CASE REPORT

High voltage lead failure diagnosed at upgrade of single-chamber ICD to dual-chamber ICD with CRT

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We describe a case of defibrillation lead damage which was detected only during an upgrade procedure from single-chamber ICD to dual-chamber ICD with biventricular pacing. The damage was not detected during routine checks in the ICD clinic.

KEYWORDS
Lead failure; Biventricular pacing; Implantable cardioverter-defibrillator

Case report

A male patient aged 58 years with history of anterior and inferior myocardial infarction in 1992 and coronary artery bypass grafting in 1996 had received a single-chamber ICD (Phylax XM, Kainox RV 75 lead, Biotronik, Berlin, Germany) in January 1999 due to symptomatic episodes of ventricular tachycardia (VT). On that occasion, the patient was symptomatically in New York Heart Association (NYHA) class II with a left ventricular ejection fraction (EF) of 30%. Until January 2005, he suffered three episodes of VT (180–200/min) converted by 20 J shocks and five episodes of fast VT recorded in the ventricular fibrillation (VF) zone converted by 26 J shocks. The defibrillation impedance ranged from 35 to 47 ohm. From 2002, heart function has gradually worsened. In February 2005, the patient was hospitalized on three occasions due to deterioration of heart failure to NYHA IV. Improvement to NYHA III with an EF = 15% was achieved on last hospitalization with administration of cilazapril, carvedilol, furosemide, and spironolactone. ECG showed regular sinus rhythm, 90 bpm, features of old anterior and inferior myocardial infarction, and QRS duration of 135 ms. Cardiac transplantation was considered. Echocardiographic studies confirmed inter- and intraventricular dyssynchrony and cardiac resynchronization therapy (CRT) was selected.

The single-chamber ICD, implanted 6 years before, was explanted. A unipolar left ventricular (LV) lead (Attain OTW, Medtronic Inc., Minneapolis, MN, USA) via percutaneous left subclavian approach was implanted. The lateral cardiac vein was used as the site of LV stimulation. An atrial lead was introduced via the same access and placed in the right atrial appendage (Figure 1). Satisfactory pacing parameters were achieved (pacing threshold <0.5 V; 0.4 ms for both leads). Pacing threshold and resistance of LV lead were checked only in unipolar configuration. A dual-chamber ICD with CRT function (Insync III Protect, Medtronic) was implanted. During the upgrade procedure, no defibrillation test was performed because the last spontaneous appropriate shock was effective with correct defibrillation impedance and the procedure did not involve the defibrillation lead.

After the placement of the new ICD in the pocket, the parameters of all leads were checked. Atrial and right ventricular lead (bipolar pace/sense channel of defibrillation lead) showed pacing threshold and sensing similar to external measurements. The LV lead, however, showed impedance >2500 ohm with no capture. Therefore, the lead was disconnected and again checked by the external analyzer showing pacing threshold to be <0.5 V; 0.4 ms and impedance 830 ohm. Radiologically, the lead position had not moved in three projections. Our conclusion was that the LV pacing channel in the ICD was faulty. We decided to implant another device (Insync III Protect) which again showed no LV pacing and high impedance (>2500 ohm). Therefore, we checked other LV pacing configurations: LV tip–RV tip, LV tip–RV ring, and LV tip–RV coil. We found that the LV was not paced only with LV tip–RV coil configuration, but this particular configuration was the only one available in the Insync III Protect ICD (apart from LV tip–LV ring for a bipolar LV lead). This explained the lack of pacing by the new ICD, but of great importance, it gave evidence of failure of the high voltage lead, necessary for defibrillation. Failure of the defibrillation lead was demonstrated by a low energy (1 J) test synchronized shock. Dissection of the extravascular part of the lead...
showed a fracture of the high-voltage conductor without damage to the insulation at 7 cm from ICD within the pocket. At that site, high-voltage and pace/sense channels were separate: the pace/sense conductor was intact. An attempt to remove the lead was unsuccessful; thus, the lead was cut, insulated, and sutured to the fascia. Through subclavian approach, a new active fixation twin-coil lead (Sprint Fidelis 6949, Medtronic) was placed at the right ventricular mid-septum (Figure 2). Satisfactory RV pacing and sensing parameters (pacing threshold 0.9 V; 0.4 ms impedance 870 ohm, R-wave 11.2 mV) as well as LV pacing (configuration LV tip–RV coil, pacing threshold <0.5 V; 0.4 ms, impedance 750 ohm) were achieved. During defibrillation testing, a 20 J shock converted induced VF to sinus rhythm. The patient was discharged home 3 days later with effective biventricular pacing. At 3 and 6 months follow-up, he showed 99.5% biventricular pacing and improvement to NYHA II. His distance on the 6 min walking test improved from 165 m before to 350 m 6 months after CRT.

Discussion

In this case, damage to the defibrillation lead was detected only during the upgrade procedure from single-chamber ICD to dual-chamber ICD with biventricular pacing. The damage was not detected during routine checks in the ICD clinic. Thus, despite having ICD, our patient was not protected from life-threatening arrhythmias. The last effective shock was delivered approximately 1 year before the upgrade procedure. On that occasion, the ICD had given the programmed energy with a normal charge time and defibrillation impedance. There were no indications of damage to the lead including a lack of episodes of noise sensing. The precise moment of lead damage cannot be established. Checking the defibrillation lead with a low energy test shock (~1 J) is not a routine part of outpatient assessment of an ICD. So the question arises: are we able to detect damage to high-voltage leads without test shocks in outpatient clinics? The Phylax XM (Biotronik) cardioverter-defibrillator with a Kainox RV 75 lead provides no such possibility. The Kainox RV 75 lead uses the tip-ring configuration, i.e. a real bipolar system for detection of arrhythmia and pacing. The RV coil–can circuit may be checked only on shocks. With a tip–coil configuration of detection and pacing (quasibipolar circuit, integrated bipolar), disruption of the RV coil–ICD may be found by making the simple measurement of pacing impedance or threshold. Such configuration of poles is found in Sprint Model 6942 leads (Medtronic) which have already been replaced by leads with real bipolar detection and pacing circuit (Quattro or Sprint Fidelis 6949).

Total lead-related complications in patients with pectoral ICD implantation and endocardial leads occurred in up to 12% of patients. Lead fractures alone are less common, 0.9% in the series of Gallik et al. Two particular sites of lead fracture were noted, i.e. one at the clavicle, first rib junction, and the other within the generator pocket. In our patient, lead conductor fracture occurred within the pocket and was probably related to friction with the can. Detection of high-voltage lead conductor fracture in true bipolar defibrillation lead without defibrillation testing is difficult. Stevens et al. described a case of a patient in whom intraoperative defibrillation threshold test and high-voltage impedance did not show lead fracture (Transvene 6936-65, Medtronic, true bipolar), but the painless lead impedance measurement function of the ICD activated the alarm, showing lead damage.

Analysis of this case provides some practical advice: on all occasions of ICD replacement or upgrade, a low-energy test

![Figure 1](https://example.com/f1.png)  
Figure 1 Posterior-anterior view of chest X-ray showing original single-coil defibrillation lead, atrial lead in the right atrial appendage, and unipolar LV lead in the lateral cardiac vein.

![Figure 2](https://example.com/f2.png)  
Figure 2 Posterior-anterior view of chest X-ray showing original single-coil defibrillation lead, atrial lead in the right atrial appendage, unipolar LV lead in the lateral cardiac vein, and a new active fixation twin-coil lead (Sprint Fidelis 6949, Medtronic) placed at the right ventricular mid-septum.
shock of the defibrillation lead should be performed; moreover, measurements of threshold, sensitivity, and impedance should be performed with the lead configurations available in each ICD, not only with classic unipolar pacing.

References