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ORIGINAL ARTICLE

Effect of spinal anesthesia versus general anesthesia on blood glucose concentration in patients undergoing elective cesarean sections.

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ABSTRACT… Objective: To compare mean blood sugar levels in patients undergoing elective cesarean sections through spinal versus general anaesthesia. **Study Design:** Prospective Cohort Study. **Setting:** Department of Anaesthesiology, Allama Iqbal Teaching Hospital DG Khan. **Period:** 1st March 2024 to 31st August 2024. **Methods:** Non-diabetic pregnant women aged 20 – 45 years with ASA-I status undergoing elective cesarean section were enrolled. Women with diabetes, eclampsia / preeclampsia, cardiomyopathy or allergy to anesthetic agents were excluded. Participants were categorized as exposed if opted for spinal anesthesia and unexposed if opted for general anesthesia. Blood glucose levels were measured preoperatively and 30 minutes of surgery using a standardized glucometer. Descriptive statistics are run using SPSS version 23. Numerical and categorical comparisons across the groups are made through t-test and chi-square test respectively at 5% significance level. **Results:** A total of 248 patients (124 per group) were included. Baseline characteristics including BMI, fasting duration, surgery duration and fluid type were comparable. Mean preoperative blood glucose was higher in spinal than general anesthesia group (83.9 ± 8.3 vs. 81.2 ± 8.6 mg/dl; p = 0.011). Post-operative glucose levels were significantly higher in spinal (126.4 ± 15 vs. 56.7 ± 9.8 mg/dl; p-value < 0.001). This difference remains significant across stratified groups. **Conclusion:** Spinal anesthesia was associated with significantly higher postoperative blood glucose levels compared to general anesthesia in non-diabetic women undergoing cesarean section. Monitoring perioperative glucose in spinal anesthesia may warrant further attention.

Key words: Blood Glucose, Cesarean Section, General Anaesthesia, Spinal Anaesthesia.

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INTRODUCTION

Because spinal anesthesia carries a lower risk of maternal and fetal problems than general anesthesia, it has emerged as the preferred anesthetic treatment for patients undergoing elective caesarean sections.[1] The stress reaction to surgery has a metabolic impact that includes reduced production of insulin and testosterone which are anabolic hormones and increased release of catabolic hormones like cortisol and catecholamines.[2] In addition to a relative insulin deficiency and decreased sensitivity of tissues to insulin, it increases the synthesis of glucose.[3] As a result, blood glucose levels will rise even if diabetes is not present already.[4]

Patients may suffer from these hyperglycemic reactions to surgical stressors during the perioperative phase, which can lead to negative consequences like slowed wound healing and a higher risk of infection.[5] Interestingly, even brief episodes of hyperglycemia impair immunity and raise the risk of infection.[6] Afferent neuronal trigger from trauma site, activates the stress response in surgical patients. By blocking afferent brain impulses, neuraxial anesthesia e.g., epidural or spinal anesthesia—inhibits the stress response after surgery, which includes hyperglycemia.[7]

In a study from Jordan, fifty-eight pregnant ladies undergoing elective c-section were enrolled (Group S contained 35 patients who were given spinal anesthesia, and group G contained 23 patients who wanted to have general anesthesia). The mean blood glucose concentration (BGC) was remarkably high in group G in contrast to group S in the times five minutes prior (80.2 ± 18.1 vs. 108.4 ± 16.7, p < 0.05) and half an hour following the operation (80.9 ± 17.7 vs. 121.1 ± 17.4, p < 0.05).[8]

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Kouzegaran S et al conducted a study on 60 patients (30 undergoing spinal anesthesia and 30 undergoing general anesthesia). They found lower levels of blood sugar (93.62 ± 15.81) in general anesthesia group than the spinal anesthesia group (110.26 ± 63.96) after surgery with remarkable difference ($P < 0.05$).[9]

Keeping in view the existing controversial results, we had planned this study to compare the mean blood sugar levels in patients undergoing spinal vs. general anesthesia. The local results from our setting will help working anesthetists to practice more suitable type of anesthesia which can reduce chances of stress-induce hyperglycemia and ultimately its associated morbidity. We hypothesized that mean blood glucose levels in women undergoing cesarean section 30-minutes post operatively would be higher in spinal anaesthesia group compared to general anaesthesia.

METHODS

This prospective cohort study was conducted at anaesthesia department of Allama Iqbal Teaching hospital DG Khan over a period of six months from 1st March 2024 to 31st August 2024 after approval from the institutional ethics review committee (ERC 75/MED/DGKMC, dated: 02-02-2024). Non-diabetic pregnant women 20 – 45 years, ASA-I status planned to undergo cesarean section were consecutively enrolled in the study after informed consent. Women with gestational as well as chronic diabetes, eclampsia / pre-eclampsia, cardiomyopathy and allergy to any anaesthetic agents were excluded from the study.

Women opting for general anaesthesia were taken as un-exposed and those opting for spinal anaesthesia were taken as exposed group. BMI was calculated pre-operatively by formula–weight in kg/height in meter.[2] Weight was measured on weighing scale and height on stadiometer.

All the participants remained nil per oral for 6 – 8 hours pre-operatively as per standard hospital protocol. During the fasting period, type of the fluid was decided by surgical team and recorded. All the procedures were performed as per standard hospital protocol. Briefly, upon arrival in operation theatre all participants were given prophylactic antibiotic, dexamethasone, ranitidine and metoclopramide before starting anaesthesia. General and spinal anaesthesia were instituted by consultant anaesthetist as per hospital protocol. Duration of surgery (minutes) was recorded in all cases. Intraoperatively same type of the fluid was infused to all participants. The baseline blood sugar levels were obtained five minutes prior to induction with GA and right before administration of local anaesthesia in SA group. Post-surgery blood glucose levels were obtained at 30-minutes. Blood sugar (mg/dl) was assessed using a single blood glucose monitoring kit with a lancet device.

A minimum sample size of 248 patients (124 in each group) was calculated using OpenEpi online software through formula for mean difference assuming mean blood glucose 93.62 ± 15.81 mg/dl in GA and 110.26 ± 63.96 mg/dl in SA groups at 80% power and 95% confidence level.[9] Data analysis was performed through SPSS version 23. Normality of numerical data was assessed through histogram visually and Shapiro-Wilk test statistically. Descriptive statistics in the form of mean ± SD for numerical and frequency and percentages for categorical comparison were run. Numerical data between the groups was compared through independent sample t-test and chi-square test for categorical data. Effect modification was controlled through stratification. P-value of < 0.05 was considered significant for all comparisons.

RESULTS

The mean age of the participants was 30.6 ± 3.4 years and 52.4% (n=130) were above 30-years. The mean BMI was 25.2 ± 3.1 kg/m^2 and 35.5% (n=88) were obese. Mean duration of fast before surgery was 7.1 ± 0.8 hours and mean duration of surgery was 47.4 ± 1.7 minutes. In 57.7% (n=143) women intravenous fluid without glucose was infused. Age, BMI, fasting status, duration of surgery and type of fluid infused were comparable between cesarean section performed under general and spinal anaesthesia [Table-I].

The mean blood sugar before surgery in study participants was 82.5 ± 8.6 mg/dl. The mean blood sugar levels were higher in spinal anaesthesia group

pre-operatively compared to general anaesthesia (83.9 ± 8.3 vs. 81.2 ± 8.6, p-value = 0.011). Post-operatively blood sugar levels were significantly higher in spinal anaesthesia group pre-operatively compared to general anaesthesia (126.4 ± 15.0 vs. 86.7 ± 9.2, p-value < 0.001) [Table-II].

Post stratification the mean blood sugar levels remained higher in spinal anaesthesia group compared to general anaesthesia group [Table-III].

TABLE-I

Characteristics of pregnant women undergoing caesarean delivery (N=248)

Characteristics	All (N=248)	General Anaesthesia (n=124)	Spinal Anaesthesia (n=124)	P-Value*
Age (years)	30.6 ± 3.4	30.2 ± 3.6	30.9 ± 3.2	0.096
≤ 30-years	118 (47.6)	65 (55.1)	53 (44.9)	0.127
> 30-years	130 (52.4)	59 (45.4)	71 (54.6)	
BMI (kg/m^2)	25.2 ± 3.1	25.4 ± 3.3	24.9 ± 2.8	0.277
Obesity – Yes	88 (35.5)	50 (56.8)	38 (43.2)	0.111
No	160 (64.5)	74 (46.3)	86 (53.8)	
NPO duration (hrs.)	7.1 ± 0.8	7.1 ± 0.7	7.1 ± 0.8	0.885
Surgery duration (mint.)	47.4 ± 1.7	47.2 ± 1.9	47.6 ± 1.6	0.066
Fluid – with glucose	105 (42.3)	53 (50.5)	52 (49.5)	0.898
without glucose	143 (57.7)	71 (49.7)	72 (50.3)	

BMI: body mass index, NPO: nil per oral *t-test for numerical and chi-square test for categorical comparison

TABLE-II

Blood sugar levels of pregnant women undergoing caesarean delivery (N=248)

Random Blood Sugar (mg/dl)	All (N=248)	General Anaesthesia (n=124)	Spinal Anaesthesia (n=124)	P-Value*
Before Surgery	82.5 ± 8.6	81.2 ± 8.6	83.9 ± 8.3	0.011
30 minutes after Surgery	106.4 ± 23.4	86.7 ± 9.2	126.4 ± 15.0	< 0.001

***** Independent sample t-test

TABLE-III

Factors affecting post-operative blood sugar levels of pregnant women undergoing caesarean delivery (N=248)

Factors		General Anaesthesia (n=124)	Spinal Anaesthesia (n=124)	P-Value*
Age (years)	≤ 30	87.1 ± 9.1	123.2 ± 15.1	< 0.001
	> 30	86.3 ± 9.4	128.2 ± 15.4	< 0.001
Obesity	Yes	87.5 ± 8.2	124.4 ± 15.5	< 0.001
	No	86.1 ± 9.8	126.8 ± 15.4	< 0.001
Fluid type	With glucose	85.5 ± 9.7	125.5 ± 16.9	< 0.001
	Without glucose	87.6 ± 8.8	126.5 ± 14.3	< 0.001

***** Independent sample t-test

DISCUSSION

Due to sympathetic nerves stimulation and the release of certain hormones, including cortisol, norepinephrine, and adrenaline, the pain and anxiety associated with operative procedures raise blood sugar levels.[10] Using spinal or general anaesthesia to lessen the pain and stress of the procedure may stop the release of hormones that raise blood sugar levels and sympathetic activation. Consequently, there will be no rise in blood sugar levels.[11] Some researchers have only looked at how blood sugar levels alter while under spinal anaesthesia. According to the findings, variations in blood sugar are influenced by the kind of medication used for spinal anaesthesia.[12]

In our study, we observed that post-operatively blood sugar levels were significantly higher in spinal anaesthesia group pre-operatively compared to general anaesthesia (126.4 ± 15.0 vs. 86.7 ± 9.2, p-value < 0.001). Our results offer a fascinating diversion from the accepted fact on the impact of anaesthesia on perioperative glucose regulation. Spinal anaesthesia has historically been linked to a lower stress response, which improves glucose homeostasis maintenance. For example, a prospective cohort study published by Samuel et al, on patients undergoing pelvic and lower abdominal surgeries revealed that the group under general anaesthesia had significantly higher mean blood glucose levels at the end of the procedure and 60 minutes after the procedure. This suggests that spinal anaesthesia is a better way to maintain perioperative glucose levels.[13]

According to El-Radaideh et al, patients undergoing elective caesarean sections under general anaesthesia had higher blood glucose levels five minutes prior to and thirty minutes following the conclusion of the procedure than patients under spinal anaesthesia.[8] Similarly, 40 non-diabetic women who were planned for an elective caesarean delivery were the subject of a study by Al-Harire HE et al. They discovered that during surgery blood glucose levels considerably rose in both groups. But in the GA group, the increase was more noticeable than in the SA group ($p < 0.05$).[14] A considerable decrease in the serum blood sugar level throughout the procedure compared to the pre-operation level was noted in a study by Fah et al on women who underwent caesarean sections under spinal anaesthesia.[15]

Our results, however, show that the spinal anaesthesia group had higher postoperative glucose levels, which is in contradiction to prior investigations. There are a few reasons for this disparity. First, different anaesthetic techniques may have different effects on the stress response depending on the type and length of surgical procedures. Second, there may be a role for patient-specific variables such baseline metabolic status, anxiety, and particular hormonal reactions. Third, glucose metabolism may be impacted by differences in intraoperative care, such as the use of vasopressors and fluid delivery.

The idea that spinal anaesthesia more effectively reduces the postoperative stress response is further supported by the observation made by Milosavljevic et al[16] that blood cortisol levels and glycemia were considerably greater in the general anaesthesia group compared to spinal anaesthesia group. The results of our investigation, however, point to the complexity of perioperative metabolic responses by indicating that this could not necessarily result in decreased postoperative glucose levels.

Nonetheless, our results are comparable to those published by Kouzegaran S et al. Following the procedure, they discovered that the group that had used the general anaesthesia method had significantly less blood sugar levels (93.62 ± 15.81) than the spinal anaesthesia group (110.26 ± 63.96).[9] Several recent investigations have investigated variables that could affect perioperative glucose levels while using various anaesthesia procedures. The impact of a single 8 mg dosage of dexamethasone on blood glucose levels in patients having spinal anaesthesia for surgery was examined by Joshi et al. They discovered that blood glucose levels significantly increased in diabetic patients following surgery, peaking three and twelve hours after the procedure. This implies that patients receiving spinal anaesthesia may experience hyperglycemia because of adjunct drugs like dexamethasone.[17]

In a comprehensive review and meta-analysis, Li

et al examined how various anaesthesia types affected diabetes patients' intraoperative blood glucose levels. They found that compared to general anaesthesia alone, combined general-epidural anaesthesia offered superior glycaemic management. However, the study also found that the effect of epidural anaesthesia on blood glucose was not statistically different from that of general anaesthesia, suggesting that the technique used for anaesthesia can affect glycaemic results.[18] These findings highlight the intricacy of managing blood sugar during surgery and imply that glycaemic results under various anaesthesia procedures might be influenced by variables like the use of adjunct medications, patient comorbidities, and particular surgical situations.

This study's rigorous inclusion/exclusion criteria and prospective cohort design, which reduced confounding from underlying medical illnesses like diabetes or hypertensive disorders, are its main strengths. The results' internal validity is improved by the two groups' similar baseline characteristics. Furthermore, the findings are made more robust using standardised procedures for anaesthesia and glucose testing as well as the comparatively high sample size.

Because this study was limited in its duration and only conducted at one centre, its findings might not be as applicable to larger groups. Despite being standardised, using a glucometer could not be as accurate as laboratory-based glucose analysis. Furthermore, the study did not take into consideration intraoperative factors that could affect blood glucose levels, such as individual anxiety levels, painkiller use, and stress response hormones (such cortisol). Because the choice of anaesthesia was patient-driven rather than randomised, selection bias may have been introduced.

A randomised controlled design should be used in future research to remove selection bias and strengthen the case for causality. External validity would be improved by multicentre trials with a variety of demographics. More thorough insights might also be obtained by assessing stress markers (such as cortisol and catecholamines) and considering long-term maternal and newborn outcomes. Routine care should include perioperative glucose monitoring, particularly for patients undergoing spinal anaesthesia during caesarean deliveries.

CONCLUSION

When compared to general anaesthesia, spinal anaesthesia produced noticeably higher postoperative blood glucose levels in non-diabetic women having elective caesarean deliveries. This highlights the significance of regular perioperative glucose monitoring and points to the necessity for more investigation into how spinal anaesthesia affects metabolism in obstetric patients.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Aisha Hussain:** Conceived the idea, data collection, writing.
2	**Syed Aushtar Abbas Naqvi:** Critical analysis.
3	**Mirza Shakeel Ahmad:** Data collection.
4	**Raheela Shaheen:** Drafting.
5	**Zomar Ayyub:** Data analysis, proof reading.