RELATIONSHIP BETWEEN THE ECHOCARDIOGRAPHIC RESPONSE OF DIASTOLIC FUNCTION AND LOAD EXERCISE

RELAÇÃO ENTRE A RESPOSTA ECOCARDIOGRÁFICA DA FUNÇÃO DIASTÓLICA E O EXERCÍCIO DE CARGA

RELACIÓN ENTRE LA RESPUESTA ECOCARDIOGRÁFICA DE LA FUNCIÓN DIASTÓLICA Y EL EJERCICIO DE CARGA

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ABSTRACT

Introduction: This article studies the echocardiographic images of patients and observes the changes in diastolic cardiac function after exercise. Objective: This article tries to find the relationship between cardiac images during exercise and the diagnosis of myocardial ischemia. Methods: Samples of people with equal fitness for the same exercise area were selected with specific equipment to measure the sample ventricular strain curve before and after 5 minutes to exercise with a load. The diastolic strain index (SDI) ratio before and after exercise assesses the relationship between myocardial ischemia and exercise load. Results: The test results showed no significant difference in the range of motion of the cardiac atrioventricular annulus both before and after subjects were subjected to intense exertion exercise. A significant change in slope was noted in the ECG data curve about the exercise index, in addition to a reduction in the diastolic period. Conclusion: When the exercise load increases, it can easily cause changes in the ventricular wall. This can make local myocardial dysfunction more prone. ***Level of evidence II; Therapeutic studies - investigation of treatment results.***

Keywords: Exercise Test; Echocardiography; Myocardial Ischemia; Diastole.

RESUMO

Introdução: Este artigo estuda as imagens ecocardiográficas de pacientes e observa as mudanças na função cardíaca diastólica após o exercício. Objetivo: Este artigo questiona alguma relação entre as imagens cardíacas durante o exercício e o diagnóstico de isquemia miocárdica. Métodos: Amostras de pessoas com igual adequação para a mesma área de exercício foram selecionadas com equipamento específico para medir a curva de tensão ventricular da amostra antes e depois de 5 minutos ao exercício com carga. A relação do índice de tensão diastólica (SDI) antes e depois do exercício avaliou a relação entre a isquemia miocárdica e a carga do exercício. Resultados: Os resultados do teste não mostraram diferença significativa na amplitude de movimento do anel atrioventricular cardíaco, tanto antes quanto depois dos sujeitos terem sido submetidos a um exercício de esforço intenso. Uma mudança significativa na inclinação foi notada na curva de dados do ECG sobre o índice de exercício, além de uma redução no período diastólico. Conclusão: Quando a carga de exercício aumenta, ela pode facilmente causar alterações na parede ventricular. Isto pode propiciar uma disfunção local do miocárdio. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

Descritores: *Teste de exercício; Ecocardiografia; Isquemia miocárdica; Diástole.*

RESUMEN

Introducción: Este artículo estudia las imágenes ecocardiográficas de los pacientes y examina los cambios en la función cardíaca diastólica después del ejercicio. Objetivo: Este artículo cuestiona cualquier relación entre las imágenes cardíacas durante el ejercicio y el diagnóstico de isquemia miocárdica. Métodos: Se seleccionaron muestras de personas con igual aptitud para la misma zona de ejercicio con equipos específicos para medir la curva de tensión ventricular de la muestra antes y después de 5 minutos de ejercicio con carga. La relación del índice de tensión diastólica (SDI) antes y después del ejercicio evaluó la relación entre la isquemia miocárdica y la carga de ejercicio. Resultados: Los resultados de la prueba no mostraron diferencias significativas en la amplitud del movimiento del anillo auriculoventricular cardíaco, tanto antes como después de que los sujetos se sometieran a un ejercicio de esfuerzo intenso. Un cambio significativo en la inclinación fue notado en la curva de datos del ECG a lo largo del índice de ejercicio, además de una reducción del periodo diastólico. Conclusión: Cuando la carga de ejercicio aumenta, puede provocar fácilmente cambios en la pared ventricular. Esto puede provocar una disfunción miocárdica local. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: *Prueba de esfuerzo; Ecocardiografía; Isquemia miocárdica; Diástole.*

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INTRODUCTION

Treadmill test exercise stress echocardiography is a method of diagnosing myocardial ischemia that combines treadmill test exercise stress with transthoracic echocardiography. However, using this method to determine abnormal wall motion accompanied by myocardial ischemia is more subjective. At the same time, the diagnosis of myocardial ischemia requires a doctor with rich experience. The above reasons limit the wide application of this method in clinical practice. The strain echocardiography method that has been developed in recent years has been applied to clinical trials.[1] It has the advantage that it can accurately and quantitatively evaluate the local myocardial movement of the left ventricle without being affected by the movement of the whole heart and adjacent myocardium and objectively evaluate the abnormality of the ventricular wall movement in the exercise load. This study used strain echocardiography to detect local diastolic dysfunction caused by myocardial ischemia induced by exercise load after 5 exercises. At the same time, we use this method to objectively evaluate local ventricular wall motion abnormalities and determine left ventricular myocardial ischemia.

METHOD

Research object

Exercise stress echocardiography was used to determine 32 patients with suspected ischemic heart disease.[2] Among them, the number of male patients was 24, and female patients were 8. The average age was (65±9) years, except for cases of segmental ventricular wall motion abnormalities and atrial fibrillation at rest.

Method

Exercise load method

The exercise load is the exercise load of the treadmill test. The exercise load program is the Bruce program. The criterion for stopping exercise load is angina symptoms (above moderate) and no abnormal Q waves. The ECG lead has an ST elevation of 1 mm or more or an ST level or declining ST decrease of 2 mm or more.

Analysis method of strain echocardiogram

The following items are calculated on the acquired strain curve of the left ventricle: 1) The strain value (A) when the aortic valve is closed (AVC). 2) The strain value (B) at 1/3 of the diastolic period (DD1/3). 3) Strain relaxation index (SDI), SDI6=AB/A100%. 4) SDI ratio before and after load = SDI afterload / SDI before load. AVC refers to the time when the pulsed Doppler waveform of the aortic valve orifice disappears.[3] From AVC to ECG, the QRS wave Q point is diastole. Calculate the diastolic time from the beginning of the diastolic period when the aortic valve is closed to 1/3 of the diastolic period to calculate DDD 1/3.

Six left ventricular walls were obtained in the area of coronary artery innervation

The middle anterior interval of the middle segment and the anterior wall's middle segment are the dominant areas of the left anterior descending branch. The back wall and the middle section of the sidewall are left circumflex branches. The posterior septum and the middle segment of the inferior wall are the areas dominated by the right coronary artery.[4] In the exercise load isotope scan, the equivalent segment with ischemia is the ischemic segment, and the segment without ischemia is the normal segment.

Left ventricular diastolic function

Record and measure the overall diastolic function of the left ventricle, such as the left ventricular inflow blood flow waveform, the highest speed of E peak, the highest speed of A peak, the deceleration time of E peak, etc.

Exercise load isotope myocardial scan

In all cases, exercise stress myocardial isotope scanning was performed to determine the ischemic coronary artery innervation area.

Research and Simulation of Athlete's Endurance Prediction Model

Suppose that m represents the comprehensive count of the athlete's frequency and the knee and ankle joints.[5] Y represents the reference sequence of the athlete's movement dimension. Use formula (1) to calculate the correlation index statistics between the athlete's exercise frequency, speed count, and endurance

$$Y_{p_j} = \frac{x_{ji}}{y_i} \times \frac{m}{Y} * p_j j \qquad (1)$$

P_j represents the comparison order of the j factor with a dimension of 1. y_i represents the actual value of the athlete's exercise volume. Y represents the predicted endurance value within the athlete's exercise intensity range. Use formula (2) to extract the athlete's exercise load characteristics

$$\varepsilon_{ji} = \frac{\Delta_{\min} + \rho\Delta_{man}}{\Delta_{ji}} \qquad (2)$$

ρ represents the resolution coefficient of endurance prediction. Δ_{man} represents the movement load changes of the hip, knee, and ankle joints on the sagittal axis, the coronal axis, and the vertical axis when the athlete exercises. Δ_{ji} represents the deviation between the historical predicted value and the actual value of the athlete's sports endurance. Use formula (3) to build a prediction model for athletes' endurance

$$\Phi = \frac{\rho\Delta_{man}}{\varepsilon_{ji} \times \Delta_{ji}} Y_{p_j} \qquad (3)$$

According to formula (3), a prediction model of athlete endurance can be constructed. Use this model to complete the endurance prediction of athletes.

Statistical methods

Continuous variables are expressed as mean ± standard deviation. The count data was judged as statistically significant with $P<0.05$.

RESULTS

In this study, exercise stress echocardiography and isotope myocardial scanning was performed on 174 segments of the myocardium in 32 patients. All patients detected one hundred twenty-six non-ischemic segments and 48 ischemic segments, and the two comparison results were consistent.[6] The SDI before the load was 48%, the SDI after 5min load was 21%, and the SDI ratio before and after load was 0.43.

There was no statistically significant difference in left ventricular inflow blood flow indicators before and after loading. It was determined that no myocardial ischemia was a normal segment during exercise stress myocardial isotope scanning. The total number is 126 segments. It was judged to have myocardial ischemia as an ischemic segment, consisting of 48 segments.[7] The strain values before and afterload in the normal 126 segments. There was no significant difference in both AVC and DD1/3. There was no statistically significant difference in the strain value before and after the load in the 48 segments of ischemia compared with the strain value during AVC. The strain value at DD1/3, the difference before and after loading on the front, side, and inferior walls, was statistically significant. There was no statistically significant difference in the average SDI value of each field before and after the load in the 119 normal segments. The difference in the average SDI value of each area before and after the load in the 43 ischemic segments was statistically significant. The front interval is (47±14) % vs. (21±9) %. The front wall is (54±19) % vs. 915±16) %. The posterior wall is (50±18) % vs. (17±12) %. The sidewall is (47±18) % vs. (19±12) %. The posterior interval is (52±22) % vs. (18±12) %. The lower wall is (43±11) % vs. (20±12) %. By comparing with exercise load isotope, it can be calculated that when the boundary value is 0.51, the sensitivity is 91%, and the specificity is 89%. This shows that strain echocardiography can determine the left ventricular ischemia. (Table 1)

Table 1. Compare myocardial strain values between the ischemic and non-ischemic segments before and after 5 minutes of exercise load.

Middle section	126 non-ischemic segments		
	Before load	Afterload	P
Strain value in AVC			
Front interval	-17.17±6.49	-17.77±3.59	NS
Front wall	-14.47±3.97	-14.73±4.98	NS
Back wall	-14.1±5.49	-14.6±8.37	NS
Sidewall	-18.46±5.1	-18.32±4.65	NS
After interval	-14.22±3.87	-14.39±3.81	NS
Lower wall	19.24±2.46	18.12±4.61	NS
Strain value at DD1/3			
Front interval	-8.84±4.4	-9.3±6.06	NS
After interval	-6.42±3.35	-8.28±2.77	NS
Lower wall	-10.43±2.87	-11.07±3.44	NS
Front wall	-6.04±2.66	-7.62±5.15	NS
Back wall	-5.74±3.64	-8.71±3.13	NS
Sidewall	-8.53±5.97	-10.47±4.83	NS
	48 ischemic segments		
	Before load	**Afterload**	**P**
Strain value in AVC			
Front interval	-19.3±3.76	-20.0±5.04	NS
Front wall	-12.1±5.39	-12.66±5.39	NS
Back wall	-15.24±5.9	-15.35±5.21	NS
Sidewall	-15.1±5.57	-14.56±4.13	NS
After interval	-18.17±5.38	-19.2±6.4	NS
Lower wall	-17.78±3.83	-17.99±4.13	NS
Strain value at DD1/3			
Front interval	-10.2±3.25	-13.0±8.90	NS
After interval	-9.6±3.78	-14.6±4.13	0.06
Lower wall	-6.45±4.33	-10.85±3.71	<0.001
Front wall	-10.21±3.47	-13.91±3.17	<0.001
Back wall	-7.68±4.8	-12.35±5.22	0.069
Sidewall	-8.23±4.7	-11.69±4.6	0.05

DISCUSSION

Treadmill test exercise stress echocardiography is used as one of the methods to evaluate ischemic heart disease. Its applicability has been confirmed, but it isn't easy to be widely used in clinical practice. It requires that immediately after the exercise load, it is necessary to skillfully play out each section that can evaluate the abnormal motion of the local ventricular wall and make a correct diagnosis. However, the latter is subjective. In this study, the strain echocardiography method was applied to the previous exercise stress echocardiography method to analyze the exercise load strain curve changes. This article analyzes the diastolic strain curve changes and objectively evaluates left ventricular wall motion abnormalities that can accurately determine myocardial ischemia. The objectively evaluating abnormal ventricular wall motion has been applied to dopamine tincture stress ultrasound.[8] At present, there are a variety of quantitative indicators for evaluating myocardial ischemia, such as the post-systolic contraction (PSS) phenomenon caused by ischemia. However, these are all indicators calculated by analyzing the systolic strain curve. In exercise experiments and clinical studies of percutaneous coronary angioplasty, there are reports that local left ventricular wall diastolic dysfunction occurs earlier than local systolic dysfunction when the myocardium is trapped in an ischemic state.

On the contrary, there are reports of local left ventricular diastolic dysfunction after improving systolic myocardial function during the recovery of myocardial ischemia due to the improvement of coronary blood flow. The SDI ratio before and after the load indicates the change before and after the SDI load. Local diastolic dysfunction due to myocardial ischemia was detected. Since the local diastolic dysfunction caused by myocardial ischemia induced by exercise load can continue to about 30 minutes after the occurrence of myocardial ischemia, this study used diastolic strain echocardiography to detect the exercise load induced by exercise load after 5 minutes. Local diastolic dysfunction caused by myocardial ischemia determines myocardial ischemia.

In normal myocardium, the diastole is 75% of the total diastole completed within 30% of the entire diastolic period from the start of diastole. This diastolic completion is reduced by myocardial ischemia. This study calculated SDI from the average strain when the aortic valve was closed and 1/3 of the diastole.[9] The results showed that compared with the SDI before the load, the SDI value after the load decreased. Compared with the exercise load isotope, when the SDI ratio before and after the load is less than 0.51, the sensitivity is 91%, and the specificity is 89%. Therefore, this method can diagnose myocardial ischemia. When myocardial ischemia occurs, local diastolic dysfunction appears earlier than systolic dysfunction.

On the contrary, it has been reported that after improving local systolic dysfunction during the recovery of myocardial ischemia, the local diastolic dysfunction can last for about 20 minutes. The author analyzes the diastolic strain curve based on the recorded images after 5 minutes of load. This article uses this method to determine myocardial ischemia.

CONCLUSION

In this study, images were acquired after 5 minutes of load. The patient's breathing and heart rate are relatively stable, and stable images of the evaluation of the ventricular wall motion can be obtained. By analyzing the diastolic strain curve, the sensitivity and specificity can be diagnosed for myocardial ischemia. The duration of local myocardial dysfunction after myocardial ischemia ranges from 15 minutes to 30 minutes. The author believes that the recovery of myocardial dysfunction after myocardial ischemia changes with time, so the necessary images are obtained as early as possible after the load is completed. This makes it easier to catch local myocardial dysfunction. From the point of view of the patient's breathing, heart rate, and blood pressure stabilization time after load, this study is set as 5min after load. 5min after exercise load, strain echocardiography can obtain the left ventricular partial diastolic dysfunction caused by delayed ischemia to determine myocardial ischemia.

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

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