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Research Article

RIGHT VENTRICULAR DIASTOLIC DYSFUNCTION: MECHANISM OF DEVELOPMENT, DIAGNOSIS AND PROGNOSTIC SIGNIFICANCE

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ABSTRACT

In patients with ischemic heart disease (IHD), the main focus is currently on the pathology of the left ventricle (LV), while the right ventricle (RV) is overlooked. This is logical, since, in IHD, as a result of damage to the left parts of the heart, their remodeling, dilatation and development of heart failure (HF) occur. However, the results of studies in recent years have shown that IHD, ischemia and myocardial infarction (MI) of the pancreas, are one of the main causes of pancreatic dysfunction. Thus, in patients with lower myocardial infarction, pancreatic pathology occurs in 41.1% of cases and is a predictor of mortality in late periods after myocardial infarction, associated with the occurrence of recurrent myocardial infarction and stent thrombosis [1,15]. In general, right ventricular dysfunction is considered to be one of the strongest independent predictors of prognosis after MI, even in the absence of RV MI [2], so it is important to diagnose this pathology as early as possible. In this regard, the assessment of RV diastolic function is considered more informative, which, on the one hand, is a marker of early or latent RV dysfunction [3, 4], and on the other hand, also has independent prognostic value [2,15].

KEYWORDS

Right ventricle, diastolic dysfunction, echocardiography, heart failure.

INTRODUCTION

Evaluation of RV diastolic dysfunction in IHD patients is rare. Usually limited to the study of RV systolic function, however, impaired systolic function may develop in the late stages of RV dysfunction [16]. In a study conducted in a cardiac surgery clinic during the examination of patients with coronary artery disease,

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RV dilatation was found in patients with normal LVEF in 20% of cases, with LVEF within 40-50% - in 38% of cases, and with LVEF less than 40% - in 64% of patients [7].

It should be emphasized that the incidence of RV dilatation is significantly less with less pronounced coronary pathology. In this regard, the advantage of assessing the diastolic function of the RV can be noted. The work devoted to identifying the frequency of diastolic dysfunction of the RV showed that in patients with coronary artery disease, disorders of the RV filling were found in 29% of cases [15]. This is not surprising since there is evidence that RV filling disorders may precede the development of RV systolic dysfunction. However, patient age, decreased LVEF, exertional angina, the presence of diabetes mellitus, and LV diastolic dysfunction (LVDD) should be considered independent factors associated with the presence of RVD [15].

In coronary pathology, in addition to extracardiac causes, the function of the right chambers of the heart can be affected by LV dysfunction with volume and pressure overload in its cavities, remodeling and development of pulmonary hypertension, as well as direct damage to the pancreas (stenosis or occlusion in the bed of the right coronary artery and myocardial infarction of the RV). Indeed, in patients with lower myocardial infarction, RV dysfunction was more often detected with suboptimal results of percutaneous coronary intervention (PCI) on the right coronary artery in the acute period [1]. In addition, there was an improvement in both systolic and diastolic RV function after a planned PCI on the right coronary artery [14].

The mechanism of development. The right ventricle has been considered a passive chamber for many years, but recent research has shown that the RV is more important than previously thought. Acute right ventricular injury, especially when RV myocardial infarction develops, can result in severe impairment of diastolic function with increased filling pressure and marked jugular venous bulging [18-20]. The pathophysiology of diastolic RV dysfunction is much more complex than just measuring myocardial thickness [31-35]. An increasing number of acute and chronic conditions are associated with RV diastolic dysfunction, including pathologies of pressure and volume overload, primary lung diseases, coronary heart disease, congenital heart disease, cardiomyopathies, LV dysfunction (via ventricular interdependence), systemic diseases, and the physiological aging process (table 1). Thus, the concept of "diastolic dysfunction" includes an increase in myocardial stiffness that has arisen against the background of functional and structural restructuring of the interstitium and cardiomyocytes [9,11]. During the contraction phase of the myocardium, Ca++ ions are actively released from the sarcoplasmic reticulum into the cytosol. In contrast, during the relaxation phase of the myocardium, Ca++ ions from the cytosol against the concentration gradient enter the sarcoplasmic reticulum, which seems to be an energy dependent process [10]. In ischemic heart disease (IHD), especially under conditions of myocardial ischemia, the violation of this process is the cause of the earliest diastolic disorders, in contrast to systole, which does not suffer in this period [11,12]. In coronary artery disease, the mechanism of violation of the myocardial relaxation process is based on a violation of active relaxation associated with insufficient coronary blood supply to the myocardium and as a result of the development of cardiosclerosis [9]. Due to the interstitial and muscle components, progression of diastolic dysfunction is accompanied by an increase in myocardial stiffness. As a result, to ensure normal ventricular filling in the diastole phase, the contribution of active atrial contraction increases, which leads to an increase in the load on the atria

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[12,8]. Taking into account the lower compensatory reserves and the small thickness of the atrial myocardium, against the background of a state of relative compensation, a violation of adaptive mechanisms will occur for a certain time. Progression of myocardial relaxation disorders is manifested by an increase in the end systolic and diastolic volumes (ESV and EDV) of the LV, changes in the speed parameters of diastolic filling, which leads to the development of impaired systolic myocardial function [8,9,11].

Table 1.

Conditions associated with right ventricular diastolic dysfunction: (Journal of the American Society of Echocardiography doi:10.1016/j.echo.2010.05.010).

1. Pulmonary embolism	2. Essential hypertension
3. Pulmonary arterial hypertension	4. Aortic stenosis
5. Smoking	6. Aortic regurgitation
7. Chronic obstructive pulmonary disease	8. Mitral regurgitation
9. Cystic fibrosis	10. Myocardial infarction due to left anterior descending coronary artery lesion
11. Acute hypoxia	12. Hypertrophic cardiomyopathy
13. Myocardial infarction or ischemia due to (proximal) right coronary artery lesion	14. Diabetes mellitus
15. Hepatopulmonary syndrome	16. Hypothyroidism
17. Repaired tetralogy of Fallot	18. Amyloidosis
19. Repaired transposition of the great arteries	20. Rheumatoid arthritis
21. Chronic heart failure	22. Systemic sclerosis
23. Cardiac transplantation	24. Antiphospholipid antibody syndrome
25. Arrhythmogenic right ventricular cardiomyopathy	26. Bechet's vasculitis
27. Normal neonates	28. b-thalassemia
29. Chagas disease	30. Renal transplantation
31. Aging	

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Diagnosis. Taking into account the technical difficulties in assessing the state of the right heart, as well as their relatively little study, the search for the optimal set of indicators characterizing the functional state of the RV is still ongoing. Along with the dimensions or parameters of the movement of the structures of the RV [2], researchers also draw attention to the distribution of flows of filling of the RV [5,6]. In order to assess the violation of the diastolic function of the RV, a comprehensive assessment of the indicators of filling the heart is necessary [2, 5, 6]. With the help of an echocardiographic examination of the patient, the diastolic dysfunction of the heart is determined. To this end, it is recommended that the examination be carried out in the apical 4-chamber position [13, 31]. With this projection, it is necessary to direct the Doppler beam parallel to the right ventricular inflow. Proper alignment can be facilitated by moving the probe medially to the inferior parasternal region. A control volume should be located between the tips of the tricuspid valve leaflets [31]. It is important to correctly measure the transtricuspid blood flow velocity with this technique [36]. Care must be taken when measuring the delayed end of exhalation or the average of 5 consecutive cardiocycles should be taken [37]. Some specialists in the presence of severe tricuspid regurgitation or atrial fibrillation do not diagnose diastolic function of the pancreas in such patients, due to the high probability of error in assessing diastolic parameters. Also, by measuring inferior vena cava (IVC) diameter and inspiratory collapse, right atrial pressures should be considered when determining RV diastolic function. The parameters used are basically the same for evaluating RV diastolic dysfunction as for assessing the left side and in a similar way as for LV, diastolic RV dysfunction is measured. The tissue Doppler velocities of the annulus of the tricuspid valve (E', A', E'/A'), Doppler velocities of the transtricuspid flow (E, A and E/A), deceleration time and isovolumic relaxation time (IVRT) have been most confirmed. Tricuspid valve E/E' ratio, diastolic strain rate, RA volume or area in recent studies have been of interest and have shown promise. In addition, a sign of restrictive diastolic filling is the presence of antegrade late diastolic pulmonary arterial blood flow (measured by pulsed Doppler sonography from a point midway through the pulmonary artery bifurcation between and the cusps of the pulmonary valve) [38]. Mostly described after the tetrad of Fallot, this sign occurs when the pulmonic valve opens prematurely in the presence of increased right ventricular end-diastolic pressure [17].

Clinical significance. The clinical impact of diastolic RV dysfunction has been assessed in a small number of studies. Tricuspid valve E/E' ratios and right atrial (RA) volume have been shown to correlate well with hemodynamic parameters. In intensive care unit patients outside cardiac surgery, an E/E' ratio > 4 had high specificity and sensitivity for predicting RA pressure > 10 mmHg. [22], and in patients with heart transplantation, for predicting pressure in the RA> 10 mm Hg, the ratio E / E'> 8 had good sensitivity and specificity [24]. The presence of diastolic RV dysfunction in patients with chronic heart failure and pulmonary hypertension (PH) was independent mortality predictor and was associated with the worst functional class [30, 39]. The pattern of diastolic filling in successful treatment of various heart conditions reflects the response to therapy and improves [40-43]. In the pathogenesis of heart failure, an important role of diastolic dysfunction has been proven in several studies [9,21,23,25]. Isolated diastolic dysfunction is diagnosed in 30–40% of patients with normal myocardial contractility and symptoms of CHF [26-28]. Impaired diastolic function of the heart worsens with the development of systolic dysfunction [21,29].

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Conclusion. Thus, the assessment of filling of the right ventricle in diastole is important for assessing the condition of patients with CHF. RV diastolic dysfunction may be clinically useful because it serves as an early and more easily quantifiable marker for subclinical RV dysfunction. Numerous studies have shown that RV diastolic dysfunction usually precedes overt systolic dysfunction and precedes RV dilatation or RV hypertrophy.

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