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MYOCARDIAL DEFORMATION AND LEFT ATRIAL FUNCTION IN HEART FAILURE WITH PRESERVED EJECTION FRACTION

**Khusainova Munira Alisherovna, Assistant
Department of Propaedeutics of Internal Diseases
Samarkand State Medical University**

Abstract: Heart failure with preserved ejection fraction is characterized by impaired myocardial relaxation despite normal left ventricular systolic function. This study evaluated left ventricular deformation and left atrial function using speckle-tracking echocardiography in patients with chronic heart failure. Eighty patients with heart failure and preserved ejection fraction underwent comprehensive echocardiographic assessment, including global longitudinal strain and diastolic function analysis. Speckle-tracking echocardiography detected early myocardial dysfunction and may improve the diagnosis and risk stratification of patients with preserved ejection fraction.

Keywords: heart failure, preserved ejection fraction, speckle-tracking echocardiography, left ventricle, myocardial strain, diastolic dysfunction, left atrium, cardiac function, echocardiography, myocardial deformation.

ДЕФОРМАЦИЯ МИОКАРДА И ФУНКЦИЯ ЛЕВОГО ПРДСЕРДИЯ ПРИ СЕРДЕЧНОЙ НЕДОСТАТОЧНОСТИ С СОХРАНЕННОЙ ФРАКЦИЕЙ ВЫБРОСА

**Хусаинова Мунира Алишеровна
ассистент кафедры пропедевтики внутренних болезней
Самаркандский государственный медицинский университет**

Аннотация: Сердечная недостаточность с сохраненной фракцией выброса характеризуется нарушением расслабления миокарда при сохраненной систолической функции левого желудочка. Целью исследования была оценка деформации миокарда левого желудочка и функции левого предсердия с использованием speckle-tracking эхокардиографии у пациентов с хронической

сердечной недостаточностью. У 80 пациентов проведено комплексное эхокардиографическое обследование с определением глобальной продольной деформации миокарда и показателей диастолической функции. Speckle-tracking эхокардиография позволяет выявлять ранние нарушения функции миокарда и улучшает диагностику и стратификацию сердечно-сосудистого риска у пациентов с сохраненной фракцией выброса.

Ключевые слова: сердечная недостаточность, сохраненная фракция выброса, speckle-tracking эхокардиография, левый желудочек, деформация миокарда, диастолическая дисфункция, левое предсердие, функция сердца, эхокардиография, миокард.

Introduction: Heart failure with preserved ejection fraction (HFpEF) has become one of the fastest growing forms of chronic heart failure, particularly among elderly patients with arterial hypertension, coronary artery disease, obesity, and diabetes mellitus. Although left ventricular ejection fraction remains within the normal range, affected patients often experience exercise intolerance, dyspnea, fatigue, and reduced functional capacity because of impaired myocardial relaxation and increased ventricular stiffness. Conventional echocardiography provides valuable structural information but may fail to identify subtle abnormalities of myocardial performance during the early stages of the disease. In recent years, speckle-tracking echocardiography has emerged as an advanced imaging technique capable of evaluating myocardial deformation and detecting subclinical ventricular dysfunction before a decline in ejection fraction becomes apparent. Assessment of global longitudinal strain and left atrial function offers additional insight into ventricular mechanics and disease progression. These parameters may improve diagnostic accuracy and assist clinicians in identifying patients at increased risk of adverse cardiovascular events. Early recognition of functional myocardial impairment allows more effective clinical management and may delay disease progression. Therefore, modern echocardiographic techniques play an increasingly important role in the comprehensive evaluation of patients with HFpEF and contribute to more individualized therapeutic decision-making. Despite

considerable progress in cardiovascular imaging, early myocardial dysfunction often remains clinically unrecognized in patients with preserved ejection fraction. Comprehensive assessment of myocardial strain and left atrial remodeling provides valuable information beyond conventional echocardiographic parameters. These advanced imaging markers may facilitate earlier diagnosis, improve prognostic evaluation, and support individualized therapeutic strategies. Therefore, incorporating speckle-tracking echocardiography into routine clinical practice may enhance the overall management of patients with heart failure and preserved ejection fraction.

Aim of the study: To evaluate left ventricular myocardial deformation and left atrial functional status using speckle-tracking echocardiography in patients with chronic heart failure and preserved ejection fraction, and to determine their clinical significance for early detection of myocardial dysfunction.

Materials and methods. A prospective observational study was performed in patients diagnosed with chronic heart failure with preserved ejection fraction according to current clinical recommendations. Eighty patients aged 50–68 years were enrolled, while thirty healthy individuals of comparable age and sex served as the control group. All participants underwent detailed clinical examination, laboratory investigations, electrocardiography, and transthoracic echocardiography. Functional capacity was assessed using the six-minute walk test, and heart failure severity was classified according to the New York Heart Association functional classification. Standard echocardiographic measurements included left ventricular dimensions, left ventricular ejection fraction, stroke volume, left atrial volume, and Doppler assessment of diastolic filling. Myocardial mechanics were analyzed using two-dimensional speckle-tracking echocardiography with specialized software to determine global longitudinal strain, segmental strain, strain rate, and circumferential deformation. Left atrial volume index and indices of diastolic dysfunction were also measured. Statistical analysis was performed using Statistica software. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as

percentages. Correlations between myocardial deformation parameters and left atrial volume were evaluated using Spearman's correlation coefficient. Statistical significance was defined as $p < 0.05$.

Results. Patients with HFpEF demonstrated preserved left ventricular ejection fraction despite significant impairment of myocardial mechanics. Diastolic dysfunction was identified in all examined patients, with abnormal relaxation predominating in individuals with lower functional class and pseudonormal filling patterns occurring in patients with more advanced disease. Left atrial volume index was significantly higher than in healthy controls and increased progressively with worsening diastolic dysfunction. Speckle-tracking echocardiography revealed a marked reduction in global longitudinal strain and strain rate, indicating early impairment of longitudinal myocardial fibers despite preserved systolic function on conventional echocardiography. Segmental analysis showed the greatest abnormalities in the basal anteroseptal and basal anterolateral regions of the left ventricle. Circumferential deformation demonstrated only mild reduction, whereas radial deformation remained largely unchanged. A significant positive correlation was observed between left atrial volume and the degree of impairment in global longitudinal strain, suggesting close interaction between ventricular relaxation and atrial remodeling. These findings confirm that myocardial deformation imaging identifies subclinical ventricular dysfunction that cannot be detected using routine echocardiographic measurements alone. The severity of strain abnormalities increased with deterioration of heart failure functional class, emphasizing the clinical value of speckle-tracking echocardiography for disease assessment and monitoring.

Conclusions: Patients with heart failure and preserved ejection fraction exhibit significant impairment of myocardial deformation despite normal left ventricular ejection fraction. Speckle-tracking echocardiography provides a sensitive method for detecting early ventricular dysfunction, assessing left atrial remodeling, and identifying subtle abnormalities of myocardial mechanics. Measurement of global longitudinal strain may improve diagnostic accuracy, facilitate earlier recognition

of disease progression, and support more effective risk stratification. Incorporating myocardial deformation analysis into routine echocardiographic evaluation may enhance clinical decision-making and optimize long-term management of patients with HFpEF.

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