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EFFECT OF SPINAL ANESTHESIA COMPARED TO GENERAL ANESTHESIA ON THE LEVEL OF BLOOD GLUCOSE IN PATIENTS UNDERGOING LOWER ABDOMINAL SURGERY

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ABSTRACT

Background: Surgery is known to induce stress and disrupt metabolic activities, potentially leading to stress hyperglycemia, making it crucial to investigate whether the choice of anesthesia modality plays a role in blood glucose regulation during the perioperative period. **Aim of the study:** This study aims to compare blood glucose levels in elective lower abdominal surgery patients receiving general versus spinal anesthesia. **Patients and methods:** A prospective single-blinded comparative study was conducted at Medical City and Baghdad Teaching Hospital from June 1st, 2022, to June 1st, 2023. Sixty patients were conveniently sampled and divided equally into two groups: Group A received general anesthesia, and Group B received spinal anesthesia. Baseline demographic data and intraoperative information, including surgical duration, were collected. Blood glucose level was monitored during the procedure, with the primary outcome measure being changes in blood glucose levels from baseline in the two study groups. **Results:** In the study, mean ages between the groups (35.8 vs. 40.7 years) showed no statistical significance ($p = 0.064$). Body weight and height were similar, but BMI differed significantly ($p = 0.025$). ASA classification and surgery duration did not significantly differ ($p = 0.4$ and $p = 0.3$, respectively). Before induction, blood glucose levels were not significantly different ($p = 0.3$), with the general group at a mean of 106.8 ± 10.1 mg/dL and the spinal group at a mean of 103.8 ± 12.1 mg/dL. At 10 minutes post-induction, no significant difference was found ($p = 0.3$) with means of 109.5 ± 10.3 mg/dL and 106.2 ± 13.3 mg/dL for the general and spinal groups, respectively. However, a significant divergence was observed before end of the surgery ($p = 0.039$), with the general group at a mean of114.8 ± 8.2 mg/dL and the spinal group at a mean of 110.1 ± 9.0 mg/dL. This difference persisted at 20 minutes after surgery ($p = 0.024$), with means of 116.1 ± 9.1 mg/dL for the general group and 111.1 ± 7.8 mg/dL for the spinal group. **Conclusion:** General anesthesia was shown to increase the blood glucose level at the end of surgery more than spinal anesthesia.

KEYWORDS: Spinal anesthesia, general anesthesia, blood glucose.

INTRODUCTION

Surgery is associated with increased stress response which results in sympathetic activations and the release of pituitary hormones that accelerate glycogenolysis and gluconeogenesis and result in stress hyperglycemia.[1]

Stress hyperglycemia is defined as any blood glucose concentration >7.8 mmol/l (140 mg/dl) without evidence of previous diabetes by the American Diabetes Association and American Association of Clinical Endocrinologists consensus.[2]

Stress-induced hyperglycemia is common and more than 50% occurs in previously non-diabetic patients.[3] Perioperative stress-induced hyperglycemia is reported in 20–40% of patients undergoing general surgical procedures.[4] The magnitude of stress hyperglycemia relates to the extent of surgical procedures, the technique of anesthesia, the anatomic location of the surgery, and the types of intraoperative fluids.[5]

The associated factors for the incidence of stress hyperglycemia include age, body mass index, duration of

surgery, baseline blood glucose level, and intraoperative blood transfusion.[3,6]

Perioperative stress hyperglycemia is associated with an increased risk of postoperative complications; including infection, and vascular and immune dysfunction both in diabetic and non-diabetic patients.[7]

AIM OF THE STUDY

The aim of this study is to investigate and compare the impact of spinal anesthesia and general anesthesia on the level of blood glucose in patients undergoing elective lower abdominal surgery. The study aims to determine if there are any significant differences in blood glucose levels between the two anesthesia techniques and provide valuable insights into the potential effects of these techniques on glucose regulation during the perioperative period.

PATIENTS AND METHOD

A clinical trial comparative prospective single-blinded conducted at Al- Emamain Al-Kadhmain medical city and Baghdad teaching hospital during a 12 months period between 1st of June 2022 and 1st of June 2023. A total of sixty patients were collected by convenience. Eligible patients were assigned to one of the two study groups in a 1:1 ratio.

- Group A (N=30): those who received general anesthesia.
- Group B (N=30): those who received spinal anesthesia.

Ethical and scientific approval for the research was obtained from the Scientific Committee at the Department of Anesthesia and Intensive Care, Arab board for medical specialization. Ethical approval was also obtained from the medical center outlined above. Verbal consent was obtained from all patients before starting data collection and after explaining the aims of the study and assuring confidentiality.

Patients eligible for inclusion in this study were.

- Adult patients of both genders aged 18-40 years old who were scheduled to undergo an elective lower abdominal surgery (inguinal hernia, paraumbilical hernia, incisional hernia, hypospadias, varicocele, ovarian cyst, uterine fibroid, etc.…).
- The surgical interventions were performed either under general anesthesia or spinal anesthesia, with a duration not exceeding 2 hours.
- American Society of Anesthesiologists (ASA) physical status classification I or II.

Patients with a history of diabetes mellitus, endocrine disorders, significant hepatic or renal impairment, and those using medications affecting glucose metabolism (like steroids) were excluded from the study.

Patients with fasting blood glucose level >126 mg/dL, also were excluded.

Baseline demographic characteristics (age, sex, weight, height and ASA classification) of all participants were recorded. Intraoperative data, including surgical duration, was also documented. Blood glucose levels and vital sign measurements (heart rate, and blood pressure) were recorded at regular intervals throughout the procedure.

In this study, subjects undergoing surgical procedures were administered two intravenous cannulas at the theater, along with non-invasive surveillance of vital parameters such as blood pressure, blood oxygen saturation, and electrocardiogram. This monitoring process was consistently maintained throughout the postoperative phase in the recovery ward. Before anesthesia induction, both cohorts received intravenous doses of 50 mg ranitidine and 10 mg metoclopramide upon their arrival in the operating room. Patients in both groups were administered 1000–1500 ml of crystalloid fluid not containing any glucose.

The application of spinal anesthesia was performed using aseptic techniques, targeting either the L3-L4 or L4-L5 spinal interspace. The anesthesia was initiated through the injection of 2.5 ml of 0.5% heavy bupivacaine, using 24-25-gauge spinal needles. Concurrently, sedation was administered with 2 mg of midazolam while providing 100% oxygen via a simple face mask at a flow rate of four liters per minute.

The initiation of general anesthesia involved a specific protocol. Firstly, the patient received oxygenation through a face mask for a duration of 3 minutes.

Subsequently, anesthesia induction was achieved using a combination of 1.5-2.0 mg/kg of propofol, 1µm/kg fentanyl, 2 mg midazolam, and 0.6 mg/kg of rocuronium, which was administered to aid tracheal intubation. The intubation process was facilitated using a standard 6.5-7.5 mmid endotracheal tube.

Throughout the procedure, anesthesia was sustained by administering 1.2% isoflurane in 100% oxygen, accompanied by 0.1 mg/kg of rocuronium.

Paracetamol vial (1000 mg) and Nefopam hydrochloride ampule (20 mg) were given intra-op at the end of surgery for post-operative pain control.

Standard monitoring, including electrocardiography (ECG), non-invasive blood pressure, pulse oximetry, and capnography, was employed for all patients in both groups during the intraoperative period. Additionally, blood glucose level was monitored during a regular time intervals.

- T1: 20 minutes before induction.
- T2: 10 minutes after induction.
- T3: 10 minutes before end of surgery.
- T4: 20 minutes after end of surgery.

The examination was performed utilizing a capillary blood glucose monitoring kit featuring a lancet device

from Accu-Chek. Following thorough disinfection with alcohol, the fingertip on the opposite side from the intravenous cannula was pricked using the lancet tip to obtain blood samples for measuring blood glucose concentration.

Continuous variables were expressed as means and standard deviations. Categorical variables were expressed as frequency and percentages. The Welch's t-test (for normally distributed variables) and Repeated measure ANOVA test were utilized for the difference in means. A P-value less than 0.05 was considered statistically significant. R software packages (dplyr, gt_summery and ggplot) were used for data processing, visualization, and statistical analysis ("R version 4.3.0, R Foundation for Statistical Computing, Vienna, Austria").

RESULTS

This study investigated and compared the characteristics of two groups: patients who had general anesthesia (N = 30) and those who had spinal anesthesia (N = 30). While the mean ages between the groups showed a slight difference (35.8 vs. 40.7 years) without statistical significance (p = 0.064), Among the General group, 40.0% were male, while in the Spinal group, 63.3% were male.

Conversely, in the General group, 60.0% were female, compared to 36.7% in the Spinal group (p = 0.071).

Body weight and height were similar between the groups, but body mass index (BMI) differed significantly (p = 0.025), with the general group having a higher BMI (27.6 kg/m2) compared to the spinal group (26.1 kg/m2). The ASA classification and surgery duration did not vary significantly between the groups (p = 0.4 and p = 0.3, respectively).

Table 1: Description of patient's demographics, anthropometrics, ASA types, and duration of surgery.

characteristic		General*	Spinal*	p-Value**
Age (years)		35.8±9.5	40.7±10.6	0.064
Sex	**Male**	12 (40%)	19 (63.3%)	0.071
	Female	18 (60%)	11 (36.7%)	
Weight (kg)		80.8±4.3	79.1±5.3	0.2
Height (cm)		171.3±6.1	174.3±5.7	0.054
BMI (kg/m^2)		27.6±2.2	26.1±2.7	0.025
ASA	**I**	23 (76.7%)	20 (66.7%)	0.4
	II	7 (23.3%)	10 (33.3%)	
Duration of surgery (min.)		72.8±23	78.4±22.4	0.3

*:Mean ± SD; n (%).
**:Welch Two Sample t-test; Pearson's Chi-squared test; Fisher's exact test.

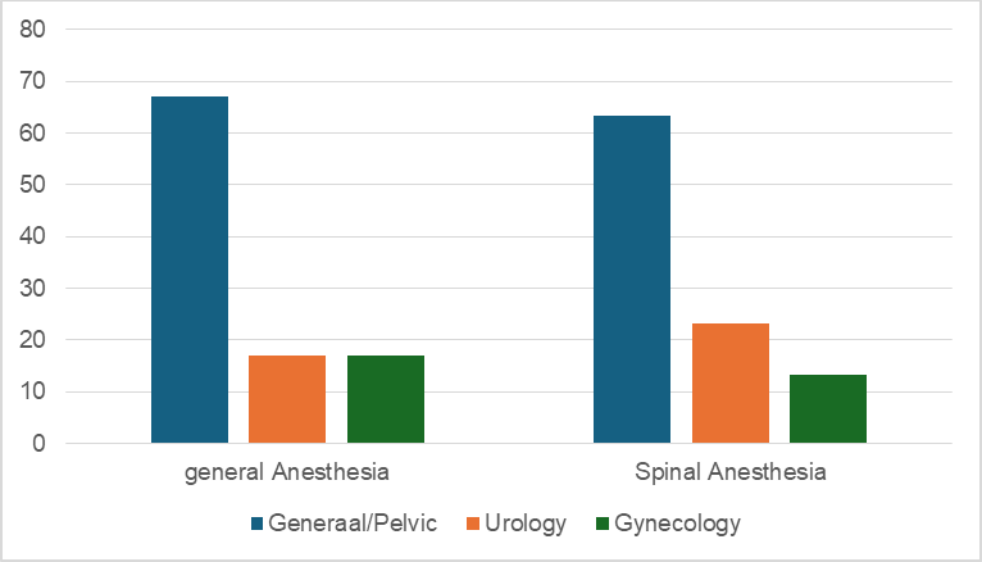

Figure 1: Proportion of the types of operations included in this study.

Approximately 20 minutes before induction, participants under general anesthesia exhibited an average blood glucose level of 106.8 ± 10.1 mg/dL, while those under spinal anesthesia recorded a slightly lower average of 103.8 ± 12.1 mg/dL, with no statistically significant difference (p = 0.3). Similarly, at 10 minutes post-induction, the mean blood glucose levels for the general and spinal anesthesia groups were 109.5 ± 10.3 mg/dL

and 106.2 ± 13.3 mg/dL, respectively, yielding a non-significant p-value of 0.3.

However, a notable divergence was observed in blood glucose levels prior to the end of surgery. Participants in the general anesthesia group presented an average blood glucose level of 114.8 ± 8.2 mg/dL, whereas those in the spinal anesthesia group displayed a slightly lower mean value of 110.1 ± 9.0 mg/dL. Notably, the p-value for this comparison was calculated at 0.039, indicating a statistically significant difference between the two groups. This trend continued even at 20 minutes after end of surgery, with the general anesthesia group showing an average blood glucose level of 116.1 ± 9.1 mg/dL, and the spinal anesthesia group having a mean value of 111.1 ± 7.8 mg/dL, accompanied by a p-value of 0.024.

Table 2: perioperative blood glucose in general and spinal anesthesia groups.

Time	Blood Glucose (mg/dl)		
	General Ans.*	Spinal Ans.*	p-Value**
20 min. before induction	106.8 ± 10.1	103.8 ± 12.1	0.3
10 min. after induction	109.5 ± 10.3	106.2 ± 13.3	0.3
10 min. before end of surgery	114.8 ± 8.2	110.1 ± 9.0	0.039
20 min. after end of surgery	116.1 ± 9.1	111.1 ± 7.8	0.024

*: Mean ± SD.
**: Welch Two Sample t-test.

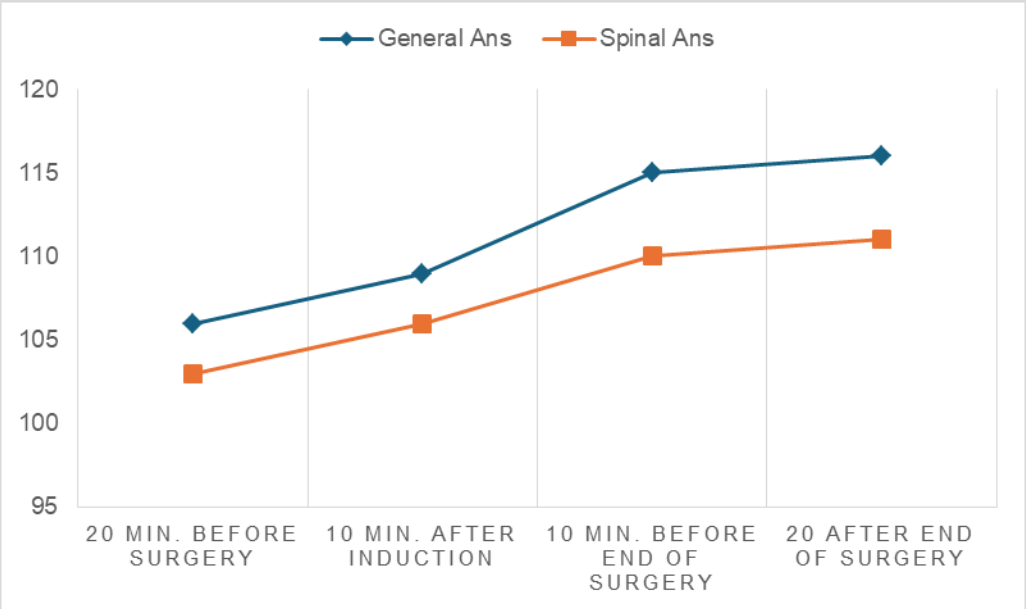

Figure 2: Line plot showing perioperative blood glucose readings over the follow-up period.

In the general group, the perioperative blood glucose was significantly different between '20 minutes before induction' (106.8 ± 10.1) and '20 minutes after end of surgery' (116.1 ± 9.1), with a p-value of <0.001, which was adjusted to 0.003 using the Holm method for pairwise comparisons. In the spinal group, blood glucose levels also showed a statistically significant difference between '20 minutes before induction' (103.8 ± 12.1) and '20 minutes after end of surgery' (111.1 ± 7.8), with a p-value of 0.018. However, after Holm adjustment, the p-value became 0.107.

Table 3: Difference between first and last blood glucose reading in both general and spinal groups.

Parameter		Blood Sugar	p-Value*	Adjusted p-Value**
General Ans.	20 min. before induction	106.8 ± 10.1	<0.001	0.003
	20 min. after end of surgery	116.1 ± 9.1		
Spinal Ans.	20 min. before induction	103.8 ± 12.1	0.018	0.107
	20 min. after end of surgery	111.1 ± 7.8		

*: Pairwise-Paired T-test.
**: Holm adjustment for Pairwise comparisons.

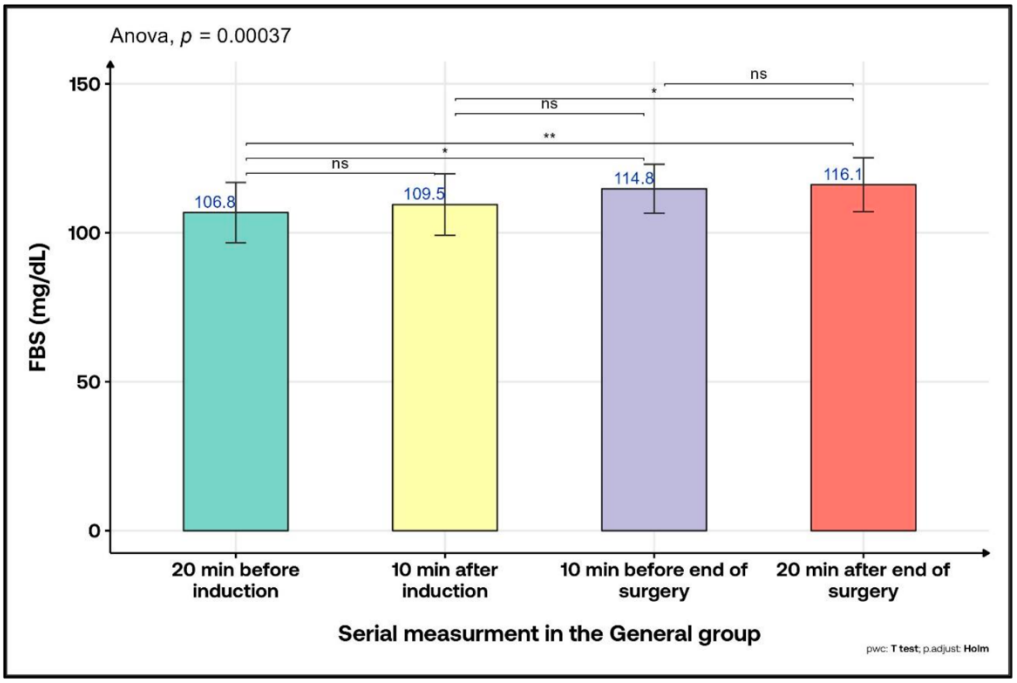

Figure 3: post-hoc analysis of perioperative blood glucose values over time in the general group (ns: non-significant; *: <0.05; **: <0.01).

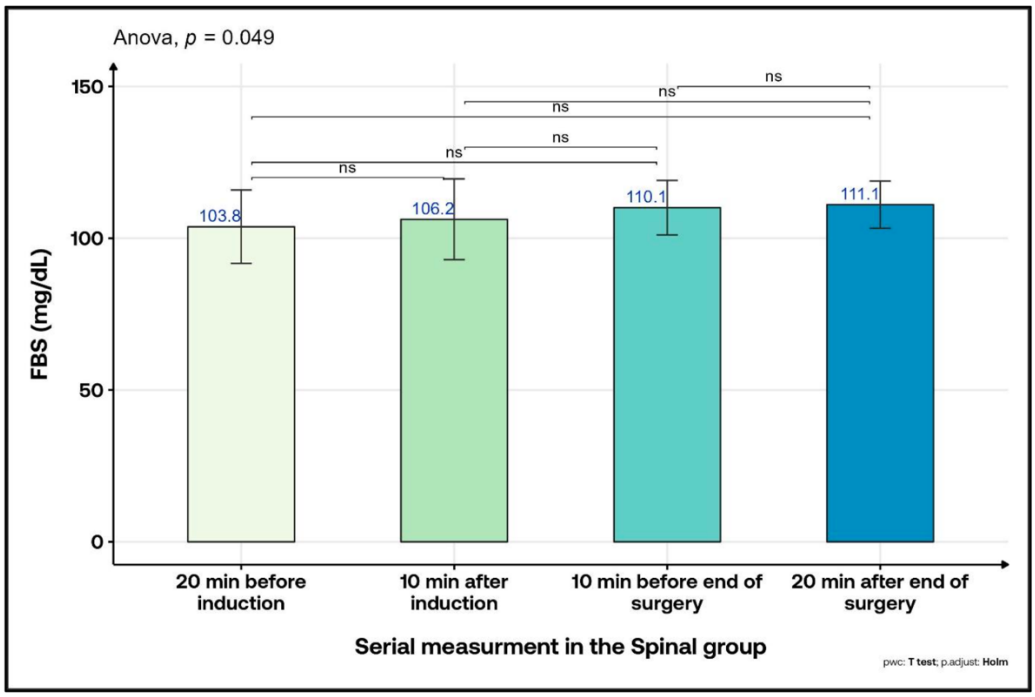

Figure 4: Post-hoc analysis of perioperative blood glucose values over time in spinal anesthesia group (ns: non-significant).

In the general group, the results indicate that there was no statistically significant difference in perioperative blood glucose levels between females and males 20 minutes before induction ($p = 0.1$). Similarly, at other time points, such as 10 minutes after induction, 10 minutes before the end of surgery, and 20 minutes after the end of surgery, the differences in blood glucose levels between the two genders were not statistically significant ($p > 0.05$). also, no difference was observed between males and females in the spinal group ($p > 0.05$).

Table 4: Difference between males and females regarding blood glucose values in the general group (received general anesthesia).

Time	Perioperative blood glucose		
	Female*	Male*	p-Value**
20 min. before induction	110.0 ± 9.0	105.9 ± 10.1	0.1
20 min. after end of surgery	105.9 ± 10.1	108.0 ± 7.9	0.5
20 min. before induction	114.3 ± 7.4	115.4 ± 9.6	0.7
20 min. after end of surgery	117.6 ± 9.7	113.9 ± 7.8	0.3

*: Mean ± SD.
**: Welch Two Sample t-test.

Table 5: Difference between males and females regarding blood glucose values in the spinal group (received spinal anesthesia).

Time	Perioperative blood glucose		
	Female*	Male*	p-Value**
20 min. before induction	107.5 ± 8.8	101.7 ± 13.4	0.2
20 min. after end of surgery	106.1 ± 14.4	106.3 ± 13.0	>0.9
20 min. before induction	110.6 ± 8.4	109.7 ± 9.5	0.8
20 min. after end of surgery	108.8 ± 7.2	112.4 ± 8.0	0.2

*: Mean ± SD.
**: Welch Two Sample t-test.

DISCUSSION

The management of blood glucose levels in patients undergoing surgical procedures holds paramount importance, as it can influence postoperative outcomes and patient well-being.[8] Among the various factors that may impact blood glucose regulation during surgery, the choice of anesthesia type stands out as a significant consideration.[9] This study explores the temporal dynamics of blood glucose changes throughout the surgical process, aiming to shed light on potential variations between the general and spinal anesthesia methods. By examining this pivotal aspect, the study aims to provide valuable insights that can contribute to informed decision-making in anesthesia selection and subsequent blood glucose management strategies.

Our results showed that blood sugar levels before induction and 10 minutes after induction (T1 and T2 timings) were comparable between the two groups, indicating no significant variance immediately following anesthesia administration. However, blood sugar levels were statistically significantly higher in the general anesthesia group than in the spinal anesthesia group at both 10 minutes before the end of surgery and 20 minutes after the surgery's conclusion (T3 and T4 timings). When blood sugar levels were compared between the first and last readings, the general anesthesia group showed significant difference while the spinal anesthesia group did not. Fasting blood sugar levels were as well comparable between male and female participants in both groups.

Samuel et al.[10], studying the effect of different types of anesthesia on perioperative blood sugar, had similar conclusion to our study with the blood glucose levels being comparable at both T1 and T2 timings between both general and spinal groups; on the other hand, the general group had significantly higher levels at the end of surgery and 60 minutes thereafter. A randomized control trial in 2014 by Gottschalk et al.[11] showed a similar result. El-Radaideh et al.[12] reported that the blood sugar was consistently increasing at all times perioperatively in both anesthesia groups; however, a much greater increase was noticed among the general than spinal group. Moreover, such increase in the blood sugar was notably significant at the conclusion of surgery and half-an-hour thereafter in patients undergoing cesarian section. This phenomenon can be explained by the fact that spinal anesthesia would suppress the glycemic response to surgery to a greater extent than general anesthesia via blocking both, afferent input from the operative site to the central nervous system and the hypothalamic-pituitary axis and efferent autonomic neuronal pathways to the liver and adrenal medulla.[13] Other studies in Iran, Jordan, and Ethiopia[14] further support our finding.

In contrast to the results of this study, a study in Serbia by Milosavljevic et al.[15] concluded that both types of anesthesia would have a comparable effect on blood sugar over the entire perioperative period. Similarly, Amiri et al.[16] showed no significant change in the mean blood glucose level between the general and spinal anesthesia groups. A study in Syria[17] additionally supported the previous finding. Such diversion in results may be attributed to several factors including the anesthetic agents used to induce and maintain anesthesia in the general group. It is well-known that ketamine tend to increase the blood glucose level secondary to its sympathomimetic properties, which lead to the activation of adrenocortical function.[18] Turing to the maintenance agents, isoflurane used in the current study has been demonstrated to cause more effect on blood glucose than other maintenance medications such as propofol[19], which was used by Milosavljevic et al.[15] in their study, explaining the different results they obtained.

Our study showed that patients who underwent general anesthesia had a significantly higher blood glucose level at the end of surgery than that before induction; on the other hand, spinal anesthesia did not have a similar effect. That finding was confirmed by other authors such as Geisser et al., Behdad et al., and Sh. et al.[14,19,20] Samuel et al.[10] further showed that the baseline blood sugar level was significantly high compared to different time intervals in the general group. Moreover, Gottschalk et al. al.[11] inferred that the blood glucose levels were comparable to the baseline value throughout the surgical procedure among those who underwent spinal anesthesia.

Nevertheless, as opposed to our findings, a study in Serbia[15] demonstrated that the glucose values at different times over the surgery were lower than the baseline values. The authors attributed that finding to their use of propofol as a maintenance agent among the general anesthesia group; which as mentioned earlier known to have less effect on glucose metabolism that other agents like isoflurane (which has been used in the current study).

Limitations

This study has some limitations that should be taken into consideration when interpreting the study's results and implications.

- The presence of confounding variables (e.g., patient stress, postoperative pain management, etc.) that could influence blood glucose levels and affect the outcomes.
- Time-dependent changes, as the blood glucose levels can vary throughout the day due to circadian rhythms, might not be fully accounted for in the study design.

CONCLUSION

This study underscores that while blood glucose levels largely remain consistent between spinal anesthesia and general anesthesia during most stages of elective lower abdominal surgery, distinct differences become apparent towards the conclusion of the surgical procedure. Moreover, general anesthesia was shown to significantly increase the blood glucose level at the end of surgery compared to the baseline as opposed to the spinal anesthesia.

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