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ARTERIAL STIFFNESS AND HEMODYNAMIC PROFILES IN PATIENTS WITH ARTERIAL HYPERTENSION: A COMPARATIVE STUDY

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Abstract: Arterial stiffness is an important indicator of vascular remodeling and plays a significant role in the progression of arterial hypertension. This study compared systemic arterial stiffness and hemodynamic characteristics in patients with hypertension of different origins. A total of 178 patients and 32 healthy volunteers underwent clinical examination, echocardiography, and assessment of vascular elasticity using integrated hemodynamic parameters. Patients with rheumatoid arthritis demonstrated the highest arterial stiffness, whereas increased peripheral vascular resistance predominated in individuals with hypothyroidism. Evaluation of arterial stiffness may improve cardiovascular risk assessment and support a more individualized therapeutic approach in hypertensive patients.

Keywords: arterial hypertension; arterial stiffness; vascular remodeling; hemodynamics; cardiovascular risk.

АРТЕРИАЛЬНАЯ ЖЕСТКОСТЬ И ГЕМОДИНАМИЧЕСКИЕ ПРОФИЛИ У ПАЦИЕНТОВ С АРТЕРИАЛЬНОЙ ГИПЕРТЕНЗИЕЙ: СРАВНИТЕЛЬНОЕ ИССЛЕДОВАНИЕ

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Аннотация: Артериальная жесткость является важным показателем сосудистого ремоделирования и играет существенную роль в развитии артериальной гипертензии. В исследовании проведено сравнение системной

артериальной жесткости и гемодинамических особенностей у пациентов с различными формами артериальной гипертензии. Обследованы 178 пациентов и 32 здоровых добровольца с использованием клинического обследования, эхокардиографии и оценки интегральных гемодинамических показателей. Наибольшая артериальная жесткость выявлена у пациентов с ревматоидным артритом, тогда как у больных с гипотиреозом преобладало повышение общего периферического сосудистого сопротивления. Оценка артериальной жесткости способствует более точной стратификации сердечно-сосудистого риска и выбору индивидуальной тактики лечения пациентов с артериальной гипертензией.

Ключевые слова: артериальная гипертензия; артериальная жесткость; сосудистое ремоделирование; гемодинамика; сердечно-сосудистый риск.

Introduction: Arterial hypertension remains one of the most prevalent cardiovascular disorders worldwide and is a major contributor to stroke, myocardial infarction, heart failure, and chronic kidney disease. Despite advances in antihypertensive therapy, many patients continue to experience vascular damage that progresses even when blood pressure is partially controlled. One of the earliest manifestations of vascular remodeling is an increase in arterial stiffness, which reflects reduced elasticity of the arterial wall and impaired hemodynamic adaptation. Arterial stiffness has gained considerable attention as an independent predictor of cardiovascular complications because it directly influences pulse wave propagation, left ventricular workload, and tissue perfusion. The mechanisms responsible for increased arterial stiffness vary depending on the underlying disease. Patients with primary hypertension, hypothyroidism, and rheumatoid arthritis may develop different patterns of vascular remodeling as a result of hormonal disturbances, chronic inflammation, endothelial dysfunction, or structural alterations of the arterial wall. Therefore, evaluation of systemic arterial stiffness provides valuable information beyond conventional blood pressure measurement. Modern echocardiography combined with integrated hemodynamic assessment allows a comprehensive evaluation of vascular function and

cardiovascular adaptation. Identification of the predominant hemodynamic mechanism responsible for elevated blood pressure may facilitate more individualized therapeutic strategies and improve cardiovascular risk stratification. A better understanding of arterial stiffness in different clinical conditions may also contribute to earlier prevention of target organ damage and long-term cardiovascular complications.

Aim of the study: To compare systemic arterial stiffness and hemodynamic characteristics in patients with different forms of arterial hypertension and to evaluate the clinical significance of arterial stiffness for cardiovascular risk assessment.

Materials and methods. A comparative observational study included 178 patients with arterial hypertension and 32 healthy volunteers who served as the control group. The hypertensive population consisted of 63 patients with essential hypertension, 82 patients with hypothyroidism accompanied by arterial hypertension, and 33 patients with rheumatoid arthritis associated with arterial hypertension. Clinical examination, medical history, laboratory investigations, electrocardiography, and transthoracic echocardiography were performed in all participants. Blood pressure was measured under standardized conditions after an adequate period of rest. Hemodynamic assessment included calculation of pulse pressure, mean arterial pressure, total peripheral vascular resistance, stroke volume, cardiac output, and the modulus of volume elasticity as an integrated indicator of systemic arterial stiffness. The ratio between arterial stiffness and total peripheral vascular resistance was calculated to identify the predominant mechanism contributing to elevated blood pressure. Patients with severe heart failure, advanced renal or hepatic disease, and other serious comorbid conditions were excluded from the study. Statistical analysis was performed using standard statistical software. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as absolute numbers and percentages. Differences between groups were analyzed using appropriate statistical methods, and a value of $p < 0.05$ was considered statistically significant.

Results. Patients with arterial hypertension demonstrated significantly greater arterial stiffness than healthy participants, indicating pronounced vascular remodeling associated with chronic elevation of blood pressure. Individuals with rheumatoid arthritis and arterial hypertension exhibited the highest values of systemic arterial stiffness, suggesting that persistent inflammatory activity substantially contributes to vascular wall alterations. In contrast, patients with hypothyroidism showed predominantly increased total peripheral vascular resistance, whereas arterial stiffness played a less important role in the maintenance of hypertension. Patients with essential hypertension demonstrated heterogeneous hemodynamic characteristics, with some individuals exhibiting increased arterial stiffness and others showing predominance of peripheral vascular resistance. Pulse pressure and the modulus of volume elasticity were significantly elevated in hypertensive groups compared with healthy controls, confirming impairment of arterial elasticity. Echocardiographic evaluation revealed corresponding changes in cardiac hemodynamics associated with vascular remodeling. Analysis of the arterial stiffness-to-peripheral resistance ratio allowed differentiation of the dominant hemodynamic mechanism responsible for blood pressure elevation in each clinical group. These findings indicate that arterial hypertension represents a heterogeneous condition with distinct pathophysiological mechanisms depending on the underlying disease. Comprehensive assessment of arterial stiffness together with conventional hemodynamic parameters may improve cardiovascular risk stratification and support a more individualized approach to antihypertensive treatment.

Conclusions: Systemic arterial stiffness differs significantly among patients with various forms of arterial hypertension and reflects disease-specific mechanisms of vascular remodeling. Increased arterial stiffness predominates in patients with rheumatoid arthritis, whereas elevated peripheral vascular resistance is more characteristic of hypertension associated with hypothyroidism. Integrated hemodynamic assessment provides valuable information that cannot be obtained from routine blood pressure measurement alone. Evaluation of arterial stiffness

may improve cardiovascular risk assessment, facilitate individualized therapeutic decision-making, and contribute to more effective prevention of cardiovascular complications in patients with arterial hypertension.

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