Early automatic remote detection of combined lead insulation defect and ICD damage

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Lead and implantable cardioverter defibrillator (ICD) device failure is a severe problem in ICD therapy and may occur without preceding signs of deterioration. Insulation lead failure and subsequent ICD defect 7 months after ICD implantation for secondary prevention of sudden cardiac death (SCD) in a 70-year-old male was automatically detected with the Home Monitoring system. Immediate lead and device replacement was performed. This case illustrates the benefit of permanent automatic remote monitoring of implanted active devices.

Keywords Remote monitoring; Implantable cardioverter defibrillator; Lead failure; Device failure

Introduction

Lead and device failure remains a severe problem in implantable cardioverter defibrillator (ICD) therapy. In response to an increasing number of failure reports, the US Food and Drug Administration1 has recently advised to increasingly use remote monitoring capabilities for device surveillance.

Case report

We describe a 70-year-old male with a secondary prevention indication for ICD implantation. A transvenous single-chamber ICD system with BIOTRONIK Home Monitoring® capability (Lexos VR-T, BIOTRONIK GmbH & Co. KG, Berlin, Germany) was implanted together with a tripolar ICD lead Riata® 1580 (St. Jude Medical Inc., Sylmar, CA, USA) with sensing amplitude of 16.2 mV, pacing threshold of 1.1 at 0.40 ms, and pacing impedance of 620 Ω. Defibrillation was repeatedly successful with 20 J, shock impedance was 47 Ω. Home Monitoring was switched on at hospital discharge. Six months after implantation, pacing threshold and pacing impedance were stable at 1.0 V and 520 Ω, respectively.

Seven months after implantation, we received a Home Monitoring event report, indicating 6 episodes detected in the VF zone, 2 successful shocks, 6 dumped shocks, and 21 capacitor charging cycles without successful termination. The patient was immediately called in for follow-up. The patient noticed two shocks but did not consider this important, so no action was taken from the patient’s side, the follow-up centre was not contacted actively. The last measured shock impedance was <25 Ω, indicating a clear drop from 47 Ω. Since the event report 3 days ago, more than 50 additional charging cycles had occurred. Chest X-ray did not show any macroscopic signs of lead failure. During the procedure, we found an insulation defect 2 cm distal of the connector split of the RV lead, and a marked sign of melting at the ICD case edge surrounded by friction marks (Figure 1).

Bench testing showed that the anti-bradycardia pacing capability of the ICD was flawless. An applied fibrillation signal was correctly detected. However, the ICD failed to deliver a shock. Opening of the ICD revealed that the charging circuit was damaged. Hence, the ICD was unable to charge the capacitors within the charge time limit of 20 s. We conclude that the charging circuit had been damaged during the shock delivery following the seventh charging cycle. The reason for this damaging is probably a short circuiting in the shock path as a result of lead insulation defect.

Discussion

The device pocket is only rarely the localization of early lead damage, and if so, the damages originate mainly from scissors, scalpel, or tight suture during lead fixation. However, because of the broad and shallow damage of our lead, none of these possibilities seems reasonable. Another possible in-pocket failure mode reported by Mera et al.2 was insulation damage originating from flexing stress at a rigid structure at the ICD header. Friction of the lead, e.g. because of continued contact with the ICD case, has been described earlier as a mechanism for insulation failure; the spot of molten titanium exactly at the ICD case’s edge supports this view as it probably indicates the point of case-lead contact and is a result of the high current density during short circuiting.

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References


Figure 1  Lead insulation defect and ICD case defect (white arrows).