A 49-year-old man consulted our department 3 months after having several implantable cardioverter-defibrillator (ICD) shocks with subsequent syncope. A CRT-D device (Boston Scientific, Cognis 100-D) and a single-element subcutaneous array (Medtronic, model 6996 SQ) had been implanted 2 years previously for primary prevention of sudden cardiac death caused by symptomatic (New York Heart Association class III) nonischemic dilated cardiomyopathy with severely impaired left ventricular function (left ventricular ejection fraction, 10%) and a left bundle-branch block (QRS width, 176 ms). ICD interrogation revealed a prolonged episode of tachyarrhythmia starting with a fast monomorphic ventricular tachycardia (VT cycle length, 230 ms). Antitachycardia pacing (ATP) during charging led to discrete VT acceleration, followed by degeneration into ventricular fibrillation (VF) caused by the first 41-J shock. Another 5 ineffective ICD shocks were delivered. Eventually, the seventh shock was able to terminate VF (Figure 1). Chest radiographic examination revealed a dislodged SQ array requiring surgical revision (Figure 2). After positioning of a new SQ array, the intraoperative defibrillation threshold (DFT) was determined at 21 J. No perioperative complications occurred, and the patient could be discharged home after recovery. On follow-up 6 weeks later, the patient remained in stable condition with no arrhythmia recurrence.

Discussion

Our current understanding conceives ventricular defibrillation as a probabilistic event that can be described by a sigmoidal probability-of-success curve. Consequently, a true DFT above which defibrillation will always succeed cannot be defined. Instead, the goal of DFT testing is to determine an energy level associated with a morning peak of failed VT/VF termination by any other specific antiarrhythmic drug. A circadian variation has been ascribed to DFT with a morning peak in DFT or any other specific antiarrhythmic drug. A circadian variation has been ascribed to DFT and Electrophysiology

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Ventricular Fibrillation Terminated by the Seventh Shock

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However, it can be demonstrated with bayesian analysis that a high proportion of failed DFT tests with modern ICDs will be false-negative results possibly resulting in unnecessary revision. Nevertheless, implant testing occasionally will correctly identify a system failure and indicate a necessary system revision that saves a patient’s life—a circumstance that has been described as “the implanter’s dilemma.” Because of a high DFT (>41 J in any shock vector configuration) at the time of implantation of the CRT-D device, a single-element subcutaneous array had been implanted in our patient to obtain an acceptable DFT. VF induced by T-wave oversensing had been successfully terminated twice at 21-J with a reversed wave form polarity (ie, RV coil = anode, can+SQ array = cathode). The device was programmed to deliver 8 shocks at maximal energy (41 J) including a single ATP train during charging. Nevertheless, 7 consecutive maximum output shocks (41 J) were required to eventually terminate the presenting VT/VF episode in our patient. On admission, interrogation of the device showed stable lead and device parameters within normal limits. There was no undersensing, and ICD charging times ranged from 7.2 to 8.6 seconds. Reversible causes of transient DFT changes such as hyperkalemia or ischemia were clinically unlikely. There were no signs or symptoms indicating a progression of the underlying cardiomyopathy. The patient was on standard heart failure medication (enalapril, carvedilol, torasemide, spironolactone) and denied the intake of amiodarone or any other specific antiarrhythmic drug. A circadian variation has been ascribed to DFT with a morning peak in DFT associated with a morning peak of failed VT/VF termination by the first ICD discharge. However, our patient’s VT/VF episode occurred during the early afternoon. Furthermore, a time-dependent increase in DFT has been reported, showing a rate of first shock failure of 6.5% after the first postoperative year. Our patient met a priori several criteria for a higher DFT such as male sex, symptomatic chronic heart failure (New York Heart Association III), long QRS duration (176 ms), severely impaired left ventricular function (left ventricular ejection fraction, 10%), and dilated cardiomyopathy. The combination of all these factors probably put him at higher risk of failed VT/VF termination through ICD therapy. However, chest radiography revealed a
cranial migration of the SQ array, a rare but known complication that from a mechanistic point of view is likely to increase DFT.3 Nevertheless, the case is curious in that all 6 successive ICD shocks delivered were ineffective, but the seventh discharge in fact terminated VF. Duration of VT/VF >15 seconds is believed to increase DFT.1 As the VF episode persisted (total of 2 minutes, 7 seconds), the patient was likely to have developed acidosis, which in turn is known to contribute to DFT rise.1 Interestingly, the body position presents another influential factor: DFTs are higher in the upright than the supine position.4 One might speculate the syncope after the first ICD shocks could have contributed to the finally successful conversion. Taken together, the present case report emphasizes all the factors potentially altering defibrillation outcome, suggesting that annual chest radiographs and/or regular DFT testing may be reasonable in patients with SQ arrays.

Luckily, our patient had received an ICD device providing up to 8 consecutive shocks for ventricular tachyarrhythmias, presuming the seventh try’s a charm.

Disclosures
None.

References

KEY WORDS: cardiac resynchronization therapy ■ ventricular fibrillation ■ defibrillation threshold ■ subcutaneous array
Figure 2. A, Posteroanterior view of chest radiography shows a dislodged single-element subcutaneous array (Medtronic, model 6996 SQ) in close proximity to the active can of the device (arrowhead). CRT-D leads are appropriately located. Macroscopically, no insulation defect can be visualized. B, Lateral view of chest radiography demonstrating the cranially migrated single-element subcutaneous array (Medtronic, model 6996 SQ). The atrial lead is located in the right atrium; the left ventricular lead lies along the coronary sinus.
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