Successful leadless pacemaker implantation in a patient with dextroposition of the heart

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Introduction

Cardiac dextroposition, as opposed to dextrocardia, is an acquired horizontal displacement of heart to the right hemithorax with normal alignment of the major axis of the heart, caused by disease processes that either pull or push the heart to the right.[1] Although dextrocardia can pose technical challenges when interventional treatments are required in such cases, dextroposition can be even more challenging given the distortion of normal anatomical relationships and the uncertainty of the accurate location and borders of the cardiac structures caused by the shift and rotation effected by the pathologic process.

We present a complicated but successful case of implantation of a leadless pacemaker (Medtronic Micra; Medtronic Inc, Minneapolis, MN) in a patient with cardiac dextroposition that was incidentally found at implant.

KEY TEACHING POINTS

- Identification of precise cardiac anatomy in the cases of unusual heart positioning is crucial for successful intervention. The position of the heart in the chest and the orientation of the cardiac apex, in addition to the axis and/or rotation, should be ascertained clearly for a safe and successful leadless pacemaker implantation.
- Dextroposition may simulate dextrocardia, and it is important to differentiate between the two to plan for the tools and techniques for a safe implantation.
- Implantation of pacemakers in cardiac dextroposition is complicated but not insurmountable.

Case report

A 73-year-old woman with history of intellectual disability, seizure disorder, and limb contractures presented to the outside hospital with episodes of sinus pauses and symptomatic bradycardia (as low as 30 beats per minute) despite discontinuation of rate-controlling medications and starting oral theophylline weeks prior to the admission. Owing to her contractures, she was not a candidate for a traditional pacemaker with leads. She was referred to our hospital for a leadless pacemaker placement.

The procedure was performed under general anesthesia owing to the patient's intellectual disability. Ultrasound-guided right femoral venous access was obtained with a micro-puncture needle. In preparation for the Micra implant, a long Amplatz stiff guidewire was inserted and advanced through the micro-puncture sheath. Fluoroscopic evaluation of the guidewire in the thoracic region showed the cardiac shadow in the right hemithorax and the wire tip above it, in the right midclavicular line. Owing to the unexpected finding, a short sheath was placed in the femoral venous access and a Berman angiographic balloon-tipped catheter was advanced to the heart. The right atrium (RA) and right ventricle (RV) were located using pressure tracings via the catheter and a power injector and biplane fluoroscopy was used to obtain angiograms of these chambers (Figure 1). The borders of the RA and RV in the right anterior oblique and left anterior oblique views were drawn on the visual monitor with markers. From this point onwards, the cameras and the table were not moved. A transesophageal echocardiography (TEE) probe was then inserted by a second electrophysiologist to assist with a safer and more accurate implantation of the Medtronic Micra leadless pacemaker. Then, guided by fluoroscopy, markings on the screen, and TEE, the Micra introducer sheath and delivery system were placed in the RA and RV, respectively, and the pacemaker was implanted in the RV septum according to the manufacturer's recommendations (Figure 2). After determination of the stability and electrical thresholds, the pacemaker was released from the catheter. Owing to the severe torque built up in the delivery system resulting from the complex anatomy (Figure 2), the cut tethers

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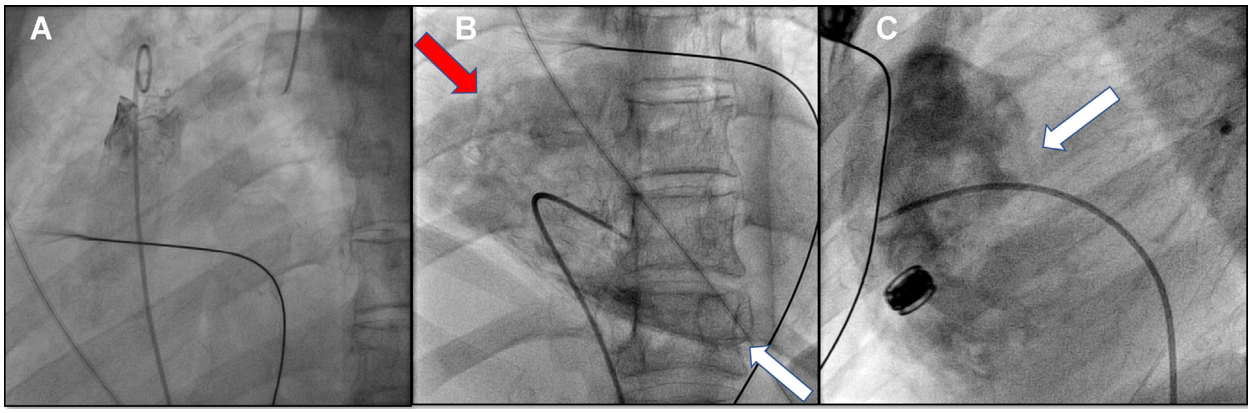

Figure 1 **A:** Pigtail catheter in superior vena cava showing the tip of catheter in the right hemithorax, demonstrating right-sided position of the heart. **B:** Right ventricle (RV) angiogram, right anterior oblique view (*red arrow* denotes base, *white arrow* denotes apex of the RV). **C:** RV angiogram, left anterior oblique view (*arrow* denotes septum).

were found to be tense and therefore extreme care was taken in removing the tethers gradually over a 3- to 5-minute period. Device function was appropriate with an R wave of 6.2 mV, impedance of 690 ohms, and a capture threshold of 0.88 V @ 0.24 ms. Final position of the Micra is shown in Figure 3. The patient was successfully extubated after the procedure and was subsequently discharged.

Discussion

Leadless pacemaker implantation is a feasible alternative when conventional pacing systems cannot be placed.[2] In our patient, a transvenous pacemaker could not be placed because of her limb contractures and compliance issues owing to intellectual disability. She had an uncommon anomalous positioning of the heart that presented a major challenge in the implantation of the pacemaker.

Cardiac electrophysiological procedures, especially device implantations, are often complicated by structural anomalies of the heart. Particularly, in procedures like leadless pacemaker implantation, where the required tools made available by the manufacturer are neither made for nor tested adequately in rare structural anomalies, the performance of these delivery systems in anatomically complex cases can

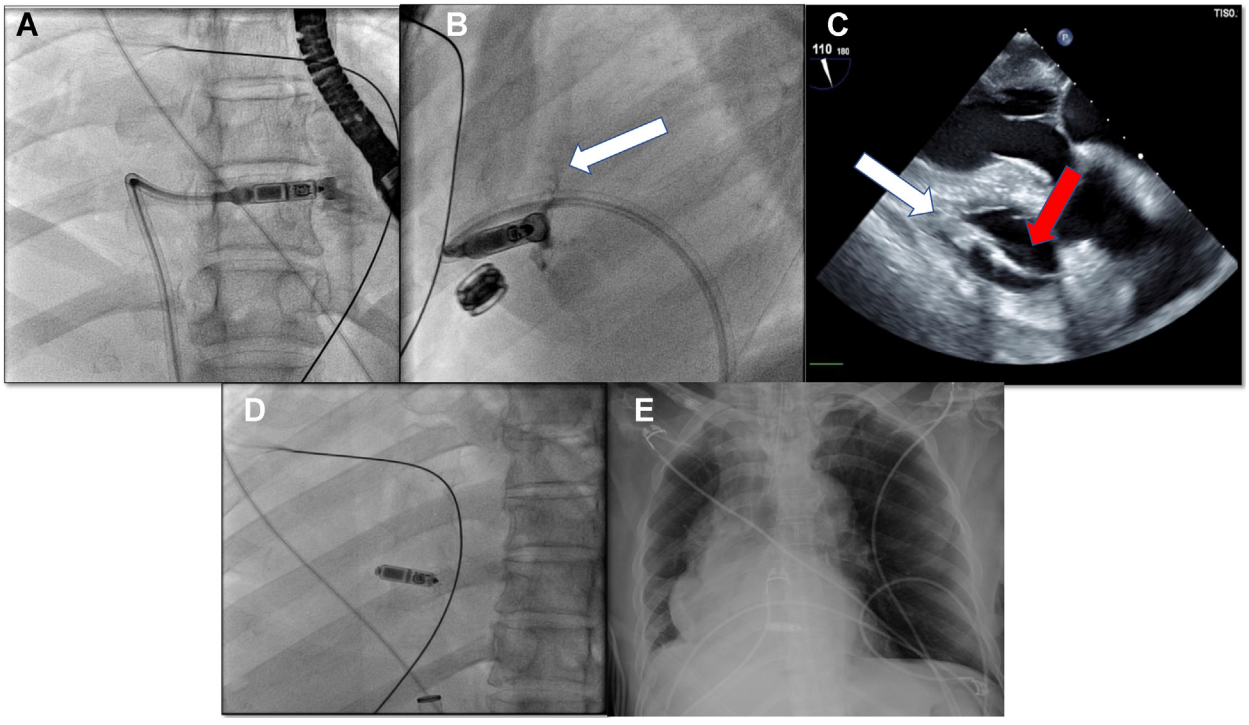

Figure 2 **A:** Micra (Medtronic Inc, Minneapolis, MN) sheath injection, right anterior oblique view. **B:** Micra sheath injection, left anterior oblique view (*arrow* denotes septal staining with contrast injection). Note the acute angle of deflection of the Micra delivery sheath in both views. **C:** Transesophageal echocardiography showing Micra sheath (*red arrow* shows position of Micra sheath, *white arrow* shows position of Micra on right ventricle septum). **D, E:** Zoomed-in anteroposterior view and chest radiograph showing the final position of Micra pacemaker. LV = left ventricle; RA = right atrium; RV = right ventricle.

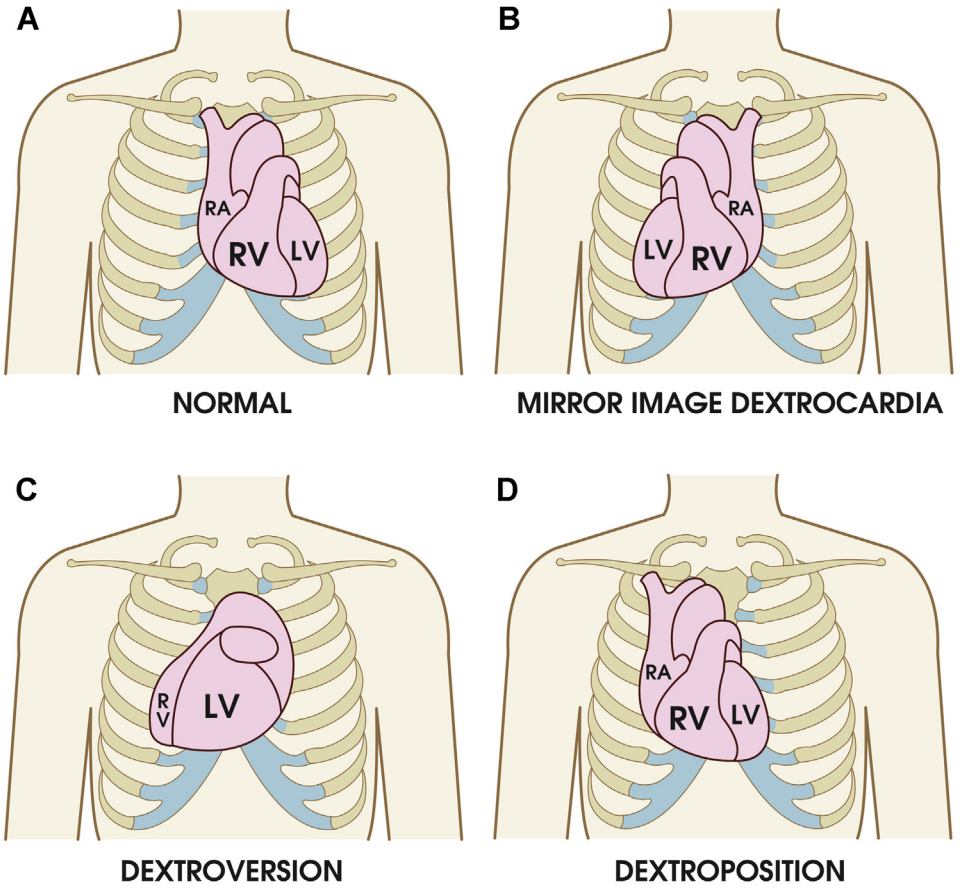

Figure 3 Pictorial representation of an anteroposterior view of the thorax showing **A:** the normal position of the heart, **B:** mirror image dextrocardia, **C:** dextroversion, and **D:** dextroposition.

be challenging or require improvisation. There are limited reports in the literature regarding implantation of leadless pacemakers in patients with dextrocardia.[3,4] Dextrocardia refers to positioning of the heart in the right side of the thoracic cavity with the base-to-apex axis of the heart pointed towards the right (Figure 3B). While implantation of leadless pacemakers in patients with dextrocardia certainly calls for impromptu, nontraditional movements like counterclockwise rotation instead of clockwise rotation of the delivery system to reach the septum, the relationships between the cardiac structures are at least fixed and predictable to the operator. Dextroversion (a condition owing to malrotation of the ventricles along the long axis, resulting in the left-sided chambers lying anterior to the right-sided chambers with or without transposition of the great arteries; Figure 3C), on the other hand, can pose considerable challenges for implantation of a leadless pacemaker but has not been described in the literature.[5] Dextroposition is defined as displacement of an otherwise normally configured heart to the right hemithorax, with a base-to-apex axis pointing towards the left (Figure 3D). Dextroposition can be congenital as well as acquired. Acquired cases can be secondary to a number of extracardiac causes, such as a diaphragmatic hernia, right pneumonectomy, or right lung hypoplasia. Interestingly, our patient did not have any prior history suggestive of the possibility of dextroposition. Owing to the fact that the apex remains towards the left, the displacement of the heart in the thorax towards the right distorts the venous connections and the anatomical relationships between the vessels, the RA, and the RV. This distortion, coupled with the variability from patient to patient, makes it extremely challenging when cardiac interventions are indicated. One case of leadless pacemaker implantation in the setting of cardiac dextroposition secondary to right pneumonectomy has been reported previously in Italy.[6] This is the second reported case and the first case reported from the United States. Unlike the first case, the cause for dextroposition in our case is not apparent and could be from reduced lung volumes on the right owing to the chronic right lateral decubitus posture of the patient. In addition to the RV angiography that was used in the other patient, we used a TEE to further guide and accurately place the device in a safe manner. While RV angiography helped us understand the anatomy and locate the cardiac chambers and helped guide catheter movements, TEE played a crucial role in confirming the septal position of the device at the time of implantation. A second femoral venous access and intracardiac echocardiography may be an alternative to TEE, sparing the need for an additional operator. Our case illustrates the challenges to

leadless pacemaker placement posed by dextroposition of the heart but offers possible solutions.

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