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Effect of the fractional flow reserve (FFR) on the treatment of coronary bifurcation disease.

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Abstract

Objective: This study is mainly to evaluate the effect of left anterior descending coronary artery after implantation on the first diagonal branch and guiding effect of the Fractional Flow Reserve (FFR) on the treatment of coronary bifurcation disease.

Methods: A total of 78 patients with left anterior descending coronary artery disease (LAD) were enrolled in this study. After implantation of coronary artery left anterior descending (LAD) stent, it was divided into FFR>0.80 group (58 cases) and FFR ≤ 0.80 group (20 example) according to marginal branch FFR scores. The general clinical features and hematological findings of the patients were observed and recorded, including blood, blood glucose, low density lipoprotein, renal function and uric acid.

Results: The contrast of before PCI operation LAD reference vessel diameter ((3.12 ± 0.15)(3.15 ± 0.17 mm), P=0.774), Quantitative Coronary Angiography (QCA) percent diameter stenosis ((0.85 ± 0.13%), (0.76 ± 0.14%), P=0.812), Lesion length ((19.89 ± 5.63), (21.53 ± 7.56 mm), P=0.659), FFR mean value (0.63 ± 0.12, 0.52 ± 0.23, P=0.824) with after LAD PCI angular branch reference blood vessel diameter ((2.61 ± 0.25), (2.59 ± 0.24 mm), P=0.746), QCA lesion percent diameter stenosis ((0.45 ± 0.18%), (0.54 ± 0.15%), P=0.112), minimum lumen diameter ((1.36 ± 0.520, (1.14 ± 0.49 mm), P=0.153), the differences were not of statistically significant (P>0.05); However, it has the statistically significance (P<0.01) of the differences in the angular branch FFR mean value (0.75 ± 0.14, 0.67 ± 0.13) after LAD PCI. After anterior descending stent implantation, in the diastolic branch greater than 0.80 group, there are 15.5% patients of QCA diameter stenosis greater than or equal to 70.0% is false negative; in the diastolic FFR ≤ 0.80 group, 70.0% of the patients with QCA diameter stenosis of less than 70.0% is false negative.

Conclusion: FFR can significantly reduce the complexity of bifurcation and improve the efficiency of diagnosis in the treatment of coronary artery bifurcation.

Keywords: FFR, Coronary artery, Bifurcation lesion, Coronary angiography.

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Introduction

Coronary bifurcation lesion is one of the difficulties in Percutaneous Coronary Intervention (PCI) [1]. As the bifurcation lesions involving two or more vessels, the marginal branch opening is often covered by the main branch of the blood vessels when coronary angiography, multi-position projection still cannot fully expose the lesions [2]. Therefore, accurate assessment of ischemic lesions of bifurcation lesions, selectively and active intervention in myocardial ischemia-related lesions, can significantly improve the patients prognosis, reducing the incidence of cardiovascular events. Bifurcation treatment decision-making choice is the difficulty to interventional therapy, there is no recognized "gold standard", complications, stent restenosis rate is high, poor in prognosis compared with a single lesion [3,4]. At present, many studies have shown that bifurcation lesion should be treated as simple as possible. For most bifurcation lesions, the efficacy of single stent is better than double stents. However, how to screen the "criminal" marginal branch, which marginal branch stenosis have the functional significance, what kind of surgery to take? There are still no recognized standards. Fractional Flow Reserve (FFR) measurement involves determining the ratio between the maximum achievable blood flow in a diseased coronary artery and the theoretical maximum flow in a normal coronary artery, which is considered to be the specific function parameters of the epicardial coronary artery lesion [5,6]. FFR has been increasingly popular in assessing the bifurcation lesions [7]. Compared with coronary angiography, FFR can identify ischemic lesions quickly [8]. The functional significance of accurate assessment of marginal vessel stenosis is critical for the treatment decision-making for bifurcation lesions. The aim of this study is to elucidate the role of FFR in guiding bifurcation treatment strategies [7].

Materials and Methods

General data

Choosing 63 patients during January 2015 to December 2016 in this hospital who received coronary angiography, two experienced technicians, who worked in cardiovascular intervention catheter chamber, by utilizing Quantitative Coronary Angiography (QAD), determine the Left Anterior Descending coronary artery (LAD) lesion, and coronary artery stenosis is greater than 70%, no obvious lesions in the first diagonal branch, and it is expected to cover the first diagonal branch ostial after the LAD stent, whose diameter will be greater than or equal to 2.5 mm.

Exclusion criteria

Acute coronary syndrome, myocardial enzymes increasing, left main bifurcation lesions, coronary artery bypass disease, cardiogenic shock, cardiomyopathy, blood system diseases, expected survival time of less than 2 y, as well as severe liver and kidney diseases. Define FFR>0.80 (58 cases) as non-ischemic related lesions (FFR>0.80 group), FFR ≤ 0.80 (20 cases) as ischemic related lesions (FFR ≤ 0.80 group). Clinically observe the index and record general clinical features of (Age, sex, heart rate, body weight index, previous history of hypertension, hyperglycemia, and hyperlipidemia, history of smoking) and hematological examination results before angiography, which are as follows: blood routine, blood glucose, Low Density Lipoprotein (LDL), renal function, uric acid and so on.

QCA and measurement

Parameters QCA analysis of the angiographic results was performed by using a two-dimensional QCA original workstation (GE Innova 2000, Fairfield, USA) from America GE Company that attached with digital flatbed angiography machine. The main measurement parameters: Reference Vessel Diameter (RVD), percentage Diameter Stenosis (DS), Percentage Area Stenosis (AS), Minimum Luminal Diameter (MLD) and lesion length (lesion length, LL).

FFR values measurements

FFR was measured using a dedicated FFR pressure guidewire system (Sheng Jiu Medical Devices Co., Ltd.). After filling the guidewire with physiological saline, keep the pressure sensor position and the patient's heart on an even keel, and use the multi-conductive physiometer to zero calibration [9]. Using a 6 F guide catheter, place the baroreceptor in the guide catheter ostial, withdraw the guide pin, and calibrate again. After the calibration, the pressure guide wire was fed into the distal segment of the target vessel. After the pressure curve was stable, injecting adenosine triphosphate 140 μg/(kg•min) into elbow middle intravenous, which induced the maximum congestive state. After taking medicine for 90 s, the majority of patients reached the maximum congestive state, blood pressure decreasing by 10% to 15%. If there is no significant change in blood pressure, we should check the infusion pump settings, intravenous access is smooth or not, drug validity and configuration methods. Pay attention to observing the adverse reactions during medication, such as atrioventricular block, hypotension, palpitations, difficulty breathing, chest tightness and so on. Continue to record for 30 s after finishing, take the lowest FFR value for the final measurement result.

Statistical analysis

Use statistical software SPSS20.0 to do analyse. Utilize rate to show enumeration data, and χ^2 test to show comparison among groups; $\bar{x} \pm s$ to show measured data, and factor analysis of variance or student t test to show the positive distribution continuous variables groups comparison. The difference of P<0.05 for was of statistically significant [10].

Results

Comparison of base line clinical features between two groups There were no statistical significance(P>0.05) of differences in gender, age, heart rate, body mass index, hypertension, hyperglycemia, history of hyperlipidemia, smoking history, white blood cell count, hemoglobin, fasting blood glucose, LDL, renal function and uric acid, details in Table 1.

Comparison of coronary artery lesion features between two groups There were no statistical significance of differences in comparing RVD, DS, LL and FFR value mean of LAD before PCI (P>0.05) before operation with RVD, DS, MLD of LAD PCI diagonal branch, however, the comparison of FFR mean value of LAD PCI diagonal branch is of statistical significance, details in Table 2.

QCA cannot accurately predict whether posterior branch bloodstream is affected after LAD stent implantation After LAD stent implantation, in the group of diagonal branch greater than 0.80, 15.5% of patients with QCA diameter stenosis greater than or equal to 70.0% for the false positive; in the group of diagonal branch FFR ≤ 0.80, 70.0% of patients with QCA diameter stenosis less than 70.0% for false negative, details in Table 3.

Table 1. *Comparation of basic demography characteristics blood normal routine in the two groups.*

Group	n	Male (n (%))	Age (x̄ ± s)	Heart rate (x̄ ± s)	Body mass (x̄ ± s)	Type 2 diabetes (n (%))	Hyperlipidemia (n (%))	Hypertension (n (%))	Smoking history (n (%))
FFR>0.80	58	41 (70.6)	55.2 ± 6.8	70.2 ± 11.6	25.6 ± 3.7	7 (12.1)	9 (15.5)	14(24.1)	32 (55.2)
FFR<0.80	20	13 (65.0)	56.3 ± 6.9	70.7 ± 10.8	26.2 ± 4.8	4 (20.0)	5 (25.0)	7(35)	13 (65)
χ^2/t	-	0.074	0.667	0.435	-0.469	0.075	0.447	0.425	3.135
P	-	0.721	0.816	0.615	0.742	0.725	0.491	0.562	1.104
Group	**n**	**WBCC (x̄ ± s, × 10^9 L^{-1})**	**Hemoglobin (x̄ ± s, g/L)**	**FBG (x̄ ± s, mmol/L)**	**LDL (x̄ ± s, mmol/L)**	**BuN (x̄ ± s, mmol/L)**	**Ucr (x̄ ± s, μmol/L)**	**Uric acid (x̄ ± s, mmol/L)**	
FFR>0.80	58	6.8±1.3	113.7 ± 13.8	5.1 ± 1.2	2.2 ± 0.3	5.1 ± 0.7	74.2 ± 11.5	314.7 ± 22.5	
FFR<0.80	20	6.5±2.2	115.4 ± 20.5	5.2 ± 1.5	2.5 ± 0.3	5.2 ± 1.4	79.5 ± 21.6	320.6 ± 30.5	
χ^2/t		1.136	-1.213	-0.341	0.018	-0.254	-1.286	-1.265	
P		0.125	0.146	0.723	0.769	0.712	0.058	0.071	

Table 2. *QCA parameters comparison in the two groups of patients with coronary artery lesions ($\bar{x} \pm s$).*

Group	n	Before PCI, LAD				After PCI, diagonal branch			
		RVD (mm)	DS (%)	LL (mm)	FFR (mean value)	RVD (mm)	DS (%)	LL (mm)	FFR (mean value)
FFR>0.80	58	3.12 ± 0.15	0.85 ± 0.13	19.89 ± 5.63	0.63 ± 0.12	2.61 ± 0.25	0.45 ± 0.18	1.36 ± 0.52	0.75 ± 0.14
FFR<0.80	20	3.15 ± 0.17	0.76 ± 0.14	21.53 ± 7.56	0.52 ± 0.23	2.59 ± 0.24	0.54 ± 0.15	1.14 ± 0.49	0.67 ± 0.13
χ^2/t	-	-0.215	0.123	1.312	1.021	-1.415	-1.537	1.564	3.132
P	-	-0.774	0.812	0.659	0.824	0.746	0.112	0.153	<0.01

Table 3. *Effect of later blood flow after LAD implantation (n (%)).*

Group	n	Diameter (QCA) ≥ 70%	Diameter (QCA) ≤ 70%
FFR>0.80	58	9 (15.5)	46 (79.3)
FFR<0.80	20	6 (30.0)	14 (70.0)

Discussion

There are great limitations in the evaluation of bifurcation lesions of coronary angiography, mostly because that marginal ostial is often covered by the main branch of the blood vessels, multi-position projection still cannot fully exposing lesions [11]. Therefore, relying solely on coronary angiography cannot accurately assess the true anatomical relationship of bifurcation lesions and the functional significance of branching vascular stenosis [12]. PCI treatment guidelines also point out that it is unscientific to rely solely on imaging of coronary artery stenosis to guide PCI treatment and should provide evidence of objective myocardial ischemia [13]. New imaging methods, such as Intravascular Ultrasound (IVUS) and Optical Coherence Tomography (OCT), can accurately reveal the anatomical relationship of bifurcation lesions, but still cannot suggest the functional significance of bifurcated blood vessels [14]. However, from the functional point of view, FFR can be to assess whether the main branch and marginal vessel stenosis will cause myocardial ischemia, therefore, there plays a significant role in the bifurcation of PCI treatment.

Generally, after implantation of main stent, posterior branch stenosis seems to be heavier, the main reasons including coronary artery spasm, thrombosis, plaque displacement, stent beam displacement and so on. Studies have shown that after the main stent implantation, the degree of posterior branch stenosis is difficult to be accurately estimated, that the functional significance shall become no answer. After the main stent implantation, the posterior branch stenosis appears to be aggravated, and the results of the FFR examination are often very different. Therefore, after the stent implantation, the lateral stenosis appears to be very heavy, FFR examination is necessary, can reduce the unnecessary stent intervention, simplify the treatment of bifurcation lesions and improve the prognosis of patients.

In this study, 78 patients with LAD stenosis greater than 70% and the first diagonal branch with no obvious lesion are included. The LAD stent was covered with the first diastolic ostial, 58 cases with diagonals FFR>0.80 and 20 cases with FFR ≤ 0.80 example. There was no statistical significance in compared difference in RVD, stenosis and LL of RVD between the two groups (P>0.05); so as the diagonal branch RVD, DS, MLO of LAD PCI (P>0.05) but not the diagonal branches of FFR mean value. (P<0.01), suggesting that QCA could not accurately predict whether the blood flow behind LAD PCI is affected. Indicating that QCA has a high "false positive" and "false negative" rate for predictive effects of the posterior branch implantation [15]. Severe coronary artery stenosis that showed by coronary angiography, most of which were independent of myocardial ischemia and that highly overestimated the proportion of ischemic-related lesions [16]. In summary, FFR-guided bifurcation lesions PCI can significantly reduce the complexity of bifurcation lesions, simplify surgical strategies, reduce operative time, reduce medical costs and improve patient after operation.

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