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

Takashi Kanda, MD,* Hitoshi Minamiguchi, MD,† Masaharu Masuda, MD, PhD,* Kiyonori Nanto, MD, * Kotaro Suemitsu, MD,‡ Toshiaki Mano, MD, PhD*

From the *Kansai Rosai Hospital Cardiovascular Center, Amagasaki, Japan, †Department of Cardiology, Osaka Police Hospital, Osaka, Japan, and ‡Division of Kidney and Dialysis, Department of Internal Medicine, Kansai Rosai Hospital, Amagasaki, Japan.

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.4 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.

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/C212; 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 to the subclavian vein. Stent placement was followed with periodic imaging and remote monitoring of the pacemaker.

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.

KEYWORDS
Endovascular stent; Hemodialysis; Lead extraction; Leadless pacemaker; Pacemaker dysfunction; Stent migration

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.

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

In recent years, transvenous excimer laser–assisted lead extraction of cardiac implantable electrical devices has become a safe procedure for the elderly. 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
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.\textsuperscript{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 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.
We finally selected to implant a leadless pacemaker, which is an effective therapy in the management of hemodialysis patients with bradycardia. 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.

**References**

1. El-Chami MF, Rao B, Shah AD, et al. Long-term performance of a pacing lead family: a single-center experience. Heart Rhythm 2019;16:572–578.
2. Fortescue EB, Berndt CL, Cecchin F, Walsh EP, Friedman JK, Alexander ME. Patient, procedural, and hardware factors associated with pacemaker lead failures in pediatrics and congenital heart disease. Heart Rhythm 2004;1:150–159.
3. Sverdlow CD, Kalahasty G, Ellenbogen KA. Implantable cardiac defibrillator lead failure and management. J Am Coll Cardiol 2016;67:1358–1368.
4. Clarke B, Jones S, Gray HH, Rowland E. The tricuspid valve: an unusual site of endocardial pacemaker lead fracture. Pacing Clin Electrophysiol 1989;12:1077–1079.
5. Scirica A, Mondoly P, Voglmaci-Stephanopoli Q, Mandel F, Maury P. Mechanical conflicts at the tricuspid level. J Am Coll Cardiol 2016;67:1358–1368.
6. Clarke B, Jones S, Gray HH, Rowland E. The tricuspid valve: an unusual site of endocardial pacemaker lead fracture. Pacing Clin Electrophysiol 1989;12:1077–1079.
7. Aytekin C, Boyvat F, Yagmurder MC, Moray G, Haberal M. Endovascular stent placement in the treatment of upper extremity central venous obstruction in hemodialysis patients. Eur J Radiol 2004;49:81–85.
8. Maskova J, Komarkova J, Kivanek J, Danes J, Slavikova M. Endovascular treatment of central vein stenoses and/or occlusions in hemodialysis patients. Cardiovasc Intervent Radiol 2003;26:27–30.
9. Vesely TM, Hovsepian DM, Pilgram TK, Coyne DW, Shenoy S. Upper extremity central venous obstruction in hemodialysis patients: treatment with Wallstents. Radiology 1997;204:343–348.
10. Teruya TH, Abou-Zamzam AM Jr, Limm W, Wong L, Wong L. Symptomatic subclavian vein stenosis and occlusion in hemodialysis patients with transvenous pacemakers. Ann Vasc Surg 2003;17:526–529.
11. Eguchi D, Homma K. Results of stenting for central venous occlusions and stenoses in the hemodialysis patients. Ann Vasc Dis 2020;13:235–239.
12. Hammer F, Becker D, Goffette P, Mathurin P. Crushed stents in benign left brachiocephalic vein stenoses. J Vasc Surg 2000;32:392–396.
13. Verstandig AG, Bloom AI, Sasson T, Haviv YS, Rubinger D. Shortening and migration of Wallstents after stenting of central venous stenoses in hemodialysis patients. Cardiovasc Intervent Radiol 2003;26:58–64.
14. Yagishita A, Goya M, Sekigawa M, et al. Transvenous excimer laser-assisted lead extraction of cardiac implantable electrical devices in the Japanese elderly population. J Cardiovasc Intervent Radiol 2020;75:410–414.
15. El-Chami MF, Clementy N, Garweg C, et al. Leadless pacemaker implantation in hemodialysis patients: experience with the Micra transcatheter pacemaker. JACC Clin Electrophysiol 2019;5:162–170.