Received: 2 February 2018 | Accepted: 22 March 2019

DOI: 10.1002/joa3.12180

CASE REPORT

WILEY Journal of Arrhythmia Open Access

Inappropriate implantable cardioverter defibrillator shocks due to atrial far-field on the tip-to-ring channel for lead dislodgement

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Abstract

We reported a case of inappropriate implantable cardioverter defibrillator shocks, due to atrial far-field on the tip-to-ring channel of the fast electrical activity during atrial fibrillation, caused by lead dislocation in the right ventricle outflow tract. During these episodes the can-to-right ventricle coil signal correctly recorded the ventricular activity. The shock storm stopped when an antitachycardia pacing restored sinus rhythm.

KEYWORDS

device complications, electrogram, implantable defibrillator, inappropriate shock, lead dislodgement

1 | INTRODUCTION

The safety and effectiveness of implantable cardioverter defibrillator (ICD) for the detection and treatment of malignant ventricular tachycardia are well established.[1] The advances in technology and multiple algorithm consent to reduce significantly the rate of inappropriate shocks; the tip and ring electrodes of the lead are typically chosen for sensing electrograms (EGM) signals, using a bipolar sensing configuration, which is known to have a higher morphological stability reducing external interference.[2]

2 | CASE REPORT

A 73-year-old man, presented at the Emergency Department for multiple ICD shocks occurred at rest, without loss of consciousness. He was affected by ischemic cardiomyopathy with severe reduction of the left ventricular ejection fraction and long-standing atrial fibrillation. The patient was followed by another Cardiology Center, in which he underwent 8 years before biologic aortic valve replacement, coronary artery bypass and left ventricular plication and, 10 days before, single chamber ICD implantation in primary prevention (model Visia AF MRI™ VR, ventricular lead positioned in the mid right ventricular [RV] septum 6935M Sprint Quattro Secure S MRI™, Medtronic, Inc.). Electrical measurements at the time of implantation were available, with an R wave amplitude of 14 mV, a pacing threshold of 0.5 V, a pacing impedance of 400 Ω. At hospital admission the patient appeared asymptomatic and the electrocardiogram showed sinus rhythm. The ICD interrogation revealed a reduction of pacing impedance (285 Ω) and of R wave amplitude (2-3 mV) and a pacing defect. Seven ICD shocks had been recently delivered. The RV tip-RV ring EGM during these episodes showed a fast electrical activity (cicle length 190-230 ms) detected on ventricular fibrillation zone and treated with during-charge antitachycardia pacing (ATP) and shocks; at the same time, the can-to-RV coil EGM (unipolar configuration) showed a high voltage irregular electrical activity with long cycle length (700-800 ms) and background noise (Figure 1, panel A). The last recorded during-charge ATP, interrupted the fast electrical activity on the bipolar EGM, with no more shocks delivered (Figure 1, panel B). ICD therapies were deactivated and the patient was conducted in the electrophysiology lab. Fluoroscopy revealed that the RV lead was dislodged and floating in the outflow tract (Figure 2). The lead was repositioned in the apical RV septum with good parameters and no complications.

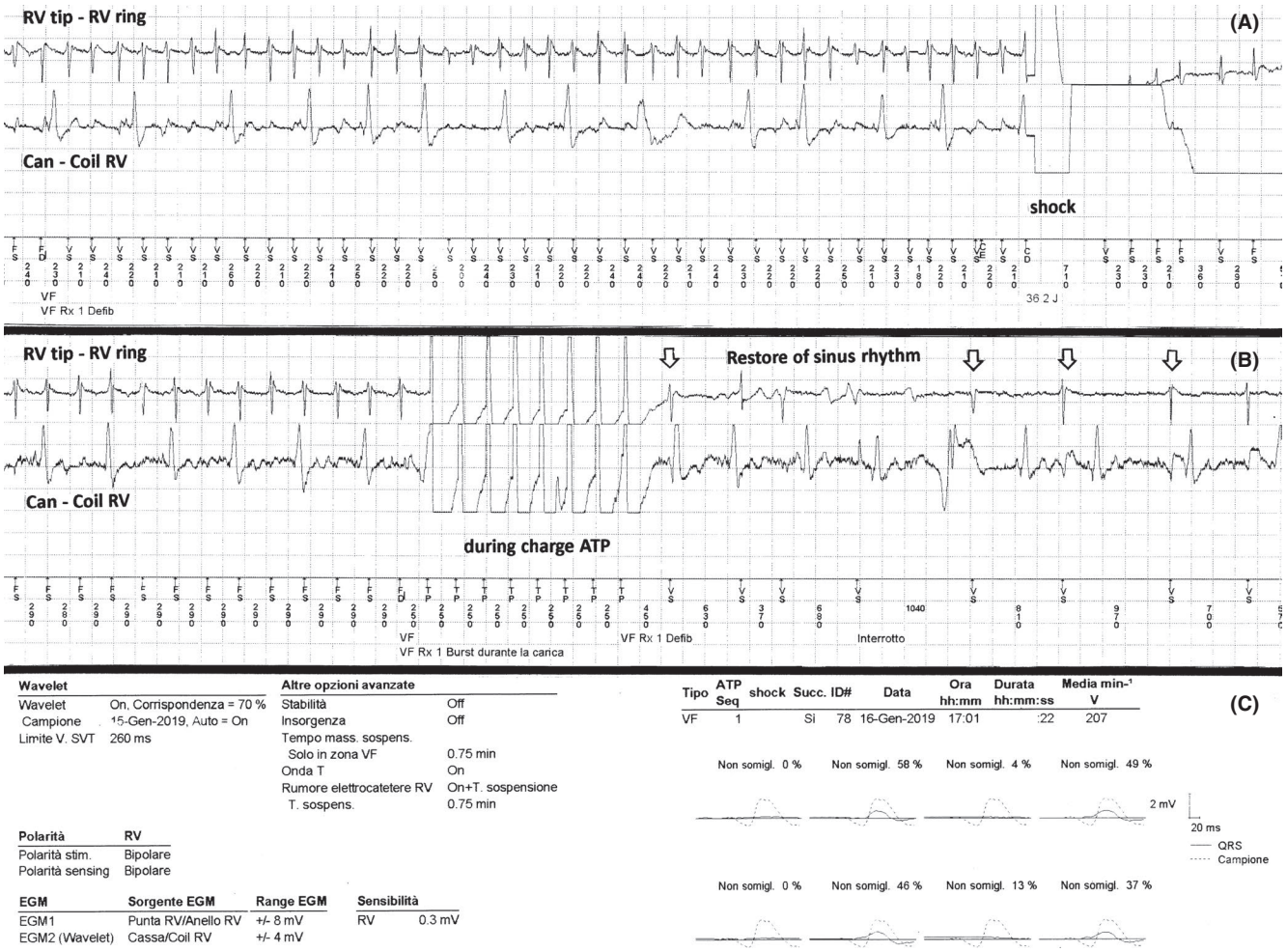

FIGURE 1 Stored recordings of intracardiac electrogram (EGM) and ICD therapy. On Panel A the first trace shows RV tip-to-RV ring EGM with fast electrical activity consisting with atrial far-field, marked on the bottom as ventricular fibrillation and treated with a 36 J shock. The second trace shows can-to-RV coil EGM; this trace records the ventricular activity with background noise due to lead floating. On Panel B the during-charge ATP that resolves atrial fibrillation; the RV tip-RV ring trace after the ATP shows an electrical activity with long and variable cycle length consistent with sinus rhythm with supraventricular ectopic beats and background noise; the can-to-RV coil channel records the ventricular activity, initially dissociated from the atrium (junctional rhythm). At the admission the patient presented sinus rhythm. Panel C shows the morphology algorithm; despite the nominal EGM source is can-to-RVcoil, the marked fast bipolar electrical activity corresponded in high percentage to noise in the unipolar channel, resulting in a "no-matching" morphology and confirming the incorrect ventricular fibrillation detection

3 | DISCUSSION

In the case that we reported, the RV lead dislocated in the outflow tract, closed to the pulmonary valve. The bipolar channel started to record a fast electrical activity consisting atrial far-field during atrial fibrillation (Figure 1, panel A); the sensing artifact was due to the proximity of the displaced RV tip-RV ring dipole to the left appendage. The can-to-RV coil EGM correctly detected the ventricular activity, however the EGM source for arrhythmia detection was the RV tip-to-RV ring channel, so a storm of inappropriate shocks was delivered. The restore of sinus rhythm by a during-charge ATP interrupted the shocks, despite the persisting atrial far-field in the bipolar channel (Figure 1, panel B). The repositioning of the lead completely resolved the problem.

Early lead dislodgement is a common complication after ICD implantation, that can be prevented checking the correct lead positioning using different fluoroscopic views, evaluating the stability of electrical parameters, requiring the presence of an injury current for active-fixation leads and suturing carefully the sleeve to pectoral fascia. However lead dislodgement can still happen and different algorithms are disposable to prevent inappropriate therapies in case of lead dysfunction.

The "Lead Noise Discrimination™" algorithm differentiates RV lead noise from ventricular arrhythmias by comparing a far-field EGM signal to near-field sensing.[3] If the RV sense signal shows activity in the ventricular fibrillation zone that is not shown on the far-field EGM signal, lead noise is determined and antitachycardia therapy is withheld. However the feature provides a programmable

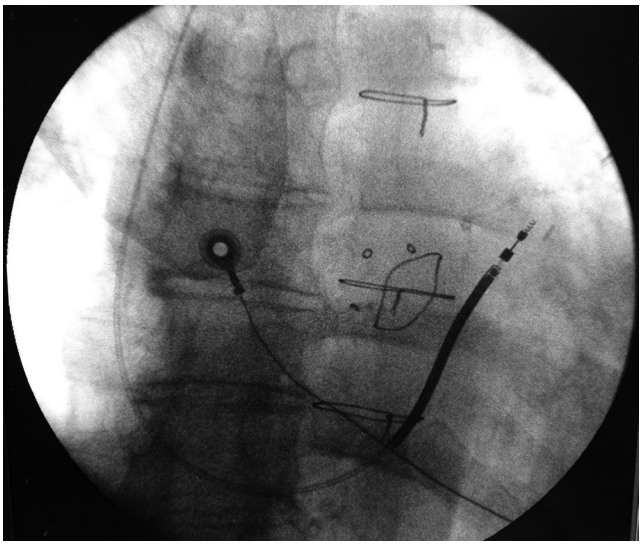

FIGURE 2 Fluoroscopy revealed that the lead was floating in outflow tract, closed to the pulmonary valve. This dislocation justifies the presence of atrial far-field due to the proximity of the tip to left atrial appendage

timeout interval (nominal of 45 seconds) and in our case the lead noise event persisted longer, so therapy was delivered.

The "RV Lead Integrity Alert™" algorithm has been designed to provide advance warning of a potential RV lead fracture with an alert tone, scoring together the RV lead impedance variations from baseline, the frequency of rapid nonsustained ventricular tachyarrhythmia episodes and the frequency of short ventricular intervals (120-130 ms).[4] In our case the cut off value was not reached, so the "RV Lead Integrity Alert" did not activate.

"Morphology" is a matching discriminator criterion that compares the EGM during tachycardia with that previously recorded during intrinsic rhythm[5] (Wavelet™). The nominal and most accurate Wavelet EGM source is can-to-RV coil which, in our case, correctly detected ventricular activity. However the algorithm was not efficacious to avoid inappropriate ICD shocks, as the marked fast bipolar electrical activity corresponded in high percentage to noise in the unipolar channel, resulting in a "no-matching" morphology which confirmed the incorrect ventricular fibrillation detection (Figure 1, panel C).

The remote monitoring can be very useful to avoid inappropriate shock reporting promptly the alteration in the electrical lead parameters. In our case there were a significant reduction of R wave amplitude, a high pacing threshold and a change in pacing impedance. The patient was not provided with remote monitoring at implantation. However the parameter trends showed an abrupt alteration of the electrical measurements the same day of the shocks storm, so we can suppose that the remote monitoring notification would have been ineffective in avoiding inappropriate shocks.

As far as we concern this is the first reported phenomenon of lonely tip-to-ring atrial far-field due to lead dislodgment causing multiple inappropriate shocks until sinus rhythm was restored thanks to atrial capture, and it resulted extremely useful to understand ICD functioning and discriminator algorithms.

ACKNOWLEDGEMENTS

The authors thank the engineers Martino Lazzari and Stefano Indrigo for their excellent support.

CONFLICT OF INTEREST

Authors declare no conflict of interests for this article.

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REFERENCES

1. Priori SG, Blomström-Lundqvist C, Mazzanti A, Blom N, Borggrefe M, Camm J, et al. 2015 ESC Guidelines for the management of patients with ventricular arrhythmias and the prevention of sudden cardiac death: the Task Force for the Management of Patients with Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death of the European Society of Cardiology (ESC) Endorsed by: association for European Paediatric and Congenital Cardiology (AEPC). Europace. 2015;17:1601–87.
2. Milpied P, Dubois R, Roussel P, et al. Morphological stability of bipolar and unipolar endocardial electrograms. Computing in Cardiology. 2010;37:733–6.
3. Gunderson BD, Gillberg JM, Wood MA, et al. Development and testing of an algorithm to detect implantable cardioverter-defibrillator lead failure. Heart Rhythm. 2006;3:155–62.
4. Ellenbogen KA, Gunderson BD, Stromberg KD, et al. Performance of Lead Integrity Alert to assist in the clinical diagnosis of implantable cardioverter defibrillator lead failures: analysis of different implantable cardioverter defibrillator leads. Circ Arrhythm Electrophysiol. 2013;6:1169–77.
5. Theuns DA, Rivero-Ayerza M, Goedhart DM, et al. Evaluation of morphology discrimination for ventricular tachycardia diagnosis in implantable cardioverter-defibrillators. Heart Rhythm. 2006;3:1332–8.

How to cite this article: Ferretto S, Brunzin K, Pettenuzzo K, Nangah Suh R, Canali C, Di Pede F. Inappropriate implantable cardioverter defibrillator shocks due to atrial far-field on the tip-to-ring channel for lead dislodgement. *J Arrhythmia*. 2019;35:562–564. https://doi.org/10.1002/joa3.12180