Normal pacing function with normal impedance trends despite evident lead fracture in an implantable defibrillator – What is the mechanism?

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ABSTRACT

A 63-year-old lady with a high-grade atrioventricular (AV) block and a structurally normal heart underwent permanent pacemaker implantation (dual chamber, Medtronic Ltd) 8 years back. On follow up, she had a recurrence of syncope after 3 years. The device interrogation at that time had revealed ventricular tachycardia (VT) for which she underwent implantable cardioverter defibrillator (ICD, Medtronic Ltd, Egida DR, DF1) upgrade at another center (electrograms not available). Now, she presents with episodes of presyncope after another 5 years. The Echocardiography was unremarkable. The ICD was interrogated & there was a stored ventricular fibrillation (VF) episode. But the electrograms suggested noise over a true VF electrogram noted in both near and far-field. In all probability, the VF was not a true one which might have arisen from some lead noise or from an electromagnetic interference (EMI). Fluoroscopy revealed an evident lead fracture near the superior vena cava (SVC) coil. The stored electrogram (EGM) characteristics also suggested possible lead noise rather than a true VF. She was advised for lead revision. Interestingly, all pacing parameters were normal along with normal impedance despite the evident lead fracture. This happened due to the ICD lead arrangements as there are separate electrodes for the SVC/RV coil and pacing. While the SVC coil was damaged, the pacing electrodes remained unaffected. Since the patient has no episode of true VT/NSVT and the echocardiography was normal, she was managed temporarily by changing the pacemaker to asynchronous (DOO) mode.

1. Case

A 63-year-old lady with a symptomatic high-grade AV block and structurally normal heart underwent permanent pacemaker implantation 8 years back at another center (Fig. 1A). On follow up, she had recurrence of syncope after 3 years. The lead threshold and impedance trend were normal but there was device detected ventricular tachycardia (electrograms not available). As a result, she underwent an upgrade to implantable cardiac defibrillator implantation (Medtronic Ltd, Egida DR, Sprint Quattro secure DF-1 lead, model 6947) at another center (lower rate 60 bpm, AV delay 150/200 ms, VT > 150, Fast VT > 190, VF > 222 bpm). Her coronary angiogram and cardiac PET-CT scan were normal at that time. She has now come back after five years with a few episodes of pre-syncope at rest. Echocardiography was unremarkable. ICD interrogation reported several episodes of ventricular fibrillation (VF) in the near field (Fig. 1B and C). Her pacing parameters are unaffected [RV threshold 0.8 V @ 0.4 ms, Impedance = 560–590 Ohms, both HV impedance — normal]. She was 99% ventricular pacing dependent. Her impedance trends were normal as well. However, on a closer look it was certain that the episodes were not VF as the far field revealed no QRS complex and possible asystole (Fig. 1B and C). Hence, it was thought to be arising from oversensing either from a lead noise or from any EMI. The presyncope was attributed to inhibition of pacing function. She underwent fluoroscopy which revealed an evident lead fracture near the SVC coil (Fig. 2). Hence the possibility of over-sensing from lead noise was suspected. She was advised to undergo a lead revision. Temporarily she was kept on DOO mode as there was no episode of true VT/VF recorded in the last 5 years. There are a few intriguing questions that need to be answered in the given case:

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i) Why is the pacing normal despite the evident lead fracture?

ii) How are the impedance trends of all channels still normal despite the evident breach in fluoroscopy?

iii) If pacing parameters are normal, why is there oversensing?

2. Commentary

To understand the case, we need a brief understanding of ICD lead arrangements. If we take a closer look at the Medtronic lead arrangement and electrode design (Fig. 3), we can see that there are 5 different electrodes/ports [1]. One is for the SVC coil, one for the RV coil, 2 are used for pacing and sensing (ring & helix) and one for spacing [Fig. 3]. The SVC/RV coils are stretchable and we believe, in this case, it has undergone stretching and incomplete breakdown. Unlike a pacing lead which has coaxial conductors, ICD leads have a total of 4 parallel running electrodes, of which 3 are cables and one is a coil. In the Quattro design, there is also a 7x7 configuration of the cables that is used which provides extra strength than the classical 1x19 configuration and hence is at a much lower risk of complete damage [1]. That has possibly led to viable electrical conduction through the remaining intact part of the stretched wire and hence had normal impedance.

We speculate that in the index case, the major damage which was macroscopically visible was in the SVC coil. However, it is likely that there is a lead fracture or damage to the pace-sense cable which finally led to the undue oversensing as VF. Isolated SVC coil stretching/damage cannot reflect into noise/oversensing as the sensing in bipolar lead happens from the tip of the pace-sense port [2]. It was interesting as there was no rise in threshold or loss of capture. This is explained by the well-known facts described in
earlier studies [1–3]. One of the reasons could be the ‘make and break’ phenomenon in the early stage of lead fracture [3]. One study has revealed that over 70% cases of lead failures present with the issue of oversensing only and normal impedance (as is the case here) while a far lesser 19% cases present with both sensing and pacing abnormalities [1]. With the advice of lead revision, a temporary decision of reprogramming the device to DOO was taken as there has been no recorded true VT/NSVT since the ICD implantation over the last 5 years. Moreover, he has normal echocardiography over the years with normal cardiac PET CT scan. Retrospectively, we suspect that the earlier device detected VT (mentioned 5 years back), before ICD implantation might have been another lead fracture (ventricular) related noise. In essence, this case highlights the importance of critical analysis of stored electrograms in cases with cardiovascular implantable electronic devices (CIEDs) to avoid inadvertent upgradation of devices. In addition, this case also highlights the fact that normal device parameters do not exclude device malfunction.

Data availability statement

All raw data and recording during the case are available for review.

Declaration of competing interest

This is to declare that all of us are authors of the following manuscript titled ‘Normal pacing function with normal impedance trends despite evident lead fracture in Medtronic defibrillator — what is the mechanism?’ and we have no conflict of interest.

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