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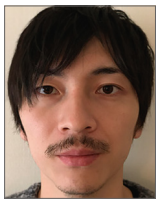
Transfemoral aortic valve implantation using the reverse X-ray image in a patient with dextrocardia situs inversus



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KEYWORDS

- aortic stenosis
- conduction abnormalities
- femoral
- TAVI

Abstract

A frail 94-year-old man, who had dextrocardia situs inversus and symptomatic severe aortic stenosis, underwent transcatheter aortic valve implantation (TAVI) using the femoral approach. Computed tomography showed that there were no other cardiovascular malformations. Generally, it was difficult to maintain awareness of the position between his heart and ascending aorta during the procedure because of the inversion of these structures. Therefore, the reverse X-ray image was used to facilitate TAVI, and the procedure was successful without complications. However, nine days after TAVI, he developed complete atrioventricular block that was symptomatic. Therefore, he underwent cardiac pacemaker implantation using the reverse X-ray image to help position the atrial and ventricular leads.

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Abbreviations

AS	aortic stenosis
AVB	atrioventricular block
CT	computed tomography
PMI	pacemaker implantation
SVC	superior vena cava
TAVI	transcatheter aortic valve implantation

Introduction

Transcatheter aortic valve implantation (TAVI) is increasingly used in patients who have symptomatic aortic stenosis (AS) and have a high risk for an invasive operation or contraindications for surgery[1,2]. Generally, it is difficult to perform any cardiovascular interventions in patients with dextrocardia situs inversus, because this condition is rare and makes it difficult to understand the relative anatomical locations of the heart and great vessels. There have been few reports of TAVI in patients with dextrocardia situs inversus. We report a patient with dextrocardia situs inversus who underwent TAVI and then required pacemaker implantation (PMI) due to delayed onset complete atrioventricular block (AVB).

Methods and results

A 94-year-old man who had dextrocardia situs inversus was referred to our hospital with recurrent syncope. His medical history included congestive heart failure, hypertension and dementia. The electrocardiogram showed sinus rhythm and first-degree AVB without bundle branch block. Echocardiography showed a heavily calcified aortic valve with a mean gradient of 46 mmHg, normal left ventricular systolic function and no other significant valvular disease. Coronary angiography revealed no significant stenosis. In addition, computed tomography (CT) showed dextrocardia **(Figure 1)**, which consisted of a right-sided aorta and left-sided inferior vena cava. CT also showed an aortic annulus area of 416 mm^2 and a mean diameter of 23 mm. Furthermore, CT demonstrated suitable iliofemoral arteries without stenosis or calcification that could be used as an access route. Our Heart Team concluded that he was a candidate for transfemoral TAVI, because of his advanced age and frailty despite an intermediate surgical risk (logistic EuroSCORE 13.6% and Society of Thoracic Surgeons score 7.2%).

The procedure was performed under general anaesthesia. An 18 Fr Edwards arterial expandable sheath (Edwards Lifesciences, Irvine, CA, USA) was inserted from the left femoral artery. All procedures except for vessel puncture and sheath insertion were performed using the reverse X-ray image **(Figure 2)**. A pacing wire was inserted from the right femoral vein, and the tip was located in the right ventricle. A 0.035-inch super-stiff wire (Amplatz Extra-Stiff Wire; Cook Medical, Bloomington, IN, USA) was passed through the aortic valve. Balloon aortic valvuloplasty was performed with a 23 mm balloon (Edwards Lifesciences) under rapid pacing. The NovaFlex+ Delivery System (Edwards Lifesciences) was inserted into the expandable sheath after a 180° rotation so that the Edwards logo pointed downwards. This allowed the delivery system to pass smoothly through the inverted aortic arch **(Figure 3)**. A 26 mm Edwards SAPIEN XT valve (Edwards Lifesciences) was implanted under rapid pacing. After valve implantation, aortography and transoesophageal echocardiography showed an excellent valve position without aortic regurgitation.

At nine days after TAVI, the patient suddenly presented complete AVB. CT before TAVI showed a left-sided superior vena cava (SVC) draining into the right atrium and no other structural malformation such as persistent left SVC. Again using the reverse X-ray image during the procedure so that the anatomical orientation could be understood and the procedure performed with the usual image, the atrial and ventricular leads of a permanent pacemaker were successfully implanted into the right atrium and ventricle through the right subclavian vein. Eventually, he was discharged without any further events after TAVI.

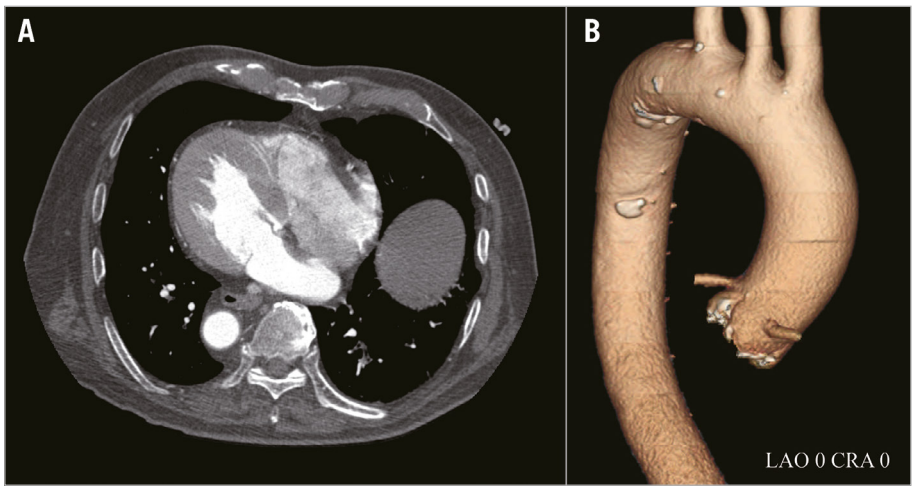

Figure 1. *Computed tomography. A) Right-sided left ventricle and descending aorta. B) 3D image of the right-sided aortic arch. CRA: cranial oblique; LAO: left anterior oblique*

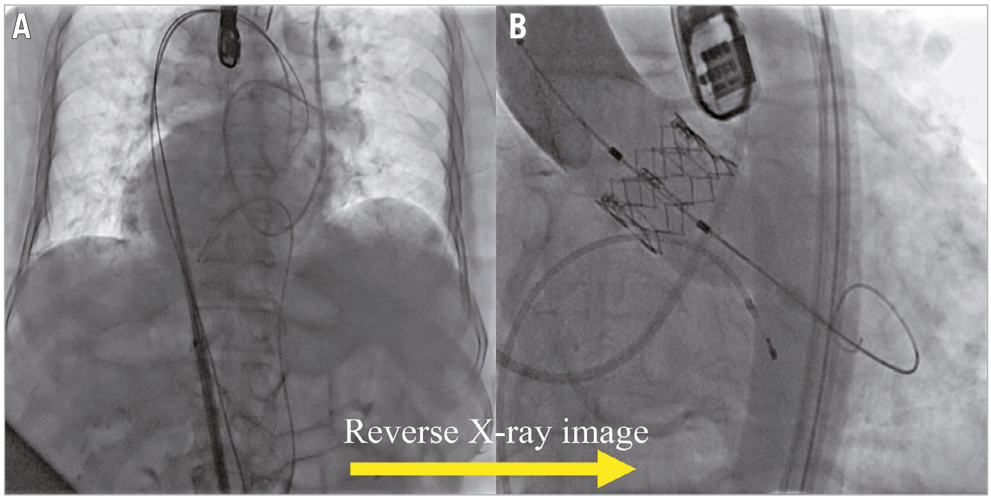

Figure 2. *X-ray image. A) Sheath insertion using a normal X-ray image. B) Deployment of a 26 mm Edwards SAPIEN XT valve using the reverse X-ray image.*

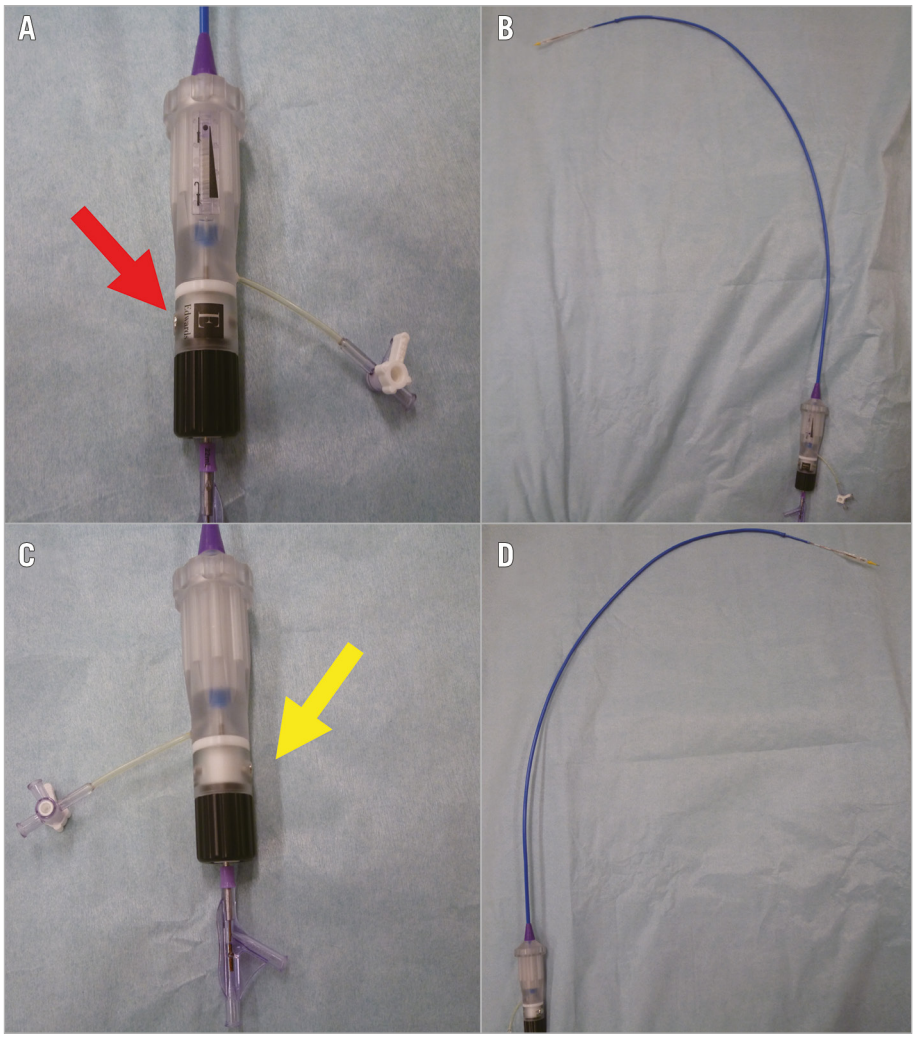

Figure 3. *NovaFlex+ Transfemoral Delivery System. In normal usage, (A) the Edwards logo faces upwards (red arrow) and (B) the delivery system flexes to the left. In this case, (C) the Edwards logo was rotated 180° (yellow arrow), so that (D) the delivery system flexed to the right and passed through the right-sided aortic arch.*

Discussion

To our knowledge, this is the first reported case of dextrocardia situs inversus to have TAVI using the reverse X-ray image.

Dextrocardia is a very rare congenital heart disease. A previous study reported that the incidence of dextrocardia is about one in 12,000 live births[3]. Dextrocardia is often associated with various structural malformations such as univentricular heart and bilateral SVC[3]. In this case, CT revealed a simple mirror image dextrocardia without other structural heart disease. There are few reports of TAVI in patients with dextrocardia situs inversus[4,5]. Dubois et al reported that an 84-year-old woman with situs inversus totalis and symptomatic AS underwent successful TAVI. Three-dimensional reconstruction of a preoperative cardiac angio CT before TAVI was useful to confirm the relative positions of the heart and great vessels[4]. In addition, Good et al showed that, when a patient with dextrocardia situs inversus undergoes TAVI, it is important to rotate the NovaFlex+ Transfemoral System by 180° when inserting it into the expandable sheath[5].

Understanding cardiac structure and appropriate modification of the procedure are mandatory in order to perform TAVI in patients with dextrocardia, because the structure of heart and arteries is different from normal. Two important issues for successful TAVI are: 1) insertion of the NovaFlex+ Delivery System into the expandable sheath after 180° rotation, and 2) the use of the reverse X-ray image. The correct insertion and advancement of the NovaFlex+ Delivery System into the expandable sheath is crucial, and this involves aiming the Edwards logo downwards instead of upwards. This should result in a smooth delivery of the device into the aortic valve through the right-sided aortic arch. Furthermore, the reverse structure of the arch and ascending aorta can lead to difficulty in performing TAVI. Therefore, the reverse X-ray image is very effective and useful for understanding the orientation of the device and simplifying the procedure. In addition, it also simplifies the pacemaker lead insertion into the right atrium and ventricle. In this case, the reverse X-ray image was used for both TAVI and pacemaker implantation.

Limitations

Our technique might not be applicable in patients with other structural malformations.

Conclusion

We need to understand the structure of the heart and great vessels in individual patients who have dextrocardia and who undergo TAVI. In cases of dextrocardia without other cardiovascular malformations, insertion of the NovaFlex+ Delivery System into the expandable sheath after 180° rotation and the reverse X-ray image are important in order to perform TAVI successfully. Theoretically, these methods can be applied when the Commander delivery system and Edwards SAPIEN 3 valve (Edwards Lifesciences) are used.

Impact on daily practice

Insertion of the NovaFlex+ Delivery System into the expandable sheath after 180° rotation, and the use of the reverse X-ray image are efficient in order to perform TAVI in a patient with dextrocardia situs inversus. These methods are theoretically useful for TAVI in the SAPIEN 3 era.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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