An unusually late dislodged atrial lead catching externalized ICD-lead conductor. A rare cause of simultaneous atrial and ICD lead over-sensing

Jens Kristensen MD, PhD | Mads Brix Kronborg MD, PhD | Peter Lukac MD, PhD | Jens Cosedis Nielsen MD, PhD, DMsc

Section for Arrhythmia, Department of Cardiology, Aarhus University Hospital, Aarhus N, Denmark

Correspondence
Jens Kristensen, Department of Cardiology, Section for Arrhythmia, Aarhus University Hospital, Aarhus N, Denmark.
Email: jenkrist@rm.dk

Abstract
This case report demonstrates a late atrial lead dislodgement, ICD lead externalization and lead interaction due to the atrial lead screw-helix catching the externalized loop of the ICD lead, leading to simultaneous dual lead over-sensing in the post-shock phase.

KEYWORDS
ICD over-sensing, inappropriate ICD therapy, lead-complication, lead dislodgement lead externalization

1 | INTRODUCTION
Defibrillator lead failure in implantable cardioverter-defibrillator (ICD) therapy is a major concern in device treatment. The present case demonstrates simultaneous over-sensing on both leads in a DDD ICD caused by an unfortunate coincidence of by themselves rare events.

2 | CASE REPORT
In 2010, a 62-year-old male was resuscitated from ventricular fibrillation (VF) and a Biotronik Lumax 540 DDD ICD, with a single coil Biotronik Linox® ICD lead, and an atrial St. Jude, Tendril 1888TC® active fixation lead was implanted. Coronary angiography (CAG) and echocardiography were normal. A VT and a VF zone, from 200 and 231 bpm respectively, were programmed with 1 ATP sequence in the VT zone. The pacing mode was DDDR, lower rate 60, upper rate 130 and sensor rate 120. The course was uneventful until August 2017, where the ICD reached ERI and was replaced with a Biotronik Itrevia® DDD ICD with no lead change, and the device programming unchanged. The leads were well situated at the device replacement.

In early May 2018 he was admitted with acute myocardial infarction for primary percutaneous coronary intervention leaving only minor myocardial damage and ejection fraction was still preserved.

In late June 2018 he was admitted to hospital after an ICD shock.

Reviewing the CAG from May 2018, the atrial lead was dislodged, and careful inspection suggested externalization of the defibrillation lead. Thus, an unusually late lead dislodgement, 7-8 years after implantation, had occurred in the interval between autumn 2017 and May 2018.

Interrogation of the ICD showed an episode of self-terminating polymorphic-VT, and the VF episode terminated by ICD shock (Figure 1). CAG was unchanged from May 2018. Evident on the pre-episode EGM from the episode leading to ICD shock are two ventricular ectopic beats followed by a compensatory pause, leading to a short-long-short sequence at initiation of VF, as well as an atrial pacing artifact without atrial capture (Figure 1B). The episode was terminated by ICD shock. The EGM from the post-shock phase shows simultaneous atrial and ventricular over-sensing suggestive of both atrial and defibrillator lead failure (Figure 1B). The lead parameters at interrogation were: Ventricular: Impedance (range last year in ()): 420 Ohm (389-443), Sensing: 2.6 mV (2.3-4.8), threshold:
FIGURE 1  Two different episodes: Non-sustained episode initiation (A) and VF episode with shock and over-sensing (B). A, Non-sustained episode (aborted shock). A functionally under-sensed ventricular event in post atrial pace ventricular blanking period is shown (thin arrows) with ventricular pacing approximately 300 milliseconds after the under-sensed ventricular event in potential vulnerable period (thick arrows), leading to a short-long-short sequence, potentially contributing to initiation of this episode (beginning of episode is shown). Double headed arrow marks two atrial pace events probably not both capturing (slightly different interval from pacing artifact to egm and different morphology of egm). B, Episode leading to shock: The left upper part shows initiation of arrhythmia displaying the short-long-short sequence at initiation. Atrial pace artifact without capture is encircled. The lower left part shows over-sensing of noise occurring simultaneous on both the atrial and defibrillator leads (two lower panels, not continuous with upper panel). The right part of the figure shows enlarged view of over-sensing. Some of the noise signals do not exceed sensitivity level or occur during blanked intervals (thick arrows). Atrial over-sensing: Broken arrows. Ventricular over-sensing: Thin arrows. FF, Far Field channel; A, Atrial near field recording; V, ventricular near field recording. Marker channel is shown above.
KRIStENSEN ET AL.

0.6 (0.4-0.9), Atrial: Impedance: 449 Ohm (375-449), sensing: 1.8 mV (1.3-4), threshold: Only intermittent capture. Automatic threshold determination since last in office measurement (1.3 V in March 2018) showed gradual increase from this value to reported 2.5 V. ICD therapies were inactivated and fluoroscopic evaluation performed (Figure 2).

The dislodged atrial lead screw-helix was now attached to the externalized conductor coil of the defibrillator lead in the right atrium and moving entangled with this (compared to CAG May). This finding explains the simultaneous over-sensing on both leads. We performed uncomplicated transvenous extraction of both leads, and a new system was implanted (Biotronik Intica DDD ICD, St. Jude Optisense 1999, atrial electrode, Biotronik Plexa ProMRI single coil ICD lead, essentially unchanged programming, rate responsive atrial pacing necessary). The atrial screw-helix was untied from the ICD lead, during counterclockwise rotation of the screw-helix and traction and rotation. The extracted defibrillator lead with conductor externalization is shown in Figure 2.

The non-sustained episode was remarkable for a ventricular ectopic beat coincident with an atrial pacing stimulus leading to functional under-sensing of the ectopic beat in the post atrial pace ventricular blanking period (PAVB) with sequential ventricular pacing during ventricular repolarization of the functionally under-sensed beat (Figure 1A), possibly contributing to induction of the non-sustained polymorphic VT episode.

3 | DISCUSSION

We are not aware of reports describing an atrial lead screw-helix catching an externalized defibrillator conductor resulting in noise on both leads after ICD shock. This case is remarkable for a very unfortunate coincidence of events. The atrial lead dislodgement occurred several years after implantation. The defibrillator lead developed conductor coil externalization. The atrial lead screw-helix caught the externalized part of the defibrillator lead (the sensing conductor to the ring electrode) and, likely, the exposed tip of the atrial lead screw-helix contributed to insulation damage of the externalized conductor, resulting in simultaneous dual lead over-sensing post-shock, probably due to associated lead stress under these circumstances. The exposed lead problem possibly prevented future inappropriate and accumulated shock events.

The dislodgement of the atrial lead took place between 8 and 2 months before the ICD shock. The mechanism for dislodgement remains speculative. However, possibly pocket revision and placement of the new ICD deeper in the pocket, during the replacement 1 year earlier, gave rise to traction on the atrial lead and finally dislodgement.

The Biotronik Linox® lead has been reported to have a slightly increased incidence of lead failures, partly due to externalization.1–3 The conductor to the pace/sense ring electrode and the conductor coil to the RV defibrillation coil are located “decentered” in the lead isolation around the central conductor coil to the tip electrode.4 Externalization of the shock coil could have led to short circuiting of current if interaction with the atrial lead had occurred and potentially low shock impedance and potentially ineffective shock. The attachment of the atrial lead tip helix likely contributed to electrical failure, through insulation damage, when the atrial lead was “snared” in the externalized conductor loop of the defibrillator lead.

This case, additionally, demonstrates, that in vulnerable patients with frequent ventricular ectopic complexes with the device operating in a dual chamber rate responsive pacing mode, the ectopics can be “trapped” in the PAVB5 (Figure 1), when atrial pacing occurs at sensor driven rate during decreasing atrial paced interval, eventually coinciding with frequent ventricular ectopics, functionally under-sensed in PAVB, with resultant pacing in the vulnerable period, contributing to arrhythmia induction.

In conclusion, this case shows the risk carried by leads with coil externalization interacting with a dislodged atrial lead with potential serious consequences. The screw-helix of the dislodged atrial lead was effectively “snared” in the externalized loop. Furthermore, the case stresses that attention has to be payed to all information contained in the shock episode EGM, even when it seems, that appropriate detection and therapy delivery took place.
CONFLICTS OF INTEREST

Authors declare no conflict of interests for this article.

ORCID

Jens Kristensen https://orcid.org/0000-0001-9784-3554

REFERENCES

1. O’Connor M, Hooks D, Webber M, et al. Long-term single-center comparison of ICD lead survival: evidence for premature Linox lead failure. J Cardiovasc Electrophysiol. 2018;29(7):1024–31.
2. van Malderen SC, Szili-Torok T, Yap SC, Hoeks SE, Zijlstra F, Theuns DA. Comparative study of the failure rates among 3 implantable defibrillator leads. Heart Rhythm. 2016;13(12):2299–305.
3. Noti F, Lam A, Klossner N, et al. Failure rate and conductor externalization in the Biotronik Linox/Sorin Vigila implantable cardioverter-defibrillator lead. Heart Rhythm. 2016;13(5):1075–82.
4. De Maria E, Borghi A, Bonetti L, Fontana PL, Cappelli S. Externalized conductors and insulation failure in Biotronik defibrillator leads: history repeating or a false alarm? World J Clin Cases. 2017;5(2):27–34.
5. Ellenbogen K, Kay N, Lau C, Wilkoff B. Clinical cardiac pacing, defibrillation, and resynchronization therapy. Philadelphia, PA: Elsevier, Inc; 2017.

How to cite this article: Kristensen J, Kronborg MB, Lukac P, Nielsen JC. An unusually late dislodged atrial lead catching externalized ICD-lead conductor. A rare cause of simultaneous atrial and ICD lead over-sensing. J Arrhythmia. 2019;35:307–310. https://doi.org/10.1002/joa3.12155