

Three-dimensional echocardiography in the diagnosis of myocardial infarction and its correlation with the expressions of serum HIF-1 α , HO-1 and VEGF

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Abstract. – **OBJECTIVE:** To investigate the correlation between three-dimensional echocardiography and the expressions of hypoxia-inducible factor-1 alpha (HIF-1 α), heme oxygenase 1 (HO-1) and vascular endothelial growth factor (VEGF) in patients with myocardial infarction.

PATIENTS AND METHODS: A total of 40 patients with acute myocardial infarction treated with three-dimensional echocardiography and 40 patients receiving normal physical examination were selected. According to whether the disease occurred, they were divided into the myocardial infarction group and the normal group. Relevant indexes of two-dimensional and three-dimensional echocardiography and the expressions of HO-1, HIF-1 α and VEGF in the myocardial infarction group and the normal group were compared. Besides, the correlation of the left ventricular ejection fraction (LVEF) measured by three-dimensional echocardiography with HIF-1 α area, HO-1 area and VEGF area was analyzed.

RESULTS: The left ventricular end-diastolic diameter (LVEDD) in the myocardial infarction group was significantly larger than that in the normal group ($p < 0.05$), while the left ventricular inferior wall thickness (LVIWT) and LVEF in the myocardial infarction group were significantly smaller than those in the normal group ($p < 0.05$). The global end-diastolic volume (GEDV) and global end-systolic volume (GESV) measured by three-dimensional echocardiography in the myocardial infarction group were significantly higher than those in the normal group ($p < 0.05$), while the level of GEF in the myocardial infarction group was lower than that in the normal group; the levels of HIF-1 α , HO-1 and VEGF in the myocardial infarction group were significantly higher than those in normal group ($p < 0.05$). LVEF measured by three-dimensional echocardiography was negatively correlated with HIF-1 α area, HO-1 area and VEGF area ($p < 0.05$).

CONCLUSIONS: Three-dimensional echocardiography significantly improves the diagnostic

value of patients with myocardial infarction, and its index, LVEF, is negatively correlated with the expressions of serum HIF-1 α , HO-1 and VEGF, which can be used for evaluating cardiac functions and predicting the prognosis of patients.

Key Words:

Three-dimensional echocardiography, Myocardial infarction, HIF-1 α , HO-1, VEGF.

Introduction

With the improvement of people's living standards and changes in diets and lifestyles in China, the incidence rate of myocardial infarction has been significantly increased, and there is a clear trend showing it occurs in younger people¹. Acute myocardial infarction is mainly caused by a sharp decline or even interruption of blood and oxygen supply due to cardiac coronary artery disease, thus leading to the severe and persistent ischemia and hypoxia in the myocardium of the corresponding part to result in myocardial necrosis². The treatment of acute myocardial infarction is very important, but to avoid the occurrence of complications, improve the prognosis of patients and prolong the life cycle of them in the late recovery stage is also the focus of clinical treatment³. After the treatment, the detection and evaluation of left ventricular functions by echocardiography in the evaluation of the prognosis of patients are of great significance⁴.

The noninvasive examination of left ventricular functions is the main method to evaluate the risk of acute myocardial infarction and the prognosis of patients⁵. The previous two-dimensional echocardiography was based on cardiac

geometries for observation⁶, and the measurement of heart-related size was relatively accurate⁷. However, in view of the three-dimensional structure of the heart, certain degree of heart deformation changes will occur in myocardial infarction, so there is a certain degree of deviation in the detection by the two-dimensional echocardiography⁸.

Therefore, this study mainly explored the diagnosis value of myocardial infarction by three-dimensional echocardiography and analyzed the correlation of LVEF measured by three-dimensional echocardiography with the expressions of hypoxia-inducible factor 1- α (HIF-1 α), heme oxygenase 1 (HO-1) and vascular endothelial growth factor (VEGF) which were closely associated with myocardial infarction⁹⁻¹¹.

Patients and Methods

Patients

A total of 40 patients with acute myocardial infarction treated in our hospital from April 2015 to April 2017 and 40 patients receiving normal physical examination in the same period were selected in this study. These patients received electrocardiogram, clinical symptoms detection and biochemical blood test for diagnosis before inclusion, and informed consent was signed. Patients with myocardial diseases, cardiovascular diseases, malignant tumors, cardiogenic shock, multiple organ dysfunction or even failure, mental illness, combined with infected blood system or who received surgical treatment or refused to sign, were excluded. The study was approved by the Ethics Committee of Hebei Cangzhou Central hospital. According to whether the disease occurred, the patients were divided into the myocardial infarction group (n=40) and the normal group (n=40). In the myocardial infarction group, there were 24 males and 14 females, aged 60-75 years old with the mean age of (68.4 \pm 2.3) years old; the onset time of myocardial infarction was 1-24 h with the mean time of (6.2 \pm 0.5) h; combination with arrhythmia: 11 patients with atrial arrhythmia, 18 patients with ventricular arrhythmia and 23 patients with complex arrhythmia. In the normal group, there were 25 males and 15 female, aged 60-75 years old with the mean age of (68.5 \pm 2.4) years old, and there were no statistically significant differences between the two groups in gender and age ($p>0.05$).

Detection Methods

The detection was conducted using the Philips E33 digital color Doppler ultrasound diagnostic equipment (Amsterdam, The Netherlands), S5-1 ultrasound two-dimensional probes (with the frequency of 2-5 MHz) and X3-1 three-dimensional probes (with the frequency of 1-3 MHz) were applied at the same time. During the detection, patients were placed in the left-lateral position and connected with limb leads. Left ventricular end-diastolic diameter (LVEDD), left ventricular inferior wall thickness (LVIWT) and left ventricular ejection fraction (LVEF) were detected by two-dimensional echocardiography, and then X3-1 three-dimensional probes were used to reveal the standard apical four-chamber echocardiography. Under the mode of "full volume", the three-dimensional full volume image was obtained, and global end-systolic volume (GESV), left ventricular end-diastolic volume (GEDV) and left ventricular holistic ejection fraction (GEF) were determined. Meanwhile, the levels of HO-1, HIF-1 α and VEGF were measured.

Observation Indexes

Relevant indexes of two-dimensional and three-dimensional echocardiography and expressions of HO-1, HIF-1 α and VEGF in the myocardial infarction group and the normal group were compared. Besides, the correlations of LVEF measured by three-dimensional echocardiography with HIF-1 α area, HO-1 area and VEGF area were analyzed.

Evaluation Criteria

Indexes of two-dimensional echocardiography included LVEDD, LVIWT and LVEF, and indexes of three-dimensional echocardiography included GESV, GEDV and GEF. The levels of hypoxia-inducible factors, HIF-1 α , HO-1 and VEGF, were measured using enzyme linked immunosorbent assay. All kits were supplied by Qingdao Wolsen Biotechnology Co., Ltd., (Qingdao, China). The results were evaluated according to the area of positive materials in cells.

Statistical Analysis

Statistical Product and Service Solutions 21.0 (provided by International Business Machines Corporation, Armonk, NY, USA) were used. All the measurement data in the paper were expressed as mean \pm standard deviation ($\bar{x}\pm s$), and all the count data were expressed as percentage. Measurement data were compared and detected

Table I. Comparisons of indexes of two-dimensional echocardiography between the two groups ($\bar{x}\pm s$).

	LVEDD (mm)	LVIWT (mm)	LVEF (%)
Myocardial infarction group	48.1±1.3	8.3±0.5	45.3±2.1
Normal group	42.0±1.1	9.8±0.6	69.4±2.5
<i>t</i>	22.655	12.147	46.684
<i>p</i>	0.000	0.000	0.000

using t-test, and count data were detected using χ^2 -test. $p < 0.05$ represented that the difference was statistically significant.

Results

Comparisons of Indexes of Two-Dimensional Echocardiography Between the Two Groups

The LVEDD in the myocardial infarction group was significantly larger than that in the normal group ($p < 0.05$), while the LVIWT and LVEF were significantly smaller than those in the normal group ($p < 0.05$) (Table I).

Comparisons of Relevant Indexes of Three-Dimensional Echocardiography Between the Two Groups

The detection levels of GEDV and GESV measured by three-dimensional echocardiography in the myocardial infarction group were higher than those in the normal group ($p < 0.05$), and the level of GEF in the myocardial infarction group was lower than that of the normal group ($p < 0.05$) (Table II).

The Expression Levels of HIF-1 α , HO-1 and VEGF

The levels of HIF-1 α , HO-1 and VEGF in the myocardial infarction group were significantly higher than those in the normal group ($p < 0.05$) (Table III).

Analysis of the Correlation Between the LVEF Measured by Three-Dimensional Echocardiography with HIF-1 area

LVEF measured by three-dimensional echocardiography was negatively correlated with HIF-1 α ($r = -0.9227$, $p = 0.000 < 0.05$) (Figure 1).

Analysis of the Correlation Between LVEF and HO-1 Area

LVEF measured by three-dimensional echocardiography was negatively correlated with HO-1 area ($r = -0.8950$, $p = 0.000 < 0.05$) (Figure 2).

Analysis of the Correlation Between LVEF and VEGF Area

LVEF measured by three-dimensional echocardiography was negatively correlated with VEGF area ($r = -0.9760$, $p = 0.000 < 0.05$) (Figure 3).

Table II. Comparisons of relevant indexes of three-dimensional echocardiography between the two groups ($\bar{x}\pm s$).

	GEDV (mL)	GESV (mL)	GEF (%)
Myocardial infarction group	98.5±3.1	50.8±2.3	45.2±1.8
Normal group	75.6±2.5	26.4±3.3	66.3±2.0
<i>t</i>	36.368	38.365	49.596
<i>p</i>	0.000	0.000	0.000

Table III. The expression levels of HIF-1 α , HO-1 and VEGF (μm^2 , $\bar{x}\pm s$).

	HIF-1 α	HO-1	VEGF
Myocardial infarction group	36.5±2.8	25.6±1.5	35.6±1.8
Normal group	9.3±0.9	4.0±0.6	6.3±0.8
<i>t</i>	58.491	84.560	94.077
<i>p</i>	0.000	0.000	0.000

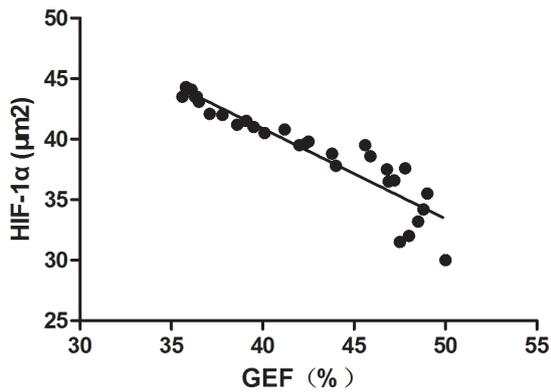


Figure 1. Analysis of the correlation between LVEF measured by three-dimensional echocardiography with HIF-1 area.

Discussion

Acute myocardial infarction is a cardiovascular disease seriously threatening human health. After the onset, arrhythmia, heart failure and even cardiac arrest easily occur¹². Decreased cardiac functions, especially the injury of left ventricular functions, easily lead to abnormalities in the cardiac cavity size, shape and tissue structure after the occurrence of myocardial infarction, which directly lead to changes in cardiac functions, thus affecting the prognosis of patients¹³. Three-dimensional echocardiography can be used for observation through the three-dimensional examination¹⁴, which shows changes in the real structure, shape and size of cardiac chambers and the ventricular wall in a relatively better way, and it can also be used for direct analysis of changes in left ventricular functions¹⁵.

In this work, comparisons of indexes of two-dimensional echocardiography between the myocardial infarction group and the normal group showed that the LVEDD in the myocardial infarction group was significantly larger than that in the normal group, and the LVIWT and LVEF in the myocardial infarction group were significantly smaller than those in the normal group. Two-dimensional echocardiography was further used to clarify that the cardiac functions and structural changes of included objects were in line with the inclusion criteria. Meanwhile, comparisons of indexes of three-dimensional echocardiography revealed that the GEDV and GESV in the myocardial infarction group were higher than those in the normal group, while the level of GEF in the myocardial infarction group was lower than that in the normal group, suggesting that there were significant abnormalities in the levels of GEDV, GESV and GEF in the myocardial infarction group. These results were consistent with those confirmed by previous investigations¹⁶ that the change in GEF levels can be used as an important index of three-dimensional echocardiography in assessing cardiac functions and outcome changes in patients with myocardial infarction. At the same time, it was confirmed in previous studies that HIF-1 α , HO-1 and VEGF are all associated with acute myocardial infarction. This research indicated that the levels of HIF-1 α , HO-1 and VEGF in the myocardial infarction group were significantly higher than those in the normal group, which is consistent with the result of previous studies¹⁷. However, there is no analysis of the correlation of LVEF of three-dimensional echocardiography with the levels of HIF-1 α , HO-1 and VEGF. We found that LVEF of three-dimensional echocardi-

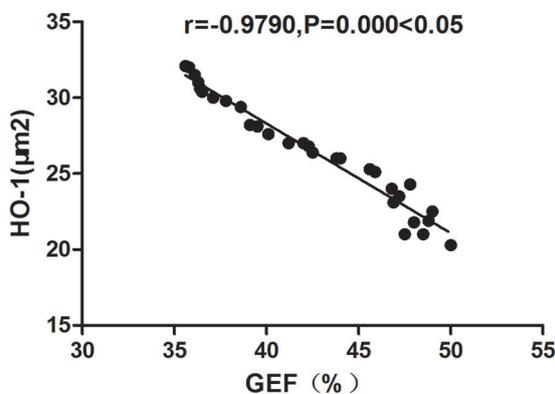


Figure 2. Analysis of the correlation between LVEF measured by three-dimensional echocardiography and HO-1 area.

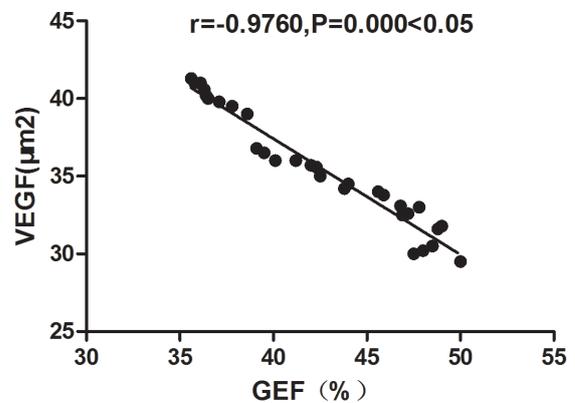


Figure 3. Analysis of the correlation between LVEF measured by three-dimensional echocardiography and VEGF area.

ography was negatively correlated with HIF-1 α , HO-1 and VEGF area¹⁸. The correlation validates that three-dimensional echocardiographic analysis takes into account the multiangular and multiplanar analyses of the left ventricle, thus allowing the structural observation not only from conventional orthogonal planes, but also oblique and intermediate planes of space visualization.

The matrix probe of cardiac three-dimensional echocardiography has a significant high-throughput data processing system, which can be used for three-dimensional spatial positioning. The operation of three-dimensional echocardiography is simpler and the obtained image is more clear¹⁹. Besides, it collects data within a few seconds, and structures of the longitudinal, transverse and rotation position of each cavity and each segment can be observed using it²⁰, thus accessing to the comprehensive three-dimensional anatomy of the heart so as to understand functions of it²¹. The study confirmed that the three-dimensional echocardiography probe used in this group had a certain degree of consistency in detecting the volume of the heart cavity and magnetic resonance, which can effectively show the entire cardiac cycle in the left ventricle overall structure and function²², while the Real-time observation is conducted for the continuous changes in any segment volume, which is of great significance for the evaluation of left ventricular systolic function²³. In addition, the analysis results of the correlation of LVEF measured by three-dimensional echocardiography with HIF-1 α , HO-1 and VEGF area revealed that the former was correlated with the latter, which further confirmed that LVEF measured by three-dimensional echocardiography can be effectively combined with the relevant cytokines or proteins to evaluate the cardiac function and the prognosis of patients after myocardial infarction.

Conclusions

The three-dimensional echocardiography can significantly improve the diagnostic value of patients with myocardial infarction, and its index LVEF is negatively correlated with expressions of serum HIF-1 α , HO-1 and VEGF, which can be used for evaluating patients with cardiac functions and predicting the prognosis.

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Conflict of Interest

The Authors declare that they have no conflict of interest.

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