External Insulation Breach near the Tip of a Single Ventricular Pacing Lead

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ABSTRACT. External insulation breach was observed near the tip after a ventricular pacing lead was extracted for possible infective endocarditis with gentle traction alone 2 years post implantation. After eliminating all the impossible causes, “inside-out” abrasion appears as the most plausible explanation. Such a modality of lead failure has only previously been reported with defibrillation but not pacing leads. The exact mechanisms, prevalence, detection and management of this modality of pacing lead failure warrant further investigation.

KEYWORDS. external insulation breach, inside-out abrasion, pacing lead failure.

Case report

A 75-year-old man with permanent atrial fibrillation had a single chamber ventricular permanent pacemaker system implanted for high-degree heart block post transcatheter aortic valve implantation. A single pacing lead (Tendril ST 1788/ST) was positioned on the high right ventricular (RV) septum (Figure 1). Two years later, he presented with Staphylococcus aureus septicemia. On transesophageal echocardiography (TEE), the pacing lead could be clearly traced to the RV septum with no mass attached to it (Figure 2a). The tricuspid valve (TV) opened well (Figure 2b) but had severe regurgitation (Figure 2c). A mobile mass was attached to RV septum (Figure 2d) but could not be shown to be associated with the pacing lead. The pacemaker was functioning within acceptable limits on interrogation (impedance 309 Ω; sensed R wave 10.7 mV; pacing threshold <1 V at 0.4 ms) and its lower rate was reduced to 30 bpm. The patient’s was found to have an adequate underlying rhythm and required only minimal pacing support. In view of his ongoing sepsis and minimal dependence on his pacemaker, despite uncertainty whether the mass identified on TEE was a vegetation or thrombus, it was decided the entire pacemaker system including the lead should be explanted. During the procedure, the pacing lead was freed up to the anchorage sleeve by dissection. A stylet could only be advanced 19 cm into the lead lumen. The fixation screw was retracted by rotating the distal pin. The whole lead was then extracted with gentle traction without any powered tools or extraction sheaths. When the extracted lead was inspected, an area of external insulation breach due to a defect in the insulation material with adjacent brownish discoloration was found at 4 cm from the lead tip (Figure 3). The wound was closed up. There were no procedure-related complications and the patient continued with his antibiotic therapy.

Discussion

Insulation defects cause the majority of pacing lead failure and are commoner with polyurethane than silicone materials. Adverse clinical events occur in up to 16% of lead failure cases, but may be averted if impending lead failure is detected at routine follow-up. This is not always possible as some lead defects only manifest with electrical anomalies (lead noise, over- or undersensing, high capture threshold or non-capture, out-of-range impedance, muscle twitching) intermittently. Lead extraction has a complication rate of 5.6% and the potential of causing death.
Figure 1: Chest radiograph post permanent pacemaker implantation. A single ventricular lead was positioned with its tip of the high right ventricular septum. A transcatheter aortic valve (TAV) was in place and anatomically distant from the pacing lead.

Figure 2: Transesophageal echocardiogram of the heart. (a) The pacing lead could be clearly traced to the right ventricular (RV) septum with no vegetation attached to the lead body. (b) The tricuspid valve leaflets were thin and mobile. (c) Severe tricuspid regurgitation during ventricular systole. (d) A mobile mass attached to the RV septum in the transgastric short axis view.
The external insulation breach in this case was near the tip of a single ventricular pacing lead and could not have been caused by “outside-in” abrasion against another lead (none existed) or the transcatheter aortic valve (in the left heart). The TV leaflets were in constant physical contact with the lead but they were thin and freely mobile (Figure 2), and the lead was not tethered to the RV endocardial surface by extensive fibrosis (which would have prevented lead extraction by gentle traction alone). Unlike polyurethane, silicone (the material used for external insulation in the lead) is resistant to biological degradation, and hence the insulation breach was unlikely to have been caused by either bacterial infection or the resulting immune/inflammatory responses. This leaves “inside-out” abrasion as the most plausible (and only) explanation. Inside-out abrasion has been extensively reported with a particular family of defibrillation leads (Riata, St. Jude Medical, St Paul, MN) but not with a pacing lead before. Why particular lead models are more prone to inside-out abrasion than others is not entirely clear and under active investigation, but the type of silicone used for insulation may be a factor. Interestingly, in this case, the external insulation breach was caused by a defect rather than a tear in the insulation material (Figure 3).

The external insulation breach in this case occurred just 2 years post lead implantation, was electrically largely “silent” (except for the relatively low impedance, the lead was sensing and pacing normally) and only incidentally identified when the lead was extracted for an unrelated reason. The brownish discoloration around the external insulation breach was most probably due to hemosiderin deposition from denatured blood within the lead body. Blood had most probably seeped into and blocked the inner conductor coil lumen, preventing stylet insertion and making lead extraction more difficult. Bipolar ventricular pacing still produced ventricular capture as electrical currents from the tip electrode could return through either the ring electrode or the exposed segment of its conductor coil to complete the circuit. Ventricular sensing was not compromised. However, based on previous experiences, major clinical adverse events related to the structural integrity compromise of the pacing lead could have occurred.

In conclusion, an unusual case of external insulation breach near the tip of a pacing lead has been described. Inside-out abrasion appears as the most plausible explanation. The exact mechanisms, prevalence, detection, and management of this modality of pacing lead failure warrant further investigation.

References
