Retrieval of an Aveir Leadless Pacemaker with a Standard Retrieval Catheter by Releasing the Wedged Docking Button Using a Loop Wire Technique

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Abstract

Introduction The docking button of the Aveir leadless pacemaker (LP) is often difficult to access due to its inappropriate position in the right ventricle (RV). **Methods and Results** We report a case where the Aveir LP was successfully retrieved by releasing the wedged docking button in the inferior wall of the RV using a loop wire technique. **Conclusion** The loop wire technique may be useful to change the position of the Aveir LP. This may be helpful to retrieve the Aveir LP even in the case where the docking button is wedged in the inferior wall of the RV.

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Key words: Leadless transcatheter pacemaker system; Aveir; Tri-loop snare; Device retrieval; Loop wire technique

Introduction

Several years have passed since the global introduction of leadless pacemakers. The Aveir (Abbott Medical Inc., Abbott Park, IL, USA) leadless pacemaker (LP) has been available for clinical use since 2023. The Aveir LP, an improvement over its predecessor the Nanostim (St. Jude Medical Inc., Saint Paul, MN, USA; now Abbott), addresses issues related to premature battery depletion that led to the recall of the Nanostim. In addition, the Aveir LP was designed to allow retrieval using a dedicated retrieval catheter. When retrieving the Aveir LP, operators need to grasp the docking button with a tri-loop snare at the end of the retrieval catheter. In this case, the side of the docking button, the contralateral side of the helix, had fallen toward the inferior wall of the right ventricle (RV) 6 months after the implantation. As a result, we were unable to retrieve the Aveir LP using the conventional methods. We share our experience of a case where the Aveir LP was successfully retrieved with a standard retrieval catheter by releasing the wedged docking button using a loop wire technique.

Case Report

A 78-year-old man with a body mass index of 26.5 kg/m^{2}had paroxysmal atrial fibrillation (AF). He was taking rivaroxaban 30 mg daily. He underwent two catheter ablation procedures to treat the AF, but the AF recurred. Because he experienced cryptogenic syncope, an implantable cardiac monitor (ICM) (Jot Dx TM Abbott) was implanted. A month after the ICM implantation, sinus node arrest was detected on the ICM when the AF terminated. Based on that finding, we decided to implant an Aveir LP. **Figure 1A-1B** shows the contrast imaging taken just prior to the fixation of the Aveir LP delivery catheter. At the end of the procedure, the pacing thresholds were 0.75V/0.2 msec and 0.5V/0.4 msec and there were no abnormalities in the position of the Aveir LP (**Figure 1C**). One month after the implantation, the pacing thresholds increased to 1.25V/0.2msec and 2.5V/0.4msec, and a chest x-ray showed that the docking button side of the Aveir LP had dropped (**Figure 1D)** . Four months after the implantation, the pacing thresholds continued to deteriorate to 5.0V/0.2 msec and 3.5V/0.4 msec, and on chest x-ray, the docking button side of the Aveir LP had dropped further toward the inferior wall of the RV (**Figure 1E)** . The helix of the Aveir LP was found to be attached to a trabeculation within the RV endocardium on the cardiac CT scan (**Figure 1F)** , which was thought to cause instability of the position of the Aveir LP. In addition, on the 3D CT images, the docking button of the Aveir LP was fixed to the inferior wall of the RV (**Figure 1G-1H**). This

patient experienced pre-syncope due to pacing failure. Thus, 6 months after the implantation, we decided to perform a retrieval of the Aveir LP and a replacement with a Micra LP (Medtronic Inc., Minneapolis, MN). During the procedure the patient was sedated with dexmedetomidine and propofol while monitoring the bi-spectral index. We performed RV angiography and confirmed the position of the Aveir LP from the right anterior oblique (RAO) and left anterior oblique (LAO) views (**Figure 2A-2B**). As observed in the preoperative cardiac CT, the docking button side of Aveir LP had dropped to the inferior wall of the RV. The Aveir LP introducer was placed through the right femoral vein while the Agilis^{TM} sheath was positioned through the left femoral vein. An initial attempt was made to capture the docking button with the Aveir LP retrieval catheter (**Figure 2C**). The docking button was wedged into the inferior wall of the RV, so we could not capture it with the tri-loop snare of the Aveir LP retrieval catheter. An attempt was then made to release the wedged docking button using an electrode catheter inserted through the Agilis^{TM} sheath via the left femoral vein. However, the electrode catheter could not be maneuvered under the Aveir LP body and the position of the Aveir LP body could not be adjusted (**Figure 2D-2E)** . The Agilis^{TM} sheath for use with a pigtail catheter was then inserted through the right internal jugular vein. The pigtail catheter was advanced from the RV septum toward the free wall of the RV, and then a Radifocus^{TM}guidewire was advanced to the caudal side of the Aveir LP body (**Figure 2F)** . After the pigtail catheter was advanced over the Radifocus^{TM} guidewire, we captured the pigtail catheter using a single-loop snare in the right atrium via the left femoral vein (**Figure 2G-2H)** . By simultaneously pulling the pigtail catheter from the cranial side and the single-loop snare from the caudal side (**Figure 2I)** , the docking button was released from the inferior wall of the RV, and a swing movement (SM) of the Aveir LP was observed under fluoroscopy (**Figure 2J)** . Then, we successfully captured the docking button using the tri-loop snare of the retrieval catheter and subsequently docked the retrieval catheter with the Aveir LP (**Figure 3A-3C)** . We also confirmed that there was no entanglement between the Aveir LP and RV structures using a protective sleeve (**Figure 3D)** . The Aveir LP was able to be released from its fixation to the trabeculation of the RV endocardium by unscrewing it counterclockwise. The retrieval catheter was removed from the Aveir LP introducer (**Figure 3E)** . RV angiography did not show any contrast retained in the pericardial sac (**Figure 3F-3G)** . We inserted the Micra delivery catheter and placed the Micra in the low septum of the RV (**Figure 3H-3I)** . The Aveir LP body and the retrieval catheter did not have any myocardial tissue or fibrosis (**Figure 3J)** . No major complications were observed during the extraction procedure or follow-up period.

Discussion

To our knowledge, this is the first case of an Aveir LP retrieval where the docking button was difficult to access due to its inappropriate position in the RV. Ultimately, the Aveir LP was successfully retrieved with a standard retrieval catheter by releasing the wedged docking button using a loop wire technique.

Sato et al. reported that the RV cavity is not smooth and numerous trabeculations develop in the RV according to the endoscopic images of the RV[1)]. On CT in this case, the helix of the Aveir LP appeared to be attached to the RV endocardial surface, including the tissue between or even on the trabeculated regions. The lack of firm burrowing of the helix into the deeper RV endocardial tissue may have caused the elevated threshold of the Aveir LP because the electrode was located in the center of the helix. In addition, the unstable fixation of the helix could have resulted in the progressive slippage of the Aveir LP. To avoid such an inappropriate placement of the helix, it is important to ensure that the RV septum is clearly contrasted by the contrast agent over the protective sleeve with the helix in the LAO view and to screw the helix perpendicular to the RV septum with appropriate tension.

Minami et al. reported the feasibility and safety of the retrieval of long-term implanted Nanostim LPs after a mean duration of 4 years[2)]. They evaluated the movement of the LP docking button during the cardiac cycle under fluoroscopic imaging and defined a swinging angle of more than 15° as a considerable SM. Nanostim LPs implanted on the RV mid-septum adhere to the sub-valvular area, which contributes to the disappearance of the SM. LPs with significant SM located in the RV septal apex have been retrieved successfully at a higher rate than LPs without SM. Based on this report, the evaluation of the Aveir LP position in the RV on the chest x-ray or CT and the presence or absence of the SM of the Aveir LP on

fluoroscopic imaging may be helpful in determining whether the Aveir LP can be retrieved or not. In the present case, the fluoroscopic imaging 4 months after the implantation showed the disappearance of the significant SM. Considering the post-implantation period, we estimated that the disappearance of the SM was mainly due to the inappropriate fixation position of the docking button on the inferior wall of the RV and not to the adherence to the surrounding tissue. Reddy et al. reported the Nanostim LP removal outcomes as having a high removal success rate[3)]. In one case, a variable electrode catheter was used to change the direction of the docking button, allowing the docking of a retrieval catheter and the successful retrieval. We first attempted to capture the docking button of the Aveir LP with a retrieval catheter, but as shown by the intraoperative RV angiography, the docking button was fixed to the inferior wall of the RV and could not be captured. As a next step, we tried to release the docking button using a deflectable electrode catheter as reported by Reddy et al.[3)] However, the mobility of the electrode catheter was limited and we were not able to release the docking button. After that, we used the loop wire technique with the incorporation of a pigtail catheter and Radifocus^{TM} guidewire through the right internal jugular vein. Maisch et al. demonstrated the utility of the loop wire technique for pacemaker lead extractions[4)]. That technique continues to be widely employed in pacemaker lead removal procedures. In our case, the Radifocus^{TM} guidewire and pigtail catheter were initially passed through the inferior wall of the RV. Then, we used the snare through the right femoral vein to grasp the pigtail catheter via the Radifocus^{TM} guidewire as a loop snare technique. Finally, we were able to release the docking button and retrieve the Aveir LP with a retrieval catheter with relatively slight traction. Our method could facilitate removals in cases with an Aveir LP when removal with a retrieval catheter is difficult due to an inappropriate position of the docking button. Further experience is warranted to evaluate the feasibility and safety of our method in cases where the Aveir LP has been implanted for longer than 6 months.

Conclusion

In cases where it is difficult to capture the docking button of the Aveir LP with the tri-loop snare of the retrieval catheter due to its inappropriate position in the RV, the loop wire technique may be useful to change its position. This may be helpful to retrieve the Aveir LP with the standard retrieval catheter even in the case where the docking button is wedged in the inferior wall of the RV.

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Figure Legends

Figure 1. Fluoroscopic images of the Aveir leadless pacemaker (LP) implantation and post-implantation findings.

A-B: Right anterior oblique (RAO) and left anterior oblique (LAO) contrast images taken just before the fixation of the Aveir LP. C: Chest x-ray immediately after the implantation showing no abnormalities in the position of the Aveir LP. D-E: Chest x-ray showing that the docking button side of the Aveir LP had gradually descended. F: Cardiac CT scan showing that the helix of the Aveir LP was attached to the trabeculation within the right ventricle (RV). G-H: The 3D CT images showing that the docking button of the Aveir LP was fixed to the inferior wall of the RV.

Figure 2. Fluoroscopic images during the Aveir leadless pacemaker (LP) docking button release procedure.

A-B: Right ventricular (RV) angiography in the right anterior oblique (RAO) and left anterior oblique (LAO) views showing that the docking button side of the Aveir LP had dropped onto the inferior wall of the RV. C: The tri-loop snare was placed around the docking button of the Aveir LP, but it was difficult to grasp the docking button. D-E: An attempt was made to release the wedged docking button with an electrode catheter, but the position of the Aveir LP body could not be adjusted. F: The pigtail catheter and Radifocus^{TM} guidewire were advanced to the caudal side of the Aveir LP body. G-H: The Radifocus^{TM} guidewire was captured by a single-loop snare. I: The pigtail catheter was pulled from the cranial side (white arrow) and the single-loop snare from the caudal side (black arrow). J: The Aveir LP docking button was released from the inferior wall of the RV.

Figure 3. Fluoroscopic images during the Aveir leadless pacemaker (LP) retrieval and Micra LP implantation.

A-C: The tri-loop snare of the retrieval catheter successfully grasped the docking button and was docked to the Aveir LP. D: No entanglement between the Aveir LP and right ventricular (RV) structures was observed using a protective sheath. E: The Aveir LP was released from its fixation to the RV and the retrieval catheter was removed from the Aveir LP introducer. F-G: Right anterior oblique (RAO) and left anterior oblique (LAO) views of the RV angiography showing no contrast retained in the pericardial sac. H-I: The Micra LP was implanted on the inferior septum of the RV. J: The Aveir LP body and retrieval catheter had no myocardial tissue or fibrosis adhering to it.

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