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Association of Glycated Hemoglobin Level and Postoperative Complications in General Surgical Procedures

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ABSTRACT

Background: Elevated glycated hemoglobin (HbA1c) levels have been identified as a significant risk factor for postoperative complications. Understanding the relationship between preoperative HbA1c and surgical outcomes is critical for improving perioperative care in diabetic patients.

Objective: To evaluate the association between HbA1c levels and the incidence of postoperative complications in diabetic patients undergoing general surgical procedures.

Material and Methods: This cross-sectional study was conducted at the DG Khan Medical College, from June 2023 to June 2024. A total of 341 diabetic patients who underwent elective and emergency surgical procedures were included. Data were collected on patient demographics, comorbidities, preoperative HbA1c levels, and postoperative complications. Glycemic control was classified as good (HbA1c ≤7%) or poor (HbA1c >7%). Statistical analyses were performed using chi-square tests, with significance set at $p < 0.05$.

Results: The mean age of the patients was 49.54±18.77 years, with a mean BMI of 26.72±4.97 kg/m² and mean HbA1c level of 8.75±1.94%. Postoperative complications were significantly higher in patients with poor glycemic control (64.8%) compared to those with good glycemic control (20.0%) ($p < 0.001$). No statistically significant associations were observed with age, sex, obesity status, duration of diabetes, or smoking status.

Conclusion: Poor preoperative glycemic control, as indicated by elevated HbA1c levels, is strongly associated with an increased risk of postoperative complications in diabetic patients. Effective glycemic management prior to surgery is crucial for optimizing outcomes.

Keywords: *Glycated hemoglobin, HbA1c, postoperative complications, diabetes mellitus, general surgery, glycemic control*

1. INTRODUCTION

Glycated hemoglobin (HbA1c), a biomarker reflecting average blood glucose levels over a period of 8-12 weeks, has emerged as a significant predictor of outcomes in various medical interventions, including surgical procedures [1,2]. Elevated HbA1c levels, particularly in diabetic and prediabetic populations, are associated with poor glycemic control, which can significantly impact surgical recovery and overall outcomes [3]. The role of HbA1c in assessing surgical risk and predicting postoperative complications has gained increased attention over the years due to its clinical implications [4,5].

In general surgical procedures, postoperative complications such as infections, delayed wound healing, and prolonged hospital stays are common among patients with uncontrolled glycemic levels. Studies have consistently shown that elevated HbA1c levels correlate with higher rates of surgical site infections (SSIs), renal complications, and mortality [6]. In this regard, HbA1c serves as a valuable indicator not only for identifying at-risk patients but also for implementing preoperative optimization strategies to reduce adverse outcomes [7].

A meta-analysis highlighted the relationship between higher preoperative HbA1c levels and increased rates of surgical site infections and myocardial infarctions in patients undergoing coronary artery surgeries [6]. Similarly, comorbidities like diabetes and higher HbA1c levels significantly influence the severity and frequency of postoperative complications in general surgery patients [7].

Emerging evidence suggests that multimodal prehabilitation programs, which include preoperative glycemic control strategies, can mitigate these risks. A trial underscored the efficacy of prehabilitation in reducing severe complications, particularly in colorectal cancer surgeries [8]. The findings advocate for a comprehensive approach to surgical patient care, emphasizing the importance of optimizing glycemic levels preoperatively.

Additionally, the utilization of advanced predictive models integrating HbA1c and other clinical parameters has revolutionized risk assessment in surgical care. A study demonstrated the application of machine learning algorithms in predicting postoperative complications, offering real-time insights into patient-specific risks [9]. These innovations underscore the potential of HbA1c as a pivotal metric in surgical risk stratification and management.

While most studies have focused on the implications of elevated HbA1c levels in diabetic populations, there is increasing interest in its role among non-diabetic patients. Research explored the association between HbA1c levels and surgical outcomes in normoglycemic patients, revealing significant correlations with complications such as prolonged wound healing and increased infection rates [10].

Furthermore, the impact of HbA1c on specific surgical disciplines, including orthopedic and neurosurgical procedures, has been extensively studied. Findings indicate that patients with uncontrolled diabetes and elevated HbA1c levels experienced higher incidences of surgical site infections in distal radial fracture treatments [11]. These findings are consistent across various surgical specialties, highlighting the systemic effects of poor glycemic control.

The implementation of HbA1c as a routine preoperative screening tool has shown promise in improving surgical outcomes. Guidelines emphasize the importance of incorporating glycemic assessments into perioperative care protocols to reduce postoperative morbidity and mortality [12].

Poor glycemic control, reflected by elevated glycated hemoglobin (HbA1c) levels, has been consistently linked to adverse surgical outcomes, including infections, organ dysfunction, and mortality. As a modifiable risk factor, preoperative HbA1c provides an opportunity to optimize glycemic control and potentially reduce postoperative complications, particularly in diabetic patients who are at inherently higher risk. Despite extensive evidence from various surgical specialties, the role of HbA1c in predicting complications in general surgical procedures remains underexplored, especially in the context of local healthcare settings. This study aims to address this gap by evaluating the association between preoperative HbA1c levels and postoperative complications in diabetic patients, providing actionable insights to improve perioperative care and surgical outcomes.

2. MATERIALS AND METHODS

This cross-sectional study was conducted at the DG Khan Medical College, from June 2023 to June 2024. The study population included diabetic patients undergoing general surgical procedures during this period. Patients were categorized into two groups based on their preoperative glycated hemoglobin (HbA1c) levels: those with good glycemic control (HbA1c ≤7%) and those with poor glycemic control (HbA1c >7%).

The sample size was calculated using the proportion-based formula. A postoperative infection frequency of 33.1% was taken from a previous study by Ahmed M., using a 95% confidence level and a margin of error (d) of 5%, the required sample size was 341 patients [13].

Inclusion criteria comprised diabetic patients aged 18 years and above, who underwent elective or emergency general surgical procedures with available preoperative HbA1c levels. Patients with incomplete records or non-diabetic status and those with complications unrelated to surgery were excluded.

Data were collected using a structured proforma. The recorded variables included postoperative complications (Yes/No), the type of complications (e.g., wound infection, delayed healing), glycemic control status (good or poor), and demographic and clinical characteristics such as age, sex, Body Mass Index (BMI), duration of diabetes, and smoking status.

Statistical analysis was performed using SPSS version 26. Continuous variables such as age and BMI were presented as mean ± standard deviation, while categorical variables such as glycemic control and postoperative complications were summarized as frequencies and percentages. The association between glycemic control and postoperative complications was

analyzed using the chi-square test. A p-value of <0.05 was considered statistically significant.

3. RESULTS

A total of 341 diabetic patients who underwent general surgical procedures were included in the study. The mean age of the patients was 49.54±18.77 years, and the average Body Mass Index (BMI) was 26.72±4.97 kg/m². The mean duration of diabetes was 14.41±8.53 years, and the mean HbA1c level was 8.75±1.94%.

A significant association was observed between glycemic control and postoperative complications ($p < 0.001$). Patients with poor glycemic control experienced a higher proportion of postoperative complications, with 166 out of 256 cases (64.8%), compared to 17 out of 85 cases (20.0%) in the good glycemic control group. Conversely, the proportion of patients without complications was higher in the good glycemic control group, with 68 out of 85 cases (80.0%), compared to 90 out of 256 cases (35.2%) in the poor glycemic control group. These findings underscore the increased risk of postoperative complications in patients with poor glycemic control. (Table 1)

The relationship between other patient characteristics and postoperative complications was also analyzed, but no statistically significant associations were found. However, certain trends were noted:

Patients were categorized into four age groups: 18–30 years, 31–45 years, 46–60 years, and 61–80 years. Postoperative complications were reported in 35 (50.7%) patients aged 18–30 years, 47 (57.3%) in the 31–45 years group, 41 (53.9%) in the 46–60 years group, and 60 (52.6%) in the 61–80 years group. No statistically significant association was observed between age and postoperative complications ($p = 0.866$).

Regarding sex, postoperative complications occurred in 85 (54.8%) male patients and 98 (52.7%) female patients, with no statistically significant difference ($p = 0.692$).

Obesity status was evaluated, and complications were observed in 60 (52.6%) of obese patients and 123 (54.2%) of non-obese patients. This difference was minimal and not statistically significant ($p = 0.786$).

The duration of diabetes was grouped into 1–10 years, 11–20 years, and 21–30 years. Complications were reported in 71 (54.2%) of patients with diabetes for 1–10 years, 63 (56.3%) for those with diabetes for 11–20 years, and 49 (50.0%) for those with diabetes for 21–30 years. No significant association was found between the duration of diabetes and postoperative complications ($p = 0.655$).

Smoking status was also analyzed. Among smokers, 94 (52.2%) experienced complications, compared to 89 (55.3%) of non-smokers. This difference was not statistically significant ($p = 0.572$). (Table 2)

In summary, poor glycemic control was significantly associated with a higher risk of postoperative complications, while other factors, including age, sex, obesity status, duration of diabetes, and smoking status, did not show statistically significant associations.

Table 1: Association of post-operative complications with glycemic control

Glycemic Control	Postoperative Complications		Total	P value
	Yes	No		
Poor Control	166 (48.7%)	90 (26.4%)	256 (75.1%)	0.000
Good Control	17 (5.0%)	68 (19.9%)	85 (24.9%)	
Total	183 (53.7%)	158 (46.3%)	341 (100%)	

Table 2: Association of Postoperative Complications with different variables

Variable	Category	Postoperative Complications (Yes)	Postoperative Complications (No)	Total	p-value
Age group	18–30 years	35 (50.7%)	34 (49.3%)	69	0.866
	31–45 years	47 (57.3%)	35 (42.7%)	82	
	46–60 years	41 (53.9%)	35 (46.1%)	76	

Variable	Category	Postoperative Complications (Yes)	Postoperative Complications (No)	Total	p-value
	61–80 years	60 (52.6%)	54 (47.4%)	114	
Sex	Male	85 (54.8%)	70 (45.2%)	155	0.692
	Female	98 (52.7%)	88 (47.3%)	186	
Obesity status	Obese	60 (52.6%)	54 (47.4%)	114	0.786
	Non-obese	123 (54.2%)	104 (45.8%)	227	
Duration of diabetes	1–10 years	71 (54.2%)	60 (45.8%)	131	0.655
	11–20 years	63 (56.3%)	49 (43.8%)	112	
	21–30 years	49 (50.0%)	49 (50.0%)	98	
Smoking status	Smoker	94 (52.2%)	86 (47.8%)	180	0.572
	Non-smoker	89 (55.3%)	72 (44.7%)	161	

4. DISCUSSION

This study highlights the critical role of preoperative glycemic control, as measured by glycated hemoglobin (HbA1c) levels, in predicting postoperative complications in diabetic patients undergoing general surgical procedures. Elevated HbA1c levels have consistently been associated with increased risks of adverse outcomes, including infections, organ dysfunction, and mortality, as evidenced by numerous studies.

Ahmed et al. [13] demonstrated that diabetic patients with HbA1c levels >8.5% experienced significantly higher rates of superficial (33.1%) and deep (12.3%) surgical site infections, as well as respiratory complications (12.9%), renal dysfunction (11%), and cardiac events (6.7%). These findings are consistent with the present study, where poor glycemic control (HbA1c >7%) was associated with a higher complication rate (64.8%) compared to good glycemic control (20.0%).

Wong et al. [14] conducted a meta-analysis showing that patients with elevated HbA1c levels had increased odds of major complications, including anastomotic leaks (OR: 2.80), wound infections (OR: 1.21), and overall complications (OR: 2.12). Their findings emphasize the need for preoperative optimization, particularly in elective surgeries, which aligns with the current study's findings.

Jones et al. [15] highlighted the association between preoperative HbA1c levels and perioperative glucose management. They observed that HbA1c >6.5% was associated with increased postoperative glucose monitoring and insulin use. This finding underscores the role of HbA1c in guiding perioperative strategies, consistent with the present study's emphasis on glycemic control as a modifiable risk factor.

Prus et al. [16] and Kulikov et al. [17] expanded this understanding to specialized surgical populations. Prus et al. reported a significant correlation between elevated HbA1c levels and early postoperative infections in spinal surgery, while Kulikov et al. demonstrated that HbA1c ≥7.5% increased infection rates in patients undergoing neurosurgical procedures. These studies validate HbA1c as a predictor of postoperative complications across various surgical specialties, complementing the findings of the present study.

In a systematic review, Wong et al. [18] emphasized that preoperative glycemic control strategies should be prioritized, as HbA1c is a strong marker of postoperative risk. They argued for HbA1c thresholds lower than 7% to minimize complications, which aligns with the significant association observed in the current study between poor glycemic control and complications.

Akhtar et al. [19] further supported the importance of HbA1c optimization, reporting that patients with HbA1c >8.5% had higher rates of complications, including prolonged hospital stays and increased mortality. This reinforces the current study's conclusion that preoperative glycemic optimization can improve surgical outcomes.

Kulikov et al. [20] highlighted that elevated HbA1c levels (>7.5%) in neurosurgical patients are associated with higher infection rates within the first postoperative week. This complements the current study's findings, emphasizing the universal relevance of HbA1c as a predictor across surgical populations.

Finally, evidence from large-scale observational studies, including the meta-analysis by Wong et al. [21], demonstrated that

HbA1c levels are not only predictive of complications but also serve as a modifiable risk factor. Their findings underscore the importance of tailored preoperative interventions to improve outcomes.

While other patient characteristics, such as age, sex, obesity, duration of diabetes, and smoking status, were analyzed in the present study, none showed statistically significant associations with postoperative complications. This emphasizes the dominant role of glycemic control, as consistently highlighted in the literature.

5. CONCLUSION

This study demonstrates that poor preoperative glycemic control, as indicated by elevated HbA1c levels, is significantly associated with an increased risk of postoperative complications in diabetic patients undergoing general surgical procedures. Patients with HbA1c levels >7% experienced markedly higher rates of complications compared to those with better glycemic control (HbA1c ≤7%). Other factors such as age, sex, obesity, duration of diabetes, and smoking status were not significantly associated with postoperative complications. These findings emphasize the importance of optimizing glycemic control before surgery to reduce complications and improve surgical outcomes. Proactive glycemic management should be a key component of preoperative care, particularly in diabetic patients..

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