Perfusion Balloon Is Useful for Preventing Obstruction of Left Main Coronary Artery During Transcatheter Aortic Valve Implantation

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Summary

The incidence of acute coronary obstruction during transcatheter aortic valve implantation (TAVI) is low (< 1.0%); however, it is associated with high mortality. An 83-year-old female with a history of chest pain and syncope was diagnosed with severe aortic stenosis. Computed tomography showed severely calcified aortic leaflets with a low left coronary ostial height of 7.8 mm, which indicates a high risk of coronary obstruction. TAVI was performed using the right femoral artery approach under general anesthesia. To prevent coronary obstruction and minimize coronary flow obstruction, coronary protection of the left main tract (LMT) via the left radial artery was established with a perfusion balloon. We crossed a 23 mm Sapien 3 transcatheter heart valve and settled it at an appropriate position on the aortic valve. After inflation of the perfusion balloon at the LMT, we started rapid ventricular pacing, and deployed the Sapien 3 using the KBI technique. Hemodynamics were stable and aortography showed excellent coronary flow with no stenosis of the LMT ostium. This strategy may serve as a useful method to prevent coronary obstruction and minimize coronary ischemia.

Key words: Aortic stenosis, Coronary protection

Acute coronary obstruction is a life-threatening complication of transcatheter aortic valve implantation (TAVI).1,2 The incidence of acute coronary obstruction during TAVI is < 1.0%; however, it is associated with high mortality.3,4 According to data from a Japanese multicenter registry, acute coronary obstruction had an incidence of 1.5%, mainly occurred in females (70%), and was primarily located in the left coronary artery (70%). There were no differences in mortality or other periprocedural complications between patients with and without coronary protection.5 However, coronary protection during TAVI is a preemptive and important technique to avoid serious complications due to coronary obstruction. We report here on a patient with high risk of coronary obstruction who underwent TAVI with the coronary protection technique using a perfusion balloon.

Case Report

An 83-year-old female with chest pain and a history of 3 episodes of syncope was diagnosed with very severe aortic stenosis (Figure 1A). Her height and body weight were 137.7 cm and 60.3 kg, respectively. Her past medical history includes diabetes mellitus controlled by oral medication (HbA1c, 7.2%) and hypertension. Transthoracic echocardiography revealed an aortic valve area of 0.4 cm², a mean aortic valve pressure gradient of 89 mmHg, and a peak velocity of 6.2 m/second with a decreased left ventricular ejection fraction (Simpson method, 47%). Concentric left ventricular hypertrophy and mild to moderate aortic regurgitation were detected. Table I shows the computed tomography (CT) measurements. The sizes of aortic annulus, sinus of Valsalva, and ST junction were 436 mm², 28 mm, and 25 mm, respectively. CT showed severely calcified aortic leaflets and a low left coronary ostial height of 7.8 mm (Figure 1B). In addition, her Agatston score for the aortic valve complex was 5296. This score indicated a very high amount of calcification on her aortic valve complex as shown in Figure 1C. The vessel diameter of the left main tract (LMT) on CT measurement was 4.0 mm. Coronary angiography showed no significant stenosis and no calcification of the LMT. Her estimated surgical mortality by the Society of Thoracic Surgeons score for surgical aortic valve replacement (SAVR) was 5.4%; hence, our cardiology team decided to proceed with TAVI using the coronary protection technique. For coronary protection while maintaining coronary flow during the procedure, we decided to use a perfusion balloon for the LMT. Because there was no LMT lesion, we selected a 3.0 mm perfusion balloon, which was...
Figure 1. CT measurement before the TAVI procedure. **A:** Short-axis view of the aortic valve. Hard calcification on the LCC. **B:** Measurement of coronary heights. The height of the left coronary artery from the annulus line measures 7.8 mm. **C:** Measurement of Agatston score for aortic valve. CT indicates computed tomography; TAVI, transcatheter aortic valve implantation; and LCC, left coronary cusp.

| Variable                        | CT Measurements                                                                 |
|---------------------------------|---------------------------------------------------------------------------------|
| Annulus                         |                                                                                |
| Area, mm²                       | 436.15                                                                          |
| Circumference, mm               | 75.77                                                                           |
| Minimum diameter, mm            | 20.48                                                                           |
| Maximum diameter, mm            | 26.38                                                                           |
| LVOT                            |                                                                                |
| Area, mm²                       | 416.19                                                                          |
| Circumference, mm               | 76.46                                                                           |
| Minimum diameter, mm            | 19.30                                                                           |
| Maximum diameter, mm            | 27.11                                                                           |
| Sinotubular junction            |                                                                                |
| Area, mm²                       | 543.05                                                                          |
| Circumference, mm               | 83.64                                                                           |
| Minimum diameter, mm            | 25.39                                                                           |
| Maximum diameter, mm            | 27.52                                                                           |
| Leaflet length of LCC, mm       | 12.0                                                                            |
| Distance between annulus and coronary ostia |                                    |
| Left, mm                        | 7.8                                                                             |
| Right, mm                       | 13.7                                                                            |
| Sinus of Valsalva               |                                                                                |
| NCC (width/height), mm          | 27.9/15.1                                                                       |
| RCC (width/height), mm          | 27.9/17.0                                                                       |
| LCC (width/height), mm          | 29.1/17.8                                                                       |
| Ascending aorta (Minimum/Maximum), mm | 31.5/33.3                       |
| Agatston score for aortic valve complex | 5296                         |

CT indicates computed tomography; LVOT, left ventricular outflow tract; NCC, non coronary cusp; RCC, right coronary cusp; and LCC, left coronary cusp.

Transesophageal echocardiography (TEE) was performed under general anesthesia. A 14 Fr eSheath (Edwards Lifesciences, Irvine, CA, USA) was inserted via the right femoral artery, and the TAVI procedural system was established. The coronary protection system was established via the left radial artery. A 6 Fr Judkins left catheter was engaged to the LMT, and a floppy coronary wire was crossed to the left anterior descending (LAD) artery. A 3.0 × 20 mm perfusion balloon (Ryusei; Kaneka Medix Corp., Osaka, Japan) was placed in the mid-LAD artery. Before the pre-balloon aortic valvuloplasty (pre-BAV), a perfusion balloon was inflated at the LMT ostium. Kissing balloon inflation (KBI) was performed using a 20 mm balloon in the aortic valve, and a perfusion balloon was used in the LMT during rapid ventricular pacing. After deflation of the 20 mm balloon for the aortic valve, we deflated the perfusion balloon and confirmed the coronary flow of the left coronary artery (LCA) by aortography. After pre-BAV, hemodynamics and the LCA flow were stable. Therefore, we decided to deploy a 23 mm Sapien 3 transcatheter heart valve (Edwards Lifesciences) with a similar KBI technique using a perfusion balloon. We crossed the 23 mm Sapien 3 and selected the appropriate position at the aortic valve (Figure 2A). After inflation of the perfusion balloon at the LMT, we started rapid ventricular pacing, and deployed a 23 mm Sapien 3 using the KBI technique (Figure 2B). After deflating the valve balloon and stopping the rapid pacing, we deflated the perfusion balloon. After valve deployment, her hemodynamics
The patients were stable and TEE and aortography showed excellent coronary flow and no significant perivalvular leakage (Figure 2C). It was easy to engage the Judkins left catheter to the LCA, and angiography showed excellent LCA flow (Figure 2D). Therefore, we successfully finished the procedure with no complications.

The post-procedural CT showed a well seated calcification on the left coronary sinus with successful LMT protection (Figure 3). The patient recovered with rehabilitation uneventfully and was discharged 10 days after the procedure without complications. At her 90-day postoperative follow-up, she had no symptoms or complications.

**Discussion**

Although TAVI is an excellent treatment option
avoided because there was no calcification or stenosis on the LMT. We concluded that unnecessary injury to the LMT should be avoided because there was no calcification or stenosis on the LMT. As an updated method for coronary protection, we performed the KBI technique using a perfusion balloon for LMT ostial protection. In a previous report, a perfusion balloon catheter was developed to allow passive myocardial perfusion during balloon inflation through a central lumen and multiple side holes in the shaft proximal and distal to the balloon. A perfusion balloon is often used for a situation like coronary perforation during percutaneous coronary intervention to block the leakage of the perforate site while perfusing minimal blood flow to the distal portion of the vessel.

Because the present case had a low coronary ostial height of the LCA and significant LCC calcification, we concluded there was a very high risk of coronary obstruction. Using the KBI technique successfully prevented LMT obstruction caused by pushing up LCC calcification during pre-BAV and deploying the Sapien 3 valve. The KBI technique should be considered in cases with small SOV size or bulky LCC calcification in addition to an LCA height less than 10 mm. In this case, the patient had an LCA height of 7.8 mm and bulky LCC calcification, so we believed KBI should be performed.

Stenting the LMT may be a more reliable method of preventing coronary artery occlusion in patients who have many risk factors for coronary artery occlusion and an LMT calcified lesion. On the other hand, it is not recommended for patients without an LMT lesion due to its high medical cost and the possibility of poor coronary access after stenting. The present KBI technique using a perfusion balloon may be considered as one option in patients with LCA height less than 10 mm, small SOV size or strong LCC calcification, and no LMT calcified lesion.

When performing KBI with a balloon expandable transcatheter heart valve (THV), coronary balloon expansion must be started before rapid pacing begins. KBI with a perfusion balloon can be performed more calmly than with a regular balloon, without worrying about the coronary no-flow time. In addition, a perfusion balloon allows for longer inflation than a regular balloon to prevent external compression after THV balloon deflation.

Although the balloon diameter (3.0 mm) was smaller than the diameter of LMT, there might be a potential risk of intimal injury at the LMT, which may provoke late adverse coronary events. Careful follow-up is required.

Since coronary access is more difficult after self-expandable valve implantation than balloon-expandable valve implantation, it is more important to protect coronary artery occlusion in cases of self-expandable valve implantation. Further, since it takes more time to complete valve deployment in self-expandable valve implantation,
coronary occlusion time during a KBI procedure may be longer than balloon-expandable valve implantation. The KBI technique with a perfusion balloon could be used to avoid this concern, and may be more useful in self-expandable valve implantation compared with balloon-expandable valve implantation.

In this case, there was a risk of coronary obstruction due to the extended sealing skirt of the self-expandable valve. Therefore, we chose a balloon-expandable valve. To clarify the usefulness of the KBI technique using a perfusion balloon, a prospective multicenter study should be conducted. The rigidity of the perfusion balloon against advanced calcification and transcatheter heart valve compression also needs to be verified in the future.

This case was successfully performed by using a slightly smaller balloon to avoid LMT dissection. Further study is needed to verify whether a smaller balloon would be better than a sufficient sized balloon.

Conclusion
Coronary protection using an inflated perfusion balloon at the LMT during TAVI may serve as a useful method with which to prevent coronary obstruction and minimize myocardial ischemia.

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Disclosure
Conflicts of interest: We have no conflicts of interest.

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