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ORIGINAL ARTICLE

Perioperative Glycemic Control in Patients Undergoing Surgery for Diabetic Foot Ulcers

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Jakaria Kabir[1], Masud Rana Badol[2], Shawkat Hossain Mollah[3], Saiful Islam[4]

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Correspondence to
Jakaria Kabir

ABSTRACT

Background: *Diabetic foot is a serious complication of diabetes, with poor glycemic control increasing the risk of ulcers, gangrene, and amputation. Perioperative hyperglycemia further elevates the risk of postoperative complications, including infection, delayed healing, and higher morbidity.* ***Objective:*** *The aim of the study was to evaluate the impact of perioperative glycemic control on surgical outcomes in patients undergoing surgery for diabetic foot ulcers.* ***Methods & Materials:*** *This observational study was conducted at the Department of Anaesthesia, North Bengal Medical College and Shahid Munsur Ali Medical College.* Sirajganj, Bangladesh, *from January to December 2024, including 120 patients with diabetic foot ulcers undergoing surgery. Patients were classified by perioperative glycemic control. Demographic, surgical, and postoperative outcome data were collected and analyzed using Fisher's exact test and independent t-test, with $p < 0.05$ considered significant.* ***Results****: Among 120 patients (mean age 59.9 ± 5.9 years, 65% male), 56.7% achieved good perioperative glycemic control. Minor amputation was the most common procedure (54.2%). Poor glycemic control was associated with higher rates of surgical site infection (36.5% vs 13.2%), delayed wound healing (38.5% vs 17.6%), re-operation (23.1% vs 7.4%), re-amputation (17.3% vs 4.4%), and longer hospital stay (12.7 ± 5.6 vs 8.2 ± 3.1 days; $p < 0.001$). In-hospital mortality was higher with poor control (11.5% vs 2.9%; $p = 0.140$).* ***Conclusion:*** *Strict perioperative glycemic control improves surgical outcomes and reduces postoperative complications in patients with diabetic foot ulcers.*

Keywords: *Perioperative, Glycemic, Diabetic Foot Ulcers*

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1. *Assistant Professor, Department of Anaesthesia, North Bengal Medical College, Sirajganj, Bangladesh (ORCID: 0000-0001-5356-9709)*
2. *Assistant Professor, Department of Urology, Shaheed M Monsur Ali Medical College, Sirajganj, Bangladesh (ORCID: 0009-0006-3499-1289)*
3. *Senior Consultant, Anaesthesia, 250 Bed General Hospital, Naogaon, Bangladesh (ORCID: 0009-0002-6418-1763)*
4. *Principal, MATS, Sirajganj, Bangladesh (ORCID: 0009-0001-0790-8375)*

INTRODUCTION

Diabetes mellitus (DM) ranks among the most prevalent chronic diseases worldwide. In 2017, the World Health Organization reported that approximately 425 million people were affected by DM globally [1]. This condition poses substantial risks to both physical and mental health. One of the most severe complications of DM is diabetic foot (DF), which frequently occurs alongside diabetic nephropathy and/or peripheral arterial disease [2]. Patients with DF commonly present with pain, foot ulcers, or gangrene, which can significantly impair mobility and impose considerable psychological and financial burdens [3]. Moreover, inadequate metabolic control has been identified as a predictor for amputation in patients hospitalized for diabetic foot ulcers [4].

The development of diabetic foot ulcers is primarily driven by peripheral neuropathy, vascular insufficiency in the lower extremities, and infection. It is estimated that 15–25% of individuals with diabetes will experience DF during their lifetime [5,6]. Chronic hyperglycemia contributes to a wide array of complications, including cardiovascular disease, nephropathy, retinopathy, neuropathy, foot disorders, and immune dysfunction [7,8]. Poor glycemic management in patients with DF aggravates the severity of foot ulcers, often necessitating urgent or life-saving amputations. These observations underscore the need for early detection and proactive management of risk factors to prevent disease progression and reduce the incidence of severe outcomes.

The perioperative period represents a particularly vulnerable time for patients with diabetes due to altered glucose metabolism, compromised immune responses, and an elevated risk of complications under general anesthesia. Perioperative hyperglycemia has been consistently linked with negative outcomes across various surgical populations, including increased rates of infection, cardiovascular complications, and mortality [9]. Hyperglycemia impairs leukocyte function, granulocyte adherence, phagocytosis, chemotaxis, and bactericidal activity, thereby heightening the risk of postoperative infections [10-14]. Conversely, meticulous glucose management during the perioperative period has been associated with reduced morbidity and mortality in surgical patients [15], highlighting the essential role of maintaining optimal glycemic control to improve surgical outcomes in individuals undergoing procedures for diabetic foot ulcers.

Despite growing evidence on the role of glycemic control in surgical outcomes, most existing studies focus on general or vascular surgery patients, with limited prospective data specifically addressing diabetic foot ulcer surgery.

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Additionally, the optimal perioperative glucose targets, the relationship between short-term glycemic fluctuations, and postoperative complications such as wound infection, re-operation, and amputation remain inadequately defined in this population. Variations in study design, sample size, and definitions of glycemic control further limit the generalizability of current findings. Therefore, there is a clear need for targeted research to evaluate the direct impact of perioperative glycemic control on surgical outcomes in patients undergoing surgery for diabetic foot ulcers. The purpose of this study is to evaluate the impact of perioperative glycemic control on surgical outcomes in patients undergoing surgery for diabetic foot ulcers.

OBJECTIVE

To evaluate the impact of perioperative glycemic control on surgical outcomes in patients undergoing surgery for diabetic foot ulcers.

METHODS & MATERIALS

This observational study was conducted at the Department of Anaesthesia, North Bengal Medical College and Shahid Munsur Ali Medical College, Sirajganj, Bangladesh, from January 2024 to December 2024. A total of 120 patients with diabetic foot ulcers undergoing surgical intervention were included, selected based on specific inclusion and exclusion criteria. The study aimed to evaluate the impact of perioperative glycemic control on postoperative outcomes, including complications, length of hospital stay, and in-hospital mortality.

Inclusion Criteria

- Patients diagnosed with diabetic foot ulcers scheduled for surgical intervention.
- Age ≥18 years.
- Patients who provided informed consent to participate in the study.

Exclusion Criteria

- Patients with critical limb ischemia requiring immediate revascularization without concurrent ulcer surgery.
- Patients with severe cognitive impairment or psychiatric illness.
- Patients undergoing palliative amputation due to terminal malignancy.

Demographic and clinical data, including age, sex, type and duration of diabetes, were recorded for all patients. Perioperative blood glucose levels were monitored to classify patients into good glycemic control (≤180 mg/dL) or poor glycemic control (>180 mg/dL) groups. Details of surgical procedures, such as surgical debridement, minor or major amputation, and incision and drainage, were documented. Postoperative outcomes, including surgical site infection, delayed wound healing, re-operation, re-amputation, length of hospital stay, and in-hospital mortality, were assessed. Data were analyzed using descriptive statistics, with continuous variables expressed as mean ± standard deviation and categorical variables as frequency and percentage. Comparisons between groups were performed using Fisher's exact test for categorical variables and Independent t-test for continuous variables, with $p < 0.05$ considered statistically significant.

RESULTS

Table I summarizes the demographic and clinical characteristics of the study population. The majority of patients were aged >60 years (66 patients, 55.0%), with a mean age of 59.9 ± 5.9 years. Male patients predominated (78 patients, 65.0%). Most participants had type 2 diabetes mellitus (115 patients, 95.8%). The duration of diabetes was >10 years in 75 patients (62.5%), while 45 patients (37.5%) had a duration of ≤10 years.

Table – I: Demographic and Clinical Characteristics of the Study Population (*n* = 120)

Variable		Frequency (n)	Percentage (%)
Age (years)	≤50	18	15.0
	51–60	36	30.0
	>60	66	55.0
	Mean ± SD	59.9 ± 5.9	
Sex	Male	78	65.0
	Female	42	35.0
Type of Diabetes	Type 1	5	4.2
	Type 2	115	95.8
Duration of Diabetes	≤10 years	45	37.5
	>10 years	75	62.5

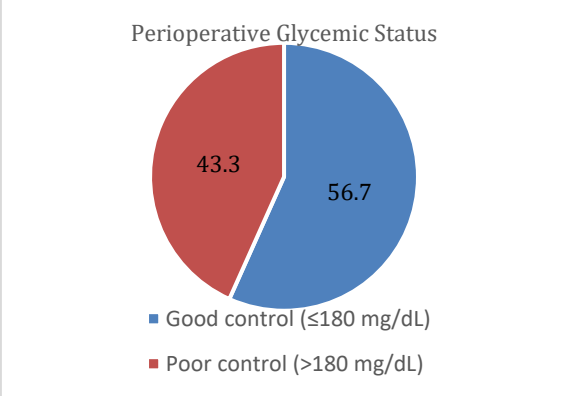

Figure – 1: Distribution of Patients According to Perioperative Glycemic Control (*n* = 120)

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Figure I illustrates the distribution of patients according to perioperative glycemic status. Good glycemic control (≤180 mg/dL) was observed in 68 patients (56.7%), while 52 patients (43.3%) experienced poor glycemic control (>180 mg/dL) during the perioperative period.

Table II depicts the distribution of surgical procedures performed in the study population. Minor amputation (toe or ray) was the most commonly performed procedure, undertaken in 65 patients (54.2%). Surgical debridement was performed in 25 patients (20.8%), while major amputation (below knee) and incision and drainage were carried out in 20 patients (16.7%) and 10 patients (8.3%), respectively.

Table – II: Types of Surgical Procedures Performed Among the Study Population (*n* = 120)

Surgical Procedure	Frequency (n)	Percentage (%)
Surgical debridement	25	20.8
Minor amputation (toe/ray)	65	54.2
Incision and drainage	10	8.3
Major amputation (below knee)	20	16.7
Total	**120**	**100.0**

Table III compares postoperative complications between patients with good and poor perioperative glycemic control. The incidence of surgical site infection, delayed wound healing, re-operation, and re-amputation was higher among patients with poor glycemic control compared to those with good control. These differences were statistically significant, with p-values ranging from 0.003 to 0.044.

Table – III: Postoperative Complications According to Perioperative Glycemic Control

Complication	Good Control (n = 68)	Poor Control (n = 52)	p-value
Surgical site infection	9 (13.2%)	19 (36.5%)	0.003
Delayed wound healing	12 (17.6%)	20 (38.5%)	0.012
Re-operation required	5 (7.4%)	12 (23.1%)	0.027
Re-amputation	3 (4.4%)	9 (17.3%)	0.044

Table IV shows the relationship between perioperative glycemic control and length of hospital stay. Patients with poor glycemic control had a significantly longer mean hospital stay (12.7 ± 5.6 days) compared to those with good glycemic control (8.2 ± 3.1 days), with the difference being statistically significant ($p < 0.001$).

Table – IV: Length of Hospital Stay According to Perioperative Glycemic Control

Glycemic Control Group	Mean Hospital Stay (days)	Standard Deviation	p-value
Good control	8.2	± 3.1	<0.001
Poor control	12.7	± 5.6	

Table V demonstrates the association between perioperative glycemic status and in-hospital mortality. Mortality was higher among patients with poor glycemic control (6 patients, 11.5%) compared to those with good glycemic control (2 patients, 2.9%). However, this difference was not statistically significant ($p = 0.140$).

Table – V: In-Hospital Mortality According to Perioperative Glycemic Status

Glycemic Status	Mortality (n)	Percentage (%)	p-value
Good control	2	2.9	0.140
Poor control	6	11.5	

DISCUSSION

Diabetic foot ulcers (DFUs) are a serious complication of diabetes mellitus that can result in significant morbidity if not appropriately managed. The presence of DFUs reflects underlying neuropathy, peripheral vascular disease, and infection, which collectively contribute to tissue breakdown and impaired wound healing. The findings of this study demonstrate that perioperative glycemic control plays a crucial role in surgical outcomes, with poor glycemic management being associated with higher rates of postoperative complications, prolonged hospital stay, and increased in-hospital mortality. These results highlight the importance of careful monitoring and optimization of blood glucose levels in patients undergoing surgery for diabetic foot ulcers to improve recovery and reduce adverse outcomes.

The demographic and clinical profile of the study population indicates that diabetic foot ulcers predominantly affect older adults, with a mean age of 59.9 ± 5.9 years and most patients being over 60 years of age. This finding is consistent with reports by Oyibo et al., who documented a mean age of 56.6 ± 12.6 years [16], and Ali et al., where the majority of patients were between 40 and 60 years [17]. A higher proportion of male patients was noted (65.0%), which is consistent with the sex distribution reported in studies by Oyibo et al. and Haji et al., which reported male proportions of 77% and 62.8%, respectively [16,18]. The majority of patients (95.8%) had type 2 diabetes, highlighting its well-established link with the development of diabetic foot ulcers. Additionally, over half of the patients had a diabetes duration exceeding 10 years, corroborating findings from Ali et al. and Haji et al. [17,18], and reinforcing the role of long-standing diabetes as a major risk factor for the development of foot ulcers. Collectively, these findings demonstrate that older age, male sex, type 2 diabetes, and prolonged disease duration are consistent characteristics across diabetic foot ulcer populations.

During the perioperative period, 56.7% of patients were able to maintain blood glucose within the target range (≤180 mg/dL), while 43.3% had levels exceeding this threshold, indicating poor glycemic control. This distribution is comparable to previous studies indicating a high prevalence of perioperative hyperglycemia among patients undergoing surgery for diabetic foot disease. Chen et al. reported that poor glycemic control was common in this population and negatively influenced wound healing and postoperative outcomes [19]. Likewise, Kinio et al. reported perioperative hyperglycemia in 38.9% of diabetic surgical patients [20], a proportion comparable to that seen in the current study. These observations highlight the ongoing challenge of achieving optimal perioperative glucose control and underscore its clinical importance in reducing postoperative complications.

Analysis of surgical interventions revealed that minor amputations, including toe and ray amputations, were the most frequently performed procedures, followed by surgical debridement, major amputations, and incision and drainage. This pattern is consistent with prior reports in the literature. Aslam et al. identified ray amputation as the most common surgical procedure in diabetic foot patients [21], while Chalya et al. similarly reported that debridement and lower-limb amputations constituted the majority of interventions, with minor amputations being more frequent than major ones [22]. These similarities suggest that many patients present with advanced but potentially limb-salvageable disease, though a significant proportion still require major amputation due to extensive infection or tissue necrosis. These findings emphasize the importance of early surgical intervention and effective perioperative management in limiting disease progression.

Postoperative outcomes in the present study were strongly influenced by perioperative glycemic control. Patients with poor glycemic control experienced significantly higher rates of surgical site infection, delayed wound healing, re-operation, and re-amputation compared to those with good control. These results are consistent with existing evidence demonstrating the deleterious effects of hyperglycemia on surgical outcomes. Sadoskas et al. reported a significantly increased risk of surgical site infection among diabetic patients with perioperative hyperglycemia undergoing foot and ankle surgery [23]. Likewise, Chen et al. found that hyperglycemia was associated with higher rates of infection and re-amputation in patients with diabetic foot ulcers [19]. Together, these findings reinforce the critical role of optimal perioperative glycemic management in minimizing postoperative morbidity and improving surgical success.

The length of hospital stay was also significantly longer among patients with poor perioperative glycemic control. This observation aligns with previous studies emphasizing the relationship between metabolic control and prolonged hospitalization. Kim et al. demonstrated that elevated HbA1c levels and inadequate perioperative glucose control were significant predictors of extended hospital stay in patients undergoing surgery for infected diabetic foot ulcers [24]. Mejia et al. similarly reported longer hospital admissions among patients with diabetic foot disease compared to those without [25], suggesting that disease severity and associated metabolic dysregulation contribute to delayed recovery. These findings collectively support the role of effective glycemic control in reducing hospitalization duration and optimizing resource utilization.

Although in-hospital mortality was higher among patients with poor perioperative glycemic control, the difference did not reach statistical significance. Nevertheless, this trend is consistent with published literature indicating increased mortality risk in patients with surgically treated diabetic foot disease. Aragón-Sánchez et al. reported high long-term mortality rates following surgical management of diabetic foot infections [26], highlighting the severe systemic burden and poor prognosis associated with advanced disease. While their study focused on long-term outcomes, the direction of association observed in the present study suggests that inadequate glycemic control may contribute to worse survival outcomes in this high-risk population.

LIMITATIONS OF THE STUDY

This study had some limitations:

- The absence of randomization in sample selection could introduce selection bias.
- The study's limited geographic scope may introduce sample bias, potentially affecting the broader applicability of the findings.

CONCLUSION

Effective perioperative glycemic control is critical in patients undergoing surgery for diabetic foot ulcers, as poor glucose management can compromise wound healing and increase the risk of complications. In this study, patients with better perioperative glycemic control experienced fewer postoperative complications and shorter hospital stays, while mortality was not significantly affected. These findings underscore the importance of strict perioperative glucose management to improve surgical outcomes in this high-risk population.

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Conflicts of interest

There are no conflicts of interest.

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