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Original Research Article

Clinical Profile and Perioperative Glycaemic Management of Adults with Type 2 Diabetes Mellitus Undergoing Elective Surgery

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ABSTRACT
Background: Type 2 diabetes mellitus is associated with increased perioperative morbidity due to stress-induced hyperglycaemia, impaired wound healing, and higher risk of postoperative complications. Optimal perioperative glycaemic management is essential to improve surgical outcomes, yet evidence from Indian clinical settings remains limited. This study evaluated the clinical profile, perioperative glycaemic management practices, and postoperative outcomes among adults with T2DM (Type 2 Diabetes Mellitus) undergoing elective surgery.
Methods: A hospital-based cross-sectional study was conducted at SSIMS & RC, Davangere, from January 2023 to December 2023. One hundred adults aged 18–75 years with T2DM (ASA Grade II–III) undergoing elective surgery were enrolled after ethical approval and informed consent. Preoperative demographic, clinical, biochemical, and glycaemic parameters were recorded. Intraoperative monitoring included haemodynamic variables, anaesthetic technique, intravenous fluids, and blood glucose levels. Postoperative outcomes such as ICU admission, hypoglycaemia, DKA (Diabetic Ketoacidosis), surgical site infection (SSI), and duration of hospital stay were assessed. Data were analysed using SPSS version 20 with appropriate statistical tests.
Results: Among 100 participants, 61% were females and 29% were aged above 60 years. The mean HbA1c was 8.04%, mean fasting blood glucose was 136.6 mg/dL, and mean preoperative glucose was 169.02 mg/dL. General anaesthesia was the most common technique (48%). Haemodynamic parameters remained stable throughout surgery. No cases of intraoperative hypotension, myocardial infarction, renal failure, or stroke were reported. ICU admission was required in 50% of patients, predominantly for one day. DKA occurred in 3%, hypoglycaemic episodes in 2%, and SSI in 13% of patients. Overall, favourable perioperative outcomes were observed with appropriate glycaemic and anaesthetic management.
Conclusion: Careful perioperative glycaemic control combined with appropriate anaesthetic management is associated with favourable surgical outcomes and a low incidence of major complications in adults with T2DM undergoing elective surgery. Larger multicentre prospective studies are warranted to validate these findings and optimize perioperative management strategies.

Keywords: Type 2 Diabetes Mellitus, Perioperative Glycaemic Management, Elective Surgery, Anaesthesia, Hyperglycaemia, Surgical Site Infection, Postoperative Outcomes and Hba1c.

INTRODUCTION

Diabetes mellitus is a group of metabolic disorders characterised by hyperglycaemia resulting from defects in insulin secretion, insulin action, or both.[1] It is a chronic multisystem disease with a rapidly increasing global prevalence, affecting approximately 537 million people worldwide, a figure projected to

reach 700 million by 2045. In Europe alone, nearly 61 million adults are living with diabetes, accounting for approximately 1 in 11 adults.[2]

The perioperative management of patients with diabetes presents significant clinical challenges. Surgical stress decreases insulin secretion while increasing insulin resistance and the release of stress hormones such as catecholamines, cortisol, and glucagon, leading to perioperative hyperglycaemia.[3,4] Maintaining optimal blood glucose levels is therefore essential, and various anaesthetic and sedative agents have been investigated for their role in attenuating the surgical stress response.[3,4]

Persistent hyperglycaemia adversely affects multiple organ systems and is associated with serious complications, including cardiovascular disease, nephropathy, retinopathy, neuropathy, and lower extremity disease, making effective glycaemic control a cornerstone of diabetes management.[5,6] Uncontrolled hyperglycaemia may also result in osmotic diuresis, electrolyte imbalance, ketogenesis, endothelial dysfunction, immune dysregulation, and increased inflammatory responses.[7] Additionally, patients with type 2 diabetes mellitus are at risk of treatment-related complications such as hypoglycaemia.

Perioperative hyperglycaemia occurs in 20–40% of patients undergoing general surgery and in up to 80% of those undergoing cardiac surgery, contributing to increased postoperative complications, prolonged hospital stay, and higher perioperative mortality compared with non-diabetic individuals.[3,6] Despite several published reviews, perioperative management of diabetic patients remains inconsistent, and clear evidence-based guidelines, particularly in the Indian setting, are limited.[8] Furthermore, the expanding use of newer antidiabetic agents in T2DM has introduced additional uncertainties regarding their perioperative management.

Aims and Objectives

The study aimed to evaluate the pattern of perioperative blood sugar control in patients with Type 2 diabetes mellitus undergoing surgery. The primary objective is to assess the perioperative clinical profile of Type 2 diabetes mellitus patients receiving different treatment regimens for glycaemic control. The secondary objective is to evaluate perioperative outcomes and identify adverse events associated with these diabetes management regimens, thereby determining their effectiveness and safety in the perioperative period.

MATERIALS AND METHODS

Study Design

A cross-sectional study was conducted among patients with Type 2 diabetes mellitus undergoing surgeries under anaesthesia at SSIMS & RC, Davangere, over a one-year period from January 2023 to December 2023. Prior to the commencement of the study, approval was obtained from the Institutional Ethics Committee. Written informed consent was obtained from all participants in both English and the local language after explaining the purpose and nature of the study.

Inclusion and Exclusion Criteria

The study included patients diagnosed with type 2 diabetes mellitus, aged between 18 and 75 years, of either gender, who were classified as American Society of Anaesthesiologists (ASA) Physical Status Grade II or III and were scheduled to undergo elective surgery under anaesthesia. Only patients who provided written informed consent were enrolled in the study. Patients with CRF (Chronic Renal Failure), IHD (Ischaemic Heart Disease), stroke, or DKA (Diabetic Ketoacidosis) were excluded from the study.

Sample Size Calculation

Sample size has been calculated using the formula, n = [DEFF*Np(1-p)]/ [(d2/Z21-α/2*(N-1)+p*(1-p)]. An estimated 25% of diabetic patients will require surgery, according to Loh Trivedi et al.,[61] was 25%. The calculated sample size at a 95% confidence interval with 10% error is 73, which is inflated to 100.

Data Collection Procedure

After obtaining approval from the Institutional Ethics Committee and written informed consent from all participants, data were collected prospectively using a structured proforma. Preoperative data included demographic details, duration of diabetes, associated comorbidities, signs and symptoms of autonomic neuropathy, frailty index, current antidiabetic medications, fasting status, baseline vital parameters, laboratory investigations (including fasting blood sugar, HbA1c, serum electrolytes, blood urea, and serum creatinine), and any changes in perioperative glycaemic management. Intraoperative data included the type of

anaesthesia administered, duration of surgery, haemodynamic parameters, intraoperative blood glucose level, insulin regimen, intravenous fluids, blood loss, and any adverse events such as hypotension, arrhythmias, or bradycardia. Postoperatively, patients were followed until hospital discharge, and data regarding blood glucose control over the first 24 hours, pain management, hypoglycaemic episodes, diabetic ketoacidosis, renal failure, intensive care unit admission, myocardial infarction, stroke, surgical site infection, length of hospital stay, and other perioperative complications were recorded for analysis.

Statistical Analysis

The collected data were compiled using Microsoft Excel and analysed using the Statistical Package for the Social Sciences (SPSS) software, version 20. Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. Appropriate tables, charts, and diagrams were used for data presentation. The normality of data distribution was assessed using suitable statistical methods. Appropriate statistical tests were applied to evaluate the association between study variables. For comparison of preoperative and postoperative continuous variables, the paired *t*-test was used. A *p*-value of <0.05 was considered statistically significant.

RESULTS

Variable	Category	Frequency	Percent
Age	31–40 Y	17	17
	41–50 Y	27	27
	51–60 Y	27	27
	>60 Y	29	29
Sex	Male	39	39
	Female	61	61
ASA	Grade II	64	64
	Grade III	36	36
Frailty	3/30	6	6
	No	94	94
History DM	Long Standing	6	6
	Newly Diagnosed	94	94

Table 1. Baseline Demographic and Clinical Characteristics

Table 1 illustrates the baseline demographic and clinical profile of the 100 study participants. The largest proportion (29%) were older than 60 years, while 54% were between 41 and 60 years, indicating that surgery was predominantly performed in middle-aged and elderly individuals. Females constituted the majority (61%). Most patients were classified as ASA Grade II (64%), suggesting acceptable pre-operative physical status, whereas 36% belonged to ASA Grade III. Only 6% demonstrated frailty and 94% had no frailty. Newly diagnosed diabetes was observed in 94% of patients, while only 6% had long-standing diabetes, indicating that most participants were recently identified with type 2 diabetes mellitus.

Characteristic	Frequency	Percent
T2DM	54	54
T2DM + HTN	33	33
HTN+T2DM+IHD	4	4
HTN+T2DM+Asthma	3	3
T2DM+IHD	3	3
T2DM+DVT	2	2
T2DM+Hypothyroidism	1	1
Autonomic Neuropathy: No	79	79
Autonomic Neuropathy: Yes	18	18
NPDR	3	3

Table 2. Comorbidities and Diabetes-Related Characteristics

Table 2 shows that isolated type 2 diabetes mellitus was the commonest clinical presentation (54%), followed by diabetes with hypertension (33%). Other associated illnesses such as ischaemic heart disease, bronchial asthma, deep vein thrombosis and hypothyroidism were relatively uncommon. Autonomic neuropathy was absent in 79% of patients and present in 18%, while only 3% had NPDR, indicating a relatively low burden of advanced diabetic complications.

Parameter	Minimum	Maximum	Mean	SD
Hba1c	5.1	16.7	8.04	2.45
24-H Pre-Op Sugar	103	274	169.02	39.33
FBS	94	220	136.6	30.32
Fasting Time	0	10	8.68	1.59
Na+	132	147	138.17	3.81
K+	2.8	5.1	3.75	0.41
Creatinine	0.4	14.5	1.32	1.95
Blood Urea	10	80	21.03	12.77

Table 3. Glycaemic and Laboratory Profile

Table 3 summarizes glycaemic control and laboratory findings. The mean HbA1c of 8.04% indicates suboptimal long-term glycaemic control. The average 24-hour pre-operative blood glucose (169.02 mg/dl) and fasting blood glucose (136.6 mg/dl) were elevated. Mean fasting duration was 8.68 hours. The mean sodium and potassium levels remained within acceptable clinical limits, while average renal function parameters were largely preserved despite a wide range of creatinine values.

Parameter	Baseline/0 Min	60 Min
Pulse	82.8	79.75
Spo2	98.06	99.35
SBP	129.5	119.08
DBP	77.5	72.4
MAP	96.54	91.48

Table 4. Intra-Operative Haemodynamic Parameters

Table 4 demonstrates relatively stable intra-operative haemodynamics. Pulse rate showed only a slight decline throughout surgery. Oxygen saturation remained consistently above 98%, indicating adequate oxygenation. Both systolic and diastolic blood pressure decreased modestly after induction of anaesthesia and remained stable thereafter. Mean arterial pressure also showed a mild reduction without major fluctuations, suggesting good haemodynamic stability.

Variable	Result
Mean IV Fluids	1245.03 Ml
Crystalloid	Normal Saline 97%; Normal Saline+RL 3%
Most Common Anaesthesia	GA 48%
SAB	18
EA+GA	9
CSE	6
Nerve Block	6
GA+Nerve Block	4
EA+SAP	3
SAP	3
Segmental Spinal	1

Table 5. Anaesthesia and Fluid Management

Table 5 illustrates peri-operative management. General anaesthesia was the predominant technique (48%), followed by subarachnoid blocks (18%). The mean intravenous fluid

administered was 1245.03 ml. Normal saline was almost universally used (97%), reflecting standard peri-operative fluid management practices.

Outcome	Result
ICU: None	50
ICU:1 Day	33
ICU:2 Days	14
ICU:3 Days	3
Side Effects	None
DKA	3%
Hypoglycaemia	2%
SSI	13%

Table 6. Post-Operative Outcomes and Complications

Table 6 shows favourable postoperative outcomes. Half of the patients did not require ICU admission, while one-third required observation for only one day. No major postoperative adverse events such as hypotension, renal failure, stroke or myocardial infarction were reported. Diabetic ketoacidosis and hypoglycaemic episodes were uncommon, occurring in only 3% and 2% of patients, respectively. Surgical site infection occurred in 13% of patients, indicating an overall low postoperative complication rate.

DISCUSSION

Diabetes mellitus is a chronic metabolic disorder characterised by hyperglycaemia resulting from impaired insulin secretion, insulin action, or both.[1] The global burden of diabetes continues to increase, with an estimated 537 million affected individuals worldwide, projected to reach 700 million by 2045.[2] Perioperative hyperglycaemia remains a major concern because the surgical stress response increases insulin resistance and the secretion of counter-regulatory hormones, leading to poor glycaemic control and increased postoperative morbidity.[3,4] Hyperglycaemia is associated with delayed wound healing, increased susceptibility to infections, endothelial dysfunction, and prolonged hospital stay, emphasising the importance of optimal perioperative glycaemic management.[5–8]

In the present study, 29.0% of patients were older than 60 years. Similar findings were reported by Coan et al, who observed a mean age of 67 years,[9] while Frisch et al., reported a mean age of 61.2 years among diabetic patients.[2] Howieson et al., also reported an older study population with a mean age of 72 years.[10] Females constituted 61.0% of the study population, which is comparable to the findings of Frisch et al.,[2] although Coan et al.,[9] and Howieson et al.,[10] reported a predominance of male patients.

Most patients (64.0%) belonged to ASA Grade II, while 36.0% were classified as ASA Grade III, indicating that the majority had mild-to-moderate systemic disease. In comparison, Coan et al., reported that nearly 70% of patients were ASA Grade IV.[9] Hypertension, ischaemic heart disease, bronchial asthma, and deep vein thrombosis were the common associated comorbidities observed in this study, reflecting the multisystem involvement of diabetes.

Autonomic neuropathy was observed in only 3.0% of patients, while a frailty index of 3/30 was noted in 6.0%. The majority of patients (94.0%) were newly diagnosed with type 2 diabetes mellitus, whereas only 6.0% had long-standing disease. This differs from the findings of Coan et al., where the mean duration of diabetes was 12 years.[9]

The mean HbA1c level in the present study was 8.04%, with mean fasting blood glucose and 24-hour preoperative blood glucose levels of 136.6 mg/dL and 169.02 mg/dL, respectively. These values were higher than those reported by Coan et al (mean HbA1c 7.0%)[9] and Frisch et al., who reported a mean preoperative blood glucose level of 120.4 mg/dL.[2] These findings suggest suboptimal glycaemic control, which is a recognised risk factor for postoperative complications.

The mean fasting duration was 8.68 hours. Mean serum sodium and potassium levels were 138.17 mEq/L and 3.75 mEq/L, respectively, while mean serum creatinine and blood urea were 1.32 mg/dL and 21.03 mg/dL, indicating generally preserved renal and electrolyte status.

Haemodynamic parameters remained stable throughout the perioperative period. The baseline pulse rate was 82.8 beats/minute,

systolic blood pressure decreased from 129.5 mmHg to 118 mmHg following anaesthesia, diastolic blood pressure decreased from 77.5 mmHg to 72.4 mmHg, and mean arterial pressure showed a transient reduction before returning towards baseline. Oxygen saturation remained satisfactory, with a mean baseline SpO_2 of 98.06%.

The average intravenous fluid administered was 1245.03 mL, with normal saline used in 97.0% of patients. General anaesthesia was administered in 48.0% of cases, whereas subarachnoid block was performed in 18.0%. No significant perioperative adverse effects were observed.

Surgical site infection occurred in 13.0% of patients, highlighting the adverse impact of diabetes on postoperative wound healing. Similar wound-related complications were reported by Howieson et al.[10] Furthermore, Howieson et al., observed that although major postoperative complications were uncommon, perioperative diabetic management was often inadequate, particularly regarding optimisation of HbA1c and perioperative glucose monitoring, with 36 patients experiencing hyperglycaemic episodes and four experiencing hypoglycaemia.[10]

Overall, the findings of the present study are consistent with those reported by Coan et al,[9] Frisch et al,[2] and Howieson et al.[10] The study highlights that careful perioperative assessment, optimisation of glycaemic control, vigilant intraoperative monitoring, and appropriate postoperative care remain essential to minimise complications and improve surgical outcomes in patients with Type 2 diabetes mellitus.

CONCLUSION

This study highlights the importance of appropriate perioperative anaesthetic management in patients with type 2 diabetes mellitus undergoing surgery. Careful perioperative care can contribute to improved surgical outcomes with fewer complications, including reduced surgical site infections. Although the study was limited by its cross-sectional design, single-centre setting, and the absence of a comparative group and sampling methods, it provides valuable insights into the anaesthetic management of these patients. Further large-scale, comparative studies are recommended to strengthen the evidence and optimise perioperative management strategies.

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