Instantaneous Wave-free Ratio-guided Complete Revascularization in a Patient with Multi-vessel Coronary Artery Disease and Diabetes in a State of ST-Elevation Myocardial Infarction

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Abstract

We present the novel experience of using iFR to assist in deciding the treatment strategy for a male diabetic patient with triple vessel CAD who declined CABG. A 55-year-old man presented to the emergency department due to progressive substernal chest pain lasting one month. He had a history of Type 2 diabetes mellitus and cigarette smoking. His physical examination on cardiac auscultation revealed an apical soft systolic murmur. An electrocardiogram (ECG) showed normal sinus rhythm and ST elevation in precordial leads V1, V2, and V3, suggesting acute anterior wall ST-elevation myocardial infarction (STEMI). Coronary angiography was performed immediately after diagnosis, revealing triple vessel CAD. The LAD was treated as the infarct-related artery (IRA), and restored with a Thrombolysis In Myocardial Infarction (TIMI) grade of 3. The patient and his family opted for total revascularization by PCI despite the risk estimated by SYNTAX score being higher for PCI than for CABG. However, they could only afford the cost of 2 drug-eluting stents (DES). Our team chose iFR-guided complete revascularization strategy. Two stents were implanted in the left anterior descending and left circumflex coronary arteries according to IRA and iFR measurement. The repeat iFR measurement of the LCX revealed the revascularization procedure to have been successful. The patient had no further adverse cardiovascular event during follow-up after discharge. Thus, iFR-guided complete revascularization might serve as a substitute strategy to treat patients with STEMI and multi-vessel CAD, notably those with multiple co-morbidities, severe coronary lesions, reluctance to receive CABG and limited finances.

Keywords: iFR, AMI, multiple vessel disease, revascularization

Background

Numerous studies have shown that coronary artery bypass grafting (CABG) is superior to percutaneous coronary intervention (PCI) in reducing all-cause mortality in diabetic patients

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with multi-vessel coronary artery disease (CAD).[1,2] With the advances in interventional devices for PCI, the superiority of CABG to PCI has been eroded. Therefore, in some selected patients with complex CAD who have been considered candidates for CABG, PCI could be a feasible option. In real-world practice, choosing an adequate revascularization strategy between CABG and PCI means striking a balance between the guidelines and the patient's willingness. Instantaneous wave-free ratio (iFR) can provide useful functional information about the severity of coronary lesions, and help operators and patients to make a rational decision regarding treatment strategy. Here we report the novel experience of using iFR to assist in deciding treatment strategy for a male diabetic patient with triple vessel CAD who has declined CABG.

Case

A 55-year-old man presented at the emergency department with progressive substernal chest pain lasting one month. He had a history of Type 2 diabetes mellitus and cigarette smoking. On admission to the emergency department, his systolic blood pressure and pulse rate were 150 mmHg and 82 beats per minute (bpm), respectively. Cardiac auscultation revealed an apical soft systolic murmur. Otherwise, physical examination yielded no significant abnormal findings. An electrocardiogram (ECG) showed normal sinus rhythm of 84 bpm and ST elevation in precordial leads V1, V2, and V3, suggesting acute anterior wall ST-elevation myocardial infarction (STEMI) (Figure 1). He received immediate coronary angiography (CAG) that revealed triple vessel CAD. Briefly, there was total thrombotic occlusion at the proximal left anterior descending coronary (LAD) artery. There were significant obstructive lesions at the proximal left circumflex (LCX) artery and the second obtuse margin (OM2) artery, with 50% and 80% stenosis, respectively (Figure 2 A, B). Furthermore, there was 50%, 70% and 70% stenosis at the proximal, middle, and distal right

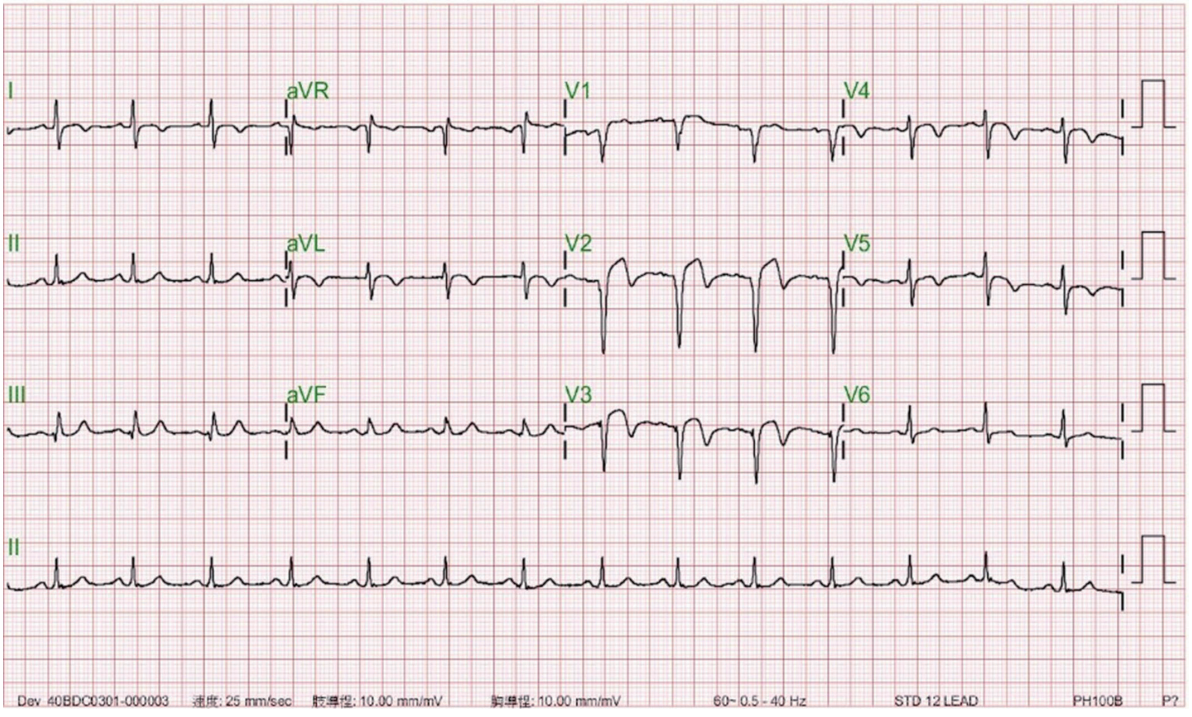

Figure 1. ECG showing an anteroseptal STEMI.

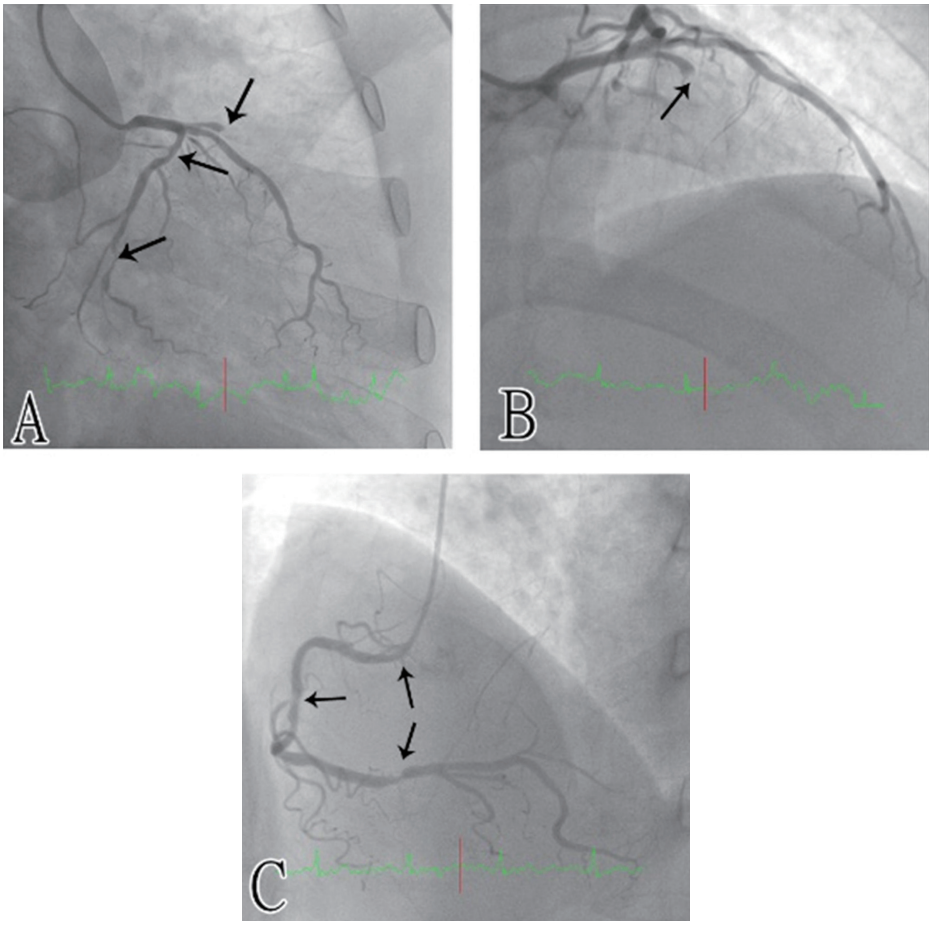

Figure 2. Coronary angiography of a STEMI patient, showing multiple coronary artery stenosis. A.B RAO and LAO views of selective angiography into left coronary artery, revealing multiple coronary stenosis (arrows). C. LAO view shows right coronary artery had multiple stenosis (arrows).

coronary artery (RCA), respectively (Figure 2 C). Taking together the findings of ECG and CAG, we considered the LAD as the infarct-related artery (IRA) to be treated immediately. Initially, we applied a thrombus suction technique using an export aspiration catheter, followed by balloon dilation at the stenotic lesions of LAD. After these aforementioned procedures, the blood flow in the LAD was restored with a Thrombolysis In Myocardial Infarction (TIMI) grade of 3. Placement of drug-eluting stents (DES) was suggested under consideration of the patient's comorbidities and residual stenoses. Since DESs are only partially covered by Taiwan's National Health Insurance, we held a detailed discussion with the patient and his family about the potentially high cost of DES placement to treat this patient's IRA and for future revascularization. We also provided a risk estimation of CABG by SYNTAX score for the patient and his family's reference.

This patient had a SYNTAX score of 30.5. The SYNTAX Score II showed the expected 4-year mortality rates for CABG and PCI to be 2.2% and 4.1%, respectively. Although the risk estimated by SYNTAX score was higher for PCI than for CABG, the patient and his family chose total revascularization by PCI. However, they could only afford the cost of 2 DESs. Under these circumstances, we decided to use iFR to guide the

treatment strategy.

For coronary reperfusion, PCI was performed on the LAD by placement of a 3.5 × 32 mm Synergy™ everolimus-eluting stent. For PCI to treat residual CAD at LCX and RCA, we used iFR to determine which artery had an actual physiological stenosis and should be treated first. Briefly, iFR was measured with a coronary guidewire (PressureWire Verrata™, Phillip) to assess the hemodynamic condition of the RCA and LCX. By definition, the ratio of resting distal coronary pressure to aortic pressure (Pd/Pa) was 1. The iFR as measured at RCA and LCX was 0.95 and 0.75, respectively. The results of iFR measurement indicated that there was a physiologically non-significant stenosis at RCA, while there was a significant stenosis of LCX. Therefore, we treated the obstructive lesions of LCX with a 2.75 × 32 mm Synergy™ everolimus-eluting stent. The repeat iFR measurement of LCX after PCI was 0.95, showing a successful revascularization procedure. Two weeks later, the patient was discharged with no adverse cardiovascular event occurring in the follow-up.

Discussion

Deciding the treatment strategy for complete revascularization in patients with diabetes and multi-vessel CAD is particularly challenging. The current recommendations state that CABG is superior to PCI with DES placement in mitigating the risk of myocardial infarction and mortality in patients with multi-vessel CAD.[1,2] However, with advances in technique and equipment, PCI has become an alternative choice to treat complex and high risk patients who are considered candidates for CABG.[3,4] In real-world practice, deciding the revascularization strategy for complex CAD should be done under detailed evaluation, including recommendations from guidelines based on clinical evidence, the patient's co-morbidities, the complexity of CAD, possibility of peri-procedural and post-procedural complications, and the patient's preferences.[5] Compared with CABG, PCI has the advantage of shorter recovery time and less invasiveness of the procedure, which might influence the patient's decision-making. According to one study reported in Korea, patients with CAD in Korea seem to be more likely to accept PCI than CABG, with a sharp increase in the annual PCI-to-CABG ratio in recent years.[6]

The current guidelines of the European Society of Cardiology (ESC) for the management of patients with STEMI and multi-vessel CAD recommend treating only the culprit vessel at the time of primary PCI, with the exception of cardiogenic shock.[7] Additionally, the use of functional fractional reserve (FFR) in the setting of acute myocardial infarction is controversial. In patients with STEMI, the accuracy of FFR values in the culprit vessels is affected by acute microvascular dysfunction resulting from infarction.[8] However, there is increasing evidence supporting the value of FFR-guided revascularization strategies in STEMI.[9] Two trials have demonstrated and supported the use of FFR-guided strategies to facilitate revascularization in non-culprit lesions in patients with STEMI. The DANAMI-3-PRIMULTI (The Third Danish Study of Optimal Acute Treatment of Patients With STEMI: Primary PCI in Multi-vessel Disease) trial revealed the effectiveness of FFR-guided complete revascularization in primary PCI.[10] The Compare-Acute (Fractional Flow Reserve-Guided Multi-vessel Angioplasty in Myocardial Infarction) trial also showed the advantages of FFR-guided complete revascularization in patients with myocardial infarction.[11] Both these randomized clinical trials showed that FFR-guided complete revascularization was associated with a decreased risk of repeat revascularization and a similar mortality rate compared to IRA-only PCI.[10,11] In addition, FFR-guided strategy was more cost-saving and related to better health outcomes compared with angiography-guided strategy in patients with multi-vessel CAD.[12]

The recent study showed the results of iFR-guided revascularization strategy to be non-inferior compared to those of FFR-guided

revascularization strategy.[13] In the clinical case reported here, we used iFR-guided strategy rather than FFR-guided strategy to avoid the adverse effects of adenosine and because FFR-guided strategy might be too time-consuming in the situation of STEMI. Furthermore, iFR served as an effective tool to help us determine actual physiological lesions requiring treatment. For the patient in the present report, there was no need to deploy a stent in RCA, indicating not only a cost-saving but also an avoidance of the risk of peri-procedural complication during PCI. After the complete evaluation of the patient's co-morbidities and preferences, our heart team decided on the iFR-guided strategy for complete revascularization. This presented itself as the best alternative option to CABG, being more cost-effective, less invasive, and carrying a reduced risk of procedural complications.

Conclusion

The iFR-guided complete revascularization might be a feasible and alternative strategy to treat CAD even in the setting of STEMI, especially for patients with multiple co-morbidities, severe coronary lesions, unwillingness to receive CABG, and limited financial ability.

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