Extraction of a leadless pacemaker 28 months after implantation owing to right ventricular outflow tract obstruction

Kikou Akiyoshi, MD,* Koji Higuchi, MD, FHRS,*† Shinsuke Iwai, MD,* Yuko Ohnishi, MD*

*From the *Department of Cardiology, Hiratsuka Kyosai Hospital, Hiratsuka, Japan, and †Department of Cardiology, Cleveland Clinic, Cleveland, Ohio.*

Introduction

Micra transcatheter pacemakers (Medtronic, Fridley, MN) have been successfully implanted with a 99% success rate and reduced complications in clinical trials.[1] However, data regarding chronic management are not comprehensive, and some cases require removal or extraction. In this case report, a Micra leadless pacemaker (LP) implanted in the high right ventricular (RV) septum obstructed the right ventricular outflow tract (RVOT), causing right-sided heart failure in the chronic phase.

Case report

A 79-year-old woman with a small body size underwent LP implantation for a paroxysmal atrioventricular (AV) block. The implantation site was relatively high in the high RV septum, as shown in Figure 1A and 1B. The threshold was 0.88 V / 0.24 ms, the amplitude of the R wave was 13.4 mV, and the impedance was 1230 Ω. The pacing mode was set at a VVIR of 60–110/min. The bradycardia symptoms significantly improved after the procedure, and there were no heart failure symptoms immediately after the procedure.

However, the ventricular pacing burden increased from 16.1% to 89.2% over 15 months after implantation, and the patient presented with a systolic heart murmur with dyspnea on exertion 20 months after implantation. Echocardiography showed stenosis of the RVOT, RV pressure overload, and RV hypertrophy, which had not been previously observed, although her left ventricular systolic function remained within the normal range (Figure 1C). Computed tomography was performed, and the LP was located horizontally at the RVOT in the transverse view (Figure 1D). The LP appeared to obstruct the RVOT.

A right heart catheter revealed a maximum pressure gradient of up to 27 mm Hg between the pulmonary artery and the RV at the site of the LP implant (Figure 2C).

Given her significant right-sided heart failure symptoms and RV hypertrophy, a decision was made to extract the LP and resolve the obstruction to improve her heart failure symptoms, although this was in the chronic phase. Extraction was performed 28 months after implantation under general anesthesia with close observation of cardiac tamponade using a transesophageal echo.

The LP introducer sheath was advanced into the right atrium over a stiff wire through the right femoral vein. A large-curve steerable sheath (Agilis; Abbott Laboratories, St. Paul, MN) was introduced through a short 14F sheath that was placed in the LP sheath. A triple loop snare catheter (EN Snare, MeritMedical Systems, South Jordan, Utah) was introduced into the RV through the Agilis steerable sheath. A 6F long sheath was inserted via the left femoral vein, and another triple loop snare catheter (EN Snare) was introduced into the RV through the long sheath. The retrieval head of the LP was captured

KEY TEACHING POINTS

- Micra leadless pacemaker (LP; Medtronic, Fridley, MN) implanted in the high right ventricular (RV) septum can cause right ventricular outflow tract (RVOT) obstruction.
- Moreover, increased pacing burden of an LP implanted in the high right ventricular septum can cause RV hypertrophy with right-sided heart failure in chronic phase.
- This is a novel report of a case that required remote extraction of LP owing to chronic obstruction of RVOT, resulting in improved right-sided heart failure after successful removal.

KEYWORDS Leadless pacemaker; Extraction; Right ventricular outflow tract obstruction; Right-sided heart failure; Right ventricular hypertrophy

(Heart Rhythm Case Reports 2024;10:124–127)

Address reprint requests and correspondence: Dr Kikou Akiyoshi, Department of Cardiology, Hiratsuka Kyosai Hospital, Oiwake 9-11, Hiratsuka City, Kanagawa, #254-8502, Japan. E-mail address: klee.brown.524@gmail.com.

https://doi.org/10.1016/j.hrcr.2023.11.002

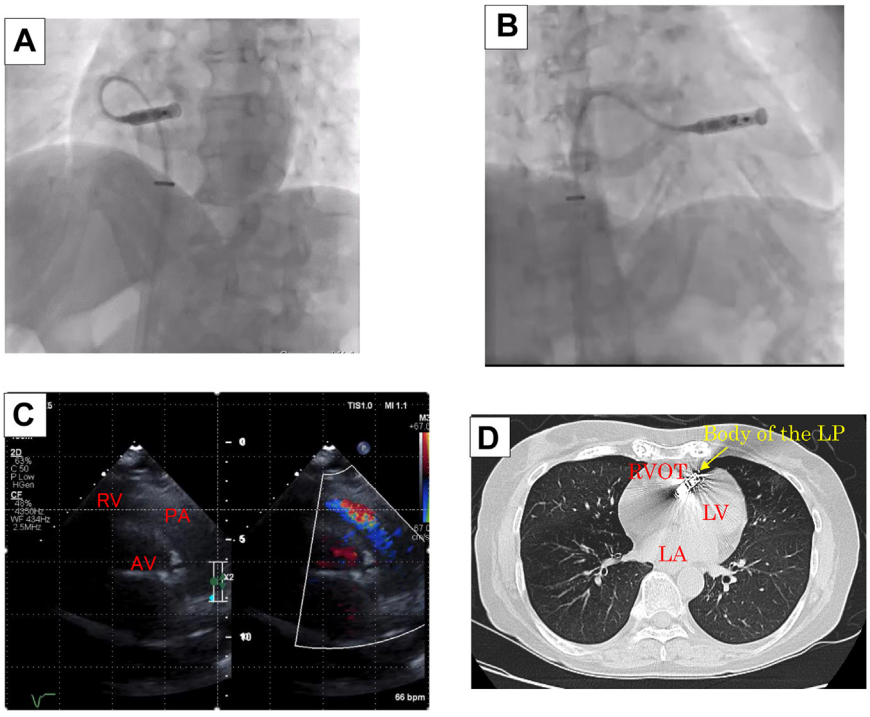

Figure 1 **A, B:** Fluoroscopic images of the location of a leadless pacemaker (LP) at the high right ventricle (RV) septum (**A:** left anterior oblique view; **B:** right anterior oblique view). **C:** Echocardiogram in the parasternal short-axis view 20 months after implantation, indicating turbulent flow at the right ventricular outflow tract (RVOT). The peak velocity was 2.1 m/s. **D:** Axial computed tomography image showing LP obstructing the RVOT. AV = aortic valve; LA = left atrium; LV = left ventricle.

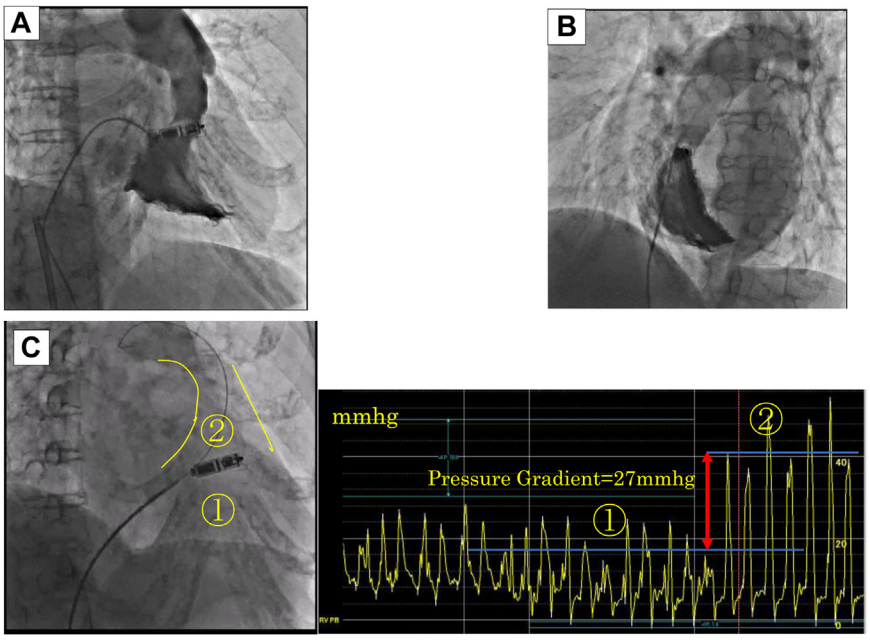

Figure 2 The fluoroscopic images of right ventriculography in the chronic phase. **A:** Systolic phase, right anterior oblique view. **B:** Systolic phase, left anterior oblique view. **C:** The pressure waveforms show a maximum pressure gradient of up to 27 mm Hg between (1) above the leadless pacemaker (LP) and (2) below the LP (red arrow).

using a snare from the steerable sheath, and the body of the LP was held using another snare from a 6F sheath under fluoroscopic guidance. The LP was successfully extracted by gentle manual traction using 2 snare catheters. The LP was retrieved into the LP sheath with the Agilis sheath and was removed from the body (Figure 3A–3D and Supplemental Video 1). After removal, the right heart catheter revealed a loss of the

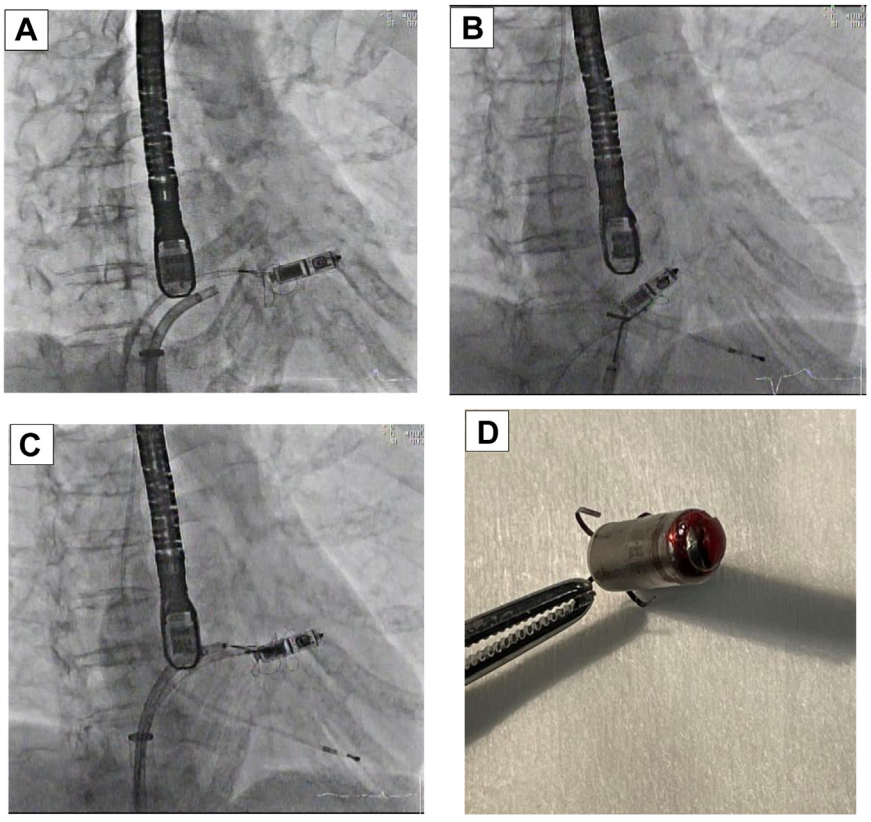

Figure 3 EN Snare catheter was advanced through a long 6F sheath to capture the body of the leadless pacemaker (LP). **A:** EN Snare catheter was advanced through a deflectable sheath (Agilis; Abbott Laboratories) placed through a short 16F sheath into the LP introducer sheath. The proximal retrieval head of the LP was captured. **B:** The LP was extracted by counter-traction with 2 snare catheters simultaneously. **C:** The LP after removal. There was no significant encapsulation.

Table 1 Previous reports about extraction of a leadless pacemaker in the chronic phase.

Case	Age	Sex	Duration of implantation (months)	Implication of extraction	Disease	New device	Complication
1	41	F	28	Battery exhaustion	Third-degree AVB	LP	No
2	38	M	44	Battery exhaustion	AF bradycardia	LP	No
3	78	M	47	Upgrade	Third-degree AVB	CRT-P	No
4	78	M	23	Battery exhaustion	AF bradycardia	VVI-PM	No
5	51	F	24	Persistent bacteremia	Third-degree AVB	LP	No

AF = atrial fibrillation; AVB = atrioventricular block; CRT-P = cardiac resynchronization therapy pacemaker; LP = leadless pacemaker; PM = pacemaker.

pressure gradient between the pulmonary artery and right ventricle. A transvenous DDD pacemaker was implanted 2 days after the extraction, and the patient was discharged 8 days after the extraction without any complications.

Her symptoms significantly improved after the extraction with a decrease in the maximum tricuspid regurgitant pressure gradient from 29.2 mm Hg to 18.9 mm Hg on echocardiogram and a significant decrease in plasma brain natriuretic peptide from 399 pg/mL to 48.4 pg/mL. However, the thickness of the RV wall remained at 5 mm on echocardiography 1 year after extraction. Thus, RV hypertrophy was assumed irreversible.

Discussion

This case report describes a patient who developed RV hypertrophy and RVOT obstruction nearly 2 years after LP implantation owing to a relatively high implantation site. The obstruction and RV pressure overload improved after the successful extraction of the LP.

The question arises as to why RVOT obstruction occurred in the chronic phase, and was not observed in the early phase. The best explanation for this might be an increase in the ventricular pacing burden. Initially, the LP was implanted for a paroxysmal AV block and the pacing burden was low. However, RV hypertrophy occurred locally as the underlying AV block worsened and the pacing burden increased. This eventually led to further RVOT obstruction, followed by global RV hypertrophy with right-sided heart failure.

Regarding the extraction of the LP, there are a few systematic extraction reports in the early phase. Afzal and colleagues reported a series of 11 patients with successful

extraction on the same day and 18 patients with early-phase extraction using an LP sheath and a steerable sheath (median, 46 days; 1–95 days after implantation).[2] In autopsy cases, complete encapsulation was observed 12 months after implantation.[3] It is difficult to evaluate the level of encapsulation noninvasively, and the degree of encapsulation may vary from patient to patient. In the present case, we did not notice any tissue attached to the device 28 months after implantation.

Reports on the extraction of LPs in the chronic phase are scarce, and only a few cases have been reported, as summarized in Table 1. The reasons for extraction were battery depletion, persistent bacteremia, and an upgrade to cardiac resynchronization therapy pacemaker.[4–7] No case was found in the literature related to chronic obstruction of the RVOT from an LP implanted in the high RV septum.

In this regard, this is a novel case report that presents remote removal of LP as a rare complication.

Conclusion

Our case report demonstrates a very rare complication requiring remote extraction owing to chronic obstruction of the RVOT from the LP.

Funding Sources: The authors did not receive support from any organization for the submitted work.

Disclosures: All authors have no conflict to disclose.

Appendix

Supplementary Data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.hrcr.2023.11.002.

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