain a high R wave was to lower the S-ICD lead

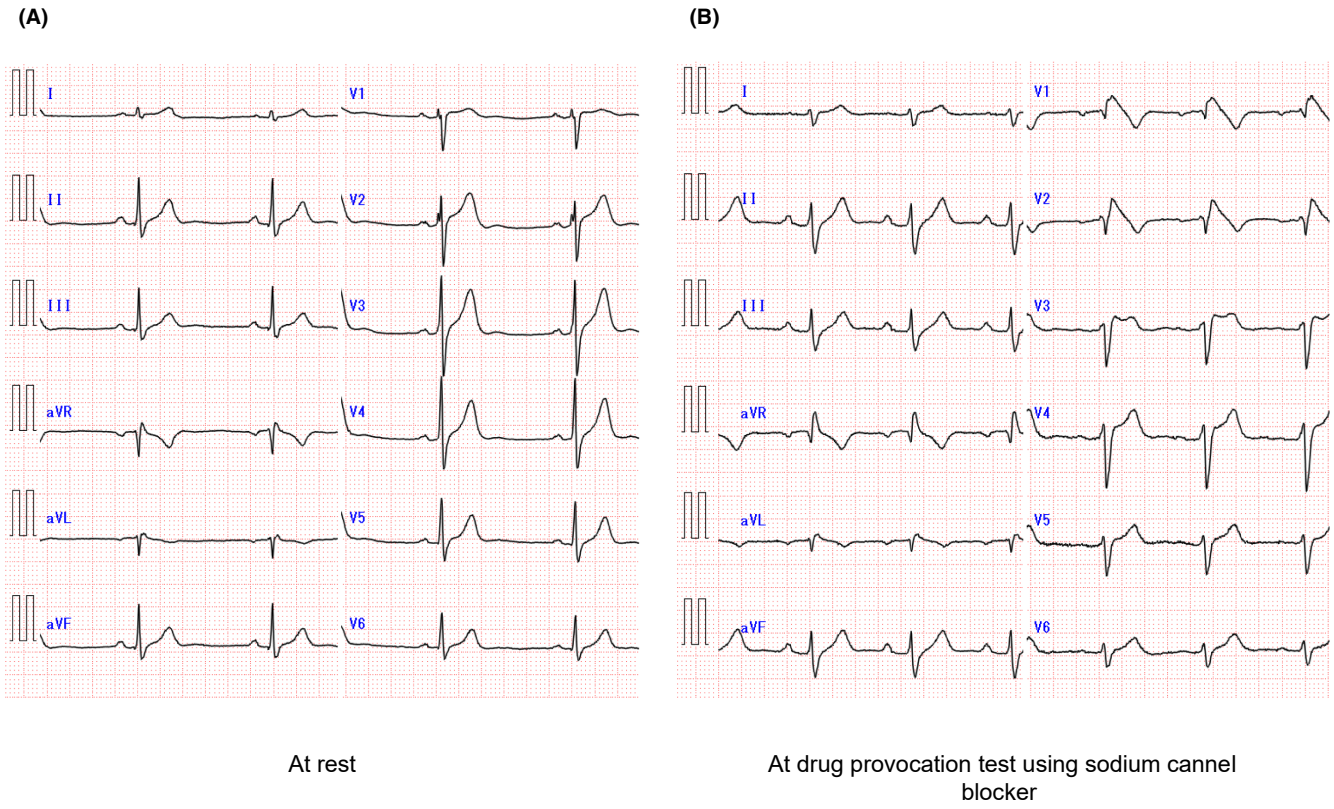

FIGURE 1 (A) The 12-lead electrocardiogram at rest. (B) The 12-lead electrocardiogram during drug provocation test using sodium channel blocker.

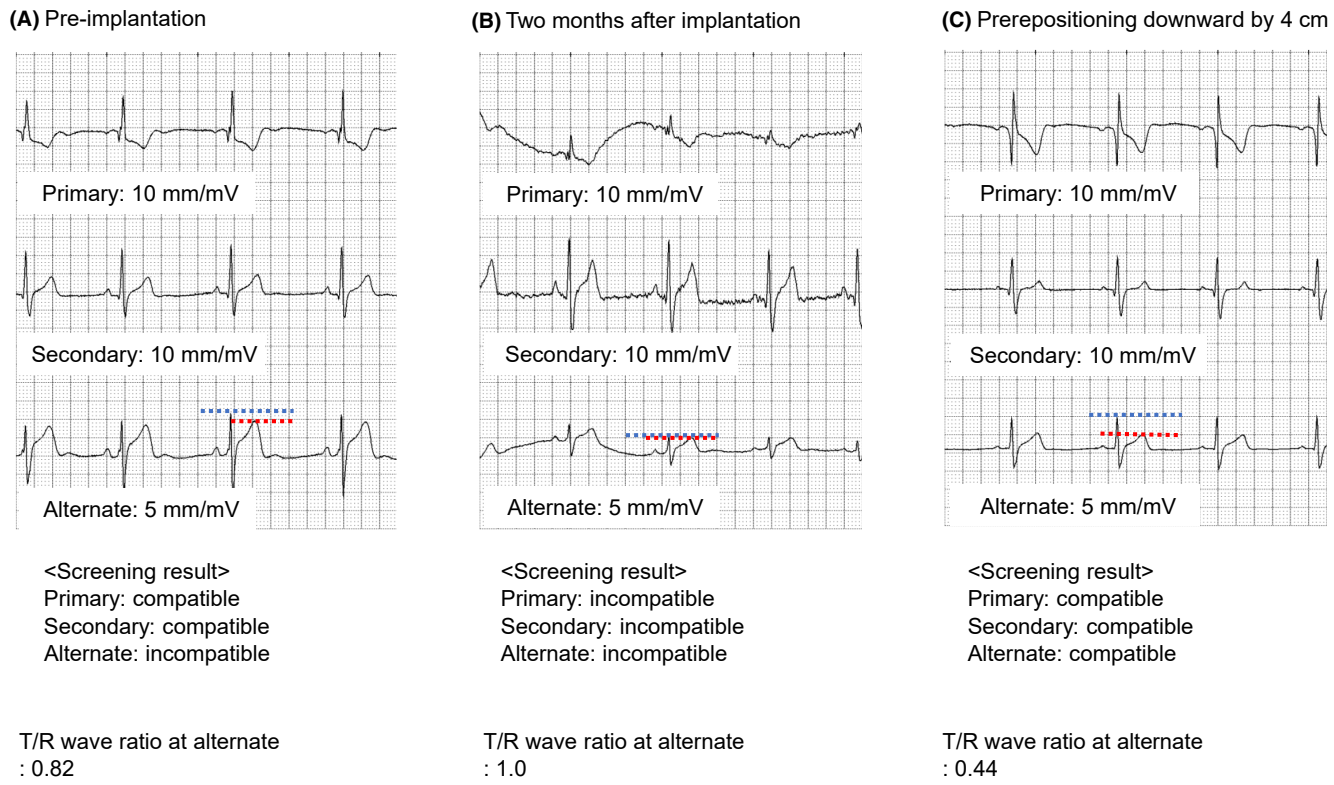

FIGURE 2 (A) Screening test prior to implantation. Only the alternate vector was incompatible due to T-wave oversensing (TWOS). (B) Screening test 2 months after implantation. Both the primary and secondary vectors were incompatible due to myopotentials. The alternate vector was also incompatible due to TWOS. (C) The screening test after lead repositioning downward by 4 cm. All vectors were compatible.

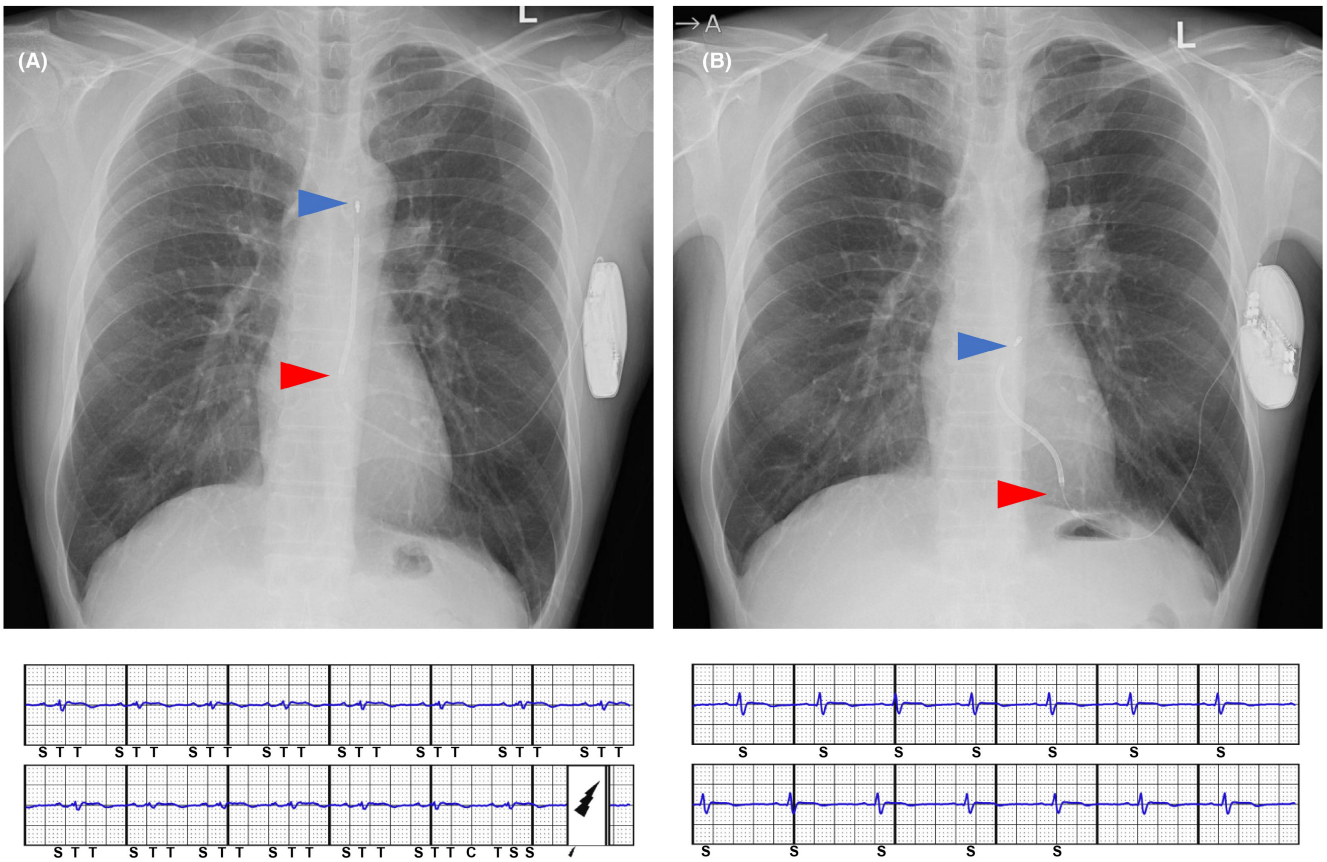

FIGURE 3 (A) Subcutaneous implantable cardioverter-defibrillator (S-ICD) lead position at initial implantation. The blue triangular marker indicates the lead tip and the red marker indicates the lower end of the coil. The lower part of the electrocardiogram shows shock activation during triple count. (B) The S-ICD lead position after downward repositioning by 4 cm. The device detected only the R wave in the lower part of the electrocardiogram.

or device position. However, it was considered cosmetically and anatomically difficult to lower the device position. Moreover, the invasiveness of the procedure for device repositioning was considered to be high. Therefore, lead repositioning was employed. First, we marked the skin preoperatively at 4 cm inferior to the original lead position. To ascertain the specific repositioning position, we decided that it would be best to fix the lead in a position along the left costal arch because the position along the sternum would have been too high. S-ICD lead repositioning was performed by adding a fourth incision (Figure S1). Finally, we used a fluoroscopic device to ascertain the distance and fixation. After repositioning of the lead (Figure 3), we confirmed that the S-ICD could only recognize the QRS complex independently in the alternate vector. Hence, the alternate vector was the only adequate sensing vector, and at 2 years since lead repositioning, inappropriate shocks have not reoccurred.

Oversensing due to myopotential is one of the causes of inappropriate shock by the S-ICD system.[4] Alternate vectors are used to avoid inappropriate shocks due to myopotential, but T-wave oversensing (TWOS) can also be a major cause of inappropriate S-ICD shock.[5] In our institution, 154 S-ICD implantations were performed from February 2016 to September 2021; among them, 44 patients received shock interventions by the S-ICD system: 25 patients with appropriate shocks and 19 patients with inappropriate shocks. Of the 19 cases of inappropriate shock, four were due to TWOS, nine were due to myopotential, five were due to both TWOS and myopotential, and one was due to atrial tachycardia. In 18 cases, shock interventions could be avoided by changing the sensing vectors, but in this case, lead repositioning was required. SMART pass is also known to effectively reduce the incidence of inappropriate shock in second-generation S-ICD,[5] but it was not effective in this case. After repositioning the lead, the ratio of T-wave height to R-wave height was <0.5, clearly distinguishing T waves from R waves (Figure 2). Additionally, the defibrillation threshold, which was 65 J, remained unchanged since the initial implantation. An electrocardiogram can show dynamic changes in BrS patients who are usually thin and often have downward displacement of the heart. Therefore, electrocardiographic screening before S-ICD implantation may be difficult. Lead repositioning may be one of the feasible solutions in BrS patients with S-ICD and frequent inappropriate shocks due to low amplitude of QRS complexes when reprogramming of the device settings is unsuccessful.

DECLARATIONS

Approval of the research protocol: This report has been approved by Ethics Committee of the Sakakibara Heart Institute (approval

number: 21-089, dated March 15, 2022). Informed consent: Written informed consent was obtained from the patient for the publication of this report.

Registry and the registration no. of the study/trial: N/A. Animal studies: N/A.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

ETHICAL APPROVAL

This report has been approved by Ethics Committee of the Sakakibara Heart Institute (approval number: 21-089, dated March 15, 2022).

PATIENT CONSENT STATEMENT

Written informed consent was obtained from the patient for the publication of this report.

ORCID

Hiroshi Fukunaga https://orcid.org/0000-0001-6094-5151

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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