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Case Report

Successful Repositioning of Left Ventricular Wire after Advancing Delivery System in a Transapical Transcatheter Aortic Valve Implantation Procedure: A Case Report

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Objective: The wire route in the left ventricle (LV) is a key factor for successful transcatheter aortic valve implantation (TAVI). The transapical (TA) approach is the only antegrade approach in which valve crossing is usually easy. In this case, we failed to cross the wire after the transcatheter heart valve (THV) became lodged. However, we bailed out and implanted successfully by confirming the wire route with a dummy valve cross technique.
Case Presentation: A woman in her late 70s presented with symptomatic severe aortic valve stenosis and shaggy descending aorta. As she was frail after bilateral arthroplasty, our heart team decided to perform TA-TAVI under general anesthesia. After apical puncture, the guidewire was passed through the aortic valve under fluoroscopy. Transesophageal echocardiography (TEE) showed the wire running along the septal wall, and the THV was advanced into the LV. However, the THV became lodged below the aortic valve. We reviewed the TEE findings and concluded the wire and delivery system had passed through the chordae tendineae. Therefore, we removed the whole system from the LV and reattempted wire crossing. To confirm the correct wire route, we advanced an aortic valvuloplasty balloon as a dummy valve before inserting the actual THV. The THV passed smoothly through the aortic valve and was implanted successfully. The postoperative course was uneventful, with no bleeding.
Conclusion: In TA-TAVI, the wire route in the LV around the apex is poorly visualized. A dummy valve cross technique might be useful to confirm the wire route.

Keywords: alternative approach, transapical, complication

Introduction

Since the first human transcatheter aortic valve implantation (TAVI) in 2002 in a non-operable aortic stenosis patient, surgical aortic valve replacement is increasingly complemented by TAVI. Currently, TAVI has been established as the standard treatment for not only older patients at high or intermediate risk for surgical aortic valve replacement[1,2] but also low-risk patients, including young patients.[3]

One of the key factors for successful TAVI is the wire route in the left ventricle (LV).[4] Among the possible approaches, the transapical (TA) approach is the only antegrade approach in which valve crossing is usually easy. In the present case, we could not cross the transcatheter heart valve (THV), which became lodged

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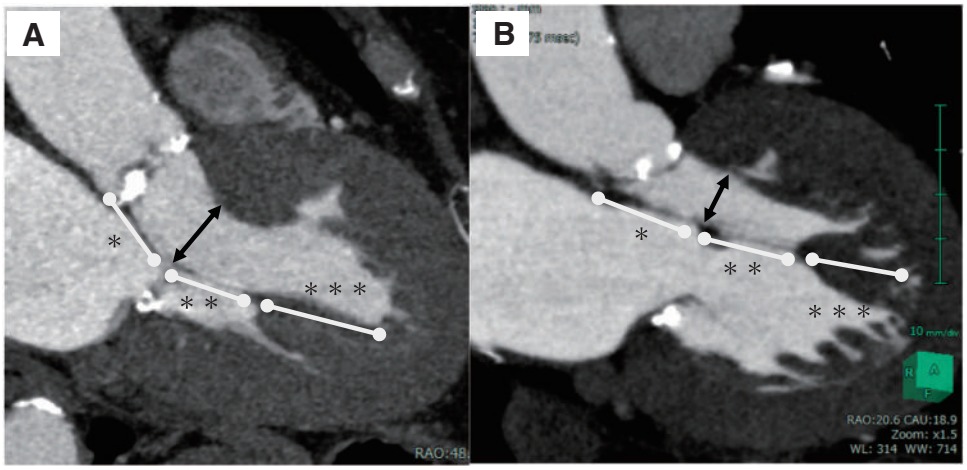

Fig. 1 Computed tomography showing the differences in the mitral subvalvular apparatus and LVOT statuses depending on the cardiac phase. In the systolic phase (**A**), the passage through the aortic valve is wide, but in the diastolic phase (**B**), the passage through the aortic valve is narrow. (*mitral valve leaflet, **chordae tendineae, and ***papillary muscle.) LVOT: left ventricular outflow tract

below the aortic valve owing to an incorrect wire route. However, we bailed out and implanted successfully by devising a technique to confirm the LV wire route using a valvuloplasty balloon as a dummy valve in TA-TAVI.

Case Presentation

A woman in her late 70s presented with dyspnea. She had a history of hypertension, diabetes mellitus, and coronary intervention for angina. She had previously undergone bilateral knee joint replacement because of knee osteoarthritis and was able to walk with a cane. The Japan score and the Society of Thoracic Surgeons (STS) score were 2.2% and 2.15%, respectively. Echocardiography showed severe aortic stenosis, with a maximum aortic valve velocity of 5.5 m/s and an aortic valve area of 0.54 cm^2. The grade of aortic regurgitation was mild. Computed tomography showed that the aortic valve annulus area was 482 mm^2, the perimeter of the aortic annulus was 79.8 mm. The diameter of the sinuses of Valsalva was 27–29 mm and the height was 14–16 mm. The LV had space enough to pass through the wire (**Fig. 1A**). The descending aorta had localized intense plaque. Following a discussion among our heart team members, we planned to perform TA-TAVI to avoid shower embolization due to the plaque, which was a risk with a transfemoral approach.

Intervention

After induction of general anesthesia, the LV apex was exposed surgically via a left anterolateral thoracotomy from the 5th intercostal space. We used transesophageal echocardiography (TEE) during the procedure to detect the puncture site on the LV and to guide the wire. There were no apparent abnormalities before the procedure. First, we punctured the area with double purse string sutures using 3-0 polypropylene with round pledgets between the left anterior descending artery and the diagonal branch and passed a J-shaped Goodtec Spring Guide Wire (NIPRO, Osaka, Japan) to the right brachial artery. Then, the first wire was exchanged to an Amplatz extra-stiff guidewire (Cook Medical Japan G.K., Tokyo, Japan) over a JR40 Goodtec Angiographic catheter (NIPRO). We assessed the wire route in the LV by TEE and confirmed no abnormal findings, such as a high degree of mitral regurgitation and close distance from the chordae tendineae (**Fig. 2A**). We then inserted a Certitude Introducer Sheath (Edwards Lifesciences, Irvine, CA, USA) for 3 cm into the LV over the extra-stiff wire. A 26-mm SAPIEN 3 valve (Edwards Lifesciences) was delivered on the Certitude delivery system (Edwards Lifesciences) to the aortic valve. However, the THV became lodged and could not be advanced below the aortic valve. TEE and fluoroscopy showed the delivery system was bent because of the lodged THV (**Figs. 2B** and **2C**). We reviewed the recorded TEE findings to assess the wire route in detail (**Fig. 2A**) and concluded the wire became tangled with the chordae tendineae and the THV lodged in the chordae. Therefore, we decided to retract and remove the wire and the whole THV system to correct the wire route. As the THV was not fixed to the Certitude delivery system, there was the risk of dropping the THV from the delivery system in the

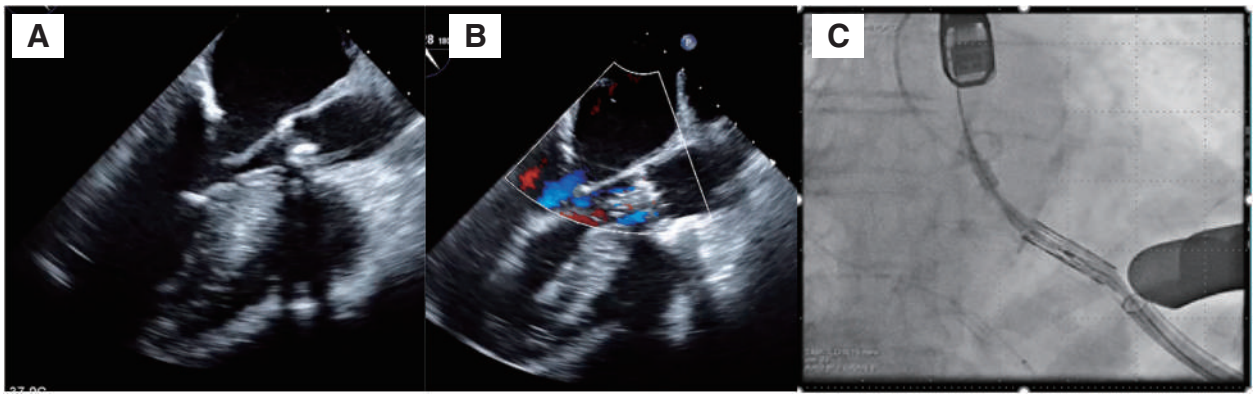

Fig. 2 Transesophageal echocardiography showing the incorrect wire route around the LVOT and aortic valve (**A**). The THV became lodged below the aortic valve, and the delivery system bent (**B**) during the first THV placement attempt. Fluoroscopy also shows the THV lodged below the aortic valve and the bent delivery system (**C**). LVOT: left ventricular outflow tract; THV: transcatheter heart valve

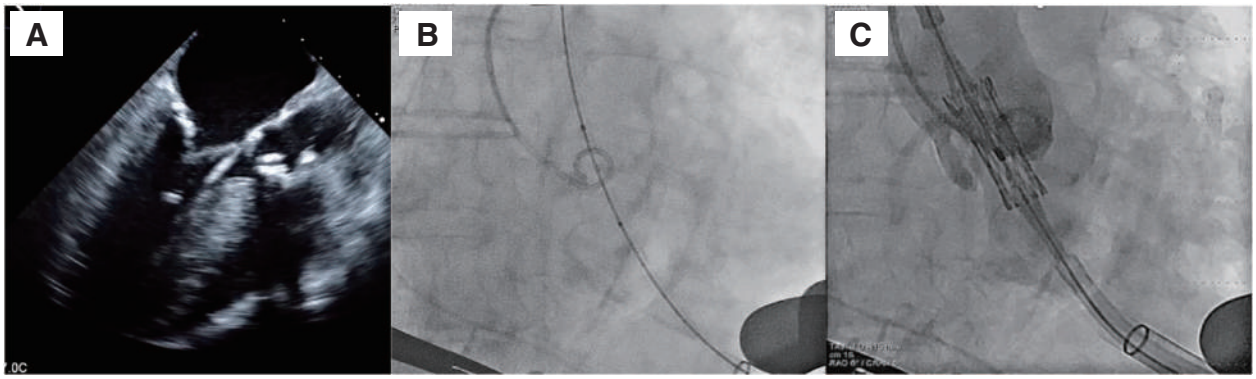

Fig. 3 Transesophageal echocardiography showing the correct wire route around the LVOT and the aortic valve during the second THV placement attempt (**A**). Fluoroscopy showing the Ascendra balloon catheter crossing the aortic valve as a dummy valve, with no resistance (**B**) and the actual THV delivered in the correct position (**C**). LVOT: left ventricular outflow tract; THV: transcatheter heart valve

LV when retracting the delivery system. Under rapid pacing, the Certitude delivery system was retracted with the Certitude Introducer Sheath to avoid dropping the THV and was successfully removed without leaving the THV in the LV. Bleeding from the puncture site was controlled by tightening the purse string sutures. After removing the whole delivery system, we inserted only the tip of the 8-Fr sheath (MEDIKIT CO., LTD., Tokyo, Japan) from the original puncture site in the LV wall. We aimed to cross the aortic valve with the wire to avoid the chordae tendineae. We confirmed the correct wire route by TEE (**Fig. 3A**); however, we needed to confirm the wire route with more confidence. We tried passing an Ascendra balloon catheter (Edwards Lifesciences), which is a provided balloon for aortic valvuloplasty, as a dummy valve, through the aortic valve before inserting the actual THV. Over the extra-stiff wire, the Ascendra balloon with a deflation state passed through the aortic valve without lodging (**Fig. 3B**, Supplementary Movie File; All supplementary files are available Online). Then, we inserted the second THV into the LV and achieved successful implantation as usual, with no difficulties (**Fig. 3C**). An additional suture was necessary to control bleeding from the puncture site in the LV wall as the hole enlarged during retraction of the first THV. Post-procedure angiography and TEE showed only mild paravalvular leakage, and no mitral regurgitation was introduced by valve lodging.

Outcome

The patient was returned to the intensive care unit under intubation and was extubated on the third postoperative day. Although she developed no cardiac deterioration postoperatively and no adverse events, including

postoperative bleeding, the long duration of intubation and the more surgical stress than TF-TAVI caused a long hospital stay. She was transferred to another hospital for rehabilitation on the 22nd postoperative day as she had walked with a cane preoperatively. Postoperative transthoracic echocardiography before transfer showed good ventricular function, with no paravalvular leaks and mitral regurgitation. The maximum aortic valve velocity was 2.0 m/s, with no pericardial effusion.

Discussion

The LV wire route and position are important for successful TAVI.[4] Wire valve crossing is usually easier in the TA approach than the transfemoral approach, as the TA approach is the only antegrade approach among the possible approaches. Usually, the delivery system also passes through the aortic valve without difficulty. Nevertheless, in the present case, the wire ran along an incorrect route, and the THV became lodged in the LV despite TEE guidance. There are two key factors in this failure. First is the blind area during TEE. As with the transfemoral approach, the wire route in the LV was confirmed by TEE with the findings of no simultaneous motion regarding the mitral valve anterior leaflet, no worsening mitral regurgitation, and visual confirmation of the wire running along the septal wall. However, in the present case, despite TEE guidance, we crossed the wire using an incorrect route. We could not detect the error of the wire route in the LV by TEE because of the blind area during TEE. Generally, TEE can visualize all four chambers without a blind area.[5] However, once the sheath is inserted from the apex, it can be difficult to visualize the wire route, especially around the apex and LV, even with TEE. This is due to artifact signals from the sheath or delivery system. Second is the dynamic change of the status of the LV structure throughout the cardiac phases. The direction, position, and tension of the mitral anterior leaflet, chordae tendineae, and papillary muscle change dynamically during beating. **Figure 1** shows the difference in the mitral subvalvular apparatus status between systole (**Fig. 1A**) and diastole (**Fig. 1B**) in the present case. Depending on the cardiac phase, the passage of the LV wire is quite different, which results in the risk of an incorrect wire route. This might be a pitfall for wire crossing in the LV in TA-TAVI.

In the present case, we successfully retracted the THV without dropping it in the LV. If the THV is dropped in the LV, it is extremely difficult to resolve the situation owing to bleeding.[6–8] Because, in principle, the THV cannot be retracted after insertion, it is extremely important to ensure that the wire route is correct before inserting the THV. Therefore, a reliable method of confirming the LV wire route is required. The dummy valve cross technique using an Ascendra balloon catheter, which was used in this case, is very useful to confirm the correct wire route in TA-TAVI before advancing the actual THV. This balloon resembles the deflation state of the actual delivery system mounting for the THV regarding the shaft diameter, stiffness, and tip shape. Therefore, this balloon is optimal, even in a deflation state, to attempt valve crossing instead of using the actual THV and delivery system. In addition, the dummy crossing takes only a few minutes and, as this balloon is provided with the SAPIEN delivery system, no extra cost is incurred.

Conclusion

We experienced wire cross failure in TA-TAVI. Before advancing the THV into the LV, the wire route in the LV should be confirmed by various evaluations, of which the dummy valve cross technique with an Ascendra balloon catheter may be useful.

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Author Contributions

Research conception and design: YN
Manuscript drafting: YN
Final approval of the version to be published: all authors
Accountability for all aspects of the work: all authors

Disclosure Statement

All authors declare there were no conflicts of interest in relation to the manuscript.

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