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ANALYSIS OF CLINICAL PROFILE AND OUTCOMES IN PATIENTS WITH METABOLIC RISK FACTORS AFTER CORONARY ARTERY BYPASS GRAFTING

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Abstract

Introduction: Coronary artery bypass grafting (CABG) is a critical intervention for patients with advanced coronary artery disease, yet its success is often challenged by the presence of systemic metabolic risk factors. Factors such as hypertension, dyslipidemia, and impaired glucose metabolism create a chronic pro-inflammatory environment that can complicate surgical recovery.

This study aims to evaluate how these metabolic disturbances influence early and late postoperative outcomes in a clinical setting.

Material and Methods: A retrospective observational study was conducted on 19 patients with established metabolic risk factors who underwent CABG at the "Zhan Mitrev Clinic" (Skopje) between February and March 2025. Preoperative comorbidities and laboratory findings were analyzed in relation to postoperative complications. Metabolic risk was assessed using NCEP ATP III guidelines.

Results: The majority of patients were male (68%), with a predominant age range of 61 to 70 years. All patients presented with hypertension and hyperlipidemia, while 36% were diagnosed with type 2 diabetes. The most frequent early postoperative complication was atrial fibrillation (42%), followed by cerebrovascular insult (16%). Long-term follow-up revealed a 5% incidence of prolonged sternal wound healing and a 5% rate of rehospitalization due to hypotension.

No perioperative mortality was recorded.

Conclusion: The presence of metabolic risk factors identifies a high-risk patient cohort prone to postoperative arrhythmias and delayed wound healing.

Preoperative identification and aggressive optimization of these risk factors are essential to mitigate the systemic inflammatory response and improve overall surgical prognosis.

Keywords: CABG, Metabolic risk factors, Atrial fibrillation, Postoperative recovery, Inflammation.

Introduction

Metabolic syndrome is a chronic, non-communicable multifactorial syndrome clinically characterized by a cluster of risk factors, including insulin resistance, arterial hypertension, abdominal obesity, impaired glucose metabolism, and dyslipidemia [1, 2]. These comorbidities represent significant risk factors for the development of cardiovascular diseases due to their pro-inflammatory properties, oxidative stress, hemodynamic disturbances, and increased risk of ischemic events [3, 4].

Coronary artery disease remains the leading cause of morbidity and mortality in patients presenting with metabolic risk factors [5].

For patients with multivessel coronary disease, coronary artery bypass grafting (CABG) is the established therapeutic method of choice. This surgical intervention aims to improve myocardial perfusion, alleviate symptoms, enhance quality of life, and improve long-term prognosis [6,7].

However, in patients with metabolic risk factors, atherosclerotic lesions are often diffuse and complex, which, combined with a chronic pro-inflammatory state, can negatively influence postoperative outcomes **[**8].

Expected complications following surgical revascularization include perioperative myocardial infarction, cerebrovascular insults, infections—particularly sternal wound infections—prolonged mechanical ventilation, acute kidney injury, and an increased requirement for blood transfusions [9, 10].

The inflammatory state in these patients can further intensify the systemic inflammatory response induced by cardiopulmonary bypass, potentially leading to increased perioperative morbidity [11, 12]. This study aims to evaluate the clinical profile and postoperative outcomes in patients with multiple metabolic risk factors undergoing surgical myocardial revascularization at our center.

Material and methods

This study is a retrospective, observational analysis of postoperative complications in patients with metabolic risk factors who underwent surgical myocardial revascularization (coronary artery bypass grafting – CABG). The study included all patients with metabolic risk factors operated on at the "Zhan Mitrev Clinic" in Skopje during the period from February to March 2025.

2.1. Inclusion Criteria The study included patients diagnosed with multivessel coronary artery disease with an indication for surgical myocardial revascularization. Preoperatively, body weight and height were measured for all patients, and the Body Mass Index (BMI) was calculated. The risk factors examined included arterial hypertension, hyperlipidemia, impaired glucose tolerance, type 2 diabetes mellitus, and obesity. Preoperative laboratory assessment included: complete blood count, biochemical parameters, fasting insulin levels, glycated hemoglobin (HbA1c), and lipid profile (total cholesterol, HDL, LDL, and triglycerides). Patients who met the criteria for metabolic syndrome were included in the study.

2.2. Exclusion Criteria Patients who did not meet the criteria for metabolic syndrome were excluded, as were patients with contraindications for surgical revascularization (e.g., advanced malignancy, terminal illness), patients with end-stage renal disease on dialysis, or patients with hepatic cirrhosis.

2.3. Follow-up Period Patients were monitored during the early postoperative period, as well as one week and four weeks after discharge from the hospital.

2.4. Outcome Measures

Primary Outcome: Occurrence of postoperative atrial fibrillation, neurological deficits (including cerebrovascular insult/stroke), acute kidney injury, respiratory complications, and mortality.
Secondary Outcome: Readmission for any reason, sternal wound infections, recurrent atrial fibrillation, worsening of renal function, respiratory complications, and mortality.

2.5. Definitions

Metabolic Syndrome: Defined as the simultaneous presence of multiple cardiovascular risk factors, including arterial hypertension, hyperlipidemia, type 2 diabetes mellitus (or impaired glucose tolerance), and abdominal obesity, according to the criteria of the National Cholesterol Education Program — Adult Treatment Panel III (NCEP ATP III) [13].
Glucose Intolerance: Defined by the presence of at least one of the following criteria: impaired fasting glucose (5.6–6.9 mmol/L), impaired glucose tolerance (7.8–11.0 mmol/L at 2 hours after a 75 g OGTT), or HbA1c of 5.7–6.4% [14].

Type 2 Diabetes Mellitus: A chronic metabolic condition characterized by impaired secretion and/or action of insulin, resulting in chronic hyperglycemia [15].
Obesity: Body Mass Index (BMI) ≥30 kg/m². Normal weight was defined as BMI 18.5–24.9 kg/m², overweight as 25.0–29.9 kg/m², moderate obesity (Class I) as 30.0–34.9 kg/m², and severe obesity (Class II/III) as ≥35 kg/m² [16].
Arterial Hypertension: Repeated elevation of systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg in clinical settings, or an average home blood pressure ≥135/85 mmHg [17].

2.6. Ethical Aspects The research was approved by the Ethics Committee of the "Zhan Mitrev Clinic." All patients provided signed informed consent for participation in the study.

2.7. Statistical Analysis Data were recorded in the Hospital Information System (HIS) and processed using Microsoft Excel for Windows 11. The results are presented in tables and graphs. Quantitative variables were analyzed by calculating the mean values and standard deviations (SD).

Results

During the period from February to March 2025, a total of 69 patients underwent surgical revascularization, of whom 19 patients (27.5%) met the inclusion criteria for the study. Two-thirds of the patients were male, with a mean age of 67 ± 7 years. Seventy-four percent of the patients were younger than 70 years of age (Table 1).

Table 1. Distribution of patients by sex and age group

Parameters	**Group**	**Total (n=19)**	**Percentage (%)**
Sex	Male	13	68%
	Female	6	32%
	Ratio (M:F)	**2.2 : 1**	
Age	**Mean Age (years)**	**67 ± 7**	
	Range (min–max)	51–79	
	51–55 years	1	5%
	56–60 years	3	16%
	61–65 years	4	21%
	66–70 years	6	32%
	71–75 years	1	5%

Parameters	Group	Total (n=19)	Percentage (%)
	76–80 years	4	21%

3.1. Metabolic Risk Factors

Arterial Hypertension: All 19 patients (100%) had a diagnosis of arterial hypertension and were receiving antihypertensive therapy.
Hyperlipidemia: All patients (100%) were diagnosed with hyperlipidemia and were under appropriate lipid-lowering treatment.
Diabetes Mellitus: Seven patients (37%) had type 2 diabetes mellitus, one of whom was on insulin therapy.
Prediabetes: Impaired glucose tolerance was identified in six patients (32%).
Smoking Status: Twelve patients (63%) were non-smokers, while seven patients (37%) were active smokers.
Body Mass Index (BMI): The mean BMI was 28 ± 5 kg/m², indicating an overweight status for the study group.

- 31% of the patients had a BMI ranging from 27.5 to < 29.9 kg/m² (overweight).
- 21% presented with Class I obesity.
- 21% presented with Class II obesity, according to the World Health Organization definitions [18].

3.2. Body Mass Index Distribution

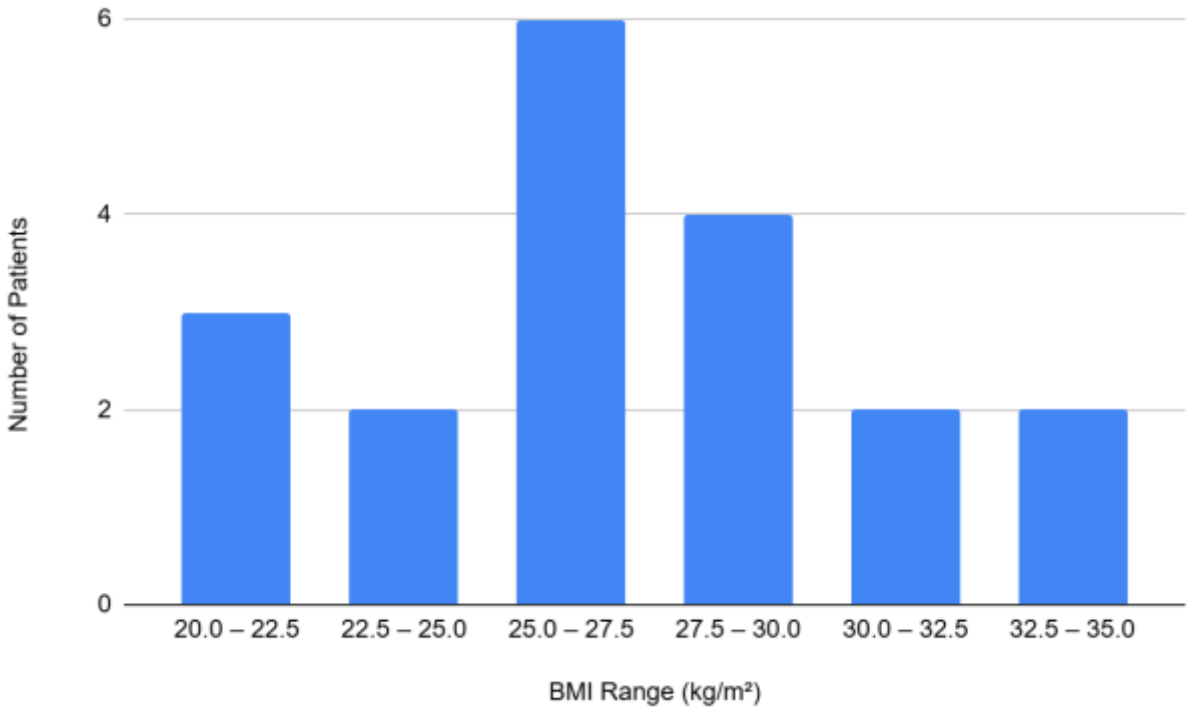

Figure 1. Distribution of Body Mass Index (BMI) across the patient population

Table 2 presents the most common preoperative comorbidities identified in the patient population.

Table 2. Comorbidities of patients with metabolic risk factors

Comorbidities	**Number of patients (%)**
Hyperlipidemia	19 (100%)
Hypertension	19 (100%)
Diabetes mellitus	7 (36%)
Previous myocardial infarction	7 (36%)
Previous cerebrovascular insult (Stroke)	1 (5%)
Previous coronary stenting (PCI)	2 (10%)
Significant carotid artery disease	3 (15%)
Paroxysmal atrial fibrillation	3 (15%)

3.3. Preoperative Laboratory Analysis

Nine biochemical parameters were analyzed: fasting glycemia, glycated hemoglobin (HbA1c), total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), triglycerides, fasting insulin levels (insulinemia), C-reactive protein (CRP), and creatinine. The results are presented in Table 3.

Table 3. Preoperative laboratory findings of the patients

Laboratory Parameter	**Mean**	**SD (±)**	**Median**	**Minimum**	**Maximum**
Fasting Glycemia (mmol/L)	7.4	2.4	7.0	4.5	11.9
HbA1c (%)	6.5	1.0	6.3	5.0	8.9
Total Cholesterol (mmol/L)	4.3	1.3	4.3	2.3	6.8
LDL Cholesterol (mmol/L)	2.0	1.0	1.8	0.5	3.7
HDL Cholesterol (mmol/L)	1.2	0.4	1.1	0.7	2.3
Triglycerides (mmol/L)	1.7	0.8	1.4	0.9	3.9

Laboratory Parameter	Mean	SD (±)	Median	Minimum	Maximum
Insulinemia (μIU/mL)	14.1	13.5	9.0	2.2	52.0
CRP (mg/L)	5.3	4.9	3.5	0.1	15.1
Creatinine (μmol/L)	93.1	16.6	88.1	68.3	130.3

HbA1c – Glycated hemoglobin; CRP – C-reactive protein; SD – Standard deviation.

3.4. Intraoperative and Postoperative Outcomes

Isolated coronary artery bypass grafting (CABG) was performed in 16 patients (84%), while combined surgery (CABG + valvular intervention) was performed in 3 patients (16%). The mean duration of hospitalization was 8 ± 3 days (range: 4–17 days), and the stay in the intensive care unit (ICU) averaged 5 ± 3 days. The average perioperative glycemia was 9 ± 2 mmol/L (range: 5.5–13.6 mmol/L).

Perioperative Complications:

Postoperative atrial fibrillation developed in 42% of patients with metabolic risk factors following coronary artery bypass grafting. This increased the risk of cerebrovascular insult (stroke), which represents the second most frequent perioperative complication (Table 4) [19].

Table 4. Postoperative complications in the study group

Complication	Number of patients (n=19)	Percentage (%)
Postoperative Atrial Fibrillation	8	42%
Cerebrovascular Insult (Stroke)	3	16%
Acute Kidney Injury	2	11%
Respiratory Complications	2	11%
Mortality	0	0%

3.5. Outcomes at the First Postoperative Follow-up

The first follow-up control was conducted for all patients at an average of 5 ± 1 days after surgery.

The mean blood glucose level was 7 ± 1 mmol/L, representing a reduction of approximately 2 mmol/L compared to preoperative values.

Rehospitalization was required for two patients due to dehydration, while one patient experienced prolonged sternal wound healing and one patient presented with respiratory complications (Table 5).

Table 5. Complications at the first postoperative follow-up

Complications at the first postoperative follow-up	**Number of patients (%)**
Rehospitalization due to dehydration	2 (11%)
Prolonged sternal wound healing	1 (5%)
Respiratory complications	1 (5%)
Atrial fibrillation	0 (0%)
Acute kidney injury	0 (0%)
Cerebrovascular insult (Stroke)	0 (0%)

3.6. Outcomes at the Second Postoperative Follow-up

The second follow-up control was conducted for all patients at an average of three weeks after the first follow-up.

Rehospitalization was indicated for one patient due to dehydration and collapse, while prolonged sternal wound healing was observed in one patient (Table 6).

Table 6. Complications at the second postoperative follow-up

Postoperative complications at the second follow-up	**Number of patients (%)**
Rehospitalization due to hypotension	1 (5%)
Prolonged sternal wound healing	1 (5%)
Respiratory complications	0 (0%)
Cerebrovascular insult (Stroke)	0 (0%)
Acute kidney injury	0 (0%)
Atrial fibrillation	0 (0%)

Discussion

Our research evaluated the impact of metabolic risk factors on early and late postoperative complications in patients with metabolic syndrome undergoing coronary artery bypass grafting (CABG). According to the literature, patients with metabolic risk factors have an increased risk of postoperative atrial fibrillation, cerebrovascular insult (stroke), and wound infection following cardiac surgery [19, 20]. Consistent with these findings, our study demonstrated that the most frequent early postoperative complication was the occurrence of atrial fibrillation.

The increased incidence of complications after CABG in patients with present metabolic risk factors is explained by higher levels of inflammatory cytokines, as well as the risk of a systemic inflammatory response syndrome (SIRS) induced by cardiopulmonary bypass [21].

The pre-existing inflammatory state associated with metabolic risk factors can further exacerbate this response, predisposing patients to perioperative complications such as impaired sternal wound healing, increased vascular permeability, and arrhythmias. Similar findings have been reported in other studies [22, 23].

Preoperative risk stratification is crucial; the presence of metabolic risk factors should be taken into account during preoperative assessment, identifying these patients as a high-risk group that requires greater caution and potentially intensive postoperative monitoring.

Aggressive measures for the optimization of metabolic risk factors (strict glycemic control, blood pressure, and lipid management) are necessary before surgery to reduce the inflammatory cascade and the risk of complications [19, 22].

Intensive postoperative management is essential to minimize complication risks, including protocols for glycemic control and careful monitoring for signs of wound infection.

The main limitation of this study is the small sample size, which limits the capacity to detect smaller differences in outcomes and to perform complex multivariable analysis. Future research should focus on larger, multicenter studies to confirm the independent prognostic value of metabolic risk factors after CABG. Specifically, it should be investigated whether aggressive pharmacological and lifestyle management of metabolic risk factors before and after surgery can improve long-term outcomes and survival in this high-risk population [20–23].

Conclusion

Patients with metabolic risk factors are most commonly between 50 and 70 years of age. The most frequent postoperative complications in these patients are atrial fibrillation and prolonged sternal wound healing. These complications can lead to cerebrovascular insult and increased mortality.

Therefore, in addition to diagnosing coronary artery disease, the presence of metabolic risk factors should be assessed preoperatively to implement preventive measures and reduce perioperative and postoperative morbidity and mortality.

References

1. Alberti KGMM, Zimmet P, Shaw J. *The metabolic syndrome — a new worldwide definition.* Lancet. 2005;366(9491):1059–1062.
2. Grundy SM. *Metabolic syndrome pandemic.* Arterioscler Thromb Vasc Biol. 2008;28(4):629–636.
3. Mottillo S, et al. *The metabolic syndrome and cardiovascular risk: a systematic review and meta-analysis.* J Am Coll Cardiol. 2010;56(14):1113–1132.
4. Neumann FJ, et al. *2018 ESC/EACTS Guidelines on myocardial revascularization.* Eur Heart J. 2019;40(2):87–165.
5. Mohr FW, et al. *Coronary artery bypass graft surgery versus percutaneous coronary intervention in multivessel disease (SYNTAX study).* N Engl J Med. 2009;360(10):961–972.
6. Esser N, et al. *Inflammation as a link between obesity, metabolic syndrome and type 2 diabetes.* Diabetes Res Clin Pract. 2014;105(2):141–150.

7. Davi G, Patrono C. *Platelet activation and atherothrombosis.* N Engl J Med. 2007;357(24):2482–2494.
8. Biancari F, et al. *Predictors of early and late outcome after coronary artery bypass grafting.* Eur J Cardiothorac Surg. 2012;41(1):107–114.
9. Viana MV, et al. *Systemic inflammatory response after cardiac surgery: pathophysiology and clinical implications.* Clinics. 2013;68(10):1345–1353.
10. Liakopoulos OJ, et al. *Impact of preoperative inflammatory state on outcome after coronary artery bypass grafting surgery.* Ann Thorac Surg. 2009;87(6):1701–1710.
11. Eckel RH, et al. *The metabolic syndrome.* Lancet. 2005;365(9468):1415–1428.
12. Cornier MA, et al. *The metabolic syndrome.* Endocr Rev. 2008;29(7):777–822.
13. National Cholesterol Education Program (NCEP). *Third Report of the NCEP Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III).* JAMA. 2001;285(19):2486–2497.
14. American Diabetes Association. *Classification and diagnosis of diabetes: Standards of Medical Care in Diabetes—2025.* Diabetes Care. 2025;48(Suppl 1):S15–S33.
15. DeFronzo RA, Ferrannini E. *Pathogenesis of type 2 diabetes mellitus.* Med Clin North Am. 2004;88(4):787–835.
16. World Health Organization. *Obesity: preventing and managing the global epidemic.* WHO Technical Report Series 894. Geneva: WHO; 2000.
17. Whelton PK, et al. *2018 ESC/ESH Guidelines for the management of arterial hypertension.* Eur Heart J. 2018;39(33):3021–3104.
18. World Health Organization. *Obesity: preventing and managing the global epidemic.* WHO Technical Report Series 894. Geneva; 2020.
19. Thourani VH et al. Impact of metabolic syndrome on outcomes after coronary artery bypass surgery. *Ann Thorac Surg.* 2019;107(5):1348–1355.
20. Ji Q, et al. Metabolic syndrome increases the risk of postoperative atrial fibrillation after CABG. *J Thorac Cardiovasc Surg.* 2018;156(5):1780–1788.
21. Vivas D, et al. Diabetes, inflammation, and postoperative complications in cardiac surgery. *Cardiovasc Diabetol.* 2020;19(1):11–19.
22. Sato A, et al. Predictors of adverse postoperative outcomes in metabolic syndrome patients undergoing CABG. *Eur J Cardiothorac Surg.* 2021;59(3):490–498.
23. Mehta RH, et al. Influence of metabolic syndrome on postoperative complications after cardiac surgery. *Circulation.* 2017;136:1027–1038.