Clinical Case Report

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Total revascularization for an epsilon right coronary artery and severe left main disease combined with profound cardiogenic shock

A case report

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Abstract

Rationale: Severe left main disease combined with right coronary artery occlusion was rarely encountered in our daily practice. Percutaneous coronary intervention in these patients was most challenging due to high probability of hemodynamic changes.

Patient Concerns: Here, we report a 67-year-old man with Non–ST-Segment Elevation Myocardial Infarction (NSTEMI) and profound cardiogenic shock and we attempted coronary intervention with total revisualization for severe left main (LM) disease and angulated epsilon right coronary artery total occlusion. He was treated successfully under intra-aortic balloon pump (IABP) and extracorporeal membrane oxygenation (ECMO) support.

Diagnoses: NSTEMI and profound cardiogenic shock.

Interventions: Coronary intervention with total revisualization was performed for severe LM disease and angulated epsilon right coronary artery total occlusion under IABP and ECMO support.

Outcomes: IABP and ECMO were removed until cardiac contractile function improved to left ventricular ejection fraction over 40 percentage 1 week later. The patient was discharged after 2 months and had survival for 5 years.

Lessons: Coronary intervention could be performed safely in this cardiogenic shock patient with severe LM and triple vessel disease who was supported by IABP and ECMO. Stent deployment for extremely angulated coronary artery was required multiple combination techniques to facilitate the final success.

Abbreviations: AMI = acute myocardial infarction, CABG = coronary artery bypass grafting, CAG = coronary angiography, CTO = chronic total occlusion, DES = drug-eluting stents, ECMO = extracorporeal membrane oxygenation, EuroScore = European System for Cardiac Operative Risk Evaluation, IABP = intra-aortic balloon pump, IVUS = intravascular ultrasound, LAD = left anterior descending artery, LCX = left circumflex artery, LM = left main, LVEF = left ventricular ejection fraction, MACCE = major adverse cardiac and cerebrovascular events, NSTEMI = non-ST-elevation myocardial infarction, PCI = percutaneous coronary intervention, RCA = right coronary artery, TR = transradial, VAD = ventricular assist device.

Keywords: cardiogenic shock, left main disease, percutaneous coronary intervention, right coronary artery total occlusion, total revascularization

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All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent: Yes.

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1. Introduction

Severe left main (LM) disease combined with cardiogenic shock and total occlusion of the right coronary artery (RCA) in acute myocardial infarction (AMI) has been the most challenging case for interventional cardiologists. Percutaneous coronary intervention (PCI) has been used for revascularization in the cases of refusal of bypass surgery, severe left ventricular dysfunction (left ventricular ejection fraction (LVEF)≦35%), or high perioperative risk.[1] Circulatory assisted devices such as the intra-aortic balloon pump (IABP), extracorporeal membrane oxygenation (ECMO), or left ventricular assist device (VAD) were made for improving hemodynamics during coronary intervention.

Heavily calcified and angulated RCA (e.g., epsilon RCA) may cause PCI more difficult during balloon passage and stent delivery. Different methods for transradial RCA PCI have been reported when facing such difficulties including: balloon anchoring technique, 5-in-6 technique, and deep-seating technique. Hence, this is a challenging case that combines with all of these challenges, and has been treated successfully with different techniques.

2. Case report

A 67-year-old man presented with non-ST-elevation myocardial infarction (NSTEMI) and cardiogenic shock. His heart rate was around 120 to 130/min, and his systolic blood pressure was around 70 to 80 mm Hg even though vasoactive agent use. The patient developed pulmonary edema and progressed to profound cardiogenic shock status within 2 hours. Electrocardiography showed diffuse ST-segment depression in precordial leads and Q-wave in inferior leads. His coronary risk factors include hypertension, diabetes mellitus, hyperlipidemia, and smoking. He received intubation and ventilator support due to impending respiratory failure. IABP was set before diagnostic coronary angiography (CAG). CAG revealed severe calcified RCA subtotal occlusion at middle portion, with retrograde collaterals from the distal portion of the left anterior descending artery (LAD) (Fig. 1A). From the distal LM to the mid LAD, there was a long tubular severe calcified 80% stenosis (Fig. 1B) and concomitant hypoplastic left circumflex artery (LCX) chronic total occlusion (CTO) without significant collaterals from LAD or RCA (Fig. 1C). Transthoracic 2-dimensional echocardiography revealed poor left ventricular performance and global hypokinesis with LVEF of 23%. His SYNTAX score (synergy between percutaneous coronary intervention with TAXUS and cardiac surgery) was 43, and the EuroScore (European System for Cardiac Operative Risk Evaluation) was 20 (estimated perioperative mortality rate 20%–38%). The patient and his family refused coronary artery bypass grafting (CABG). Due to unstable hemodynamic condition, ECMO were set up immediately.

Coronary intervention was performed via right transradial (TR) approach because both femoral arteries were used for ECMO and IABP. A 6-French (Fr.) Ikari IL 3.5 guiding catheter (Terumo, Tokyo, Japan) was used for engaging the left main ostium. Tirofiban was used for intracoronary bolus and intravenous maintenance. After advancing a 0.014 Runthrough Floppy wire (Terumo, Tokyo, Japan) to the distal LAD, sequential dilatation was performed using Maverick 2.5 × 20 mm (Boston Scientific, New York, USA) up to 18 atm, NC Sprinter 2.75 × 12 mm (Medtronic, Minneapolis, MN) up to 18 atm, NC Sprinter 3.0 × 12 mm (Medtronic) up to 20 atm, and Quantum 3.5 × 8 mm (Boston Scientific, USA) up to 28 atm. All of these balloons ruptured and long linear dissection occurred. Two drug-eluting stents (DES) Taxus Liberte (Boston Scientific, USA) 2.75 × 28 mm and 3.0 × 32 mm were deployed at mid LAD to distal LM, and subsequently, postdilatation of the in-stent portion up to 30 atm by Quantum (Boston Scientific, USA) 3.0 × 8 mm, 3.25 × 8 mm, and 3.5 × 8 mm balloons. Intra-vascular ultrasound (IVUS) and angiography (Fig. 1D) revealed that 2 stents were well deployed and well apposed to the vessel wall (Fig. 1E–H) with retrograde collaterals to the distal RCA.

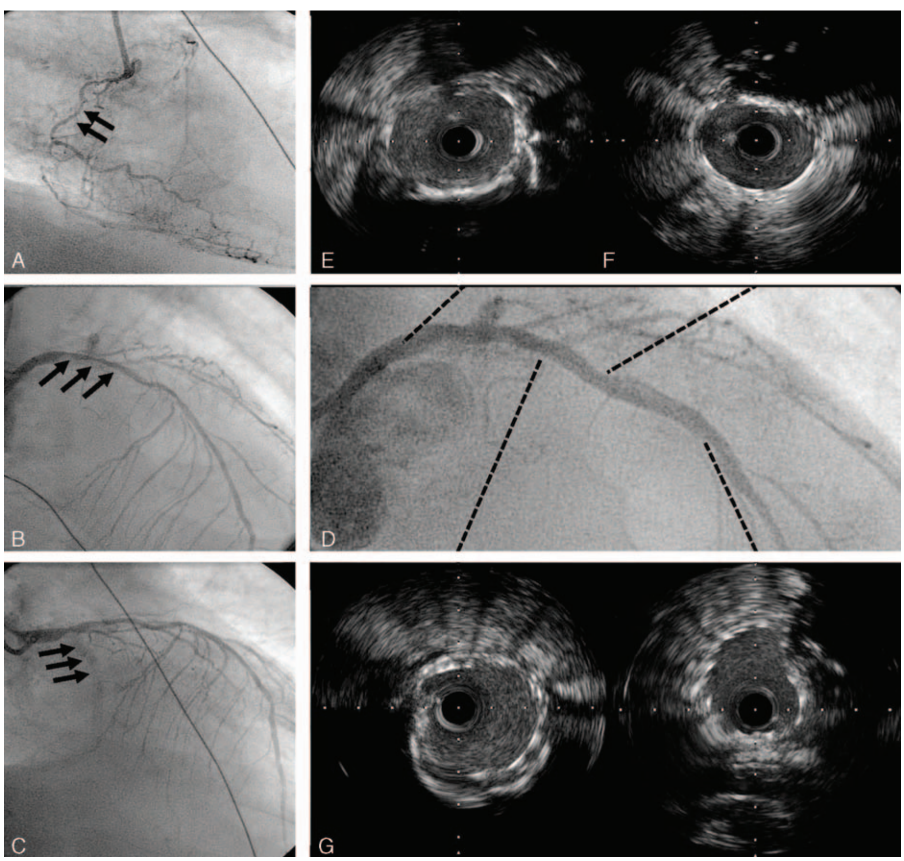

Figure 1. A, Right coronary angiogram showed heavily calcified right coronary artery (RCA) subtotal occlusion in the middle portion with collaterals from distal left anterior descending artery (LAD) (right anterior oblique view). Mid RCA showed angulated "Epsilon" shape before occlusion site (black arrow). B, From distal left main coronary artery (LMCA) to mid LAD heavily calcified and long tubular 80% stenosis (black arrow) (right anterior oblique cranial view). C, Left circumflex artery (LCX) chronic total occlusion (CTO) without stump (black arrow) (right anterior oblique caudal view). D, Final angiography of LAD (right anterior oblique cranial view) after 2 drug-eluting stent (DES) deployments and instent portion high pressure dilatation. From (E) to (F) showed Taxus Liberte 3.0 × 32 mm (Boston, MA) and from (G) to (H) Taxus Liberte 2.75 × 28 mm, both stent well expansion and well position under intravascular ultrasound study (IVUS).

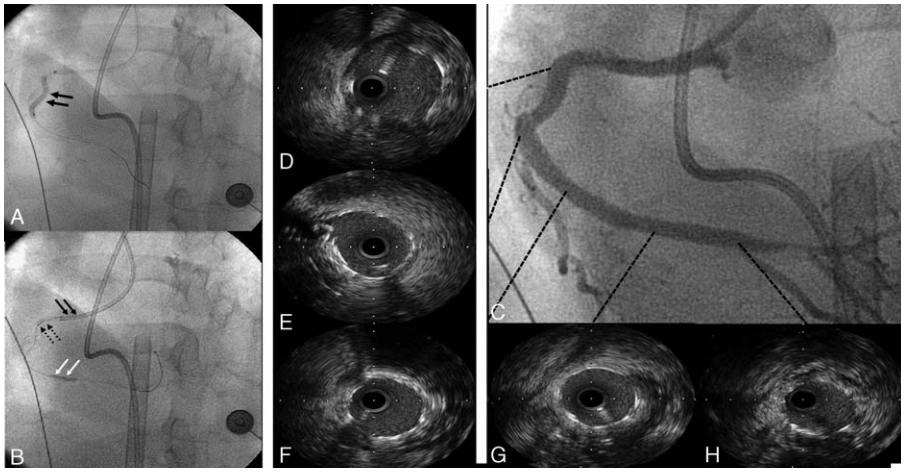

Figure 2. A, RCA subtotal occlusion recanalized by Pilot 50 hydrophilic wire and predilated by a Maverick 2.0 × 20 mm balloon up to 18 atm (black arrow). We can see the "Epsilon" shape RCA in this view (left anterior oblique cranial view). B, Three combine method including guiding catheter deep seating in right coronary ostium (black arrow), 5 in 6 technique with a 5Fr S101 catheter through first angulated portion (black dot arrow) and balloon anchoring technique (Ottimo 1.5 × 10 mm up to 16 atm) (white arrow) made stent delivery successfully. C, Final angiography of RCA after 5 bare-metal stent deployments and instent portion high pressure dilatation (left anterior oblique cranial view). From (D) to (H), IVUS study showed all 5 stents including "Vision 3.5 × 12 mm, Vision 3.0 × 28 mm, Vision 2.75 × 18 mm (Abbott, Chicago, IL), micro-Driver 2.5 × 24 mm (Medtronic, Minneapolis, MN) and Pixel 2.5 × 23 mm (Abbott)" well expansion and well position. RCA = right coronary artery.

We performed PCI for the difficult lesion of RCA to complete revascularization due to cardiogenic shock. A hydrophilic wire Pilot 50 (Abbott, Chicago, IL) was successfully advanced to the distal posterior descending artery with a 6 Fr. Ikari IL 3.5 guiding catheter (Terumo, Tokyo, Japan) via the right TR approach. An Ottimo 1.5 × 10 mm balloon (Kaneka, Osaka, Japan) and a Maverick 2.0 × 20 mm balloon (Boston Scientific, USA) were used for dilatation of the lesions from mid RCA to proximal RCA up to 18 atm. Because the RCA was much angulated with an epsilon shape (Fig. 2A) and linear dissection occurred after balloon angioplasty, we tried to deploy stents from the distal to the ostium RCA but failed. Even though we employed methods such as 2 guidewire technique, balloon anchoring technique, 5-in-6 technique using 5Fr. ST01 catheter (Terumo, Tokyo, Japan), and deep-seating technique to deploy stents (including one drug-eluting stent), but all were unsuccessful when applied separately. Therefore, we proceeded to apply 3 techniques in combination (balloon anchoring technique, 5-in-6 technique, and deep-seating technique) to deploy the first stent Vision 2.75 × 18 mm (short stent) (Abbott) at the most angulated portion (Fig. 2B) which attributed the success of deploying other 4 stents from the distal to the ostium RCA: pixel 2.5 × 23 mm (Abbott), micro-Driver 2.5 × 24 mm (Medtronic, USA), Vision 3.0 × 28 mm, and Vision 3.5 × 12 mm. After high-pressure dilatation of the in-stent portion, IVUS and angiography (Fig. 2C) revealed that the 5 stents were well deployed and well apposed to the vessel wall (Fig. 2D–H).

We removed IABP and ECMO until cardiac contractile function improved to left ventricular ejection fraction over 40 percentage after 1 week. The patient was discharged after 2 months and had survival for 5 years.

3. Discussion

The treatment strategies for unprotected left main disease (UPLMD) with either PCI or CABG had been debate for several decades. Current European guidelines on myocardial revascularization give a class I recommendation for the patients with low SYNTAX score (0–22), but a class IIa recommendation for the subgroup of patients with intermediate anatomical complexity (SYNTAX score 23–32).[2] However, the American guidelines give a class IIa recommendation for SYNTAX score 0 to 22 and a class IIb recommendation for SYNTAX score 23 to 32.[3] Cavalcante et al[4] recently published a study that confirmed that in patients with UPLMD, CABG is associated with a reduced need for repeat revascularization and similar rates of the safety endpoint of death, MI or stroke when compared with PCI. In a large series study in Fuwai hospital,[5] more than 4000 UPLMDs were treated with CABG or PCI concluded that the PCI was associated with significant higher risk of 3-year all-cause mortality. Once again, no statistically difference among patients with low or intermediate SYNTAX score (0–32) or diabetes, but PCI was associated with an increased risk among those with high SYNTAX score (>32) for all-cause mortality.

In this patient, the EuroScore was 20, predicted perioperative mortality rate was too high, CABG was also refused by patient, and PCI then was selected as an alternative treatment; however, the SYNTAX score was 43 which will translate into higher incidence of reintervention in the future. Most clinical trials were designed for elective patients in comparing with PCI or CABG, but there were limited reports comparing 2 strategies for severe LM disease in AMI. According to American College of Cardiology/American Heart Association guideline in 2011, PCI was recommended as a class IIb indication in unprotected LM disease or complex coronary artery disease with proximal LAD lesion in unstable angina or NSTEMI settings.[6]

The choice of the most appropriate revascularization strategy is still controversial in diabetes patients. Farooq et al[7] had published the treatment strategies for multivessel revascularization in patients with diabetes. CABG was superior to PCI in that it significantly reduced rates of death and myocardial infarction, with a higher rate of stroke. However, Tarantini el al[8] concluded that for patients with multivessel CAD with diabetes which were revascularized by drug-eluting stents PCI was not associated with worse 2-year outcome compared with CABG. In the EXCEL trial[9] (Evaluation of Xience prime versus coronary artery bypass surgery for effectiveness of left main revascularization), the benefits of PCI were less pronounced in diabetics than non-diabetics. Furthermore, the results of Fuwai hospital analysis showed that the impact of diabetes mellitus on clinical outcomes among patients treated with PCI was limited, but was more pronounced among those treated with CABG.[5]

Evidence-based medicine has demonstrated the additional benefit of complete revascularization by coronary artery bypass graft surgery in improving in long-term clinical outcomes for unstable angina patients with multiple vessel diseases. While some studies claimed improved short-term clinical outcome from complete revascularization during primary PCI,[10] some studies found that harm actually outweighed benefits for simultaneous PCI to noninfarct related artery during primary PCI.[11] In some preliminary studies, successful revascularization of CTO in the non-IRA is associated with improved clinical outcomes in patients with STEMI undergoing primary PCI and is associated with reduced risk of cardiac mortality in NSTEMI when comparing to patients with failed PCI for CTO or treated medically.[12,13] In such scenario with myocardial infarction patient with cardiogenic shock, there was no doubt to revascularize all the vessel as we could. In our case, the LCX was hypoplastic CTO without significant collaterals from LAD and RCA. This means total revascularization after LM-LAD and RCA were recanalized. The reasons why choose LM-LAD as the first PCI target were 2-fold, first, the RCA was extremely angulated CTO, the operator needs more collaterals information from LAD to complete revascularization if retrograde approach is needed. Second, the ECMO support may be more needed when performing LM-LAD PCI to decrease the degree of hemodynamic fluctuation compared with RCA PCI at next staged PCI.

ECMO is the heart–lung machine which had been modified to support life and allowing adequate time for recovery from severe cardiac and pulmonary failure. More and more data supported the use of ECMO in those who had refractory postoperative cardiogenic shock and those with cardiogenic shock from AMI. In our study,[14] profound cardiogenic shock was defined as systolic blood pressure <75 mm Hg despite intravenous inotropic agent administration and IABP support, associated with altered mental status and respiratory failure. The benefit over 30-day clinical outcomes in early ECMO-assisted PCI in AMI patients with profound cardiogenic shock had been well established.[15] In addition, when the patient experienced critical condition and multiple vessel diseases, complete revascularization and the use of ECMO for hemodynamic support is very important.

In this patient, both femoral arteries were used as access routes for IABP and ECMO, TR or transbrachial were the only choice for emergent PCI. TR approach for primary PCIs in AMI patients, the safety and feasibility were quite comparable with conventional transfemoral approach, and even better in terms of major vascular bleeding complications.[15] In this case, the key step for successful stent delivery was applying a short Cobalt-–Alloy stent at mid RCA angulated segment, rather than a longer DES. Debulking therapy like rota-ablation was not considered for this patient, because severe angulation had potential risk of perforation. In addition, the combination of 3 techniques (balloon anchoring technique, 5-in-6 technique, and deep-seating technique) was important for stent deployment of extremely angulated vessel.

4. Conclusion

PCI could be performed safely in this cardiogenic shock patient with severe LM and triple vessel disease who was supported by IABP and ECMO. TR PCI with stent deployment for extremely angulated coronary artery required multiple combination techniques to facilitate the final success.

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