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LATE LEAD FAILURE IN CARDIAC IMPLANTABLE ELECTRONIC DEVICES: "CATASTROPHIC IF MISSED"

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Abstract

Late lead failure in cardiac implantable electronic devices (CIED) pose a significant clinical challenge and has life threatening consequences. The etiology is multifaceted and can be due to patient specific factors, external mechanical stress or lead characteristics. Diagnosing a lead failure typically involves device interrogation, electrogram monitoring and imaging studies. Treatment often requires either lead revision or replacement. Lead related reintervention is the most common complication after CIED implantation and carries a higher risk of infection. Proactive monitoring is essential to ensure patient safety. We have discussed two cases of late lead failure which were diagnosed and managed by lead revision without extraction.

Categories: Cardiology
Keywords: Late lead failure, lead conductor fracture, lead insulation breach

Introduction

Cardiac Implantable electronic devices (CIED) such as permanent pacemakers and automated implantable cardiac defibrillators (AICD) used in the heart rhythm management have undergone significant advances in technology. Structural integrity of transvenous endocardial leads is essential for effective pacing, sensing and defibrillation therapy.[1] Despite recent advances, lead failure after device implantation leading to device malfunction pose significant challenges and life threatening consequences compromising patient safety. Lead related reintervention is the most common complication after device implantation and carries a higher risk of infection compared to first intervention.[2] We present two cases of late lead failure which were managed with lead revision without extraction.

Case Series

CASE 1: A 58 year old male who is a known ischemic heart disease with moderate to severe Left ventricular systolic dysfunction (LVEF-34%). He underwent single chamber AICD implantation elsewhere for recurrent ventricular tachycardia in 2014 and pulse generator replacement in April 2021 with Evera XT VR device (Medtronic, USA). Post procedure review was satisfactory as regards to lead and battery status. After 3 years, he presented with recurrent CIED alerts/alarms from the device. Device interrogation revealed high pacing impedance (>3000 ohms) and high pacing threshold. His chest radiograph and interrogation parameters were suggestive of lead conductor fracture (Fig. 1). Hence the patient underwent revision of AICD lead. Old lead was coiled, capped and kept inside the pocket. New AICD lead (Sprint Quattro MRI Sure scan, Medtronic, USA) was positioned in the right ventricular mid-septum and connected to the old pulse generator. Procedure was uneventful and the patient is doing well at 3 month follow up with satisfactory device and lead parameters.

CASE 2: A 73 year old male who is a known diabetic and hypertensive with adequate Left ventricular systolic function (LVEF-61%) underwent dual chamber permanent pacemaker implantation with Accent MRI device with Tendril MRI Right atrial and right ventricular leads (St Jude Medical, USA) in DDD mode for complete heart block in October 2012. He presented to the out patient department with giddiness and palpitation for one week with an episode of syncope. Device interrogation revealed predominantly atrial sensed and ventricular paced rhythm in DDD mode with elective replacement indication (ERI) and electrogram showing high ventricular rate episodes of high frequency with noise reversion. Right ventricular lead impedance was 410 ohms with threshold of 0.62V/0.4ms. His chest radiograph was suggestive of lead integrity breach (Fig. 2). Despite no drastic change in RV lead impedance and threshold, these observations were highly suggestive of lead failure. Hence with temporary pacemaker backup, he underwent successful pulse generator replacement and right ventricular lead revision by extra thoracic axillary vein approach. Lead was placed in the lower right ventricular septum. Old right ventricular lead was coiled, capped and kept inside the pocket. Procedure was uneventful and the patient is on regular follow up for the last 2 years with satisfactory device and lead parameters.

Discussion

CIED leads contain conductors in a silicone cylinder coated with polyurethane, fluoropolymers (PTFE, ETFE), silicone or copolymer like optin. AICD leads are of multi lumen design with 3 to 6 lumen of conductors for the pacing anode ring and high voltage coils arranged as parallel cables surrounding the central cathode tip coil. In bipolar pace-sensing leads, cathode tip and anode ring conductors are placed either coaxially as a tube inside a tube or coradially as side by side coils. The central cathode tip coil is used for stylet insertion and the extension/retraction of fixation helix. AICD leads commonly use DF-4 or DF-1 connection pins whereas the bipolar pace sensing leads use IS-1 connection pins.[1,3,4]

Despite advances in lead design, insulator materials and technology, lead failure in CIED remains a challenge. Incidence of Lead failure ranges from 1 to 4% in currently implanted leads.[2-4] Lead failure can be due to lead dislodgement, loose screws, insulation breach, conductor fracture and exit blocks. Early lead failure is commonly due to lead dislodgement and loose header connection pins on the pulse generator whereas late lead failure is commonly due to insulation breach and conductor fracture.[5] Steroid eluting leads have significantly reduced exit block due to scar formation or calcium deposition at the lead myocardial interface.[2]

Most lead damages occur due to “subclavian crush syndrome” in the area adjacent to the venous entry site due to compression of lead between the clavicle and the first rib or entrapment of the lead between the soft tissue in the costoclavicular space. Extra thoracic axillary vein approach reduces the risk of entrapment.[6,7] Lead failure have also been reported following weightlifting, excessive movement of the upper limbs and direct trauma.[8-11] Young patients are at increased risk of lead failure due to vigorous physical activity.[12]

Diagnosing a lead failure typically involves device interrogation, electrograms and imaging studies to confirm the defect and assess its impact on device function. A high index of suspicion is warranted if patient is symptomatic. The characteristic indicators of lead failure include abnormal sensing amplitudes, abnormal pacing threshold and lead impedance abnormalities.[1,3,4] Conductor fracture causes high frequency non-physiological noise in electrogram caused by intermittent contact between disrupted conductor elements and abrupt rise in lead impedance. An insulation breach exposes the conductors causing oversensing of surrounding myopotentials and can cause fall in impedance.[13,14]

Effective management involves both immediate and long-term interventions. Immediate measures may involve programming to asynchronous or unipolar mode to avoid inadvertent shock and temporary pacing in those presenting with symptomatic bradycardia. Long-term management requires either lead revision or lead extraction and replacement. Lead extraction may be considered in cases where the failed lead is detected in the background of infection or other complications. Lead extraction of a chronic lead carries potential complications like perforation, tear or rarely death. However, lead abandonment with placement of a new lead may be performed safely.[1,3,4,14]

Conclusion

Late lead failure in CIED presents significant risks and life threatening consequences in patients with pacemakers and AICDs. The causes are multifaceted, involving mechanical stress, lead characteristics and patient specific factors. Prompt diagnosis through device interrogation, electrogram monitoring and radiologic imaging is critical for early diagnosis and effective management. Treatment often requires either lead revision or replacement. Advances in lead technology and proactive monitoring are essential to reduce the incidence of lead failure and ensure patient safety.

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The authors have no competing interest.

Consent:

Informed consent obtained for data collection and publication from the patients.

Consent:

None

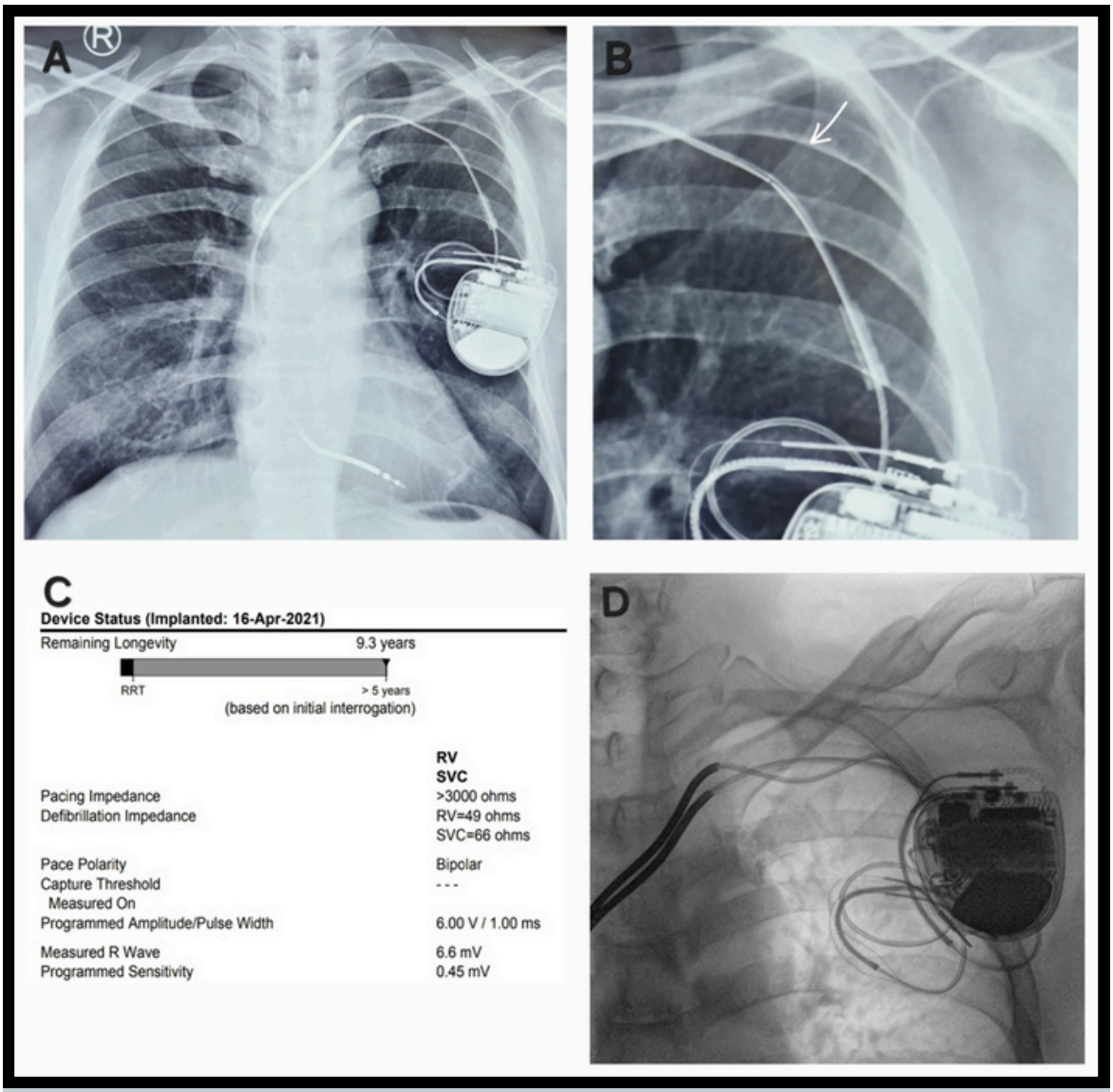

Fig. 1: Case 1. (A) Chest radiograph showing the AICD device and right ventricular lead in situ. (B) Zoomed view of the chest radiograph showing damage (white arrow) in the AICD lead. (C) Device interrogation showing high pacing impedance suggestive of lead conductor fracture. (D) Fluoroscopy post lead revision showing device with capped old lead and functional new lead.

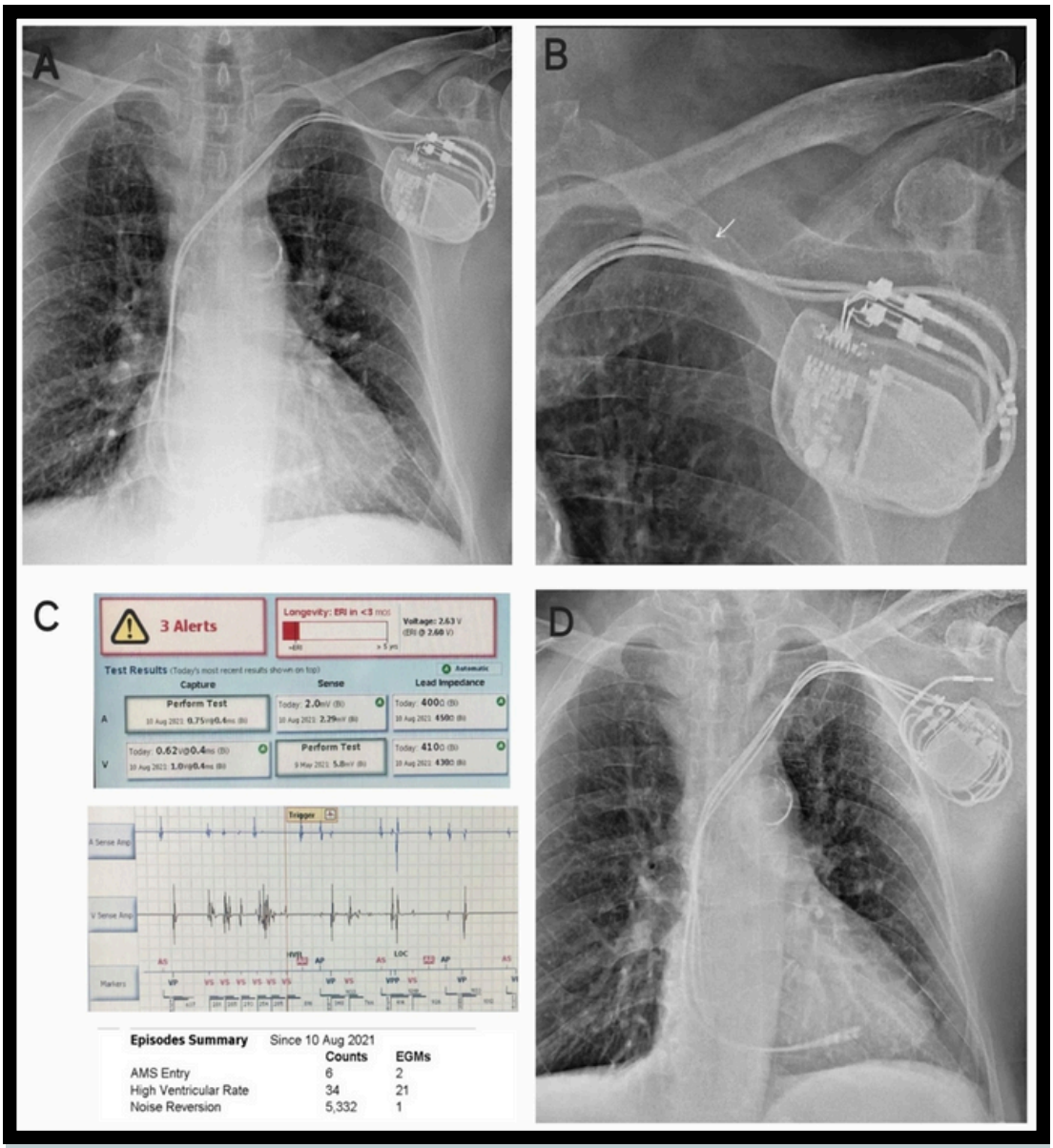

Fig. 2: Case 2. (A) Chest radiograph showing the pacemaker device with right atrial and right ventricular leads in situ. (B) Zoomed view of the chest radiograph showing damage (white arrow) in right ventricular lead. (C) Device interrogation showing high ventricular rate alert with noise reversion suggestive of lead failure. (D) Chest radiograph post right ventricular lead revision showing capped old right ventricular lead and functional right atrial and new right ventricular leads.

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