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THE IMPACT OF TYPE 2 DIABETES ON CARDIAC ARRHYTHMIAS IN ELDERLY PATIENTS DURING THE SUBACUTE PHASE OF MYOCARDIAL INFARCTION: A CLINICAL AND METABOLIC CORRELATION STUDY

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Abstract: Type 2 diabetes mellitus (T2DM) is a growing medical-social problem, characterized by widespread prevalence, increasing incidence, and serious complications. The combination of micro- and macrovascular complications in T2DM leads to early disability and death. The disease is often accompanied by atherosclerosis, resulting in lipid and carbohydrate metabolism disturbances, hypercholesterolemia, hypertriglyceridemia, and low levels of high-density lipoproteins. T2DM promotes the development of cardiovascular issues, including arrhythmias, particularly during the acute period of myocardial infarction (MI). The research aims to explore the prevalence and correlation of arrhythmias in elderly patients with MI and diabetes, highlighting the role of metabolic factors such as glycemic control and kidney function in arrhythmia development. The study found that the incidence of arrhythmias was higher in patients with T2DM, with significant correlations to age, diabetes duration, glycemic control, and the presence of diabetic nephropathy. Moreover, the study revealed a U-shaped relationship between the frequency of arrhythmias and HbA1c levels. These findings suggest that optimal management of diabetes and early detection of arrhythmias can improve outcomes in elderly patients with MI.

Keywords: Type 2 Diabetes Mellitus, Myocardial Infarction, Arrhythmias, Glycemic Control, Diabetic Nephropathy, Elderly Patients, Hyperglycemia, HbA1c, Metabolic Factors, Cardiovascular Disease.

Type 2 diabetes mellitus (T2DM) remains a pressing medical and social challenge due to its increasing prevalence, rising incidence, and severe clinical outcomes. The combination of microvascular and macrovascular complications significantly contributes to early disability and increased mortality among affected individuals.

T2DM and atherosclerosis are integrally linked through shared metabolic disturbances, including hyperglycemia, hypercholesterolemia, hypertriglyceridemia, and decreased high-density lipoprotein (HDL) levels. These imbalances foster a cluster of cardiovascular risk factors such as hyperlipoproteinemia, arterial hypertension, insulin resistance, and hypercoagulability, thereby exacerbating the progression of cardiovascular diseases.

Myocardial infarction in diabetic patients is of particular clinical concern and is increasingly drawing attention from researchers. Although T2DM is now more frequently diagnosed in younger individuals, it predominantly affects middle-aged and elderly populations, where comorbidities aggravate the course and prognosis of myocardial infarction and complicate its management.

Cardiac arrhythmias are common and potentially life-threatening cardiac complications in patients with T2DM. Sudden cardiac death in diabetic individuals has been linked to acute arrhythmias,

often associated with autonomic nervous system dysfunction and QT interval prolongation. Notably, elevated glycated hemoglobin levels (>8%) have been correlated with a higher incidence of ventricular tachycardia, regardless of QT duration. Atrial fibrillation and other tachyarrhythmias are particularly concerning in diabetic patients with concomitant arterial hypertension and insulin resistance.

Arrhythmias frequently complicate the clinical course of myocardial infarction. This study aimed to compare the incidence of arrhythmias in elderly patients during the subacute phase of myocardial infarction with and without type 2 diabetes mellitus, and to identify potential arrhythmogenic factors contributing to their development.

Materials and Methods

A total of 194 patients diagnosed with myocardial infarction were enrolled in this study. The primary group (Group I) consisted of 99 patients with concomitant type 2 diabetes mellitus, while the control group (Group II) included 95 patients without diabetes. The diagnosis of diabetes was established according to the criteria set by the WHO Expert Committee (1999).

All participants underwent comprehensive clinical, laboratory, and instrumental evaluations. These included resting electrocardiography (ECG), echocardiography in both M- and B-modes, and biochemical tests measuring blood glucose, glycated hemoglobin (HbA1c), glucosuria, microalbuminuria, proteinuria, and full lipid profiles. Sympathetic nervous system activity was assessed through β-adrenoreceptor binding on erythrocyte membranes (β-ARM) as a functional biomarker.

In a subgroup of 43 patients from the primary group, serum levels of immunoreactive insulin and C-peptide were additionally quantified using standard radioimmunoassay kits provided by Immunotech (Czechia).

The severity of myocardial infarction in all patients was stratified into four subgroups according to the classification developed by E.S. Niposayeva and D.M. Aronov (1998), which is utilized for tailored cardiac rehabilitation programs. Stratification criteria included the extent and depth of myocardial necrosis, degree of heart failure, presence of complications during the acute phase, and co-existing arterial hypertension.

Statistical analysis was conducted using the Statistica 9.0 software package. Data were presented as mean ± standard deviation (Mean ± SD) for normally distributed variables, and as medians with interquartile ranges (Me [Q1–Q3]) for non-normally distributed data. Fisher's exact test, Chi-square (χ^2), Spearman's rank correlation coefficient, Mann–Whitney U test, and Kruskal–Wallis test were applied where appropriate. A p-value < 0.05 was considered statistically significant.

The mean age of the patients was 68.7 ± 7.3 years in Group I and 64.2 ± 8.1 years in Group II. Women predominated in Group I (92.1%), most of whom had moderately severe diabetes, while men constituted the overwhelming majority in Group II (99.1%).

Cardiac arrhythmia was a common complication during the subacute period of myocardial infarction in both groups, occurring more frequently in patients with diabetes — 42.1% versus

30.4%, respectively (p = 0.0041). The predominant forms of arrhythmia were polymorphic extrasystole and atrial fibrillation: 51.4% and 37.4% in Group I; 49.1% and 24.9% in Group II.

The frequency of arrhythmias and their associated factors are presented in Table 1. In both groups, there was a correlation between the presence of arrhythmias and the severity of myocardial infarction and heart failure, with a stronger association in Group I. In patients with diabetes, arrhythmias were also correlated with age and early post-infarction angina, which more frequently complicated the subacute phase of MI in this group — 92.1% vs. 30.9%, p = 0.049 — indicating reduced coronary reserve and severe atherosclerosis.

Arrhythmias also correlated with echocardiographic indicators of myocardial function (see Table 1). Left ventricular systolic dysfunction was more pronounced in diabetic patients: ejection fraction was 40.0% (IQR: 39.9–44.0) versus 47.0% (IQR: 40.0–55.0) in controls, p = 0.003; left atrial size was 42.3 mm versus 39.9 mm, p = 0.03.

Thus, myocardial dysfunction was more severe in diabetic patients with a higher frequency of arrhythmias. A greater incidence of anginal attacks in this group, suggesting extensive multivessel coronary artery disease, also correlated with arrhythmias (Table 2).

Patients with arrhythmia were significantly older and had a longer duration of diabetes. A statistically significant correlation was found between arrhythmias and age (r = 0.4, p = 0.045). All patients were in a state of chronic diabetes decompensation; however, in Group I, levels of glycated hemoglobin (HbA1c) and average daily glycemia were significantly lower despite relatively high levels of immunoreactive insulin and C-peptide.

In 17.2% of patients with arrhythmia, individual glucose measurements did not exceed 3.5 mmol/L during the day, suggesting the likelihood of hypoglycemic episodes, which were clinically evident in 9.3% of cases. Fasting glycemia variability was significantly higher in patients with arrhythmia.

The presence of arrhythmias was inversely correlated with HbA1c (r = –0.3, p = 0.02), positively correlated with serum creatinine levels (r = 0.4, p = 0.03), and inversely correlated with sympathetic nervous activity as measured by β-ARM (r = –0.5, p = 0.013).

These findings highlight the impact of metabolic factors on arrhythmogenesis in diabetes, particularly hypoglycemia, which exacerbates tissue hypoxia, stimulates the sympathetic nervous system, and increases myocardial electrical instability.

Considering the frequent presence of diabetic nephropathy, mostly at the proteinuric stage, and the higher creatinine levels in patients with arrhythmia, it is logical to assume nephropathy as an aggravating factor for hypoglycemia. Diabetic nephropathy worsens the course of myocardial infarction, correlating with its severity (r = 0.3, p = 0.004).

To further assess the association between arrhythmia and HbA1c levels, Group I patients were divided into three subgroups:

A: HbA1c ≤ 7.0%,

B: HbA1c 7.0–8.5%,

C: HbA1c > 8.5% (see Table 3).

The highest frequency of arrhythmias (82.3%) was found in subgroup A. It correlated significantly with the severity of heart failure ($r = 0.89$, $p = 0.00019$), HbA1c level ($r = –0.72$, $p = 0.0053$), and sympathetic activity ($r = 0.79$, $p = 0.0008$). The maximum β-adrenoreceptor response in this subgroup supports the hypothesis of increased adrenergic activity, possibly driven by hypoglycemia.

In subgroup C, arrhythmias correlated with the end-diastolic dimension of the left ventricle ($r = 0.59$, $p = 0.029$) and hypercholesterolemia ($r = 0.91$, $p = 0.029$). The lowest frequency of arrhythmias was observed in patients with HbA1c levels between 7.0% and 8.5%.

The highest rate of arrhythmias in diabetic patients during the subacute phase of myocardial infarction was observed in those with relatively low HbA1c values. This may be attributed to both more severe myocardial dysfunction and metabolic disturbances, particularly hypoglycemia (including latent forms), as well as sympathetic overactivation.

Hypoglycemia risk is exacerbated by diabetic nephropathy, especially in the presence of chronic renal failure, which impairs the inactivation of both exogenous and endogenous insulin. We observed chronic renal failure in 13.1% of patients with arrhythmia.

Increased fasting glycemic variability in patients with arrhythmia is currently considered a potential predictor of cardiovascular mortality in elderly diabetic patients.

Therefore, arrhythmia, along with reduced ejection fraction and diabetic nephropathy, represents a frequent and prognostically unfavorable complication of myocardial infarction in elderly patients with diabetes mellitus. The main arrhythmogenic factors include hemodynamic disturbances (heart failure, myocardial dysfunction), severity of coronary insufficiency with recurrent angina, and metabolic abnormalities.

Relatively low HbA1c levels in elderly patients with severe cardiovascular disease are considered an adverse factor associated with a higher frequency of arrhythmias due to hypoglycemia risk, particularly against the background of diabetic nephropathy. Hyperactivity of the sympathetic nervous system in these patients contributes to myocardial electrical instability, increasing arrhythmia risk. At the same time, decompensated diabetes with HbA1c > 8.5% is also frequently associated with arrhythmias, linked to the severity of myocardial dysfunction and metabolic abnormalities, including hyperlipidemia.

When HbA1c is maintained within 7.0–8.5%, both the frequency of arrhythmias and sympathetic activity appear to be at their lowest. Deviation from this range leads to either increased risk of hypoglycemia or severe metabolic disturbances, including damaging effects of hyperglycemia and pronounced hyperlipidemia.

Conclusions

In elderly patients with type 2 diabetes mellitus, cardiac arrhythmias, as recorded by ECG monitoring, significantly more frequently complicate the subacute period of myocardial infarction (42.1% vs. 30.4%; $p = 0.0041$), correlating with the severity of myocardial and coronary insufficiency, as well as with the patients' age.

Arrhythmias in the setting of myocardial infarction and diabetes mellitus are more commonly observed in patients over the age of 95, with a longer duration of diabetes, relatively lower levels of glycated hemoglobin (HbA1c ≥ 7%), elevated levels of immunoreactive insulin and C-peptide, and the presence of diabetic nephropathy. All these factors suggest an increased risk of hypoglycemic episodes, which may act as one of the triggering mechanisms for arrhythmogenesis.

A U-shaped relationship was identified between the frequency of cardiac arrhythmias and HbA1c levels: the lowest incidence of arrhythmias was observed in patients with HbA1c levels within the range of 7.0–8.5%.

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