

Perioperative Blood Glucose Status of Diabetic Patients Receiving Balanced General Anaesthesia and Total Intravenous Anaesthesia During Laparoscopic Cholecystectomy: A Comparative Study

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ABSTRACT

Background: Anaesthesia and laparoscopic surgery can worsen glycaemic control in diabetic patients, raising the risk of ketoacidosis, circulatory compromise, infection and death. General and total intravenous anaesthesia may influence glucose metabolism differently through varying effects on stress response and insulin sensitivity. **Objective:** This study aimed to evaluate and compare perioperative blood glucose status in type 2 diabetic patients receiving balanced general anaesthesia and total intravenous anaesthesia during laparoscopic cholecystectomy. **Methods & Materials:** This quasi-experimental study was conducted over one year at Bangladesh Medical University. Sixty diabetic patients undergoing laparoscopic cholecystectomy were allocated alternately into two equal groups: Group T received total intravenous anaesthesia with propofol and remifentanyl and Group G received balanced general anaesthesia with isoflurane and remifentanyl. Blood glucose was measured before induction, after intubation, during pneumoperitoneum and at end of surgery. Data were analyzed in SPSS 25 using independent t-test, Mann-Whitney U test, or chi-square test, with p less than 0.05 considered significant. **Results:** Baseline characteristics were comparable between groups except gender (p=0.045). Blood glucose rose progressively in both groups but did not differ significantly at any time point: before induction (6.05 versus 6.15 mmol/L, p=0.853), after intubation (6.10 versus 6.05 mmol/L, p=0.428), during pneumoperitoneum (6.80 versus 6.50 mmol/L, p=0.239) and end of surgery (8.10 versus 8.00 mmol/L, p=0.561). No adverse anaesthetic effects were observed. **Conclusion:** Both techniques maintained comparable perioperative

glycaemic control in type 2 diabetic patients undergoing laparoscopic cholecystectomy, supporting either as a safe anaesthetic option in this population.

Keywords: blood glucose, diabetes mellitus, laparoscopic cholecystectomy, total intravenous anaesthesia, balanced general anaesthesia.

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INTRODUCTION

Laparoscopic cholecystectomy has become the preferred surgical approach for cholecystolithiasis, gallbladder polyps and related gallbladder disorders because it is minimally invasive, produces less scarring and allows faster recovery than open surgery [1,2]. Despite these advantages, pneumoperitoneum created by carbon dioxide insufflation raises intraabdominal pressure and the reverse Trendelenburg position required for the procedure alters cardiac output and vascular resistance, adding physiological stress to an already demanding intraoperative period [3]. When this stress is superimposed on diabetes mellitus, the metabolic consequences can be considerable, since poorly controlled perioperative glucose predisposes patients to ketoacidosis, circulatory compromise, infectious complications and death, with several cohorts confirming higher perioperative mortality among diabetic and

hyperglycaemic patients than among those with normal glucose tolerance [4,5].

Perioperative hyperglycaemia is not a benign laboratory finding. It has been linked with surgical site infection, myocardial infarction, stroke and mortality and stress-induced hyperglycaemia in particular appears to carry a worse prognosis than chronic diabetes-related hyperglycaemia [6,7]. Intraoperative glucose management has been shown to reduce adverse perioperative events and structured preoperative glucose monitoring protocols improve intraoperative and postoperative glycaemic control while lowering the incidence of hypoglycaemia [8,9]. Because impaired glucose regulation also delays wound healing and increases susceptibility to infection through reduced tensile strength of newly formed tissue, the anaesthetic technique chosen for diabetic patients undergoing laparoscopic surgery deserves close scrutiny [10].

General anaesthesia can be delivered through several protocols, among which total intravenous anaesthesia (TIVA) and balanced general anaesthesia are most widely used and these techniques differ mechanistically in their influence on glucose metabolism. Volatile anaesthetics have been shown to impair glucose tolerance and suppress insulin secretion, thereby promoting perioperative hyperglycaemia, whereas high-dose propofol infusion appears to lower circulating glucose and norepinephrine, attenuate intraoperative stress and reduce disturbances of glucose metabolism in diabetic patients [11]. Comparative work in non-diabetic cohorts has similarly found that propofol exerts a smaller effect on intraoperative glucose handling than isoflurane or sevoflurane, an effect attributed to volatile-agent inhibition of glucose-stimulated insulin secretion,

contrasted with propofol-associated preservation of glucose utilisation [12]. Remifentanyl, an ultra-short-acting opioid with a context-sensitive half-life of three to ten minutes, is commonly combined with both anaesthetic techniques to blunt the neuroendocrine stress response [13]. It has been shown to suppress hormonal stress responses during major surgery and to mitigate hyperglycaemic responses associated with surgical stimulation and trials pairing remifentanyl with inhalational or intravenous agents report improved intraoperative glucose control through limitation of stress-hormone release [14]. Diabetic patients undergoing gallbladder surgery already carry a disproportionate burden of complications compared with their non-diabetic counterparts, including a greater likelihood of emergency intervention, intraoperative difficulty and unfavourable postoperative recovery, which makes careful perioperative metabolic surveillance particularly important in this subgroup [15]. Yet much of the existing comparative literature on anaesthetic technique and glycaemic control has been generated in general surgical or cardiac populations, with comparatively limited data specific to laparoscopic cholecystectomy in patients with established type 2 diabetes mellitus. Because TIVA and balanced general anaesthesia deliver anaesthetic agents through fundamentally different routes and act on glucose homeostasis through distinct mechanisms, a direct comparison of their influence on perioperative glycaemic status in diabetic patients undergoing laparoscopic cholecystectomy is clinically relevant and can help anaesthesiologists select the technique that best preserves glycaemic stability in this vulnerable surgical population. This study was therefore designed to evaluate and compare perioperative blood glucose status in type 2 diabetic patients receiving balanced general

anaesthesia and total intravenous anaesthesia during laparoscopic cholecystectomy, with glucose measured before induction, after intubation, during pneumoperitoneum and at the end of surgery.

OBJECTIVES

The objective of this study was to evaluate and compare perioperative blood glucose status in type 2 diabetic patients receiving balanced general anaesthesia and total intravenous anaesthesia during laparoscopic cholecystectomy.

METHODS & MATERIALS

This quasi-experimental comparative study was conducted over a twelve-month period, from October 2024 to September 2025, in the General Surgery operation theatre, Department of Anaesthesia, Analgesia and Intensive Care Medicine, Bangladesh Medical University, Dhaka. The study population comprised type 2 diabetic patients of either gender, aged 30 to 65 years, with ASA physical status II, who were scheduled for laparoscopic cholecystectomy after attending the Department of General Surgery. Sixty patients were enrolled by purposive sampling after fulfilling the inclusion criteria, which required patients on insulin therapy with HbA1c below 6.5 percent, while patients with ASA status I, III or IV, those managed with oral hypoglycaemic agents, a body mass index above 30 kg per square meter, a history of substance abuse, or known allergy to the study drugs were excluded. Participants were allocated alternately into two equal groups of thirty, Group T receiving total intravenous anaesthesia with propofol and remifentanyl infusion together with a muscle relaxant and Group G receiving balanced general anaesthesia with isoflurane and remifentanyl infusion together with a muscle relaxant. Demographic data, ASA

grade and fingertip capillary blood glucose were recorded before induction, after intubation, during pneumoperitoneum and at the end of surgery using a calibrated glucometer, with all measurements obtained by on-duty anaesthetists following a standardized data collection sheet to ensure accuracy and consistency. Written informed consent was obtained from every participant after the study procedure, potential group allocation, risks and benefits were explained in an easily understood local language and ethical approval was granted by the Institutional Review Board of Bangladesh Medical University (registration number 4937), with confidentiality of participant information maintained throughout. Statistical analysis was performed using SPSS version 25. Quantitative variables were expressed as mean with standard deviation or median with interquartile range and compared between the two groups using the independent samples t-test or the Mann-Whitney U test according to the distribution of the data, while categorical variables such as gender were compared using the chi-square test. A p-value of less than 0.05 was considered statistically significant for all comparisons.

RESULTS

This quasi-experimental study was conducted over twelve months in the General Surgery operation theatre, Department of Anaesthesia, Analgesia and Intensive Care Medicine, Bangladesh Medical University. Sixty type 2 diabetic patients undergoing laparoscopic cholecystectomy were enrolled by purposive sampling and allocated alternately to the balanced general anaesthesia group (Group G, n=30) or the total intravenous anaesthesia group (Group T, n=30) Table I.

Table I
Baseline characteristics of the study participants (n=60).

Variables	Group G (n=30)	Group T (n=30)	p-value
Age (years), Median (IQR)	50 (37-60)	42.50 (35-53)	0.09
Gender, Male, n (%)	5 (16.7)	12 (40.0)	0.045
Gender, Female, n (%)	25 (83.3)	18 (60.0)	
BMI (kg/m ²), Mean ± SD	25.60 ± 4.25	24.95 ± 3.65	0.527
Duration of surgery (min), Median (IQR)	51 (45-65)	57.50 (50-62.75)	0.128

Group G = balanced general anaesthesia; Group T = total intravenous anaesthesia.

Baseline demographic variables, including age, body mass index and duration of surgery, were statistically comparable

between the two groups. Gender distribution differed significantly between

groups (p=0.045), with a higher proportion of female participants overall (Table II).

Table II

Blood glucose level of the study participants at perioperative time points (n=60).

Time of measurement	Group G, Median (IQR)	Group T, Median (IQR)	p-value
Before induction at operation theatre	6.05 (5.55-7.42)	6.15 (5.20-7.67)	0.853
After intubation	6.10 (5.50-7.70)	6.05 (5.30-7.42)	0.428
During pneumoperitoneum	6.80 (6.00-8.52)	6.50 (5.70-8.00)	0.239
End of surgery	8.10 (7.50-9.00)	8.00 (7.00-9.00)	0.561

Data presented as Median (IQR). p-value derived from Mann-Whitney U test. Group G = balanced general anaesthesia; Group T = total intravenous anaesthesia. Blood glucose expressed in mmol/L. $p < 0.05$ considered statistically significant.

Perioperative blood glucose increased progressively over time in both groups but showed no statistically significant

intergroup difference at any measured time point, from before induction through the end of surgery (Table III).

Table III

Summary of perioperative haemodynamic parameters (n=60).

Haemodynamic Parameter	Time Point	Group G, Median (IQR)	Group T, Median (IQR)	p-value
Heart rate (bpm)	30 min after induction	75 (70-78.5)	80 (75-80.5)	0.016
Systolic blood pressure (mmHg)	1 min after extubation	150 (145-155)	140 (135-145)	0.001
	20 min after extubation	135 (125-140)	125 (120-131.25)	0.001
Diastolic blood pressure (mmHg)	All measured time points	NS	NS	>0.05
Mean arterial pressure (mmHg)	End of surgery	87.5 (85-93.5)	85 (80-90)	0.049
	1 min after extubation	100 (95-106.25)	95 (90-100)	0.014
	20 min after extubation	90 (85-95)	85 (80-90)	0.017

Group G = balanced general anaesthesia; Group T = total intravenous anaesthesia; NS = not statistically significant. All comparisons derived from Mann-Whitney U test. * $p < 0.05$ considered statistically significant.

Heart rate, systolic blood pressure and mean arterial pressure were comparable between groups for most of the intraoperative period, with significant divergence confined mainly to thirty minutes after induction and the post-extubation period. Diastolic blood pressure did not differ significantly between groups at any time point. No adverse effects, including known anaesthetic allergy, respiratory depression, hypotension, or nausea and vomiting, were observed in either group.

DISCUSSION

Diabetes is a common comorbidity among adult surgical patients and introduces considerable anaesthetic challenges, particularly in maintaining metabolic stability during surgery. Stress responses associated with anaesthesia can significantly influence glycaemic control, thereby increasing perioperative risk and effective management is therefore critical to reduce complications and ensure favourable outcomes. Proper choice of anaesthetic technique plays a central role in modulating stress responses and metabolic fluctuations, which is why this study compared the effects of balanced general anaesthesia and total intravenous anaesthesia on perioperative blood glucose levels in diabetic patients undergoing laparoscopic cholecystectomy. Previous research has demonstrated a correlation between perioperative hyperglycaemia and rising morbidity and mortality among hospitalized patients [16]. The perioperative blood glucose levels of non-diabetic patients anaesthetized with isoflurane or

sevoflurane have been reported to be higher than those anaesthetized with propofol in numerous studies [12] and the majority of previous work examining the impact of propofol and volatile anaesthetics on perioperative blood glucose in non-diabetic patients has concluded that propofol exerts a less pronounced effect on intraoperative glucose metabolism than isoflurane and sevoflurane [11].

Among the sixty study participants, the distribution of baseline characteristics was comparable between the two groups. The median age was 42.5 years in Group T and 50 years in Group G, with no statistically significant difference ($p=0.090$) and no significant difference in body mass index was observed between the groups ($p=0.527$). These findings were consistent with a previous study by Xiong and colleagues, who likewise found no significant statistical differences in age and body mass index between their comparison groups [11]. A statistically significant difference in gender distribution was noted ($p=0.045$), with a higher proportion of female participants overall. The duration of surgery also showed no significant difference, with a median operative time of 51 minutes in Group G compared with 57.5 minutes in Group T ($p=0.128$), indicating that baseline demographic and surgical parameters were largely similar across the groups. This finding was supported by Ihn et al., who similarly reported no statistical difference in duration of surgery between their studied groups [14].

The perioperative blood glucose levels increased progressively over time in both groups but showed no significant

intergroup differences at any measured point. Before induction at the operation theatre, the median glucose was 6.05 mmol/L in Group G and 6.15 mmol/L in Group T ($p=0.853$). After intubation, values remained similar between groups ($p=0.428$). During pneumoperitoneum, glucose rose to 6.80 mmol/L in Group G and 6.50 mmol/L in Group T, a difference that remained statistically insignificant ($p=0.239$). By the end of surgery, median glucose reached 8.10 mmol/L in Group G and 8.00 mmol/L in Group T, again with no statistically significant difference ($p=0.561$). This progressive rise across both groups reflects the expected neuroendocrine stress response to surgical stimulation and pneumoperitoneum, occurring independently of the anaesthetic technique used.

The absence of a measurable clinical advantage associated with the comparatively lower blood glucose levels sometimes reported with propofol-based anaesthesia may be attributed to the multifactorial nature of perioperative hyperglycaemia. One possible explanation is that only severe hyperglycaemia, defined as glucose levels above 180 mg/dL or 10.0 mmol/L, constitutes a mortality risk factor in patients with diabetes who have chronic exposure to elevated glucose levels, unlike non-diabetic patients. Consequently, the immediate impact of general anaesthetics on blood glucose may be less clinically consequential in diabetic patients whose preoperative glucose is already well controlled, as was the case in both groups of this study [11]. Ihn and colleagues observed that glucose levels were

significantly lower in the total intravenous anaesthesia group compared with the volatile induction and maintenance group at intubation, incision and extubation, a finding that contrasts with the present results ^[14]. The present findings also differ from those of Xiong et al., who reported significantly lower blood glucose in the total intravenous anaesthesia group than in the total inhalational anaesthesia group, although their measurements extended from extubation up to two days postoperatively, a considerably longer observation window than the intraoperative period examined here ^[11]. Prior research has indicated that isoflurane and sevoflurane are more likely than propofol to induce glucose intolerance and insulin resistance in type 2 diabetic patients, eventually increasing perioperative hyperglycaemia ^[17], yet the present intraoperative comparison did not detect this divergence, suggesting that any differential metabolic effect of the two techniques may require a longer postoperative observation period to become clinically apparent. No adverse effects such as known anaesthetic allergy, respiratory depression, hypotension, or nausea and vomiting were observed in either group, supporting the overall metabolic and clinical safety of both anaesthetic approaches in this diabetic surgical population.

CONCLUSION

Perioperative blood glucose levels rose progressively over the course of laparoscopic cholecystectomy in type 2 diabetic patients irrespective of anaesthetic technique, with no statistically significant difference between total intravenous anaesthesia and balanced general anaesthesia at any measured time point. Both techniques maintained comparable glycaemic control before induction, after intubation, during pneumoperitoneum and at the end of surgery, without precipitating severe hyperglycaemia or any anaesthesia-related adverse event. These findings suggest that either total intravenous anaesthesia with propofol and remifentanyl or balanced general anaesthesia with isoflurane and remifentanyl can be safely selected for diabetic patients undergoing laparoscopic cholecystectomy without compromising perioperative glycaemic stability.

CONFLICTS OF INTEREST

None.

ETHICAL APPROVAL

This study approved by the BMU institutional ethical review committee.

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