Blood glucose changes in general and spinal anesthesia

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Abstract

Background:

Medical literature describes how several metabolic and hormonal changes occur while undergoing different kinds of Anesthesia. This study aims to compare the effects of general and spinal anesthesia on blood glucose.

Methods:

This prospective cross-sectional study was conducted on 254 patients from Al-Zahrawi Hospital. The patients were divided into three groups: patients with diabetes - patients without diabetes - patients with gestational diabetes. Blood glucose levels were measured before surgery and in the first and second hours after surgery, for patients undergoing both general and spinal anesthesia.

Results:

There were no statistically significant differences in the average blood glucose levels before and after surgery in patients with diabetes undergoing the two types of anesthesia: general anesthesia - spinal anesthesia. There were no statistically significant differences in the average blood glucose levels before and after surgery in non-diabetic patients, undergoing the two types of anesthesia: general anesthesia - spinal anesthesia. There were no statistically significant differences in the average blood glucose before and after surgery in patients with gestational diabetes, according to the two types of anesthesia: general anesthesia - spinal anesthesia.

Conclusion:

There are no clear differences between general and spinal anesthesia in affecting the levels of blood glucose. It is reasonable to suggest that blood glucose levels should be monitored during surgery in patients undergoing general or spinal anesthesia and during the 6, 12, and 24 postoperative hours.

Introduction

An extensive amount of data over the years has shown that an increase in blood glucose levels or hyperglycemia is fairly common in the perioperative period and the significant relationship between an increase in blood glucose level in the perioperative period and the increased mortality rates [1-2-3-4-5-6]. Metabolic changes are experienced in all types of surgeries, this is due to the activation of the hypothalamic-pituitary-adrenal axis [7]. This in turn leads to an increase in growth hormone, cortisol, adrenaline, noradrenaline, glucagon, and consequently an increase in the level of glucose in the blood. It is also worth noting, that an increase in aldosterone occurs as well, which will lead to the retention of water and sodium and the expulsion of potassium [8]. The body also responds to the stress after surgery by bringing about a group of changes, that affect the nervous, glandular, and immune systems, which means an increase in all the hormones that oppose insulin's effects in lowering blood glucose [9]. All these factors will lead to an increase in blood glucose levels, which affects diabetic and non-diabetic patients. This will cause a delay in wound healing post-operation, an increase in hospital stay, and an elevated risk of infection [10-11-12]. Medical literature that investigated blood glucose levels within 48 hours post-surgery showed that reducing both tension and stress before any surgical procedure by administering diazepam, contributes to a reduction in the postoperative elevation of blood glucose levels [13]. Other studies say that lumbar anesthesia helps relieve stress and contributes to reducing high blood glucose because it blocks the roots of the sensory nerves of the spinal cord, which is why the body's response to surgical stress is less compared to general anesthesia [14-15-16-17].

Therefore, this study aims to analyze the differences in blood glucose levels after surgical procedures, between general and spinal anesthesia in diabetic, non-diabetic, and patients suffering from gestational diabetes. And try to find if there's a correlation between the type of anesthesia used during the surgical procedure and the postoperative blood glucose levels.

Methods

This study aims to compare the effects of general and spinal anesthesia on blood glucose levels in patients who underwent a cesarean section. Samples were collected in Al-Zahrawi Hospital in Damascus, affiliated with the Syrian Ministry of Health, between 1/7/2021 and 1/1/2022. The samples were daily analyzed using a personal glucose meter (Glucolab), and 254 samples were collected.

Inclusion and exclusion criteria:

The sample included patients undergoing cesarean sections under general or spinal anesthesia. These patients were divided as follows:

- Non-Diabetic patients undergoing general anesthesia
- Non- Diabetic patients undergoing spinal anesthesia
- Diabetic patients undergoing general anesthesia
- Diabetic patients undergoing spinal anesthesia
- Patients with gestational diabetes undergoing general anesthesia
- Patients with gestational diabetes undergoing spinal anesthesia

Patients with (heart failure, kidney failure, liver failure, pulmonary failure), serious diseases (tumors), preeclampsia and eclampsia syndrome, patients with HELLP syndrome, and patients who regularly drink alcohol were excluded.

Instrumentation and Procedure: The study was conducted in a prospective cross-sectional study design, in the period between 1/7/2021 and 1/1/2022 after obtaining the ethical approvals. The medical and surgical files of all the patients in our study sample were thoroughly studied. The researchers collected blood samples of the mentioned patients after obtaining their verbal consent and analyzed them using a personal glucose meter (Glucolab) before and after the surgery. Then specifically designed forms were filled up with the gathered data.

Data Analysis: The variables and data were entered and encoded in Excel, and then entered and decoded in SPSS-25 to analyze relationships, graphs, and statistical tables through it. In studying the relationship between the surgery's duration and blood glucose levels, the Pearson correlation coefficient was used. The student's T-Test was used for the rest of the variables.

Ethical considerations: Ethical approval was obtained from the Institutional Review Board (IRB) Faculty of Medicine, Syrian Private University, and the Zahrawi Hospital Institutional Review Board (IRB). Verbal consent was obtained from each patient when contacting them for data collection purposes.

Results

The study included 254 patients who met the inclusion criteria. The number of patients with gestational diabetes was 9 (3.5%), the number of patients with diabetes was 37 (14.6%), and the number of patients without diabetes was 208 (81.9%). Patients were divided into two groups depending on the anesthesia type they underwent; the spinal group (SA

group) and the general group (GA group). The number of patients who underwent spinal anesthesia was 86 (34%), while the number of patients who underwent general anesthesia was 168 (66%). The SA group included 3 patients with gestational diabetes, 15 patients with diabetes mellitus, and 68 non-diabetic patients. While the GA group included 6 patients with gestational diabetes, 22 patients with diabetes mellitus, and 140 non-diabetic patients.

The arithmetic mean of age in the SA group was 26.49 ± 5.974 years, while in the GA group was 24.66 ± 5.592. Statistical analysis was carried out using student's t-test, and the differences between the two groups were statistically significant, with a P-value of 0.017. **(Table 1)**

The arithmetic mean of body mass index (BMI) in the SA group was 23.31 ± 2.55, while in the GA group was 22.66 ± 2.549. Statistical analysis was carried out using student's t-test, and the differences between the two groups were not statistically significant, with a P-value of 0.27. **(Table 1)**

The arithmetic mean of surgery duration in the SA group was 58.33 ± 7.275 minutes, while in the GA group 58.41 ± 7.319 minutes. Statistical analysis was carried out using student's t-test, and the differences between the two groups were not statistically significant, with a P-value of 0.93. **(Table 1)**

The arithmetic mean of blood glucose levels in patients with gestational diabetes before anesthesia in the SA group was 86 ± 16.523, while in the GA group 104.83 ± 28.308. Statistical analysis was carried out using student's t-test, and the differences between the two groups were not statistically significant, with a P-value of 0.331. **(Table 2)**

The arithmetic mean of blood glucose levels in patients with gestational diabetes one hour after anesthesia in the SA group was 97.33 ± 9.609, while in the GA group 177.33 ± 40.766. Statistical analysis was carried out using student's t-test, and the differences between the two groups were not statistically significant, with a P-value of 0.444. **(Table 2)**

The arithmetic means of blood glucose levels in patients with gestational diabetes two hours after anesthesia in the SA group was 102.33 ± 11.547, while in the GA group 111.33 ± 22.115. Statistical analysis was carried out using student's t-test, and the differences between the two groups were not statistically significant, with a P-value of 0.538. **(Table 2)**

The arithmetic mean of blood glucose levels in patients with diabetes mellitus before anesthesia in the SA group was 121.27 ± 47.471, while in the GA group 140.45 ± 50.921. Statistical analysis was carried out using student's t-test, and the differences between the two groups were not statistically significant, with a P-value of 0.256. **(Table 3)**

The arithmetic mean of blood glucose levels in patients with diabetes mellitus one hour after anesthesia in the SA group was 120.60 ± 48.556, while in the GA group 131.05 ± 45.489. Statistical analysis was carried out using the student's t-test, and the differences between the two groups were not statistically significant, with a P-value of 0.509. **(Table 3)**

The arithmetic means of blood glucose levels in patients with diabetes mellitus two hours after anesthesia in the SA group was 126.40 ± 56.520, while in the GA group 128.45 ± 47.809. Statistical analysis was carried out using student's t-test, and the differences between the two groups were not statistically significant, with a P-value of 0.906. **(Table 3)**

The arithmetic means of blood glucose levels in non-diabetic patients with Mellitus before anesthesia in the SA group was 99.52 ± 53.147, while in the GA group 87.39 ± 30.21. Statistical analysis was carried out using student's t-test, and the differences between the two groups were not statistically significant, with a P-value of 0.08. **(Table 4)**

The arithmetic means of blood glucose levels in non-diabetic patients one hour after anesthesia in the SA group was 102.68 ± 50.828, while in the GA group 94.65 ± 30.369. Statistical analysis was carried out using student's t-test, and the differences between the two groups were not statistically significant, with a P-value of 0.305. **(Table 4)**

The arithmetic means of blood glucose levels in non-diabetic patients two hours after anesthesia in the SA group was 98 ± 40.102, while in the GA group 98.75 ± 30.872. Statistical analysis was carried out using student's t-test, and the differences between the two groups were not statistically significant, with a P-value of 0.883. **(Table 4)**

In studying the relationship between the surgery's duration and blood glucose levels, the Pearson correlation coefficient was used, and the results were as follows: **(Table 5)**

The P-value was 0.415 in the first hour after the surgery in non-diabetic patients in the GA group, while it was 0.58 in the SA group. In the second hour after the surgery in non-diabetic patients in the GA group, P-value was 0.729 while it was 0.858 in the SA group.

The P-value was 0.653 in the first hour after the surgery in diabetic patients in the GA group, while it was 0.954 in the SA group. In the second hour after the surgery in diabetic patients in the GA group, P-value was 0.6 while it was 0.961 in the SA group.

The P-value was 0.9 in the first hour after the surgery in gestational diabetes patients in the GA group, while it was 0.429 in the SA group. In the second hour after the surgery in gestational diabetes patients in the GA group, P-value was 0.932 while it was 0.667 in the SA group.

Tables:

Table (1): Represents the arithmetic mean of age, BMI, and surgery duration in both SA and GA groups.

	SA (N=86) Mean ± SD	GA (N=168) Mean ± SD	P-Value
Age	26.49 ± 5.974	24.66 ± 5.592	**0.017**
BMI	23.31 ± 2.55	22.66 ± 2.549	0.27
Surgery duration	58.33 ± 7.275	58.41 ± 7.319	0.93

Table (2): Represents the arithmetic mean of blood glucose levels in patients with gestational diabetes in both SA and GA groups.

Patients with gestational diabetes	SA (N=3) Mean ± SD	GA (N=6) Mean ± SD	P-Value
glucose levels before anesthesia	86 ± 16.523	104.83 ± 28.308	0.331
glucose levels after 1 hour	97.33 ± 9.609	117.33 ± 40.766	0.444
glucose levels after 2 hours	102.33 ± 11.547	111.33 ± 22.115	0.538

Table (3): Represents the arithmetic mean of blood glucose levels in patients with diabetes mellitus in both SA and GA groups.

Patients with diabetes mellitus	SA (N=15) Mean ± SD	GA (N=22) Mean ± SD	P-Value
glucose levels before anesthesia	121.27 ± 47.471	140.45 ± 50.921	0.256
glucose levels after 1 hour	120.60 ± 48.556	131.05 ± 45.489	0.509
glucose levels after 2 hours	126.40 ± 56.520	128.45 ± 47.809	0.906

Table (4): Represents the arithmetic mean of blood glucose levels in non-diabetic patients in both SA and GA groups.

Non-diabetic patients	SA (N=68) Mean ± SD	GA (N=140) Mean ± SD	P-Value
glucose levels before anesthesia	99.52 ± 53.147	87.39 ± 30.21	0.08
glucose levels after 1 hour	102.68 ± 50.828	94.65 ± 30.369	0.305
glucose levels after 2 hours	98 ± 40.102	98.75 ± 30.872	0.883

Table (5): Represents the relation between the surgery's duration and blood glucose levels in non-diabetic patients, Patients with diabetes mellitus, and Patients with gestational diabetes.

Non-diabetic patients	GA (N=140) P-Value	SA (N=68) P-Value
glucose levels after 1 hour	0.415	0.58
glucose levels after 2 hours	0.729	0.858
Patients with diabetes mellitus	**GA (N=22) P-Value**	**SA (N=15) P-Value**
glucose levels after 1 hour	0.653	0.954
glucose levels after 2 hours	0.6	0.961
Patients with gestational diabetes	**GA (N=6) P-Value**	**SA (N=3) P-Value**
glucose levels after 1 hour	0.9	0.429
glucose levels after 2 hours	0.932	0.667

Discussion

This study compares the impact of spinal and general anesthesia on blood glucose levels before and after cesarean section in diabetic patients, patients with gestational diabetes, and non-diabetic patients.

General anesthesia caused a more-significant increase in blood glucose levels in non-diabetic patients and patients with gestational diabetes than spinal anesthesia during the first hour of anesthesia, while there was a decrease in blood glucose levels in patients with diabetes mellitus who underwent general anesthesia. It was also noted that there was a slight decrease in blood glucose levels in the second hour after the anesthesia in patients with gestational diabetes and patients with diabetes mellitus who underwent general anesthesia, while the increase in blood glucose levels was persistent in the second hour after anesthesia in all the patients who underwent spinal anesthesia, and non-diabetic patients who underwent general anesthesia.

In comparing the differences between SA and GA, statistical analysis was carried out using student's t-test, and the differences between the two groups were not statistically significant (P-Value >0.05)

In a study about the effects of hyperglycemia in surgical patients, it was illustrated that short-term hyperglycemia and hyperinsulinemia are associated with significantly decreased monocyte HLA-DR expression, which is a parameter that closely correlates with the rate of infectious complications and mortality in critically ill patients [18]. Furthermore, the

process of hyperglycemia management puts the patient at an increased risk of having a hypoglycemic response [19], which can be severe enough to cause death. That's why maintaining blood glucose levels that are as close as possible to the normal levels, is vital to protect the patient from the complications of hyper and hypoglycemia.

Hyperglycemia in diabetic patients undergoing surgery is responsible for an elevated ratio of surgical site infections (SSI), myocardial infarction (MI), stroke, and death [20-21]. Hyperglycemia also occurs in up to 67% of surgical patients who are not diabetic [20]. Recently, it was demonstrated in some studies that there is a greater risk of complications related to hyperglycemia in non-diabetic patients in comparison with DM patients. A study by Kwon et al. [22] illustrated that non-diabetic patient who had perioperative hyperglycemia had double the risk of infections, re-operative interventions, and in-hospital deaths as DM patients and hyperglycemia. In addition, Frisch et al. [23] reported an elevated risk of 30-day death caused by hyperglycemia for non-diabetic patients in comparison with diabetic patients.

SA is the most commonly used technique in conducting anesthesia for women who undergo elective cesarean section because of its low risk of causing complications to the mother and the fetus in comparison with general anesthesia. [24] The outcomes of this research suggest that the use of spinal anesthesia in obstetric patients is favorable because it aids in keeping blood glucose levels close to the normal range perioperatively. This might be a great positive outcome in decreasing the incidence of the earlier complications caused by hyperglycemia. As a result, these extra benefits favoring spinal anesthesia over general anesthesia should be conducted during patient counseling about cesarean sections.

Conclusion

There are no clear differences between general and spinal anesthesia in affecting the levels of blood glucose. It is reasonable to suggest that blood glucose levels should be monitored during surgery in patients undergoing general or spinal anesthesia and during the 6, 12, and 24 postoperative hours.

Declarations

Ethics approval and consent to participate

The Research Ethics Committee in the Syrian Private University and the ethical committees in the concerned hospitals approved the study protocol. Verbal informed consent was obtained from every participant before participation. All procedures performed in studies involving human participants were by the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent for publication

Not applicable.

Availability of data and materials:

All data related to this paper's conclusion are available and stored by the authors. All data are available from the corresponding author on a reasonable request.

Conflict of interest:

The authors declare that they have no conflict of interest.

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Authors' contributions:

M.A. and N.R. conceptualized the study. M.A. and Y.J wrote the study protocol, performed the statistical analysis, participated in data collection, and did the literature search. F.K. and A.T. participated in the literature search, interpret the results, wrote the main manuscript, and prepared the tables. N.R. revised the draft. All authors read and approved the final draft.

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Abbreviations

BMI: body mass index, SA: Spinal anesthesia, GA: general anesthesia, DM: diabetes melilites.

Figures

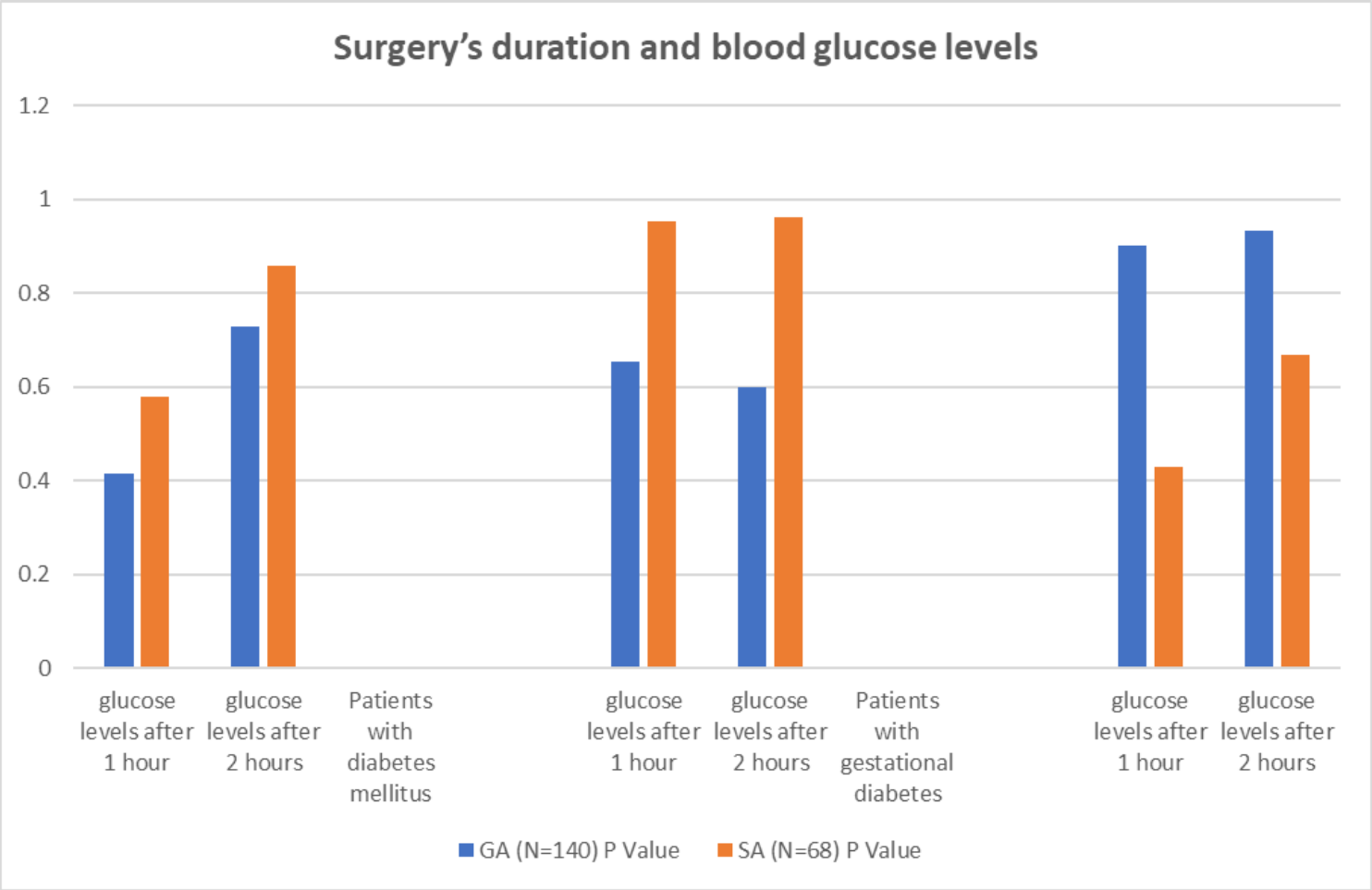

Figure 1

Legend not included with this version