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Case Report

Two-staged stent-assisted angioplasty treatment strategy for severe left main coronary distal bifurcation stenosis associated with the right coronary chronic total occlusion

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Abstract: A 63-year-old female patient, with history of 8-year hypertension and 10-year hyperlipidemia, presented with severe left main coronary bifurcation stenosis (LMCS) associated with the right coronary artery chronic total occlusion (CTO-RCA). On the day of admission, she received drug treatment with aspirin, clopidogrel, heparin, statins, angiotensin converting enzyme inhibitors and β-blocker. On the next day, she underwent CTO recanalization with 6F guiding-catheter and two rapamycin-eluting stents, and showed no postoperative discomfort after interventional treatment. Considering having hypertensive nephropathy and chronic renal insufficiency, the patient then received intravenous saline full hydration therapy. Two weeks after successful completion of the RCA revascularization, the original collateral circulation in the blood flow from the LMC to RCA became two-way flow. Under the safe and reliable protective condition, staged percutaneous coronary intervention (PCI) with 6F XB3.0 guiding catheter and rapamycin-eluting stents was applied to treat the LMCL. 9-month postoperative follow-up with coronary computed tomographic imaging showed no restenosis inside the original stent, without any myocardial ischemic event. Our successful approach to turn the original unprotected LMCS combined with CTO-RCA into a protective one reduces the interventional risk and provides additional option besides coronary artery bypass graft surgery to treat such complex coronary artery disease (CAD).

Keywords: Left main coronary artery stenosis, the right coronary artery chronic total occlusion, angiography, percutaneous coronary intervention

Introduction

LMCS or occlusion associated with other arterial stenosis is the major cause of unstable angina, malignant arrhythmia, cardiogenic shock, myocardial ischemic events and sudden death [1]. Severe LMCS associated with CTO-RCA is a rare and most serious condition of CAD, and drug therapy has very limited effect on it. Intervention therapy is regarded as a contraindication due to the high risk, high complication incidence and low success rate. Current standard treatment for such complex CAD is coronary artery bypass graft (CABG) surgery. PCI is also an effective approach for the diagnosis of ischemia-related arteries and for its revascularization [2], and is an alternative option when CABG is not feasible in the hospital or in case the patient refuses to have CABG surgery. However, the selection of reasonable approach for revascularization, partial revascularization or complete revascularization, one-time PCI or staged PCI to treat severe LMCL associated with CTO-RCA is still on debate, due to the complexity and the higher risk of PCI surgery in comparison with single-artery disease. Here, we report a successful two-staged interventional approach for a patient with severe LMCS associated with CTO-RCA.

Case report

A 63-year-old female, had 8-year hypertension and 10-year hyperlipidemia, and presented with exertional chest tightness and shortness of breath when came to hospital. Echocardiography examination showed that she had normal atrioventricular cavity diameter, larger dou-

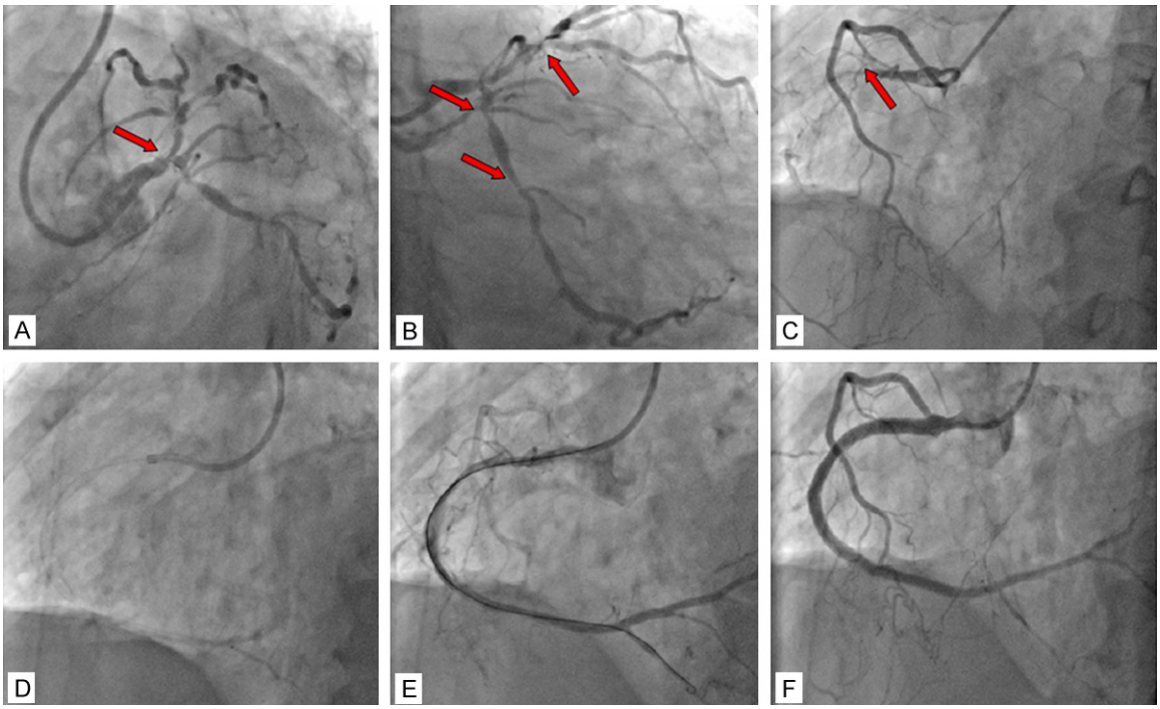

Figure 1. Angiogram of the first operation. A: Coronary angiography revealed a LMCS 60% (red arrow). B: LAD stenosis (70%), LCX stenosis (80%), LCX ostium segment stenosis 70% (red arrow). C: RCA-CTO (red arrow) with abundant collateral bridging branches. D: Conquest Pro guide wire run through LAD occlusion. E: Guide wire reached to the lumen confirmed by Maverick OTW angiography. F: RCA series final result after stent implanted.

ble room (The left one: 34.5 mm, the right one: 51 × 49 mm), decreased left ventricular wall motion and coordination, and reduced left ventricular systolic function (EF46%). Serum markers included myocardial necrosis creatine kinase (CK-MB) at 71 U/L, ultra-sensitive troponin T at 25.04 μg/L, serum creatinine at 110.1 μmol/L. Admission diagnosis showed she had coronary heart disease with previous inferior wall myocardial infarction and acute non-ST-segment elevated myocardial infarction, as well as hypertensive nephropathy with chronic renal insufficiency.

After admission, she received drug treatment with aspirin, clopidogrel, low molecular weight heparin, statins, angiotensin converting enzyme inhibitors and β-blocker. Coronary angiography on the next day revealed: LMC distal bifurcation stenosis 60% (**Figure 1A**), left anterior descending (LAD) artery stenosis 70%, left circumflex (LCX) stenosis (80%), LCX mid-segment stenosis (70%) (**Figure 1B**), TIMI flow at level 3; Proximal right coronary artery (RCA) complete occlusion with abundant collateral bridging branches (**Figure 1C**). TIMI flow at level 0, coronary artery SYNTAX score at 40. She refused to have CABG, but agreed to have CTO-RCA treated first, if successful, then undergo intervention for LMCS 6F JR4.0 guiding-catheter was chose and deployed through the radial artery into RCA (**Figure 1D**). The Conquest Pro (Asahi) guide-wire passed through the lesion under the support of an OTW balloon and reached to distal true lumen, confirmed by angiography (**Figure 1E**). After balloon dilatation, two rapamycin-eluting stents (3.5 × 29 mm and 3.5 × 18 mm) (Firebird 2, Micro Invasive Medical Devices, Ltd., China) were inserted into the distal and proximal arteries respectively. The patient had no postoperative discomfort after interventional treatment. Angiography showed that there was no residual stenosis in RCA, and the blood flow became normal (**Figure 1F**). Two weeks later, angiography further confirmed the patency of RCA stents.

Considering having hypertensive kidney disease with renal insufficiency, the patient then underwent intravenous saline full-hydration therapy before initiating LMC treatment. Staged PCI approach was chose to treat LMCS. 6F XB3.0 guiding catheter and 0.3556 mm Pilot guide wire were deployed through LMC into the

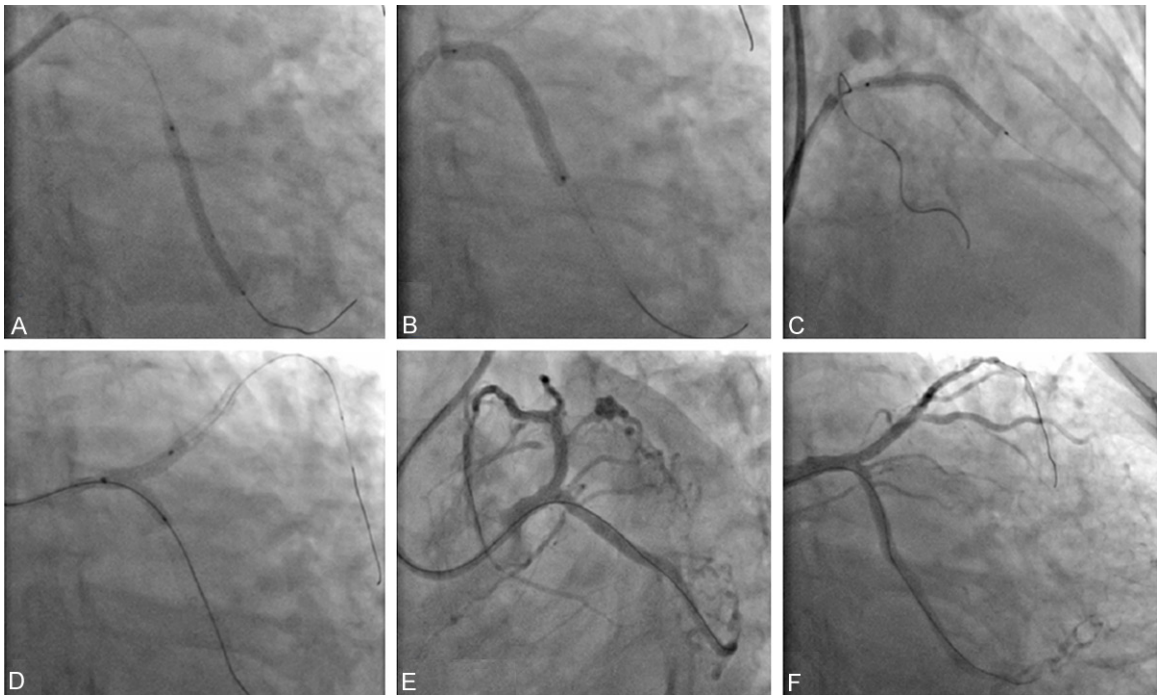

Figure 2. Angiogram of the second operation. A: Guide wire run through LAD and LCX. B: After balloon inflation, LCX distal, proximal bifurcate to LMC, and two series stents were deployed. C: Using Culotte technology, guide wire run through LMC and LCX, mesh into the LAD artery, and release of LAD stent. D: Retention of LMC LCX balloon with complete kissing dilation of the LAD balloon. E: LAO 45°+ Cau 30° angiography showed the final treatment result of LMCS. F: RAO 30°+ Cau 20° angiography revealed the final treatment result of LMCS.

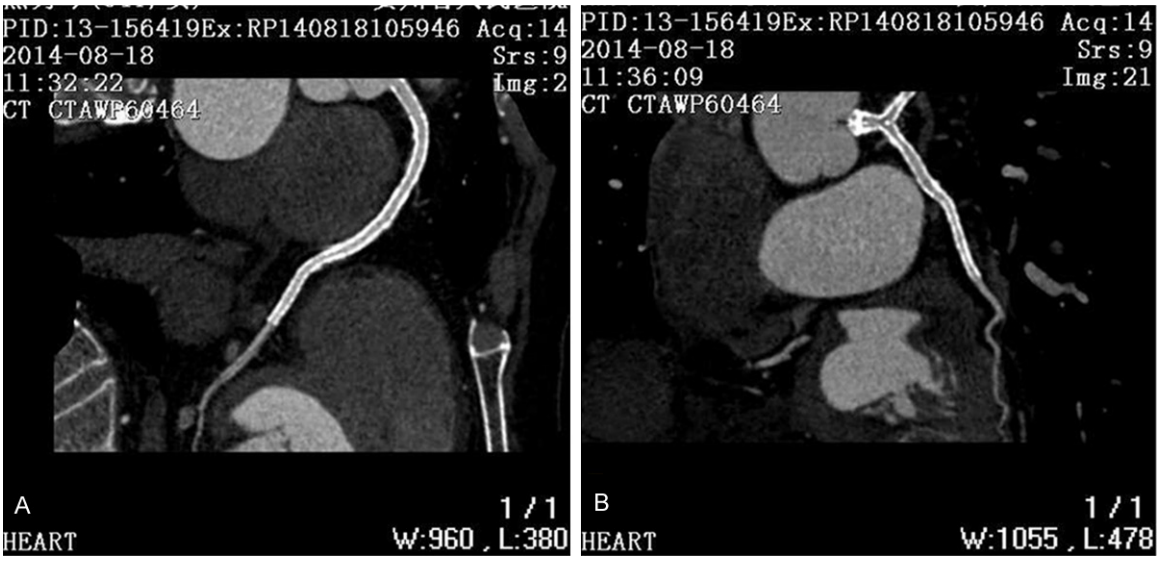

Figure 3. Nine-month visit multi-slice computed tomography showed the patency of all stents, without re-stenosis. A: Patency of RCA stent. B: Patency of LMC bifurcation stent.

LAD artery, and run through to the distal LCX artery (**Figure 2A**). A balloon was applied to extend the LCX and the LAD artery. A rapamycin-eluting stent (2.5 × 33 mm) (Firebird 2) was implanted into the mid-LAD artery. Two rapamycin-eluting stents (3.0 × 33 mm and 3.5 × 33 mm) (Firebird 2) were then deployed between the LMC and the LCX artery distal. The stents connected as stand-phase (**Figure 2B**). The LCX and the LAD artery guide-wires were switched,

and the trunk to the LAD artery proximal segment was opened by Culotte surgery, following the implantation of a 3.5 × 29 mm rapamycin-eluting stent (Firebird 2) (**Figure 2C**). After a 3.5 × 33 mm non-compliant balloon extended from LMC to the LAD artery stent, a 3.5 × 15 mm balloon was placed between the LMC to the proximal LAD artery, and a 3.0 × 15 mm balloon positioned between LMC and the cross-kiss expandable stent in the proximal LCX artery (**Figure 2D**). After completion of the surgery, coronary angiography revealed: stenosis in the LMC, the LAD artery, and the LCX artery disappeared; no residual stenosis existed in the stents; TIMI flow score at 3; collateral circulation disappeared (**Figure 2E**, **2F**). No severe intraoperative arrhythmias and angina occurred during the surgery. After surgery, radial artery sheath was immediately unplugged, and local pressure bandaged for four hours. The patient was then treated with enhanced anticoagulant (low molecular weight heparin) and antiplatelet agents (aspirin, clopidogrel and tirofiban). Postoperative follow-up last for 9 months, considering the probably higher restenosis rates in the double stents at the bifurcation. Coronary computed tomographic imaging showed there was no restenosis inside the original stent, and the bifurcation stent was patency (**Figure 3A**, **3B**); and no myocardial ischemic event and corresponding ischemic electrocardiogram change recurrented.

Discussion

We report a successful two-staged stent-assisted angioplasty strategy to treat severe LMCS associated with CTO-RCA. LMCS is classified into two subtypes: protected and unprotected stenosis. The former refers to the one with previous CABG or the existence of good collateral circulation from RCA to LMC; the latter is defined as the one lacking CABG and the collateral circulation [3]. Whether patients with LMCS should have CABG surgery depends on the presence of collateral circulation. Since LMC dominates the whole left ventricular system, LMCS concomitant with CTO-RCA likely causes severe myocardial ischemic complications such as cardiogenic shock, ventricular fibrillation, and cardiac arrest. Thus choosing optimal strategy to treat such complex coronary lesions and revascularization is extremely important to save patient's life. In this case, the patient was characterized with coronary SYNTAX score at 40 points; hypertensive nephropathy with decompensated renal insufficiency; a collateral circulation existed between the RCA and the side branch of LMC; and recent acute coronary syndrome. CABG is considered as the standard treatment for LMC and/or the three branches' stenosis. For patients with SYNTAX score ≥ 33 points, CABG had better long-term prognosis than the drug-eluting stents. However, in this case, CABG could be not enough to complete the revascularization in both LMC and RCA, due to the fact that the patient only had the distal coronary collateral circulation and interlinked. Collateral circulation formation after coronary occlusion is a slow process, and its retrograde perfusion is similar to the forward blood flow of severe coronary artery stenosis (≥ 90%). Considering the patient wish and her clinical characteristics, we decided to treat CTO-RCA first. Two weeks after successful completion of the RCA revascularization, the original collateral circulation in the blood flow from the left artery to the right one became two-way flow. Under that safe and reliable protective condition, we chose staged interventional treatment on the LMCS, which made the original unprotected LMC disease become the protected one, and reduced the interventional risk on the LMC and its branches.

With the application of drug-eluting stents, and postoperative antiplatelet drugs, PCI is becoming a more attractive approach to treat complex multiple coronary artery lesions. The American Heart Association and the American College of Cardiology recently adjusted the level of PCI for LMC treatment from III to IIb [4]. Clinical studies showed that PCI treatment of LMCS was almost equal to CABG, the long-term efficacy of PCI even better CABG. PCI is even more suitable for patients with surgical contraindications or with diffuse stenosis of vascular anastomosis in remote branch arteries of LMC, although interventional therapy might have slightly higher rate of repetitive revascularization. However, PCI approach for unprotected LMCS combined with other severe RCA disease still remains technically difficult. Our experience from this case are: (1) compared with the one-time PCI, staged PCI approach can reduce single-surgery time, contrast agent, the incidence of heart failure, contrast-induced nephropathy and PCI-related complications. Currently, the optimal time of staged PCI and its interval for patients

with multi-artery disease are still under debate and remain unclear. The American College of Cardiology reported that most doctors chose PCI for non-infarct arteries two weeks after the first PCI [5]. In this case, we started staged-PCI two weeks later in order to let the original collateral circulation from LMC to RCA become a secure and reliable two-way blood flow. (2) Treatment of the RCA occlusion with severe chronic calcified remains technically difficult. Strong-support guiding catheter can facilitate the penetration of the balloon through the occlusive lesions, but the catheters may also damage the proximal portion with 85% stenosis. Once the proximal dissection occurred, follow-up treatment will be very difficult; therefore we chose a safe 6F JR4.0 guiding catheter. (3) In PCI, selection of Culotte, Crush or T surgical stent to treat bifurcation lesions is still controversial. Kaplan et al found that Culotte stent had better immediate angiography and medium-term surgical clinical effect than T stent. The rate of 9-month targeted arterial revascularization was 8.9% for Culotte stent vs. 27.3% for T stent [6]. Using in vitro coronary bifurcation model and micro-computer tomography reconstruction techniques, Foin N found that the malapposition rate of Crush, Culotte or T stent was 41.5 ± 8.2%, 31.4 ± 5.2%, and 36.7 ± 8.0% respectively [7]. Recent multi-center, randomized prospective study by DKCRUSH-III found that Culotte stent has a higher rate of targeted arterial revascularization in comparison with Crush stent [8]. In this case, bifurcation lesions had larger angle, and the diameters of the anterior descending artery and the circumflex artery are similar, therefore, Culotte stent and procedure was utilized and had very good immediate angiography. Nine-month follow-up with CT scan showed that the stents in this case were adherent very well without significant restenosis, and developed very good distal coronary filling. Thus, Culotte stent is safe and effective for the treatment of LMCS.

Conclusion

In case CABG is not feasible, the two-staged stent-assisted angioplasty treatment strategy is an additional option for interventional cardiologist to treat severe LMCS associated with CTO-RCA.

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Disclosure of conflict of interest

None.

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