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DIAGNOSTIC ALGORITHM FOR VERIFICATION AND RISK STRATIFICATION OF PATIENTS WITH MICROVASCULAR ANGINA BASED ON IMMUNOLOGICAL AND BIOCHEMICAL INDICATORS

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Introduction. The development of a diagnostic algorithm based on immunological and biochemical markers helps improve the accuracy of microvascular angina diagnosis, reducing diagnostic errors and ineffective invasive interventions. Early risk stratification enables a personalized approach to diagnosis and treatment, optimizes the use of medical resources, and improves the prognosis for patients with this condition. Developing such an algorithm is an important task in modern cardiology.

Purpose of the study. To develop a diagnostic algorithm for verifying patients with microvascular angina and to carry out their risk stratification based on a set of immunological and biochemical indicators.

Materials and methods. A receiver operating characteristic (ROC) analysis was performed to evaluate the diagnostic value of immunological markers (IL-6, TNF-α, sVCAM-1, sICAM-1, endothelin-1, and hsCRP) and circulating endothelial microparticles for the verification of microvascular angina. Prognostic models and risk stratification algorithms were constructed using parametric and nonparametric comparison methods, correlation and regression analysis, and logistic regression. Optimal marker thresholds for maximum sensitivity and specificity were determined. The algorithm was validated on an independent patient sample.

Research results. ROC analysis revealed high diagnostic value of the complex of immunological markers for verification of microvascular angina. Endothelin-1 demonstrated the highest area under the curve (AUC) of 0.92 (95% CI: 0.87–0.96), with an optimal threshold of 3.1 fmol/ml (sensitivity 88%, specificity 86%). IL-6 showed an AUC of 0.89 (95% CI: 0.84–0.94) at a threshold of 12.4 pg/ml (sensitivity 84%, specificity 82%). TNF-α was characterized by an AUC of 0.87 (95% CI: 0.81–0.92) at a threshold of 24.2 pg/ml (sensitivity 82%, specificity 80%). The combined use of endothelin-1 and IL-6 increased the diagnostic accuracy to AUC 0.95 (95% CI: 0.91–0.98) with a sensitivity of 92% and a specificity of 90%. Adhesion molecules also demonstrated high diagnostic value: sVCAM-1 — AUC 0.85 (threshold 712 ng/ml), sICAM-1 — AUC 0.83 (threshold 324 ng/ml). The hsCRP level showed AUC 0.78 (threshold 3.8 mg/l). The concentration of circulating endothelial microparticles was characterized by AUC 0.86 (threshold 856 μh/μl). Based on the data obtained, a multi-stage diagnostic algorithm was developed: Stage I — screening by the hsCRP level (>3.8 mg/l); Stage II — determination of IL-6 (>12.4 pg/ml) and TNF-α (>24.2 pg/ml); Stage III — verification by endothelin-1 (>3.1 fmol/ml) and adhesion molecules (sVCAM-1 >712 ng/ml, sICAM-1 >324 ng/ml). For risk stratification, a prognostic model was developed, including 5 risk levels: low (total score 0–4), moderate (5–8), elevated (9–12), high (13–16), and very high (≥17). Validation of the algorithm

on an independent sample confirmed its high diagnostic efficiency: sensitivity 90%, specificity 88%, positive predictive value 89%, negative predictive value 91%. The use of the algorithm in clinical practice has reduced the number of ineffective coronary angiographies by 34% and accelerated the verification of the diagnosis of MCC by an average of 5.2 days.

Conclusion. The developed diagnostic algorithm, based on a combination of immunological and biochemical parameters, ensures highly accurate verification of microvascular angina, enables early risk stratification, and personalized approaches to diagnosis and treatment. The algorithm can be recommended for implementation in clinical diagnostic centers and outpatient practices.

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