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**ASSOCIATION OF ARTERIAL HYPERTENSION WITH
ELECTROPHYSIOLOGICAL MYOCARDIAL REMODELING IN
RHEUMATOID ARTHRITIS**

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Abstract: Rheumatoid arthritis is associated with an increased risk of cardiovascular complications, particularly in patients with concomitant arterial hypertension. This study aimed to compare the electrophysiological remodeling of the myocardium in patients with rheumatoid arthritis with and without arterial hypertension using vectorcardiography. A total of 124 patients underwent comprehensive clinical evaluation, electrocardiography, echocardiography, and vectorcardiographic assessment of P, QRS, and T loop areas together with maximal vector parameters. Patients with arterial hypertension demonstrated a significantly larger QRS loop area despite the absence of echocardiographic evidence of left ventricular hypertrophy, indicating early electrophysiological remodeling ($p < 0.05$). Early identification of electrophysiological myocardial changes may improve cardiovascular risk assessment and facilitate timely preventive interventions in patients with rheumatoid arthritis.

Keywords: rheumatoid arthritis, arterial hypertension, electrophysiological remodeling, myocardium, vectorcardiography, cardiovascular risk, left ventricle, QRS loop, echocardiography, inflammation.

**СВЯЗЬ АРТЕРИАЛЬНОЙ ГИПЕРТЕНЗИИ С
ЭЛЕКТРОФИЗИОЛОГИЧЕСКИМ РЕМОДЕЛИРОВАНИЕМ
МИОКАРДА ПРИ РЕВМАТОИДНОМ АРТРИТЕ**

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Аннотация: Ревматоидный артрит сопровождается повышенным риском сердечно-сосудистых осложнений, особенно у пациентов с сопутствующей артериальной гипертензией. Целью исследования явилось сравнительное изучение электрофизиологического ремоделирования миокарда у пациентов с ревматоидным артритом при наличии и отсутствии артериальной гипертензии с использованием векторкардиографии. В исследование были включены 124 пациента, которым проведены комплексное клиническое обследование, электрокардиография, эхокардиография и векторкардиография с оценкой площадей петель P, QRS, T и параметров максимального вектора. У пациентов с артериальной гипертензией выявлено достоверное увеличение площади петли QRS при отсутствии эхокардиографических признаков гипертрофии левого желудочка, что свидетельствует о раннем электрофизиологическом ремоделировании миокарда ($p < 0,05$). Ранняя диагностика электрофизиологических изменений миокарда может способствовать более точной оценке сердечно-сосудистого риска и своевременному проведению профилактических мероприятий у пациентов с ревматоидным артритом.

Ключевые слова: ревматоидный артрит, артериальная гипертензия, электрофизиологическое ремоделирование, миокард, векторкардиография, сердечно-сосудистый риск, левый желудочек, петля QRS, эхокардиография, воспаление.

Introduction: Rheumatoid arthritis (RA) is a chronic autoimmune inflammatory disease characterized by progressive joint destruction and systemic manifestations. In addition to musculoskeletal involvement, RA is associated with a markedly increased risk of cardiovascular complications, which remain one of the leading causes of premature mortality. Arterial hypertension is one of the most common comorbidities in patients with RA and contributes significantly to myocardial remodeling and cardiovascular dysfunction. Structural cardiac abnormalities often develop gradually and may remain undetected during the early stages of disease.

Electrophysiological remodeling of the myocardium precedes structural and geometric alterations, reflecting early disturbances in myocardial electrical activity before morphological changes become evident. Vectorcardiography is a noninvasive diagnostic technique that provides detailed spatial assessment of cardiac electrical activity and enables early detection of electrophysiological abnormalities. Analysis of P, QRS, and T loops, together with maximal vector characteristics, offers valuable information regarding myocardial function and ventricular remodeling. Early identification of electrophysiological changes may improve cardiovascular risk stratification and allow timely preventive interventions in patients with rheumatoid arthritis. Therefore, evaluating myocardial electrophysiological remodeling in patients with rheumatoid arthritis, particularly in the presence of arterial hypertension, is important for understanding early cardiovascular involvement and optimizing clinical management.

Aim of the study: To compare the electrophysiological remodeling of the myocardium in patients with rheumatoid arthritis with and without arterial hypertension using vectorcardiographic assessment and to evaluate its significance for early cardiovascular risk detection.

Materials and methods. A prospective comparative study included 124 patients with rheumatoid arthritis in advanced stages of the disease. The mean age of the participants was 53.1 ± 1.15 years. Patients were divided into two groups: 77 patients with rheumatoid arthritis without arterial hypertension and 47 patients with rheumatoid arthritis combined with stage 1–2 arterial hypertension. The study groups were comparable regarding age, sex, and disease stage. Individuals with severe concomitant diseases were excluded from the investigation. Standard clinical examination included medical history, physical assessment, electrocardiography, and two-dimensional echocardiography, which revealed no significant structural myocardial abnormalities in either group. All participants additionally underwent vectorcardiography to assess electrophysiological myocardial remodeling. The examination included measurement of the P-loop,

QRS-loop, and T-loop areas, as well as determination of the maximum vector, maximum vector azimuth, and maximum vector elevation. Statistical analysis was performed using STATISTICA 10.0 software. Quantitative variables were compared using the Mann–Whitney U test because of nonparametric data distribution. Continuous variables were expressed as mean, minimum, and maximum values. Differences between groups were considered statistically significant at $p < 0.05$.

Results. Vectorcardiographic analysis demonstrated significant differences between patients with rheumatoid arthritis alone and those with concomitant arterial hypertension. The mean P-loop and T-loop areas, maximum vector magnitude, azimuth, and elevation showed no statistically significant differences between the study groups. However, the QRS-loop area was significantly greater in patients with rheumatoid arthritis and arterial hypertension than in those without hypertension ($p < 0.05$). Patients with rheumatoid arthritis without hypertension had a mean QRS-loop area of 870.8 mV, whereas those with arterial hypertension demonstrated a value of 1169.4 mV. Despite these electrophysiological differences, conventional electrocardiography and echocardiography revealed no evidence of left ventricular hypertrophy or other significant structural myocardial abnormalities. These findings indicate that electrophysiological remodeling of the left ventricle develops before detectable structural remodeling occurs. The results suggest that arterial hypertension accelerates myocardial electrical remodeling in patients with rheumatoid arthritis and may contribute to future cardiovascular complications. Vectorcardiography therefore represents a sensitive method for identifying early myocardial alterations that cannot be detected using conventional diagnostic techniques. Early recognition of electrophysiological remodeling may facilitate more accurate cardiovascular risk assessment and improve preventive management in patients with rheumatoid arthritis and arterial hypertension.

Conclusions: Patients with rheumatoid arthritis and concomitant arterial hypertension demonstrate earlier and more pronounced electrophysiological

myocardial remodeling than patients without hypertension. Vectorcardiography detects abnormalities before structural myocardial changes become apparent on conventional echocardiography, making it a valuable method for early cardiovascular assessment. Identification of increased QRS-loop area may serve as an early marker of left ventricular remodeling and future cardiovascular risk. Incorporating vectorcardiographic evaluation into routine clinical assessment may improve early diagnosis, risk stratification, and timely prevention of cardiovascular complications in patients with rheumatoid arthritis.

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