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STRUCTURAL PATTERNS AND CLINICAL FEATURES OF LEFT VENTRICULAR REMODELING IN HYPERTROPHIC NON-OBSTRUCTIVE CARDIOMYOPATHY

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Abstract: This study assessed the patterns of left ventricular remodeling and their clinical and instrumental associations in patients with hypertrophic non-obstructive cardiomyopathy. The study included 97 patients, comprising 57 men and 40 women, with a mean age of 42.5 ± 14.9 years. Echocardiography showed myocardial hypertrophy localized to the interventricular septum in 59% of patients, involving the apex in 18%, and distributed more extensively in 22%. Concentric left ventricular hypertrophy was the predominant remodeling pattern, identified in 80% of patients, and was associated with disease progression during long-term observation.

Keywords: hypertrophic cardiomyopathy; left ventricular remodeling; concentric hypertrophy; echocardiography; myocardial hypertrophy.

СТРУКТУРНЫЕ ВАРИАНТЫ И КЛИНИЧЕСКИЕ ОСОБЕННОСТИ РЕМОДЕЛИРОВАНИЯ ЛЕВОГО ЖЕЛУДОЧКА ПРИ ГИПЕРТРОФИЧЕСКОЙ НЕОБСТРУКТИВНОЙ КАРДИОМИОПАТИИ

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Аннотация: Целью исследования была оценка вариантов ремоделирования левого желудочка и их клинико-инструментальных взаимосвязей у пациентов с гипертрофической необструктивной кардиомиопатией. В исследование включили 97 пациентов, среди которых было 57 мужчин и 40 женщин, средний возраст составил $42,5 \pm 14,9$ года. По данным эхокардиографии

гипертрофия миокарда локализовалась в области межжелудочковой перегородки у 59% больных, с вовлечением верхушки у 18%, а распространенная гипертрофия выявлена у 22%. Наиболее часто определялась концентрическая гипертрофия левого желудочка, выявленная у 80% пациентов, которая была связана с прогрессированием заболевания при длительном наблюдении.

Ключевые слова: гипертрофическая кардиомиопатия; ремоделирование левого желудочка; концентрическая гипертрофия; эхокардиография; гипертрофия миокарда.

Introduction: Hypertrophic non-obstructive cardiomyopathy is a heterogeneous myocardial disease characterized by increased left ventricular wall thickness without significant resting outflow tract obstruction. Structural remodeling is important because the distribution and geometry of hypertrophy may influence diastolic filling, systolic performance, atrial enlargement, and clinical progression. Although hypertrophic cardiomyopathy is often described as asymmetric septal hypertrophy, septal, apical, and more extensive patterns may occur. Recognition of these variants is clinically important because similar increases in wall thickness can be accompanied by different structural and functional characteristics. Echocardiography provides a principal noninvasive method for evaluating ventricular geometry, myocardial mass, wall thickness, chamber dimensions, and systolic and diastolic function. Relative wall thickness and left ventricular mass index allow classification into concentric hypertrophy, eccentric hypertrophy, concentric remodeling, or normal geometry. However, the relative thickness index may classify some patients with marked asymmetry as having eccentric remodeling when hypertrophy is unevenly distributed. Therefore, ventricular geometry should be assessed using several echocardiographic measurements together with localization of hypertrophy. The source study investigated 97 patients with hypertrophic non-obstructive cardiomyopathy and analyzed relationships between hypertrophy localization, remodeling pattern, and clinical

and instrumental characteristics. Particular attention was given to myocardial asymmetry, left ventricular mass, chamber size, systolic function, diastolic function, and disease progression during long-term observation. This approach may improve structural phenotyping and help identify patients with potentially unfavorable remodeling clinically.

Aim of the study: To evaluate the prevalence of left ventricular remodeling patterns in patients with hypertrophic non-obstructive cardiomyopathy and determine their relationships with myocardial hypertrophy localization, structural and functional echocardiographic characteristics, clinical status, and disease progression.

Materials and methods. The study evaluated 97 patients with hypertrophic non-obstructive cardiomyopathy, including 57 men (59%) and 40 women (41%). Chronic heart failure of functional class I was present in 44 patients (45%), class II in 40 (41%), and class III in 13 (14%). The diagnosis was established after exclusion of other diseases capable of producing myocardial hypertrophy or dysfunction. Inclusion criteria included left ventricular myocardial thickness greater than 1.5 cm during diastole, concentric or asymmetric hypertrophy with increased cardiac mass, and left ventricular diastolic dysfunction. A resting left ventricular outflow tract gradient below 30 mmHg defined the non-obstructive form. Patients with arterial hypertension, ischemic heart disease, or other causes of secondary myocardial hypertrophy were excluded. Electrocardiography and standard transthoracic echocardiography were performed. During standardized echocardiographic examination, assessment included interventricular septal thickness, posterior wall thickness, left ventricular end-diastolic size and volume, myocardial mass and ejection fraction. Relative wall thickness was calculated from septal and posterior wall thickness and left ventricular end-diastolic diameter. Remodeling was classified as normal geometry, concentric hypertrophy, eccentric hypertrophy, or concentric remodeling according to relative wall thickness and indexed myocardial mass. Increased myocardial mass was defined as above 125

g/m² in men and 110 g/m² in women. Diastolic function was assessed using the E/A ratio, isovolumic relaxation time. Statistical analysis was performed using appropriate standard nonparametric tests and correlation analysis, with significance accepted at $p < 0.05$.

Results. Among the 97 patients, myocardial hypertrophy was localized to the interventricular septum in 57 patients (59%), involved the septum and apex in 18 (19%), and was more extensively distributed in 22 (22%). More widespread hypertrophy was associated with male sex ($r = 0.416$, $p < 0.05$), greater diastolic dysfunction ($r = 0.306$, $p < 0.05$), and a higher functional class of chronic heart failure ($r = 0.236$, $p < 0.05$). Using relative wall thickness and myocardial mass index, normal geometry was found in 1 patient (1.0%), concentric hypertrophy in 78 (80%), eccentric hypertrophy in 6 (6.2%), and concentric remodeling in 12 (12%). Disease progression during long-term observation occurred in 45 patients with concentric hypertrophy, 3 with eccentric hypertrophy, and 3 with concentric remodeling. A direct relationship was identified between concentric hypertrophy and progression of hypertrophic non-obstructive cardiomyopathy ($r = 0.487$, $p < 0.05$). The mean asymmetry coefficient for the cohort was 1.66 ± 0.06 , and a value of at least 1.5 was observed in 51 patients (52%). When the relative thickness index was applied, 73 patients (75%) were classified as having concentric hypertrophy, 17 (19%) as eccentric hypertrophy, and 6 (6.2%) as concentric remodeling. In the eccentric group, indexed end-diastolic volume was significantly higher, whereas relative thickness index and relative wall thickness were lower. Asymmetry was greater in this group, suggesting possible overdiagnosis of eccentric remodeling when the relative thickness index is used alone. The findings support combining relative wall thickness, asymmetry, and wall measurements at multiple ventricular levels.

Conclusions: Hypertrophic non-obstructive cardiomyopathy demonstrates substantial heterogeneity in the localization and geometry of left ventricular hypertrophy. Septal hypertrophy was most frequent, while extensive myocardial

involvement was associated with greater myocardial mass, left atrial enlargement, impaired systolic indices, and more pronounced diastolic dysfunction. Concentric hypertrophy was the dominant remodeling pattern and showed a significant relationship with disease progression. The asymmetry coefficient was increased in more than half of patients, confirming important regional differences in wall thickness. Classification based only on the relative thickness index may increase the number of patients labeled with eccentric hypertrophy. Therefore, echocardiographic assessment should combine myocardial mass index, relative wall thickness, asymmetry, and measurements at several ventricular levels.

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