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**PROGNOSTIC VALUE OF ELECTROCARDIOGRAPHIC MARKERS OF
METABOLIC CARDIOMYOPATHY AFTER CORONARY
REVASCULARIZATION IN MEN WITH CORONARY
ATHEROSCLEROSIS**

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Abstract: This study evaluated electrocardiographic markers of metabolic cardiomyopathy and their prognostic significance in men with coronary atherosclerosis undergoing coronary artery bypass grafting. The analysis included 77 men aged 42–77 years with angiographically verified coronary atherosclerosis and stable angina. Before surgery, ECG markers included arrhythmias, left ventricular hypertrophy, TV1>TV6 syndrome, T-wave abnormalities, ST-segment elevation, ST depression, and prolonged QT. During 5-year follow-up, 7 patients died, 4 experienced nonfatal myocardial infarction, and 11 underwent repeat revascularization procedures. TV1>TV6 and ST-segment elevation were significantly associated with adverse long-term outcomes and increased mortality risk.

Keywords: metabolic cardiomyopathy; electrocardiographic markers; coronary atherosclerosis; coronary artery bypass grafting; long-term prognosis.

**ПРОГНОСТИЧЕСКОЕ ЗНАЧЕНИЕ
ЭЛЕКТРОКАРДИОГРАФИЧЕСКИХ МАРКЕРОВ
МЕТАБОЛИЧЕСКОЙ КАРДИОМИОПАТИИ ПОСЛЕ КОРОНАРНОЙ
РЕВАСКУЛЯРИЗАЦИИ У МУЖЧИН С КОРОНАРНЫМ
АТЕРОСКЛЕРОЗОМ**

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Аннотация: В исследовании оценены электрокардиографические маркеры метаболической кардиомиопатии и их прогностическое значение у мужчин с коронарным атеросклерозом после операции коронарного шунтирования. В исследование включили 77 мужчин в возрасте 42–77 лет со стенозирующим коронарным атеросклерозом и стабильной стенокардией. До операции анализировали аритмии, гипертрофию левого желудочка, синдром $TV1>TV6$, изменения зубца Т, повышение и депрессию сегмента ST, а также удлинение интервала QT. За 5 лет умерли 7 пациентов, у 4 развился нефатальный инфаркт миокарда, а 11 потребовали повторной операции. Синдром $TV1>TV6$ и повышение ST были связаны с неблагоприятным послеоперационным прогнозом и повышенным риском смерти.

Ключевые слова: метаболическая кардиомиопатия; электрокардиографические маркеры; коронарный атеросклероз; коронарное шунтирование; отдалённый прогноз.

Introduction: Coronary atherosclerosis remains a major cause of cardiovascular morbidity and mortality, while metabolic abnormalities may additionally influence myocardial structure, electrical activity, and long-term outcomes. Metabolic cardiomyopathy represents myocardial injury associated with disturbed energy metabolism and biochemical processes within cardiomyocytes. In patients with significant coronary atherosclerosis, metabolic myocardial changes may coexist with ischemic disease and complicate the clinical course even after surgical revascularization. Electrocardiography provides a simple method for identifying functional abnormalities that may reflect myocardial metabolic impairment. Changes in ventricular repolarization, including alterations of the ST segment and T wave, prolongation of the QT interval, left ventricular hypertrophy, and rhythm disturbances, can provide clinically relevant information before overt heart failure develops. The $TV1>TV6$ pattern has also been described as an electrocardiographic manifestation associated with metabolic myocardial injury. Their prognostic significance is important after coronary artery bypass grafting because outcomes may depend not only on restoration of coronary blood flow but

also on myocardial condition. Long-term assessment allows identification of patients who remain at increased risk of death, recurrent myocardial infarction, or repeat intervention. Therefore, evaluation of preoperative ECG markers may improve risk stratification and provide information for follow-up after myocardial revascularization. The present analysis focuses on selected ECG indicators of metabolic cardiomyopathy and their relationship with five-year outcomes in men with angiographically verified coronary atherosclerosis undergoing coronary artery bypass grafting.

Aim of the study: To determine the prognostic significance of selected electrocardiographic markers of metabolic cardiomyopathy for five-year outcomes after coronary artery bypass grafting in men with coronary atherosclerosis.

Materials and methods. The study included 77 men aged 42–77 years with coronary atherosclerosis verified by selective coronary angiography, ischemic heart disease without acute coronary syndrome, and stable exertional angina of functional class II–IV. All participants were admitted for coronary artery bypass grafting and consented. Patients with myocardial infarction occurring less than 6 months before enrollment, acute inflammatory disease, exacerbation of chronic inflammatory conditions, active liver disease, renal insufficiency, or malignant disease were excluded. Before surgery, each participant underwent resting electrocardiography in 12 standard leads with subsequent coding according to the Minnesota system. The analyzed electrocardiographic markers included QT interval duration, corrected QT interval, ST-segment elevation greater than 5 mm, nonischemic ST-segment depression greater than 5 mm, T-wave flattening or reduced amplitude, T-wave inversion, the TV1>TV6 pattern, left ventricular hypertrophy, and rhythm or conduction disturbances. All patients subsequently underwent surgical myocardial revascularization by coronary artery bypass grafting. Outcomes were assessed during five years. Endpoints included survival, myocardial infarction, worsening of angina functional class, and repeat intervention. Progression of coronary atherosclerosis was also evaluated using repeat coronary angiography. Statistical processing was performed using SPSS for

Windows. Pearson and Spearman correlation coefficients, linear regression, and analysis of variance were applied according to variable type. Statistical significance was defined as $p < 0.05$ throughout the analysis. Long-term follow-up characterized delayed postoperative events.

Results. Before coronary artery bypass grafting, electrocardiographic manifestations of metabolic cardiomyopathy were detected. Arrhythmias were recorded in 38 of 77 patients (49.4%), left ventricular hypertrophy in 55 (71.4%), the $TV1 > TV6$ pattern in 24 (31.2%), T-wave abnormalities in 58 (75.3%), ST-segment elevation in 44 (57.1%), ST-segment depression in 23 (29.9%), and QT interval prolongation in 5 patients (6.5%). During follow-up, 7 patients died from fatal myocardial infarction, resulting in a five-year survival rate of 90.9%. Nonfatal myocardial infarction occurred in 4 patients, while repeat surgery because of worsening angina functional class was required in 11 patients. Overall, 22 patients were classified as having a complicated postoperative course, including the 7 deaths, 4 nonfatal myocardial infarctions, and 11 repeat operations. ECG analysis demonstrated associations for $TV1 > TV6$ and ST-segment elevation. $TV1 > TV6$ was significantly associated with mortality during follow-up. Patients with this ECG pattern had a 5.5-fold higher relative risk of death during the five-year period after coronary artery bypass grafting compared with patients without the pattern ($p < 0.01$). The marker was associated with a 2.9-fold higher risk of an unfavorable outcome, defined as death, myocardial infarction, or repeat operation. ST-segment elevation before surgery was also positively associated with fatal outcome and overall unfavorable prognosis. ST-segment elevation was associated with a 4.8-fold higher risk of an unfavorable course. Associations for left ventricular hypertrophy, T-wave abnormalities, ST depression, QT prolongation, and rhythm disturbances were not statistically significant. Selected ECG abnormalities may therefore provide prognostic information after surgical revascularization. Associations were strongest for these two specific ECG markers.

Conclusions: Preoperative electrocardiographic markers of metabolic cardiomyopathy were common among men with coronary atherosclerosis

undergoing coronary artery bypass grafting. During five-year follow-up, TV1>TV6 and ST-segment elevation demonstrated the strongest prognostic associations. TV1>TV6 was associated with a 5.5-fold higher risk of death and a 2.9-fold higher risk of an overall unfavorable outcome, while ST-segment elevation was associated with a 4.8-fold higher risk of an unfavorable long-term course. Selected ECG markers may help identify patients requiring closer cardiovascular surveillance after revascularization. Their assessment may complement clinical evaluation and support postoperative observation. Further prospective studies with larger populations are needed to confirm these relationships in practice.

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