Rotational Atherectomy Followed by Drug-Coated Balloon Dilation for Left Main In-Stent Restenosis in the Setting of Acute Coronary Syndrome Complicated with Right Coronary Chronic Total Occlusion

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Summary

An 83-year-old man presented with recurrent acute coronary syndrome (ACS) at the left main coronary artery (LMCA) complicated with ostial chronic total occlusion (CTO) in the right coronary artery (RCA) (RCA-CTO). At the first LMCA-ACS approximately 1 year earlier, he had undergone LMCA-crossover stenting with a biolimus-eluting stent in the presence of RCA-CTO. At the second LMCA-ACS, we angiographically confirmed severe in-stent restenosis in the distal LMCA, in addition to angled severe stenosis in the just proximal LCx, and performed primary PCI for the LMCA bifurcation lesion under intra-aortic balloon pumping support. Because of difficulty in crossing a guidewire through the just proximal LCx lesion, we first performed rotational atherectomy against the LMCA in-stent eccentric lesion. After successfully crossing the guidewire into the LCx, we added balloon dilation with kissing balloon inflation followed by alternate drug-coated balloon dilation. An eight-month follow-up coronary angiography revealed no further vessel narrowing in the LMCA bifurcation lesion.

Key words: Acute myocardial infarction, Intravascular Ultrasound, Percutaneous coronary intervention

Significant unprotected left main coronary artery (LMCA) disease in the presence of chronic total occlusion (CTO) in the right coronary artery (RCA) (RCA-CTO) is a deteriorated condition with high morbidity and mortality, and generally remains an absolute candidate for coronary artery bypass grafting (CABG) surgery even during new-generation drug-eluting stent (DES) era. Drug-coated balloon (DCB) has now played a central role in the treatment for in-stent restenosis (ISR) through inhibiting neointimal hyperplasia, despite its little evidence for ISR in DES implanted in LMCA. We describe our experience with an unusual critical case of recurrent acute coronary syndrome (ACS) due to ISR in LMCA complicated with ostial RCA-CTO, in which rotational atherectomy followed by DCB dilation against the LMCA bifurcation lesion could defer a further repeat intervention.

Case Report

An 83-year-old man with repeat ACS was admitted to our hospital due to general fatigue and chest discomfort for 24 hours. His coronary risk factors included hypertension and diabetes mellitus. He had experienced inferior myocardial infarction (MI) 35 years earlier, and undergone percutaneous coronary intervention (PCI) using a bare metal stent (BMS) (Multi-link Penta 2.5/18) for a posterolateral branch of the left circumflex coronary artery (LCx) 12 years before. He had suffered from LMCA-culprit ACS complicated with ostial RCA-CTO (Figure 1A-C) and undergone LMCA-left anterior descending coronary artery (LAD) crossover stenting with a biolimus-eluting stent (Nobori 3.5/18) under intra-aortic balloon pumping (IABP) support 11 months earlier (Figure 1D-F). Pre-procedural intravascular ultrasound imaging (IVUS) depicted much concentric plaque with partial superficial calcification (Figure 2A), and final IVUS after the stent implantation showed tissue protrusion through the stent strut characterized by spotty superficial hyperechoic signal and acoustic shadowing in the distal LMCA, suggesting the probable presence of lipidic plaque with small superficial calcification inside the stent (Figure 2B). The peak value of CPK was 379 IU/L. A three-month follow-up coronary angiography (CAG) revealed an ISR in the distal LMCA (Figure 3A). Since he declined to receive CABG surgery, we planned to perform elective PCI against the LMCA-
ISR. However, the occurrence of an acute subdural hematoma required postponement of the PCI and exchange of dual antiplatelet therapy (DAPT) (aspirin 100 mg/day and clopidogrel 75 mg/day) for clopidogrel alone. A seven-month follow-up CAG depicted a slight further progression of the ISR in the LMCA (Figure 3B). Since then, we strongly and repeatedly recommended him to undergo CABG; however, he did not express his will to receive PCI or CABG.

On arrival by ambulance at the emergency room, his physical examination was unremarkable with his blood pressure 124/64 mmHg and pulse rate 80 beats/min, regular. An electrocardiogram (ECG) showed significant ST-segment depression in precordial leads, I, and aVL, in addition to ST-segment elevation in aVR and abnormal Q wave in inferior leads, and chest radiograph revealed mild lung congestion. Subsequent transthoracic echocardiography revealed a decreased motion in the apico-anteroseptal wall of the left ventricle concomitant with inferior old MI. A routine blood test showed leukocytosis without elevation of cardiac enzyme. Based on the diagnosis of probable LMCA-culprit recurrent ACS, we immediately inserted IABP, an 8-Fr sheath and a 7-Fr sheath into the left femoral artery, right femoral artery and right femoral vein, respectively. After intravenous administration of unfractionated heparin (2,000 U), left CAG revealed severe ISR in the distal LMCA, in addition to angled severe stenosis in the just proximal LCx, including a posterolateral branch (Figure 3C-E).

The distal segment of the RCA was delineated via collaterals from the septal perforator (Figure 3F). Based on the clinical history and the CAG findings, the distal-LMCA ISR lesion was concluded to be the current ACS culprit site. Therefore, we planned to perform PCI solely against the ISR in the LMCA and the severe stenosis in the just proximal LCx, using DCB under IABP-support and onsite CABG surgery backup.

After loading of aspirin 200 mg and intravenous additional administration of unfractionated heparin (6,000 U), using an 8-Fr guiding catheter (mach-1, Q 3.5 SH, Boston Scientific), a guidewire (Sion blue, Asahi Intecc) was passed through the culprit lesion in the LMCA and advanced into the distal LAD. We could not cross another guidewire through the just proximal LCx lesion even by reverse-wire technique, and then performed IVUS (Opti-cross, Boston Scientific) through the LMCA-LAD. The IVUS at the distal LMCA depicted much plaque with protruding superficial high-echoic mass at a side close to the LCx ostium (Figure 2C). Taking CAG and IVUS findings into consideration, we speculated that even small-sized balloon dilation against the distal-LMCA ISR lesion without a protection wire for the LCx might result in total occlusion at the just proximal LCx via plaque-shift, leading to much difficulty in recrossing a guidewire through true lumen in the LCx. Moreover, there was a possibility that occlusion at the just proximal LCx in the presence of RCA-CTO might result in hemodynamic collapse. Thus, we decided to perform rotational atherectomy for the in-
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Figure 2. Intravascular ultrasound imaging (IVUS) during the first PCI (A, B) and second PCI (C-F) at the distal LMCA (A-E) and the LMCA bifurcation (F). A: Pre-first-PCI IVUS image showing concentric much plaque with superficial calcification. B: Post-first-PCI IVUS image showing protrusion of probable lipidic plaque with small superficial calcification inside the stent strut. C: Pre-second-PCI IVUS image showing in-stent intimal thickening with protruding superficial high-echoic mass (white arrow) at a side close to the LCx ostium. D: After ablation with a 2.15 mm burr. E: Post-second-PCI IVUS image at the distal LMCA showing an optimal dilation. F: Post-second-PCI IVUS image at the LMCA bifurcation showing an acceptable enlargement of the LCx ostium (white arrowheads).

Discussion

For nonprotected LMCA-disease patients with a high surgical risk and those with low or intermediate SYNTAX scores, PCI using DES has become an acceptable revascularization therapy of choice.7,8) In addition, a recent observational study from Chinese investigators has shown that DES-based PCI was superior to CABG in reducing major adverse cardiac/cerebral events and bleeding complications among aged patients (average age 72.5, range 60-89) with nonprotected LMCA-disease.9) However, restenosis of the DES implanted in LMCA is not uncommon (reaching 10% to 20%),10-12) and it could theoretically provoke a broad myocardial ischemia, leading to a fatal outcome. According to a retrospective registry of 70 restenotic cases stent eccentric lesion in the distal LMCA in order to cross a guidewire to the LCx. We exchanged the wire for another wire (Rotawire extrasupport, Boston Scientific) via micro catheter (Finecross GT, TERUMO), and performed rotational atherectomy with a 2.15 mm burr (Rotalink Plus, Boston Scientific, 200000 rpm). Since we could not pass the burr through the culprit, we exchanged the burr for a downsized burr (1.75 mm) and performed an ablation (200000 rpm). We added a rotational atherectomy with a 2.15 mm burr (200000 rpm) (Figure 4A), and then could pass a tapered guidewire (X-treme XT-R, Asahi Intec) with a double-lumen catheter (Crusade, Kaneka) backup through the angled severe stenosis at the just proximal LCx. After the repeat IVUS (Figure 2D), we dilated the just proximal LCx lesion with a balloon catheter (Hiryu iBi 1.25/6, TERUMO) at 20 atm and a balloon catheter (IKAZUCHI ZERO 2.0/10, Kaneka) at 16 atm, dilated the distal LMCA-ISR residual lesion with a balloon catheter (Lacrosse NSE ALPHA, 4.0/13 mm, GOODMAN) at 18 atm, and added a kissing balloon inflation (Lacrosse NSE ALPHA, 4.0/13 mm, GOODMAN for LAD, IKAZUCHI ZERO 2.0/10, Kaneka for LCx) at 10 atm (Figure 4B). Then we subsequently inflated a DCB catheter (SeQuent Please, 4.0/20, B. Braun) at 10 atm for 40 seconds (Figure 4C) and a DCB catheter (SeQuent Please, 2.5/15, B. Braun) at 7 atm for 60 seconds against the distal LMCA-LAD lesion and the just proximal LCx lesion (Figure 4D), respectively, with an acceptable angiographic result (Figure 4E, F). Final IVUS through the LMCA-LAD showed an adequate stent expansion with an acceptable compression of the intima at the culprit (Figure 2E, F). After PCI, his chest symptom disappeared, and the peak value of CPK was 560 IU/L. He was discharged under DAPT with aspirin and clopidogrel on the 28th hospital day and has been kept free of cardiac events. Eight-months follow-up CAG revealed no further vessel narrowing in the LMCA bifurcation lesion and good collateral flows in the distal RCA (Figure 5A-D).
Figure 3. Follow-up CAG after PCI for the first ACS (A, B: left anterior caudal view) and emergency CAG at the recurrent ACS (C: left anterior caudal view; D: right anterior caudal view; E, F: anterior-posterior cranial view). A, B: 3-months (A) and 7-months follow-up CAG (B) revealed a gradual progression of ISR in the distal LMCA. C-E: Emergency left CAG depicted severe ISR in the distal LMCA, in addition to angled severe stenosis in the just proximal LCx and stenosis in the mid LCx bifurcation lesion. F: The distal segment of the RCA was delineated via collaterals from the septal perforator.

Figure 4. Primary PCI for ISR in LMCA bifurcation lesion at the recurrent ACS (A, F: right anterior caudal view; B-E: left anterior caudal view). A: Ablation with a 2.15 mm burr in the distal LMCA. B: Postdilation with a kissing balloon technique. C: Adjunctive 4.0-mm drug-coating balloon (DCB) dilation in the LMCA-proximal LAD. D: Adjunctive 2.5-mm DCB dilation in the LMCA-proximal LCx. E, F: Final left CAG after PCI.
from 718 patients undergoing PCI with DES for LMCA disease, 30.8% and 29.4% of the restenotic cases presented with ACS and stable angina, respectively. In the registry, 59 restenotic cases underwent repeat PCI, 7 CABG, and 4 medical treatment alone. The PCI procedures included 34 additional DES implantations, 22 plain or cutting balloons, 2 rotational atherectomies, and 1 BMS implantation. In another registry from Korean investigators of 71 restenotic cases from 402 patients with DES for LMCA disease, 25.3% of the restenotic cases presented with ACS, while 40 restenotic cases underwent repeat PCI, 10 CABG, and 21 medical treatment alone. Moreover, the Korean registry has demonstrated that diabetes mellitus, renal failure, female gender, distal bifurcation involvement, and two-stent procedures are associated with LMCA-ISR.

A series of reports suggest that for high-surgical-risk patients with severely calcified unprotected LMCA lesions, PCI using a rotational atherectomy is a revascularization therapy of choice. In the present ACS case with ISR in the LMCA as a culprit, a rotational atherectomy for LMCA was performed for lesion debulking rather than lesion modification in order to cross a guidewire through an angled tight lesion at the just proximal LCx. The role of a rotational atherectomy for debulking in LMCA still remains uncertain; however, debulking before stenting in a LMCA with directional coronary atherectomy (DCA) under IVUS guidance was reported to reduce restenosis. Another report has also shown that plaque debulking in a LMCA with DCA prior to DES implantation reduce restenosis of the LCx ostium. Therefore, in our case with in-stent LMCA bifurcation lesion, rotational atherectomy prior to DCB dilation might contribute in part to an acceptable follow-up angiographic result 8 months after the PCI. Rotational atherectomy followed by DCB dilation, one of non-stenting PCI procedures, might be effective also for stenosis due to coronary sequelae of Kawasaki disease. On the other hand, in the rotational atherectomy-incapable hospitals, cutting or scoring balloon dilation might be an alternative therapy of choice in cases such as the present case, because cutting balloon dilation was reported to induce less plaque-shift. Compared with rotational atherectomy; however, even small-sized cutting or scoring balloon dilation against the distal-LMCA ISR lesion theoretically has a residual risk of total occlusion at the just proximal LCx via plaque-shift in the present case.

As a primary interventional therapy for ISR during
the DES era, utility of DCB has almost been established.\(^5\)\(^,\)\(^6\) In contrast, for ISR in DES implanted in LMCA, no definite evidence supporting superiority of DCB have been available, while a few registry and case reports have shown acceptable results regarding safety and efficacy of DCB.\(^4\)\(^,\)\(^6\) As a major limitation of DCB use in LMCA, it is difficult to inflate the balloon for 30-60 seconds, because a relatively long inflation of DCB in LMCA could cause broad myocardial ischemia and hemodynamic collapse, while dilation of DCB for a short inflation time might result in an inadequate drug transfer to a vessel wall. The present case had an unfavorable condition due to the co-presence of an ostial RCA-CTO; however, IABP support might enable the patient to endure a relatively long inflation of DCB in the LMCA-LAD.

**Conclusion**

The present case suggests that an IABP-supported rotational atherectomy followed by DCB dilation under onsite CABG back-up could be a revascularization therapy of choice among ACS patients with ISR in LMCA bifurcation complicated with RCA-CTO.

**Disclosures**

**Conflict of interest:** The authors have no conflicts of interest regarding the content of the manuscript.

**References**