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CASE REPORT

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Limitation of the bandpass filter in preventing oversensing of pectoral myopotentials over the long-term follow-up

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Abstract

A 60-year-old male experienced an inappropriate shock from an implantable cardioverter-defibrillator (ICD) because of oversensing of pectoral myopotentials. Battery depletion was also observed, and a generator change was performed. A single-chamber ICD (VENTAK PRIZM II 1860) was changed to a new ICD (INCEPTA VR F161). The myopotentials were clearly eliminated by the difference in the band pass filter (PRIZM; 21-171 Hz, INCEPTA; 20-85 Hz), but unfortunately, new noise was documented 4 years later. The utility of the bandpass filter for preventing oversensing of myopotentials was observed, but the limitation of its use for long-term follow-up was also indicated.

KEYWORDS

bandpass filter, implantable cardioverter defibrillator, inappropriate shock, lead fracture, myopotential

1 | INTRODUCTION

Ventricular oversensing of myopotentials with implantable cardioverter defibrillators (ICDs), causes inappropriate shocks, and lead-replacements are needed in some cases. However, there are patients who are at very high risk of lead extractions, and also not eligible for additional lead placements for some reason. In many cases, a device replacement can be avoided or postponed by reprogramming the ICD, however, making difficult decisions is needed. We report a nonischemic cardiomyopathy patient that had an inappropriate ICD shock induced by oversensing of pectoral myopotentials. The myopotentials were clearly removed by the use of a different band pass filter, but unfortunately, a new type of noise was documented again 4 years later. This case indicates the utility of bandpass filters for preventing oversensing of myopotentials, but also the limitation of trusting it over the long-term follow-up.

2 | CASE REPORT

A 60-year-old male with nonischemic cardiomyopathy, severe left ventricular dysfunction (ejection fraction, 26%), and sustained ventricular tachycardia underwent a single-chamber ICD implantation in January 2004. An integrated bipolar lead (ENDTAK DSP 0125, Guidant Corporation, St. Paul, MN, USA) was positioned in the right ventricular (RV) apex, and the patient also underwent a generator change for battery depletion in October 2007, in which a single-chamber ICD (VENTAK PRIZM II 1860 VR/DF-1, Guidant Corporation, St. Paul, MN, USA) was implanted in the left pectoral region. The ICD was configured for one zone of therapy, >200 beats/min for 3.0 seconds, then defibrillation.

Myopotentials were suddenly observed in a routine device check in June 2012, but they were at first still too small to cause any oversensing. However, the myopotentials gradually became significant, and in June 2013 the patient experienced an inappropriate shock while

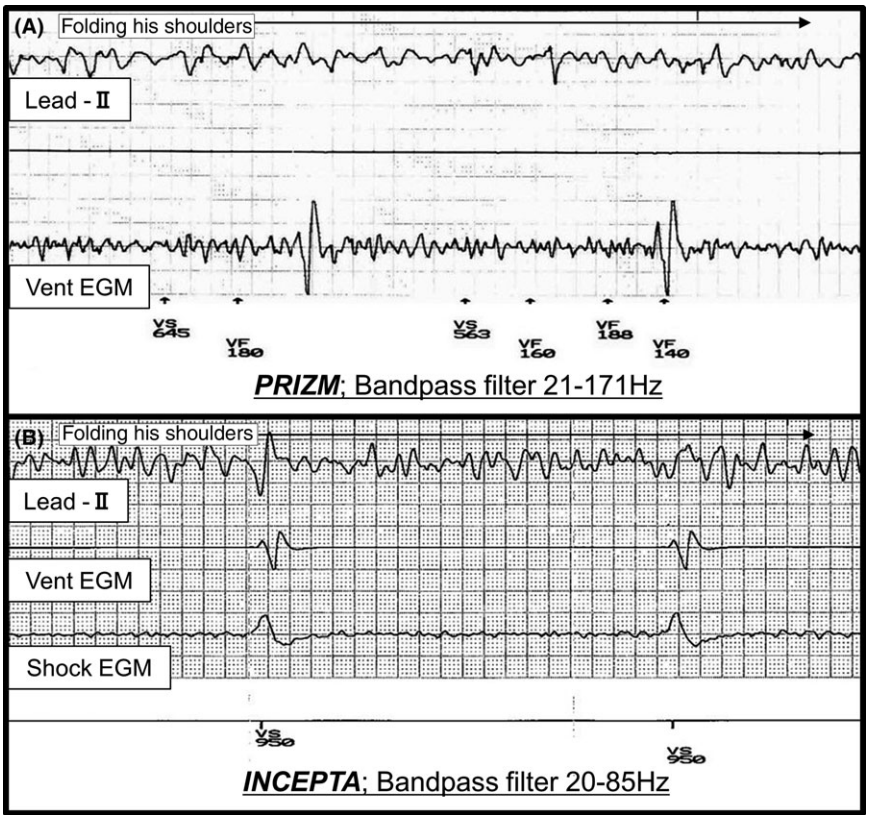

FIGURE 1 Pectoral myopotentials were documented by flexing his shoulders during the generator change. A, Myopotentials were documented in the ventricular EGM when the implantable cardioverter defibrillator (ICD) lead was still connected to the old ICD (PRIZM II).B, The myopotentials were clearly removed from the ventricular EGM when the new ICD (INCEPTA) was connected

washing his hands. Interrogation of the device revealed sensed R-waves of 5.2 mV, an RV pacing threshold of 0.9V at 0.4 ms, and ICD lead impedance of 525Ω. The electrogram (EGM) was checked, and the myopotentials were easily documented in both the shock and ventricular EGM (ring-coil) recordings by grabbing his hands in front of him, while not by touching the leads or can from the outside. Therefore, oversensing of the pectoral myopotentials was suggested. No significant change was observed in the chest X-ray, and the myopotentials could not be eliminated by device reprogramming. A generator change was decided due to battery depletion, and also a new lead implantation was considered to treat the myopotential oversensing.

The new ICD was an INCEPTA (F161 VR DF-1, Boston Scientific Corp., St. Paul, MN, USA) and had a different bandpass filter range than the old ICD (PRIZM; 21-171 Hz, INCEPTA; 20-85 Hz). The INCEPTA ICD had a low-pass filter, which was appropriate for attenuating high frequency components, and additionally, we also expected the Boston Scientific noise rejection algorithm to reduce the oversensing. The operation was performed with local anesthesia, and the myopotentials were easily documented by flexing his shoulder muscles (Figure 1A). The PRIZM ICD was removed from the pocket and no connecter problem existed. The INCEPTA ICD was implanted, and the patient was again instructed to fold his shoulders. The high-frequency noise disappeared dramatically from the ventricular EGM, on the other hand, the bandpass filter was applied only for the ventricular EGM, and the myopotentials were still observed on the shock EGM (Figure 1B). Defibrillation threshold (DFT) testing was properly performed with 14J, and as the new ICD was suspected to have correctly identified the potentials with the use of the bandpass filter, the implantation was completed without implanting a new lead.

No myopotentials appeared on the ventricular EGM for 4 years, but a new type of noise was suddenly documented again during a regular ICD check in September 2017 (Figure 2A). Interrogation of the device revealed sensed R-waves of 5.1 mV, an RV pacing threshold of 1.3V at 0.4 ms, and ICD lead impedance of 470Ω. The noise was documented during pectoral muscle exercise, while not by touching the leads or can from the outside. No inappropriate ICD shocks occurred, but a new shock lead implantation, and also an upgrade to a cardiac resynchronization therapy defibrillator (CRT-D) was planned. During the operation, a fractured shock lead was observed, which was not confirmed during the past procedure (Figure 2). The fracture point was located in the loop inside the pocket, which was a relatively strongly curved point. A new ICD lead was placed in the RV apex, and the patient was upgraded to a CRT-D device without performing an ICD lead extraction.

3 | DISCUSSION

Implantable cardioverter defibrillators are proven to reduce the patient mortality, but on the other hand, inappropriate shocks are reported to

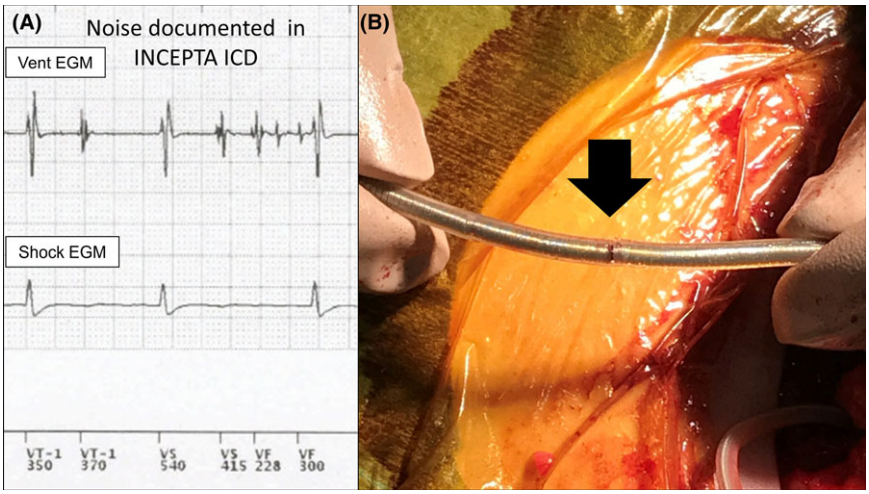

FIGURE 2 A, Noise documented during the pectoral muscle exercise in the ventricular EGM of INCEPTA. B, An ICD lead fracture was found during an upgrade to a cardiac resynchronization therapy defibrillator

have a higher risk of all-cause mortality.[1,2] In the present case, myopotentials were suddenly documented 8 years from the lead implantation, and as previously reported,[3] no significant change was observed in the lead impedance. In the first procedure, the connection problem was completely denied during the generator change, and upon the pocket exploration, no identifiable insulation damage to the lead was observed. Nevertheless, the observation of pectoral myopotentials indicated an insulation defect in the lead outside the pocket, or a microinsulation defect inside the pocket, which was difficult to identify.[4,5]

Four years later, a new type of noise was documented during the ICD check (Figure 2A). Thirteen years had passed since the ICD implantation, and an actual fractured shock lead was observed during the CRTD upgrade. There was no significant change in the lead impedance, but the development of a lead failure was strongly suspected. The band pass filter was able to eliminate the pectoral myopotentials in 2013, but the development of the insulation fracture may have resulted in new sensing of the noise related to the pectoral muscle exercise, and was difficult to eliminate by the band pass filter.

Adding a sensing lead or new ICD lead was one of our choices in the first procedure. However, adding a new lead required careful consideration. First, a lead extraction was suspected to have been difficult because of the long implant duration, and a new-lead implantation might have worsened the tricuspid regurgitation and lead to difficulty in controlling the heart failure. Second, considering the age of the patient, several new ICD lead insertions would have been needed, and we intended to delay the time of any new ICD lead insertion for as long as possible. As the myopotentials were clearly eliminated by changing the ICD, and the DFT test was perform without any trouble, we decided to observe the patient without adding a new lead in the first procedure. During the follow-up, the patient was readmitted due to heart failure, while the myopotentials were completely eliminated from the ventricular EGM by the bandpass filter for 4 years. Our case demonstrated the complete elimination of myopotentials by using a different bandpass filter, but on the other hand, the limitation of using band pass filters for oversensing because of lead fractures needs to be noted.

CONFLICT OF INTEREST

Authors declare no conflict of interests for this article.

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