VALUE OF ECHOCARDIOGRAPHIC DIASTOLIC FUNCTION REACTIVITY UNDER EXERCISE LOAD

VALOR DA REATIVIDADE DA FUNÇÃO DIASTÓLICA ECOCARDIOGRÁFICA SOB CARGA DE EXERCÍCIO

VALOR DE REACTIVIDAD DE LA FUNCIÓN DIASTÓLICA ECOCARDIOGRÁFICA BAJO CARGA DE EJERCICIO

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ABSTRACT

Introduction: Left ventricular diastolic dysfunction is one of the important long-term survival and prognosis factors in patients with coronary heart disease. Objective: To evaluate the diastolic function of the left ventricle in patients with coronary heart disease (CHD) using 3D speckle tracking echocardiography (3D-STE). Methods: Full volume images of four apical cavities were collected, and 4D Auto LVQ software was used for offline analysis to obtain longitudinal strain (GLS), circumferential strain (GCS), area strain (GAS) and radial strain (GRS) of the left ventricle as a whole (four three-dimensional strain indicators). Results: The receiver operating characteristic (ROC) curve analysis showed that the sensitivity and specificity of GLS in predicting left ventricular diastolic dysfunction were both 68% at -15.5%. The sensitivity and specificity of GCS for predicting left ventricular diastolic dysfunction at -17.5% were 76% and 81%, and those of GAS at -29.5% were 84% and 68%, respectively. Conclusions: The strain parameters of 3D-STE can be used to predict LVEDP in patients with coronary heart disease with normal left ventricular ejection fraction, and can be used as a new ultrasonic diagnostic index to evaluate left ventricular diastolic function in patients. ***Level of evidence II; Therapeutic studies - investigation of treatment results.***

Keywords: Coronary artery disease; Aortic left ventricular tunnel; Ultrasound.

RESUMO

Introdução: A disfunção diastólica do ventrículo esquerdo é um dos fatores importantes para sobrevida e prognóstico a longo prazo em pacientes com doença cardíaca coronariana. Objetivo: A função diastólica do ventrículo esquerdo em pacientes com doença coronariana (CHD) é avaliada por Speckle-Tracking com Ecocardiografia tridimensional (3D-STE). Métodos: Imagens de volume total de quatro cavidades apicais foram coletadas e o software 4D Auto LVQ foi usado para análise off-line para obter a deformação longitudinal (GLS), a deformação circunferencial (GCS), a deformação de área (GAS) e a deformação radial (GRS) do ventrículo esquerdo como um todo (quatro indicadores tridimensionais de deformação). Resultados: A análise da curva característica de operação do receptor (ROC) mostrou que a sensibilidade e a especificidade da GLS na predição da disfunção diastólica do ventrículo esquerdo foi de 68% a -15,5%. A sensibilidade e a especificidade da GCS para predizer disfunção diastólica do ventrículo esquerdo em -17,5% foram 76% e 81%, e as da GAS em -29,5% foram 84% e 68%, respectivamente. Conclusões: Os parâmetros de deformação do 3D-STE podem ser usados para prever a LVEDP em pacientes com doença cardíaca coronariana com fração de ejeção ventricular esquerda normal e podem ser usados como um novo índice de diagnóstico ultrassônico para avaliar a função diastólica do ventrículo esquerdo. ***Nível de Evidência II; Estudos terapêuticos – Investigação dos resultados do tratamento.***

Descritores: *Doença da artéria coronariana; Túnel aórtico ventricular esquerdo.*

RESUMEN

Introducción: La disfunción diastólica del ventrículo izquierdo es uno de los factores importantes para la sobrevida y el pronóstico a largo plazo de los pacientes con cardiopatía coronaria. Objetivo: La función diastólica del ventrículo izquierdo en pacientes con enfermedad coronaria (EC) se evalúa mediante Speckle-Tracking con ecocardiografía tridimensional (3D--STE). Métodos: Se recopilaron imágenes de volumen de cuatro cavidades apicales y se utilizó el software 4D Auto LVQ para el análisis offline a fin de obtener la deformación longitudinal (GLS), la deformación circunferencial (GCS), la deformación de área (GAS) y la deformación radial (GRS) del ventrículo izquierdo en su conjunto (cuatro indicadores de deformación tridimensionales). Resultados: El análisis de la curva característica operativa del receptor (ROC) demostró que la sensibilidad y la especificidad de la GLS para predecir la disfunción diastólica del ventrículo izquierdo fue del 68% al -15,5%. La sensibilidad y la especificidad de la GCS para predecir la disfunción diastólica del ventrículo izquierdo a -17,5% fueron del 76% y el 81%, y las de la GAS a -29,5% fueron del 84% y el 68%, respectivamente. Conclusiones: Los parámetros de deformación de la 3D-STE pueden utilizarse para predecir la LVEDP en pacientes con cardiopatía coronaria con una fracción de eyección ventricular izquierda normal y pueden utilizarse como un nuevo índice de diagnóstico ultrasónico para evaluar la función diastólica del ventrículo izquierdo. ***Nivel de Evidencia II; Estudios terapéuticos – Investigación de los resultados del tratamiento.***

Descriptores: *Enfermedad de la arteria coronaria; Túnel aorto-ventricular izquierdo.*

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INTRODUCTION

Left ventricular diastolic dysfunction is one of the important factors for long-term survival and prognosis of patients with coronary heart disease.[1,2] Doppler echocardiography is an important indicator commonly used in clinical evaluation of left ventricular diastolic function in patients with coronary heart disease, due to the influence of included angle, the evaluation of left ventricular diastolic function has certain limitations.[3,4] Recently developed (3D-STE) is a new ultrasonic diagnostic technology, which can obtain real-time ventricular total volume data by tracking the movement of myocardial spots in three-dimensional space, which can more accurately reflect the movement and strain of myocardial in all directions, and then comprehensively evaluate the overall systolic and diastolic function of myocardium.[5,6]

Studies have shown that the strain index of 3D-STE can accurately evaluate the cardiac structure and function, and the overall area strain value is highly correlated with the severity of heart failure patients, which is one of the important indicators to evaluate the left ventricular systolic function of patients.[7,8] In addition, Shin et al. have recently confirmed that three-dimensional strain value has a certain correlation with left ventricular end-diastolic pressure (LVEDP) of patients with coronary heart disease, which has certain reference value for evaluating left ventricular diastolic function of patients, however, this study did not cover CHD patients with different degrees of left ventricular diastolic dysfunction due to a small number of cases and a large number of diseases.[9,10]

METHOD

Research Objects

In this study, 68 patients with coronary heart disease, 56 males, 12 females; The mean age was (57.7 ± 8.4) years; Among them, 31 (46%) had diabetes, 42 (62%) had hypertension, 59 (87%) had dyslipidemia, and 30 (44%) had a history of myocardial infarction. All patients had sinus rhythm and underwent left ventricular angiography and coronary angiography [15 patients (22%) had single-vessel coronary artery disease and 53 patients (78%) had multi-vessel coronary artery disease]. Exclusion criteria: (1) Age ≥ 80 years; (2) After atrial fibrillation, conduction block or pacemaker implantation; (3) Unstable condition, including acute coronary syndrome, cardiogenic shock and ventricular aneurysm, etc.; (4) Severe mitral and aortic valve lesions; (5) Left ventricular ejection fraction < 50 %.

Grouping

According to LVEDP, all patients were divided into two groups: normal left ventricular diastolic group (N = 31) [LVEDP ≤ 15 mmHg (1mmHg=0.133 kPa)], and left ventricular diastolic group (N = 37) (LVEDP>15 mmHg).

Statistical methods

SPSS16.0 analysis software was used. The receiver operating characteristic (ROC) curve was drawn, the area under the curve and the optimal cut-off point were determined, and the sensitivity and specificity of predicting left ventricular diastolic dysfunction at different thresholds for each three-dimensional strain value were calculated. P<0.05 was considered statistically significant. (Table 1)

RESULTS

Correlation between patient data comparison and LVEDP: There was no significant difference in age, sex, heart rate and coronary artery disease involvement between the group with normal left ventricular diastolic function and the group with left ventricular diastolic dysfunction, there were no significant differences in early diastolic mitral flow velocity (E), late diastolic mitral flow velocity (A), E/A value, deceleration time and left ventricular ejection fraction (ALL P >0.05) (Table 2).

Comparison of THREE-DIMENSIONAL strain indexes and their correlation with LVEDP: (1) Four three-dimensional strain indexes (GLS, GCS, GAS and GRS) between the two groups: The four three-dimensional strain indexes in the left ventricular diastolic dysfunction group were lower than those in the normal left ventricular diastolic dysfunction group, with statistical significance (P<0.001). (2)Pearson correlation analysis: Four three-dimensional strain indicators are moderately correlated with LVEDP: GLS (r=0.585, P<0.001), GCS (r=0.589, P<0.001), GAS (r=0.674, P<0.001) and GRS (r=-0.643, P<0.001). (Table 3)

Diagnostic accuracy: ROC curve analysis showed that the sensitivity and specificity of GLS in predicting left ventricular diastolic dysfunction were both 68% at -15.5% [AUC =0.74, P<0.001]. The sensitivity and specificity of GCS for predicting left ventricular diastolic dysfunction at -17.5% were 76% and 81% AUC=0.82, P<0.001), and that of GAS at -29.5% were 84% and 68%, respectively (AUC=0.82, P<0.001). P < 0.001). (Figure 1)

DISCUSSION

Coronary heart disease is mainly caused by coronary artery atherosclerosis lesions and coronary artery lumen stenosis, obstruction, resulting in coronary artery corresponding to the blood supply area of the myocardium is not adequate blood oxygen supply, thereby causing myocardial local contraction and diastolic function of the abnormal. It has been reported

Table 1. Comparison of three dimensional left ventricular diastolic function indexes between patients and normal controls.

	HCN Patient			Normai conto=rol (n=50)	p
	Group1 (n=23)	Group2 (n=37)	Group3 (n=9)		
EDSI	43.96±7.89	44.62±11.00	50.64±14.85	40.3±10.03	0.0010
DDI-late	5.3±2.19	5.8±2.65	7.95±2.75	5.17±1.62	<0.0001
DISPED-late	21.63±5.28	19.07±9.67	26.76±17.19	20.34±6.66	<0.0001

*P<0.05 vs control group, #P<0.05 3 vs group 2, +P<0.05 vs group 1.

Table 2. Comparison of patient data between the two groups and correlation with LVEDP (±s).

	All patients n=68	Normal left ventricular diastolic function group n=31	Left ventricular diastolic dysfunction group n=37	P* value	Correlation with LVEDP	
					r	P value
Age (years)	57.7±8.4	58.7±7.7	56.8±8.9	0.35	-0.02	0.90
Male [cases (%)]	56	25	31	0.35	-0.02	0.90
Heart rate (times/min)	65.9±9.5	66.0±10.5	65.8±8.7	0.94	0.05	0.66
Body mass index (kg/m)	26.3±2.6	26.3±2.6	26.2±2.7	0.87	-0.12	0.32
Diabetes	31	14	17	0.95	0.12	0.32
Hypertension	42	20	22	0.68	0.03	0.81
Dyslipidemia	59	27	32	0.94	0.11	0.39
Myocardial infarction	44.1	41.9	45.9	0.75	-0.02	0.85
Single lesion	15	8	7	0.50	-0.07	0.58
Multivessel lesions	53	23	30	0.50	0.07	0.58
E(m/s)	0.73±0.14	0.71±0.15	0.75±0.13	0.24	0.09	0.48
A (m/s)	0.75±0.16	0.75±0.15	0.75±0.17	0.98	0.09	0.49
Deceleration time(ms)	181.96±24.79	185.45±24.56	179.03±24.94	0.29	-0.18	0.15
Left ventricular ejection fraction (%)	61.26±3.02	62.00±3.11	60.65±2.84	0.07	-0.08	0.50

Note: * represents the left ventricular insufficiency group compared with the normal left ventricular diastolic function group. E: early diastolic mitral valve flow velocity A: late diastolic mitral valve flow velocity LVEDP: left ventricular end diastolic pressure.

Table 3. Comparison of three-dimensional strain indicators between the two groups and their correlation with LVEDP.

3 D strain index %	All patients n=68	Normal left ventricular diastolic function group n=31	Left ventricular diastolic dysfunction group n=37	P* value	Correlation with LVEDP	
					r	P value
Left ventricular global long-sleeve strain	-15.18±2.59	-16.39±2.42	-14.16±2.30	0.000	0.585	<0.001
Global circumferential strain of left ventricle	-17.82±3.03	-19.61±2.38	-16.32±2.71	0.000	0.589	<0.001
Global area strain of left ventricle	28.71±4.20	-31.13±3.19	-26.68±3.87	0.000	0.674	<0.001
Global radial strain value of left ventricle	46.62±7.99	51.29±6.46	42.70±7.04	0.000	-0.643	<0.001

Note: * represents the left ventricular insufficiency group compared with the normal left ventricular diastolic function group. E: early diastolic mitral valve flow velocity A: late diastolic mitral valve flow velocity LVEDP: left ventricular end diastolic pressure.

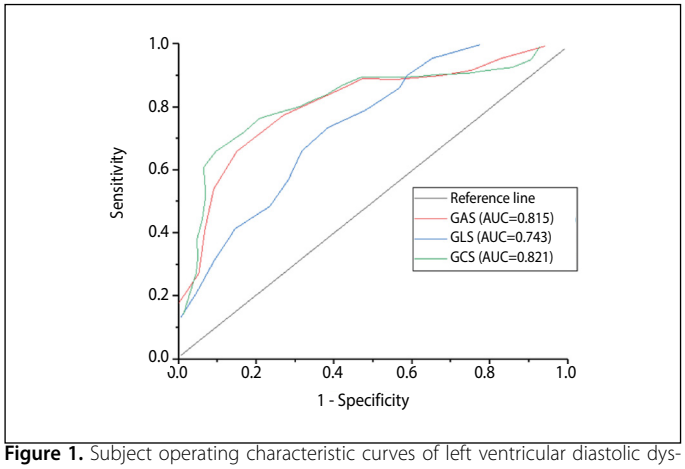

Figure 1. Subject operating characteristic curves of left ventricular diastolic dysfunction predicted by three-dimensional strain indicators.

that patients with coronary heart disease, especially after acute coronary syndrome, have a significantly higher incidence of abnormal left ventricular diastolic function, and a significantly lower long-term survival and prognosis than patients with normal left ventricular diastolic function. Therefore, early assessment is valuable for clinical treatment and prognosis. LVEDP measured by left ventricular catheterization is the gold standard for the diagnosis of left ventricular diastolic dysfunction. But because of invasiveness and high cost, it is limited to be widely used in clinic. According to the Society of Echocardiography: Multiple indicators of Doppler echocardiography can accurately assess left ventricular diastolic function, and its advantages are simple, fast, effective and non-invasive, however, it has a certain Angle dependence, because it needs to be combined with other indicators to assist in the diagnosis of left ventricular diastolic dysfunction. 3D-STE is a new angle-independent ultrasonic diagnosis technology developed on the basis of 2D speckle tracking imaging. It mainly tracks the motion trajectory of myocardium by automatically recognizing the echoic speckle signal of myocardium in 3D images, the strain of each segment of the myocardium was evaluated to obtain the longitudinal, radial, circumcircular and area strain information of the local and global myocardium, so as to accurately reflect the overall systolic and diastolic functions of the myocardium.

At present, 3D-STE can accurately assess left ventricular diastolic function in patients with coronary heart disease, and confirm that GLS and GAS are closely related to left ventricular diastolic function. But there are many diseases, including hypertension, dilated cardiomyopathy and coronary heart disease. It was found that GLS and GAS strain indexes of 3D-STE were highly correlated with LVEDP, and GCS and GRS were also correlated with LVEDP in patients with coronary heart disease.

CONCLUSION

In conclusion, this study confirmed that the strain related indicators of 3D-STE can accurately predict THE LVEDP of patients with CHD, and it is a new diagnostic indicator to evaluate the left ventricular diastolic function of patients with CHD.

The author declare no potential conflict of interest related to this article

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