Rise in ICD pacing impedance: What is the cause?

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1. Case report

A 72-year-old patient presented with complaints of vibratory alert from implantable cardioverter-defibrillator (ICD). He had sustained monomorphic ventricular tachycardia with left ventricular dysfunction earlier and had undergone implantation of a single-chamber ICD (Evera XT VR DVBB1D4 single-chamber ICD, lead 6935 M Quattro Secure S DF4, Medtronic Inc) five years ago. His previous device interrogation 6 months ago was normal. His routine labs were normal, and there was no history of recent hospitalization or change in his medications. Device interrogation revealed the sensed R wave to be 6 mV, and the pacing threshold was 0.8 V @ 0.4 ms. The current bipolar impedance was 1026 Ω, and it was out of range as the programmed cut-off was 1000 Ω. The impedance trend graph revealed a gradual rise of both-bipolar and tip to coil impedance from 500 to 1000 Ω from May to August 2020. Subsequently, the impedance value plateaued just above 1000 Ω (Fig. 1A).

The pacing mode was VVI with a programmed lower rate of 40 beats per minute (bpm). During telemetry, pauses in the electrogram (EGM) were observed (Fig. 1B). Chest X-Ray and cinefluoroscopy imaging showed intact lead without any perceptible mechanical damage or loose set screw. What is the probable cause for the abnormality seen in the EGMs, and impedance measurement? How to troubleshoot the problem?

2. Discussion

Firstly, let us turn our attention to the pause. An intermittent loss of R waves, and isolated small-amplitude deflection (asterisk) is observed (Fig. 1B). The deflection has the exact morphology of the T wave of the preceding beats. Moreover, the RR that encompasses the T wave is twice the preceding RR interval. T wave, which represents repolarization of the ventricular myocardium, always follows a depolarization wave, i.e., QRS complex. Hence, this isolated T wave artifact could not have occurred without depolarization. Concomitantly, there is failure to pace without any Vp (ventricular pace) annotation or pacing artifact at the escape interval (lower rate limit - 40 bpm). These EGM abnormalities represent the failure of the PSA to record the QRS, and QRS drop out.

Secondly, there is rise in pacing lead impedance. This could be due to lead fracture or loose sets screws. Fluoroscopy and physical manoeuvres did not reveal any noise/oversensing or impedance fluctuations. Rarely, gradual rise in impedance as in here, may occur due to mineralization of the electrodes and coils or by other unknown mechanisms [1,2]. Calcium deposits can cause improper sensing, pacing, and defibrillation function due to the involvement of the tip (cathode). Certain ICD leads, eg. Endotak Reliance defibrillation leads, and disease states like hypercalcemia and chronic kidney disease, are prone to calcification process involving shocking coil and distal pacing electrode calcification [3]. Usually, lead mineralization is a slow and progressive process. Transient mineralization could explain the gradual rise and plateau of the impedance trend in the distal electrodes.
The pertinent question is whether the rise in impedance and the above EGM abnormality are related? This is unlikely due to the following reasons. The impedance trend was suggestive of mineralization at the lead’s tip (cathode), which cannot explain global EGM abnormality. Intermittent EGM abnormality was seen in all vectors, pointing to an improper recording of signals. Due to these factors, intermittent loss of telemetry communication was suspected to be the cause of EGM artifacts [4]. Repeat manoeuvres after placement of programme system analyser wand in a stable position could not reproduce the earlier EGM abnormalities (Fig. 2). As there was no abnormality in shock coil impedance, noise in the EGM, or inappropriate shock, the lead was managed conservatively. The impedance alarm threshold was set high at 1500 Ω, and there was no further rise in impedance.
Simultaneous ECG lead placement will help to troubleshoot the telemetry loss problem.

3. Conclusion

Failure to recognize recording artifacts due to intermittent loss of telemetry can lead to unnecessary diagnostic tests and manoeuvres. CIED implanters should be aware of this “great masquerade” in order to avoid workup. Close observation is necessary in cases of gradual impedance rise due to the mineralization of the leads. Diagnosis of this condition may lead to a more conservative wait and watch approach, and we may avoid extraction of the lead.

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Declaration of competing interest

None.

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