Removal of a leadless pacemaker using a 2.5cc syringe and silk thread during surgical treatment of infective endocarditis

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Introduction

The leadless transcatheter pacemaker system (TPS) has become more widely used because of its growing indication and low rate of various complications associated with conventional transvenous cardiac pacemakers. However, an extraction of the leadless TPS is often needed for various reasons, such as its infection and an inadequate pacing threshold.[1] Previous studies have reported successful cases with a percutaneous extraction of the leadless TPS using a steerable sheath, delivery catheter, and snare. However, there are concerns about percutaneous retrieval failures owing to difficulty in grasping the leadless TPS using a snare because of device encapsulation and an inaccessible site of the implantation (subvalvular region or high septal site). Current guidelines recommend a total extraction of cardiac implantable electronic devices (CIEDs) in the setting of infective endocarditis (IE) with or without definite involvement of the CIED system. In general, surgical extractions of CIEDs are considered when the patient has another reason for cardiac surgery. Thus, if surgical treatment of IE is needed, a simultaneous removal of the leadless TPS and surgical treatment could be considered. However, the management of the leadless TPS by a surgical extraction remains unknown. We described a case of a patient with IE that eventually led to the removal of a Micra TPS (Medtronic Inc, Minneapolis, MN) under direct visualization during a surgical treatment for IE.

KEY TEACHING POINTS

- This is the first case of a Micra transcatheter pacemaker system extraction during surgical treatment of infective endocarditis.
- A safe and relatively easy extraction of the Micra under direct visualization was performed using a modified 2.5cc syringe and silk thread 2.5 months after the device implantation.
- Surgical extraction of a Micra could be considered as an alternative option to a percutaneous extraction when the patient has failed a prior extraction procedure.

Case report

The patient was a 78-year-old man with dyspnea. He had a history of diabetes mellitus and received hemodialysis owing to diabetic nephropathy. His initial electrocardiography exhibited bradycardic atrial fibrillation. After a few days, the electrocardiography revealed an advancement to complete atrioventricular block with atrial fibrillation. Because he developed heart failure owing to bradycardia, a decision was made to first implant a Micra TPS. He was discharged on day 14 after an uneventful hospital stay. Sixty days after the implantation of the Micra TPS, he developed a fever. His body temperature was 38.5°C, and transesophageal echocardiography demonstrated a vegetation with a diameter of 1.2×0.9 cm that was attached to the mitral valve and severe

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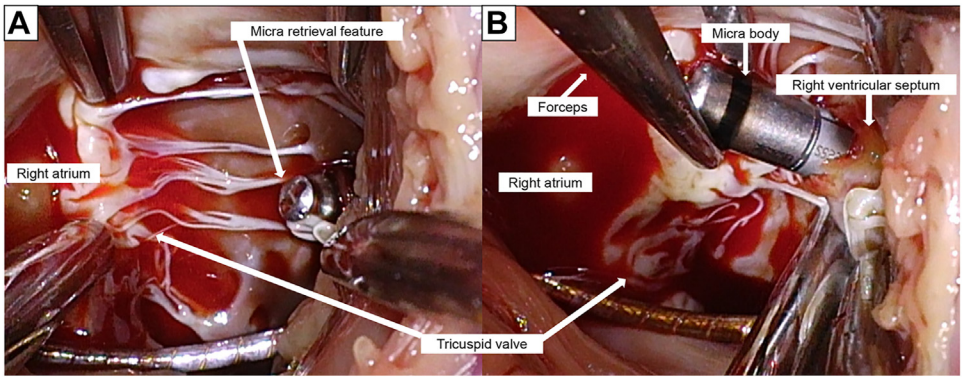

Figure 1 Images of the Micra transcatheter pacemaker system (TPS) in an opened right ventricle under direct visualization. **A:** The distal half of the Micra TPS is covered with the right ventricular midseptal tissue. **B:** No fibrotic encapsulation on the proximal Micra body is observed.

mitral regurgitation. Methicillin-resistant *Staphylococcus aureus* was isolated in 3 separate blood cultures, for which IE was diagnosed based on the Duke criteria. The portal of entry for the methicillin-resistant *S aureus* was unknown from the medical anamnesis and various examinations. Gallium scintigraphy was positive in the mitral valve and spleen, but negative in the right heart system including the Micra TPS. Despite antibiotic therapy with a vancomycin infusion for 2 weeks, the transesophageal echocardiography findings revealed that the vegetation had become larger. Thus, the subsequent plan was to perform a surgical treatment of the IE.

Seventy-four days after the implantation of the Micra TPS, the removal of the vegetation attached to the mitral valve and a mitral valve replacement using a biological valve were conducted. The histopathology of the vegetation revealed fragments of fibrinous material focally infiltrated by dense neutrophils admixed with a few histiocytes, which was consistent with an infected vegetation. Subsequently, we approached the right ventricle via the right atrium to remove the Micra under direct visualization. The distal half of the Micra was covered with the right ventricular midseptal tissue, but there was no fibrotic encapsulation on the body of the Micra. In addition, no contaminated tissue around the Micra was observed (Figure 1). The 2 surgical operators pulled on the Micra directly using the forceps with a moderate degree of traction, but the Micra was impossible to remove owing to the fixation tines and adhesion with the surrounding tissue (first half of Supplemental Movie). Therefore, we used a 2.5cc syringe (Terumo Corporation, Tokyo, Japan) and silk thread to pull the Micra with counter-traction. We removed the plunger and cut the cylindrical tip of the 2.5cc syringe. The silk thread was tightened around the waist of the retrieval feature botton on the proximal end of the Micra (Figure 2). The Micra and fixation tines were then retracted into the 2.5cc syringe by pulling the silk thread with a mild degree of counter-traction and the entire system was removed from the myocardium (latter half of Supplemental Movie). The extracted device was found to have no adherent tissue, such as thrombus or a fibrotic encapsulation attached to the body and fixation tines. There was no injury to the surrounding tissue. The myocardial lead was attached to the heart during the same procedure. The antibiotic therapy was continued for 4 weeks and eventually the blood cultures became negative in 2 separate samples. No major complications were observed during the extraction procedure or the follow-up period.

Discussion

To the best of our knowledge, this is the first case of a simultaneous Micra TPS extraction with a surgical treatment of IE.

The leadless TPS has a lower risk of infection when compared to conventional transvenous cardiac pacemakers. A previous study has shown that a simultaneous leadless TPS implantation and CIED extraction could be safe and feasible even in the setting of an active infection.[2] At this time, there is limited data for determining whether the leadless TPS should be removed or not when IE occurs. In our case, unfortunately, the removed Micra was not sent for cultures, so it was unknown whether the Micra was infected or not. Considering the risk of infection of prosthetic heart valves after surgical treatment of IE, a simultaneous removal of a leadless TPS and surgical treatment could be considered as a reasonable treatment option during surgical treatment of IE even if an active infection of the leadless TPS was not proven.

Koay and colleagues[1] demonstrated that the Micra was pulled into the Micra introducer sheath with a single loop snare tightened onto the retrieval feature under fluoroscopy visualization. Recently, Bonner and colleagues[3] demonstrated that pulling the Micra into the Micra cup using a snare could provide counter-traction, which leads to an easy Micra extraction without an excessive pull force in a human cadaver almost 3 years after the device implantation. Following that case report, we made a modified 2.5cc syringe that resembled the Micra cup and used a silk thread instead of a snare to retrieve the Micra under direct visualization. As a result, we achieved a safe and relatively easy extraction of the entire system using these tools 2.5 months after the device implantation.

Over time, the fibrotic tissue around the leadless TPS matures, resulting in encapsulation of the leadless TPS similar to transvenous pacemaker leads. One of the key factors making

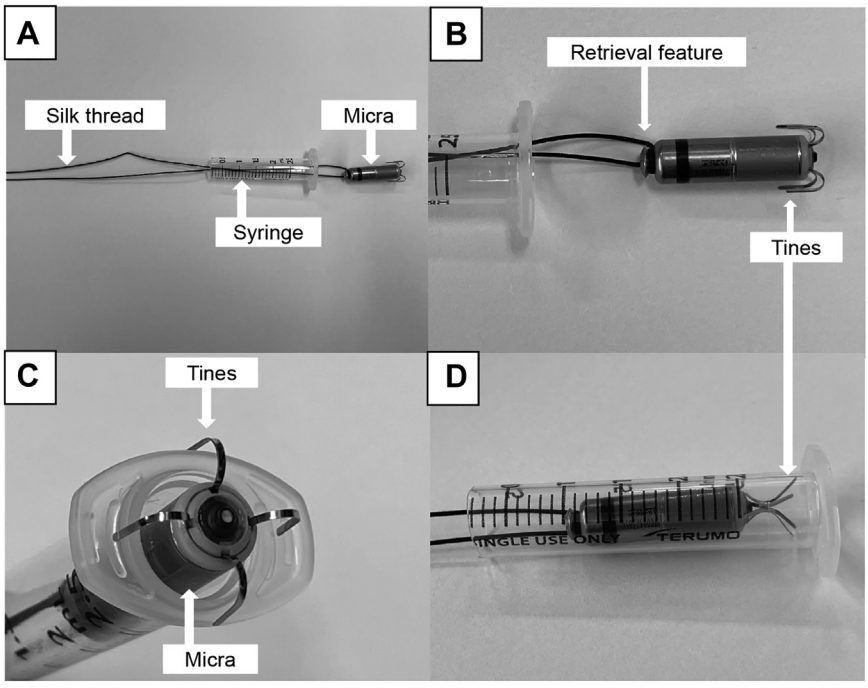

Figure 2 How to use the 2.5cc syringe and silk thread. **A:** The silk thread is connected to the Micra through a 2.5cc syringe with the plunger removed and the cylindrical tip cut. **B:** The silk thread is tightened around the waist of the retrieval feature. **C:** The appearance of the tines when the Micra body is covered with the 2.5cc syringe. **D:** The Micra and tines are retracted into the 2.5cc syringe by pulling the silk thread.

the process of a percutaneous extraction difficult is the amount of encapsulation on the Micra body, particularly around the retrieval feature. The case series with the Nanostim TPS extraction described an unsuccessful procedure because of the difficulty in grasping the docking button using a snare owing to the encapsulation of the docking button about 5 years after the device implantation.[4] The only nonisodiametric section of the Micra is the retrieval feature, in which there is often tissue ingrowth, but it is not clear how often the encapsulation on the retrieval feature of the Micra will happen. However, even if the retrieval feature is fully encapsulated, the procedure under direct visualization would allow accessing the retrieval feature with minimal tearing of the encapsulation tissue, which could result in a successful extraction of the Micra. In addition, Oosterwerff and colleagues[5] reported damage to the tricuspid valve in a few patients after a Nanostim TPS extraction, resulting in the development of tricuspid regurgitation. The authors mentioned that it was most likely caused by the frequent occurrence of fibrotic adhesions to the tricuspid valve or subvalvular apparatus. Visual confirmation of the device position within the heart and a minimal force for the counter-traction may contribute to minimal damage to the surrounding tissue. Our method would facilitate the removal of the Micra TPS at the time of heart surgery with less trauma because of the ability to apply traction and counter-traction, compared to a simple pull force using surgical instruments such as the forceps and Allis clamp. Surgical extraction of the Micra TPS could be considered as an alternative option to percutaneous extraction when the patient has failed a prior extraction procedure. As factors such as the duration of the device implant and implant site also affect the impact of the ease of the extraction, further experience with the Micra TPS by a surgical extraction are needed to evaluate the feasibility in addition to the safety.

Conclusion

Surgical extraction of a Micra TPS under direct visualization was safely performed using simple and existing tools with minimal force.

Appendix

Supplementary Data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.hrcr.2023.01.017.

References

1. Koay A, Khelae S, Wei KK, Muhammad Z, Mohd Ali R, Omar R. Treating an infected transcatheter pacemaker system via percutaneous extraction. HeartRhythm Case Rep 2016;2:360–362.
2. Chang D, Gabriels JK, Soo Kim B, et al. Concomitant leadless pacemaker implantation and lead extraction during an active infection. J Cardiovasc Electrophysiol 2020;31:860–867.
3. Bonner M, Hilpisch K, Wika K, Mesich ML, Harris M, White T. Visual observation of extraction of a micra leadless pacemaker from a human cadaver. Pacing Clin Electrophysiol 2022;45:1056–1061.
4. Breeman KTN, du Long R, Beurskens NEG, et al. Tissues attached to retrieved leadless pacemakers: histopathological evaluation of tissue composition in relation to implantation time and complications. Heart Rhythm 2021;18:2101–2109.
5. Oosterwerff EFJ, Salavati A, Lenssen M, Delnoy PP, Adiyaman A, Elvan A. Experience with malfunctioning leadless pacemakers: troubleshooting and management during medium-term follow-up. Heart Rhythm 2022;19:894–900.