Late presentation of recurrent syncope after permanent pacemaker implantation due to Lead–Header malapposition

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ABSTRACT

Permanent pacemaker (PPM) malfunction due to electrical connection problems such as a loose set screw or lead-header malapposition is extremely rare. We present a patient with complete heart block (CHB) who had PPM malfunction and recurrent syncope, late (14 months) after initial implantation, which was caused by the ventricular lead pin disengagement from the header resulting in oversensing due to noise, pacing inhibition and recurrent syncope. PPM due to lead-header malapposition this late after device implantation has previously not been reported.

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1. Case report

A 62 year old man with a past medical history of hypertension and mild coronary artery disease underwent dual chamber PPM implantation in April of 2015 for CHB. A Boston Scientific Ingenio K173 (Boston Scientific, St. Paul, MN) generator was inserted and connected to 2 Medtronic 5076 pacing leads (Medtronic, Minneapolis, MN) which were positioned in the right atrium (RA) and right ventricle (RV). The operative report noted “normal testing results” with an acute RV lead bipolar pacing threshold of 0.6 V at 0.4 msec and pacing impedance of 550 Ω. The PPM was programmed DDDR 60–130 bpm with RA and RV lead outputs programmed at 3 times the threshold.

He had no further syncope after implant but continued to complain of intermittent lightheadedness as soon as a week out from the implant. Multiple pacemaker interrogations revealed stable atrial and ventricular lead function and he was told that his symptoms were likely due to low blood pressure which resulted in his blood pressure medicines being adjusted. The patient presented to his local hospital with recurrent syncope without warning 14 months after the initial implant. PPM interrogation recorded noise resulting in RV pacing inhibition (Fig. 1). RV bipolar lead pacing threshold was 0.6 V at 0.4 msec and the pacing impedance measured 660 Ω. Historical RV lead pacing threshold and impedance trends were stable. RV lead oversensing was suspected and pocket manipulation, deep inspiration, Valsalva maneuver, arm isometrics, left arm extension, abduction and adduction did not duplicate the noise. The device was reprogrammed to asynchronous mode (DOO at 80 bpm) and the patient was transferred to our hospital for lead extraction.

After confirming the interrogation findings, a chest radiograph was performed which showed no obvious fracture, gross dislodgement or lead discontinuity but revealed that the RV lead terminal pin was not fully inserted into or engaged in the pacemaker header (Fig. 2). This was suspected as the potential cause for the intermittent noise. The patient was brought to the electrophysiology laboratory for lead revision. Failure of complete lead terminal pin insertion was confirmed intra-op (Fig. 3). Both set screws were set but the distal set screw was not fully in contact with the terminal pin. The RV lead was repeatedly tested using the pacing system analyzer revealing a bipolar threshold of 0.6 V at 0.4 msec and a pacing impedance of 630–660 Ω. New lead insertion or
lead extraction was not performed and the RV lead was fully reinserted into the header and both set screws were tightened. At 22 months follow-up, the patient is asymptomatic without syncope or lightheadedness and device function is normal.

2. Discussion

PPM malfunction is an infrequent cause for recurrent syncope [1]. PPM malfunction due to electrical connection problems such as a loose set screw or lead-header malaposition, is even more uncommon [2–5]. We present a case of PPM malfunction, late (14 months) after initial implantation, in a patient with complete heart block (CHB), which was caused by the ventricular lead pin disengagement from the header resulting in oversensing due to noise, pacing inhibition and recurrent syncope. Pacemaker malfunction due to lead-header malapposition this late after device placement has previously not been reported.

Oversensing in cardiovascular implantable electronic devices (CIEDs) can be defined as sensing of signals that are not caused by local depolarizations and is often due to physiologic or non-physiologic causes [2]. Non-physiologic causes of oversensing, often referred to as noise, include electromagnetic interference (EMI), lead failure, lead-header connection problems, myopotentials, and sensing of extraneous pacemaker signals, such as those emitted by the minute ventilation sensor [6,7].

Determining the cause of noise requires a step-by-step approach and often involves a process of elimination. For example, if noise is due to EMI (external source), it should be recorded on all channels

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Fig. 1. Stored electrograms at the time of the syncopal episode. Stored electrograms corresponding to the time of the patient’s syncopal episode showing high frequency, non-physiologic (cycle length – 150 msec) noise on the ventricular (V) channel which saturates the amplifier. The pacemaker interprets the noise as ventricular tachycardia (VT) on the marker channel (M). There is pacing inhibition (no ventricular pace [VP] is noted). A — atrial channel, V — ventricular channel, M — marker channel, VT — ventricular tachycardia, AS — atrial sense, PVP — Post ventricular atrial refractory period extension.

Fig. 2. Magnified view of the pacemaker generator on chest radiography. Antero-posterior chest radiograph with a magnified view of the pacemaker generator showing that the ventricular lead is not fully inserted into the header and the terminal pin is not seen past the distal set screw (black arrow). In contrast, the atrial lead is fully inserted.
which was not the case in our patient. Lead component failure (fracture or insulation breach) is the most common cause of non-physiologic oversensing and is often associated with changes in impedance, sensing or threshold [2]. However, lead parameters were stable in our patient. Oversensing of myopotentials (either due to diaphragm or pectoral muscle) is often provable with maneuvers such as deep inspiration, isometrics, or straining [3]. None of these maneuvers elicited noise in our patient. Noise due to oversensing of minute ventilation signals is also high frequency, intermittent and may resemble those seen in our patient, but the Ingenio pacemaker is not involved in the recently released Boston Scientific safety advisory [8].

Lead-header connection problems such as loose set screw or terminal pin-header malapposition most often present soon after implantation. Our patient is unusual in its late presentation resulting in recurrent syncope 14 months after initial implant and also because lead-header connection problems are usually associated with a rise in impedance [9] which was not seen in this patient (Fig. 4). The actual graphs obtained during device interrogation are not available. Intermittent make-or-break behavior of the connection problem could account for a lack of changes in impedance, sensing and threshold parameters. Because noise due to lead-header connection problems is rare, it is often overlooked, but can be recognized by its characteristic appearance – typically high frequency, intermittent, with saturation of the amplifier [10,11]. We hypothesize that the lead-header malapposition was present since implant but was underrecognized especially in association with unremarkable serial interrogations at the outside hospital.

Recurrent syncope after PPM implantation is a common problem, often leading to emergency room visits, but is rarely due to PPM malfunction. In one study evaluating 162 patients presenting with syncope after PPM implantation, device malfunction was responsible for less than 5% (8/162) of the episodes [1]. Premature battery or primary lead failure were responsible for all 8 cases and required either generator change or new lead insertion. No lead-header connection problems were noted. The etiology of the syncope was not found in >50% of patients in this cohort but hemodynamic causes such as orthostasis were suspected.

The evaluation of a patient who presents with recurrent syncope after CIED implantation includes device interrogation in addition to orthostatic vital signs, electrocardiogram and routine laboratory data [1]. Chest radiography (CXR) is often performed in the evaluation of PPM malfunction. While not systematically studied, the reported yield of routine CXR is low [1,12]. This is likely due to the fact that a lead insulation breach, micro-fracture or micro-dislodgement are usually not visible on CXR. But in our patient, the CXR was very valuable in helping find the cause for the noise. Since CXR is a modality that is readily available, non-invasive and relatively inexpensive, it still has value and should be performed in the work-up of PPM malfunction. In addition to a CXR, a screening fluoroscopy in magnified view can be useful in suspected...
cases. A “tug test” should also be employed during implantation procedure after screwing in the lead to ensure secure connection of the lead to the header.

3. Conclusion

PPM malfunction is an infrequent cause of recurrent syncope in CIED recipients. Lead-header dislodgement or malapposition is an uncommon cause of noise but can be recognized by its characteristic appearance on stored electrograms. It typically presents early after PPM implantation and is usually associated with a rise in impedance. Our patient however presented late after PPM implantation (14 months) and had normal and stable impedance values. These findings suggest that lead–header connection problems should be on the list of differentials for PPM malfunction late after implantation, even if the impedance values are stable and within the normal range. Proper re-engagement of the lead into the header may obviate the need for more invasive procedures such as new lead insertion or lead extraction.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Ofman P, Rahilly-Tierney C, Djousse L, Peralta A, Hoffmeister P, Gaziano JM, Weiss A, et al. Pacing system malfunction is a rare cause of hospital admission for syncope in patients with a permanent pacemaker. Pacing Clin Electrophysiol 2013;36:109–12.
[2] Gunderson BD, Swerdlow CD, Wilcox JM, Hayman JE, Ousdigian KT, Ellenbogen KA. Causes of ventricular oversensing in implantable cardioverter-defibrillators: implications for diagnosis of lead fracture. Heart Rhythm 2010;7:626–33.
[3] Sondhi S, Bhardwaj R, Kandoria A, Ganju N, Sharma R. Pacemaker malfunction – disengagement of lead PIN from connector head – rare cause for loss of capture. BJH Cardiovasc Case Rep (CVR) 2018;2:196–200.
[4] Coleman AE, Defrancesco TC, Chanoit G. Pacemaker malfunction due to mechanical failure of the lead-header interface. J Vet Cardiol 2012;14:519–523. https://doi.org/10.1016/j.jvc.2012.07.003.
[5] Kuruvilla C, Voigt L, Kachmar K, Reddy CV, Kassotis J. Inappropriate mode switching in a dual chamber pacemaker due to oversensing of a high frequency signal from a conductor/ming discontinuity (loose set screw). Pacing Clin Electrophysiol 2002;25:115–117. https://doi.org/10.1046/j.1460-9592.2002.00115.x.
[6] Kowalski M, Ellenbogen KA, Wood MA, Friedman PL. Implantable cardiac defibrillator lead failure or myopotential oversensing? An approach to the diagnosis of noise on lead electrograms. Europace 2008;10:814–7.
[7] McClelland J, Nayak HM, Tung R, Upadhyay GA. Respiratory rate trending as a cause for atrial lead noise: a first report in an implantable defibrillator patient. Heart Rhythm Case Rep 2018;4:454–7.
[8] Minute ventilation signal oversensing physician letter. December 2017, vol. 2018. http://www.bostonscientific.com/en-US/pprc/product-advisories.html.
[9] Swerdlow CD, Sachanandani H, Gunderson BD, Ousdigian KT, Hjelle M, Ellenbogen KA. Preventing overdiagnosis of implantable cardioverter-defibrillator lead fractures using device diagnostics. J Am Coll Cardiol 2011;57:2330–9. https://doi.org/10.1016/j.jacc.2010.12.042. PMID: 21636034.
[10] Swerdlow CD, Friedman PA. Advanced ICD troubleshooting: Part I. Pacing Clin Electrophysiol 2005;28:1322–46.
[11] Mulpuru SK, Madhavan M, McCleod CJ, Cha Y, Friedman PA. Cardiac pacemakers: function, troubleshooting and management. J Am Coll Cardiol 2017;69:189–210.
[12] Pavlovic SU, Kocovic D, Djordjevic M, Belkic K, Kostic D, Velimirovic D. The etiology of syncope in pacemaker patients. Pacing Clin Electrophysiol 1991;14. 2086-2081.