

Leadless Pacemaker Implantation in a Patient with Dextrocardia and Situs Inversus: Tips and Tricks

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INTRODUCTION

Situs inversus with dextrocardia is a rare congenital disorder manifested by mirror images of the abdominal visceral organs and the heart. Implanting a conventional pacemaker in such patients remains challenging because of the complex spatial orientation of the cardiac chambers and vascular accesses. Although the newly developed leadless pacemaker benefits patients, as it has no need for pocket creation or transvenous lead insertion, its implantation to patients with dextrocardia is even more difficult. Herein, we reported a successful implantation of leadless pacemaker in a patient with situs inversus with dextrocardia. A comprehensive pre-procedural image study was conducted to determine the route of approach, and a proper setting on the fluoroscopy image could facilitate the success of implantation.

CASE

A 79-year-old man had medical histories of situs inversus with dextrocardia, and coronary artery disease that was treated with stent deployment at the left ante-

rior descending coronary artery. For the last 8 months, he suffered from frequent palpitation and near syncope. Holter's electrocardiography (ECG) monitor disclosed atrial fibrillation (AF) with the highest ventricular rate of 164 beats per minute (bpm), and an episode of junctional bradycardia with a ventricular rate of 30 bpm (Figure 1A), indicating a tachycardia-bradycardia syndrome. Since his AF burden was near 100%, we chose to implant a ventricular pacing system for bradycardia. After shared decision making, we decided to implant a leadless pacemaker (Micra Transcatheter Pacemaker System, Medtronic Inc, Minneapolis, MN) because this patient was unwilling to have a conventional pacemaker pocket on chest wall.

His pre-procedural echocardiography showed dextrocardia with normal right ventricular chamber size, and an abdominal sonography disclosed a left-sided inferior vena cava (IVC). Therefore, we introduced the delivery system passing through the left femoral vein. Using a bi-plane fluoroscopy with right anterior oblique (RAO) angle of 40° and left anterior oblique (LAO) angle of 50° projections as usual, the leadless pacemaker was advanced to the low right atrium. With a slight counterclockwise torque on the delivery catheter, the catheter tip was advanced across the tricuspid valve into the right ventricle, approaching the anterior ventricular septum (Figure 1B and C). Since the fluoroscopy images of this patient were horizontally flipped compared to patients with levocardia, we switched the fluoroscopy image to the "mirror image" mode, converting images similar to patients with levocardia (Figure 1D and E). With the operator-familiar fluoroscopic images, the pacemaker was advanced and deployed at the low inter-ventricular septum by counterclockwise torque of the delivery catheter (Figure 1F). The pacing threshold was measured of 0.50 volts at pulse width 0.24 milliseconds, and the sensed R wave was 5.2 millivolts. No syncope episodes had occurred thereafter.

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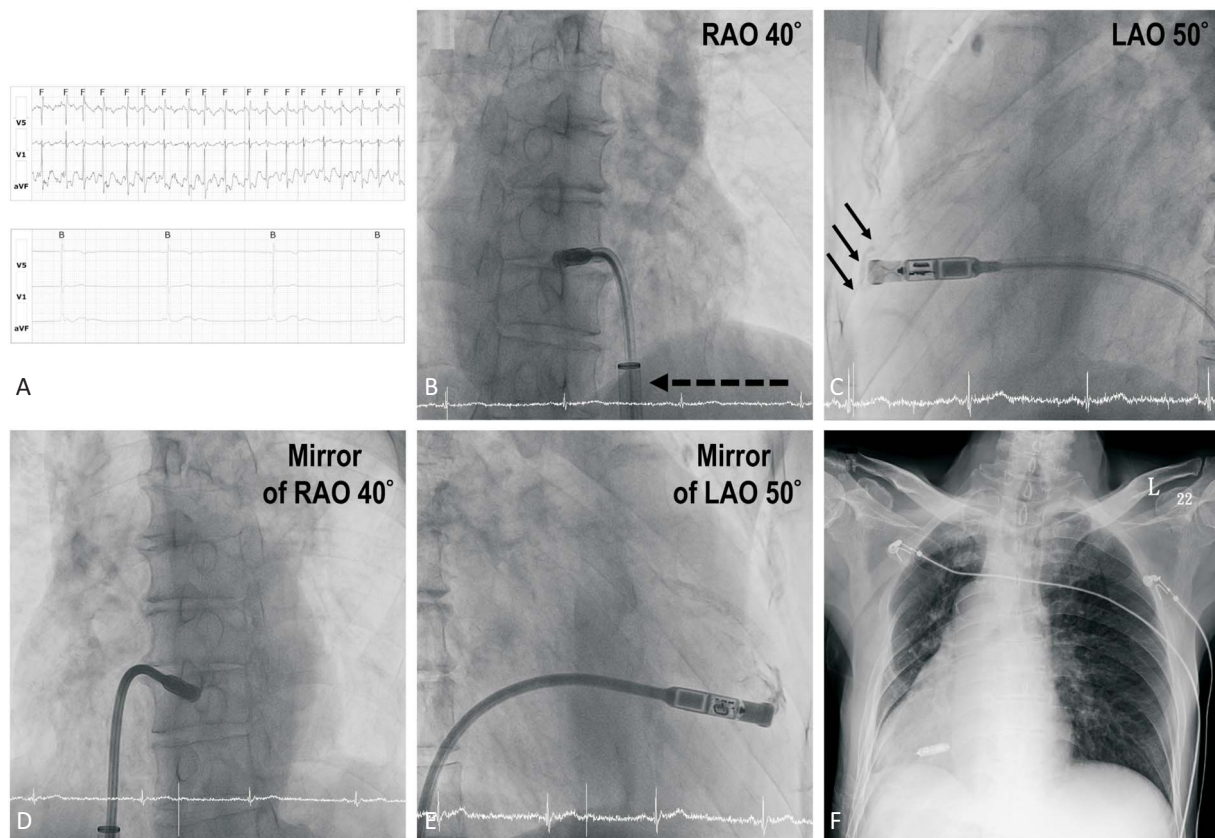


Figure 1. (A) Holter's ECG disclosed atrial fibrillation with the highest ventricular rate of 164 beats per minute (bpm), and an episode of junctional bradycardia with a ventricular rate of 30 bpm. (B) Right anterior oblique (RAO) 40° projection. The pacemaker introducer was located at the left-sided inferior vena cava (dotted arrow). (C) Left anterior oblique (LAO) 50° projection. The pacemaker was advanced toward the anterior septum of the right ventricle. The endocardium was illuminated by contrast medium (solid arrow). (D) Mirror image of RAO 40° projection. (E) Mirror image of LAO 50° projection. (F) Chest film after pacemaker implantation.

DISCUSSION

Situs inversus with dextrocardia is a rare congenital disorder that has a mirror image of both the abdominal organs and the heart, in which bradycardia necessitating pacing therapy is an even rarer situation. Despite the literatures on techniques of implanting a subcutaneous pacemaker in patients with dextrocardia, this procedure is still challenging. Leadless pacemaker is an emerging technology for these patients, and only limited studies have reported on the feasibility of leadless pacemaker in patients with congenital dextrocardia (Supplementary Table 1).^{1,2}

In these candidate patients for leadless pacemaker implantation, it is noteworthy that a "cardiac dextroposition" and a true "dextrocardia" are not synonyms.³ "Cardiac dextroposition" refers to the spatial interaction

of the organs in the thorax, in which cases the heart orientation points to the right while the chamber alignment is not changed. Therefore, in a suspected case of cardiac dextroposition, the pre-procedural images including chest X-ray, abdominal sonogram, and transthoracic echocardiography (TTE) are important in elucidating the cardiovascular anatomy. In our case, we chose the left femoral vein as the route for our delivery system as indicated by the pre-procedural TTE and abdominal sonogram. Because the IVC is left-sided in situs inversus, the left femoral approach might enhance the coaxial alignment between the delivery catheter and the IVC, thus preventing the 27-French catheter to be kinked during introduction, leading to IVC damages. Similar to our method, Sanhoury et al. also used a left femoral vein approach in a patient with double outlet right ventricle and dextrocardia.¹

In patients with dextrocardia undergoing a leadless pacemaker implantation, the fluoroscopic images with standard biplane projections were horizontally flipped for comparison with levocardia. Furthermore, the torque maneuver of the delivery system was in opposite direction with that in patients with levocardia. In such a double opposite situations, the procedure is even more challenging. As the operators were accustomed to the standard images with levocardia, we switched fluoroscopic images to the “mirror image” mode, which resembles images under common practice with levocardia. This image switching method expedited the procedure and improved the chance of success.

Implantation of a leadless pacemaker in patients with situs inversus and dextrocardia remains challenging. A comprehensive pre-procedural image evaluation might facilitate the decision for choosing vascular access. We suggested the use of a left femoral vein approach together with switching to “mirror image” mode on fluoroscopy to simulate a normal levocardia during the procedure. These methods might improve the success of implantation.

LEARNING POINTS

Leadless pacemaker implantation in patients with si-

tus inversus and dextrocardia is challenging because of the complex spatial orientation of the organs. A comprehensive pre-procedural image evaluation might facilitate the decision for choosing vascular access. Using a left femoral vein approach together with switching to “mirror image” mode on fluoroscopy to simulate a normal levocardia during the procedure might expedite the procedure and improve the chance of success.

DECLARATION OF CONFLICT OF INTERESTS

The authors declare that they have no competing interests.

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SUPPLEMENT

Supplementary Table 1. Case reports of leadless pacemaker implantation in patients with dextrocardia

Case (age/gender)	History and situs	Indication for VP Indication for LPM	Venous route	Fluoroscopic projection/guidance
47/female ¹	Dextrocardia Situs inversus DORV and VSD	CAVB Absent transvenous route	LFV	N/A
36/male ²	Dextrocardia Situs inversus	CAVB Endocarditis	RFV	Biplane RAO/LAO
79/male*	CAD Dextrocardia Situs inversus	Slow AF	LFV	Biplane RAO/LAO Prone position of the orientation to make mirror images

AF, atrial fibrillation; CAD, coronary artery disease; CAVB, complete AV block; DORV, double outlet right ventricle; LAO, left anterior oblique; LFV, left femoral vein; LPM, leadless pacemaker; N/A, non-available; RAO, right anterior oblique; RFV, right femoral vein; VP, ventricular pacing; VSD, ventricular septal defect.

* Our presenting case.