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Comparison of the Effect of Spinal Anesthesia and General Anesthesia on Blood Glucose Concentration in Patients Undergoing Transurethral Lithotripsy

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ABSTRACT

Background and Objective: Prevention of hyperglycemia caused by surgical stress is a challenging issue. The present study was conducted to compare the effect of spinal anesthesia versus general anesthesia on blood glucose concentration in patients undergoing transurethral lithotripsy.

Methods: This cross-sectional study was conducted on 58 patients undergoing transurethral lithotripsy in Imam Khomeini Hospital in Urmia. Group S included patients who chose spinal anesthesia and group G included patients who chose general anesthesia. For both groups, blood glucose and insulin concentrations were measured at different times: five minutes before induction (T1), five minutes after induction (T2), five minutes before the end of the procedure (T3) and 30 minutes after the end of the procedure (T4).

Findings: The mean blood glucose in T3 (83.18±37.108) and T4 (82.16±125) in general anesthesia group was significantly higher than T3 (85.16±89.79) and T4 (72.5±10.81) in spinal anesthesia group ($p<0.001$). Furthermore, in the general anesthesia group, the increase in blood glucose in the time intervals T1-T2, T2-T3, T3-T4 and T1-T4 was significant (p-value: 0.03, 0.003, 0.001, <0.001, respectively). Moreover, in our study, the decrease in insulin secretion between T1 and T4 was significant only in the general anesthesia group ($p=0.006$).

Conclusion: The results of this study showed that the spinal anesthesia method is a more preferable method to prevent the increase in blood glucose in transurethral lithotripsy.

Keywords: *Spinal Anesthesia, General Anesthesia, Blood Glucose, Blood Insulin Concentration, Ureteral Stone.*

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Introduction

Any type of surgical procedure causes stress responses, endocrine stimulation, metabolic and immunological changes by activating the hypothalamic-pituitary-adrenal (HPA) axis (1, 2). In general, the metabolic effects of the stress response caused by surgery include an increase in the release of catabolic hormones, and a decrease in anabolic hormones such as insulin and testosterone. The increase in the levels of catabolic hormones in the plasma leads to the production of glucose along with a decrease in the amount of insulin and tissue sensitivity to insulin and a decrease in the use of glucose, which is called insulin resistance (3-6). Increased blood glucose as a result of stress response caused by surgery may be harmful to patients during surgery, endangering tissue repair and increasing the possibility of wound infection (4, 6, 7). The possibility of hyperglycemia increases in diabetic and non-diabetic patients (8). In patients who have undergone surgery, the stress response caused by surgery occurs in the place where the surgical trauma occurred due to the activation of afferent neurons in that area. These afferent neurons convey stimulation along the sensory nerves to the nerve roots located in the back of the spinal cord and from there along the spinal cord to the top where the hypothalamus is located and it will be activated. Neuraxial anesthesia such as epidural and spinal anesthesia will block the passage of these stimulations and prevent stress responses, including increased blood glucose (6, 7, 9, 10).

A number of different immunological parameters have been identified through which increased blood glucose affects the host's susceptibility to infection. In these disorders, the inflammatory cytokine cascade increases in response to the increase in blood glucose, and the levels of cytokines that activate the inflammatory wave including IL-6 and TNF-α increase (11, 12). Moreover, the high levels of blood glucose disrupt the relaxation of blood vessels with a very small diameter and reduce the response of these vessels to vasodilators, including nitric oxide, and reduce the accumulation and adhesion of neutrophils and monocytes (13-15). Acute increase in blood glucose affects cellular activities such as phagocytosis (16-19).

The results of a study by Gottschalk et al. showed that there is no statistical difference in intraoperative glucose concentration in spinal and general anesthesia groups in diabetic and non-diabetic patients (8). In a prospective study, El-Radaideh et al. found that blood glucose concentration increases less in spinal anesthesia than in general anesthesia (17). The results of a study by Anderson et al. showed that epidural anesthesia slightly improved blood glucose homeostasis in the first 24 hours after surgery, but did not affect the level of hyperglycemia three days after surgery (6). Since few studies and investigations have been conducted in this regard in Iran and in this province, and considering that hyperglycemia in the surgical process can clearly cause a decrease in the body's immunity level and worsen the prognosis of the disease, therefore, this study was conducted to determine the effect of spinal anesthesia versus general anesthesia on blood glucose concentration in patients undergoing transurethral lithotripsy.

Methods

After being approved by the Ethics Committee of Urmia University of Medical Sciences with the ethics code IR.UMSU.REC.1400.023, this cross-sectional study was conducted on 58 patients who had referred to Imam Khomeini Hospital for transurethral lithotripsy. The samples were selected through convenience sampling method and the sample size was determined to be 58 people using a specific formula. Transurethral lithotripsy candidates who signed the informed consent to participate in the research were included according to American Society of Anesthesiology (ASA) class I-II and age between 20 and 60 years and 8-12 h fasting time before the operation. Patients with type 1 diabetes, type 2 diabetes, advanced chronic

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kidney disease, heart failure, ischemic heart disease and mental disorders were excluded from the study. All patients whose spinal anesthesia failed or those whose anesthesia was changed from spinal anesthesia to general anesthesia were excluded from the study.

Two intravenous lines were prepared for all participants upon entering the operating room. Standard monitoring of blood pressure, 3-lead ECG, and pulse oximetry were performed. They were continuously monitored during the operation in the operating room and after the operation in the post-anesthesia care unit. Patients were divided into two groups (Spinal= S and General= G) based on their preference and selection of the type of anesthesia. Group S included patients who chose spinal anesthesia and group G included patients who chose general anesthesia. For group S, spinal anesthesia was performed under aseptic conditions, at the segments of L3-L4 or L4-L5 of the spine. Spinal anesthesia was performed with 2.3 ml of 0.5% hyperbaric bupivacaine and 0.4 ml of 0.005% fentanyl using 25-gauge spinal needles. Pure oxygen was administered through a simple face mask with a flow of four liters per minute. For group G, 1 milligram of midazolam and 100 micrograms of fentanyl were used for premedication. After breathing oxygen for three minutes through a face mask, anesthesia with 2.5 mg/kg of propofol and 0.5 mg/kg/body weight of atracurium muscle relaxant was inserted to facilitate tracheal intubation. Anesthesia was maintained with 1.2% isoflurane in 50% oxygen and 50% nitrous oxide. ETCO2 was maintained between 30 and 40 mmHg during the procedure. At the end of the surgery, anesthetics were discontinued and neuromuscular reversal agents including 0.04 mg of neostigmine and 0.02 mg of atropine per kg was injected intravenously (IV). Extubation was performed when the patient was breathing spontaneously, fully awake, and able to maintain head elevation for more than five seconds. Both groups received one to two liters of Ringer's solution. For group G, blood glucose and insulin concentrations were measured five minutes before induction (T1) and five minutes after induction (T2). For group S, blood glucose concentration was measured immediately before the injection of local anesthetic (T1) and five minutes after the complete block (T2). For both groups, blood glucose and insulin concentrations were measured five minutes before the end of the operation (T3) and 30 minutes after the end of the operation in the intensive care unit after anesthesia (T4). After disinfecting with alcohol, the tips of the fingers of the non-dominant hand were used for sampling with the tip of a lancet, and blood glucose levels were measured in this way. Then the data were analyzed using SPSS version 23 and chi-square tests (if necessary, Fisher's test), independent t and paired t, and $p<0.05$ was considered significant.

Results

In the present study, 58 patients with ureteral stones who underwent transurethral lithotripsy at Imam Khomeini Hospital were examined. 29 patients were under general anesthesia and 29 patients were under spinal anesthesia. The mean age of the studied population was 27.75±3.50 years. The majority of patients, equivalent to 60.3%, were men, and there was no significant difference between the two groups in this respect. Moreover, independent t-test was used to compare the mean age in the two spinal and general groups, and according to the results of the test, there was no significant difference between the two groups. The mean duration of fasting in all subjects was equal to 9.51±1.23 hours and there was no significant difference between the two groups in this respect.

Comparison of blood glucose and insulin levels in spinal and general groups: For group G, blood glucose and insulin concentrations were measured five minutes before induction (T1) and five minutes after induction (T2). For group S, blood glucose concentration was measured immediately before the injection of local anesthetic (T1) and five minutes after the complete block (T2). For both groups, blood glucose and insulin concentrations were measured five minutes before the end of the operation (T3) and 30 minutes after

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the end of the operation in the intensive care unit after anesthesia (T4). In order to compare the values obtained in the two groups of spinal anesthesia and general anesthesia, the independent parametric t test was used and according to the test results, the mean blood glucose in five minutes before the end of the operation and 30 minutes after the end of the operation was significantly higher in the general anesthesia group (p<0.001). However, there was no statistically significant difference between the two groups in the mean blood insulin at different times (Table 1).

Table 1. Comparison of blood glucose and insulin levels in the spinal and general groups

Group	Spinal anesthesia Mean±SD	General anesthesia Mean±SD	p-value
Glucose concentration (mg/dl)*			
T1	82.31±13.90	77.72±11.43	0.17
T2	78.79±18.76	88.86±24.82	0.08
T3	79.89±16.85	108.37±18.83	<0.001
T4	81.10±5.72	125.62±16.82	<0.001
Blood insulin (µU/ml)			
T1	7.75±1.82	8.34±1.71	0.23
T2	7.51±2.66	8.06±2.63	0.43
T3	7.24±1.32	7.72±2.34	0.90
T4	7.16±2.20	7.06±2.22	0.33

***(T1) 5 minutes before induction, (T2) 5 minutes after induction, (T3) 5 minutes before the end of the procedure and (T4) 30 minutes after the end of the procedure**

In the general anesthesia group, the increase in blood glucose in the time intervals T1-T2, T2-T3, T3-T4 and T1-T4 was significant (p-value: 0.03, 0.003, 0.001, and <0.001, respectively). However, in the spinal anesthesia group, the increase in blood glucose in the time intervals T1-T2, T2-T3, T3-T4 and T1-T4 was not significant (p-value: 0.45, 0.82, 0.71, 0.67, respectively) (Figure 1).

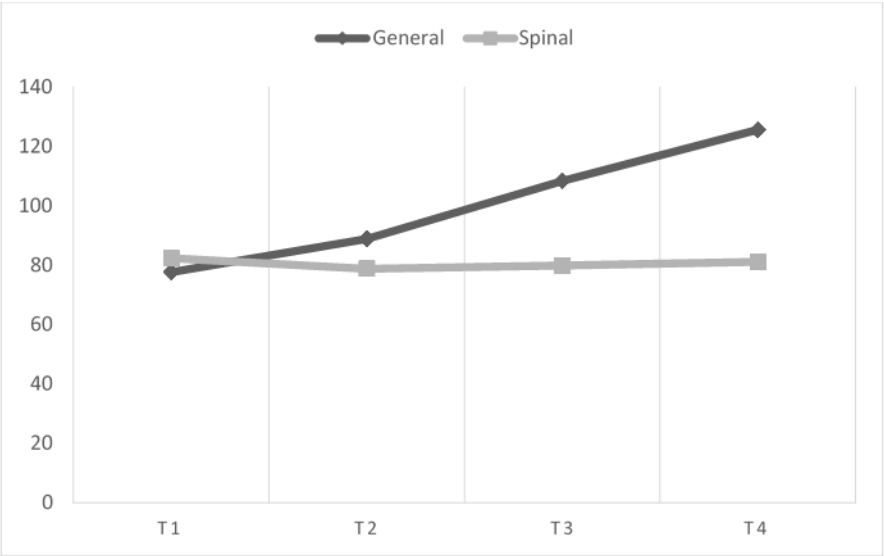


Figure 1. Comparison of blood glucose values at different times in spinal and general groups

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Furthermore, in the general anesthesia group, the decrease in blood insulin was significant in T1-T4 intervals (p=0.006). However, in the spinal anesthesia group, the amount of blood insulin reduction in the time intervals T1-T2, T2-T3, T3-T4 and T1-T4 was not significant (p-value: 0.71, 0.59, 0.65, 0.22, respectively) (Figure 2).

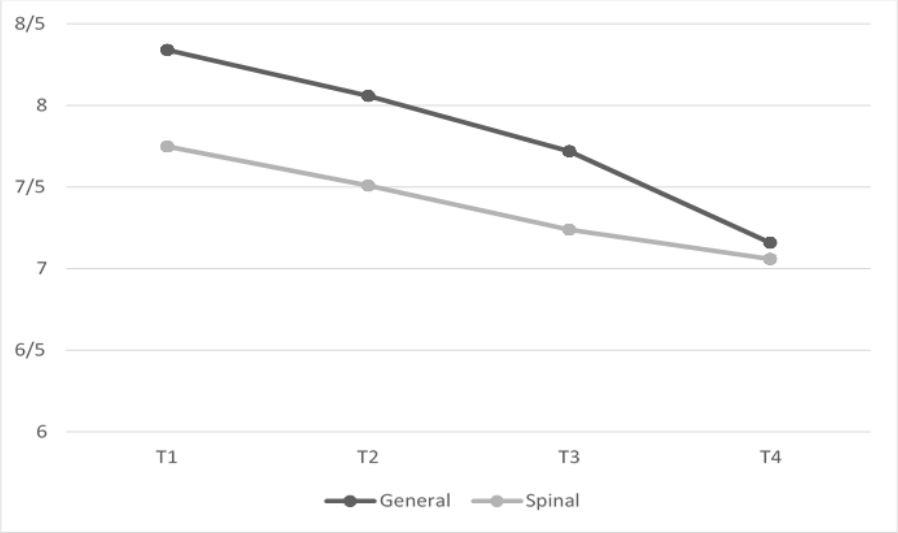


Figure 2. Comparison of blood insulin values at different times in spinal and general groups

Discussion

In our study, the mean blood glucose five minutes before the end of the operation and 30 minutes after the end of the operation in the general anesthesia group was significantly higher than the spinal anesthesia group, and also in the general anesthesia group, the increase in blood glucose in time intervals T1-T2, T2-T3, T3-T4 and T1-T4 was significant. However, in the spinal anesthesia group, the increase in blood glucose in the mentioned time intervals was not significant. Moreover, in our study, the decrease in insulin secretion in the T1-T4 time interval was significant in the general anesthesia group, but this decrease was not significant in the spinal anesthesia group.

In the study of El-Radaideh et al., similar to the results obtained in our study, blood glucose level generally increased in both groups of spinal anesthesia and general anesthesia, but the amount of blood glucose increase in different time intervals in people under general anesthesia was significantly higher than spinal anesthesia (17). The results of this study were completely consistent with the findings of our research.

It has been proven for a long time that the method used for anesthesia is effective in hyperglycemia caused by surgery and the amount of blood glucose increase is higher in anesthesia with inhalation. A number of animal studies have shown that inhalation anesthetics such as Enflurane and Halothane cause impaired glucose tolerance by reducing insulin secretion and reducing insulin sensitivity in tissues. It has also been shown in a number of other studies that isoflurane causes an increase in serum glucose by stimulating the production of glucose in the body (4, 20). Tanaka et al. also showed in a study that in people who were under general anesthesia with sevoflurane and isoflurane, there is disruption of blood glucose tests and insulin secretion (21). Also, Cok et al. found in a study that the disruption of glucose tests during anesthesia with sevoflurane and isoflurane was not dependent on the drug dose (19). The results of their

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studies were consistent with the findings of our research. On the other hand, neural anesthesia such as spinal and epidural anesthesia has afferent neurons from the surgical site to the central nervous system and the hypothalamic-pituitary-adrenal axis and efferent neurons to the liver and adrenal gland, which ultimately leads to the limitation of adrenocortical and glycemic responses to surgical stress (22). Greisen et al. also showed in a study that epidural block before surgery prevents the increase of blood glucose during heart surgery (23). The findings of this study were in line with the results of our study.

In another study that investigated blood glucose changes after spinal anesthesia in cesarean section, the results of the study showed that in the comparison between blood glucose before anesthesia and blood glucose during recovery, there is a significant increase in blood glucose during recovery. However, this increase was not in the hyperglycemic range in any of the cases, and during spinal anesthesia with bupivacaine, they did not recommend the need for regular blood glucose monitoring (24). Furthermore, in a study that examined the effect of general anesthesia and spinal anesthesia on blood glucose changes during surgery, the results of the study showed that compared to general anesthesia, spinal anesthesia has a better ability to control blood glucose and perhaps it has adrenergic and metabolic reactions to stress and can be a good alternative to general anesthesia if not prohibited, especially in patients with metabolic problems (25). The results of our study were consistent with the results of these studies.

Considering that limited studies have been conducted in this regard, new clinical methods with different approaches and the integration and combination of clinical knowledge and experience will play an important role in generalizing the results of evidence-based clinical studies regarding the treatment and reduction of joint injuries caused by surgery (26). Therefore, it is recommended to conduct more studies with a larger number of samples in this area.

Although both spinal anesthesia and general anesthesia increase blood glucose and decrease insulin secretion and sensitivity, the blood glucose increase in people under general anesthesia is significantly higher and the results of this study showed that the spinal anesthesia method is a more preferable method in patients undergoing transurethral lithotripsy. It is suggested to conduct more studies with a larger sample size in order to achieve more accurate results.

Ethical Considerations: Before carrying out the implementation steps, all the people under the study were given enough information about the objectives and steps of the research. Subjects were included in the study if they were willing. All collected information remained confidential. All stages of the project were carefully examined by the University Research Ethics Committee. None of the patients were charged any fees.

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