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Original Article

Investigation of the value of carotid-femoral pulse wave velocity and coronary artery lesions in prognosis of percutaneous coronary intervention patients

Yulin Fang[1], Qiuying Zhong[2]

[1]*Department of Integrated Chinese and Western Medicine, The Sixth Hospital of Wuhan, Affiliated Hospital of Jianghan University, Wuhan 430000, Hubei, China;* [2]*Department of Geriatrics, The Sixth Hospital of Wuhan, Affiliated Hospital of Jianghan University, Wuhan 430000, Hubei, China*

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Abstract: Objective: To investigate the value of carotid-femoral pulse wave velocity (CFPWV) and coronary artery lesions in assessing prognosis of percutaneous coronary intervention (PCI) patients. Methods: A total of 300 PCI patients admitted to our hospital were selected as study subjects, and were divided into Group A (0-13 m/s, n=180) and Group B (> 13 m/s, n=120) in accordance with different carotid-femoral pulse wave velocities (CFPWVs). Coronary artery lesions, incidence rates of major adverse cardiac events (MACE) at different stages, and differences in the indexes of cardiac function were compared between the two groups. Results: Compared to Group A, Group B had more severe coronary artery lesions and higher incidence rates of postoperative complications and MACE during hospital stay and 2-year follow-up ($P < 0.05$). At 1 month after surgery, the left ventricular stroke volume, left ventricular end-diastolic volume and left ventricular ejection fraction in Group A were higher than those of Group B. CFPWV was significantly correlated with Gensini score (GS) and incidence rate of MACE ($P < 0.05$), and the differences in the area under curve (AUC) of CFPWV for predicting the incidence rate of MACE were significant ($P < 0.05$). Conclusion: CFPEV, exhibits value in assessing the prognosis of PCI patients, and can effectively predict the postoperative incidence of MACE, which is conducive to the establishment of subsequent regimens. Therefore, CFPEV is worthy of clinical promotion and implementation.

Keywords: CFPWV, coronary artery lesions, PCI, assessment of prognosis, value

Introduction

Recently, changes in the dietary structure and living habits have led to a marked increase in the incidence of cardiovascular and cerebrovascular diseases in China [1]. An investigation of urban residents aged over 45 years shows that the new incidence rate of hypertension is as high as 24%, the patients' awareness of hypertension is low, and the therapeutic effect is not satisfactory [2]. Percutaneous coronary intervention (PCI) involves the opening of stenotic or occluded coronary arteries using cardiac catheterization, so as to improve myocardial ischemia and hypoxia [3]. Clinically, PCI is a commonly-used option for the treatment of acute myocardial infarction. PCI can quickly improve coronary blood circulation and myocardial blood perfusion, and plays an irreplaceable role in saving endangered myocardium. Studies indicate that PCI reveals a positive significance in elevating the survival rate of patients with acute myocardial infarction [4, 5].

Assessment of the prognosis of PCI patients has important reference significance for the establishment of clinical therapeutic strategies. Clinical findings show that the postoperative incidence of major adverse cardiac events (MACE) is higher in some PCI patients, and even may lead to death [6]. Studies indicate that arterial structure and dysfunction may be the pathologic basis and leading cause of MACE. An early decrease of large arterial distensibility can lead to a high diagnostic sensitivity for MACE, and the increase in arterial distensibility may be closely related to mortality in PCI patients [7, 8]. Carotid-femoral pulse wave

velocity (CFPWV), a commonly used indicator for the assessment of large arterial distensibility, features non-invasiveness and good repeatability. Currently, CFPWV has been extensively implemented for the diagnosis of carotid artery lesions and coronary artery lesions [9]. An investigation of 200 patients with suspected coronary heart disease suggested that CFPWV exhibits high diagnostic value for coronary heart disease, with a sensitivity of 93.7% and a specificity of 77.5% [10].

The objective of this study is to analyze the value of CFPWV in assessing the prognosis of PCI patients. This may prove the implementation value of CFPWV through assessing the correlation between CFPWV and coronary artery lesions,and analyzing and comparing the incidence rates of MACE in patients with different CFPWVs, so as to provide a theoretical reference for the establishment of postoperative therapeutic strategies for PCI patients.

Materials and methods

General data

A total of 300 PCI patients with acute coronary syndrome admitted to our hospital from October 2015 to October 2019 were selected as study subjects, and were divided into Group A (0-13 m/s, n=180) and Group B (> 13 m/s, n=120) in accordance with different CFPWVs. All subjects received a CFPWV test.

Inclusion criteria: (1) clinically diagnosed with acute coronary syndrome and treated with PCI [11]; (2) clear consciousness and ability to cooperate with the investigation after surgery; (3) complete clinical data; (4) the data regarding the investigation were submitted to the Hospital Ethics Committee for approval and implementation; (5) voluntary signing of informed consent form by patients or their families.

Exclusion criteria: (1) complicated by mental illness; (2) complicated by aortic aneurysm; (3) previous history of PCI; (4) complicated by atrial fibrillation; (5) previous history of coronary artery bypass grafting (CABG); (6) severe hepatic and renal dysfunction; (7) severe arrhythmia; (8) malignant tumors; (9) pregnancy or lactation.

Rejection criteria: (1) voluntary withdrawal during the investigation; (2) loss to follow-up during the investigation.

Intervention methods

CFPWV test was performed on the enrolled subjects preoperatively using the Omron VP-100 CFPWV testing device (Omron, Kyoto, Japan) by the same group of physicians, so as to minimize the influence of human factors on the results. After measurement, patients' data were input into the software for processing. Then, the patients were treated in accordance with the procedures for PCI, and the patients' Gensini scores (GS) were recorded during surgery. After surgery, the patients received conventional postoperative care in accordance with the clinical routine.

Observational indexes and assessment criteria

Before surgery, patients were divided into Group A (0-13 m/s, n=180) and Group B (> 13 m/s, n=120) in accordance with the measured CFPWVs. The coronary artery lesions (including the average number of involved arteries and lesion types), the incidence rates of complications after PCI and MACE (revascularization, myocardial reinfarction, and cardiogenic death) during hospital stay and 2-year follow-ups after surgery, and the cardiac functions [including left ventricular end-systolic volume (LVESV), left ventricular end-diastolic volume (LVEDV) and left ventricular ejection fraction (LVEF)] at the time of the follow-up visit one month after surgery, were compared between the two groups. Finally, correlations between CFPWV and GS and the incidence rate of MACE were investigated using Spearman's correlation analysis, and the predictive value of CFPWV for the postoperative incidence of MACE in PCI patients was calculated by plotting a receiver operating characteristic (ROC) curve.

Statistical methods

The collected data were input into an EXCEL table, and SPSS 22.0 was adopted for statistical analysis. The collected data were detected using normal distribution. Data conforming to a normal distribution were expressed using [n (%)]. Differences between groups were analyzed using chi-square test. The measured data were expressed using mean ± standard deviation (mean ± SD). Differences between groups were analyzed using t test, and Spearman's correlation analysis was performed. $P < 0.05$ indicated a significant difference [12].

Table 1. Comparison of general clinical indexes between the two groups (mean ± SD)/[n (%)]

General clinical data		Group A (n=180)	Group B (n=120)	t/X^2	*P*
Gender	M	98	67	0.056	0.813
	F	82	53		
Mean age (years)		40.33±4.33	39.98±4.51	0.675	0.5
Mean weight (kg)		71.29±3.22	71.11±3.44	0.461	0.645
Education level	University and above	34	31	0.778	0.221
	High school	96	60		
	Junior high school and below	50	29		
Hypertension	Y	21	19	1.082	0.298
	N	159	101		
Diabetes	Y	20	10	0.617	0.432
	N	160	110		
Smoking	Y	49	23	2.562	0.109
	N	131	97		
Alcohol drinking	Y	54	30	0.893	0.345
	N	126	90		

Table 2. Comparison of differences in average number of coronary arteries with lesions and types of coronary artery lesions between the two groups (mean ± SD)/[n (%)]

Group	n	Average number of coronary arteries	Lesion type		
			Type A	Type B	Type C
Group A	180	1.23±0.21	104 (57.78)	71 (39.44)	5 (2.78)
Group B	120	2.87±0.71	12 (10.00)	38 (31.67)	70 (58.33)
X^2	-	29.157	69.303	3.454	118.519
P	-	< 0.001	< 0.001	0.063	< 0.001

Table 3. Comparison of differences in the number of coronary arteries with lesions between the two groups [n (%)]

Group	n	Single-vessel disease	Two-vessel disease	Triple-vessel disease
Group A	180	108 (60.00)	54 (30.00)	18 (10.00)
Group B	120	15 (12.50)	25 (20.83)	80 (66.67)
X^2	-	67.156	3.119	105.112
P	-	< 0.001	0.077	< 0.001

Results

Comparison of general data between the two groups

The basic information (e.g., gender, sex, weight, education level, marital status, smoking (≥ 1 cigarette/d, more than 1 year), alcohol drinking (≥ 2 times/d, more than 5 years), and history of diseases in the two groups were collected, and were compared between the two groups. The results suggested no marked difference in general clinical data between Group A and B ($P > 0.05$), and the data were comparable (**Table 1**).

Comparison of differences in coronary artery lesions between the two groups

Coronary angiogram results were used to assess the coronary artery lesions in the two groups, and the differences were compared. Results exhibited that the average number of involved coronary arteries in Group A was lower than that in Group B ($P < 0.05$). The comparison of the lesion types between groups revealed that the ratio of type C lesions in Group B was markedly higher than that of Group A, while the ratio of type A lesions in Group B was significantly lower than that in Group A ($P < 0.05$) (**Table 2**). A comparison of the number of coronary arteries with lesions between groups revealed that the ratio of triple-vessel disease (TVD) in Group B was higher than that of Group A, while the ratio of single-vessel disease in Group B was much lower than that of Group A ($P < 0.05$) (**Table 3**).

Comparison of incidence rates of adverse events between the two groups during treatment and follow-up

Statistics were performed on the incidence rates of complications after PCI and MACE dur-

Table 4. Comparison of incidence rates of adverse events between the two groups during treatment and follow-up [n (%)]

Adverse event		Group A (n=180)	Group B (n=120)	X^2	*P*
Complications after PCI		0 (0.00)	8 (6.67)	12.329	< 0.001
MACE during hospital stay	Myocardial reinfarction	0 (0.00)	3 (2.50)		
	Cardiogenic death	0 (0.00)	1 (0.83)		
	Total	0 (0.00)	4 (3.33)	6.081	0.014
MACE 2 years after surgery	Myocardial reinfarction				
	Revascularization		7 (5.83)		
	Cardiogenic death		3 (2.50)		
	Total		16 (13.33)	21.991	< 0.001

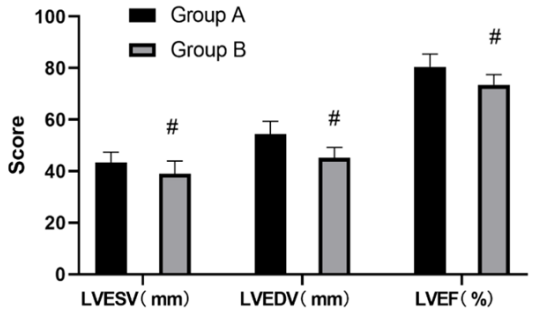

Figure 1. Comparison of differences in cardiac function between the two groups at one month after PCI. Comparison shows that one month after PCI, left ventricular end-systolic volume (LVESV), left ventricular end-diastolic volume (LVEDV) and left ventricular ejection fraction (LVEF) in Group A are remarkably higher than those in Group B ($P < 0.05$). #indicates a statistically significant difference in the same indexes between the two groups before and after surgery.

ing hospital stay and 2-year follow-ups after PCI in the two groups. The comparison of differences between groups showed that the incidence rates of complications after PCI and MACE during hospital stay and 2-year follow-up after PCI in Group B were higher than those of Group A ($P < 0.05$) (**Table 4**).

Comparison of differences in cardiac function between the two groups at one month after PCI

At the time of follow-up visit one month after PCI, the indexes of cardiac function (e.g., LVESV, LVEDV and LVEF) were assessed and compared between the two groups. The results demonstrated that LVESV, LVEDV, and LVE in Group A were significantly higher than those of Group B ($P < 0.05$) (**Figure 1**).

Correlation between CFPWV and GS and incidence rate of MACE

During PCI, the coronary artery lesions of the subjects were assessed using the Gensini scale. The Gensini scale comprises degree of stenosis and lesion site. The degree of stenosis is scored by 1-32 points, with 1 point indicating 1%-25% stenosis and 32 points indicating complete occlusion. The lesion sites were divided into left main coronary artery, left anterior descending branch or proximal segment of circumflex branch, and the middle and distal segments of the left anterior descending coronary artery. The total score of the Gensini scale is the result of scores of degrees of stenosis at the sites multiplied by the scores of lesion sites. Spearman's correlation analysis revealed that CFPWV was strongly positively correlated with Gensini scale score and incidence rate of MACE (r=0.7718, 0.9254, $P < 0.05$) (**Figure 2**).

Value of CFPWV in predicting the incidence of MACE after PCI

The ROC curve for the value of CFPWV in predicting the incidence of MACE after PCI was plotted. Results suggested that CFPWV showed good value in predicting the incidence of MACE after PCI, and its area under curve (AUC) was 0.7500, 95% CI=0.5983-0.9017, P=0.0045 (**Figure 3**).

Discussion

Clinically, PCI is a commonly used option for interventional therapy [13], and its therapeutic principle is that the opening of stenotic or occluded coronary arteries is performed using cardiac catheterization, so as to improve myo-

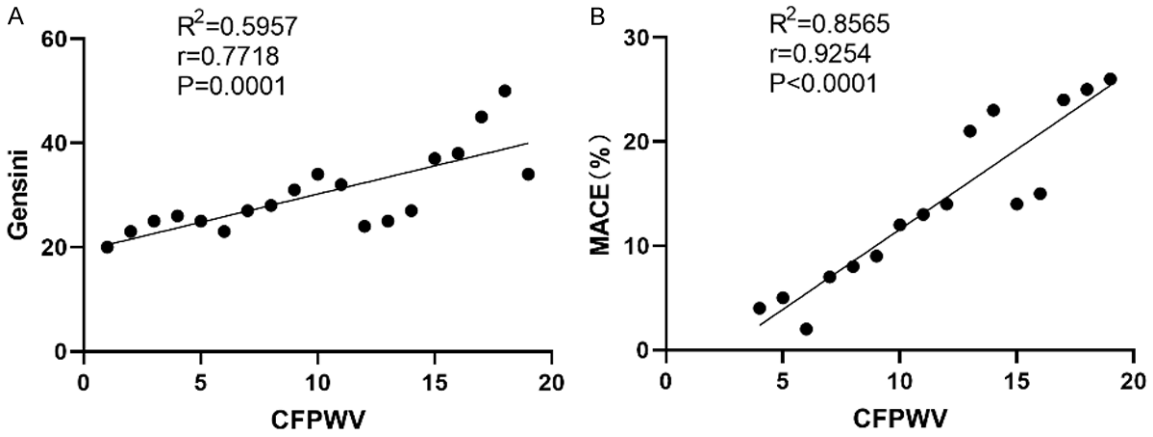

Figure 2. Investigation of correlation between CFPWV and GS and incidence rate of MACE. The assessment exhibits that CFPWV is remarkably positively correlated with Gensini scale score (A) and incidence rate of MACE (B) (r=0.7718, 0.9254, $P < 0.05$).

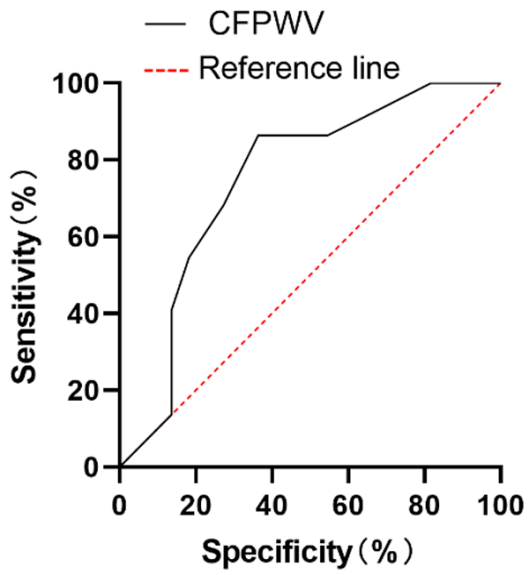

Figure 3. Investigation of the value of CFPWV in predicting incidence of MACE after PCI. CFPWV shows a good value in predicting the incidence of MACE after PCI, and its AUC is 0.7500, 95% CI=0.5983-0.9017, P=0.0045.

cardial blood perfusion. In 2012, PCI was considered by the European Society of Cardiology as the preferred option for the treatment of acute myocardial infarction (AMI) patients. PCI, which has been extensively implemented clinically, has of incomparable value in elevating the survival rate and prolonging the overall survival (OS) of AMI patients [14-16].

As PCI has been extensively promoted and implemented, a growing number of scholars believe that an indicator for assessing the prognosis of PCI patients should be selected, so as to provide guidance on the establishment of clinical therapeutic strategies [3, 17]. A study indicates that it takes over 6 weeks for AMI patients with injured myocardium to form firm cicatricial tissues. Therefore, AMI patients should rest in bed for 6-8 weeks after PCI [18]. A study on 324 AMI patients receiving PCI after 2-year follow-up shows that approximately 9.26% of the patients experience myocardial reinfarction and approximately 3.09% of the patients experience revascularization [19]. Researchers believe that early clinical assessment on PCI patients may lead to reduced incidence rate of adverse cardiovascular events [20].

In this study, the clinical value of CFPWV and coronary artery lesions in assessing the prognosis of PCI patients was explored through grouping. Results suggested that after grouping was performed in accordance with CFPWVs, the comparison between groups showed that the patients with CFPWV ≥ 13 m/s in Group B had a larger average number of coronary arteries with lesions, and more severe coronary artery lesions compared to those with CFPWV of 0-13 m/s in Group A. This exhibited that the changes in CFPWV may reflect the coronary artery lesions of patients. A retrospective study of 530 patients with hypertension showed that the CFPWVs of the enrolled subjects were significantly correlated with the severity of carotid atherosclerosis, which was specifically reflected by the fact that CFPWV > 13 m/s was a

strong predictive factor of the occurrence of risk events of the cardiovascular disease [21]. In addition, a comparative study of 771 cases of primary hypertension and 243 cases of healthy individuals suggested that the CFPWVs of patients with hypertension were markedly higher than those of the healthy control group. Correlation analysis demonstrated that CFPWV was positively correlated with the C-reactive protein (CRP) level, systolic blood pressure, and pulse pressure, indicating that CFPWV could reflect the inflammatory state of patients with hypertension [22]. The author believes that a decrease in large arterial distensibility is a risk factor leading to multiple cardiovascular events, and CFPWV can effectively reflect the large arterial distensibility. PCI features a simple operation and non-invasiveness. The coronary artery lesions in Group B were more severe than those of Group A. This may be explained since compared with Group A, Group B had a lower large arterial distensibility and a higher pulse pressure, and the excessive vasoconstriction and vasorelaxation led to fatigue and fracture, thus inducing the incidence of adverse cardiovascular events [23]. This is consistent with the result that the incidence rates of MACE during hospital stay and 2-year follow-ups in Group B are higher than those of Group A.

In this study, the differences in cardiac function between the two groups after PCI were further compared, and the correlation between CFPWV and GS and incidence rate of MACE was explored. Results exhibited that Group A was superior to Group B regarding cardiac function, which may be related to the alleviated coronary artery lesions in Group A. A study of 80 patients with coronary atherosclerosis pointed out that the blood supply in patients with coronary atherosclerosis could only meet the requirement of myocardial metabolism, while patients with a high CFPWV had a lower vascular elasticity and reduced compliance, and there was no marked change in their vascular elasticity even though normal blood supply was restored after PCI., Thus the cardiac function is not markedly improved, and the postoperative monitoring should be strengthened for such patients, thereby preventing the incidence of MACE [24, 25]. This has been proven by a positive correlation between CFPWV and GS and the ROC curve for the value of CFPWV in predicting the incidence of MACE. Gensini score is a commonly used indicator for quantifying the degree of coronary artery lesions, and its correlation with CFPWV can further illustrate the effectiveness of CFPWV in assessing coronary artery lesions, thereby providing a theoretical basis for the clinical implementation of CFPWV.

In summary, CFPEV can assess the prognosis of PCI patients, and can effectively predict the postoperative incidence of MACE, which is conducive to the establishment of subsequent regimens. Therefore, CFPEV is worthy of clinical implementation. The innovation of this study lies in investigating the value of CFPWV in assessing the prognosis of PCI patients through comparing the PCI patients and assessing the correlation between CFPWV and the severity of coronary artery lesions. The data, which are detailed and reliable, provide a reference for predicting the prognosis in PCI patients. The limitations of this study lie in the failure to group PCI patients according to underlying health conditions and conduct a comparison, and a possibly biased conclusion as a result of the differences in the underlying health conditions among the subjects. Future studies are planned to improve this.

Disclosure of conflict of interest

None.

Address correspondence to: Qiuying Zhong, Department of Geriatrics, The Sixth Hospital of Wuhan, Affiliated Hospital of Jianghan University, No. 168, Hong Kong Road, Wuhan 430000, Hubei, China. Tel: +86-027-82430834; E-mail: zhongqiuying2020@yeah.net

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