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CASE REPORT
Electrophysiology

3D computed tomography integration guiding permanent Aveir AR leadless pacemaker implantation: a case report

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Background The use of single-chamber, right ventricular (RV) leadless pacemakers (LPs) has been well established, the introduction of a right atrial LPs has opened the door for dual-chamber leadless pacing. Cardiac computed tomography (CT) segmentation integration might provide proper visual guide during the procedure.

Case summary A 58-year-old male patient was brought to the emergency department with dizziness and complete heart block. The patient underwent single-chamber permanent LP implantation. During the upgrade to a dual-chamber LP, 3D CT image fusion with fluoroscopy was utilized to accurately identify the ideal and safe implantation site for the device.

Discussion Integrating CT image guidance with fluoroscopy could enhance procedure safety, success rates, and reduces fluoroscopy time.

Keywords Case report • Leadless pacemaker • Sick sinus syndrome • 3D computed tomography • Dual leadless pacemaker

ESC curriculum 2.1 Imaging modalities • 2.4 Cardiac computed tomography • 5.7 Bradycardia • 5.9 Pacemakers

Learning points

- Incorporating computed tomography (CT) image guidance alongside with fluoroscopy during Aveir AR implantation procedures has the potential to improve both safety and success rates, while also might reduce the overall procedure time.
- Cardiac CT could assist in the pre-planning for the ideal placement of the Aveir AR/VR devices, in order to ensure optimal implant-to-implant communication.

Introduction

Leadless pacemakers (LPs) were aiming to lower complications associated with transvenous leads and the subcutaneous pulse generator pocket.[1–3] Whereas the use of single-chamber, right ventricular (RV) LPs has been well established,[4–6] the introduction of a right atrial (RA) LP has opened the door for dual-chamber leadless pacing. Additionally, integrating 3D cardiac images from segmented computed tomography (CT) scans can be valuable in guiding device implantation.

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Summary figure

Timeline	
August 2023	Admission to hospital with complete heart block and syncope, followed by Aveir VR implantation
September 2023	Follow-up at Device Clinic with stable Aveir VR parameters
February 2024	Follow-up at Device Clinic with stable Aveir VR parameters
June 2024	Cardiac computed tomography scan preformed
22 June 2024	Aveir AR implanted as an upgrade to DR
23 June 2024	Discharge from the hospital

Case presentation

This case represents the first Aveir AR implantation outside North America, performed on 22 June 2024. A 58-year-old male patient with a known diagnosis of type II diabetes mellitus, was transported via national ambulance due to dizziness and a syncopal episode, presenting with mild distress and a mean arterial blood pressure within normal limits. The electrocardiogram conducted by the ambulance indicated intermittent complete heart block (*Figure 1A*), whereas the electrocardiogram performed in the emergency department showed a normal sinus rhythm with alternating bundle branch blocks (*Figure 1B*).

The patient reported a history of recurrent, similar episodes of dizziness, with no significant past medical history. A transvenous temporary pacemaker was placed. The patient denied any use of negative chronotropic medications, and the initial workup did not reveal any clinical, laboratory, or imaging findings suggestive of underlying infiltrative or infectious diseases.

A decision was made to proceed with permanent pacemaker implantation. Given the patient's preference and his job, which involves manual labour with both hands, a LP was chosen after obtaining an informed consent. Specifically, the AVEIR VR (@Abbott) LP was selected, with plans for a future upgrade to a DDD leadless pacing system.[7]

The patient underwent implantation of a single-chamber permanent LP (Aveir VR (@Abbott)), which was positioned in the apico-septal region. Intraoperative measurements of the Aveir VR pacemaker were as follows: pacing threshold of 0.5 V at 0.4 ms, impedance of 710 Ω, and an R wave of 9.5 mV. The patient was discharged from the hospital in stable condition with optimal pacemaker measurements and parameters.

Follow-up measurements taken 10 months later showed stable parameters: pacing threshold of 0.75 V at 0.4 ms, impedance of 570 Ω, and an R wave of 13 mV with 83% ventricular pacing.

Considering the patient's young age and physically active lifestyle, the decision was made to upgrade to a dual-chamber LP system (Aveir DR @Abbott) as per guidelines.[7,8] This involved the transcatheter implantation of a permanent Aveir AR LP in the right atrium.

Pre-procedural cardiac CT was performed to define the RA anatomy and to assist with the Aveir AR implantation procedure.

After securing vascular access and administering of anticoagulation, the Aveir AR LP was introduced into the right atrium and positioned at the base of the right atrial appendage (RAA). The implantation site was accurately mapped using guidance from integrated and merged 3D images of the right atrium and RAA, as provided by the HeartNavigator Release 3.1.0 (@Philips) creating the merge with the bronchus and contrast injection (*Figure 2*).

After confirming satisfactory parameters sensing at 2.7 mV, impedance at 440 Ω, and a threshold of 0.75 V at 0.4 ms and ensuring reliable implant-to-implant (i2i) communication, the device was securely fixed following standard implantation protocols.

The procedure lasted 43 min, with total fluoroscopy time of 5.6 min. Post-procedure chest X-ray and device interrogation confirmed stable device and electrical parameters. The patient was discharged after 24 h, with clinical and device parameters remaining stable throughout a 2-month follow-up period.

Discussion

While the preparation and implantation steps of Aveir AR closely mirror those of Aveir VR,[9] there are some key differences, such as the device loading procedure and the technique used to ensure stability during implantation, we anticipate that the below key points observations might help in increasing procedure safety and success:

(1) As for the initial procedures, to start first by upgrading Aveir VR to DR.

(2) Computed tomography segmentation can be highly valuable for pre-procedure planning, especially given the variability in RAA anatomy and morphology among patients. Furthermore, Integrating CT image with fluoroscopy helps in planning the ideal RAA implantation site and measuring distances to predict the success of i2i communication. Additionally, the merged imaging provides continuous visualization of the RAA during the procedure, facilitating precise identification of the implantation site and thereby enhancing both safety and operator confidence. In same context, previous reports have shown that combining CT segmentation with fluoroscopy improves cardiac resynchronization therapy (CRT) implantation by evaluating venous patency and predicting CRT response.[10,11]

Although CT may result in higher radiation exposure compared to fluoroscopy, its advantages in improving procedural safety and reducing the risk of complications—such as perforation (0.7%) and intra-procedural device dislodgment (1.7%)[9]—outweigh the associated risks. Furthermore, CT can help minimize the need for excessive contrast injection, which is especially beneficial during the learning phase of device implantation.

(3) Using undiluted contrast enhances visualization. Additionally, employing either a small deflectable catheter or a standard pigtail catheter through the Aveir introducer sheath provides added support, and it confirms the integration of CT imaging and fluoroscopy.

(4) Of interest, the main working view during implantation of the Aveir AR is in left anterior oblique unlike the Aveir VR, which is the right anterior oblique. Thus, the closer the two devices the better the pairing. Hence, the integration of CT imaging provides the ability to measure such distances, offering an added benefit as mentioned above.

(5) Avoid unnecessary rotation of the delivery system to minimize the risk of tether overlap and facilitate smooth device release, thereby preventing potential tether breakage when transitioning to tether mode. Having real-time CT anatomical images helps reduce manipulation, thereby preventing such issue.

(6) Monitoring current of injury is advised to ensure proper contact, keeping in mind that minimal impedance increase is expected, unlike in the Aveir VR.

(7) To achieve optimal i2i communication, it is crucial to position both devices as close to each other as feasible. Therefore, it is suggested to prioritize Aveir VR implants initially and aim to place the device at the junction of the mid to low septum or preferably at the mid septum

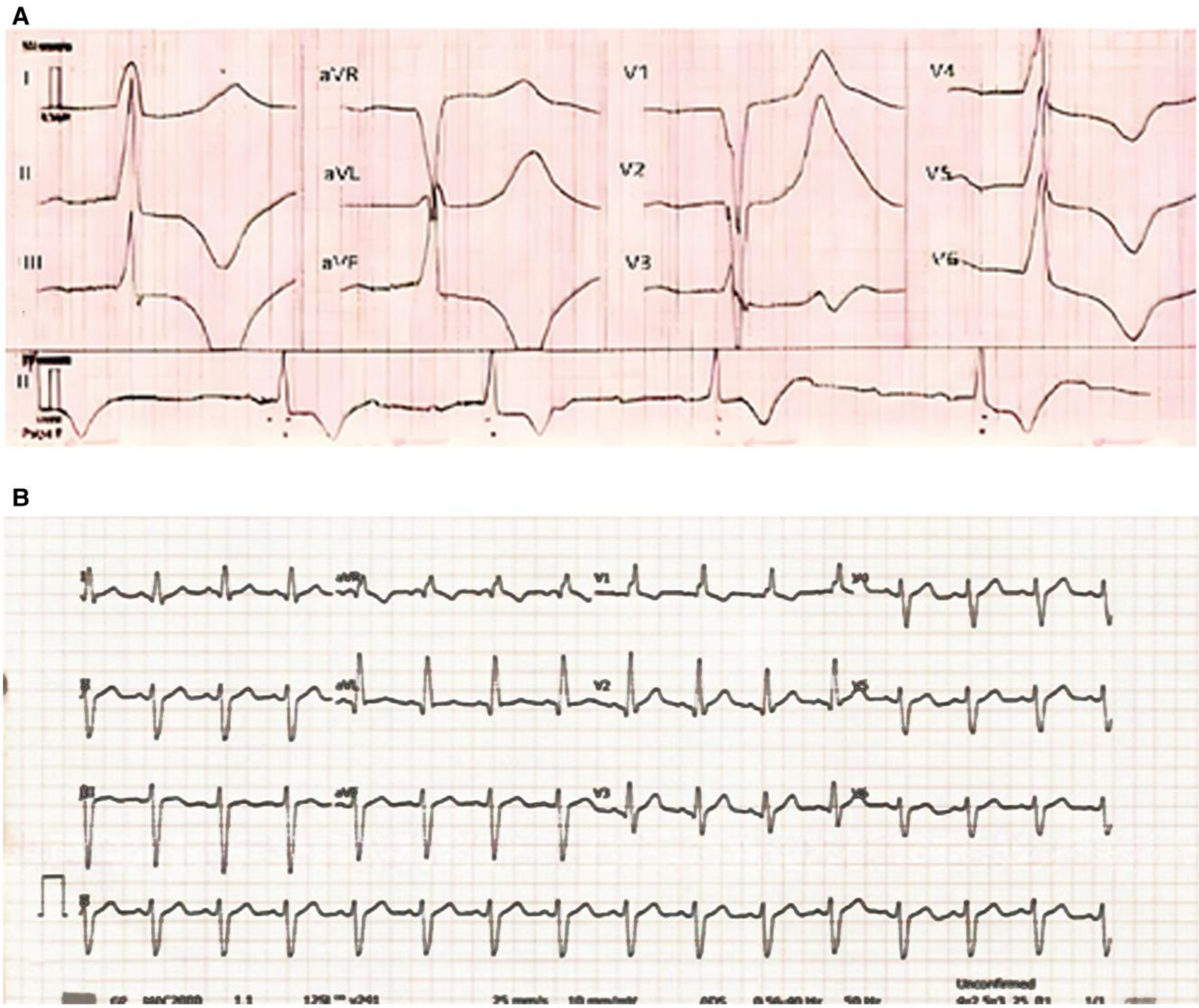

Figure 1 (*A*) Electrocardiogram in the ambulance showing heart block with left bundle branch block. (*B*) Electrocardiogram showing bifasicular block.

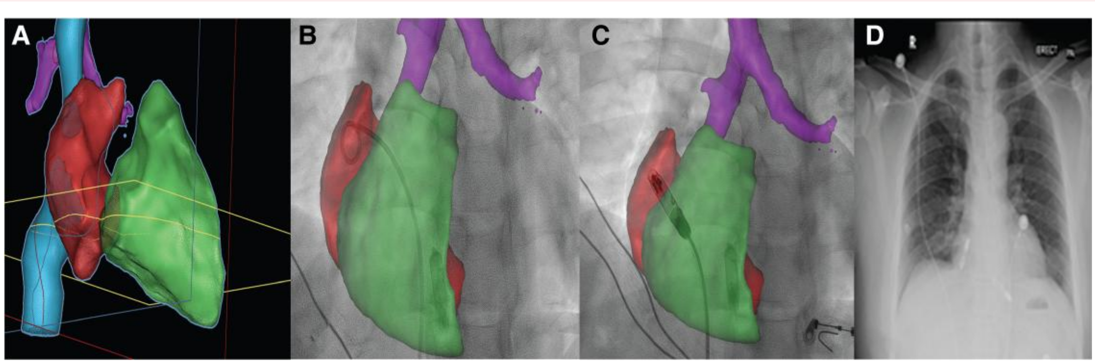

Figure 2 (*A*) Cardiac computed tomography segmentation. (*B*) AP view: computed tomography integrated with position of pigtail catheter in right atrial appendage. (*C*) Left anterior oblique view: computed tomography integrated with fluoroscopy for guiding Aveir AR implantation. (*D*) Plain AP X-ray showing Implanted Leadless Aveir AR and VR.

if distance from the tricuspid valve allows, thus emphasizing the value of CT fusion.

(8) For patients with Sick Sinus Syndrome and intermittent AV nodal disease, it is optional to program each device separately. This approach helps conserve battery life by avoiding continuous pairing. Currently, this programming needs to be done manually, but there is hope for future software upgrades to automate this process.

(9) Compared to other leadless pacing systems, the Aveir LP offers notable advantages, including the potential for upgrade to a dual-chamber leadless system, longer estimated battery longevity in VVI pacing mode, and more feasible retrievability.[12]

In conclusion, integrating CT imaging with fluoroscopy offers several advantages over using fluoroscopy alone. The enhanced 3D visualization provided by CT improves the accuracy of device positioning and enhances procedural safety. Additionally, pre-planning and navigating complex anatomical structures with CT images guidance contribute to greater procedural efficiency and could potentially reduce overall operating times and possibly eliminating the need for a pigtail catheter in the future. Furthermore, the integration of artificial intelligence for predicting inter-device i2i communication may offer additional benefits. This case report serves as a hypothesis generator for future studies in this area.

Lead author biography

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Consent: The authors confirm that written consent for the submission and publication of this case report, including images and associated text, has been received from the patient in line with the Committee on Publication Ethics (COPE) guidelines.

Conflict of interest: None declared.

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Data availability

The data underlying this article will be shared on reasonable request to the corresponding author.

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