EP CASE REPORT

Subcutaneous implantable cardioverter-defibrillator: the impedance of air

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Case

A 68-year-old lady with ischaemic cardiomyopathy underwent implantation of a subcutaneous implantable cardioverter-defibrillator (S-ICD) (Boston Scientific, MA, USA) in 2016. Four years later, although no shock had been delivered, there was a sudden battery failure; projected battery longevity dropped from 65% to 6% over 6 months. Pulse-generator replacement was advised. Subsequent manufacturer analysis revealed the degradation of an internal component due to hydrogen accumulation.

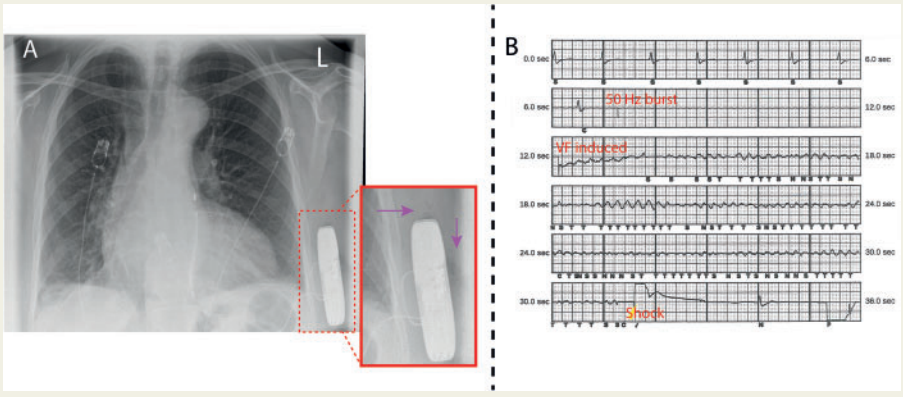

Figure 1 Chest X-ray (CXR) and successful defibrillation threshold (DFT) test. (*A*) There is loculated air trapped within the pulse-generator pocket (purple arrows) causing an abnormally high shock impedance. (*B*) A week after the generator substitution, repeat DFT test was performed: delivery of a 50 Hz burst for 5 s induced VF which was appropriately sensed and defibrillated to sinus rhythm using 40 J of energy; the shock impedance had reduced from 135 Ω to 98 Ω. *VF, ventricular fibrillation*.

Generator replacement was under sedation using standard technique: blunt dissection with plasma-blade assistance freed the device which was then substituted for a new generator. The capsule was minimally disturbed and to dispel air before closure, it was irrigated with saline, and the tissue was massaged. The wound was closed, and an impedance test shock of 10 J was delivered which was unsatisfactory with high impedance (135 Ω). Air entrapment within the device pocket was confirmed on a chest radiograph (*Figure 1*).

Having temporarily disabled shock therapy, time was afforded for air absorption. On repeat testing 7-days later, the shock impedance was acceptable at 98 Ω. A defibrillator test was performed: ventricular fibrillation (VF) was induced with a 50 Hz burst, which the device sensedappropriately and defibrillated to sinus rhythm using 40 J. At 5-months follow-up, the battery life is 95%, and no shock has been required.

Discussion

We describe the first case of high shock impedance secondary to air entrapment in the generator pocket at S-ICD pulse-generator substitution. This case highlights the importance of careful pocket irrigation after hardware exposure to air. The large surface area and profile of the device, with the hydrophobic nature of the fibrous capsule may make it difficult to completely expel all air. As the generator is a necessary component of the circuit for defibrillating shocks, this is potentially hazardous. The fact that the device lies vertically rather than horizontally in a supine patient in the anatomical position may make it more vulnerable to this than a transvenous device. A capsulotomy can be considered to provide a route for faster air expulsion from the device pocket.

The S-ICD is an option for patients requiring a defibrillator without pacing capability. Air insulation around the lead is well known to increase current impedance, causing inefficient shock therapy[1], and also inappropriate sensing, resulting in inappropriate shock delivery.[2] Dispersal of air from around the lead is recommended by the manufacturer. Air insulation in the pocket has not previously been reported at generator substitution, but our experience suggests that air dispersion from the pocket is also vital and that a defibrillation test should be standard practice; chest radiography may be an important diagnostic tool.

The sudden battery failure in this case was secondary to hydrogen build-up causing a malfunction of the low-voltage capacitor,[3] a failure that is prevalent in EMBLEM™ devices implanted before August 2018. The manufacturer has recommended the replacement of these

generators. Approximately 38 350 active S-ICD devices are thought to be affected.[3] A surge of pulse-generator replacements is on the horizon; physicians should be aware of the risk of air entrapment.

Conclusion

Air entrapment in the device pocket can occur during S-ICD pulse-generator substitution causing a high shock impedance and potentially failure of life-saving therapy.

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Conflict of interest

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