Can Pre-Operative HbA1c Values in Coronary Surgery be a Predictor of Mortality?

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Objective: One of the most frequently studied parameters in terms of outcome estimation in cardiac surgery is HbA1c. Several studies in literature suggest that high HbA1c value increases mortality and morbidity, but there is no relation between them. The primary aim of the present study is to investigate whether HbA1c value in diabetic patients undergoing coronary bypass graft surgery is an independent predictor for post-operative mortality and morbidity, and our secondary goal was to determine independent risk factors that cause mortality and morbidity in the same patient population.

Methods: 380 diabetic patients diagnosed with diabetes who underwent coronary surgery with cardiopulmonary bypass in Mersin State hospital between July 2014 to December 2016 after the approval of the Mersin University Faculty of medicine ethics committee were included in this retrospective, observational, and cross-sectional study. Patient demographic and perioperative information were obtained from the electronic information operating system and from anesthesia-intensive care follow-up forms. The HbA1c threshold was accepted as 7%, which was reported to be more appropriate for evaluating high-risk groups.

Results: Three hundred and fifty-four patients with complete access to the data were included in the study. The mean age of the patients was 60.8±9.4 years. 37% of the patients (131 patients) were female. The number of patients with HbA1c≥7 was 194 (54,8%) in the entire patient population. In this study, high HbA1c (≥7) values in diabetic patients undergoing isolated coronary bypass graft surgery were not found to be independent predictors of post-operative mortality and morbidity. Mortality was seen in 28 patients (7.9%). Ejection fraction (EF) was found to be an independent predictor factor for pre-operative factors in logistic regression models constructed according to mortality predictors (OR:0.94; 95% CI: 0.90–0.99; p=0.016). Complications were seen in 50 patients (14.1%). In the models formed from the point of view of the complication predicators, only EF was found to be independent predictor (OR:0.95; 95% CI: 0.92–0.98; p=0.004). It was found that HbA1c was not predictive in all models for mortality and complication (p>0.05).

Conclusion: There are reports in the literature that mortality increases 4-fold when HbA1c value is higher than 8.6% in coronary surgery. However, there is a view that HbA1c alone cannot predict mortality in coronary surgery if diabetes associated factors are excluded. In this study, high HbA1c (≥7) values in diabetic patients undergoing isolated coronary bypass graft surgery were not found to be independent predictors of post-operative mortality and morbidity. Pre-operative low ejection fraction was found as an independent risk factor for post-operative mortality and morbidity in the general patient population.

Keywords: Diabetes mellitus, HbA1c, glycosylated hemoglobin, cardiac anesthesia, cardiac surgery, mortality prediction
Introduction

It is possible to optimise patient management in advance by determining the risks that may be encountered during cardiac surgeries in the preoperative period. Keeping the comorbidities under control, determination of intraoperative anaesthesia management and postoperative careful follow-up ensure patient protection from the predicted risks. Because of all these reasons, various scoring systems and some laboratory values are used preoperatively. Some of the parameters that are routinely examined while preparing the patient for surgery help us do a risk assessment for the postoperative outcome.

Glycosylated haemoglobin (HbA1c) is one of the most frequently studied parameters for outcome prediction in cardiac surgery. HbA1c test is a blood test used to measure the efficacy of antidiabetic therapy and, sometimes, to diagnose diabetes. A glycosylation reaction occurs when haemoglobin is exposed to blood sugar. The glycosylation reaction is defined as adherence of sugar molecules in the blood to haemoglobin, resulting in structural changes. During 120 days of erythrocyte lifespan, the rate of glycosylation of haemoglobin increases in parallel with the blood glucose levels. The HbA1c test measures the rate of glycosylation; therefore, HbA1c provides information about the blood glucose profile belonging to the erythrocyte lifespan, which is past 2–3 months. Levels of ≥7% indicate poor blood glucose control. Although some articles in the literature argue that high HbA1c levels increase mortality and morbidity, there are studies arguing that there is no relation between them (1–3). In this study, our primary aim was to investigate whether HbA1c levels are an independent predictor for postoperative mortality and morbidity among diabetic patients who underwent coronary artery bypass graft surgery at our hospital and our secondary aim was to determine the independent risk factors associated with mortality and morbidity in the same patient population.

Methods

After the approval of the Ethics Committee of the Mersin University Medical Faculty (14.07.2016-231), 380 patients who underwent isolated coronary surgery at the Mersin State Hospital between July 2014 and December 2016 and who were using oral antidiabetics and were known to have diabetes mellitus were included in our retrospective, observational and descriptive study. As a routine practice at the cardiac surgery outpatient clinic of our hospital, HbA1c levels of diabetic patients are examined along with other routine examinations approximately 7–10 days before the surgery. In the same preoperative preparation period, endocrinology and cardiology consultations are requested and ejection fraction measurements and other echocardiographic evaluations are made using echocardiography. One night before the surgery, infusion of a buffered fluid is started with the recommendations of the endocrine clinic, and it is continued until the morning of the surgery. The surgery is allowed by the anaesthesia clinic if fasting blood glucose (FBG) levels are<120 mg/dL on the morning of the surgery in diabetic patients. In the intraoperative period, blood gas and glucose levels are followed up, and blood glucose regulation is achieved through insulin, buffered fluid and potassium replacement in patients in whom it is required.

The demographic and perioperative information of the patients for our study was obtained from the electronic information operating system and anaesthesia-intensive care follow-up forms. Women and men aged between 18 and 80 years who underwent elective, on-pump, coronary artery bypass graft surgery were included in the study. The patients in whom surgery was performed under emergency and semi-emergency conditions, paediatric patients, the patients who underwent combined procedures and the patients who underwent off-pump cardiac surgery were excluded from the study. Their demographic data, preoperative comorbidities and American Society of Anaesthesiology (ASA) scores and European System for Cardiac Operative Risk Evaluation (EuroSCORE) information were recorded. HbA1c threshold was accepted as 7%, which was reported to be more appropriate

| Table 1. Perioperative patient information according to the HbA1c value |
|---------------------------------------------------------------|
|                  | <7 (n=160) | ≥7 (n=194) | p   |
| Age              | 62.01±9.81 | 59.84±8.97 | 0.018|
| Gender (F/M)     | 49/111    | 84/110     | 0.007|
| ASA 2            | 60        | 71         | 0.790|
| 3                | 98        | 123        |      |
| Logistic EuroSCORE| 2.63±2.66 | 2.61±2.49  | 0.874|
| EF               | 51.27±8.35 | 48.67±9.82 | 0.024|
| Preoperative Hct  | 38.59±11.15 | 37.67±5.90 | 0.721|
| Smoking          | 33 (20.6%) | 25 (12.9%) | 0.050|
| COPD             | 31 (19.4%) | 33 (17%)   | 0.565|
| HT               | 73 (45.6%) | 99 (51%)   | 0.311|
| Peripheral vascular disease | 11 (6.9%) | 19 (9.8%) | 0.326|
| HL               | 33 (20.6%) | 35 (18%)   | 0.539|
| Cerebrovascular disease | 3 (1.9%) | 3 (1.5%) | 1.000|
| Duration of surgery, minute | 251.02±48.25 | 259.01±57.06 | 0.205|
| Duration of ventilator support, minute | 580.94±975.39 | 1267.78±829.1 | 0.287|
| Duration of stay in intensive care unite, day | 2.74±2.15 | 2.84±2.36 | 0.790|
| Duration of stay in hospital, day | 8.14±4.49 | 8.64±5.15 | 0.491|
| Mortality        | 6 (3.8%)  | 22 (11.3%) | 0.008|

Values are given as mean±standard deviation. F: female; M: male; ASA: American Society of Anaesthesiology; EF: ejection fraction; COPD: Chronic Obstructive Pulmonary Disease; HT: hyperlipidaemia; HL: hypertension.
for evaluating high-risk groups (1). The anaesthesia, cross-
clamp, cardiopulmonary bypass, mechanical ventilation and
intensive care as well as hospital stay durations were record-
ed. Complications developing during the postoperative peri-
od and information related to mortality were also obtained
from the data system. Postoperative complications such as
prolonged ventilation, development of low output, bleed-
ing-induced reoperation, renal insufficiency and postopera-
tive myocardial infarction were evaluated as cerebrovascular
events.

**Statistical analysis**

Primarily, Shapiro–Wilk normality test was applied to deter-
mine the statistical methods to be applied, and nonparametric
test methods were selected in case normality assumption was
not achieved in any of the groups. In this context, Mann–
Whitney U test was used to compare the measured variables in
two independent groups; χ² and Fisher’s exact tests were used
to examine the relationship or differences between the groups
in terms of categorical variables. To determine the risk fac-
tors considered to affect mortality, logistic regression analyses
were first performed, and the variables with a significance level
of ≤0.10 were included in the multivariate logistic regression
model. In the result of the analysis, the variables remaining
in the model and the odds related to them, 95% confidence
intervals (CIs) and ‘p’ values are summarised in the related
tables. The results of other demographic and group compar-
isons concerning the study have been presented as ratios in
qualitative variables and as mean±standard deviation and/or
median (minimum–maximum) in quantitative variables. Sta-
ristical analyses were performed using the programme Statistical
Package for the Social Sciences 15.0 (SPSS Inc., Chicago,
IL, USA), and the significance was set at p<0.05.

**Results**

In total, 354 patients whose complete data could be accessed
were included in our study. The mean age of the patients 37%
(131) of whom were females was 60.8±9.4 years. Of the en-
tire diabetic patient population, the number of patients with
HbA1c≥7 was 194 (54.8%). In the group with HbA1c≥7, the
ejection fraction was lower (p=0.024) and mortality was higher
(p=0.008) (Table 1). Although HbA1c was found to be pre-
dictive in the univariate analysis (Table 2), it was not found
to be an independent predictor of morbidity and mortality in
the multivariate analysis (Table 3). In general, mortality was
seen in 28 (7.9%) patients. In univariate analysis that was per-
formed to investigate the mortality predictivity, age, gender,
logistic EuroSCORE value, input ejection fraction, HbA1c
levels and preoperative albumin levels were found to be associ-
ated with mortality (Table 2). However, in multivariate logistic
regression models based on mortality predictors, among the

| Table 2. Univariate logistic analysis performed to investigate the mortality predictivity (mean±standard deviation) and comorbidity ratios |
|---------------------------------------------------------------|
| **Non-mortality patients (n=326)** | **Patients in whom mortality developed (n=28)** |
| Age (years) | Median (min-max) | Median (min-max) | p |
| 60.53±9.28 | 64.21±10.40 | 0.029* |
| Gender (F/M) | 115/211 | 16/12 | 0.021* |
| ASA 2 | 122 | 9 | 0.563 |
| ASA 3 | 202 | 19 | 0.563 |
| Logistic EuroSCORE | 2.41±2.28 | 5.1±4.05 | <0.001* |
| Ejection fraction | 50.5±8.72 | 42.14±11.74 | <0.001* |
| HbA1c | 7.82±2.21 | 8.73±1.97 | 0.021* |
| Preoperative albumin | 3.86±0.46 | 3.59±0.57 | 0.019* |
| Preoperative creatinine | 1.15±0.17 | 0.99±0.41 | 0.598 |
| Preoperative sodium | 137.6±8.2 | 138 (135–150) | 0.025 |
| Preoperative potassium | 4.28±0.46 | 4.35±0.53 | 0.025 |
| Preoperative haematocrit | 38.24±8.93 | 36.3±0.6 | 0.025 |
| Smoking | 45 (16.6%) | 4 (14.3%) | 0.755 |
| Pulmonary diseases | 57 (17.5%) | 7 (25%) | 0.321 |
| Hypertension | 161 (49.4%) | 11 (39.3%) | 0.305 |
| Peripheral vascular disease | 29 (8.9%) | 1 (3.6%) | 0.332 |
| Hyperlipidaemia | 64 (19.6%) | 4 (14.3%) | 0.491 |
| Cerebrovascular disease | 5 (1.5%) | 1 (3.6%) | 0.423 |

*Parameters with significant difference between the groups. Values are given as mean±standard deviation. ASA: American Society of Anaesthesiology
preoperative factors, only the ejection fraction was found to be an independent predictor of mortality [odds ratio (OR): 0.94; 95% CI: 0.90–0.99; p=0.016]. Each 10% reduction in the ejection fraction was found to increase the mortality risk by about two folds (OR: 0.52; 95% CI: 0.34–0.80; p=0.003). In the intraoperative and postoperative periods, the variables such as erythrocyte transfusion and cross-clamp, cardiopulmonary bypass, surgery, ventilator support and intensive care as well as hospital stay durations were significantly different in patients in whom mortality developed (Table 4).

Postoperative complications were seen in 50 (14.1%) patients. In the univariate analysis that was performed to inves-

| Table 3. Multivariate logistic regression models in terms of mortality |
|------------------------|--------|--------|--------|
| **OR** | **95% CI** | **p** |
| Gender | 2.3 | 0.98–5.3 | 0.056 |
| Age | 1.04 | 0.98–1.08 | 0.146 |
| Ejection fraction | 0.94 | 0.90–0.99 | 0.016* |
| HbA1c | 1.15 | 0.95–1.40 | 0.156 |
| Preoperative albumin | 0.61 | 0.25–1.50 | 0.278 |
| *Parameters with significant difference between the groups |
| CI: Confidence Interval |

| Table 4. Variables associated with intraoperative and postoperative mortality (mean±standard deviation) |
|----------------------------------------|------------------|------------------|--------|
| **Non-mortality patients (n=326)** | **Patients in whom mortality developed (n=28)** | **p** |
| Duration of cross-clamps, minute | 60.24±23.2 | 72.32±33.62 | 0.120 |
| Duration of cardiopulmonary bypass, minute | 100.78±33.8 | 126.54±46.74 | 0.003* |
| Erythrocyte transfusion (unit) | 1.14±1.09 | 2.04±1.55 | 0.002* |
| Duration of surgery | 252.81±49.33 | 285±82.59 | 0.071 |
| Duration of ventilator support | 449.19±236.58 | 6873.75±21410.54 | <0.001* |
| Duration of stay in emergency care unit | 2.62±1.78 | 4.79±4.92 | 0.018 |
| Duration of stay in hospital | 8.5±4.21 | 7.46±9.72 | <0.001* |
| * Parameters with significant difference between the groups |

| Table 5. Univariate logistic analysis (mean ± standard deviation) performed to investigate the predictivity of postoperative complication |
|----------------------------------------|------------------|------------------|--------|
| **Patients without complications (n=304)** | **Median (min-max)** | **Patients with complications (n=50)** | **Median (min-max)** | **p** |
| Age (years) | 60.37±9.35 | 60 (36–83) | 63.58±9.41 | 65 (43–89) | 0.020 |
| Gender (F/M) | 108 (35.5%)/196 (64.5%) | 23 (46%)/27 (54%) | 0.155 |
| ASA 2 | 114 (37.7%) | 17 (34%) | 0.612 |
| ASA 3 | 188 (62.3%) | 33 (66%) | 0.004 |
| Logistic EuroSCORE | 2.36±2.26 | 1.59 (0.88–18.89) | 4.23±3.56 | 3.05 (0.88–17 ) | <0.001 |
| Ejection fraction | 50.66±8.65 | 50 (25–65) | 44.9±11.23 | 50 (25–60) | 0.001 |
| HbA1c | 7.79±2.2 | 7.2 (4.5–14.1) | 8.45±2.1 | 7.9 (4.46–14.5) | 0.040 |
| Preoperative albumin | 3.87±0.45 | 3.9 (2.7–4.9) | 3.63±0.54 | 3.8 (2.3–4.6) | 0.004 |
| Preoperative creatinine | 1.15±4.32 | 0.83 (0.33–76 ) | 1.01±0.38 | 0.94 (0.58–2.46) | 0.061 |
| Preoperative sodium | 137.4±8.25 | 138 (135–150) | 137.68±2.87 | 138 (128–146) | 0.480 |
| Preoperative potassium | 4.27±0.46 | 4.21 (2.85–5.88) | 4.32±0.51 | 4.3 (3.5–5.4) | 0.700 |
| Preoperative haematocrit | 38.8±9.15 | 37.9 (25.6–56.7) | 36.28±4.54 | 37.2 (24.2–47.1) | 0.020 |
| Smoking | 53 (17.4%) | 5 (10%) | 0.188 |
| Pulmonary diseases | 52 (17.1%) | 12 (24%) | 0.240 |
| Hypertension | 145 (47.7%) | 27 (54%) | 0.409 |
| Peripheral vascular disease | 25 (8.2) | 5 (10%) | 0.676 |
| Hyperlipidaemia | 60 (19.7%) | 8 (16%) | 0.534 |
| Cerebrovascular disease | 3 (1%) | 3 (6%) | 0.011 |
| ASA: American Society of Anaesthesiology |
tigate the complication predictivity, age, logistic EuroSCORE value, input ejection fraction, HbA1c levels, preoperative albumin and creatinine levels and haematocrit values were found to be related to the complications causing morbidity (Table 5). In the multivariate logistic regression models that were formed to determine the complication predictors, only ejection fraction was found to be an independent predictor (OR: 0.95; 95% CI: 0.92–0.98; p=0.004) (Table 6). HbA1c was not found to be predictive in all logistic models formed for mortality and complication (p>0.05). In the intraoperative and postoperative periods, the variables such as erythrocyte transfusion and cross-clamp, cardiopulmonary bypass, surgery, ventilator support and intensive care durations were significantly different in patients in whom complications developed (Table 7).

**Discussion**

In this study, high HbA1c (≥7%) levels in diabetic patients who underwent isolated coronary artery bypass graft surgery was found not to be an independent predictive factor for postoperative mortality and morbidity. Preoperative low ejection fraction was found to be an independent risk factor for postoperative mortality and morbidity in the general patient population.

### Table 6. Multivariate logistic regression models in terms of complications

| OR     | 95% CI    | p     |
|--------|-----------|-------|
| Age    | 1.03      | 0.99–1.07 | 0.129 |
| Ejection fraction | 0.95 | 0.92–0.98 | 0.004* |
| HbA1c  | 1.12      | 0.97–1.3 | 0.004* |
| Preoperative albumin | 0.54 | 0.27–1.10 | 0.090 |
| Preoperative haematocrit | 0.99 | 0.94–1.04 | 0.600 |
| Preoperative creatinine | 0.99 | 0.84–1.20 | 0.910 |
| Preoperative cerebrovascular disease | 0.31 | 0.06–1.70 | 0.170 |

*Parameters with significant difference between the groups

 Poor blood sugar control in the perioperative period of the cardiac surgery negatively affects the postoperative results (4). On the contrary, it has been reported that postoperative outcomes improve in diabetic patients with a strict preoperative blood sugar control (5, 6). Studies assessing the risk factors associated with outcomes after cardiac surgery suggested that perioperative high blood glucose levels are an independent predictor for postoperative morbidity and mortality in (7). Because it is one of the frequently used biomarkers that reflect high blood sugar values and poor glycaemic control, HbA1c has been thought to be an ideal predictor in terms of postoperative outcome predictivity (8). It has been claimed that high HbA1c levels are a strong predictor of mortality and morbidity independently of the patient's previous diabetic condition, and the mortality risk increases four-fold especially in coronary surgery cases when HbA1c levels are>8.6%. In other studies, it has been suggested that HbA1c is a strong predictor of morbidity and mortality in coronary surgery and that HbA1c levels>7.03% increase the risk of postoperative complications (9,10). In a study examining long-term outcomes after coronary bypass surgery in patients with type 2 diabetes mellitus, it was suggested that mortality increased when HbA1c levels were>9% and morbidity and complications increased when the levels were>8.1%. However, in the same study, mortality was not found to be associated with HbA1c levels in patients using insulin (11). Considering that diabetes causes renal failure, stroke, peripheral and coronary vascular diseases by leading to end-organ damage and that these conditions affect the postoperative outcomes, our findings may not be roughly surprising. However, when the details were examined, not all the patients with high HbA1c levels had diabetes. It is even controversial whether or not high HbA1c level are a good biomarker for the development of diabetes. In high-risk patient groups, while the development of diabetes is probable in patients with HbA1c>7.0%, it is said that clinical diabetes does not develop within 10 years and is classified as false diabetes on the basis of this threshold criterion in approximately 20% of the low-risk patients with HbA1c levels≥7.0% (12,13). In addition, HbA1c levels in the form of mild glucose intolerance significantly overlap with FBG values (14,15). While this dispute continues between HbA1c level elevation.

### Table 7. Variables associated with intraoperative and postoperative complications (mean±standard deviation)

|                                    | Patients without complications (n=50) | Median (min-max) | Patients with complications (n=304) | Median (min-max) | p     |
|-----------------------------------|-------------------------------------|----------------|------------------------------------|----------------|-------|
| Duration of Cross-clamp           | 59.5±23.13                          | 57 (14–143)    | 71.28±29.02                       | 67 (22–160)    | 0.009 |
| Duration of Cardiopulmonary bypass| 99.26±32.21                         | 98 (32–221)    | 124.4±46.48                       | 116 (50–270)   | <0.001|
| Erythrocyte transfusion           | 1.12±1.08                           | 1 (0–5)        | 1.78±1.45                         | 2 (0–6)        | 0.002 |
| Duration of surgery               | 251.7±49.5                          | 240 (135–515)  | 277.76±69.01                      | 250 (160–480)  | 0.007 |
| Duration of ventilator support    | 414.59±169.69                       | 375 (135–990)  | 4257.3±16173.06                   | 1080 (60–115200)| <0.001|
| Duration of stay in emergency care unit | 2.5±1.62                      | 4.58±4.1       |                                    |                | <0.001|
| Duration of stay in hospital      | 8.26±4.15                           | 7 (4–41)       | 9.36±7.94                         | 10 (1–44)      | 0.904 |

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and prediction of diabetes development, there are conflicting results regarding whether or not HbA1c level elevation is predictive for the risk of cardiovascular events. When a risk assessment was made for the cardiovascular events in some studies, some of the results were considered to be significant in terms of HbA1c level elevation; however, HbA1c was not found to be predictive when multivariate regression statistical analysis was performed separately from the other risk factors (16, 17). Beattie (18) examined perioperative cardiac biomarkers and suggested that HbA1c is not a useful assessment parameter in the management of surgical patients, and it is the biomarker of a process that cannot be changed, although it shows chronic poor glycaemic control. In three prospective studies, no improvement was observed in cardiovascular disease risk when the analysis was repeated by reducing HbA1c levels (19). Preoperative high HbA1c levels were found in 57% of nondiabetic patients and in 96% of diabetic patients who underwent coronary surgery (20). Considering these high rates, mortality and postoperative complications should have been expected to be very high postoperatively. After the studies on HbA1c, which is reported to strongly predict mortality, publications suggesting that high HbA1c can predict postoperative adverse events but cannot reveal any presumption related to mortality started to become evident in the literature (3, 21). Bardia et al (22) showed that postoperative complications and mortality were not related to HbA1c levels in patients undergoing isolated valve surgery; they found it remarkable that there was no association specifically between the postoperative glycaemic variability and the complications and emphasised that it was different from the previous findings in coronary patients. It is interesting that HbA1c shows different predictions in valve and coronary surgeries in patients with open heart surgeries using cardiopulmonary bypass because it is known that valve surgeries are associated with more complications than coronary surgeries (23). Similar to the above studies, we also observed in our univariate analysis that HbA1c levels in diabetic patients undergoing isolated coronary bypass graft surgery were predictive. However, on conducting further analysis excluding the other factors, we found that it was not an independent predictor for the postoperative mortality and complications.

Risk factors that could be the indicators for postoperative mortality and morbidity were examined in our study. Age, gender, logistic EuroSCORE value, input ejection fraction, HbA1c levels and preoperative albumin levels were found to be associated with mortality in the univariate analysis performed to investigate the mortality predictivity. Age, logistic EuroSCORE value, input ejection fraction, HbA1c levels, preoperative albumin and creatinine levels and haematocrit values were found to correlate with morbidity. However, among these factors, only the low ejection fraction that was determined through echocardiography during preoperative patient preparation was found to be an independent predictor in multiple analyses. This finding is a result known from past to present and is not surprising (24, 25).

Our study has a number of limitations that similar studies in the literature also have. First, the descriptions of postoperative complications, adverse events and morbidity are very different from each other in the studies conducted. In our study, we evaluated prolonged ventilation, development of low output, bleeding-induced reoperation, renal failure, postoperative myocardial infarction and cerebrovascular events as the postoperative complications. Second, HbA1c levels were not taken into account together with the values of FBG. Third, subgrouping was not made according to the types of diabetes and antidiabetic drugs used by the patients were not categorised accordingly. Because the drugs such as angiotensin converting enzyme inhibitors, beta blockers and diuretics used by patients in the preoperative period were not questioned while making the adjusted analysis, they could not be included in the exclusion criteria.

**Conclusion**

In this study, it was found that in diabetic patients who underwent isolated coronary bypass graft surgery, HbA1c levels were not an independent predictor for postoperative mortality and morbidity and low ejection fraction was an independent risk factor. Future studies should focus on reducing glycaemic variability in cardiac surgery patients, and the disease should be evaluated in terms of medications and developing pathologies by making further subgroupings.

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