African Journal of Biological Sciences

Research Paper Open Access

Predictive Value of Metabolic Profile on Cardiovascular Outcomes in Diabetic Versus Non-Diabetic Patients

Lobna Farag El-Toony[1], Ahmed Elminshawy[2], Hosam Hasan-Ali[3], Soheir Mustafa Kassem[1], Rabab Mashhour[1], Salma mokhtar Osman[1], Salma Taha[3], *Ahmed Taha[2]*

[1]Internal medicine Department, Faculty of medicine, Assiut University, Assiut, Egypt

[2]Cardiothoracic surgery Department, Faculty of medicine, Assiut University, Assiut, Egypt

[3]Cardiovascular medicine Department, Faculty of medicine, Assiut University, Assiut, Egypt

Corresponding author (*): Rabab Mashhour
Email: rababemadahmedmashhour@gmail.com

Article Info

Volume 6, Issue 8, April 2024
Received: 12 Feb 2024
Accepted: 23 March 2024
Published: 26 April 2024

Abstract

Background: Coronary artery disease (CAD) is the primary cause of mortality on a global scale. Despite the utilization of therapies recommended by guidelines, the prognosis for acute coronary syndrome (ACS) remains unfavorable, necessitating the early identification of risk factors. DM is associated with abnormal endothelial function, increased inflammatory response and seems to be an important factor deteriorating microvascular reperfusion in acute phase of myocardial infarction. Consequently, there has been a surge in research focusing on new inflammatory biomarkers that can aid in the diagnosis and risk stratification of patients. However, the role of fundamental hematological and metabolic parameters, which are routinely performed as predictors of short- and long-term mortality and the detection of major cardiovascular events (MACE), as well as the influence of DM on these parameters, has not been extensively investigated. **Objective:** The aim of this study was to assess the value of hematological and metabolic parameters in predicting short and long-term Major cardiovascular events (MACE) and other non-cardiovascular complications, and the impact of diabetes on these factors. **Methodology:** The approach employed in this study involved the inclusion of 206 ACS patients (STEMI, non-STEMI) who were divided into two distinct groups: group A consisted of type 2 diabetic patients, while group B comprised non-diabetic patients. Furthermore, each group was further subdivided based on whether the patients underwent PCI or CABG within 3 months after ACS. Follow-up assessments were conducted at 6 and 12 months to ascertain short- and long-term outcomes subsequent to revascularization. **Results**: The results of our study revealed a statistically significant discrepancy in the mean levels of blood urea, creatinine, liver enzymes, and the three components of CBC at the baseline, 6-month, and 1-year follow-up between the diabetic and control groups. Diabetic patients exhibited a significantly higher risk of developing MACE compared to their non-diabetic counterparts (p=0.009). Additionally, patients with low Hb levels demonstrated a significantly greater incidence of MACE compared to those with higher Hb levels (p=0.049). Moreover, an increase of one g/dl in the Hgb level at the ICU was associated with a 31% (OR=1.31, 95% CI; 1.04–1.65, p=0.022) rise in the likelihood of successful revascularization.

Key words: Diabetes mellitus, coronary revascularization, acute coronary syndrome.

© 2024 Rabab Mashhour, this is an open access article under the CC BY license (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made

Introduction

Coronary artery disease (CAD) is the primary cause of mortality on a global scale (1) Despite the utilization of therapies recommended by guidelines, the prognosis for acute coronary syndrome (ACS) remains unfavorable, necessitating the early identification of risk factors (2) . Diabetes mellitus (DM) is associated with a range of cardiovascular consequently, this gives rise to severe medical complications that significantly impact patient outcomes (3), The pathophysiology of acute coronary syndromes (ACS) is significantly influenced by the presence of inflammation. The inflammatory process, characterized by a persistent low-grade inflammation, plays a crucial role in the initiation and progression of the atherosclerotic process (4). This process is associated with elevated concentrations of erythropoietin and the presence of hematological markers in the peripheral blood, which are correlated with ACS (5). In order to prevent complications and reduce mortality, it is imperative to identify patients at high risk and provide them with careful monitoring and intensive treatment. Unfortunately, current diagnostic techniques for CAD prognosis lack simplicity and efficacy. Furthermore, the role of hematological and metabolic parameters in predicting in-hospital and short-term outcome of patients with ACS remains largely unknown.

Materials and Methods

This study was a prospective observational study conducted at Assuit University Heart Hospital, following a single center, cross-sectional design. The study spanned from July 1, 2020, to June 31, 2022, and involved a total of 206 patients with Acute Coronary Syndrome (ACS), aged between 18 and 70 years. The patients were categorized into two groups, namely Group A comprising individuals with type 2 Diabetes Mellitus (DM), and Group B consisting of non-diabetic patients. Each group was further divided into two subgroups, Group 1 composed of patients who underwent Percutaneous Coronary Intervention (PCI) within 3 months after ACS, and Group 2 encompassing patients who underwent Coronary Artery Bypass Grafting (CABG) within the same time frame. The selection process for the patients was based on randomization, taking into account the primary PCI evaluation for coronary vessel involvement.

The inclusion criteria for this study required patients to fall within the age range of 18 to 70 years, irrespective of gender, and to provide clear consent for participation. Additionally, patients needed to present with ACS and have undergone revascularization, either by PCI or CABG, within 3 months following the ACS event.

On the other hand, the exclusion criteria encompassed patients with advanced renal disease (stages 3 and 4 or on dialysis), advanced hepatic diseases (Child B and C), individuals with poor echo window, including those with morbid obesity. Furthermore, patients with a previous history of significant valvular diseases and an Ejection Fraction (EF) below 40% upon admission were also excluded.

The procedures followed in this study adhered to the guidelines set forth by the European Guidelines of 2017 for managing ACS. The success of revascularization was assessed, and both short-term and long-term outcomes were carefully monitored. Major Adverse Cardiac Events (MACE) were recorded, encompassing in-hospital mortality, acute kidney injury within a 6-month period, and MACE within a 1-year period.

All patients participating in the study underwent a comprehensive systemic examination. Basic hematological and metabolic Laboratory investigations were also conducted, including non-fasting lipogram, liver and kidney function, Complete Blood Count (CBC), fasting and postprandial blood glucose, HbA1c levels and assessments of cardiac enzymes (troponin I, CKMB). These laboratory investigations were repeated at baseline and during the 6 to 12-month follow-up period. Furthermore, an Electrocardiogram (ECG) tracing was performed at baseline and during the follow-up visits.

Revascularization success was evaluated based on quantitative coronary analysis or ocular examination. A successful outcome of PCI treatment was defined as achieving a residual diameter stenosis of less than 30% in treated lesions, along with the absence of major adverse cardiac events (MACE) such as myocardial infarction, mortality, or repeat coronary revascularization of the target lesion during the hospital stay. For several device procedures, such as balloon angioplasty, an attainment of less than 50% diameter stenosis through visual examination or quantitative coronary analysis was considered an acceptable criterion for procedure success. As for CABG, success was defined as the patient's survival during the operation, followed by a smooth postoperative period free from complications.

Short-term outcomes were diligently monitored, encompassing in-hospital MACEs, in-hospital mortality, and acute kidney injury within the 6-month follow-up period.

Long-term outcomes were evaluated by tracking major adverse cardiac and cerebrovascular events (MACCEs), at any point during the follow-up period. Additionally, the occurrence of MACEs within the 1-year follow-up period was carefully scrutinized.

MACEs is system involved selecting the most severe event per patient based on a specific sequence, namely death, myocardial infarction (MI), and heart failure (HF). Death was defined as all-cause mortality during the follow-up period. MI was identified as a significant rise in troponin-T levels, exceeding 8 times the upper reference limit, after revascularization, accompanied by clinical symptoms or the appearance of new Q waves on an electrocardiogram (6).

In accordance with the recommendations outlined in the study "Pharmaco-invasive strategy for ST-Segment-Elevation MI" (7), complete revascularization was identified as a crucial aspect of our investigation. This approach ensures that all coronary lesions are treated to maximize the likelihood of restoring optimal myocardial perfusion.

Results and Discussion

206 patients were included in this study, aged 18–70 with ACS at Assiut University Heart Hospital. They were divided into Group A (type 2 DM patients) and Group B (non-diabetic patients). Each group was further divided into Group 1 (PCI within 3 months after ACS) and Group 2 (CABG within 3 months after ACS).

Both groups had no significant difference regarding age, gender, and residence. The mean of age in the diabetic groups was 55.07 ± 8.2 years old in comparison to 55.45 ± 7.9 years old in the control (non-diabetic) group. The majority of the patients were males in diabetic and control groups (68.5% and 78% respectively). There was no significant difference regarding the residency in both groups (p = 0.610), Regarding Smoking as a risk factor, Smoking index and the anthropometric measures, were statistically insignificant in both groups. The general characteristics (risk factors, age and gender) of the patient population were set out in **(Table 1)**

Table 1: Baseline Characteristics of the studied groups

	Control (n= 82)	Diabetics (n= 124)	P-value
Age/years	55.45 ± 7.9	55.07 ± 8.2	= 0.735*
Sex			
• Male	64 (78%)	85 (68.5%)	= 0.136**
• Female	18 (22%)	39 (31.5%)	
Residence			
• Rural	42 (51.2%)	68 (54.8%)	= 0.610**
• Urban	40 (48.8%)	56 (45.2%)	
Smoking Status			
• Non-smoker	22 (26.8%)	47 (37.9%)	
• Current Smoker	39 (47.6%)	60 (48.4%)	= 0.061**
• Ex-smoker	21 (25.6%)	17 (13.7%)	
Smoking Index	150 (0 - 900)	300 (0 - 900)	= 0.358***
Smoking Type			
• Cigarette	33 (40.2%)	56 (45.2%)	
• Shisha	1 (1.2%)	1 (0.8%)	= 0.691**
• Both	7 (8.5%)	7 (5.6%)	

*Independent t-test was used to compare differences in means between groups.

**Chi-square test was used to compare differences in frequency between groups.

***Mann Whitney U-test was used to compare differences in medians between groups.

BMI =Body Mass Index; WC=Waist Circumference; W/C = Waist Circumference; W/Ht.=Wait /Hight; WHR/HC =Waist hip ratio /Hip Circumference); cm=centimeter

Both groups were comparable regarding the history of previous CVS, previous CABG (p=0.160 and 0.871 respectively). History of previous PCI was significantly (p=0.043) higher among control group (98%) compared with the diabetic cases (90%). Likely, the prevalence of hypertension was significantly (p = 0.026) higher in diabetic group (55%) than control group (39%).

Regarding the clinical characteristics of the group with diabetes (n=124), the average duration of diabetes was 12.74 ± 1.5 years. In terms of oral medications for diabetes mellitus, 15.3% (n=19) were solely on metformin, 33.9% (n=42) were on a combination of oral medication, and 11.3% (n=14) switched from oral medications to insulin.

As for the involvement of coronary vessels, the presence of multi-vessel affection was found to be insignificantly (p=0.618) lower in the diabetic patients (81.5%, n=101) compared to the control group (84.1%, n=69).

During the duration of the study, it was observed that patients who underwent PCI more than once accounted for approximately 39% (n=48) of the diabetic group and 35.4% (n=29) of the control group, and this difference was not statistically significant (p=0.302).

Furthermore, an insignificant (p=0.201) higher percentage of diabetic patients (84%) necessitated the use of drug-eluting stents (Everolimus eluting stent and Zotarolimus eluting stent) when compared to the control group (76%). Similarly, the difference in the distribution of the number of stents utilized was insignificant (p=0.364). Moreover, the frequency of individuals who had two or more grafts during CABG was higher in the group of diabetic patients (50%) compared to the control group (43%). However, this difference did not reach the level of statistical significance (p=0.102).

In terms of the change in blood urea level, there was a statistically significant difference in the mean level of blood urea at the baseline, 6-months, and 1-year follow-up in both the diabetic and control groups (p = 0.022 and 0.045 respectively). Similarly, the mean level of serum creatinine showed a significant difference at the baseline, 6-months, and 1-year follow-up in both the diabetic and control groups (p = 0.004 and 0.015 respectively).

Regarding the change in hemoglobin levels, there was a statistically significant difference in the mean level at the baseline, 6-months, and 1-year follow-up in both the control and diabetic groups (p = 0.001 and 0.001, respectively) with a tendency towards lower values in both groups. In relation to the white blood cell count, there was a statistically significant difference in the mean level in the diabetic groups at the baseline, 6-months, and 1-year follow-up (p = 0.001). However, there was no statistically significant difference in the change of measures in the control group (p = 0.182). Regarding the platelet count, there was a statistically significant difference in the mean count at the baseline, 6-months, and 1-year follow-up in both the control and diabetic groups (p < 0.001 in both groups).

Table 2: Change of blood picture Parameters over Time

(Mean ± SD)	Control (n= 82)	P-value**	Diabetics (n=124)	P-value**	P-value***
Hemoglobin (gm/dl)					
• Baseline (1)	13.70 ± 1.2	1 vs. 2<0.001*	12.85 ± 1.3	1 vs. 2<0.001*	= 0.001*
• 6-Month FU (2)	12.37 ± 2.6	2 vs. 3=0.637	11.90 ± 2.4	2 vs. 3=0.065	= 0.212
• 1-Year FU (3)	11.49 ± 2.5	1 vs. 3<0.001*	10.44 ± 2.6	1 vs. 3<0.001*	= 0.103
P-value*	< 0.001*		= 0.001*		= 0.231
White blood cell count *10³					
• Baseline (1)	6.56 ± 1.8	1 vs. 2=0.646	7.20 ± 2.5	1 vs. 2=0.001*	= 0.033*
• 6-Month FU (2)	6.26 ± 1.5	2 vs. 3=0.136	5.99 ± 1.3	2 vs. 3=0.002*	= 0.501
• 1-Year FU (3)	4.99 ± 1.2	1 vs. 3<0.001*	5.23 ± 1.1	1 vs. 3<0.001	= 0.525
P-value*	= 0.182		= 0.001*		= 0.438
Platelet count *10³					
• Baseline (1)	258.5 ± 18.5	1 vs. 2<0.001*	243.4 ± 15.7	1 vs. 2<0.001*	= 0.115
• 6-Month FU (2)	215.9 ± 20.4	2 vs. 3=0.024*	199.5 ± 17.5	2 vs. 3=0.066	= 0.196
• 1-Year FU (3)	197.6 ± 20.1	1 vs. 3<0.001*	183.2 ± 19.7	1 vs. 3<0.001*	= 0.231
P-value*	< 0.001*		< 0.001*		= 0.926

*Two-Way Repeated Measure ANOVA was used to compare the mean differences over time.

**Post-hoc test with Bonferroni Correction for Pairwise comparison.

***Independent t-test was used to compare the mean differences.

Regarding the change in AST level, there was a statistically significant difference in the mean levels at the base line, 6-months and 1-year follow up in the diabetic and control groups with tendency to lower value (p = 0.009 and 0.034 respectively). Also, there was a statistically significant difference in the mean ALT levels at the base line, 6-months and 1-year follow up in the diabetic and control groups (p = 0.001 and 0.001 respectively). Further, there was a statistically significant disparity observed in the average serum albumin levels at the baseline, 6-months, and 1-year follow-up periods among individuals with diabetes (p = 0.016). Conversely, no significant change was observed in the control group (p = 0.671).

It is likely that there was a statistically significant difference in the mean cholesterol levels at the baseline, 6-months, and 1-year follow-up periods for both the diabetic and control groups (p = 0.044 and 0.047, respectively). However, the change in serum HDL level did not show any significant difference in the mean levels at the baseline, 6-months, and 1-year follow-up periods for both the diabetic and control groups (p = 0.337 and 0.214, respectively). Similarly, there was no significant difference in the mean LDL level at the baseline, 6-months, and 1-year follow-up periods for both the diabetic and control groups (p = 0.289 and 0.341, respectively). In an unlikely scenario, there was a statistically significant difference in the mean triglyceride level at the baseline, 6-months, and 1-year follow-up periods for both the diabetic and control groups (p = 0.001 and 0.001, respectively). Additionally, the reduction in TGD level was higher in the control group compared to the diabetic group (p = 0.041).

The multivariable logistic regression model was used to determine the predictors of successful revascularization among diabetic cases (n=70). After adjusting for age and sex, the final model included 10 predictors, namely revascularization technique, admission days, Hgb at ICU, admission TGD, HbA1C, PCI, stent, graft number, and ICU admission number.

In simpler terms, patients who underwent CABG were 2.9 times (OR=2.88, 95% CI; 1.18–7.02, p=0.02) more likely to experience successful revascularization compared to those who underwent PCI, and this difference was statistically significant (p= 0.020).

Furthermore, it was discovered that for every one-day reduction in the duration of admission, there was a 10% (OR=1.10, 95% CI; 1.01–1.20, p=0.026) increase in the likelihood of successful revascularization.

Likewise, for every one g/dl increase in the level of Hgb at ICU, there was a 31% (OR=1.31, 95% CI; 1.04–1.65, p=0.022) increase in the probability of successful revascularization. It is likely that for every one percentage decrease in the HbA1c at admission, there was a 40% (OR=1.401, 95% CI; 1.052–1.864, p=0.021) increase in the likelihood of successful revascularization.

Additionally, it was observed that a lower number of previous ICU admissions, a smaller number of previous PCIs, and a smaller number of used stents were significant predictors for successful revascularization (p= 0.015, p<0.001, and <0.001, respectively).

The increase in the number of used grafts in CABG was a statistically significant predictor for successful revascularization (OR=1.664, 95% CI; 1.104 – 2.508, p= 0.015).

Table 3: Independent Predictors of Successful Revascularization among Diabetic Patients: Multivariable Logistic Regression Model

	OR (95% CI) *	*P*-value
• Age/years	0.983 (0.930 – 1.038)	= 0.530
• Sex (Male)	1.733 (0.633 – 4.421)	= 0.285
• CABG vs PCI	2.880 (1.181 – 7.024)	= 0.020*
• Days of Admission	1.102 (1.012 – 1.201)	= 0.026*
• Hemoglobin at ICU	1.309 (1.039 – 1.649)	= 0.022*
• Triglyceride Admission	0.993 (0.986 – 0.999)	= 0.048*
• HbA1C	1.401 (1.052 – 1.864)	= 0.021*
• Numbers of PCI after ACS	0.178 (0.089 – 0.355)	< 0.001*
• Numbers of Stents	0.409 (0.261 – 0.642)	< 0.001*
• Numbers of Grafts	1.664 (1.104 – 2.508)	= 0.015*
• No. ICU Admissions	0.610 (0.409 – 0.908)	= 0.015*

OR=Odds Ratio; CI, Confidence Interval

During follow up, It was observed that the diabetic patients who underwent CABG had a significantly higher rate of in-hospital hemodialysis compared to those who underwent PCI (p = 0.001). Furthermore, there was a significant difference in the change of albumin levels between PCI patients and CABG patients (p = 0.033).

Among the non-diabetic group, there was a noteworthy decrease in serum triglyceride levels in the CABG patients compared to the PCI patients (p = 0.039). However, there was no significant difference observed among the non-diabetic patients who underwent either of the two procedures with regards to various metabolic outcomes.

In terms of the short-term clinical outcome after 6 months, both diabetic and control patients who underwent CABG had a significantly higher incidence of MACE compared to patients managed with PCI (p = 0.041 and 0.023 respectively). Additionally, the median ICU admissions within a 6-month period were significantly higher among diabetic patients who underwent CABG compared to the PCI group (p = 0.023).

In the long-term post-procedural outcome after 1 year, both diabetic and control patients who underwent PCI showed a significantly higher incidence of revascularization compared to those exposed to CABG (p = 0.017 and 0.018, respectively). Furthermore, diabetic cases who underwent CABG had a significantly higher incidence of MACE, revascularization, median ICU admissions, and mortality during the 1-year duration compared to the PCI group (p = 0.023, 0.017, 0.007, and 0.041 respectively).

Diabetic patients had a significantly higher risk of developing MACE compared to non-diabetic patients (p = 0.009). Patients on hemodialysis showed a significant incidence of MACE compared to those who did not undergo hemodialysis (p = 0.000). Additionally, patients with low Hb levels had a significantly higher incidence of MACE compared to those with higher Hb levels (p = 0.049).

Table 4: Post-procedural (Long- and short-term Outcome)

	Control (n=82)		P-value	Diabetic (n= 124)		P-value
	PCI (n=37)	CABG (n=45)		PCI (n=51)	CABG (n=73)	
In-Hospital Dialysis No (%)	1 (2.7%)	5 (11.1%)	= 0.157*	2 (3.9%)	21 (28.8%)	= 0.001*
Anemia No. (%)	7 (18.9%)	7 (15.6%)	= 0.678*	13 (25.5%)	15 (20.5%)	= 0.517*
BMI Change% (Mean ± SD)	-4.9 ± 0.2	-4.1 ± 0.2	= 0.866**	-16.3 ± 0.4	-13.1 ± 0.3	= 0.633**
Albumin Change% (Mean ± SD)	-7.6 ± 1.2	25.5 ± 2.9	= 0.046**	-14.6 ± 1.4	-7.9 ± 1.3	= 0.033**
Triglycerides Change% (Mean ± SD)	-17.7 ± 4.6	-24.1 ± 5.2	= 0.039**	-25.9.3 ± 6.1	-27.3 ± 4.3	= 0.483**
HbA1C Change% (Mean ± SD)	-2.6 ± 0.3	-1.1 ± 0.1	= 0.126**	-10.9 ± 1.1	-14.2 ± 1.3	= 0.064**

*Chi-square test was used to compare differences in frequency between groups.

**Independent Sample t-test was used to compare differences in means between groups.

***Mann Whitney U-test was used to compare differences in medians between group.

Table 5: Post-procedural Complications within 6-months (Short term Clinical Outcome)

	Control (n=82)		P-value	Diabetic (n= 124)		P-value
	PCI (n=37)	CABG (n=45)		PCI (n=51)	CABG (n=73)	
MACE	0 (0%)	6 (13.3%)	= 0.023*	3 (6%)	10 (13.7%)	= 0.041*
Revascularization	1 (0%)	5 (6.7%)	= 0.160*	0 (2%)	3 (6.8%)	= 0.210*
Mortality at 6-months	0 (0%)	4 (8.9%)	= 0.085*	3 (5.9%)	7 (9.6%)	= 0.347*
No. ICU Admissions (Median (IQR))	0 (0 - 2)	0 (0 - 3)	= 0.245**	0 (0 - 2)	1 (0 - 4)	= 0.023***

*Chi-square test was used to compare differences in frequency between groups.

**Independent Sample t-test was used to compare differences in means between groups.

***Mann Whitney U-test was used to compare differences in medians between groups.

Table 6: Post-procedural Complications within one-year (Log term Clinical Outcome)

	Control (n=82)		P-value	Diabetic (n= 124)		P-value
	PCI (n=37)	CABG (n=45)		PCI (n=51)	CABG (n=73)	
MACE	1 (2.7%)	6 (13.3%)	= 0.091*	3 (6%)	15 (20.5%)	= 0.023*
Revascularization	12 (32.4%)	5 (11.1%)	= 0.018*	16 (31.4%)	10 (13.7%)	= 0.017*
Stroke	0 (0%)	1 (2.2%)	= 0.549*	1 (2%)	0 (0%)	= 0.411*
Positive COVID Infection	27 (73%)	31 (68.9%)	= 0.686*	35 (70%)	46 (63%)	= 0.422*
Mortality at 1-year	1 (2.7%)	4 (8.9%)	= 0.284*	3 (6%)	10 (13.7%)	= 0.041*
No. ICU Admissions (Median (IQR))	0 (0 - 4)	0 (0 - 5)	= 0.167**	0 (0 - 4)	1 (0 - 6)	= 0.007***

*Chi-square test was used to compare differences in frequency between groups.

**Independent Sample t-test was used to compare differences in means between groups.

***Mann Whitney U-test was used to compare differences in medians between group.

Table 7: Predication of Major adverse cardiovascular events outcome (short- and long-term outcome)

		MACE		P-value
		Yes (n= 25)	No (n= 181)	
		Mean ± SD	Mean ± SD	
DM	No. (%)	21 (84.0%)	103 (56.9%)	0.009*
Dialysis	No. (%)	15 (60.0%)	14 (7.7%)	0.000*
BMI		32.72 ± 5.47	32.88 ± 6.73	0.911
Hb		12.72 ± 1.22	13.26 ± 1.27	0.049*
Cholesterol		194.25 ± 10.41	188.23 ± 29.02	0.316
Triglyceride		143.29 ± 56.39	153.50 ± 50.74	0.599

Chi-square test was used to compare differences in frequency between groups.

Independent Sample t-test was used to compare differences in means between groups.

Discussion: The present study examined various predictors of clinical outcomes in patients with type 2 diabetes mellitus who presented with acute coronary syndrome and underwent either percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG). In our study of metabolic predictors, we observed that diabetic patients exhibited higher levels of blood urea, serum creatinine, and lower hemoglobin levels compared to non-diabetic patients. Furthermore, this patient group experienced greater changes in serum cholesterol and triglyceride levels during the one-year follow-up after the intervention. These findings align with the research conducted by Victòria Lorente et al., who reported that diabetic patients admitted to the intensive care unit (ICU) with high-risk acute coronary syndrome (ACS) had higher rates of anemia compared to non-diabetic patients ($p = 0.001$) (8). Similarly, Penta Bhavanadhar et al. found that diabetic patients with ACS exhibited lower hemoglobin levels ($p = 0.04$) (9). This can be attributed to the presence of chronic anemia, which commonly associated with older age and comorbidities such as hypertension, diabetes mellitus, peripheral vascular disease, and a history of myocardial infarction (MI). Additionally, hospital-acquired anemia (HAA) is frequently observed in MI patients, which linked to an increased risk of bleeding and hem dilution. Lastly, anemia induced by inflammation in the ischemic myocardium can lead to a rapid decline in hemoglobin (Hb) levels (approximately 2-3 g/dL) within one to two days. This process is mediated by tumor necrosis factor-alpha and suppressed erythropoiesis. Anemia in the context of MI is speculated to increase catecholamine levels, disrupt oxygen supply and demand, impair vascular healing, deplete nitric oxide, and induce reactive oxygen species-mediated ischemia-reperfusion injury and pathological ventricular remodeling *(10)*.

Cheng-Chun Wei has previously documented a similar discovery in the present study. They reported that individuals with both diabetes and acute coronary syndrome (ACS) exhibited significantly elevated levels of serum creatinine ($p < 0.001$). Additionally, they observed that this particular patient group faced a higher likelihood of requiring renal dialysis compared to the non-diabetic group ($p < 0.001$) (11). The occurrence of acute kidney injury (AKI) following a medical procedure has been correlated with a notable increase in short- and long-term mortality rates, as well as renal function decline. Few investigations have directly compared the incidence of post-procedural AKI and in-hospital mortality rates between two principal revascularization modalities, namely coronary artery bypass grafting (CABG) and percutaneous coronary intervention (PCI). Furthermore, the results of these studies have been inconsistent. Specifically, the incidence of AKI after CABG was found to be higher than that following PCI (8.9% vs. 4.5%, OR 2.05, 95% CI 1.99-2.12, $p < 0.001$) (12).

In our own study, a multivariable logistic regression model was employed to identify predictors of successful revascularization among diabetic patients. After adjusting for age and sex, the final model included 10 predictors: revascularization technique, length of admission, hemoglobin (Hgb) level at the intensive care unit (ICU), admission TGD level, HbA1C level, number of PCI/stent/graft procedures, number of ICU admissions, and change in glucose level. Our study discovered that patients who underwent CABG had a 2.9-fold greater likelihood of achieving successful revascularization in comparison to those who underwent PCI. Additionally, for each day reduction in admission duration, there was a 10% increase in the likelihood of successful revascularization. Furthermore, for each 1 g/dl increase in Hgb level at the ICU, there was a 31% increase in the likelihood of successful revascularization. Moreover, a lower number of previous ICU admissions, a smaller number of previous PCI procedures, and a smaller number of utilized stents were identified as statistically significant predictors of successful revascularization.

Revascularization in diabetic patients may partially mitigate the impact of DM on unfavorable outcomes. Additionally, it has been discovered that the completeness of revascularization achieved with CABG is associated with a higher number of treated lesions and a greater percentage of successful complete revascularization when compared to a PCI strategy (13).

According to the multivariate analysis conducted by Lee MG et al to identify predictors of in-hospital death following revascularization, factors such as old age (> 65 years old), low HDL cholesterol levels, and multi-vessel involvement are indicative of worse outcomes post-procedure ($p < 0.001$, $<0.001 = 0.003$, and $= 0.015$, respectively) (15).

In our study, it was observed that mortality and one-year ICU admissions were significantly more prevalent among the group of diabetic patients. This group also showed a higher inclination towards undergoing CABG rather than PCI. Patients who underwent CABG exhibited higher rates of one-year revascularization and mortality compared to those who underwent PCI. This finding is consistent with the study conducted by Srinidhi S. Hegde et al, who reported that a majority of diabetic patients (46%) require CABG as a treatment option, as opposed to only 16% of non-diabetics (16). In our study, it was found that apart from one-year revascularization, there was no significant difference between CABG and PCI in terms of the occurrence of adverse outcomes in diabetic patients. In the FREEDOM trial, there were minimal differences in baseline characteristics between CABG and PCI/DES treatment in both the Insulin-treated group, and these differences were not variables that are known to be strong risk factors for unfavorable outcomes *(17)*.

Our study has discovered a higher rate of mortality within one year and a lower rate of revascularization within one year in patients who have undergone PCI. This finding is consistent with the results of the CARDia trial and the 5-year findings of the SYNTAX trial, which both indicate higher rates of major adverse cardiac and cerebrovascular events in diabetic patients treated with PCI compared to those treated with CABG. The superiority of CABG treatment over PCI/DES is not only evident in repeat revascularization, but also in a significant reduction in all-cause death and myocardial infarction in patients with diabetes and multivessel disease. The protective effects of CABG may be attributed to the higher rates of restenosis following angioplasty in patients with diabetes and incomplete revascularization associated with multi vessel angioplasty (18,19).

In our study, we observed higher mortality in diabetic patients with acute coronary syndrome (ACS) compared to the non-diabetic group. This finding is consistent with the Gulf COAST Registry, which reported significantly higher in-hospital, 30-day, and 1-year mortality rates in patients with diabetes compared to those without diabetes (22). Another study that examined the influence of diabetes on mortality following ACS, found similar results. Diabetes at presentation with ACS was associated with significantly higher mortality one year after UA/NSTEMI. Xiaolong Ma et al. reported no significant difference in overall major adverse cardiac events between diabetic and non-diabetic patients who had undergone PCI with a previous history of CABG ***(20)*.**Guo et al 2020 discovered that the frequency of major adverse cardiovascular events (MACE) was significantly higher in individuals with diabetes compared to those without diabetes. The adjusted hazard ratio (HR) was 1.32, with a 95% confidence interval (CI) of 1.09-1.61 and a p-value of 0.005. Within the diabetic group, the MACE rate was significantly lower in the successful chronic total occlusions percutaneous coronary intervention (PCI) group compared to the medical therapy group, with an adjusted HR of 0.61, a 95% CI of 0.42-0.87, and a p-value of 0.006. Furthermore, in the non-diabetic group, the prevalence of MACE (adjusted HR 0.85, 95% CI 0.64-1.15, p=0.294) and cardiac death (adjusted HR 0.94, 95% CI 0.51-1.70, p=0.825) were similar between the two groups (14).

According to the study conducted by Cebrián-Cuenca (year not specified), patients with type 2 diabetes mellitus (T2DM) accounted for more than 25% of all coronary artery disease (CAD) patients who underwent percutaneous coronary intervention (PCI). Despite advancements in stent technologies, T2DM remains a significant risk factor for major adverse cardiovascular events (MACE) following PCI. Therefore, identifying biomarkers that can predict post-PCI outcomes noninvasively in type 2 diabetic patients holds great clinical significance (21). Our study also supports these findings, as it revealed that diabetic patients had a higher risk of ICU admission and mortality within one year after the intervention compared to the non-diabetic group.

Conclusion

In our study, it was observed that diabetes mellitus, hemodialysis, and low hemoglobin (Hb) levels were significant predictors for the development of major adverse cardiovascular events (MACE). Diabetic patients had a significantly higher risk of developing MACE compared to non-diabetic patients (p=0.009). Patients on hemodialysis showed a significantly higher incidence of MACE compared to those who did not undergo hemodialysis (p=0.000). Similarly, patients with low Hb levels had a significantly higher incidence of MACE compared to those with higher Hb levels (p=0.049). In line with our study, Padda et al. (year not specified) also found that anemia is associated with increased all-cause mortality in acute myocardial infarction. (10).

References

1) Yeh, R.W.; Sidney, S.; Chandra, M.; Sorel, M.; Selby, J.V.; Go, A.S. Population trends in the incidence and outcomes of acute myocardial infarction. *N. Engl. J. Med.* **2010**, *362*, 2155–2165.
2) Virani, S.S.; Alonso, A.; Benjamin, E.J.; Bittencourt, M.S.; Callaway, C.W.; Carson, A.P.; Chamberlain, A.M.; Chang, A.R.; Cheng, S.; Delling, F.N.; et al. Heart Disease and Stroke Statistics-2020 update: A report from the American Heart Association. *Circulation* **2020**, *141*, e139–e596.
3) Refaat Allam, Sameh, El-Sayed Ali Abdo El-Marghany, and Omar Ahmed Helmi. "IMPACT OF DIABETES MELLITUS ON MICROVASCULAR MYOCARDIAL PERFUSION AND LEFT VENTRICULAR REMODELING IN PATIENTS WITH ACUTE MYOCARDIAL INFARCTION TREATED WITH PRIMARY CORONARY INTERVENTION." *Al-Azhar Medical Journal* 49.1 (2020): 149-160.
4) Babes, E.E.; Zaha, D.C.; Tit, D.M.; Nechifor, A.C.; Bungau, S.; Andronie-Cioara, F.L.; Behl, T.; Stoicescu, M.; Munteanu, M.A.; Rus, M.; et al. Value of Hematological and Coagulation Parameters as Prognostic Factors in Acute Coronary Syndromes. *Diagnostics* **2021**, *11*, 850
5) Hider, Doha Ibrahim, et al. "The relationship between liver and kidney dysfunction with acute myocardial infarction." *Minia Journal of Medical Research* (2024).
6) Zhou Y, Chen Z, Chen A, Ma J, Dai C, Lu D, et al. (2022): Association between the magnitude of periprocedural myocardial injury and prognosis in patients undergoing elective percutaneous coronary intervention. European Heart Journal-Quality of Care and Clinical Outcomes, 8(8): 871-880.
7) Hassan AK, Bergheanu SC, Hasan-Ali H, San Liem S, Van Der Laarse A, Wolterbeek R, et al. (2009): Usefulness of peak troponin-T to predict infarct size and long-term outcome in patients with first acute myocardial infarction after primary percutaneous coronary intervention. The American journal of cardiology, 103(6): 779-784.
8) Lorente V, Aboal J, Garcia C, Sans-Roselló J, Sambola A, Andrea R, et al. (2020): Anemia in patients with high-risk acute coronary syndromes admitted to Intensive Cardiac Care Units. Journal of Geriatric Cardiology: JGC, 17(1): 35.
9) Bhavanadhar P, Srinivasan VR, Oruganti SS & Adiraju KP (2016): A prospective study on prevalence and causes of anaemia in patients with acute coronary syndrome. Journal of clinical and diagnostic research: JCDR, 10(7): OC01.
10) Padda J, Khalid K, Hitawala G, Batra N, Pokhriyal S, Mohan A, et al. (2021): Acute anemia and myocardial infarction. Cureus, 13(8).

11) Wei C-C, Shyu K-G, Cheng J-J, Lo H-M & Chiu C-Z (2016): Diabetes and adverse cardiovascular outcomes in patients with acute coronary syndrome-data from Taiwan's Acute Coronary Syndrome Full Spectrum Data Registry. Acta Cardiologica Sinica, 32(1): 31.
12) Shen W, Aguilar R, Montero AR, Fernandez SJ, Taylor AJ, Wilcox CS, et al. (2017): Acute kidney injury and in-hospital mortality after coronary artery bypass graft versus percutaneous coronary intervention: a nationwide study. American journal of nephrology, 45(3): 217-225.
13) Wang S, Borah BJ, Cheng S, Li S, Zheng Z, Gu X, et al. (2021): Diabetes associated with greater ejection fraction improvement after revascularization in patients with reduced ejection fraction. Frontiers in Cardiovascular Medicine, 8: 751474.
14) Guo L, Wang J, Ding H, Meng S, Zhang X, Lv H, et al. (2020): Long-term outcomes of medical therapy versus successful recanalisation for coronary chronic total occlusions in patients with and without type 2 diabetes mellitus. Cardiovascular Diabetology, 19: 1-12
15) Lee MG, Jeong MH, Ahn Y, Chae SC, Hur SH, Hong TJ, et al. (2010): Impact of the metabolic syndrome on the clinical outcome of patients with acute ST-elevation myocardial infarction. Journal of Korean medical science, 25(10): 1456-1461.
16) Hegde SS, Mallesh P, Yeli S & Gadad VM (2014): Comparitive angiographic profile in diabetic and non-diabetic patients with acute coronary syndrome. Journal of clinical and diagnostic research: JCDR, 8(9): MC07.
17) Dangas GD, Farkouh ME, Sleeper LA, Yang M, Schoos MM, Macaya C, et al. (2014): Long-term outcome of PCI versus CABG in insulin and non–insulin-treated diabetic patients: results from the FREEDOM trial. Journal of the American College of Cardiology, 64(12): 1189-1197.
18) Kapur A, Hall RJ, Malik IS, Qureshi AC, Butts J, De Belder M, et al. (2010): Randomized comparison of percutaneous coronary intervention with coronary artery bypass grafting in diabetic patients: 1-year results of the CARDia (Coronary Artery Revascularization in Diabetes) trial. Journal of the American College of Cardiology, 55(5): 432-440.
19) Head SJ, Davierwala PM, Serruys PW, Redwood SR, Colombo A, Mack MJ, et al. (2014): Coronary artery bypass grafting vs. percutaneous coronary intervention for patients with three-vessel disease: final five-year follow-up of the SYNTAX trial. European heart journal, 35(40): 2821-2830.
20) Ma X, Dong R, Chen P, Zhao Y, Zeng C, Xin M, et al. (2020): Percutaneous coronary intervention in diabetic versus non-diabetic patients with prior coronary artery bypass grafting: a propensity score matching study. BMC cardiovascular disorders, 20(1): 1-12.
21) Cebrián-Cuenca AM, Mata-Cases M, Franch-Nadal J, Mauricio D, Orozco-Beltrán D & Consuegra-Sánchez L (2021): Half of patients with type 2 diabetes mellitus are at very high cardiovascular risk according to the ESC/EASD: data from a large Mediterranean population. European Journal of Preventive Cardiology, 28(18): e32-e34.
22) Shehab A, Bhagavathula AS, Al-Rasadi K, Alshamsi F, Al Kaab J, Thani KB, et al. (2020): Diabetes and mortality in acute coronary syndrome: findings from the Gulf COAST registry. Current Vascular Pharmacology, 18(1): 68-76.