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Inappropriate shock delivery by an implantable cardioverter-defibrillator due to electrical interference with a refrigerator in a 4-year-old child

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Brief Report

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Abstract

We report a patient with long QT syndrome who received an inappropriate implantable cardioverter-defibrillator shock due to electrical interference from a refrigerator. This electrical interference was mistakenly detected as an episode of ventricular fibrillation and ended with an inappropriate delivery of shock without any warning symptoms before.

Electromagnetic interference (EMI) can mimic cardiac signals and cause inappropriate implantable cardioverter-defibrillator shocks.[1] EMI can be caused by the normal operation of electrical equipment or alternating current leakage.[2,3] The present patient had an inappropriate implantable cardioverter-defibrillator shock when he touched a refrigerator. This was due to electrical interference that was wrongly detected as ventricular fibrillation.

Case presentation

A 4-year-old boy who had a cardiac arrest 2 years ago, was diagnosed as having long QT syndrome in our centre (Fig 1a). As secondary prophylaxis, an epicardial implantable cardioverter-defibrillator (Medtronic, Cardia VR D384VRG) and lead (Medtronic 6947 Sprint Quattro Secure, Medtronic 4968 CapSure® Epi) was implanted (Fig 1b). The ventricular fibrillation (VF) detection rate was programmed as 207 bpm for at least 30 of 40 beats. The sensed VF wave amplitude was measured as 4.4 mV during implantation and the sensitivity was set as 0.25 mV. The patient was under regular follow-up at the paediatric arrhythmia clinic.

The patient presented to our clinic due to the implantable cardioverter-defibrillator alarming twice in the last 24 hours. The implantable cardioverter-defibrillator controls revealed 6 VF records lasting 1–3 seconds without any shock delivery. However, when the device intracardiac electrogram (EGM) records were examined, only short electromagnetic interference records with 50 Hz frequency was seen (Fig 2a). The impedance, sensitivity, and threshold measurements of the lead were in the normal range (right ventricle pacing impedance of 513 ohms, right ventricle defibrillation impedance of 60 ohms, pacing threshold of 0.25 V at 0.40 ms) and also there was no fracture or stretching of the lead seen on the radiography.

His parents reported that the child had often been hiding behind the refrigerator in recent days. The parents were warned to be careful about any possible electricity leakage from the refrigerator and to have it checked by an electrician. Three days later, the patient presented to our clinic for a short syncope attack. He was found lying on the floor behind the refrigerator unconscious and awakened shortly after. When the device records were examined, it was found that the patient was shocked with 35 J once with an inappropriate diagnosis of VF lasting 24 seconds (Fig 2b). The EMG records again revealed typical electromagnetic interference of 50 Hz frequency in the ventricular channel, consistent with alternating current. On the next day, an electricity leakage from the refrigerator was detected by an electrician, which was repaired.

The parents were advised to close the space between the refrigerator and the wall to prevent further accidents in the future. The patient is still under follow-up without any similar problems.

Discussion

Inappropriate implantable cardioverter-defibrillator shock is a common and important problem in paediatric patients diagnosed with channelopathy, cardiomyopathy and congenital heart disease.[4] The most common causes of inappropriate shocks are supraventricular tachycardia,

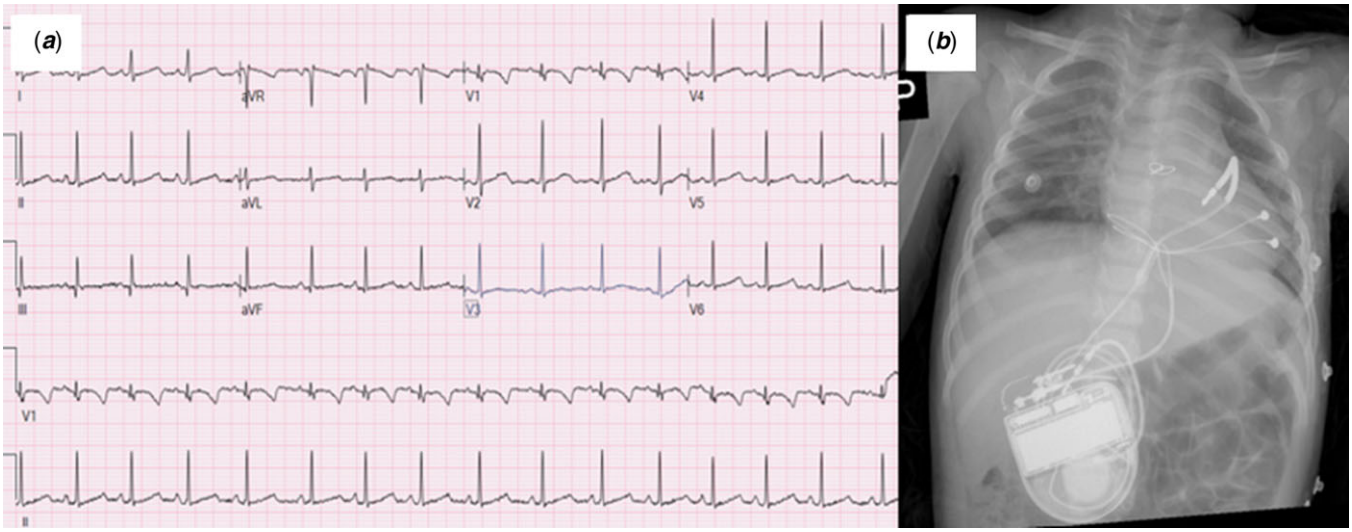

Figure 1. (***a***) 12-lead ECG of the patient with long QT syndrome. Notice the QT prolongation. The QTc is about 482 ms. (***b***) An epicardial ICD and leads are showned in chest x-ray image.

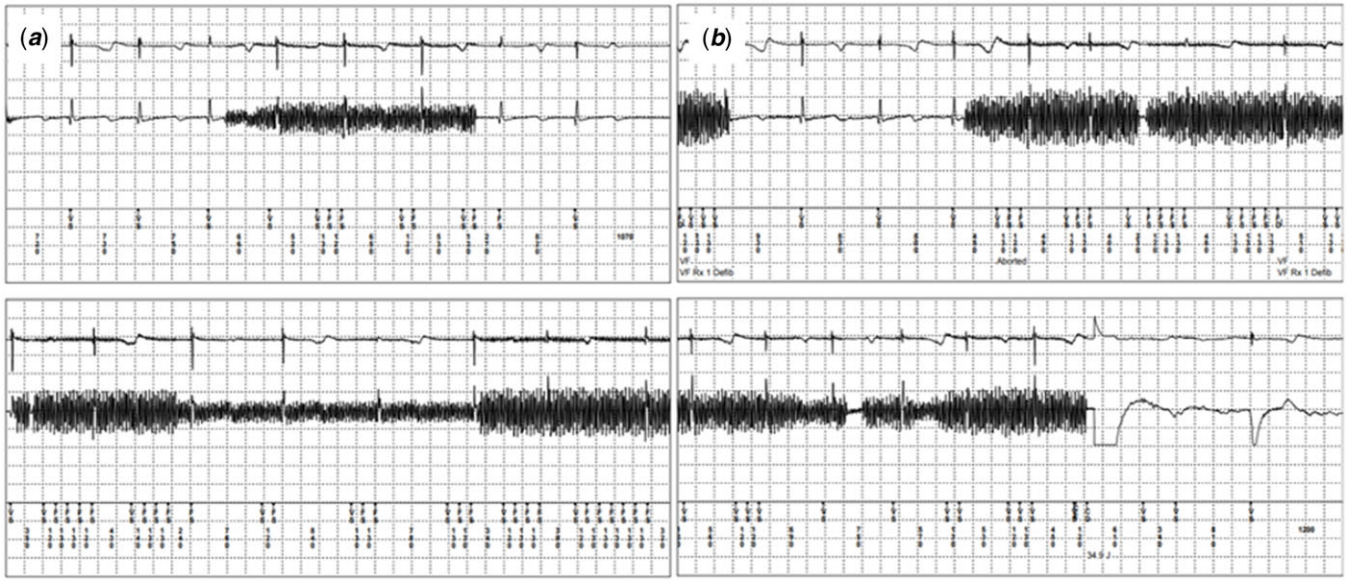

Figure 2. (***a***) Intracardiac electrocardiogram at 25 mm/second. A typical electromagnetic interference in the ventricular channel due to 50 Hz alternating current. (***b***) A typical electromagnetic interference in the ventricular channel due to 50 Hz alternating current wrongly detected as ventricular fibrillation, resulting in delivery of an inappropriate shock.

lead malfunction, sinus tachycardia, T wave oversensing, and external noise.[4–6] There are cases in the literature of electromagnetic interference being caused by handheld radiofrequency remote controls, electric razors, electronic article surveillance systems, power drills, washing machines, refrigerators, and slot machines.[7]

This patient experienced an inappropriate implantable cardioverter-defibrillator discharge due to an electrical leakage from the refrigerator. Electrical leakage problems causing such a potential hazard to patients are seen when electrical appliances are not adequately grounded.[7] In Turkey, the domestic supply of alternating current has a voltage of 230 V and a frequency of 50 Hz. An alternating current leakage can be sensed as ventricular fibrillation and result in inappropriate shock. In this patient, the intracardiac electrocardiogram clearly showed that he was in normal sinus rhythm and the baseline perturbations due to 50 Hz alternating current were falsely detected as VF.

Conclusions

EMI is one of the rare causes of inappropriate shock in patients without device and electrode failure, which we can diagnose with detailed anamnesis and EGM records. Patients with implantable cardioverter-defibrillator devices must be educated to be careful while using electrical appliances. In this way, inappropriate shock from EMIs can be avoided.

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Conflicts of interest. None.

Ethical standards. The authors assert that this work complies with the ethical standards of the relevant national guidelines on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. This case was approved by the patient's family.

References

1. Pai RK, Abedin M, Rawling DA. Inappropriate ICD shocks for inappropriate reasons. Indian Pacing Electrophysiol J 2008; 8: 69–71.
2. Chan NY, Wai-Ling Ho L. Inappropriate implantable cardioverter-defibrillator shock due to external alternating current leak: report of two cases. Europace 2005; 7: 193–196. DOI 10.1016/j.eupc.2004.09.010.
3. Sabaté X, Moure C, Nicolás J, Sedó M, Navarro X. Washing machine associated 50 Hz detected as ventricular fibrillation by an implanted cardioverter defibrillator. Pacing Clin Electrophysiol 2001; 24: 1281–1283. DOI 10.1046/j.1460-9592.2001.01281.x.
4. Garnreiter JM, Pilcher TA, Etheridge SP, Saarel EV. Inappropriate ICD shocks in pediatrics and congenital heart disease patients: risk factors and programming strategies. Heart Rhythm 2015; 12: 937–942. DOI 10.1016/j.hrthm.2015.01.028.
5. Krause U, Müller MJ, Wilberg Y, et al. Transvenous and non-transvenous implantable cardioverter-defibrillators in children, adolescents, and adults with congenital heart disease: who is at risk for appropriate and inappropriate shocks? Europace 2019; 21: 106–113. DOI 10.1093/europace/euy219.
6. Garnreiter JM. Inappropriate ICD shocks in pediatric and congenital heart disease patients. J Innov Card Rhythm Manag 2017; 8: 2898–2906. DOI 10.19102/icrm.2017.081104.
7. Al Khadra AS, Al Jutaily A, Al Shuhri S. Detection of refrigerator-associated 60 Hz alternating current as ventricular fibrillation by an implantable defibrillator. Europace 2006; 8: 175–177. DOI 10.1093/europace/euj001.

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