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Original Article

Impact of Spinal Anaesthesia on Perioperative Glycemic Dynamics: A Comparative Study of Diabetic and Non-Diabetic Patients

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ABSTRACT

Introduction- Perioperative hyperglycemia increases surgical morbidity in both diabetic and non-diabetic patients. Spinal anaesthesia may attenuate the surgical stress response through sympathetic blockade, potentially influencing glycemic dynamics. However, comparative data between diabetic and non-diabetic patients remain limited. This study evaluates perioperative blood glucose changes under spinal anaesthesia in both groups.

Material and Method- This comparative observational study included 100 adults (50 diabetics, 50 non-diabetics) undergoing elective lower abdominal or limb surgeries under spinal anaesthesia. Perioperative blood glucose was measured at baseline, 30 minutes, end of surgery, and 2 hours postoperatively. Hemodynamic parameters and surgery duration were recorded. Data were analyzed using t-test, ANOVA, Chi-square test, Pearson correlation and multivariate logistic regression analysis.

Result- Among 100 patients undergoing surgery under spinal anaesthesia (50 diabetics, 50 non-diabetics), baseline characteristics were comparable except HbA1c. Absolute perioperative glucose levels were significantly higher in diabetics at all time points ($p<0.001$), though glucose rise from baseline was similar between groups. Hyperglycemia and insulin requirement occurred only in diabetics. Surgical duration correlated with glucose rise, and diabetes and duration >90 minutes independently predicted hyperglycemia.

Conclusion- Diabetic patients exhibited significantly higher perioperative glucose levels under spinal anaesthesia, although relative glucose rise was comparable to non-diabetics. Diabetes and prolonged surgery independently predicted hyperglycemia, while hemodynamic responses were similar. Vigilant perioperative glucose monitoring remains essential, particularly in diabetic and prolonged procedures.

Keywords*: Spinal anaesthesia, perioperative hyperglycemia, diabetes, blood glucose dynamics, glycemic control etc.*

INTRODUCTION

Perioperative glycemic control is a critical determinant of surgical outcomes, particularly in the context of the rising global prevalence of diabetes mellitus. According to recent epidemiological estimates, the burden of diabetes continues to increase worldwide, with significant implications for perioperative morbidity and mortality [1,2]. Hyperglycemia during the perioperative period has been associated with adverse outcomes such as surgical site infections, delayed wound healing, prolonged hospital stay, and increased cardiovascular events in both diabetic and non-diabetic patients [3,4]. Therefore, understanding factors that influence perioperative glycemic dynamics remains a priority in anaesthetic practice. Surgical trauma activates a complex neuroendocrine stress response mediated by the hypothalamic–pituitary–adrenal axis and the sympathetic nervous system. This response leads to increased secretion of catecholamines, cortisol, glucagon, and growth hormone, promoting glycogenolysis, gluconeogenesis, and insulin resistance, thereby resulting in stress-induced hyperglycemia [5,6]. Although this physiological response is more pronounced in patients with pre-existing diabetes, non-diabetic individuals may also develop significant perioperative hyperglycemia, which can independently predict poor outcomes [4,7].

Anaesthetic technique plays a crucial role in modulating the magnitude of the surgical stress response. Regional anaesthesia, particularly spinal anaesthesia, attenuates afferent nociceptive transmission and sympathetic outflow by producing neural blockade, thereby potentially reducing the endocrine-metabolic response to surgery [6,8]. Several studies have demonstrated that regional anaesthesia may provide better glycemic stability compared to general anaesthesia by limiting perioperative stress hormone release [8,9]. However, the degree to which spinal anaesthesia influences glycemic trends specifically in diabetic versus non-diabetic patients remains inadequately explored. Diabetic patients often exhibit altered autonomic function and baseline insulin resistance, which may modify their metabolic response to spinal-induced sympathetic blockade [10]. Despite this physiological rationale, limited prospective comparative data exist evaluating serial perioperative blood glucose changes under spinal anaesthesia across these two populations. Most available literature focuses on comparisons between anaesthetic techniques rather than targeted comparisons within defined metabolic cohorts [8]. Given the increasing surgical load of diabetic patients and the clinical significance of perioperative hyperglycemia, it is essential to delineate the impact of spinal anaesthesia on glycemic dynamics in both diabetic and non-diabetic individuals. A clearer understanding of these variations may aid in optimizing perioperative glucose monitoring strategies, tailoring anaesthetic plans, and improving overall patient safety. This study therefore aims to comparatively evaluate perioperative blood glucose changes in diabetic and non-diabetic patients undergoing surgery under spinal anaesthesia.

MATERIAL AND METHOD-

This comparative observational study was conducted in the Department of Anaesthesiology at Laxmi Chandravansi Medical College and Hospital, Bishrampur, Palamu, after obtaining approval from the Institutional Ethics Committee and written informed consent from all participants. The study was carried out over a period of 12 months from October 2024 to October 2025. Adult patients aged 30–70 years of either gender, belonging to American Society of Anesthesiologists (ASA) physical status I–III, scheduled for elective lower abdominal or lower limb surgeries under spinal anaesthesia were included. Participants were divided into two groups: Group D (patients with diagnosed type 2 diabetes mellitus on treatment) and Group N (non-diabetic patients). Patients with uncontrolled diabetes (HbA1c >9%), those receiving perioperative steroid therapy, patients with endocrine disorders other than diabetes, those requiring conversion to general anaesthesia, and emergency surgeries were excluded. The sample size was calculated based on an expected mean difference of 20 mg/dL in perioperative blood glucose levels between groups, with a standard deviation of 30 mg/dL, power of 80%, and alpha error of 0.05. Using these parameters, the minimum required sample size was 45 patients per group. To account for potential dropouts, 50 patients were enrolled in each group, making a total sample size of 100 participants.

All patients were kept fasting as per standard guidelines. Baseline fasting blood glucose was measured in the preoperative room using a calibrated glucometer. Standard monitoring including heart rate, non-invasive blood pressure, and oxygen saturation was instituted in the operating theatre. Spinal anaesthesia was administered in the sitting position at the L3–L4 interspace using 0.5% hyperbaric bupivacaine (3 ml) under aseptic precautions. No additional adjuvants were used. Blood glucose levels were recorded at predefined intervals: preoperative baseline (T0), 30 minutes after spinal anaesthesia (T1), at the end of surgery (T2), and 2 hours postoperatively (T3). Intraoperative hemodynamic parameters and duration of surgery were also documented. Data were entered into Microsoft Excel and analyzed using SPSS software version 25. Continuous variables were expressed as mean ± standard deviation and compared using independent t-test and repeated measures ANOVA. Pearson correlation analysis was used to assess correlation between duration of surgery and rise in blood glucose, and multivariate logistic regression analysis was performed to identify independent predictors of hyperglycemia.Categorical variables were analyzed using Chi-square test. A p-value <0.05 was considered statistically significant.

RESULT-

A total of 100 patients undergoing spinal anesthesia were included in the study, with 50 patients in the diabetic group (Group D) and 50 in the non-diabetic group (Group N). The baseline demographic and clinical characteristics of the participants are presented in Table 1. The mean age of patients in Group D was 56.2 ± 8.4 years, compared to 54.8 ± 9.1 years in Group N, with no statistically significant difference between the groups (p = 0.412). The duration of surgery was also comparable, with a mean duration of 78.4 ± 18.6 minutes in Group D and 75.2 ± 17.9 minutes in Group N (p = 0.398). Preoperative fasting duration did not differ significantly between the groups (8.6 ± 1.2 hours vs 8.4 ± 1.1 hours; p = 0.421). As expected, HbA1c levels were significantly higher in the diabetic group (7.6 ± 0.8%) compared to the non-diabetic group (5.4 ± 0.4%), and this difference was statistically significant (p < 0.001). The mean systolic blood pressure (SBP) fall following spinal anaesthesia was comparable between the two groups (18.4 ± 7.6 mmHg in Group D vs 20.2 ± 8.1 mmHg in Group N; p = 0.241). Similarly, body mass index (BMI) did not differ significantly between Group D and Group N (26.8 ± 3.2 kg/m² vs 25.9 ± 3.5 kg/m²; p = 0.184). Distribution across BMI categories (normal, overweight, and obese) was comparable between the two groups (p = 0.278). Gender distribution was also similar, with males constituting 56% in Group D and 60% in Group N (p = 0.689). Additionally, ASA physical status classification showed no statistically significant difference between groups (p = 0.231). Overall, both groups were comparable with respect to baseline demographic and perioperative characteristics, except for HbA1c levels, which were significantly higher in diabetic patients undergoing spinal anesthesia.

Table 1- Baseline demographic and clinical characteristics of study participants

Variable		Group D (Diabetics under spinal anaesthesia) (n=50)	Group N (Non-Diabetics under spinal anaesthesia) (n=50)	p-value
Age (years)		56.2 ± 8.4	54.8 ± 9.1	0.412
Duration of Surgery (minutes)		78.4 ± 18.6	75.2 ± 17.9	0.398
Preoperative Fasting Duration (hours)		8.6 ± 1.2	8.4 ± 1.1	0.421
HbA1c (%)		7.6 ± 0.8	5.4 ± 0.4	**<0.001**
Mean SBP Fall (mmHg)		18.4 ± 7.6	20.2 ± 8.1	0.241
BMI (kg/m²)		26.8 ± 3.2	25.9 ± 3.5	0.184
BMI Category	Normal (18.5–24.9)	14 (28%)	18 (36%)	0.278
	Overweight (25–29.9)	24 (48%)	22 (44%)	
	Obese (≥30)	12 (24%)	10 (20%)	
Gender	Male	28 (56%)	30 (60%)	0.689
	Female	22 (44%)	20 (40%)	
ASA Physical Status	ASA I	6 (12%)	14 (28%)	0.231
	ASA II	28 (56%)	26 (52%)	
	ASA III	16 (32%)	10 (20%)	

Perioperative blood glucose levels at different time intervals are presented in Table 2. Baseline (fasting) blood glucose levels were significantly higher in the diabetic group (Group D) compared to the non-diabetic group (Group N) (148.6 ± 24.3 mg/dL vs 96.8 ± 11.4 mg/dL; p < 0.001). At 30 minutes following spinal anaesthesia (T1), mean blood glucose levels increased in both groups and remained significantly higher in Group D (162.4 ± 28.7 mg/dL) compared to Group N (108.5 ± 13.6 mg/dL), with a statistically significant difference (p < 0.001). At the end of surgery (T2), glucose levels further increased to 171.2 ± 31.5 mg/dL in Group D and 115.7 ± 15.2 mg/dL in Group N (p < 0.001). Two hours postoperatively (T3), blood glucose levels showed a slight decline but remained elevated compared to baseline in both groups, measuring 165.8 ± 29.8 mg/dL in Group D and 110.4 ± 14.9 mg/dL in Group N (p < 0.001). The mean rise in blood glucose from baseline was also analyzed. At T1, the mean increase was +13.8 ± 9.6 mg/dL in Group D and +11.7 ± 7.4 mg/dL in Group N, which was not statistically significant (p = 0.238). Similarly, at T2, the mean rise from baseline was +22.6 ± 11.8 mg/dL in Group D and +18.9 ± 9.1 mg/dL in Group N (p = 0.087). At T3, the mean increase was +17.2 ± 10.4 mg/dL in Group D and +13.6 ± 8.3 mg/dL in Group N, with no statistically significant difference between groups (p = 0.091). Thus, although absolute perioperative glucose levels were significantly higher in diabetic patients at all time points, the magnitude of glucose rise from baseline following spinal anaesthesia was comparable between diabetic and non-diabetic patients.

Table 2- Comparison of perioperative blood glucose levels and mean change in blood glucose from baseline

Parameter		Group D (n=50)	Group N (n=50)	p-value
Perioperative blood glucose level (mg/dL) at different time intervals	T0 – Baseline (Fasting)	148.6 ± 24.3	96.8 ± 11.4	**<0.001**
	T1 – 30 min after SA	162.4 ± 28.7	108.5 ± 13.6	**<0.001**
	T2 – End of Surgery	171.2 ± 31.5	115.7 ± 15.2	**<0.001**
	T3 – 2 hrs Postoperative	165.8 ± 29.8	110.4 ± 14.9	**<0.001**
Mean change in blood glucose from baseline (mg/dL)	Mean Rise at T1	+13.8 ± 9.6	+11.7 ± 7.4	0.238
	Mean Rise at T2	+22.6 ± 11.8	+18.9 ± 9.1	0.087
	Mean Rise at T3	+17.2 ± 10.4	+13.6 ± 8.3	0.091

Figure 1 illustrates the comparison of perioperative glycemic and hemodynamic outcomes between diabetic (Group D) and non-diabetic (Group N) patients undergoing surgery under spinal anaesthesia. With respect to glycemic outcomes, 14 patients (28%) in the diabetic group developed perioperative hyperglycemia (blood glucose >180 mg/dL), whereas none of the patients in the non-diabetic group exhibited glucose levels above this threshold. This difference was statistically highly significant (p < 0.001). Similarly, insulin correction was required in 10 patients (20%) in Group D, while no patient in Group N required insulin therapy during the perioperative period (p < 0.001). In contrast, hemodynamic outcomes were comparable between the two groups. Hypotension episodes occurred in 11 patients (22%) in Group D and 14 patients (28%) in Group N, with no statistically significant difference (p = 0.487). Vasopressor requirement was observed in 9 patients (18%) in the diabetic group and 12 patients (24%) in the non-diabetic group, which was also not statistically significant (p = 0.456). Overall, while diabetic patients demonstrated a significantly higher incidence of perioperative hyperglycemia and insulin requirement, the occurrence of hypotension and vasopressor use following spinal anaesthesia was similar between diabetic and non-diabetic patients.

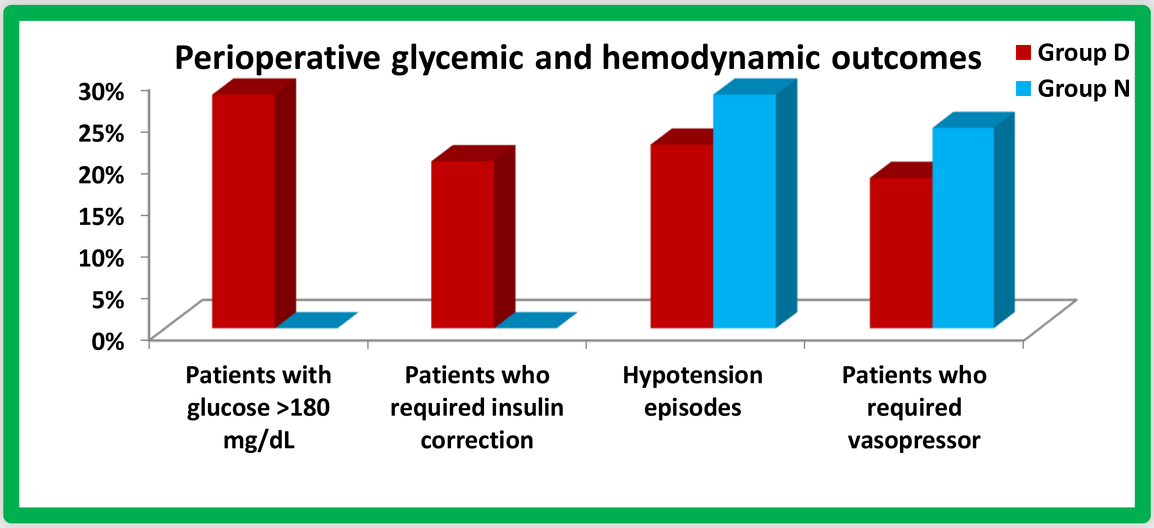

Figure 1- Comparison of perioperative glycemic and hemodynamic outcomes between diabetics and non-diabetics under spinal anaesthesia.

The correlation between duration of surgery and rise in blood glucose levels is presented in Table 3. In the diabetic group (Group D), a moderate positive correlation was observed between duration of surgery and increase in blood glucose levels (r = 0.42), which was statistically significant (p = 0.003). This indicates that longer surgical duration was associated with greater elevation in blood glucose among diabetic patients. Similarly, in the non-diabetic group (Group N), a positive correlation was noted between duration of surgery and rise in blood glucose (r = 0.31), which was also statistically significant (p = 0.028). However, the strength of correlation was comparatively weaker than that observed in the diabetic group. Overall, these findings demonstrate that prolonged surgical duration is significantly associated with increased perioperative glycemic rise in both diabetic and non-diabetic patients undergoing spinal anaesthesia, with a stronger association observed in diabetic patients.

Table 3- Correlation between duration of surgery and rise in blood glucose

Parameter	Correlation Coefficient (r)	p-value
Group D (Diabetics under spinal anaesthesia)	0.42	**0.003**
Group N (Non-Diabetics under spinal anaesthesia)	0.31	**0.028**

Multivariate logistic regression analysis was performed to identify independent predictors of perioperative hyperglycemia in patients undergoing surgery under spinal anaesthesia (Table 4). Diabetes mellitus emerged as a strong independent predictor of hyperglycemia, with an odds ratio (OR) of 6.8 (95% CI: 2.4–14.6), which was statistically highly significant (p < 0.001). This indicates that diabetic patients had nearly seven times higher odds of developing perioperative hyperglycemia compared to non-diabetic patients. Duration of surgery greater than 90 minutes was also identified as a significant predictor, with an OR of 2.3 (95% CI: 1.1–5.8; p = 0.041), suggesting that prolonged surgical procedures were associated with increased risk of hyperglycemia. In contrast, age greater than 60 years (OR: 1.4; 95% CI: 0.6–3.2; p = 0.312) and BMI greater than 27 kg/m² (OR: 1.7; 95% CI: 0.8–3.9; p = 0.184) were not found to be statistically significant predictors of perioperative hyperglycemia. Overall, diabetes mellitus and prolonged surgical duration were independent risk factors for hyperglycemia in patients receiving spinal anaesthesia.

Table 4- Multivariate logistic regression for predictors of hyperglycemia in patients under spinal anaesthesia.

Variable	Odds Ratio (OR)	95% CI	p-value
Diabetes Mellitus	6.8	2.4–14.6	**<0.001**
Duration >90 min	2.3	1.1–5.8	**0.041**
Age >60 years	1.4	0.6–3.2	0.312
BMI >27	1.7	0.8–3.9	0.184

DISCUSSION-

The present study evaluated perioperative glycemic dynamics in diabetic and non-diabetic patients undergoing surgery under spinal anaesthesia. Our findings demonstrate that although absolute blood glucose levels were significantly higher in diabetic patients at all perioperative time points, the magnitude of glucose rise from baseline following spinal anaesthesia was comparable between the two groups. Additionally, diabetes mellitus and prolonged surgical duration were identified as independent predictors of perioperative hyperglycemia. The elevated absolute glucose levels observed in diabetic patients are expected due to impaired insulin secretion and increased insulin resistance. Similar observations were reported by Saha et al. [11], who documented higher perioperative glucose levels in diabetic patients under spinal anaesthesia compared to non-diabetics. Samuel et al. [12] also found that diabetic status significantly influenced intraoperative glycemic trends despite the use of regional anaesthesia. These findings reinforce the concept that baseline metabolic dysfunction remains a key determinant of perioperative glycemia. Interestingly, despite significant differences in absolute glucose values, the mean rise from baseline did not differ significantly between groups. This suggests that spinal anaesthesia may partially attenuate the neuroendocrine stress response in both diabetic and non-diabetic patients. Neural blockade reduces afferent nociceptive input and sympathetic activation, thereby limiting catecholamine-induced gluconeogenesis [13]. Bajracharya et al. [14] similarly reported that regional anaesthesia was associated with a moderated glycemic response compared with general anaesthesia. However, Duggan et al. [15] noted that surgical stress alone can provoke significant hyperglycemia even under regional techniques. Variations in surgical stress intensity and patient characteristics may explain these differences.

In our study, the incidence of hyperglycemia (>180 mg/dL) and the requirement for insulin correction were significantly higher among diabetic patients. These findings are consistent with Kotagal et al. [16], who demonstrated that perioperative hyperglycemia is more common in diabetic individuals and is associated with adverse outcomes. Although postoperative complications were not assessed in the present study, the higher frequency of hyperglycemia in diabetics highlights the need for close metabolic monitoring. Hemodynamic parameters, including hypotension episodes and vasopressor requirement, were comparable between groups. Despite concerns that diabetic autonomic neuropathy may predispose patients to exaggerated hypotension under spinal anaesthesia, no significant differences were observed. Similar conclusions were drawn by Vinik and Ziegler [17], who reported that well-controlled diabetics may maintain hemodynamic stability. Conversely, some authors have described increased variability in patients with established autonomic dysfunction [18], suggesting that neuropathy severity may influence outcomes. A significant positive correlation between duration of surgery and glucose rise was observed in both groups, with a stronger association in diabetics. Kehlet [19] emphasized that prolonged surgical stress sustains neuroendocrine activation, thereby amplifying metabolic disturbances. Logistic regression further confirmed diabetes mellitus (OR 6.8) and surgical duration >90 minutes (OR 2.3) as independent predictors of hyperglycemia, findings comparable to recent perioperative glycemic studies [20]. Overall, while spinal anaesthesia may moderate stress-induced metabolic changes, diabetic status and operative duration remain critical determinants of perioperative hyperglycemia. These results underscore the importance of vigilant glucose monitoring in all patients undergoing spinal anaesthesia, particularly those with diabetes and those undergoing prolonged procedures.

CONCLUSION-

The present study demonstrates that perioperative glycemic dynamics differ significantly between diabetic and non-diabetic patients undergoing surgery under spinal anaesthesia. Although spinal anaesthesia may attenuate the surgical stress response through sympathetic blockade, diabetic patients exhibited consistently higher absolute blood glucose levels at all perioperative time points. However, the magnitude of glucose rise from baseline was comparable between the two groups, suggesting that spinal anaesthesia exerts a similar relative metabolic influence regardless of diabetic status. Importantly, diabetes mellitus and prolonged surgical duration emerged as independent predictors of perioperative hyperglycemia. In contrast, demographic variables such as age and body mass index were not significant determinants in this cohort. Hemodynamic responses, including hypotension and vasopressor requirement, were comparable between groups, indicating that well-controlled diabetic patients tolerate spinal anaesthesia similarly to non-diabetics in terms of cardiovascular stability. The findings underscore the necessity for vigilant perioperative glucose monitoring in all patients receiving spinal anaesthesia, particularly those with diabetes and those undergoing longer surgical procedures. Early identification and timely management of hyperglycemia may help reduce potential metabolic and postoperative complications. Future studies with larger sample sizes and postoperative outcome assessment are warranted to further clarify the long-term clinical implications of perioperative glycemic fluctuations under regional anaesthesia.

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Conflict of Interest- None

REFERENCES-

1. International Diabetes Federation. IDF Diabetes Atlas. 10th ed. Brussels: International Diabetes Federation; 2021.
2. World Health Organization. Global report on diabetes. Geneva: World Health Organization; 2023.

3. American Diabetes Association. Standards of medical care in diabetes—2024. *Diabetes Care*. 2024;47(Suppl 1):S1–S350.
4. Shuford R, Miller-Ocuin JL. Hyperglycemia in the perioperative period. *Clin Colon Rectal Surg*. 2023;36(3):198–200.
5. Acharya K, Rout DK, Kapadia NA, Caroicar YS, Karunakaran NB, Patel P, et al. Surgical stress response: a physiological review of the endocrine, immune, and metabolic changes. *Cureus*. 2025;17(12):e100101.
6. Gokhru S, Jain S. Effect of spinal anaesthesia on perioperative hyperglycemia in diabetic patients undergoing lower limb orthopaedic surgeries. *MedPulse Int J Anesthesiol*. 2018;6(1):1–5.
7. Anderson M. Effects of perioperative hyperglycemia in patients with diabetes compared to patients without diabetes: a retrospective study of treatment and outcomes [dissertation]. Omaha: University of Nebraska Medical Center; 2019.
8. Reysner T, Wieczorowska-Tobis K, Kowalski G, Grochowicka M, Pyszczorska M, Mularski A, et al. The influence of regional anesthesia on the systemic stress response. *Reports (Basel)*. 2024;7(4):89.
9. Halter JB, Pflug AE. Effects of anesthesia and surgical stress on insulin secretion in man. *Metabolism*. 1980;29(11 Suppl 1):1124–7.
10. Gottschalk A, Rink B, Smektala R, Piontek A, Ellger B, Gottschalk A. Spinal anesthesia protects against perioperative hyperglycemia in patients undergoing hip arthroplasty. *J Clin Anesth*. 2014;26(6):455–60.
11. Saha P, Shah BB, Thakur A. Glycemic response under spinal anaesthesia in diabetic versus non-diabetic patients. *IIUM Med J Malaysia*. 2024;23(2):1–6.
12. Samuel H, Girma B, Negash M, Muluneh E. Comparison of spinal versus general anesthesia on perioperative blood glucose levels. *Ann Med Surg (Lond)*. 2023;85:104–12.
13. Desborough JP. The stress response to trauma and surgery. *Br J Anaesth*. 2000;85(1):109–17.
14. Bajracharya A, Sharma SM, Bawa SN, et al. Intraoperative blood glucose levels under regional versus general anaesthesia. *Birat J Health Sci*. 2018;3(2):412–6.
15. Duggan EW, Carlson K, Umpierrez GE. Perioperative hyperglycemia management. *Anesthesiology*. 2017;126(3):547–60.
16. Kotagal M, Symons RG, Hirsch IB, Umpierrez GE, Dellinger EP, Farrokhi ET, et al. Perioperative hyperglycemia and risk of adverse events among patients with and without diabetes. *Ann Surg*. 2015;261(1):97–103.
17. Vinik AI, Ziegler D. Diabetic cardiovascular autonomic neuropathy. *Circulation*. 2007;115(3):387–97.
18. Kadoi Y. Anesthetic considerations in diabetic patients. *J Anesth*. 2016;30(4):593–602.
19. Kehlet H. Modification of responses to surgery by neural blockade. *Br J Anaesth*. 2018;120(4):675–87.
20. Umpierrez GE, Pasquel FJ. Management of inpatient hyperglycemia and diabetes. *Lancet Diabetes Endocrinol*. 2017;5(2):96–106.