Intermittent, erratic behaviour of an implantable cardioverter defibrillator secondary to a hidden magnetic source of interference

Roy Beinart*, Mary L. Guy, and Patrick T. Ellinor

Cardiac Arrhythmia Service, Massachusetts General Hospital, 55 Fruit Street, GRB 109, Boston, MA 02114, USA

*Corresponding author. Tel: +617 724 8729; fax: +617 726 2155, Email: rbeinart@partners.org

Interference between pacemakers or implantable cardioverter-defibrillators (ICDs) and electromagnetic fields are of great concern due to the potential harmful influence on the function of the device. We report a case of intermittent, erratic behaviour of an ICD secondary to electromagnetic interference (EMI) caused by small magnets that were incorporated into the patient's clothing.

Case summary

A 71-year-old patient with ischaemic heart disease, who has a single-chamber implantable cardioverter-defibrillator (ICD) in place (Medtronic Maximo II VR, Medtronic Inc., Minneapolis, USA) since 2003 for secondary prevention of sudden cardiac death and subsequently underwent lead revision, was referred to the ICD clinic by her physician after her device started beeping during a routine office visit. Interrogation of her ICD showed no alerts or other abnormalities (programmed parameters: ventricular fibrillation zone >188 bpm and monitor zone set to 162–188 bpm), and the beeping was attributed to transient EMI. Three days later, the patient reported >50 episodes of ICD beeping. Initially, the interrogation revealed no abnormalities, although the beeping was found to be associated with intermittent suspension of therapy. The manufacturer was contacted and no clear explanation for the apparently erratic behaviour of the device could be deduced, even after the aforementioned behaviours were observed by technical representatives in person. Given the concern for an ICD malfunction, the patient underwent an urgent generator change (Medtronic Secura VR) the same day.

The next morning the patient had four more tonal alerts from the ICD. An exhaustive exploration of the patient's clothing led to the identification of four small magnetic snaps sewn inside pockets within the patient's jacket (Figure 1). This jacket is configured to have a hood that can be unzipped to form a large collar: the flaps of this collar are held down over the upper pectoral regions by magnets situated in the tips of the collar flaps and the pectoral areas of the garment. The case was reported to the manufacturer and the distributor of the jacket as well as the US Consumer Product Safety Commission.

Interference between ICDs or pacemakers and electromagnetic fields are of great concern due to unfavourable influence on the function of the device that could potentially cause harm to patients. While electrocautery is one of the most common sources of EMI, many other daily sources may also cause significant interference with implanted cardiac devices.¹ In recent years, strong magnets have become widely available. They are incorporated into many commonly found articles, including jewellery and clothing and can be small and difficult to recognize. Both *in vitro* and clinical studies have shown that these small magnets may cause interference with cardiac pacemakers and ICDs.^{2,3}

This case report underscores the importance of identifying sources of EMI and emphasizes the fact that small powerful magnets are being commercially used and their detection may be challenging. Patients and clinicians should be cautioned about the interference risk associated with these magnets during everyday life. A renewed effort should be made to encourage manufacturers to avoid the use of magnets to avoid serious consequences for patients with implantable devices.

Figure 1 A picture of the patient's jacket with hood (A) and collar (B) configurations. The red boxes mark the location of the magnets; a picture of one of the small magnetic snaps that were found inside the patient's jacket (C).

Conflict of interest: none declared.

Funding

National Institutes of Health (R01HL092577, R01HL104156, R21DA027021, and K24HL105780 to P.T.E.)

References

1. Yerra L, Reddy PC. Effects of electromagnetic interference on implanted cardiac devices and their management. *Cardiol Rev* 2007;**15**:304–9.
2. Ryf S, Wolber T, Duru F, Luechinger R. Interference of neodymium magnets with cardiac pacemakers and implantable cardioverter-defibrillators: an in vitro study. *Technol Health Care* 2008;**16**:13–8.
3. Wolber T, Ryf S, Binggeli C, Holzmeister J, Brunckhorst C, Luechinger R et al. Potential interference of small neodymium magnets with cardiac pacemakers and implantable cardioverter-defibrillators. *Heart Rhythm* 2007;**4**:1–4.

CASE REPORT

doi:10.1093/europace/eur151

Online publish-ahead-of-print 15 May 2011

Familial Brugada syndrome uncovered by hyperkalaemic diabetic ketoacidosis

Pieter G. Postema¹*, Alexander P.J. Vlaar², J. Hans DeVries², and Hanno L. Tan¹

¹Department of Cardiology, Academic Medical Center, Meibergdreef 9, 1105AZ Amsterdam, The Netherlands; and ²Department of Internal Medicine, Academic Medical Center, Amsterdam, The Netherlands

*Corresponding author: Tel: +31 20 5663072; fax: +31 20 6971385, Email: p.g.postema@amc.uva.nl

We describe a case of diabetic ketoacidosis with concomitant hyperkalaemia that uncovered a typical Brugada syndrome electrocardiogram (ECG). Further provocation testing in the patient and his son confirmed familial Brugada syndrome. Diabetic ketoacidosis with hyperkalaemia may uncover an inheritable arrhythmia syndrome that may put the patient and his/her next of kin at risk for a sudden death, irrespective of diabetes mellitus.

A 59-year-old man was admitted because of nausea, vomiting, diarrhoea, polydipsia, polyuria, and abdominal as well as chest discomfort. His medical history included type-1 diabetes mellitus with retinopathy, nephropathy, and neuropathy. His respiratory rate was 30/min, his heart-rate was 100/min, and his body temperature was 37.8°C, while oxygen saturation and blood pressure were normal. Investigations revealed hyperglycaemia (46 mmol/L, ULN 5.6), hyperkalaemia (6.9 mmol/L, ULN 4.5), metabolic acidosis (pH 7.21, PaCO₂ 2.5 kPa, HCO₃ 7.3 mmol/L), and glucosuria/ketonuria. His electrocardiogram (ECG) showed convex ST segment elevations in right-pre-cordial leads (Figure 1) suspicious for acute myocardial infarction. He was treated with intravenous fluids and insulin, and coronary angiography was performed. However, angiography revealed no significant coronary disease and cardiac enzymes remained negative. His ECG returned to normal on normalization of his glucose and potassium (Figure 1). However, he subsequently developed severe pain in the right-lower abdomen. Abdominal ultrasound imaging was suggestive for appendicitis and a gangrenous appendix was surgically removed. Following this, he recovered quickly and could be discharged in good condition with the diagnosis of diabetic ketoacidosis due to appendicitis.

His peculiar ECG abnormalities, however, raised the suspicion of Brugada syndrome (BrS). Brugada syndrome is a familial sudden death syndrome with an increased risk of potential lethal ventricular tachyarrhythmias and is associated with particular right-precordial ST-elevations known as the type-1 BrS-ECG. Its pathophysiologic basis is debated but believed to include reduced cardiac excitability.¹ Importantly, ECG abnormalities in BrS-patients may be latent, with the added presence of provoking factors such as drugs required to

Figure 1 Electrocardiogram during ketoacidosis with concomitant hyperkalaemia (6.9 mmol/L), during normal conditions and during ajmaline provocation testing in the patient and his son. A type-1 Brugada syndrome-electrocardiogram ECG with coved-type segment elevations in the right pre-cordial electrocardiogram leads compatible with Brugada syndrome is seen during ketoacidosis and/or ajmaline provocation.