A Pitfall of Fractional Flow Reserve Associated with the Presence of Collateral Circulation

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Abstract

An 82-year-old man had a severe stenosis in the proximal left anterior descending artery (LAD) and an intermediate stenosis in the distal right coronary artery (RCA). The territory of mid to distal LAD was perfused via an angiographically well-developed collateral circulation from the distal RCA. Fractional flow reserve (FFR) in the distal RCA was 0.84. After successful coronary intervention for the proximal LAD, repeat FFR in the distal RCA was 0.96. In this case, the severity of the stenosis in the donor artery was overestimated by using FFR due to the presence of well-developed collateral circulation.

Key words: coronary artery, collateral circulation, fractional flow reserve


Introduction

Fractional flow reserve (FFR) is increasingly used to evaluate the physiological significance of intermediate coronary stenoses (1-6). Its clinical use has been advocated in the setting of both single- and multivessel disease. FFR is not influenced by hemodynamic parameters such as heart rate or blood pressure. In this report, we describe a case showing overestimated severity of the stenosis in the donor artery by using FFR because of the presence of well-developed collateral circulation.

Case Report

An 82-year-old man with previous percutaneous coronary intervention (PCI) and effort angina underwent cardiac catheterization. Left ventriculography showed normal systolic function with an ejection fraction of 62%. Coronary angiography showed a severe stenosis in the proximal left anterior descending artery (LAD) and an intermediate stenosis in the distal right coronary artery (RCA). The territory of mid to distal LAD was perfused via an angiographically well-developed collateral circulation from the distal RCA, grade III on the Rentrop scale (Fig. 1, arrowheads). A pressure wire (PressureWire, RADI Medical Systems, Uppsala, Sweden) was advanced into the RCA, and its pressure sensor was positioned precisely beyond the intermediate stenosis. FFR was measured during maximal vasodilation with intravenous infusion of adenosine triphosphate, and its value was 0.84. Subsequently, PCI for the proximal LAD was performed successfully by using drug-eluting stent. The pressure-derived collateral flow index determined as coronary wedge pressure divided by aortic pressure was 0.98 indicating a well-developed collateral circulation (7, 8). After successful PCI, left coronary angiography showed an antegrade perfusion beyond the mid LAD, and right coronary angiography showed a reduced collateral circulation to the territory of LAD (Fig. 2, arrowheads). The value of repeat FFR in the distal RCA was 0.96 indicating no physiologically significant stenosis. He was discharged the following day.

Discussion

We demonstrated a case showing the overestimated severity of the stenosis in the distal RCA by using FFR because it supplied a well-developed collateral circulation to the LAD. FFR is a simple tool to determine the severity of interme-
Coronary angiography showed a severe stenosis in the proximal left anterior descending artery (LAD) and an intermediate stenosis in the distal right coronary artery (RCA) (arrow). The territory of mid to distal LAD was perfused via an angiographically well-developed collateral circulation (arrowheads) from the distal RCA, grade III on the Rentrop scale. The value of fractional flow reserve in the distal RCA was 0.84.

Figure 1.

Intermediate coronary stenoses. The normal value of FFR is 1.0, and the value of <0.80 is accepted to be indicative of physiologically significant stenosis (4). FFR has been shown to be independent of hemodynamic changes including heart rate, blood pressure or contractility. However, as shown here, FFR in the donor artery seems to be dependent on the presence of collateral circulation. The overestimated severity of the stenosis in the distal RCA can be explained as follows. RCA supplied a well-developed collateral circulation to the LAD indicating the increased amount of distal vascular beds. Consequently, increased coronary blood flow of RCA resulted in a FFR of 0.84 in the distal RCA. PCI for the proximal LAD reduced the amount of distal vascular beds supplied by RCA, and resulted in a FFR of 0.96 as the original estimate of the intermediate stenosis in the distal RCA.

A recent clinical trial demonstrated that routine measurement of FFR in patients with multivessel disease who are undergoing PCI reduces the rate of the composite end point of death, non fatal myocardial infarction and repeat PCI (4). FFR is used frequently in many catheterization laboratories to guide clinical decision-making with regard to PCI for intermediate stenoses. However, patients with multivessel disease often have a well-developed collateral circulation, and there is a possibility that the stenosis in the donor coronary artery is overestimated by using FFR. When there are stable coronary stenoses with FFR of <0.80 in the donor artery as well as the collateral-receiving artery (9, 10), the stenosis in the collateral-receiving artery usually has priority to be treated with PCI. After successful PCI in the collateral-receiving artery, repeat FFR in the donor artery should be measured as the original estimate.

Melikian et al previously reported a similar case showing the overestimated severity of the stenosis in the distal LAD that supplied a collateral circulation to the RCA (11). In their case, FFR in the LAD increased from 0.75 to 0.84 after successful PCI for the RCA, although hemodynamics of collateral circulation were not evaluated by using the pressure-derived collateral flow index. In the present case, pressure-derived collateral flow index was measured during PCI, and its value was 0.98 indicating that the donor artery had the increased amount of distal vascular beds. Thus, high pressure-derived collateral flow index may be suggestive of the overestimated severity of the stenosis in the donor artery. Cardiologists should be aware of the pitfall of FFR associated with the presence of collateral circulation especially in...
Figure 2. After successful coronary intervention for the proximal left anterior descending artery (LAD), right coronary angiography showed a reduced collateral circulation (arrowheads) to the territory of LAD. The result of repeat fractional flow reserve in the distal right coronary artery (arrow) was 0.96 indicating no physiologically significant stenosis.

patients with multivessel disease.

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References


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