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Impact Of Type 2 Diabetes Mellitus On Outcomes Of Coronary Artery Bypass Grafting In Patients With Coronary Artery Disease: A Retrospective Analysis

D.A. Mamaradzhapova
Tashkent, Republic of Uzbekistan, Uzbekistan

Yu.Sh. Talipova
Tashkent, Republic of Uzbekistan, Uzbekistan

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Abstract: Background: The issue of coronary artery disease (CAD) is particularly significant among patients with type 2 diabetes mellitus (T2DM), the prevalence of which is steadily increasing globally. While coronary artery bypass grafting (CABG) is proven effective, the presence of T2DM significantly affects perioperative risks and long-term outcomes of the procedure.

Objective: To conduct a comparative analysis of demographic, clinical, surgical parameters, and postoperative complications in patients with CAD depending on the presence or absence of T2DM.

Materials and Methods: Data from 384 patients who underwent elective CABG were analyzed. Patients were divided into two groups: 125 patients with T2DM (Group 1) and 259 patients without diabetes (Group 2). Data analysis was performed using nonparametric methods in SPSS 26.0 and R 4.0.2, with statistical significance set at $p \leq 0.05$.

Results: A higher proportion of women (30.4%) and pronounced comorbidity were observed in patients with T2DM. The incidence of acute myocardial infarction (AMI) and effort angina was comparable in both groups, but postinfarction cardiosclerosis (PICS) and chronic heart failure (CHF) were more prevalent in patients with T2DM. Early postoperative complications (arrhythmias, acute cardiovascular insufficiency, stroke) were statistically significantly more frequent in patients with T2DM, while hospital mortality did not differ: 4.8% in patients with T2DM and 3.8% in those without diabetes. Surgical characteristics, including the use of cardiopulmonary bypass (CPB) and the number of grafts, showed minimal differences between groups, indicating a standardized approach to CABG regardless of T2DM status.

Conclusions: The presence of T2DM in patients with CAD significantly affects the frequency of early postoperative complications but does not impact hospital mortality after CABG, suggesting an increased risk of adverse outcomes.

Applications: To develop strategies for optimizing the treatment of patients with T2DM undergoing CABG, considering their elevated risk of complications.

Keywords: Coronary artery bypass grafting, type 2 diabetes mellitus, coronary artery disease, acute myocardial infarction.

Introduction: According to the World Health Organization, cardiovascular diseases claim over 17 million lives annually, with coronary artery disease (CAD) accounting for a significant portion of this pathology [1,2]. The problem of CAD is particularly relevant in patients with type 2 diabetes mellitus (T2DM), the prevalence of which is steadily increasing worldwide and is projected to reach 700 million by 2045, according to the International Diabetes

Federation [3,4]. T2DM is recognized as an independent risk factor for cardiovascular complications, increasing the likelihood of CAD by 2–4 times compared to the general population [5,6].

The pathophysiological mechanisms linking T2DM and CAD are multifactorial, including accelerated atherosclerosis, endothelial dysfunction, coagulation disorders, diabetic cardiomyopathy, and microvascular changes [7,8]. Chronic hyperglycemia contributes to the glycation of vascular wall proteins, activation of inflammatory processes, and oxidative stress, leading to a more aggressive atherosclerotic process and diffuse coronary artery involvement [9,10].

In patients with T2DM, CAD is often characterized by more pronounced multivessel coronary artery disease, involvement of distal arterial segments, and an increased propensity for thrombosis. The clinical course of the disease is frequently atypical due to diabetic neuropathy, which complicates timely diagnosis and may lead to delayed medical care [11,12].

Coronary artery bypass grafting (CABG) is the gold standard for surgical treatment of CAD in cases of multivessel coronary artery disease, particularly in patients with T2DM. Numerous studies, including the large randomized controlled trials FREEDOM, SYNTAX, and BARI 2D, have demonstrated the advantages of CABG over percutaneous coronary interventions in diabetic patients with complex coronary artery lesions [13,14,15].

However, despite the proven efficacy of CABG, the presence of T2DM can significantly influence perioperative risks and long-term outcomes. Patients with diabetes have an increased risk of infectious complications, impaired wound healing, and cardiovascular events in the postoperative period [16,17]. Additionally, diabetic nephropathy, retinopathy, and other microvascular complications may further complicate the perioperative management of these patients [18].

Comorbidities in patients with T2DM also require careful attention. These patients often suffer from arterial hypertension, dyslipidemia, obesity, chronic kidney disease, and other conditions that can affect the prognosis after cardiac surgery [19,20]. The systemic nature of metabolic disorders in diabetes necessitates a comprehensive approach to preoperative preparation and postoperative management.

At the same time, data on the impact of T2DM on immediate CABG outcomes remain controversial. Some studies report an increased incidence of postoperative complications and hospital mortality in diabetic patients, while others find no significant differences in short-term outcomes [21,22]. These discrepancies may be due to differences in the characteristics of the studied populations, patient selection criteria, surgical techniques, and postoperative care.

The relevance of studying this issue in the Republic of Uzbekistan is driven by the growing prevalence of both CAD and T2DM in the region. Genetic, ethnic, and socioeconomic factors may influence the course of these diseases and treatment outcomes, necessitating local studies to optimize the management of this patient population.

Thus, a retrospective analysis of CABG outcomes in patients with CAD, depending on the presence of T2DM, is highly relevant for identifying clinical features, risk factors for complications, and developing personalized treatment approaches for this complex patient group.

Objective: To conduct a retrospective analysis of the impact of type 2 diabetes mellitus on early outcomes of coronary artery bypass grafting in patients with coronary artery disease.

METHODS

Data from 384 patients with CAD and multivessel coronary artery disease who underwent elective CABG from January to December 2022 were analyzed. The CABG procedures were performed in the cardiac surgery department of the American Hospital in Tashkent by a single surgical team under general anesthesia, using either cardiopulmonary bypass (CPB) or off-pump techniques (on a beating heart).

To study the impact of T2DM on early hospital outcomes, patients were divided into two groups: Group 1 consisted of 125 patients with T2DM (32.6% of the cohort), and Group 2 included 259 patients without diabetes (67.4%).

Inclusion criteria were: confirmed diagnosis of CAD, indications for elective CABG, and complete clinical and instrumental data necessary for analysis. Exclusion criteria included emergency surgeries, severe non-cardiac pathologies in the decompensation stage, and lack of patient consent for participation in the study.

Demographic and clinical data were systematized and analyzed using modern statistical methods. Qualitative variables were presented as absolute values and percentages, while quantitative variables were expressed as means with standard deviations (M ± SD) or with 95% confidence intervals (CI). For group comparisons, nonparametric tests (Mann-Whitney U test, Kruskal-Wallis test) were used for continuous variables, and the chi-square test or Fisher's exact test was applied for categorical data. Statistical significance was set at $p \leq 0.05$. Data processing was performed using SPSS 26.0 and R 4.0.2.

Ethical approval for the study was obtained from the hospital's local ethics committee. All patients provided informed consent for the use of their anonymized data for scientific purposes. Results were visualized in tables and graphs for clear representation of key patterns.

RESULTS

Demographic Characteristics

Of the 384 patients included in the study, males accounted for 80.9% and females for 19.1%. In Group 1 (patients with T2DM), males comprised 69.6% and females 30.4%, with a mean age of 61.89 ± 3.5 years. In Group 2 (patients without diabetes), males dominated with 86.4%, females accounted for 13.5%, and the mean age was 61.7 ± 2.5 years.

Age distribution in the overall cohort showed a predominance of patients aged 60–69 years (46.9%), followed by 50–59 years (29.2%), 70–79 years (15.6%), 40–49 years (7%), 80 years and older (1%), and minimal representation of 30–39 years (0.2%). A similar trend was observed in both groups (Table 1).

Criteria	Total population n-384 N (%)	Group 1 Patients with T2DM n-125 N (%)	Group 2 Patients without DM n-259 N (%)
Men		87 (69.6)	224 (86.4)
Women		38 (30.4)	35 (13.5)
30-39 years	1 (0.2)	1 (0.8)	-
40-49 years	27 (7)	7 (5.6)	20 (7.7)
50-59 years	112 (29.2)	34 (27.2)	78 (30.1)
60-69 years	180 (46.9)	64 (51.2)	116 (44.8)
70-79 years	60 (15.6)	17 (13.6)	43 (16.6)
80 and above	4 (1.0)	2 (1.6)	2 (0.7)

Table 1: Age Distribution of Patients Undergoing Coronary Artery Bypass Grafting

[Description: The table presents the age distribution of patients, showing the percentage of patients in each age group for the overall cohort and the two comparative groups.]

Clinical Characteristics

The incidence of acute myocardial infarction (AMI) was similar in both groups. In Group 1 (T2DM), AMI was diagnosed in 24% of patients, with 14.4% having anterior wall involvement and 9.6% inferior or lateral wall involvement. In Group 2, AMI was observed in 22%, with 13.5% anterior wall and 8.5% inferior-lateral wall involvement (Table 2). Of the total 384 patients, 22% with AMI underwent CABG.

Stable effort angina was diagnosed in 62.4% of patients with T2DM, with nearly all (96.1%) having Functional Class (FC) III and 3.9% FC IV. In patients without diabetes, effort angina was observed in 58.6%, with 0.6% FC I, 1.3% FC II, 93.2% FC III, and 4.6% FC IV (Table 2).

Progressive angina was more frequent in patients without T2DM (19.6%) compared to those with T2DM (13.6%). Conversely, early postinfarction angina (EPIA) was 2.1 times more common in Group 1 (4%) than in

Group 2 (1.9%) (Table 2). In the overall cohort, 17.7% of patients with progressive angina and 2.6% with EPIA underwent CABG.

Parameters	Total population n-384 N (%)	Group 1 Patients with T2DM n-125 N (%)	Group 2 Patients without DM n-259 N (%)
AMI	87 (22.6)	30 (24)	57 (22)
- anterior extensive	53 (13.8)	18 (14.4)	35 (13.5)
- inferior-lateral	34 (8.8)	12 (9.6)	22 (8.5)
Angina pectoris	230 (59.8)	78 (62.4)	152 (58.6)
- FC I	1 (0.2)	-	1 (0.4)
- FC II	2 (0.4)	-	2 (0.8)
- FC III	217 (56.5)	75 (60)	142 (54.8)
- FC IV	10 (2.6)	3 (2.4)	7 (2.7)
Progressive angina	68 (17.7)	17 (13.6)	51 (19.6)*
EPA	10 (2.6)	5 (4)*	5 (1.9)*

Table 2: Clinical Characteristics of Patients with CAD With and Without T2DM

[Note: * - statistical significance $p \geq 0.05$]

[Abbreviations: AMI – Acute Myocardial Infarction, FC – Functional Class of Angina, EPIA – Early Postinfarction Angina]

Hypertension was present in nearly all patients undergoing CABG (98.2%), with 99.2% in Group 1 and 97.6% in Group 2. Notably, hypertension stages 2 and 3 were 1.4 and 1.8 times more frequent in patients with T2DM compared to those without (Table 3).

Postinfarction cardiosclerosis (PICS) was observed in 36.4% of the overall cohort, with a significantly higher prevalence in Group 1 (51.2%) compared to Group 2 (29.3%). This indicates that every second patient with T2DM undergoing CABG had a history of PICS, with 50% of them unaware of a prior myocardial infarction (detected via ECG and echocardiography during examination) (Table 3).

Large-scale studies and our data confirm that CAD in patients with T2DM often progresses without clinical symptoms, leading to a poorer prognosis. Therefore, patients with CAD, T2DM, and a history of PICS should be considered high-risk candidates for CABG.

Of the 64 patients with T2DM and PICS, 6.25% underwent myocardial revascularization within one year, 25% within 1–5 years, and 18.7% within 6–10 years (Table 3).

Chronic heart failure (CHF) was present in nearly all patients with T2DM (99.2%) and without T2DM (97.6%) (Table 3).

Criteria	Group 1 Patients with T2DM (n-125)	Group 2 Patients without DM (n-259)	Total (n-384)
HD	124 (99.2%)	253 (97.6%)	377 (98.2%)
Including:			
- Grade 1 AH	92 (74.2%)	205 (81%)	297 (77.3%)
- Grade 2 AH	29 (23.3%)*	43 (16.9%)	72 (18.7%)
- Grade 3 AH	4 (3.4%)*	5 (1.9%)	9 (2.3%)
PICS	64 (51.2%)*	103 (39.7%)	140 (36.4%)
Including:			
- after 1 year	4 (6.25%)	10 (13.1%)*	14 (3.6%)
- 1-5 years	16 (25%)	20 (19.4%)	55 (6.8%)
- 6-10 years	12 (18.7%)	27 (26.2%)*	39 (10.1%)
- PICS by ECG and Echo	32 (50%)	46 (44.6%)	79 (20.6%)
CHF	124 (99.2%)	253 (97.6%)	377 (98.2%)

Table 3: Clinical Characteristics of Patients with CAD With and Without T2DM

[Note: * - statistical significance p ≥ 0.05]

[Abbreviations: HTN – Hypertension, PICS – Postinfarction Cardiosclerosis, PCI – Percutaneous Coronary Intervention, CHF – Chronic Heart Failure]

Prior Percutaneous Coronary Intervention (PCI)

In Group 1 (T2DM), 22 patients (17.6%) had a history of PCI with stenting: 14 (11.2%) with one coronary artery stented, 3 (2.4%) with two, 4 (3.2%) with three, and 1 with six coronary arteries stented (Figure 1). Notably, all 8 patients with stents in two or more coronary arteries underwent CABG within 1–2 years, while those with one artery stented underwent CABG within 3–5 years post-PCI.

In Group 2 (no T2DM), 27 patients (10.4%) had a history of PCI with stenting: 5 (1.9%) with one artery, 9 (3.4%) with two, 8 (3.1%) with three, and 4 (1.5%) with four arteries stented, with one patient having six arteries stented (Figure 1). Of these 27 patients, 5 underwent PCI twice with intervals of several years, 3 underwent PCI three times, 44.4% (n=12) underwent CABG within 1–2 years, and 55.5% (n=15) within 5 or more years.

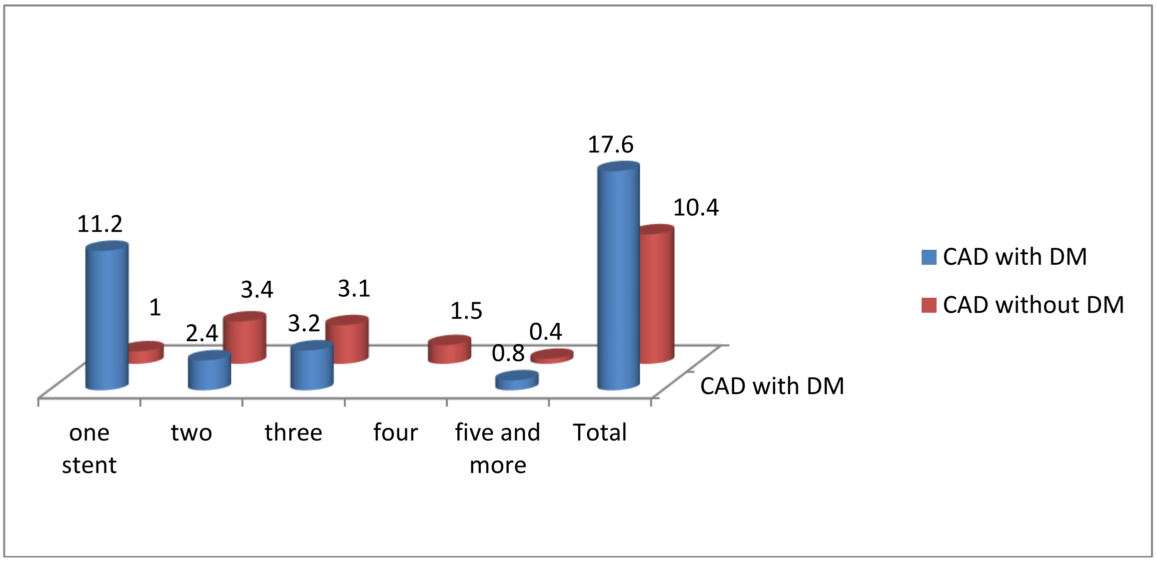

Figure 1: Coronary Artery Bypass Grafting in Patients with CAD With and Without T2DM After PCI with Stenting

[Description: The figure illustrates the distribution of CABG procedures in patients with prior PCI, comparing those with and without T2DM based on the number of stented coronary arteries.]

The study results indicate that patients with CAD, regardless of T2DM status, with a history of PCI underwent myocardial revascularization. Most patients underwent CABG within 1–2 years post-PCI, with T2DM patients requiring CABG after single-vessel stenting and non-diabetic patients after stenting of two or more vessels with intervals of several years.

Comorbidities

Liver and gallbladder diseases were more common in patients with T2DM (26.4%) compared to those without (14.2%). Kidney diseases were 3.3 times more frequent in Group 1 (44.8%) than in Group 2 (13.5%), including chronic pyelonephritis (12.8% vs. 6.5%) and urolithiasis (15.6% vs. 3.8%). Chronic kidney disease was 5.3 times more prevalent in patients with T2DM (16.8%) compared to those without (3.1%). Gastrointestinal diseases were more frequent in patients with T2DM (40.8%) compared to 31.2% in those without. Obesity was more pronounced in Group 1: 32% (14.4% grade 1, 16% grade 2, 1.6% grade 3) compared to 19.3% in Group 2 (10.8% grade 1, 5% grade 2, 3.1% grade 3) (Figure 2).

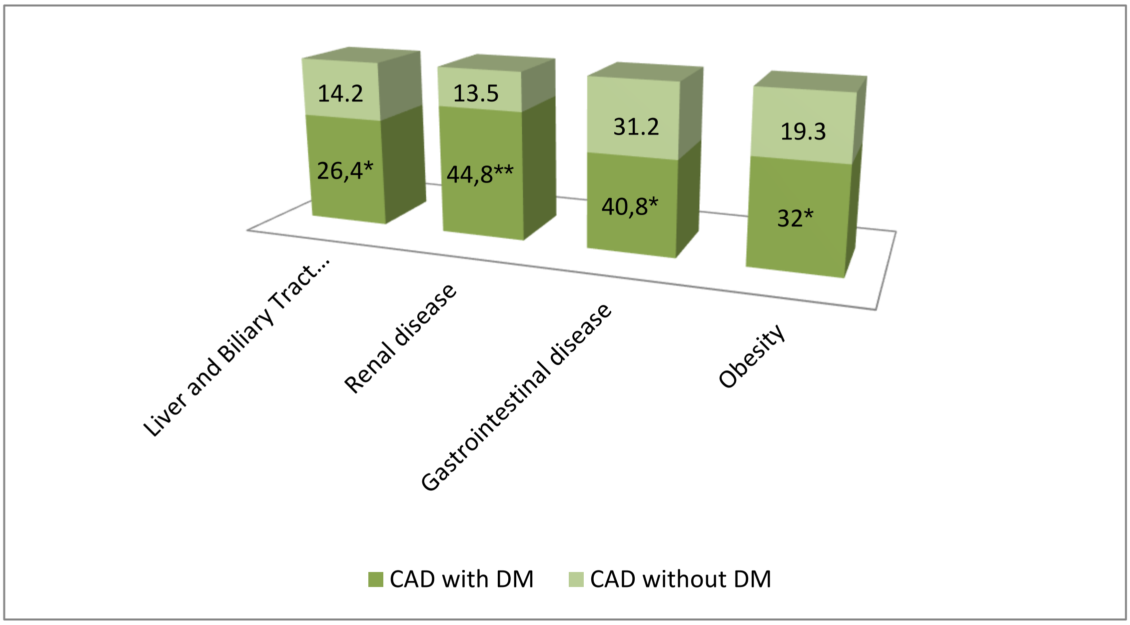

Figure 2: Prevalence of Comorbidities in Comparative Groups

[Note: * - statistical significance p ≥ 0.05, ** - p ≥ 0.01]

[Description: The figure shows the prevalence of comorbidities (liver/gallbladder diseases, kidney diseases, gastrointestinal diseases, and obesity) in patients with and without T2DM.]

Intraoperative Parameters

No statistically significant differences were observed in intraoperative parameters between the groups. In Group 1, 69.6% of the 125 patients underwent off-pump CABG, compared to 72.2% of the 259 patients in Group 2 ($p \leq 0.458$). CPB was used in 30.4% (n=38) of Group 1 and 27.8% (n=72) of Group 2.

The number of grafts was similar across groups: 1 graft (0.8% with T2DM vs. 4.2% without), 2 grafts (18.4% vs. 21.2%), 3 grafts (66.4% vs. 59.8%), and 4 grafts (14.4% vs. 14.6%). The most common was the placement of three grafts, accounting for approximately two-thirds of patients in both groups (Figure 3).

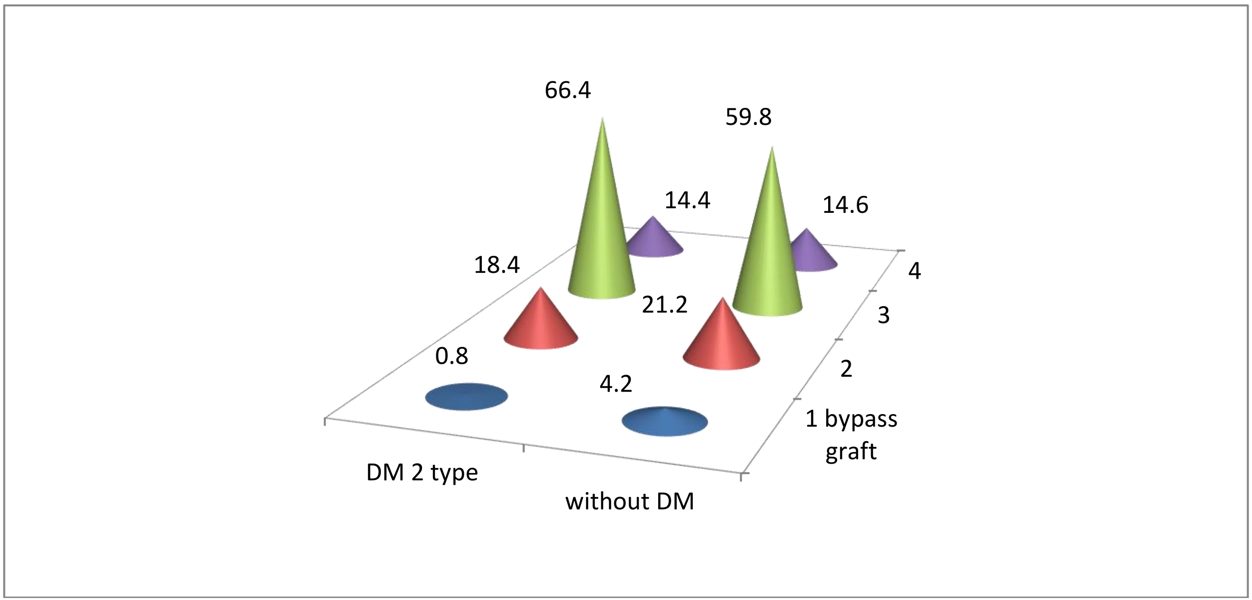

Figure 3: Intraoperative Parameters in Comparative Groups

[Description: The figure compares the number of grafts and use of CPB in patients with and without T2DM undergoing CABG.]

Additional surgical interventions performed concurrently with CABG included thrombectomy (5.6% in T2DM vs. 6.9% without) and aneurysmectomy (5.6% vs. 8.1%), showing similar frequencies across groups.

Early Postoperative Complications

Hospital complications analyzed included postoperative mortality, early postoperative AMI, stroke, serious arrhythmias and conduction disorders, pulmonary artery thromboembolism, acute cardiovascular insufficiency, and early postoperative PCI with stenting.

The overall incidence of early postoperative complications was significantly higher in patients with T2DM. Within one year, postoperative AMI occurred in 1.6% of patients with T2DM and 0.8% without, with T2DM patients undergoing PCI with stenting.

Thromboembolic complications were also significantly more frequent in T2DM patients (1.6%) compared to those without (0.04%) ($p \leq 0.05$).

Stroke in the early hospital period occurred in 4% of T2DM patients compared to 1.9% in non-diabetic patients ($p \leq 0.01$). Serious arrhythmias and conduction disorders were significantly more frequent in Group 1 (15.2%), including 6 cases of paroxysmal supraventricular tachycardia, 7 cases of atrial fibrillation, 3 cases of complete AV block requiring pacemaker implantation, and 3 cases of frequent ventricular extrasystoles. Acute cardiovascular insufficiency was observed in 9.6% of T2DM patients and 2.3% of non-diabetic patients.

One-year mortality was 2,4% in Group 1 (T2DM) and 2,7% in Group 2 (no T2DM).

Complications after CABG	**Group 1 Patients with T2DM (n-125) n %**	**Group 2 Patients without DM (n-259) n %**	**Total (n-384) n %**
AMI	2 (1.6)*	2 (0.8)	4 (1)
PCI	2 (1.6)*	2 (0.8)	4 (1)

Pulmonary embolism	2 (1.6)**	1 (0.04)	3 (0.8)
Stroke	5 (4)*	5 (1.9)	10 (2.6)
Arrhythmias	19 (15.2)**	8 (3.1)	27 (7)
ACVI	12 (9.6)**	6 (2.3)	18 (4.7)
Mortality	3 (2.4)	7 (2.7)	10 (2.6)

Table 4: Frequency of Early Postoperative Complications in Comparative Groups

[Note: * - statistical significance p ≥ 0.05, ** - p ≥ 0.01]

[Abbreviations: AMI – Acute Myocardial Infarction, PCI – Percutaneous Coronary Intervention Post-CABG, PA – Pulmonary Artery, Stroke – Acute Cerebrovascular Event, ACI – Acute Cardiovascular Insufficiency]

The presence of T2DM in patients with CAD significantly influences the frequency of early postoperative complications but does not affect hospital mortality after CABG.

DISCUSSION

The findings confirm that T2DM significantly impacts the clinical profile and postoperative outcomes in patients with CAD undergoing CABG. The higher proportion of women in the T2DM group may be linked to the known influence of diabetes on cardiovascular risk in women, warranting further investigation. The similar incidence of AMI and effort angina in both groups suggests comparable CAD severity, but the higher prevalence of PICS in T2DM patients reflects more pronounced myocardial remodeling, possibly due to chronic hyperglycemia and metabolic disorders.

The high frequency of comorbidities such as obesity, kidney diseases, and gastrointestinal disorders in the T2DM group underscores the systemic nature of the metabolic syndrome associated with diabetes. These factors may contribute to a higher risk of complications post-CABG.

Life-threatening arrhythmias and acute cardiovascular insufficiency were significantly more frequent in T2DM patients, possibly due to diabetic cardiomyopathy, impaired microcirculation, and more severe atherosclerosis.

Surgical characteristics, including the use of CPB and the number of grafts, showed minimal differences between groups, indicating a standardized approach to CABG regardless of T2DM status.

The findings suggest that the specific pattern of coronary artery involvement in T2DM patients with CAD results in a more severe disease course, a propensity for recurrence, and reduced compensatory and functional capacity compared to non-diabetic CAD patients. The progression of coronary artery disease in T2DM patients may be linked to glycemic decompensation and diffuse coronary artery involvement, increasing the risk of complications and adverse outcomes. This necessitates proactive management of disease progression mechanisms and the selection of appropriate conservative therapy, considering the high risk of combined pathology, and calls for the development of individualized prevention methods for CAD patients with T2DM.

CONCLUSIONS

1. Differences between groups indicate a higher proportion of women and more pronounced comorbidities, including kidney and gastrointestinal diseases and obesity, in patients with T2DM compared to those without.

2. The clinical characteristics of major CAD forms, such as AMI and effort angina, are similar in both groups, but PICS and CHF are more prevalent in patients with T2DM.

3. Patients with CAD and a history of PCI, regardless of T2DM status, underwent myocardial revascularization. T2DM patients required CABG after single-vessel stenting, while non-diabetic patients required CABG after stenting of two or more coronary arteries with intervals of several years.

4. The presence of T2DM in CAD patients significantly influences the frequency of early postoperative complications but does not affect hospital mortality after CABG, indicating an increased risk of adverse outcomes.

5. There is a need to develop individualized prevention methods for CAD patients with T2DM undergoing CABG, with proactive management of disease progression mechanisms and appropriate conservative therapy, considering the high risk of

combined pathology.

6. Strategies to optimize the treatment of T2DM patients undergoing CABG are necessary, given their elevated risk of complications.

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