Original Article

Revisiting Factors that Influence Length of Stay and Wound Infection after Coronary Artery Bypass Grafting

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Abstract

Background: Diabetes is common among patients undergoing Coronary Artery Bypass Grafting (CABG). This study aims to revisit the predictive significance of diabetes, elevated HbA1c, low serum albumin levels, and gender on wound infection and hospital stay after CABG.

Methods: This retrospective study included patients who had CABG from June 2019 to March 2020. We included patients who underwent elective CABG and excluded emergency CABG surgeries and combined surgeries. Elevated HbA1c is defined as an HbA1c level above 5.8%, and the normal range for serum albumin level is at 33-54 gm/L

Results: A total of 87 patients were included, 81 males (93%) and six females (7%) with a mean age of 58 ± 8.5 years. Sixt-eight patients (78%) had diabetes mellitus Type 2 (D.M.). Mean Hb1Ac level was at 8.3 ± 1.8 %; mean preoperative serum albumin level was 34.7 ± 3.3 gm/L, mean postoperative serum albumin level was 16± 0.37 gm/L; preoperative EF of <50% (31%), 50-55% (14%) and >55% (55%). Mean hospital length of stay was 8.3±10.1 days, mean bypass duration was 110.9±35.4 minutes, the mean number of grafts was 3.15±.829; 98% of patients had LIMA to L.A.D. Female gender was a significant predictor of length of stay (coefficient: 4.38 (1.63- 7.13); P= 0.002) and postoperative wound infection (OR: 38.5 (5.35- 276.80); P<0.001).

Conclusion: Females could be associated with increased length of stay and wound infection after CABG. Identifying factors that influence the length of stay and wound infections could facilitate recovery and reduce complications.

Introduction

In the latest update of the International Diabetes Federation for the Middle East and North Africa (IDF-MENA), 463 million people worldwide were affected by diabetes (D.M.) and 55 million in the MENA region. In Saudi Arabia alone, the prevalence of D.M. was 18.3%, affecting nearly 4.3 million adults [1]. The prevalence of D.M. was 60.7% in patients with acute heart failure and 53% in those with high-risk chronic heart failure [2]. Females were at more risk of atherosclerosis and rheumatic heart disease (11.3%), while in males, the primary cause of heart failure was ischemic heart disease (50.6%) [3]. The Saudi Ministry of Health Statistical Year Book for 2019 accounted for more than 17,000 cardiac, chest, and vascular

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surgeries, including coronary artery bypass grafting (CABG) [4]. Sixty-one percent of males and 79% of females who underwent CABG had concurrent D.M. [5]. Moreover, several studies showed that elevated HbA1c levels preceding CABG surgery were strongly related to the severity of subsequent complications and deep sternal wound infection [6,7].

Serum albumin has been widely valued as a biomarker for predicting adverse outcomes and mortality in patients undergoing high-risk surgery. Albumin can prompt inflammatory responses that can precede endothelial dysfunction and edema secondary to capillary leak across all critical organ systems, which are evident in the immediate postoperative period of CABG surgery [8]. The mean population serum albumin concentration surges around 20 years old and then declines with increasing age. Its level drops briskly in females and then to a near similar level of males at 60 years of age [9].

Likewise, varying studies have been published regarding the association or predictive significance of gender in the length of stay and developing infection between males and females undergoing different surgical operations [10,11]. Several studies found that reduced left ventricular ejection fraction (E.F.) (≤ 40%) in cardiac surgery patients was associated with a high risk of postoperative complications and higher mortality [12,13]. This study aims to revisit the predictive significance of diabetes, elevated HbA1c, low serum albumin levels, and gender on wound infection and hospital stay after CABG.

Patients and methods:
Study Design and setting:
This research is a retrospective study. We collected the data for patients who underwent CABG in a single center from June 2019 to March 2020 from the patient electronic medical records.

Ethical Approval:
The Institutional Review Board approved this study proposal (Project Approval No. E-20-5193-I.R.B. of the College of Medicine, King Saud University, Riyadh Saudi Arabia for human studies). Corresponding informed consent was collected from study participants.

Inclusion and Exclusion Criteria:
We included patients who underwent elective CABG and excluded emergency CABG surgeries and combined surgeries.

Table 1: Basic Characteristics of Study Participants. Frequency (Percentage) for categorical data, Mean, Range, ±SD-Standard Deviation for continuous variables

	N=87
Male	81(93.1)
Age, in years	58± 8.5
Diabetes Mellitus	68(78.2)
HbA1c, %	8.3± 1.8
Elevated	83(95.4)
Within Normal Range	4(4.6)
Pre-Op Albumin Level, gm/L	34.8± 3.3
Low Albumin level	21(24.1)
Within Normal Range	66(75.9)
Post-Op Albumin Level, gm/L	16± 0.37
Low Albumin level	73(83.9)
Within Normal Range	14(16.1)
Length of Stay, days	8.3± 10.1
Ejection Fraction, %	
Less than 50%	27(31)
Between 50-55%	12(13.8)
More than 55%	48(55.2)
Bypass Duration, min	110.9± 35.4
Number of Grafts	3.15± 0.83
LIMA To LAD	85(97.7)
Wound Infection	8(9.2)

Pre-Op Alb-Pre-operative albumin, **Post-Op Alb**-post-operative albumin, **LIMA to LAD**-left internal mammary artery (**LIMA**) to the left anterior descending (**LAD**) artery

Data:
Variables collected for the study included age, sex, D.M., HbA1c level (percentage), and serum albumin level on admission, 5th, 10th, and 15th-day postoperatively (gm/L). The normal percent of HbA1c is less than or equal to 5.8%, above 5.8% is considered elevated, and the normal range for serum albumin level is at 33-54 gm/L. Other variables included length of hospital stay (L.O.S.) (in days), preoperative ejection fraction (E.F.) (less than 50%, 50-55%, more than 50%), and bypass

duration (in minutes), the number of grafts, grafting of the left internal mammary artery (LIMA) to the left anterior descending (L.A.D.) artery, presence of Wound infection, and the organism.

Statistical analysis

We presented data as mean ± standard deviation for continuous variables, whereas categorical variables were presented as numbers and percentages. An independent sample t-test was used to compare the means between two unrelated groups, and non-normal data were compared using the Mann-Whitney test. Categorical data were compared using the Chi-square or Fisher exact tests when appropriate. Multivariable quantile regression was used to assess the factors affecting hospital stay, and univariable logistic regression was used to evaluate factors affecting wound infection. Statistical analyses were performed using the Statistical Package for the Social Sciences software, version 22 (S.P.S.S. Inc., Armonk, NY, U.S.A.). A P-value of less than 0.05 was considered statistically significant.

Results:

A total of 87 patients who underwent elective CABG surgery were included in the study. There were 81 males (93%) with a mean age of 58 ± 8.5 years. Sixty-eight patients (78%) had diabetes mellitus Type 2 (D.M.). The mean Hb1Ac level was at 8.3 ± 1.8 %, with almost 95 % of patients has elevated HbA1c during admission or above 5.8 % normal range. The overall mean preoperative serum albumin level was at 34.7 ± 3.3 gm/L, with almost 76% of patients within a normal range. Meanwhile, the mean postoperative serum albumin level was 16±0.37 gm/L, with 84 % of patients below normal. The number of patients with ejection fraction (E.F.) of less than 50% was 31%, between 50-55% was 14%, and more than 55% was 55%, respectively. Mean L.O.S. was 8.3±10.1 days, mean bypass duration was 110.9±35.4 minutes, the mean number of grafts was 3.15±.829. (Table 1)

Of the eight patients who develop wound infections after CABG surgery, six microorganisms have been identified, namely, Pseudomonas aeruginosa (n= 1), Klebsiella pneumonia (n= 3), Enterobacter cloacae (n= 1), Proteus mirabilis (n= 1), methicillin-resistant staphylococcus aureus (M.R.S.A.) (n= 1), and Enterobacter (n= 1).

There was a significant difference in L.O.S and wound infection between males and females. (Table 2)

Multiple regression analysis showed that gender was a significant predictor of length of stay. (Table 3) Furthermore, gender was associated with postoperative wound infection. (Table 4)

Discussion

According to published studies, patients with D.M. who undergo CABG surgery are at increased risk of mortality, and morbidity including stroke, renal failure, sternal infection, and blood transfusion when compared to those without D.M. [14]. Previous studies have indicated that diabetic patients have a higher likelihood of getting sternal wound infections. Repeated hyperglycemia was associated with increased rates of postoperative infections, especially septic wound complications [15-16]. In this study, diabetes had no significant association with the increasing length of stay, supporting the results of the previous study published in Oman [17]. However, it contradicts previous studies' results that suggest that being diabetic can certainly affect the likelihood of developing wound infection for patients who underwent CABG surgery.

In comparison to a study that investigated 305 patients with elevated HbA1c levels found that L.O.S. was not affected by preoperative HbA1c levels (with a cut-off point of HbA1c = 7% for optimal and suboptimal levels; P=0.367) among the Saudi population [18]. The results of our study also showed that elevated HbA1c had no significant relationship or effect in L.O.S. Other previous studies found that preoperative HbA1c was an independent predictor of wound infection after cardiac surgery in diabetic patients [19]. Although there was only 9% of wound infection reported from this study, the high percentage of elevated HbA1c among patients point out the

Table 2: Comparison between two groups of parameters on length of stay and wound infection

		Length of Stay (L.O.S.)			Wound Infection		
	N=87	Mean	±SD	p-value	Number	%	p-value
Gender							
Male	81	7.21	4.80	0.03	4	4.49	<0.001
Female	6	23.17	33.01		4	66.67	
Diagnosis of Diabetes							
With D.M.	68	8.78	11.26	0.13	8	11.78	0.19
Without DM	19	6.63	2.91		0		
HbA1c, %							
Elevated HbA1c	83	8.43	±10.28	0.61	8	11.78	>0.99
Within Normal Range	4	5.75	±1.5		0	0	
Pre-Op Albumin Level, gm/L							
Low Albumin level	21	7.76	±3.48	0.78	2	9.52	>0.99
Within Normal Range	66	8.48	±11.41		6	9.09	
Post-Op Albumin Level, gm/L							
Low Albumin level	73	8.62	±10.91	0.52	8	10.96	0.35
Within Normal Range	14	6.71	±2.73		0		

importance of HbA1c screening because unrecognized diabetes and poor glycemic control may have pressing and long-term prognostic consequences that could be managed before surgery especially for those planned for elective surgery.

Table 3: Quantile regression for the effect of Age, Gender, DM, HbA1c, Pre-Op Albumin, and Post-Op Albumin on Length of Stay after CABG surgery

Hospital stay	Coef. (95% CI)	p-value
Age	0.01 (-0.01- 0.09)	0.99
Gender	4.38 (1.63- 7.13)	0.002
Diabetes mellitus	-0.39 (-1.46- 0.68)	0.47
HA1C (%)	0.34 (-0.12- 0.81)	0.15
Preoperative albumin	-0.08 (-0.32- 0.15)	0.48
Postoperative albumin	-0.17 (-0.42- 0.06)	0.15

Preoperative serum albumin level is a vital independent predictor of major complications and mortality in post-CABG surgery. Patients with low preoperative serum albumin levels have worse long-term survival after CABG than normal serum albumin levels [20]. The early decline of postoperative serum albumin level certainly gauges the magnitude of surgery and its complicated postoperative course. Low serum albumin levels increase L.O.S. by more than ten days of hospitalization after the operation [21-23].

Table 4: Univariable logistic regression for the effect of Age, Gender, HbA1c, Pre-Op Albumin, and Post-Op Albumin on wound infection after CABG surgery

	OR (95% CI)	p-value
Age	1.03 (0.94- 1.12)	0.56
Gender	38.5 (5.35- 276.80)	<0.001
HA1C (%)	1.30 (0.87- 1.95)	0.21
Preoperative albumin	0.92 (0.74- 1.16)	0.50
Postoperative albumin	0.82 (0.65- 1.02)	0.08

Preoperative low serum albumin directly relates to the rate of postoperative complications, including surgical site infection, noninfectious wound complications including seroma formation, and wound dehiscence [24]. Preoperative (p = 0.024, OR = 4.16 95% CI 1.203-14.44) and postoperative hypoalbuminemia (p <0.001 OR = 5.22 95% CI 2.84-9.58) were statistically significant for surgical wound dehiscence [25]. However, in the result of our study, the preoperative albumin levels have no association or prediction significance in the length of stay and development of wound infection among patients. Meanwhile, low postoperative albumin level was not also a significant predictor of patient length of stay.

These results were comparable to previous studies that concluded that low postoperative albumin levels were associated with developing a wound infection. The lower the serum albumin level, the likelihood of wound infection increases. As a barometer of the severity of inflammation, low serum albumin levels interfere with medical and surgical treatment success, diminishing the adequacy of the response to trauma. Thus, the impetuous increase or decrease in serum albumin levels are valuable indicators of recovery or deterioration of health [26]. A previous study deduced that if microalbuminuria has been ascertained, it helps to forecast adverse outcomes before and after CABG surgery [23].

Some studies have determined that intensive care and hospital stay were longer in female patients than in male patients. Females may have a higher incidence of deep sternal wound infections than male CABG patients, regardless of age, race, type of admission, hospital volume, or presence of comorbidities [10,11]. Meanwhile, other studies reported that the male gender was an independent risk factor for prolonged cardiac intensive care unit stay and one of the significant predictors of S.S.I. in patients undergoing cardiac surgery [27]. A recent cohort study published in the same institution but used much old data has concluded that gender is not a significant predictor of infection after CABG surgery [28]. However, the result of this study supports the conclusion that gender is a significant predictor that affects the length of hospital stay and developing wound infection in patients who had undergone CABG surgery. As the majority of the patients in this study were male, thus its result can be compared to previous studies that concluded that male gender is a significant predictor of length of hospital stay and developing wound infection after CABG surgery. Thus, exploring current evidence-based preoperative and postoperative preventive measures is vital to facilitate fast recovery, wound healing, and prevention of wound infection, whether one is male or female.

A study also found decreased preoperative left ventricle E.F. was associated with postoperative infections (odds ratio, 1.33; 95% confidence interval, 1.03-1.68; P= .0265) and renal complications [29].

Limitations:

There are several limitations to this study. First, the study was done in a single-center venue, which may require external validity to support changes that might be implemented in practice compared to multi-center studies. Second, as a retrospective study, it has a small number of sampling and thus cannot represent the general population. Finally, the results may be subject to confounding or other risk factors that were not measured, like the body mass index, smoking, blood transfusion, and chronic obstructive pulmonary disease.

Conclusion

The female gender could be associated with increased length of stay and wound infection after CABG. Identifying factors that influence the length of stay and wound infections could facilitate recovery and reduce complications.

Conflict of interest: Authors declare no conflict of interest.

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