A Case With Successful Retrograde Stent Delivery via AC Branch for Tortuous Right Coronary Artery

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Abstract: The retrograde approach is a novel technique of percutaneous coronary intervention for chronic total occlusion. This technique has improved the success rate of guidewire passage through the occlusion. In the retrograde approach, a microcatheter and balloon are delivered through a retrograde channel. However, it is difficult for a stent to pass through collateral arteries. We report a case of coronary artery stenosis in a markedly tortuous right coronary artery for which a drug-eluting stent was delivered retrogradely via the atrial circumflex branch.

Key words: percutaneous coronary intervention, retrograde approach, collateral artery

Coronary stents have long been used for the treatment of atherosclerotic coronary artery disease because of their ability to achieve lower restenosis rates than balloon angioplasty alone. In addition, the introduction of the drug-eluting stent (DES) has helped reduce the need for target lesion revascularization and in this regard, the rate of cardiac events including revascularization during 1 year of follow-up after placement of a Cypher stent, the first provided DES for use in the clinical setting, was less than 10%. However, as stents are made of metal and therefore rigid, they are occasionally difficult to deliver, especially to tortuous vessels. Recently, the retrograde approach has been employed mainly for the treatment of chronic total occlusion of the coronary artery, and with advances in devices exclusive for the retrograde approach, it is becoming established as a therapeutic technique. With this procedure, the microcatheter and balloon are delivered through collateral vessels such as septal perforator and epicardial coronary arteries such as atrial circumflex (AC) branch, posterolateral (PL) branch, and right ventricular (RV) branch, for support of the guidewire and dilatation of the subintimal space. However, it was considered practically impossible to deliver stents via collateral arteries due to their rigid profile. Here, we report a case of coronary artery narrowing in a markedly tortuous right coronary artery (RCA), treated with a DES delivered via the AC branch in a retrograde manner.

Case report
An 81-year-old male with hypertension and hyperlipidemia presented with exertional chest pain. Diagnostic catheterization was undertaken to explore for the presence of coronary artery stenosis. Coronary arteriography revealed severe luminal narrowings in the RCA and left circumflex (LCX) coronary artery (Figures 1A-1D). Moreover, the RCA was markedly tortuous and huge collateral networks were identified between the RCA and LCX (Figure 1E).

The patient underwent first percutaneous coronary intervention for the LCX lesion with the right radial approach. A 5.5 Fr JL 3.5 sheathless guiding catheter (Medikit) was cannulated to the left coronary artery. The back-up force of the guiding catheter was adequate for delivery of a Multi-Link Vision stent (4.0 × 23 mm; Abbott Vascular) despite moderate tortuosity of the ostial LCX. The lesion was successfully dilated and sufficient coronary flow was obtained after stent placement (Figure 2A), and after opening the LCX lesion, abundant collateral circulations to the peripheral RCA via the AC branch were observed.

Thereafter, percutaneous coronary intervention (PCI) for the coronary stenoses in the
RCA was attempted. The two target lesions were located in the middle and distal portions, respectively. The RCA was markedly tortuous between the stenoses and therefore, the operator decided on a femoral approach to obtain a strong back-up force for the guiding catheter. Insertion of a 7 Fr sheath was attempted from the right femoral artery, but the tortuosity of the right iliac artery resulted in incomplete insertion of the 20-cm long sheath. The left iliac artery was even more tortuous; therefore, the procedure was started with the right femoral approach. When a 7 Fr SAL1 guiding catheter (Launcher; Medtronic) was cannulated to the RCA, engagement of the guiding catheter was insufficient because of reduced torque transmission due to the tortuosity of the iliac artery. A Fielder FC guidewire (Asahi Intecc) crossed the two lesions toward the distal RCA, and IVUS examination was attempted. An Eagle Eye IVUS catheter (Volcano) was able to advance to the proximal portion of the middle RCA lesion, and a Cypher stent (3.5 × 18 mm; Cordis Corporation) could be delivered and deployed to the middle RCA lesion (Figure 2B). After implantation of the first Cypher stent, the Eagle Eye was able to advance across the middle RCA lesion, though the guiding catheter was pushed back when the IVUS catheter was advanced further. At this moment, delivery of the Cypher stent to the distal RCA lesion was considered to be too laborious, and the operator therefore decided to attempt retrograde stent delivery through the AC branch. A 90-cm long 7 Fr AL1 guiding catheter (Axess; SJM Japan) was inserted from the right brachial artery and cannulated to the left coronary artery. Then, another Fielder FC guidewire was advanced to the LCX and negotiated the AC branch. Consequently, the guidewire reached the peripheral RCA through the AC branch, crossed the distal RCA lesion retrogradely, and reached the aortic root (Figure 3A). Firstly, competence of device passage through the conspicuously large AC branch was examined using a 2.0 mm balloon, which had been used for predilatation of the middle RCA lesion. After confirming the crossability of the small balloon, we tried with a 3.5 mm Cypher stent delivery balloon, which was much more rugged than the 2.0 mm balloon. The operator experienced no resistance in the passage of either of these balloons through the AC branch. Then, the Eagle Eye was delivered retrogradely to the RCA for examination of both the distal RCA lesion and the AC branch (Figure 3B). The Eagle Eye successfully advanced to the RCA through the AC branch and the diameter of the AC branch was determined to be approximately 2.0 mm, which was considered to be large enough for stent delivery (Figure 5B). Finally, another Cypher stent (3.0 × 18 mm) was successfully delivered to the distal RCA lesion through the AC branch in a retrograde manner (Figure 3C). The position was confirmed with antegrade dye injection and the Cypher stent was deployed to the distal RCA at 20 atm (Figure 3D). The coronary angiogram showed sufficient coronary flow, and a retrograde IVUS examination revealed adequate expansion and complete apposition of the stent (Figures 4A, 4B, 5C). Hemodynamics were stable and no ischemic episode was observed throughout the procedure. The patient was discharged the next day and he experienced no further angina.

Discussion
To date, only two cases of retrograde stent delivery have been reported. In the first one, 6 Vision stents were delivered through an epicardial collateral channel between the distal LAD and posterior descending artery of the RCA. In the second one, a Cypher stent was delivered via the septal perforator after the septal channel was dilated with a 2.0 mm balloon. These were cases of CTO and the retrograde stent delivery was attempted because antegrade guidewire crossing was unsuccessful. Accordingly, our report is the first case of retrograde stent delivery for a lesion other than CTO, in which antegrade stent delivery was thought to be difficult due to the tortuosity of the proximal RCA.

The retrograde approach was recently introduced for percutaneous interventions for chronic total occlusion (CTO-PCI). In CTO-PCI, the retrograde approach has been performed to improve the success rate of guidewire crossing using the retrograde wire crossing, kissing wire, controlled antegrade and retrograde subintimal tracking (CART), or reverse CART technique. In this novel procedure, the microcatheter and balloon are
delivered via collateral channels such as septal branches and epicardial collateral channels (eg, AC branch, RV branch, and PL branch). In ordinary situations, the collateral channel is too small for a stent to pass, and having stents cross tiny vessels by force may cause dissection and perforation, leading to cardiac tamponade and critical ischemia. In the present case, the AC branch was approximately 2 mm in diameter as measured by IVUS, and the pathway was relatively straight. Therefore, we considered that the retrograde stent delivery would be possible and risk of injury to the collateral vessel would be extremely low.

Conclusion
We have reported a case of retrograde DES delivery through the huge AC branch. Retrograde stent delivery may be a possible therapeutic option for cases in which antegrade stent delivery is difficult.

References

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Figure 1. Diagnostic angiography. (A) Severe luminal narrowing in middle left circumflex. (B-D) Right coronary artery was markedly tortuous and stenosed in the middle and distal segments, respectively. (E) Huge collateral networks were observed between the right coronary and left circumflex.
**Figure 2.** Percutaneous coronary intervention for left circumflex (LCX) and proximal right coronary artery (RCA). (A) A Multi-Link Vision stent (4.0 × 23 mm) was placed in a LCX lesion (double arrow). (B) A Fielder FC guidewire was crossed antegradely, and then a Cypher stent (3.5 × 18 mm) was delivered and deployed in a proximal RCA lesion (double arrow).
Figure 3. Percutaneous coronary intervention for distal right coronary artery (RCA). (A) Another Fielder FC guidewire was advanced retrogradely from the left circumflex (LCX) to RCA via the AC branch, and reached the aortic root (arrow). (B) An Eagle Eye IVUS catheter was advanced retrogradely to the distal RCA through the atrial circumflex (AC) branch (arrow). (C, D) Another Cypher stent (3.0 × 18 mm) was delivered retrogradely via the AC branch (arrow) and deployed to the distal RCA lesion.
Figure 4. Final angiogram. (A, B) Sufficient antegrade coronary flow was obtained.
The preprocedural EUS image of the distal right coronary artery lesion showed a minimal luminal diameter of less than 3 mm and abundant soft plaque with positive vessel remodeling. Note that an antegrade guidewire can be seen at ten o'clock. The EUS image of the atrial circumflex branch revealed that the vessel was located subepicardially and the diameter was approximately 3 mm. The postprocedural EUS image showed the second Cypher stent in the distal RCA was well expanded.