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Original Research Article

Application of two-dimensional speckle tracking imaging in the follow-up of patients with coronary heart disease treated with metalol

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Abstract

Purpose: *To investigate the application of two-dimensional speckle tracking imaging (2D-STI) in the follow-up of patients with coronary heart disease (CHD) who were treated with metalol.*
Methods: *A total of 100 patients with CHD (CHD group) who were treated with metalol and had undergone percutaneous coronary intervention (PCI) at Tangshan Works' Hospital, Tangshan, China, and another 100 healthy people (control group) were enrolled in this study. Prior to and after 6 months of treatment, echocardiography was performed on patients in control and CHD groups, respectively, and the wall motion score was calculated. The 2D-STI was used to obtain systolic peak longitudinal strain value (SLs), global peak longitudinal strain (GSL) and early diastolic peak longitudinal strain rate (SrLe) in the early diastolic period of 6 wall basal segments, middle segments, and apical segments of the left ventricle.*
Results: *The wall motion score index (WMSI) of CHD group was higher than that of the control group, while the WMSI of CHD group after treatment was significantly lower than the value before treatment, ($p < 0.05$). In 2D-STI, the SLs, SrLe and GLS of patients after 6 months of treatment were significantly higher than those before treatment ($p < 0.05$).*
Conclusion: *Thus, 2D-STI can be used to quantify the motion of the chamber wall and the effect of PCI surgery, and it also provides a stable new index and technique for evaluating the effects of treatment of CHD.*

Keywords: *Coronary heart disease, Metalol, Percutaneous coronary intervention (PCI) two-dimensional speckle tracking imaging (2D-STI), Speckle tracking imaging*

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INTRODUCTION

Coronary heart disease (CHD) refers to the coronary artery atherosclerosis caused by lumen stenosis or occlusion, leading to myocardial ischemia and hypoxia, or myocardial tissue necrosis caused by heart disease [1]. The typical symptoms of CHD are chest pain, chest tightness and aggravated after activity [2]. CHD mostly occurs in adults aged over 40 years of age. However, with change in people's living habits, as well as a population that is steadily aging, the incidence of CHD is getting prevalent in younger adults, leading to increasing mortality rate. It has, therefore, become one of the major diseases threatening man. At present, percutaneous coronary intervention (PCI) has become an important and common clinical method used in the treatment of CHD. Early PCI effectively opens heart-related narrow and blocked blood vessels, rebuilds the myocardial blood supply, improves myocardial perfusion and blood microcirculation, which effectively improves the systolic and diastolic function of the left ventricle, and relieves clinical symptoms such as chest pain and chest tightness [3-5]. Therefore, how to accurately evaluate left ventricular myocardial strain, global and local systolic function before and after PCI is very important.

Echocardiography is an important method for the diagnosis and follow-up of a variety of cardiac diseases. With the emergence of new ultrasound technologies such as tissue Doppler, myocardial contrast-enhanced echocardiography, three-dimensional echocardiography and speckle tracking, echocardiography has been widely used in clinical practice due to its advantages of simplicity, non-trauma, repeatability, convenience and low cost [6-8]. However, ultrasound window has some limitations for guiding intervention treatment, so other imaging techniques are often needed to assist diagnosis.

Two-dimensional speckle tracking imaging (2D-STI) is based on two-dimensional ultrasound images, which automatically tracks the movement trajectory of speckle echo in the heart tissue of the region of interest during cardiac cycle, observes the motion track of speckle in the process of myocardial contraction and relaxation, analyzes the mechanical deformation of the myocardium, and calculates cardiac work parameters such as velocity, acceleration, displacement, strain and strain rate [9-11]. The device has no angle dependence, but it quantitatively evaluates myocardial motion and contractile function in multiple directions. In the present study, 2D-STI was used to evaluate the longitudinal, radial, circumferential and torsional motion of patients with CHD, in order to comprehensively analyze and accurately evaluate the left heart function, and provide more valuable information for the formulation of clinical diagnosis and treatment.

METHODS

Subjects and ethical issues

A total of 100 patients with confirmed CHD who underwent PCI in the Department of Cardiology of Tangshan Works' Hospital from January 2019 to December 2021 were selected as the subjects for this study which followed the guidelines of the Declaration of Helsinki [12], and was approved by the ethics committee of Tangshan Works' Hospital (approval no. IRB-037). Signed and written informed consents were obtained from all participants before the study.

Inclusion criteria

(1) Patients with CHD diagnosed by medical history inquiry, signs, electrocardiogram, myocardial zymography and coronary angiography; (2) patients with more than 50 % stenosis of single or multiple major coronary arteries confirmed by coronary angiography; (3) patients who underwent PCI successfully (4) patients give informed consent and are willing to participate in and cooperate with the examination.

Exclusion criteria

(1) Patients with severe peripheral vascular disease or peripheral vascular embolism; (2) combined with other important organ dysfunction; (3) patients with gastrointestinal ulcers or severe hematopoietic diseases, who cannot tolerate basic antiplatelet therapy; (4) currently participating in other clinical trials; (5) life expectancy < 1 year.

Treatments

During hospitalization, all patients were given standard medication for CHD, including antiplatelet aggregation therapy, anticoagulant therapy, lipid-regulating therapy, nitrates, calcium channel antagonists, and ACEI/ARB. All the patients were also given oral metalol tablets. The initial dose of metalol tablets was 11.875 - 23.75 mg, once a day and the dose was doubled every 2 - 3 weeks, gradually reaching a tolerable dose of 95 mg once a day subsequently.

In addition, 100 volunteers who received physical examination in the hospital during the same period were set as the control group, excluding patients with external cardiomyopathy, *cor pulmonale*, hypertension, diabetes, hyperthyroidism and other heart diseases or diseases affecting the heart.

Diagnostic criteria

CHD was diagnosed by luminal stenosis of > 50 % in the left anterior descending artery (including the first diagonal branch), circumflex artery (including the blunt margin branch), or right coronary artery confirmed by coronary angiography. Foe healthy subjects, no abnormal test and imaging indicators were found in the health examination center.

Equipment and procedures

HP color Doppler ultrasound diagnostic instrument and M3S heart probe were used for diagnosis. The SLs, GLs and SrLe were measured by conventional thoracic echocardiography and 2D-STI. The examination took place prior to the start of treatment and 6 months after treatment.

Wall motion score index (WMSI)

The patient was placed in the left decubitus position, and conventional echocardiography was performed. The parasternal short axis view of the left ventricle was obtained, and the dynamic images of the basal, middle and apical segments were obtained, and the images were saved for offline analysis. The wall motion was qualitatively analyzed by 16-level method, and the wall motion score index (WMSI) was used for semi-quantitative analysis as follows: Motion enhancement = 0 points; normal motion = 1 point; motion reduction = 2 points; no motion = 3 points; contradictory motion = 4 points; ventricular aneurysm: 5 points. WMSI was calculated as the sum of the wall motion score of each segment (or) the number of segments involved in wall motion score.

Two dimensional speckle tracking imaging (2D-STI)

The 2D-STI was used to obtain SLs, GSL and SrLe of basal, middle and apical segments.

Statistical analysis

SPSS statistical analysis software (version 26.0) was used for data analysis. Measurement data conforming to normal distribution were obtained by *t*-test and expressed as mean ± SD. $P < 0.05$ was considered statistically significant. Rank-sum test was used if the distribution was not normal.

RESULTS

Wall motion index

Before treatment, the wall motion index of patients with CHD for left ventricular myocardial was significantly higher than that of the control group ($p < 0.05$), as shown in Table 1. After treatment, the local systolic function of ischemic myocardium segment and left ventricular global systolic and diastolic function were significantly improved, and the wall motion index was decreased ($p < 0.05$), as shown in Table 1.

STI parameters

Before treatment, STI parameters in CHD group were significantly lower than those in the control group ($p < 0.05$). After treatment, STI parameters in CHD group were significantly higher than those before treatment (Table 2, Table 3 and Table 4).

DISCUSSION

In the past, the commonly used methods to evaluate left ventricular function in patients with CHD were color wall motion analysis technique, anatomical M-mode echocardiography, tissue doppler imaging (TDI), and myocardial tissue strain rate imaging technique developed on the basis of TDI, which measures myocardial deformation and reflects local myocardial motor function [13-15]. However, this technique has some limitations, such as angle dependence, poor repeatability and susceptibility to SNR. In recent years, the rapid development of 2D-STI is based on a two-dimensional ultrasound image display, which automatically tracks the myocardial echo speckle movement, and calculates the strain and strain value parameters of each segment of the ventricular [16,17]. 2D-STI can accurately measure the strain value of each segment of the chamber wall in patients with myocardial infarction, and accurately evaluate the left ventricular segmental wall motion abnormalities [18,19]. The sensitivity of 2D-STI is better than that of ordinary echocardiography, as it reduces the influence of human factors.

Table 1: Comparison of wall motion index between CHD group and control group before and after treatment (n = 100)

Group	Pre-treatment		Post-treatment	
	Wall motion score	Wall motion score index	Wall motion score	Wall motion score index
Control	16.00	1.00	19.33 ± 1.56	1.33 ± 0.25
CHD	19.33 ± 1.56*	1.33 ± 0.25*	16.59 ± 1.29	1.13 ± 0.20

Note: Compared with the control group, *$p < 0.05$

Table 2: Comparison of SLs of left ventricular wall segment in each group (n = 100)

Group	Segment	Anteroseptm	Anterior wall	Inferior wall	Posterior wall	Side wall	Posterior interval
Control	Basal	-20.14 ± 1.77	-19.85 ± 1.87	-20.87 ± 1.98	-20.08 ± 1.41	-21.56 ± 2.07	-22.56 ± 2.42
	Mid	-20.65 ± 1.56	-20.11 ± 2.08	-20.11 ± 1.79	-20.87 ± 1.23	-20.89 ± 1.78	-21.89 ± 2.12
	Apical	-20.74 ± 2.19	-20.87 ± 1.89	-20.98 ± 2.14	-20.44 ± 1.30	-21.41 ± 1.90	-21.15 ± 1.87
Before treatment for CHD	Basal	-12.67 ± 1.56#	-12.63 ± 1.87#	-13.64 ± 1.67#	-15.73 ± 1.68#	-15.75 ± 2.11#	-16.54 ± 1.76#
	Mid	-12.77 ± 1.89#	-12.98 ± 1.76#	-14.56 ± 1.98#	-15.47 ± 1.58#	-15.74 ± 1.89#	-17.54 ± 1.54#
	apical	-12.68 ± 1.68#	-12.53 ± 1.53#	-15.08 ± 2.11#	-15.98 ± 1.86#	-16.03 ± 2.21#	-16.44 ± 1.86#
After treatment for CHD	Basal	-16.67 ± 1.64*	-17.53 ± 1.21*	-17.97 ± 1.89*	-18.65 ± 1.11*	-18.65 ± 1.78*	-18.74 ± 1.57*
	Mid	-16.56 ± 1.50*	-17.45 ± 1.64*	-17.56 ± 2.05*	-18.12 ± 0.89*	-18.98 ± 2.12*	-18.97 ± 1.87*
	apical	-17.75 ± 1.62*	-17.78 ± 1.40*	-17.35 ± 1.80*	-17.84 ± 1.13*	-18.76 ± 2.05*	-18.45 ± 2.01*

Note: Compared with the control group, #p < 0.05; Compared with the group before treatment, *p < 0.05

Table 3: Comparison of SrLe of left ventricular wall segment in each group (n = 100)

Group	Segment	Anteroseptm	Anterior wall	Inferior wall	Posterior wall	Side wall	Posterior interval
Control	Basal	1.85 ± 027	1.84 ± 0.23	1.88 ± 0.28	2.31 ± 0.22	2.13 ± 0.29	2.11 ± 0.25
	Meddle	1.81 ± 0.19	1.72 ± 0.19	1.93 ± 0.31	2.28 ± 0.19	2.10 ± 0.19	2.08 ± 0.21
	apical	1.87 ± 0.23	1.81 ± 0.17	1.84 ± 0.25	2.35 ± 0.16	2.09 ± 0.25	2.05 ± 0.23
Before treatment for CHD	Basal	1.07 ± 0.16 #	1.06 ± 0.15 #	1.31 ± 0.20#	1.44 ± 0.16#	1.40 ± 0.16#	1.44 ± 0.19#
	Meddle	1.11 ± 0.13 #	1.01 ± 0.23#	1.37 ± 0.19#	1.38 ± 0.15#	1.34 ± 0.19#	1.41 ± 0.29#
	apical	1.16 ± 0.10 #	1.05 ± 0.19#	1.42 ± 0.22#	1.42 ± 0.17#	1.42 ± 0.23#	1.39 ± 0.23#
After treatment for CHD	Basal	1.33 ± 0.16*	1.44 ± 0.20*	1.68 ± 0.20*	1.83 ± 0.20*	1.75 ± 0.21*	1.77 ± 0.23*
	Meddle	1.29 ± 0.18*	1.40 ± 0.14*	1.65 ± 0.23*	1.80 ± 0.24*	1.68 ± 0.26*	1.73 ± 0.23*
	apical	1.34 ± 0.15*	1.51 ± 0.18*	.1.71 ± 0.19*	1.76 ± 0.19*	1.76 ± 0.20*	1.75 ± 0.19*

Note: Compared with the control group, #p < 0.05; compared with the group before treatment, *p < 0.05

Table 4: Comparison of SrLe of left ventricular wall segment in each group

Group	Number	Left ventricular long axis	Apical two-chamber	Apical four-chamber	Left ventricular global strain
Control	100	21.53 ± 1.78	21.97 ± 2.23	20.68 ± .2.22	21.44 ± 2.23
Before treatment for CHD	100	16.45 ± 1.87#	16.76 ± 2.12#	13.85 ± 2.01#	15.54 ± 1.94#
After treatment for CHD	100	18.97 ± 1.88*	19.54 ± 2.41*	17.34 ± 1.98*	18.25 ± 2.45*

Compared with the control group, #$p < 0.05$; compared with the group before treatment, *$p < 0.05$

In this study, wall motion score and 2D-STI were used to evaluate local and global function of left ventricular in patients with CHD after treatment. Both techniques evaluate the changes in left cardiac function. The WMSI of the intervention group was higher than that of the control group, and the WMSI of the intervention group after treatment was significantly lower than that before treatment. In 2D-STI, the SLs, SrLe and GLS of patients after 6 months of treatment were significantly higher than those before treatment.

In recent years, numerous studies have found that left ventricular movement includes not only major axis and minor axis, but also there are spatial torsional and unwinding motions. 2D-STI can quantitatively evaluate left ventricular torsion in patients with CHD, and it can be used as a quantitative index to evaluate left ventricular systolic function. It overcomes the shortcoming of subjective aspect and provides quantitative index for wall motion. Firstly, 2D-STI reflects the recovery of cardiac muscle movement in real time, and determines the effect of PCI surgery in real time. Secondly, 2D-STI is non-invasive and analyzes the motion of cardiac muscle chamber wall under the non-invasive strip, which is accepted by the majority of patients.

CONCLUSION

Thus, 2D-STI can be used to quantify the motion of the chamber wall and the effect of PCI surgery, as well as it provides a stable new index and technique for evaluating the effect of treatment on CHD.

DECLARATIONS

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Ethical approval

None provided.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of Interest

No conflict of interest associated with this work.

Contribution of Authors

We declare that this work was done by the authors named in this article and all liabilities pertaining to claims relating to the content of this article will be borne by the authors. Mengyuan Li and Chunwang Zhou contributed equally to this work. Mengyuan Li and Chunwang Zhou designed the study and performed the experiments, Li Li and Yi Ma collected the data, Li Li, Yi Ma and Biqiong Zhao analyzed the data, Mengyuan Li and Chunwang Zhou prepared the manuscript. All authors read and approved the final manuscript.

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