A case of pacemaker dysfunction due to interference from a stent placed in the subclavian vein

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Introduction

Insulation failure is a common cause of permanent pacemaker and implantable cardioverter-defibrillator lead failure.[1–3] Most insulation failures occur inside the pacemaker pocket, from the connector to the venous entry, often implying compression between the clavicle and first rib.[4,5] Damage to leads in this region are known to be often caused by soft tissue entrapment and repetitive movements rather than true bone contact.[6] Lead dysfunction caused by mechanical contact with the leads has also been reported, although rarely.[4,5]

In hemodialysis patients, venous occlusion on the arteriovenous fistula side may cause swelling of the upper limbs and difficulty in hemodialysis. Angioplasty and stent placement in the treatment of subclavian and brachiocephalic vein stenosis and occlusion are an alternative to surgical options, which are limited owing to the morbidity associated with the exposure and repair of these deep thoracic veins.[7–9]

Here, we describe a rare case of pacemaker dysfunction due to postoperative interference of the stent with the leads in a patient with right-sided dual-chamber pacemaker implantation who underwent endovascular treatment for occlusion of the left subclavian vein.

KEY TEACHING POINTS

- Stent migration and pacemaker failure may occur when stents are used in close proximity to pacemaker leads.
- When a stent is implanted, it should be placed as far away from the lead as possible and followed up with periodic imaging and remote monitoring of the pacemaker.
- Leadless pacemakers may be more useful in hemodialysis patients because of a high incidence of vascular problems.

Case report

This 71-year-old male patient had a history of angina pectoris, peripheral arterial disease, diabetes, hypertension, and chronic renal failure. Hemodialysis was started when he was 55 years old. The arteriovenous fistula was created in the left forearm. At age 68, a dual-chamber pacemaker (generator, Assurity MRI™; atrial lead, 2088TC-46; ventricular lead, 2088TC-52; all Abbott Medical Inc; Abbott Park, IL) was implanted for complete atrioventricular block. Lead profile at implantation was ventricular lead impedance 440 Ω, atrial lead impedance 390 Ω, atrial wave amplitude 3 mV, ventricular pacing threshold 0.75 V at 0.4 ms, and atrial pacing threshold 0.5 V at 0.4 ms. Postimplantation course was good, but swelling in the left upper limb developed at age 69 years. A computed tomography (CT) scan showed stenosis of the subclavian vein. Endovascular treatment was performed, and S.M.A.R.T. (Cordis Corporation, Miami Lakes, FL) stents (14 × 60 mm and 14 × 40 mm) were implanted from the left brachiocephalic vein to the subclavian vein. Stent size was determined following confirmation of distal vessel diameter by intravascular ultrasound. The stent was placed at the junction of the left brachiocephalic vein and the superior vena cava using intravascular ultrasound. Fluoroscopic images during treatment and postoperative chest radiographs showed that the stent and the pacemaker lead were separated (Figure 1A and Supplemental video). After the procedure, the swelling of the left upper extremity improved. More than 1 year after the procedure, however, the ventricular lead impedance decreased (<180 Ω), and a pause associated with oversensing of the ventricular leads was recorded on routine electrocardiography (Figure 2A). Chest

KEYWORDS Endovascular stent; Hemodialysis; Lead extraction; Leadless pacemaker; Pacemaker dysfunction; Stent migration
(Heart Rhythm Case Reports 2021;7:722–725)

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. All authors have no conflicts of interest to disclose. **Address reprint requests and correspondence:** Dr Masaharu Masuda, Kansai Rosai Hospital Cardiovascular Center, 3-1-69 Inabaso, Amagasaki, 660-8511, Japan. E-mail address: masuda-masaharu@kansaih.johas.go.jp.

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https://doi.org/10.1016/j.hrcr.2021.07.014

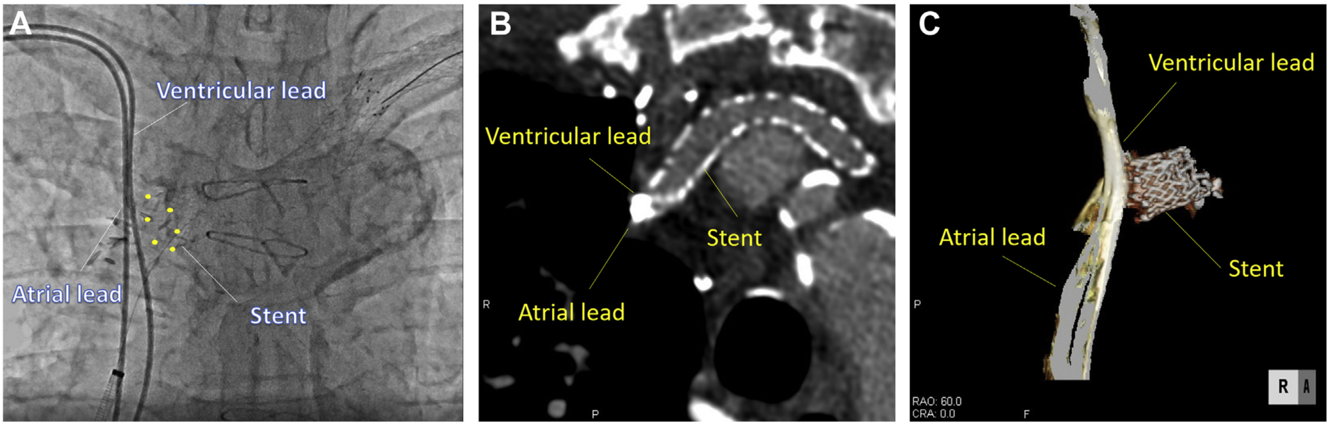

Figure 1 **A:** Fluoroscopic image during endovascular treatment. The yellow dots highlight the edge markers of the implanted stent. In this image, the stent and lead are separated by a sufficient distance. **B:** Computed tomography (CT) image showing contact between the lead and stent. **C:** CT image with 3-D reconstruction also shows contact between the lead and stent.

radiograph and CT scan revealed that the pacemaker leads and the stent were in extremely close proximity to each other (Figure 1B). Checking the intracardiac electrocardiogram with the patient supine on the examination table revealed noise (Figure 2B). This was considered due to interference of the stent with the pacemaker leads, resulting in oversensing by the leads.

The patient was admitted for extraction of the pacemaker and implantation of a leadless pacemaker, which were performed in the hybrid operating room under general anesthesia. Intracardiac echocardiography was conducted via the right femoral vein. The stent and the lead were visualized, and the edge of the stent and the lead were found to be in contact. This contact between the stent and lead was confirmed by fluoroscopic imaging. The atrial and ventricular leads were locked using a locking stylet (atrial lead, LLD EZ™; Philips, Andover, MA; ventricular lead, Liberator™; Cook Medical Inc, Bloomington, IN) through the inner coil lumen. A 12F laser sheath (GlideLight™, Philips) was advanced over the leads and tied with 2 sutures on the insulation. The screw of the atrial lead could not be completely retracted, so a snare catheter was inserted through the right femoral vein, grasped at the tip, and extracted while trying not to trap the stent. The 2 leads could be fully extracted by gentle traction using a laser sheath. After confirming the absence of pericardial effusion by transesophageal echocardiography, a leadless pacemaker (Micra™; Medtronic Inc, Minneapolis, MN) was subsequently implanted through the right femoral vein into the right ventricular apex septum. The extracted pacemaker lead showed insulation damage that was probably caused by the stent edge (Figure 3). The postoperative period passed without complication, and the patient was discharged on the fourth postprocedure day.

Discussion

To our knowledge, this is the first case in which a stent placed in the subclavian vein caused capsular damage to a pacemaker lead, leading to sensing failure associated with oversensing owing to lead noise.

In patients receiving chronic hemodialysis, stenosis or occlusion of the central and proximal veins results in considerable edema of the arm and vascular access that is unable to drain normally. This is a formidable problem because it very often necessitates closing the vascular access, which is sometimes the last one available.[7–9] The presence of pacemaker electrodes in the subclavian vein and the flow associated with hemodialysis may accelerate the occurrence of subclavian venous stenosis and occlusion.[10]

In this case, endovascular treatment was performed for occlusion of the left subclavian vein, which was discovered after swelling of the left hand. About a year and a half after the endovascular treatment, however, the pacemaker lead insulation was damaged by the stent and noise oversensing occurred. During the endovascular treatment, the stent had been implanted with care to prevent contact with the pacemaker lead. However, the CT scan showed that the edge of the stent was in fact in contact with the lead, suggesting that the distance between the stent and lead had been shortened by body movement after stent placement. Physiologically, the brachiocephalic vein is almost closed in its course between the sternum and aortic arch during normal inspiration, and the subclavian vein is markedly narrowed at the thorax outlet during upper limb abduction. This anatomical background highlights the need to consider the possibility of migration or fracture during stent placement in this area.[11,12] Selection of a stent with sufficient diameter to prevent it moving downstream and placement at a sufficient distance upstream of the lesion for anchorage are necessary.[13]

In recent years, transvenous excimer laser–assisted lead extraction of cardiac implantable electrical devices has become a safe procedure for the elderly.[14] In our present case, the damage caused by the stent was limited to the insulation, so the leads could be removed without any residual parts. However, if the leads had been severely fractured, complete removal may have been difficult. Retention of the leads

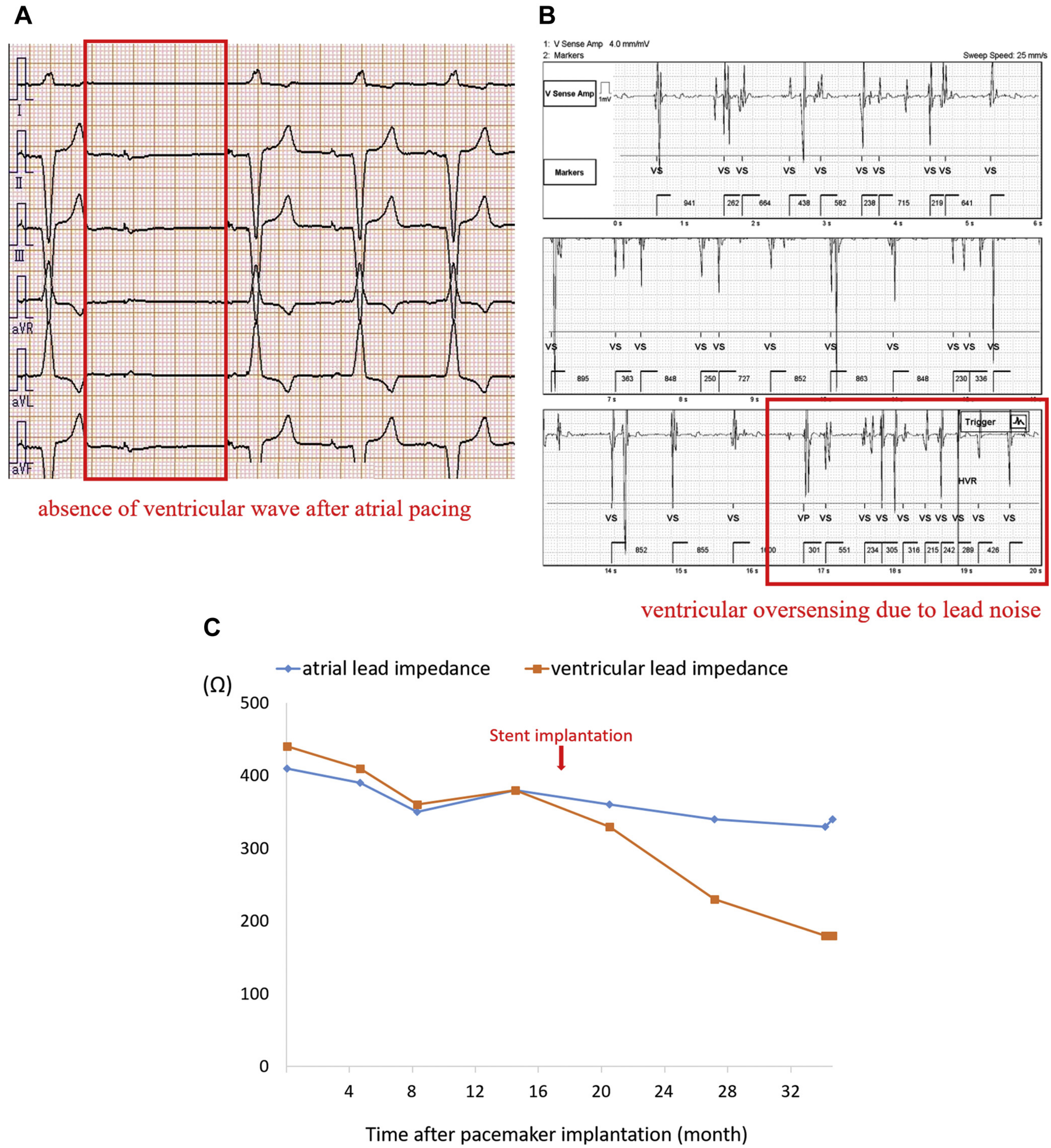

Figure 2 **A:** A 12-lead electrocardiogram with pacing failure. **B:** Noise in the intracardiac electrocardiogram recorded by pacemaker interrogators. The noise was induced when the patients rolled over on the examination table. **C:** Changes in lead impedance after pacemaker implantation. The ventricular lead impedance was gradually decreasing after the endovascular therapy.

in the body would result in the inability to perform magnetic resonance imaging testing or might have increased the risk of future narrowing and obstruction of the central vein.[10] In our case, there was a decrease in lead impedance in the ventricular lead over time after the endovascular treatment (Figure 2C). Presumably, capsular damage had begun to occur at the same time. We noted that the sensing failure was associated with oversensing owing to intermittent noise. Failure to detect such failure can lead to fatal adverse events, such as fainting. Here, after discovering the decrease in lead impedance, we shortened the interval for outpatient follow-up to cope with the problem, but this could have been managed more safely if remote monitoring had been available.

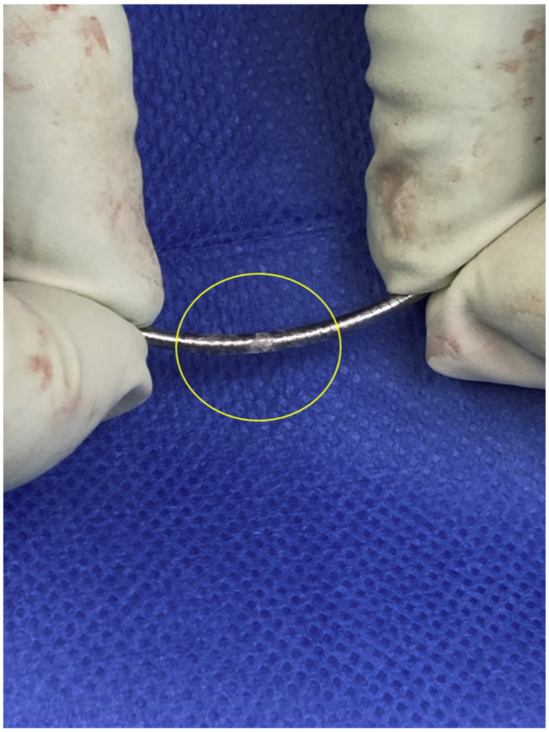

Figure 3 Picture of the extracted ventricular lead. The yellow circle shows insulation damage considered caused by the stent edge.

We finally selected to implant a leadless pacemaker, which is an effective therapy in the management of hemodialysis patients with bradycardia.[15] Leadless pacemakers avoid the problems associated with leads and are a useful option for patients on dialysis, in whom venous obstruction can be a major problem.

In summary, this case highlights the need to be aware of the possibility of interference between stent and leads in endovascular therapy for subclavian vein occlusion in patients with a cardiac implantable electronic device. If stent placement near the lead is unavoidable, it should be strictly monitored, such as by remote monitoring system, and the relationship between the stent and the lead should be checked frequently on chest radiography. Selection of a larger and longer stent—with due care to avoid vessel damage—may help prevent stent dislodgement.

Conclusion

We report a case of lead insulation damage caused by stents that resulted in pacemaker dysfunction. Endovascular treatment of subclavian vein occlusion in hemodialysis patients after pacemaker implantation requires careful treatment and follow-up management to avoid possible interference between the lead and stent.

Appendix

Supplementary data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.hrcr.2021.07.014.

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