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ABOUT COVER

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WJCC mainly publishes articles reporting research results and findings obtained in the field of clinical medicine and covering a wide range of topics, including case control studies, retrospective cohort studies, retrospective studies, clinical trials studies, observational studies, prospective studies, randomized controlled trials, randomized clinical trials, systematic reviews, meta-analysis, and case reports.

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Retrospective Study

Ultrasonographic assessment of cardiac function and disease severity in coronary heart disease

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Abstract

BACKGROUND

Coronary heart disease (CHD) causes many adverse cardiovascular events and poses a threat to the patient's health and quality of life.

AIM

To evaluate ultrasonography for evaluation of cardiac function and lesion degree in patients with CHD.

METHODS

A total of 106 patients with CHD (study group) and 106 healthy individuals (control group) in our hospital from March 2019 to September 2020 were selected for this study. All subjects were examined by ultrasound, and the mitral orifice's early-to-late diastolic blood flow velocity ratio (E/A), left ventricular end-diastolic volume (LVDd), and left atrial diameter (LAD) were measured. Values were compared between the study group and healthy group, and the correlation between the ultrasonic parameters of patients with different cardiac function grades and the degree of CHD were assessed. In addition, the ultrasonic parameters of patients with different prognoses were compared after a follow-up for 6 mo.

RESULTS

E/A (1.46 ± 0.34) of the study group was smaller than that of the control group (1.88 ± 0.44), while LVDd (58.24 ± 5.05 mm) and LAD (43.31 ± 4.38 mm) were larger (48.15 ± 3.93 and 34.94 ± 2.81 , respectively; $P < 0.05$). E/A for patients with grade III disease (1.41 ± 0.43) was smaller and their LVDd (60.04 ± 4.21 mm) and LA (44.16 ± 2.79 mm) were larger than those in patients with grade II disease (1.71

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± 0.48 , 52.18 ± 3.67 mm, and 39.68 ± 2.37 , respectively; $P < 0.05$). Patients with grade IV disease had smaller E/A (1.08 ± 0.39) and larger LVDd (66.81 ± 5.39 mm) and LAD (48.81 ± 3.95 mm) than patients with grade II and III disease ($P < 0.05$). In patients with moderate disease, E/A (1.44 ± 0.41) was smaller and LVDd (59.95 ± 4.14 mm) and LAD (45.15 ± 2.97 mm) were larger than in patients with mild disease (1.69 ± 0.50 , 51.97 ± 3.88 and 38.81 ± 2.56 mm, respectively; $P < 0.05$). In patients with severe disease, E/A (1.13 ± 0.36) was smaller and LVDd (67.70 ± 6.11 mm) and LAD (49.09 ± 4.05 mm) were larger than in patients with moderate disease ($P < 0.05$). E/A was negatively correlated with cardiac function classification and disease severity, while LVDd and LAD were positively correlated with cardiac function classification and disease severity ($P < 0.05$). E/A (1.83 ± 0.51) for patients with good prognosis was higher than that for those with poor prognosis (1.39 ± 0.32), while LVDd (49.60 ± 4.39 mm) and LAD (36.13 ± 3.05 mm) were lower ($P < 0.05$).

CONCLUSION

The ultrasonic parameters of patients with CHD are abnormal, and differ significantly in patients with different cardiac function grades, lesion degree, and prognosis.

Key Words: Ultrasonography; Left ventricular end-diastolic volume; Left atrial diameter; Coronary heart disease; Cardiac function

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Core Tip: This article confirms that patients with coronary heart disease have abnormal ultrasound examination parameters, and there are significant differences in these parameters among patients with different levels of cardiac function, disease severity, and prognosis. Therefore, ultrasound can be used to assess the condition and prognosis of the disease.

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INTRODUCTION

Coronary heart disease (CHD), a clinical multiple cardiovascular disease mainly caused by coronary artery atherosclerosis[1], leads to vascular lumen obstruction or stenosis and, eventually, to myocardial hypoxia and ischemia. CHD causes many adverse cardiovascular events and, without timely intervention, poses a threat to the patient's health and quality of life [2-4]. The incidence of CHD has recently increased, creating an urgent social and public health problem.

Early diagnosis and evaluation of CHD are important to guide clinical treatment and help improve prognosis of patients[5,6]. Ultrasound has been widely used in the diagnosis and treatment of cardiovascular diseases and has the advantage of being a simple, low-cost, noninvasive procedure. With the continuous development and improvement of ultrasonic diagnosis and treatment technology, it is readily tolerated by the majority of patients, and its use is increasing[7,8].

Therefore, this study sought to explore the usefulness of ultrasound in the evaluation of cardiac function and lesion degree in patients with CHD.

MATERIALS AND METHODS

Selection criteria

Inclusion criteria: Patients diagnosed with CHD after admission to our hospital from

March 2019 to September 2020 were enrolled. Patients were included if they met the diagnostic criteria for CHD according to the Chinese experts' consensus on the diagnosis and treatment of CHD in elderly patients, if their cardiac function was classified as grade II–IV, and if they were compliant with the investigation and research instructions. Healthy individuals from the same period were selected as the control group. This study was approved by the Ethics Committee of our hospital. All patients provided signed informed consent.

Exclusion criteria: Patients with valvular disease, myocarditis, or cardiomyopathy; acute or previous myocardial infarction; persistent ventricular tachycardia or frequent premature heartbeats; secondary changes of the ST-T segment; prior treatment with spironolactone, diuretics, or valsartan; abnormal mental behavior, hearing loss, retinopathy, or unconsciousness; or a history of drug dependence or alcoholism.

Methods

All subjects were examined by ultrasound within 12 h of admission using the iE33 color Doppler ultrasound machine (Phillips) with a S5-1 probe and a probe frequency of 3–4 MHz. Dynamic echocardiography of the left ventricle was performed for five consecutive cardiac cycles on patients in the left recumbent position. Images of the aortic valve orifice, left ventricular outflow tract, and mitral orifice blood flow vein were collected, and measurements of the mitral orifice's early-to-late diastolic blood flow velocity ratio (E/A), left ventricular end-diastolic volume (LVDd), and left atrial diameter (LAD) were recorded. Targeted treatment was provided according to the conditions of the patients with CHD.

Observation index

The ultrasonic parameters (E/A, LVDd and LAD) of the study and control groups were examined. In addition, patients from the study group were categorized by cardiac function and lesion degree, and the correlation between ultrasonic parameters and cardiac function and lesion degree was analyzed. The study group was followed up for 6 mo. The ultrasonic parameters were divided into the poor prognosis or good prognosis group based on whether the patients experienced adverse events. The correlation between the ultrasonic parameters and the patients' prognoses was assessed.

Statistical analysis

The data were analyzed using SPSS version 22.0. The data are expressed as mean \pm SD, and *t* tests were used for analysis. Numerical data are expressed as *n* (%), and the χ^2 test was used. The correlation between ultrasonic parameters and the cardiac function grade and lesion degree was analyzed using the Spearman correlation. *P* < 0.05 indicated statistical significance.

RESULTS

General data

A total of 106 patients with CHD in our hospital from March 2019 to September 2020 were selected for the study group, and 106 healthy subjects from the same period were selected for the control group. The study group had 65 men and 41 women, aged 46–79 years (average: 62.41 ± 13.05 years). According to the New York Heart Association Functional Classification of cardiac function, there were 45, 37 and 24 cases of grade II, III and IV, respectively. According to the Gensini score, there were 43, 38 and 25 cases of mild (Gensini < 20), moderate ($20 \leq$ Gensini < 40), and severe (Gensini \geq 40) CHD. The control group had 61 men and 45 women, aged 43–78 years (average: 64.19 ± 11.98 years). The sex, age and clinical data of the two groups were comparable (*P* > 0.05) (Table 1).

Comparison of ultrasonic parameters

E/A in the study group (1.46 ± 0.34) was lower than that in the control group (1.88 ± 0.44). LVDd and LAD were significantly higher in the study group than in the control group (58.24 ± 5.05 and 43.31 ± 4.38 mm *vs* 48.15 ± 3.93 and 34.94 ± 2.81 mm, respectively; *P* < 0.05) (Table 2).

Table 1 Comparison of ultrasonic parameters between two groups (mean \pm SD)

Group	n	E/A	LVDd (mm)	LAD (mm)
Research group	106	1.46 \pm 0.34	58.24 \pm 5.05	43.31 \pm 4.38
Control group	106	1.88 \pm 0.44	48.15 \pm 3.93	34.94 \pm 2.81
t		7.776	16.234	16.560
P value		< 0.001	< 0.001	< 0.001

E/A: Early-to-late diastolic blood flow velocity ratio; LVDd: Left ventricular end-diastolic volume; LAD: Left atrial diameter.

Table 2 Comparison of ultrasonic parameters in patients with coronary heart disease with different cardiac function grades (mean \pm SD)

Group	n	E/A	LVDd (mm)	LAD (mm)
Grade II	45	1.71 \pm 0.48	52.18 \pm 3.67	39.68 \pm 2.37
Grade III	37	1.41 \pm 0.43	60.04 \pm 4.21	44.16 \pm 2.79
Grade IV	24	1.08 \pm 0.39	66.81 \pm 5.39	48.81 \pm 3.95
t/P value (Grade II vs III)		2.950/0.004	8.995/0.000	7.863/0.000
t/P value (Grade III vs IV)		3.035/0.004	5.490/0.000	5.391/0.000

E/A: Early-to-late diastolic blood flow velocity ratio; LVDd: Left ventricular end-diastolic volume; LAD: Left atrial diameter.

Comparison of ultrasonic parameters in patients with different cardiac function grades

In patients with grade III cardiac function, E/A (1.41 \pm 0.43) was smaller and the LVDd (60.04 \pm 4.21 mm) and LAD (44.16 \pm 2.79 mm) were greater than those of patients with grade II cardiac function (1.71 \pm 0.48, 52.18 \pm 3.67 mm, and 39.68 \pm 2.37 mm, respectively; $P < 0.05$). The E/A of patients with grade IV cardiac function (1.08 \pm 0.39) was lower than that of patients with grade III cardiac function (1.41 \pm 0.43). The LVDd (66.81 \pm 5.39 mm) and LAD (48.81 \pm 3.95 mm) of patients with grade IV cardiac function was greater than those of patients with grade III cardiac function (60.04 \pm 4.21 mm and 44.16 \pm 2.79 mm, respectively; $P < 0.05$) (Table 3).

Comparison of ultrasonic parameters in patients with different severity of CHD

E/A of patients with moderate CHD (1.44 \pm 0.41) was lower than that of patients with mild CHD (1.69 \pm 0.50). Patients with moderate CHD had higher LVDd (59.95 \pm 4.14 mm) and LAD (49.09 \pm 4.05 mm) were greater in patients with severe CHD than in those with moderate CHD (59.95 \pm 4.14 mm and 45.15 \pm 2.97 mm, respectively; $P < 0.05$) (Table 4).

Correlation between ultrasonic parameters and cardiac function grade and lesion degree of CHD

LVDd and LAD were positively correlated with grade of cardiac function and lesion degree ($P < 0.05$). There was a negative correlation between E/A and the grade of cardiac function and lesion degree ($P < 0.05$) (Table 4).

Comparison of ultrasonic parameters in patients with different prognoses

Of the 106 patients in the study group, 11 experienced adverse cardiovascular events during follow-up and were categorized into the poor prognosis group, while the other 95 patients were categorized into the good prognosis group. E/A values for the good prognosis group (1.83 \pm 0.51) were higher than those for the poor prognosis group (1.39 \pm 0.32). LVDd (49.60 \pm 4.39 mm) and LAD (36.13 \pm 3.05 mm) were lower in the good prognosis group compared to those in the poor prognosis group (59.09 \pm 5.67 mm and 45.10 \pm 5.60 mm, respectively; $P < 0.05$) (Table 5).

Table 3 Comparison of ultrasonic parameters in patients with different degrees of coronary heart disease (mean \pm SD)

Group	Number	E/A	LVDd (mm)	LAD (mm)
Mild	43	1.69 \pm 0.50	51.97 \pm 3.88	38.81 \pm 2.56
Moderate	38	1.44 \pm 0.41	59.95 \pm 4.14	45.15 \pm 2.97
Severe	25	1.13 \pm 0.36	67.70 \pm 6.11	49.09 \pm 4.05
<i>t</i> / <i>P</i> value (Grade II vs III)		2.441/0.017	8.952/0.000	10.319/0.000
<i>t</i> / <i>P</i> value (Grade III vs IV)		3.078/0.003	6.009/0.000	4.453/0.000

E/A: Early-to-late diastolic blood flow velocity ratio; LVDd: Left ventricular end-diastolic volume; LAD: Left atrial diameter.

Table 4 Correlation between ultrasonic parameters and cardiac function grade and lesion degree of coronary heart disease (*n* = 106)

Project	E/A	LVDd	LA
Cardiac function classification			
<i>r</i>	0.606	0.589	0.577
<i>P</i> value	< 0.001	< 0.001	< 0.001
Degree of lesion			
<i>r</i>	0.631	0.597	0.561
<i>P</i> value	< 0.001	< 0.001	< 0.001

E/A: Early-to-late diastolic blood flow velocity ratio; LVDd: Left ventricular end-diastolic volume; LA: Left atrial diameter.

Table 5 Comparison of ultrasonic parameters in patients with coronary heart disease with different prognosis (mean \pm SD)

Group	<i>n</i>	E/A	LVDd (mm)	LAD (mm)
Good prognosis group	95	1.83 \pm 0.51	49.60 \pm 4.39	36.13 \pm 3.05
Poor prognosis group	11	1.39 \pm 0.32	59.09 \pm 5.67	45.10 \pm 5.60
<i>t</i>		2.791	6.579	8.333
<i>P</i> value		0.006	< 0.001	< 0.001

E/A: Early-to-late diastolic blood flow velocity ratio; LVDd: Left ventricular end-diastolic volume; LAD: Left atrial diameter.

DISCUSSION

CHD has a chronic progression. Most patients in the early stage of the disease have no obvious symptoms. However, when symptoms appear, most patients are diagnosed with serious coronary artery disease because of the strong compensatory function of the myocardium, leading to an adverse impact on prognosis[9,10]. Coronary angiography is the gold standard for clinical diagnosis of CHD because it can comprehensively and stereoscopically show entire vascular lesions, providing an imaging basis for disease diagnosis[11-13]. Since it is an invasive examination with a high cost and long procedural time, there are some limitations to its clinical application[14-17].

In the clinical diagnosis of CHD, ultrasound can quickly determine the velocity, direction and distribution of myocardial motion through the Doppler effect; accurately detect abnormal myocardial activity; and intuitively show the global and regional myocardial systolic function of the left ventricle. For these reasons, it provides an objective basis for the clinical evaluation of myocardial function and disease diagnosis [18]. Studies have confirmed that two-dimensional color Doppler ultrasound has a high diagnostic value for CHD and is a low-cost, simple, accurate and noninvasive method to evaluate cardiac function. Furthermore, studies have shown that carotid ultrasound can effectively identify the differences in intima media thickness of the carotid bifurcation, common carotid artery, and internal carotid artery between

patients with CHD and healthy individuals, thereby allowing a differential diagnosis of CHD. Their results showed lower LVDd and LAD in the study group than in the control group, with significant differences in the E/A, LVDd and LAD between patients with CHD with different cardiac function grades and disease severity. There was a close correlation between ultrasonic parameters and heart disease severity, indicating that abnormalities in echocardiographic parameters were related to cardiac function in patients with CHD, and the severity of the lesions was aggravated as the cardiac function grade increased. The increase or decrease in E/A, LVDd and LAD was more significant, indicating that echocardiography can effectively identify the abnormal cardiac function of patients with CHD and evaluate the cardiac function and the degree of pathological changes, so as to guide the clinician to take targeted prevention and control measures that will ensure a successful intervention, rehabilitation of cardiac function, and good prognosis. The pathological basis of CHD is coronary atherosclerosis and plaque formation. A more serious lesion corresponds to a narrower coronary artery. Concurrently, coronary atherosclerosis and plaque formation cause coronary artery trunk and branch stenosis and blockage, which adversely affect myocardial oxygen and blood supply, cause myocardial tissue damage, and affect cardiac function. Consequently, changes in cardiac function are visible upon ultrasonic examination[19,20]. Some studies have shown that E/A is significantly decreased and LVDd and LAD are significantly increased in patients with CHD. There was a significant difference in E/A, LVDd and LAD between patients with different degrees of CHD, with a negative correlation between E/A and disease severity and a positive correlation between LVDd or LAD and disease severity. The reason is that increases in LVDd and LAD are closely related to decreases in the left ventricular ejection fraction, left atrial volume emptying, and abnormal left atrial function. An abnormal decrease in E/A is closely related to mechanical dysfunction of the left atrium, an increase in left atrial volume load, a decrease in left ventricular filling, and abnormalities in left atrial diastolic function.

Based on the above findings, patients with CHD were treated with the corresponding treatment and followed up for 6 mo, during which they were divided into groups according to prognosis. The results showed higher E/A and lower LVDd and LAD values in the good prognosis group compared to those in the poor prognosis group. These findings suggest that ultrasonography is useful for evaluating the prognosis of patients with CHD. This may be due to the significant inhibition of ventricular remodeling, decrease in myocardial fibrosis and necrosis, increase in cardiomyocytes, and recovery of cardiac function in patients with CHD after effective treatment, resulting in improvement of the relevant parameters of ultrasonic examination. Consequently, patients with CHD can receive regular ultrasound examinations after treatment to clarify their cardiac function and guide the clinician to formulate further intervention programs to ensure a good prognosis.

CONCLUSION

Generally, the ultrasonic parameters of patients with CHD are abnormal. Patients with different cardiac function grades, lesion degree, and prognoses have significantly different parameters, as there is a close relationship between these parameters and CHD. Consequently, ultrasound can be used to evaluate the status and prognosis of heart disease and provide an objective reference for diagnosis and treatment.

ARTICLE HIGHLIGHTS

Research background

Coronary heart disease (CHD) is a clinical multiple cardiovascular disease that is mainly caused by coronary artery atherosclerosis. The incidence of CHD has recently increased, creating an urgent social and public health problem.

Research motivation

To provide a basis for the evaluation of cardiac function and disease severity in patients with CHD.

Research objectives

To evaluate the value of ultrasonography in the evaluation of cardiac function and lesion degree in patients with CHD.

Research methods

A total of 106 patients with CHD and 106 healthy individuals were selected for this study. All subjects were examined by ultrasound, and the mitral orifice's early-to-late diastolic blood flow velocity ratio (E/A), left ventricular end-diastolic volume (LVDd) and left atrial diameter (LAD) were measured. Values were compared between the study group and healthy group, and the correlation between the ultrasonic parameters of patients with different cardiac function grades and the degree of CHD were assessed.

Research results

E/A of the study group was smaller than that of the control group (1.88 ± 0.44), while LVDd and LAD were larger. E/A for patients with grade III disease was smaller and LVDd and LAD were larger than those in patients with grade II disease. Patients with grade IV disease had smaller E/A and larger LVDd than patients with grade II and III disease. E/A was negatively correlated with cardiac function classification and disease severity, while LVDd and LAD were positively correlated with cardiac function classification and disease severity.

Research conclusions

The ultrasonic parameters of patients with CHD are significantly different in patients with different cardiac function grade, lesion degree and prognosis. They can be used to evaluate the disease's condition and prognosis, providing an objective reference for disease diagnosis and treatment.

Research perspectives

There is a close relationship between CHD and ultrasound parameters, which has a wider clinical application value.

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