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Case Report

Percutaneous Coronary Intervention Supported by Extracorporeal Membrane Oxygenation in a Patient With Cardiogenic Shock and Prior Coronary Artery Bypass Grafting

*Li-Chin Sung[1,2], Bee-Song Chang[3], Ji-Hung Wang[2]**

[1]*Division of Cardiology, Department of Internal Medicine, Shuang Ho Hospital, Taipei Medical University, Taipei, Taiwan*
[2]*Division of Cardiology, Department of Internal Medicine, Buddhist Tzu Chi General Hospital and Tzu Chi University, Hualien, Taiwan*
[3]*Division of Cardiovascular Surgery, Department of Surgery, Buddhist Tzu Chi General Hospital, Hualien, Taiwan*

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Abstract

We report a diabetic man with prior coronary artery bypass grafting (CABG) who underwent coronary angiography (CAG) because of medically refractory unstable angina. CAG revealed severe stenosis of the left circumflex artery (LCX) and the right coronary artery (RCA), patent artery graft to the left anterior descending artery and total occlusion of saphenous venous grafts to the RCA and LCX. During percutaneous coronary intervention (PCI), the patient suffered from circulatory collapse. We postponed the procedure and placed an intra-aortic balloon pump (IABP); however, the patient remained hemodynamically unstable. He was rescued by PCI with extracorporeal membrane oxygenation (ECMO) support. No major cardiovascular event was reported during the 6-month follow-up period since treatment. We have learned that PCI in patients with prior CABG and severe left ventricular dysfunction has a high risk of inducing cardiogenic shock when an IABP is used. ECMO should be considered for these patients when PCI is performed on the vessels that supply only viable and contractile myocardium. [*Tzu Chi Med J* 2010;22(4):232–236]

*Corresponding author. Division of Cardiology, Department of Internal Medicine, Buddhist Tzu Chi General Hospital, 707, Section 3, Chung-Yang Road, Hualien, Taiwan.
E-mail address: jihung_wang@tzuchi.com.tw

1. Introduction

Coronary artery bypass grafting (CABG) is the treatment of choice for patients with diabetes and multivessel coronary artery disease (CAD). The recurrence of angina pectoris in patients with prior CABG is usually due to atherosclerotic progression in native coronary arteries, bypass graft failure, or both. Repeat CABG and percutaneous coronary intervention (PCI) are the two available options for revascularization in this patient group. However, PCI and repeat CABG have several limitations and involve significant risks. Extracorporeal membrane oxygenation (ECMO) has been reported to provide full hemodynamic support in patients with a failing circulation. We report a male patient with prior CABG who received PCI. He suffered circulatory collapse during the initial PCI and was subsequently completely revascularized with PCI under ECMO support.

2. Case report

A 51-year-old male patient with a previous history of hypertension, diabetes mellitus, uremia under regular hemodialysis, and peripheral artery occlusive disease had suffered from intermittent chest tightness for 1 week. CABG had been performed 3 years earlier using the left internal mammary artery (LIMA) to the left anterior descending artery (LAD) and two saphenous vein grafts (SVG) to the first obtuse marginal branch (OM1) and posterior descending artery. The patient had undergone regular follow-ups at an outpatient clinic and was receiving medication, including aspirin, beta-blocker and lipid-lowering agents. Transthoracic echocardiography showed global left ventricular (LV) hypokinesis, with the exception of the inferoposterior segments, with a LV ejection fraction (LVEF) of 40%. Myocardial perfusion scan revealed anteroapical perfusion defect with minimal reversibility and reversible myocardial ischemia of the LV inferoposterior wall, with an estimated LVEF of 30% at rest.

The patient was admitted to our institution because of medically refractory unstable angina. Coronary angiography (CAG) demonstrated patent LIMA to the LAD (Fig. 1A), total occlusion of both SVGs, 95% stenosis of the proximal portion of the right coronary artery (RCA) (Fig. 1B), and 99% stenosis of the heavily calcified bifurcation lesions that involved the left circumflex artery (LCX) and its OM1 (Fig. 1C). The distal RCA branch received collateral supply from the LAD (Fig. 1D). We performed PCI to the LCX lesion, using a Runthrough floppy guidewire (Terumo Corp., Tokyo, Japan) to pass through the stenotic lesion. However, the patient began to experience severe substernal chest pain, dyspnea and nausea when we tried to pass through the OM1 lesion. Repeat contrast injection revealed thrombolysis in the Myocardial Infarction Grade 1 flow of the LCX and OM1 (Fig. 1D). Systolic blood pressure (SBP) dropped to 80 mmHg and heart

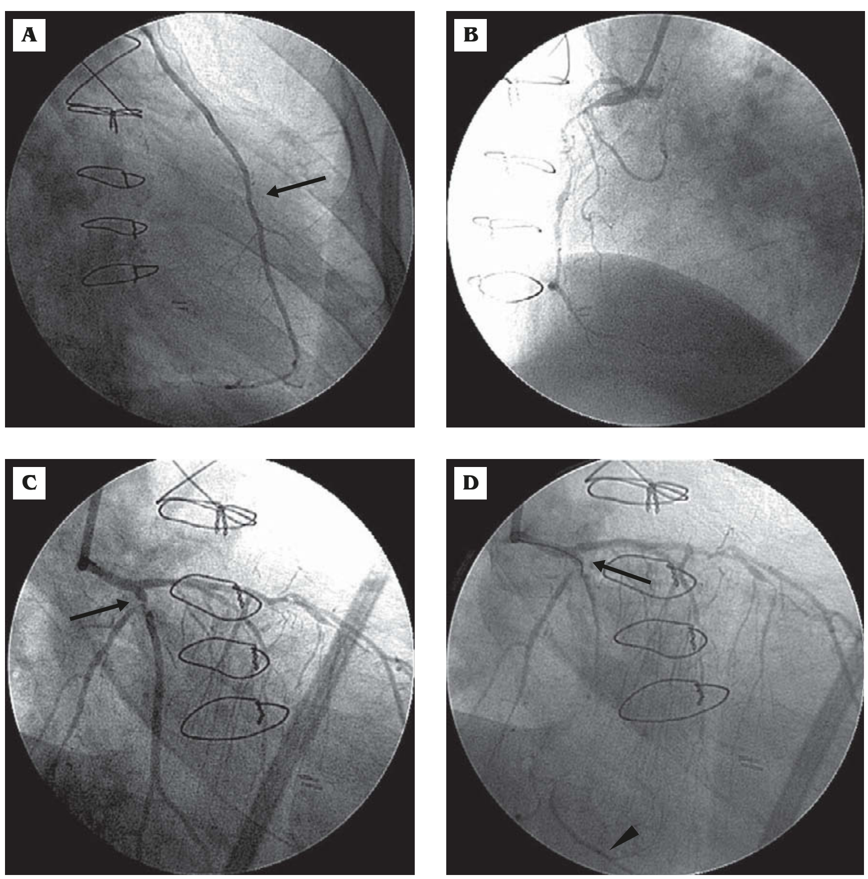

Fig. 1 — Coronary angiography demonstrates: (A) patent left internal mammary artery to the left anterior descending artery (arrow); (B) severe stenosis of the right coronary artery; (C) critical bifurcation lesions involving the left circumflex artery and its first obtuse marginal branch (arrow); and (D) the distal right coronary artery branch receiving a collateral supply from the left anterior descending artery (arrowhead), and acute closure of the first obtuse marginal branch when a wire was passed (arrow).

rate increased from 82 to 110 bpm. Cardiogenic shock occurred and concomitant inotropic agents with an intra-aortic balloon pump (IABP) were used to stabilize the patient's hemodynamics. PCI was postponed and the patient was sent to the intensive care unit.

Chest radiography demonstrated bilateral pulmonary infiltrates, consistent with acute pulmonary edema. The patient's SBP was approximately 95 mmHg, even with IABP support. Repeat CABG was judged to have a high perioperative mortality risk in these circumstances, and the feasibility of PCI under ECMO support was discussed. His family agreed to this treatment strategy and provided informed consent on the patient's behalf.

We used venoarterial ECMO with a centrifugal pump via the femoral approach with vascular exploration by the cut-down method. One 17-Fr arterial cannula was inserted into the iliac artery via the left femoral artery and one 19-Fr venous cannula was inserted through the left femoral vein and advanced into the inferior vena cava. The initial ECMO blood flow rate was 2.5 L/minute. An 8-Fr Judkins L4 guiding catheter (Cordis Corp., Miami, FL, USA) was used to engage the left coronary artery. High-speed rotational atherectomy of the LCX was performed with a 1.25 mm burr, followed by a 1.75 mm burr. Simultaneous kissing balloon dilatation was then performed at the LCX (2.5 × 20 mm Maverick balloon; Boston Scientific Corp./Scimed Inc., Natick, MA, USA) at 12 atmospheres (atm) and OM1 (2.0 × 20 mm Maverick balloon at 10 atm). A 3.5 × 23 mm Xience V (Abbott Vascular, Santa Clara, CA, USA) drug-eluting stent (DES) was deployed from OM1 to the proximal LCX. The stent was post-dilated with a 3.5 × 12 mm Maverick balloon at 18 atm, which yielded an angiographic residual stenosis of < 10% (Fig. 2A). A 7-Fr Judkins R4 guiding catheter was then engaged at the RCA ostium. The RCA was crossed with a Runthrough guidewire and the proximal and middle lesions were predilated with a 2.5 × 20 mm Maverick balloon at 16 atm. Two Taxus (Boston Scientific Corp.) DESs were deployed sequentially from the middle to the ostial segments of the RCA. The two stents overlapped with one 3.0 × 32 mm DES in the middle lesion and the other 3.5 × 24 mm DES in the proximal part to the ostium of the RCA. The angiographic result was deemed acceptable (Fig. 2B). The patient was weaned from ECMO immediately after PCI and the total support duration was 231 minutes.

The hemodynamics of the patient improved and the IABP was removed the next day. The angina pectoris and pulmonary edema improved following treatment. However, the patient experienced severe ECMO wound infection and a plastic surgeon was consulted for wound management. The patient recovered well and was discharged 22 days after admission. Over a 6-month follow-up period, the patient remained free of symptoms and did not experience any cardiovascular events.

3. Discussion

The number of patients with prior CABG who have recurrent symptoms has been steadily increasing [1]. One reason is vein graft failure, which often leads to early coronary revascularization. The risk factors for repeat revascularization in patients with prior CABG are younger age at first operation, hypertriglyceridemia, lower high-density lipoprotein, diabetes mellitus and triple vessel disease [1]. Revascularization, including PCI or repeat CABG, in patients with prior CABG is considered a high-risk procedure.

The Society of Thoracic Surgery has reported that 8.6–10.4% of patients require repeat CABG [2]. Our patient had reversible inferoposterior myocardial ischemia before intervention. Patients with ischemic cardiomyopathy and viability undergoing repeat CABG benefit from revascularization [3]. However, repeat CABG is associated with a high incidence of complications. Our patient had peripheral artery occlusive

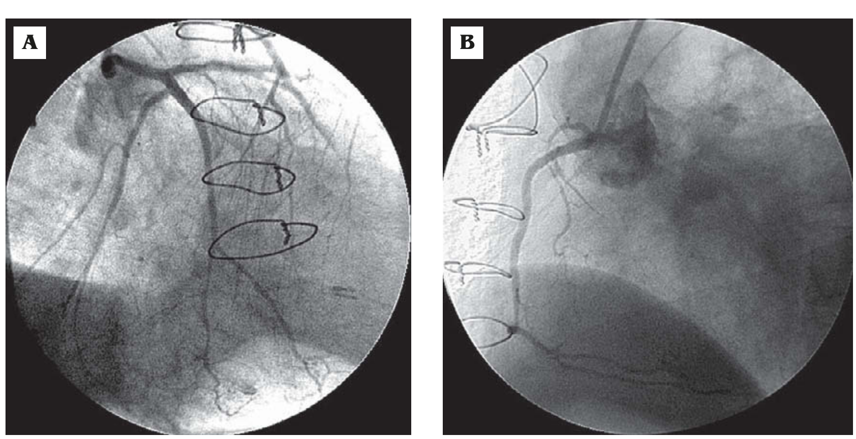

Fig. 2 — Post-intervention coronary angiography images of: (A) left circumflex artery; (B) right coronary artery.

disease, which indicated systemic atherosclerosis and a high risk of stroke. The target vessels (RCA/LCX) are also difficult for the surgeon to approach because of dense adhesion between the right atrium, right ventricle and the sternum. The European System for Cardiac Operative Risk Evaluation (EuroSCORE) is a scoring system for predicting operative mortality before CABG (4). The EuroSCORE of our patient was 15 points, indicating a predicted high operative mortality of about 55%. In recent years, minimally invasive surgical approaches, including mini-thoracotomies and beating heart techniques, have been used (5). These techniques are less invasive and are effective alternative procedures that are often used by more experienced surgeons. Jacobs et al (5) reported 46 patients who underwent this surgery using the LIMA to the LAD. All patients had prior CABG without the use of LIMA and significant LAD lesions, and the outcomes were comparable to those using the median sternotomy approach. Our patient had patent LIMA to the LAD and was not suitable for this type of surgery. Minimally invasive surgery using the SVG in repeat CABG has been rarely reported (6). Our patient had early vein graft failure, which may predict a poor outcome for subsequent SVG implantation. The elective surgical intervention for our patient was not adopted due to a poor operative risk-benefit ratio.

PCI is increasingly an option for patients with prior CABG. However, the choice of PCI for bypass graft or native coronary artery is dependent on the ischemic territories identified by a myocardial perfusion scan or the characteristics of coronary lesions upon CAG. Despite the use of bare-metal stents, PCI in patients with prior CABG has been associated with worse outcome than PCI in patients without prior CABG (7). In the Angina With Extremely Serious Operative Mortality Evaluation (AWESOME) randomized trial, Morrison et al (7) reported that PCI is preferable to CABG for many prior CABG patients with myocardial ischemia. The 3-year survival rate difference was statistically insignificant when PCI (73%) and CABG (76%) were compared. Cole et al (8) reviewed the outcomes of diabetic patients with prior CABG who underwent repeat PCI or CABG. The inhospital mortality was less in the PCI group but differences in terms of long-term mortality up to 10 years were not significant. In a previous retrospective analysis (9), PCI was preferred in older patients with two-vessel CAD, patent LIMA to LAD, fewer chronic total occlusions, and higher LVEF. Poor LVEF, left main stenosis and chronic total occlusion are the major factors for the choice of CABG. The two SVG of our patient were totally occluded from the ostium, which implied a lower success rate and higher thromboembolic risk during PCI. Consequently, we chose to perform PCI in the native vessels. However, the use of PCI is not without limitations. The incidence of subsequent revascularization is higher in patients with prior CABG undergoing PCI than in patients with no prior CABG (10). DES is effective in reducing the need for restenosis or repeat revascularization. Tejada et al (10) retrospective analyzed 91 post-CABG patients who underwent 197 stent implantations (84% DES) for 154 lesions and obtained a relatively low target lesion revascularization (5.4%) at 1 year compared with previous studies before the DES era. One patient had late stent thrombosis, which was related to premature discontinuation of aspirin and clopidogrel. The independent predictors of major adverse cardiac events at 1 year for post-CABG patients who underwent PCI were LVEF $<50\%$ and multivessel intervention (10).

Cardiogenic shock is a catastrophic event with a high mortality and the use of IABP is essential in this situation. Although IABP increases coronary perfusion, the hemodynamic support from IABP is usually insufficient (11). ECMO can serve as a temporary rescue tool for patients with cardiogenic shock and provides full circulatory support (12–14). However, ECMO remains an invasive and expensive therapy and requires extensive resources. The complications of ECMO (15,16) include renal failure, risk of stroke, bleeding, hemolysis, thromboembolism, infection, vessel perforation and limb ischemia, all of which should never be overlooked. Prophylactic ECMO support is reported to be associated with a lower procedural mortality in patients with severe LV dysfunction undergoing PCI than standby ECMO support (4.8% *vs.* 18.8%, $p<0.05$) (14). Vainer et al (13) evaluated the effectiveness of ECMO in 15 patients undergoing elective high-risk PCI, but patients with prior CABG were not included in their series. The authors concluded that elective high-risk PCI under prophylactic ECMO support was a satisfactory option (13). Our patient had only viable and contractile myocardium in the inferoposterior segments of the LV, and the acute closure of the LCX may have resulted in cardiogenic shock. ECMO support was reasonable in our patient based on the findings in the literature. However, a change in the PCI strategy may have avoided this complication. Since the RCA is protected by a collateral supply from the left coronary arteries, it would be safer to open the RCA first. If we had revascularized the RCA successfully, the myocardium in the RCA territory would no longer need to receive a collateral supply from the LCX. Therefore, we would have been able to perform PCI to the LCX with less risk.

CABG cannot prevent the progression of atherosclerosis in patients with CAD. Aggressive atherosclerosis risk factor reduction and the use of as many arterial grafts as possible at the primary CABG should be encouraged to secure adequate long-term results. Myocardial perfusion scan is required to evaluate the necessity of repeat revascularization. However, revascularization is only beneficial if patients have reversible myocardial ischemia. The selection of PCI or repeat

CABG is dependent on patient age, angiographic evaluations, LV function, and patient preference. Coronary lesions in patients with prior CABG are more complex and preclude rapid intervention; furthermore, LV function in these patients is usually poor due to multivessel CAD or prior myocardial infarction. PCI in such patients is, therefore, always associated with high risk. ECMO support can be applied in prior CABG patients with severe LV dysfunction and/or increased surgical risk who are undergoing PCI to vessels that supply only viable and contractile myocardium.

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