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ORIGINAL ARTICLE

Effect of Preoperative Level of Hemoglobin A1C on Early Outcome After Coronary Artery Bypass Graft Surgery

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ABSTRACT

Background: Diabetics represent an increasing proportion of patients undergoing coronary artery bypass graft (CABG). Glycosylated hemoglobin (HbA1C) is a key indicator for glycemic control. The degree of glycemic control is directly reflected in the outcome after CABG. Our study aims to analyze the early outcome concerning preoperative HbA1C levels.

Methods: This prospective study evaluated the early outcome of 623 isolated elective CABG patients over 19 months. The patients were divided into group A (347 patients) with HbA1C < 7% and group B (276 patients) with HbA1C ≥ 7%. Postoperative renal failure, myocardial infarction, atrial fibrillation (AF), wound infection, cerebrovascular accidents, and 30-day mortality were recorded.

Results: Baseline characteristics showed a non-significant difference between both groups. The mean age of patients in group A was 59.6 years, and in group B it was 59.5 years. The mean graft number was 3.35 and 3.32 for groups A and B, respectively. First-month death was 0.9% in group A and 1.4% in group B without a significant difference. The incidence of AF, superficial wound infection, and other site infections showed a statistically substantial difference between both groups.

Conclusions: Increased levels of HbA1c, more than 7%, may be a potential risk factor for postoperative complications with a substantial rise in the risk of wound infections (superficial sternal and non-sternal surgical) and AF.

Keywords: Glycosylated hemoglobin, HbA1C, CABG, Sternal wound infection

INTRODUCTION

Diabetes mellitus (DM) is a metabolic disorder with micro and macrovascular drawbacks. The incidence of diabetes mellitus, especially DM type 2 (T2DM), is high among patients with cardiovascular disease (CVD), as DM doubles the risk of CVD [(1)].

The increasing number of diabetic patients undergoing CABG is due to the increase in the prevalence of diabetes over the past 30 years and because diabetics are more prone to developing complications during PCI and are therefore referred away from PCI toward CABG [(2)].

More than one-quarter of patients undergoing coronary artery revascularization have diabetes [(3)]. Coronary artery bypass grafting (CABG) surgery is the standard procedure for treating coronary artery disease [(4)]. Perioperative Blood sugar control is crucial as the degree of glycemic control is directly reflected in the outcome after CABG [(5)].

It is well known that glycosylated hemoglobin (HbA1C) indicates blood glucose level control over long periods in diabetic patients [6, 7]. As diabetics represent an increasing proportion of patients undergoing CABG, HbA1C is a key indicator for glycemic control [3].

It's important to map to effects of high HbA1C levels on the morbidity and mortality of such intervention to obtain a better assessment of the risk to which indicated uncontrolled diabetics are exposed during and after CABG. Many studies have shown significance, and others have shown a non-significant effect of HbA1C on the incidence of mortality and morbidity after CABG [8].

The prevalence of diabetes has risen in the last three decades in the gulf region and is now among the highest anywhere in the world [9, 10].

We have conducted our study to investigate the prevalence of early postoperative mortality and morbidity concerning preoperative HbA1C levels.

METHODS

The study population was recruited in the Kuwait chest diseases hospital from Jan 2020 until July 2021. This prospective observational cohort study was conducted on 623 isolated elective CABG patients after excluding combined procedures or emergency cases. Written informed consent was obtained from all participants, and the study was approved by the research ethics committee of the chest disease hospital. The study was done according to the Code of Ethics of the World Medical Association (Declaration of Helsinki) for human studies**.**

HbA1C level was done for all patients, and accordingly, 2 groups of patients were established; group A which comprised 347 patients with HbA1C < 7%, and group B which comprised 276 patients with HbA1C ≥ 7%. Preoperative characteristics and operative data were recorded. Postoperative renal failure (RF), myocardial infarction (MI), atrial fibrillation (AF), deep sternal wound infection (DSWI), superficial sternal wound infection (SSWI), other sites of infection, cerebrovascular accidents (CVA), 30-day mortality were recorded.

Statistical analysis:

SPSS software, version 22 (USA), was used for all analyses. Descriptive statistics were used to summarize the patients' data. The t-test was used to examine changes in parametric data. The Chi-square test was applied for categorical data, and Fisher's exact test was used when needed. A P-value < 0.05 or less was considered substantial.

RESULTS

The clinical and demographic aspects of 623 patients are listed in table (1), which revealed statistically non-significant differences between both groups. The mean age of patients in group A was 59.6 years, and in group B was 59.5 years. In group A, 56 patients (16.1%) were females, while 42 patients (15.2%) were females in group B. About 18.4 % and 18.1% of groups A and B patients were on insulin therapy. Creatinine clearance < 51, hypertension, dyslipidemia, peripheral vascular disease, chronic obstructive lung disease, and ejection fraction < 30% were the most common recorded comorbidities. The mean Euro score was 3.39 and 3.43 for groups A and B, respectively.

The operative data of the recruited patients were listed in table (2) without any significant records between both groups. The mean graft number was 3.35 and 3.32 for groups A and B, respectively.

The postoperative outcomes are represented in table (3). Within 30 days following the procedure, 3 patients (0.9%) died in group A, and 4 patients (1.4%) died in group B without significant difference (P = 0.7). Regarding cardiac complications, 9 patients (2.6%) in group A suffered from MI, while 14 patients (5.1%) were in group B (P = 0.13). The incidence of AF showed a statistically significant difference between the two groups, where 35 patients developed AF in group A (10.1%), while 46 patients developed AF in group B (16.7%) (P = 0.017). About 8.9% of patients in group A complicated with renal failure (RF), while 10.1% of patients in group B did (P = 0.68).

As for those who developed deep sternal wound infections (DSWI), only one patient did in group A (0.3%) while 3 patients in group B developed a DSWI (1.1%) but without a statistically significant difference (P = 0.33). Five patients developed superficial sternal wound infection (SSWI) in group A (1.4%), and 12 patients in group B did (4.3%); this difference is also substantial (P = 0.045). The number of patients who presented with other site infections in group A was 9 (2.6%), while 18 patients in group B did (6.5%); this difference also shows a substantial difference (P = 0.028). Concerning postoperative extracardiac complications, 5 patients (1.4%) in group A developed cerebrovascular accidents (CVA), and 5 patients (1.8%) in group B experienced such events (p = 0.76).

Table (1): Baseline characteristic of 623 patients:

Variables	**Group A (n=347)**	**Group B (n= 276)**	**P-value**
Age **Mean ± SD** **Median (Min-Max)**	 59.6±7.6 59 (38–78)	 59.5±8.1 59 (40-82)	 P = 0.859 F = 0.649
Sex, n (%) **Male** **Female**	 291 (83.9%) 56 (16.1%)	 234 (84.8%) 42 (15.2%)	 P = 0.825 X^2 = 0.098
Creatinine Clearance < 51	29 (8.4%)	32 (11.6%)	P = 0.222 X^2 = 1.824
Insulin therapy	64 (18.4%)	50 (18.1%)	P = 1 X^2 = 0.011
Hypertension	181 (52.2%)	126 (45.7%)	P = 0.108 X^2 = 2.606
Dyslipidemia	190 (54.8%)	153 (55.4%)	P = 0.872 X^2 = 0.029
PVD	22 (6.3%)	15 (5.4%)	P = 0.734 X^2 = 0.226
COPD	26 (7.5%)	15 (5.4%)	P 0.333 X^2 = 1.059
EF < 30%	19 (5.5%)	16 (5.8%)	P = 0.863 X^2 = 0.030
Euro score **Mean ± SD** **Median (Min-Max)**	 3.39±1.36 3 (2-8.2)	 3.43±1.34 3 (2-8.1)	 P = 0.717 F = 0.002

PVD Peripheral vascular disease. COPD Chronic obstructive pulmonary disease. EF Ejection fraction.

Table (2): Operative data of the recruited patients:

Variables	Group A (n=347)	Group B (n= 276)	P-value
Graft analysis **Mean ± SD** **Median (Min-Max)**	 3.35±0.95 3 (1- 6)	 3.32±0.95 3 (1- 6)	 P = 0.76 F = 0.08
Number of grafts, N (%) **One** **Two** **Three** **Four** **Five**	 5 (1.4%) 58 (16.7%) 133 (38.3%) 120 (34.6%) 25 (7.2%) 6 (1.7%)	 10 (3.6%) 36 (13%) 110 (39.9%) 97 (35.1%) 21 (7.6%) 2 (0.7%)	 P = 0.33 X^2 = 5.762
Bilateral ITAs, n (%)	29 (8.4%)	19 (6.9%)	P = 0.93 X^2 = 0.469

ITA Internal thoracic artery.

Table (3): Postoperative outcomes:

Variables	Group A (n=347)	Group B (n= 276)	P-value
30-days Mortality n, (%)	3 (0.9%)	4 (1.4%)	0.7
MI	9 (2.6%)	14 (5.1%)	0.13
AF	35 (10.1%)	46 (16.7%)	0.017*
RF	31 (8.9%)	28 (10.1%)	0.68
DSWI	1 (0.3%)	3 (1.1%)	0.33
SSWI	5 (1.4%)	12 (4.3%)	0.045*
OTHER SITE INFECTION	9 (2.6%)	18 (6.5%)	0.028*
CVA	5 (1.4%)	5 (1.8%)	0.76

* Significant. MI myocardial infarction. AF atrial fibrillation. RF Renal failure. DSWI Deep sternal wound infection. SSWI Superficial sternal wound infection. CVA Cerebrovascular accident.

DISCUSSION

Our study investigated the co-relationship between preoperative HbA1C level and early postoperative results after elective primary CABG. A total of 623 patients were examined, with an overall mortality percentage of 1.12%. However, this percentage was higher in the elevated HbA1C group (1.44%) than in the other group with lower HbA1C levels (0.9 %) but with no statistical significance.

Multiple studies reported the incidence of mortality concerning the HbA1C level with ranges from 6.5% and above as a border for comparison. All the studies have shown an increased incidence of mortality with high HbA1C; some found it statistically significant, while others found no statistical significance. Wang *et al*. did a meta-analysis of 19 studies from 2010 to 2019 and found that elevated HbA1C level has no significant impact on post-CABG mortality [(11)].

On the other hand, Zheng and associates found a significant relationship between elevated HbA1C and survival after CABG when they analyzed the results of seven studies from 2008 to 2015 [(12)].

When we examined the incidence of postoperative wound infection, we found that the

prevalence of Superficial sternal wound infection (SSWI), deep sternal wound infection (DSWI), and other surgical site wound infections is higher in the high HbA1C group. Statistically, only superficial sternal wound infection and the other surgical site infection rate were significant. When we go through the literature to check other similar studies, Halkos *et al*. found deep sternal wound infection is significantly higher when HbA1C > 7% [13].

Goksedef *et al*. found that there is no significant difference in the rate of sternal and non-sternal wound infection in both groups with HbA1C more or less than 7%, but this rate was substantially high in diabetic patients with HbA1C > 7% if compared to nondiabetic patients in the same group [14].

Biancari and his associates went through 14 studies examining the relationship between HbA1c and sternal wound infection after cardiac surgery. They found that the risk of sternal wound infection increased when preoperative HbA1c levels were more than 6-7% [15].

Wang and his coworkers, in a more recent meta-analysis of twelve studies, examined the infection rate after CABG concerning HbA1C. They concluded that higher preoperative HbA1C levels carry a higher risk of post-CABG wound infection in diabetic patients [11].

Finger *et al*. study supported that findings when they found that elevated HbA1C levels were linked to an increased risk of postoperative infection and longer hospital stay [16].

In our study, renal failure (RF) incidence was higher with elevated HbA1C with no statistical significance. This supports the finding of Knapik *et al*., who found that RF was higher with HbA1C of more than 7%, with no significant difference from the statistical point of view [17].

Two meta-analyses of a total of 14 studies; showed pooled results that concluded that elevated HbA1C carries a higher risk of post-CABG acute kidney injury and also without statistical significance [11, 12]. Hudson *et al*. concluded the same results but with statistical significance as comparing patients with HbA1C levels above and below 6% [18].

We had an increased postoperative myocardial infarction (MI) among the group with HbA1C >7%; however, it was not statistically significant. Strahan *et al*. showed a non-significant increase in the postoperative MI associated with HbA1c >7% [19].

Two studies had the same findings when comparing postoperative MI to preoperative high HbA1C levels; nevertheless, this was found statistically significant [13, 17]. Zheng *et al*. went through multiple studies, and the combined analyses of five studies that considered HbA1C as a predictor for postoperative MI were significantly higher with elevated HbA1C [12]. On the other hand, Oztruk *et al*., in their meta-analysis, didn't find statistical significance in that aspect [20].

The postoperative stroke incidence was nearly the same in our study groups. This was not a surprising outcome, as most previous studies and meta-analyses had revealed that even with the increased incidence of stroke if the HbA1C was greater than 7%, it didn't have any significance [11, 12, 16, 21].

Halkos *et al*. reported a reduced incidence of AF with every rise-up in the HbA1C unit [13]. Kinoshita *et al*. found that the median HbA1C Level was substantially less in patients who developed AF [22].

Matsuura *et al*. concluded that HbA1c > 6.5 leads to a higher AF percentage, however with no significance [23]. Moreover, the meta-analyses by Wang *et al*. showed no significant difference in the incidence of AF with higher and lower HbA1C levels post-CABG [11].

Surprisingly, our data showed that AF significantly increased in patients with preoperative HbA1C >7%. The overall incidence of AF is high in our center which may be a result of our intensive care unit protocol, which avoids the use of B-blockers while the patient is still on any dose of vasopressors.

This study established a firm conclusion that increased levels of HbA1c, more than 7%, maybe a potential risk factor for postoperative complications with a substantial rise in the risk of superficial sternal wound infection, non-sternal surgical wound infection, and atrial

fibrillation. Our findings ensure that preoperative levels of HbA1C are considered a firm chronic control metric of blood sugar rather than a snapshot of glycemic concentration at a such particular hour/day, and so they play a crucial role in the outcome of diabetics having CABG.

REFERENCES

1. Gu K, Cowie CC, Harris MI. Mortality in adults with and without diabetes in a national cohort of the U.S. population, 1971–1993. Diabetes Care 1998; 21(7): 1138–45. DOI: 10.2337/diacare.21.7.1138
2. International Diabetes Federation. IDF Diabetes Atlas, 7th edition. Brussels, Belgium: International Diabetes Federation; 2015. Available from: http://www.diabetesatlas.org.
3. Flaherty JD and Davidson CJ. Diabetes and coronary revascularization. The Journal of the American Medical Association 2005; 293(12):1501–8 DOI: 10.1001/jama.293.12.1501
4. Gerstein HC, Pogue J, Mann JF, Lonn E, Dagenais GR, McQueen M, *et al*. The relationship between dysglycaemia and cardiovascular and renal risk in diabetic and non-diabetic participants in the HOPE study: a prospective epidemiological analysis. Diabetologia 2005; 48(9): 1749–55. DOI: 10.1007/s00125-005-1858-4
5. Tennyson C, Lee R, and Attia R. Is there a role for HbA1c in predicting mortality and morbidity outcomes after coronary artery bypass graft surgery? Interactive cardiovascular and thoracic surgery 2013; 17(2) 1000-8. DOI: 10.1093/icvts/ivt351
6. Selvin E, Marinopoulos S, Berkenblit G, Rami T, Brancati FL, Powe NR, *et al*. Meta-analysis: Glycosylated hemoglobin and cardiovascular disease in diabetes mellitus. Annals of Internal Medicine 2004; 141(6): 421–31. DOI: 10.7326/0003-4819-141-6-200409210-00007
7. Gerstein HC, Islam S, Anand S, Damasceno A, Dans A, Lang CC, *et al*. Dysglycaemia and the risk of acute myocardial infarction in multiple ethnic groups: an analysis of 15,780 patients from the INTERHEART study. Diabetologia 2010; 53(12): 2509-17. DOI: 10.1007/s00125-010-1871-0
8. Zheng J, Cheng J, Wang T, Zhang Q, Xiao X. Does HbA1c Level Have Clinical Implications in Diabetic Patients Undergoing Coronary Artery Bypass Grafting? A Systematic Review and Meta-Analysis. International Journal of Endocrinology 2017; 2017: 1155-62.DOI: 10.1155/2017/1537213
9. Ziyab AH, Mohammad A, Maclean E, Behbehani K, Carballo M. Diabetes: a fast-evolving epidemic. Kuwait Med J 2015; 47(4): 291–301. https://pesquisa.bvsalud.org/portal/resource/pt/emr-183425
10. Guariguata L, Whiting DR, Hambleton I, Beagley J, Linnenkamp U, Shaw JE. Global estimates of diabetes prevalence for 2013 and projections for 2035. Diabetes Res Clin Prac. 2014; 103(2): 137–49. DOI: 10.1016/j.diabres.2013.11.002
11. Wang J, Luo X, Jin X, Lv M, Li X, Dou J, *et al*. Effects of preoperative HbA1c levels on the postoperative outcomes of coronary artery disease surgical treatment in patients with diabetes mellitus and nondiabetic patients: A systematic review and Meta-Analysis. Journal of Diabetes Research 2020; 2020: 3547491. DOI: 10.1155/2020/3547491
12. Zheng J, Cheng J, Wang T, Zhang Q, Xiao X. Does HbA1c Level Have Clinical Implications in Diabetic Patients Undergoing Coronary Artery Bypass Grafting? A Systematic Review and Meta-Analysis. Int J Endocrinol 2017; 2017:1537213. DOI: 10.1155/2017/1537213
13. Halkos M, Puskas J, Lattouf O, Kilgo P, Kerendi F, Song H, *et al*. Elevated preoperative hemoglobin A1c level is predictive of adverse events after coronary artery bypass surgery. J Thorac Cardiovasc Surg 2008;136: 631–40. DOI: 10.1016/j.jtcvs.2008.02.091
14. Goksedef D, Omerolu S, Yalvac E, Bitargil M, Ipek G. Is elevated HbA1c a risk factor for infection after coronary artery bypass grafting surgery? Turk J Thorac Cardiovasc Surg 2010; 18: 252–8. https://tgkdc.dergisi.org/uploads/pdf/pdf_TGKDC_1324.pdf
15. Biancari F, Giordano S. Glycated hemoglobin and the risk of sternal wound infection after adult cardiac surgery: A systematic review and meta-analysis. Semin Thorac Cardiovasc Surg 2019; 31(3): 465-7. DOI: 10.1053/j.semtcvs.2019.02.029
16. Finger B, Brase J, He J, Gibson WJ, Wirtz K, Flynn BC. Elevated Hemoglobin A1c Is Associated with Lower Socioeconomic Position and Increased Postoperative Infections and Longer Hospital Stay After Cardiac Surgical Procedures. Annals of Thoracic Surgery 2017; 103(1): 145-51. DOI: 10.1016/j.athoracsur.2016.05.092
17. Knapik P, Ciesla D, Filipiak K, Knapik M, Zembala M. Prevalence and clinical significance of elevated preoperative glycosylated hemoglobin in diabetic patients scheduled for coronary artery surgery. Eur J Cardiothorac Surg 2011; 39: 484–9. DOI: 10.1016/j.ejcts.2010.07.037
18. Hudson C, Welsby I, Phillps-Bute B, Matthew J, Lutz A, Hughes C, *et al*. Glycosylated hemoglobin levels and outcome in non-diabetic cardiac surgery patients. Can J Anesth 2010; 57: 565–72. DOI: 10.1007/s12630-010-9294-4
19. Strahan S, Harvey RM, Campbell-Lloyd A, Beller E, Mundy J, Shah P. Diabetic control and coronary artery bypass: effect on short-term outcomes. Asian Cardiovascular and Thoracic Annals 2013; 21(3): 281–7. DOI: 10.1177/0218492312451983
20. Ozturk S, Kayacoglu I, Sensoz Y, Ozcelik S, Arslan Y, Ozturk I. Is there a predictive value of hemoglobin A1C for complications of cardiac surgery? J Coll Physic Surg Pak 2021; 30: 686–93. DOI: 10.29271/jcpsp.2021.06.686
21. Tsuruta R, Miyauchi K, Yamamoto T, Dohi S, Tambara K, Dohi T, *et al*. Effect of preoperative hemoglobin A1c levels on long-term outcomes for

diabetic patients after off-pump coronary artery bypass grafting. J Cardiol 2011; 57: 181–6. DOI: 10.1016/j.jjcc.2010.11.003

22. Kinoshita T, Asai T, Suzuki T, Kambara A, Matsubayashi K. Preoperative hemoglobin A1c predicts atrial fibrillation after off-pump coronary artery bypass surgery. Eur J Cardiothorac Surg 2012; 41: 102–7. DOI: 10.1016/j.ejcts.2011.04.011

23. Matsuura K, Imamaki M, Ishida A, Shimura H, Niitsuma Y, Miyazaki M. Off-pump coronary artery bypass grafting for poorly controlled diabetic patients. Ann Thorac Surg 2009; 15: 18–22.

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