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CASE REPORT

Fractional flow reserve measured *via* left internal mammary artery after coronary artery bypass grafting: Two case reports

Li-Ying Zhang, Yi-Rong Gan, Yan-Zhen Wang, Ding-Xiong Xie, Zong-Ke Kou, Xiao-Qing Kou, Yun-Long Zhang, Bing Li, Rui Mao, Tian-Xiang Liang, Jing Xie, Jian-Jian Jin, Jin-Mei Yang

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Abstract

BACKGROUND

The fractional flow reserve (FFR) has made the treatment of coronary heart disease more precise. However, there are few reports on the measurement of FFR *via* the left internal mammary artery (LIMA). Herein, we described the determination of further treatments by measuring FFR *via* the LIMA in 2 cases after coronary artery bypass grafting (CABG).

CASE SUMMARY

Case 1 was a 66-year-old male who was admitted due to "chest tightness after CABG." The patient underwent CABG 7 years prior due to coronary heart disease. Coronary artery angiography showed complete occlusion of the left anterior descending artery (LAD), and subtotal occlusion of the third segment of the right coronary artery. On arterial angiography, there was 85% stenosis at the distal end of the anastomosis of the LIMA-LAD graft. FFR *via* LIMA was determined at 0.75. Thus, balloon dilation was performed in Case 1. FFR after balloon dilation was 0.94. Case 2 was a 60-year-old male who was admitted due to "chest tightness after CABG." The patient underwent CABG 6 years prior due to coronary heart disease. There was 60% segmental stenosis in the middle segment of LAD and 75% anastomotic stenosis. FFR measured *via* LIMA was 0.83

(negative); thus the intervention was not performed. Case 2 was given drug treatments. At the 3-mo follow-up, there was no recurrence of chest tightness or shortness of breath in both cases. They are currently under continual follow-up.

CONCLUSION
We provided evidence that FFR measurement *via* grafted blood vessels, especially LIMA, after CABG is a good method to determine the intervention course.

Key Words: Left internal mammary artery; Fractional flow reserve; Coronary artery bypass; Intervention; Case report

Core Tip: We reported the determination of intervention by fractional flow reserve value measured *via* the left internal mammary artery after coronary artery bypass grafting in 2 cases. We provided evidence that fractional flow reserve measurement *via* grafted blood vessels, especially the left internal mammary artery, after coronary artery bypass grafting is a good method to determine whether to intervene.

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INTRODUCTION

Coronary angiography can only perform anatomical evaluation of the stenosis degree and cannot functionally evaluate the effect of the stenosis on the distal blood flow or identify the extent of myocardial ischemia. This causes overestimation or underestimation of the lesion severity and results in over-treatment or under-treatment of lesions[1]. Fractional flow reserve (FFR), which was first proposed in 1993[2], is an index for estimating coronary blood flow by pressure measurement. In recent years, the wide application of FFR has enabled patients with coronary heart disease to receive precise treatment[3,4]. The left internal mammary artery (LIMA) has an excellent long-term patency rate and is the preferred vessel for coronary artery bypass grafting (CABG)[5]. However, the measurement of FFR *via* the LIMA is rarely reported. Herein, we reported the determination of further treatments in 2 patients by measuring FFR through the LIMA. These patients received CABG for coronary heart disease and had graft occlusion after CABG.

CASE PRESENTATION

Chief complaints

Case 1: A 66-year-old male was admitted to Gansu Institute of Cardiovascular Diseases due to “chest tightness after CABG.”

Case 2: A 60-year-old male was admitted to Gansu Institute of Cardiovascular Diseases because of “chest tightness after CABG.”

History of present illness

Case 1: The patient experienced intermittent chest tightness and shortness of breath in the prior 3 years. The symptoms worsened in the 3 mo prior to admission.

Case 2: The patient suffered from chest tightness and shortness of breath in the week prior to admission.

History of past illness

Case 1: The patient underwent CABG 7 years prior due to coronary heart disease. The coronary artery bypass grafts included the graft from LIMA to the left anterior descending artery (LAD), the graft from the ascending aorta (AO) to the right posterior descending coronary artery and the graft from the AO to the first diagonal branch of the left coronary artery.

Case 2: The patient received CABG 6 years prior due to coronary heart disease. The coronary artery bypass grafts included the LIMA-LAD graft and the saphenous vein-obtuse marginal branch graft.

Personal and family history

Case 1: The patient denied any family history of heart disease or genetic disease. The patient had a smoking history of 30 years (3 cigarettes a day).

Case 2: The patient denied any family history of heart disease or genetic disease. The patient had a smoking history of 30 years (20 cigarettes a day).

Physical examination

Case 1: Physical examination showed blood pressure of 152/93 mmHg and heart rate of 61 beats/min. There was no arrhythmia or pathological murmur.

Case 2: Physical examination showed blood pressure of 135/85 mmHg and heart rate of 77 beats/min. No arrhythmia or pathological murmur was observed.

Laboratory examinations

Case 1: Laboratory examinations showed that low density lipoprotein was 3.80 mmol/L, and total cholesterol was 5.70 mmol/L. No obvious abnormality was observed in other blood biochemical indicators.

Case 2: Laboratory examinations showed that low density lipoprotein was 2.06 mmol/L, and total cholesterol was 3.59 mmol/L. There was no obvious abnormality in other blood biochemical indicators.

Imaging examinations

Case 1: Coronary artery angiography showed complete occlusion of LAD and subtotal occlusion of the third segment of the right coronary artery (RCA). The angiography also showed that the AO-first diagonal branch of the left coronary artery and the AO-posterior descending coronary artery grafts had smooth blood flow and had no anastomotic stenosis. On the arterial angiography, it was observed that the LIMA-LAD graft had smooth blood flow and had no anastomotic stenosis. However, there was 85% stenosis at the distal end of the anastomosis of the LIMA-LAD graft (Figure 1A). Cardiac ultrasound showed that the left ventricular ejection fraction was 54%.

Case 2: Coronary artery angiography observed that the left coronary artery was dominant. There was no abnormality in the left main coronary artery. However, there was 60% segmental stenosis in the middle segment of LAD and chronic occlusion of the RCA from the opening with visible collateral circulation. The LIMA-LAD graft was unobstructed. However, there was 75% anastomotic stenosis (Figure 2A). Additionally, the saphenous vein-obtuse marginal branch graft was unobstructed. On cardiac ultrasound, the left ventricular ejection fraction was 50%, consistent with the changes of old myocardial infarction at the inferior and posterior heart walls.

Further diagnostic work-up

Case 1: The pressure measuring guide wire was inserted into the stenotic segment of LAD through the LIMA, and the FFR value was measured to be 0.75 (positive) (Figure 1B).

Case 2: The FFR measured from the LIMA to the distal end of the anastomosis was 0.83 (negative) (Figure 2B).

FINAL DIAGNOSIS

Case 1

The final diagnosis was stenosis at the distal end of the anastomosis of the LIMA-LAD graft.

Case 2

The final diagnosis was segmental stenosis in the middle segment of LAD, chronic occlusion of the RCA and anastomotic stenosis.

TREATMENT

Case 1

Based on the positive FFR value, intervention was performed. In detail, dilation with a 2.0 mm × 31.0

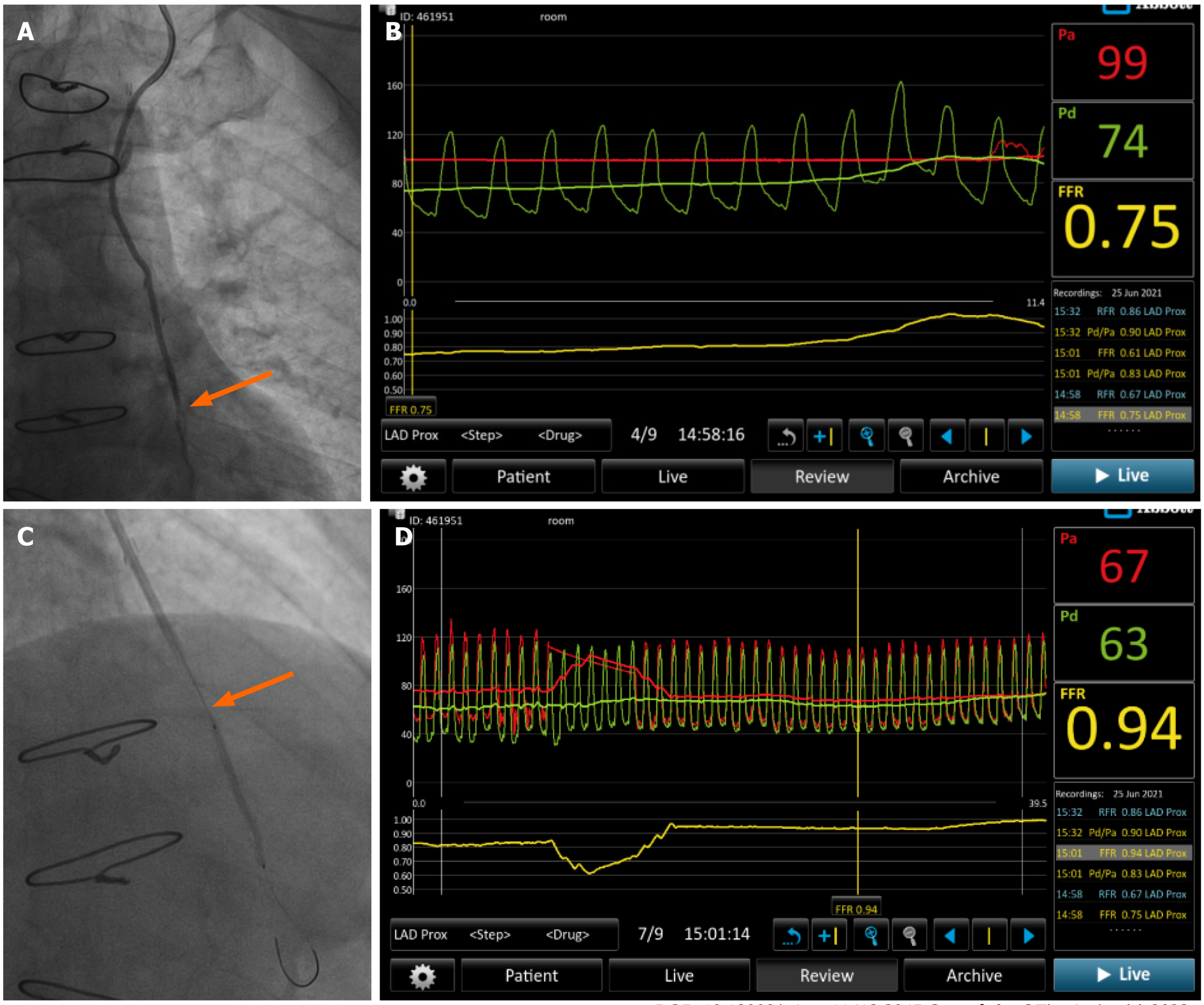

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Figure 1 Images of case 1. A: Angiography showed 85% stenosis at the distal end of the anastomosis of the left internal mammary artery (LIMA)-left anterior descending artery graft (orange arrow); B: Before intervention, the fractional flow reserve measured *via* the LIMA was 0.75 (positive); C: Dilation with a 2.0 mm × 31.0 mm drug containing balloon was performed at the stenotic segment of the left anterior descending artery *via* the LIMA (orange arrow); D: After balloon dilation, remeasurement of pressure showed that the fractional flow reserve was 0.94.

mm balloon containing drugs was performed at the stenotic segment of the LAD *via* the LIMA (Figure 1C).

Case 2

Based on the negative FFR value, the intervention was not performed. The patient was given drug treatments according to traditional Chinese medicine and Western medicine.

OUTCOME AND FOLLOW-UP

Case 1

Remeasurement of pressure showed that the FFR after balloon dilation was 0.94 (Figure 1D). There was no residual stenosis as shown on coronary angiography. Three days after intervention, the symptoms of chest tightness were significantly relieved, and the patient was discharged. At the 3-mo follow-up, the patient had no recurrence of chest tightness or shortness of breath. The patient is currently under continual follow-up.

Case 2

One week after drug treatment, the symptoms of chest tightness and shortness of breath were significantly relieved and the patient was discharged. At the 3-mo follow-up, there was no recurrence of chest tightness or shortness of breath. The patient is currently under continual follow-up.

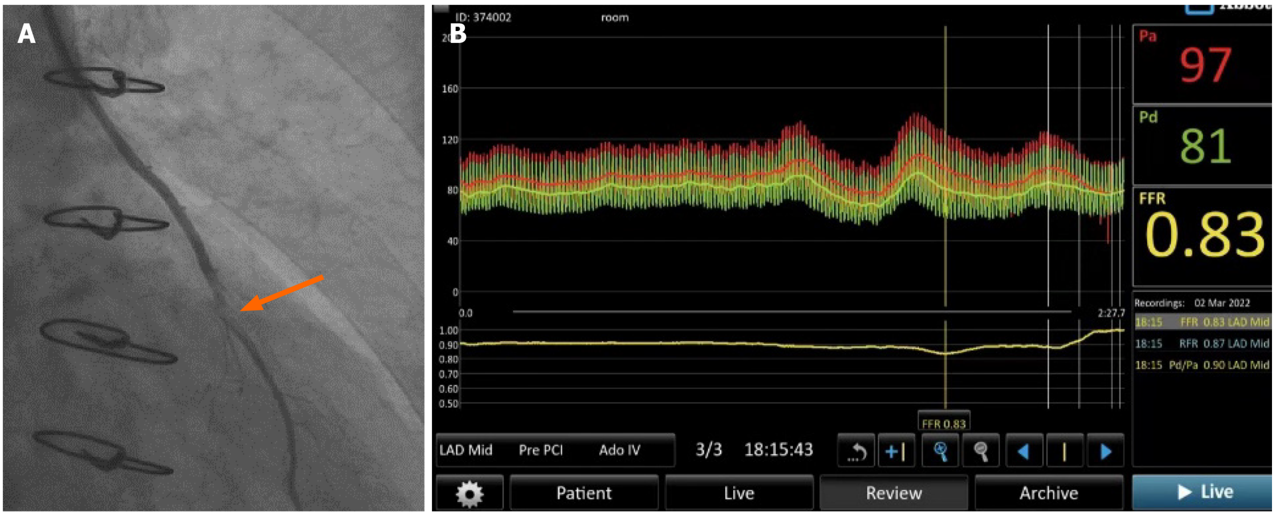

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Figure 2 Images of case 2. A: Angiography indicated 75% anastomotic stenosis (orange arrow); B: The fractional flow reserve measured from the left internal mammary artery to the distal end of the anastomosis was 0.83 (negative).

DISCUSSION

LIMA is a commonly used vessel for CABG. Its advantages[6] are as follows: (1) The pedicled LIMA can regulate blood flow according to physiological needs; (2) The LIMA can produce prostaglandins, which can dilate blood vessels and resist platelet aggregation; and (3) The LIMA has less possibility of atherosclerosis, ensuring a high long-term patency rate. The 2 patients in this report had occlusion in the proximal segment of the anterior descending artery and occlusion in the middle segment of the anterior descending artery. The blood supply of the anterior myocardium mainly came from the LIMA graft. Thus, intervention may be performed through the LIMA. However, re-intervention therapy should be performed with caution after recurrence. It is shown that nearly 25% of patients with coronary angiography stenosis above 70% do not have myocardial ischemia[7]. For these patients, stenting or coronary bypass based on the results of coronary angiography alone will not only have no effect but also increase the financial and psychological burden of patients, leading to over-treatment.

FFR can objectively and accurately evaluate coronary function, thus providing evidence for interventional therapy and assisting in making precise treatment plans during interventional therapy[8,9]. A multicenter clinical trial[7] showed that compared with traditional percutaneous coronary intervention using FFR as the gold standard to guide patients with coronary artery diseases for revascularization intervention significantly improved the prognosis of patients and significantly reduced the incidence of adverse events. The 3-year follow-up results from the Compare-Acute study showed that FFR-guided complete revascularization in patients with ST-segment elevation myocardial infarction and multivessel disease could significantly reduce costs[10]. FFR measurement is currently the optimal method to confirm whether coronary stenosis is complicated with myocardial ischemia. The latest international views believe that coronary angiography + FFR measurement is the “gold standard” for the diagnosis and treatment of coronary heart disease[11]. Clinically, an FFR value greater than 0.8 indicates no myocardial ischemia, and an FFR value less than 0.8 indicates myocardial ischemia[12]. Under this gold standard, the precise treatment of coronary heart disease by stenting or bypass grafting can be achieved [13].

In patients with chest tightness and shortness of breath after CABG, it should be first considered whether there is a problem with the grafted blood vessels, especially the LIMA-LAD graft. There may be factors such as atherosclerotic stenosis in LIMA, anastomotic stenosis and stenosis in LAD at the distal end of the anastomosis[14]. Previously, intervention was determined by the stenosis degree assessed by the angiography of LIMA. However, angiography cannot determine whether there is ischemia in the distal myocardium. Thus, the intervention may have some blindness to a certain extent [7]. The measurement of FFR enables the quantitative evaluation of the degree of myocardial ischemia at the distal end of the anastomosis and can more accurately determine whether to intervene.

In this report, Case 1 had 85% stenosis in the LAD at the distal end of the anastomosis of the LIMA-LAD graft. The measured FFR value was 0.75 (positive), and then balloon dilation was performed. The measured FFR value after drug balloon dilation was 0.94 (negative). The patient’s symptoms were significantly relieved after intervention. In Case 2, although there was 75% stenosis at the anastomosis between the LIMA and the LAD, the FFR value was 0.83 (negative). This indicated that there may be no myocardial ischemia. Thus, intervention was not performed in Case 2, avoiding over-treatment. Case 2 was discharged after drug therapy.

Notably, this report is limited in that the measurement of FFR *via* LIMA was invasive and that we did not compare the FFR measured *via* LIMA with that measured by cardiac color Doppler.

CONCLUSION

In conclusion, we provided evidence that FFR measurement of grafted blood vessels, especially LIMA grafts, after CABG is a good method to determine the intervention course.

FOOTNOTES

Author contributions: Zhang LY, Gan YR and Wang YZ contributed equally to the study; Zhang LY, and Gan YR collected the cases and wrote the paper; Kou ZK and Kou XQ were responsible for surgical intervention; Zhang YL and Li B collected the data; Mao R was responsible for patient care; Liang TX was responsible for cardiopulmonary bypass; Xie J was responsible for clinical examination; Jin JJ analyzed the data; Xie DX, Wang YZ and Yang JM supervised the process, provided the financial support and revised the paper; All authors have read and approved the manuscript.

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