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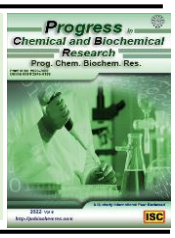

Review Article

Comparison of Blood Sugar Changes during Orthopedic Surgeries in Patients under Spinal Anesthesia and General Anesthesia: A Systematic Review

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ABSTRACT

Introduction: Surgery with general anesthesia increases blood sugar in two ways, one is due to surgical stress and the other is the pharmacological effects of anesthetic drugs; On the other hand, the use of spinal anesthesia has positive effects such as reducing deep vein thrombosis, pulmonary embolism, etc. Based on the studies conducted on the blood sugar level 15 minutes before the operation and 25 and 50 minutes after the operation. The aim of this systematic review is to investigate these two anesthesia methods in patients undergoing orthopedic surgery.

Methodology: In this study, which was a systematic review and was conducted during 2022 based on the steps of the PRIZMA guidelines, databases that publish articles in the medical field were searched based on the objectives of this study; In this search, every article that was published in English and Farsi and had a good quality was included in this systematic review so that its contents could be used for the purposes of this study.

Results: No significant difference in the average blood sugar between spinal anesthesia and general anesthesia groups before surgery, after surgery, 30 minutes and 60 minutes after surgery and during recovery. The average blood sugar in this group decreased after surgery compared to before surgery.

Conclusion: Considering the importance of blood sugar regulation around the time of surgery, the current study found spinal anesthesia to be somewhat preferable to general anesthesia in controlling the patient's blood sugar.

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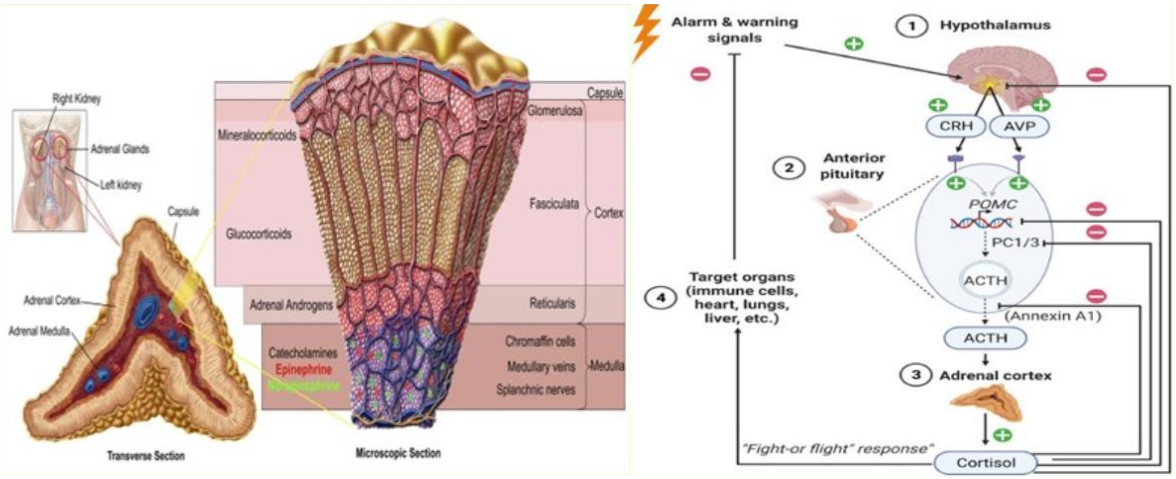

1- Introduction

It is believed that the hypothalamic-pituitary-adrenal axis is responsible for the immediate and long-term effects of stress [1-3].

The proper functioning of the immune system is regulated through the cooperation of sympathetic nervous system and the hypothalamus-pituitary-adrenal (Figure 1) axis and includes the controlled release of stress hormones, glucocorticoids, and norepinephrine [4].

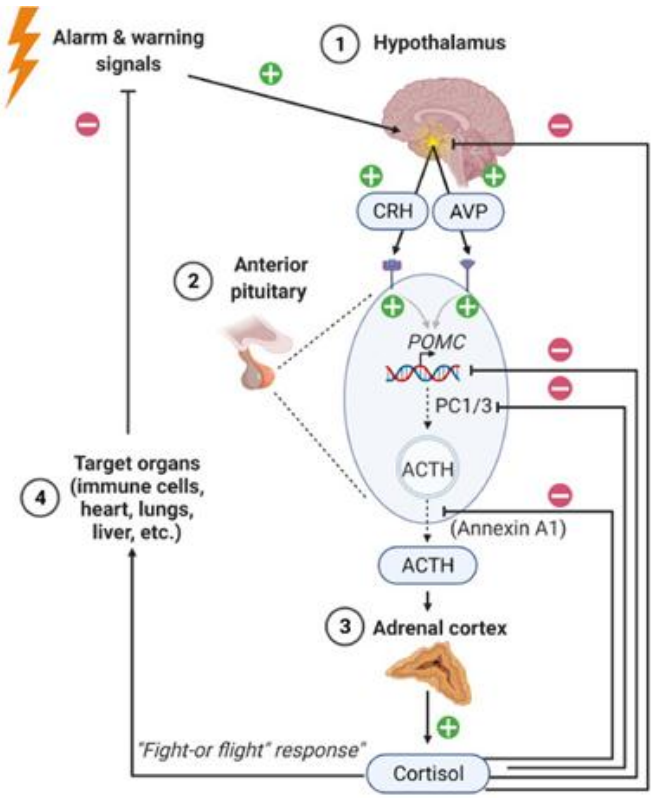

Fig 1 Hypothalamus-pituitary-adrenal axis

Stress can cause complications such as insomnia, anxiety, and even mental disorders [5].

Following any type of stress, including induction and maintenance of anesthesia and surgical procedures, a set of well-known responses known as the induced stress response occurs [6-8].

In general, in all types of surgery certain metabolic and hormonal changes occur as a result of adrenal stimulation [9-11]. Afferent waves lead to the hypothalamus and pituitary artery and lead to an increase in the secretion of growth hormones, cortisol, glucagon, aldosterone and catecholamines (Figure 2) [12].

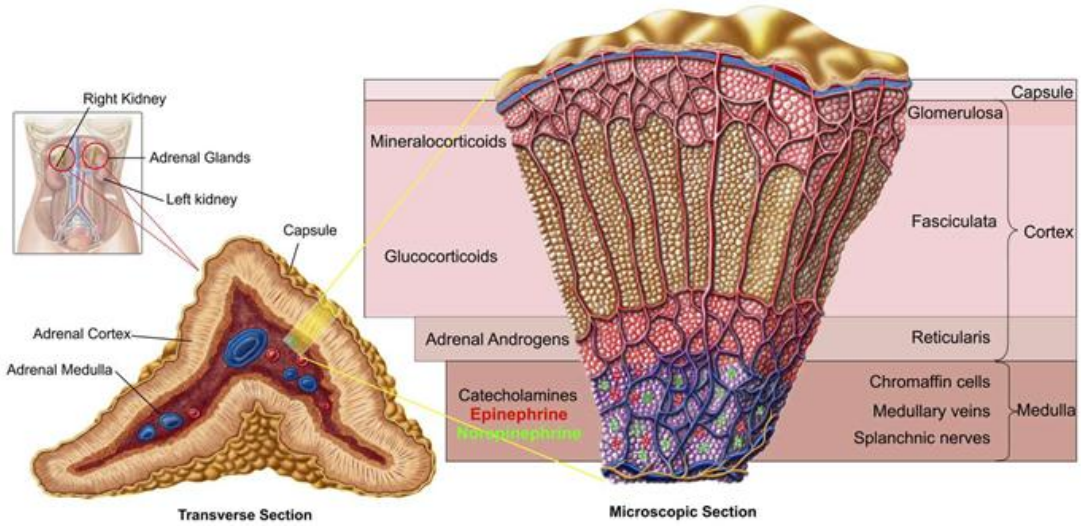

Fig 2 Catecholamines

It should be noted that the sympathetic nervous system prevents the insulin secretion, which leads to the fat formation in the target organs such as the liver and increases blood sugar (hyperglycemia) [13-15].

There are non-diabetics. Recently, it is believed that the increase in blood sugar has a significant effect on the patient's condition, it is associated with an increase in the length of stay in the hospital and the intensive care unit, and it leads to an increase in the rate of septicemia, urinary tract and lung infections, and reoperations [16].

In addition, this event is associated with a decrease in glucose absorption and glycogen storage, an increase in protein catabolism, and causes post-operative weakness and a decrease in muscle movement power [17-19].

Hyperglycemia specifically leads to a decrease in chemotaxis of neutrophils, and this causes an increase in postoperative infection and mortality due to a decrease in the body's innate immunity, a decrease in collagen secretion, nerve, kidney, cardiovascular, and vascular damage [20-22]. It seems that hyperglycemia increases the infection risk and by increasing lactic acid, it leads to nerve damage as well as increased production of free radicals and inflammatory factors including interleukin-5 and interleukin-10 [23].

Many researchers found that hyperglycemia can increase tumor growth. Concerning the many complications of hyperglycemia, reducing stress and anxiety during surgery may prevent high blood sugar and its side effects [24-26]. It is believed that blocking these extreme reactions through general anesthesia may help control these adrenergic reactions [27].

It is also thought that peripheral blockade through epidural and spinal cord at a low level

has an important role in controlling such changes. An increase in blood sugar levels before surgery can easily lead to a variety of complications and more risks of surgery [28-30].

Therefore, choosing the type of anesthesia is an important matter to ensure the stability of blood sugar levels [31-33].

Few studies have compared the effect of general anesthesia and spinal anesthesia on changes in blood sugar levels [34].

The results of the study conducted with the aim of investigating the difference in blood sugar at 5 and 10 hours after the operation showed that there is a significant decrease in the blood sugar of patients under spinal anesthesia (Figure 3) compared to the general anesthesia [35].

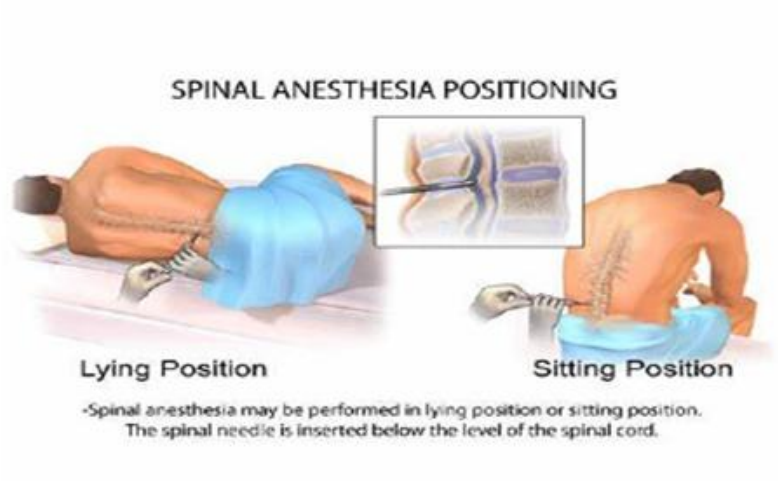

Fig 3 Spinal anesthesia method

According to the researches, surgery with general anesthesia causes blood sugar to increase in two ways, one is due to the stress of surgery and the other is the pharmacological effects of anesthetic drugs [3].

On the other hand, the use of spinal anesthesia has positive effects, such as reducing deep vein thrombosis, pulmonary embolism, reducing the need for blood transfusions, reducing the possibility of pneumonia and respiratory depression, and reducing cases of myocardial ischemia and infarction based on the studies conducted on the blood sugar level 15 minutes before the operation as well as 25 and 50 minutes after the operation [34].

The aim of this systematic review is to investigate these two anesthesia methods in patients undergoing orthopedic surgery [4].

2- Methodology

In this study, which was a systematic review and was conducted during 2022 based on the steps of the PRIZMA guidelines, the databases that publish articles in the medical field were searched based on the objectives of this study. In this search, each article published in English and Persian and had a good quality was included in this systematic review so that its contents could be used for the purposes of this study.

Inclusion criteria included: non-diabetic candidates for orthopedic surgery with anesthesia class one and two, consent of the person to participate in the study and age range of 18-65.

Having a history of any cardiovascular disease, diabetes, pregnancy, breastfeeding, allergies, alcoholism, liver problems, and the use of narcotics or drugs affecting insulin were considered as exclusion criteria.

Before the patients entered the study, they were given a sufficient explanation about the research process and informed consent was obtained. In all stages of the study, the researchers adhered to the principles of the Declaration of Helsinki and confidentiality of patient information.

All patients had anesthesia class one and two and had no history of illness or taking drugs affecting blood sugar and underwent orthopedic surgery while they were fasting (6 hours).

Intraoperative monitoring included pulse oximetry, heart rate, and blood pressure.

Information about age, type of anesthesia, duration of surgery, and the amount of fluids received during surgery were recorded in the checklist. SBP and DBP, HR, and arterial O_2 saturation were measured and recorded before the operation, after the operation, 30 and 60 minutes during the operation and when leaving the recovery room.

Likewise, the blood sugar level of the patients was measured and recorded ten minutes before the operation, after spinal anesthesia or general anesthesia, every 30 minutes during the operation and during the recovery with a glucometer device.

3- Results

No significant difference in systolic blood pressure between the spinal anesthesia group and the general anesthesia group before the operation, at the time after the operation, and at 30 minutes and 60 minutes after the operation (Figure 4), However in the recovery of systolic blood pressure, it showed a significant difference between spinal anesthesia and general anesthesia groups (Figure 5).

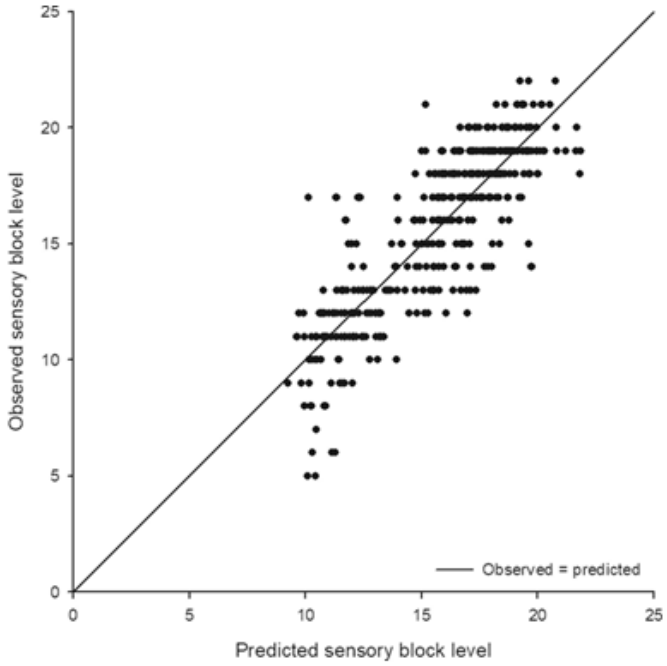

Fig 4 Hemodynamic changes

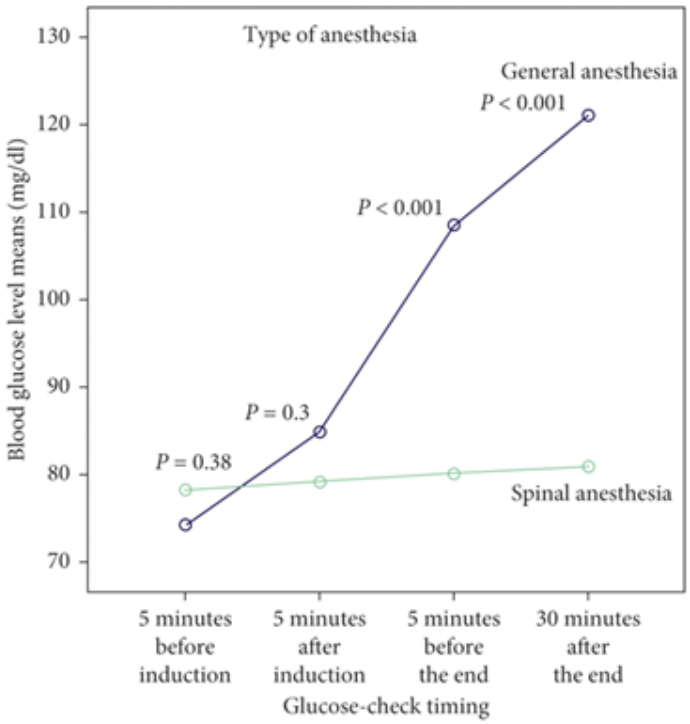

Fig 5 Blood glucose after anesthesia

The results showed that there is no significant difference in the average blood sugar between spinal anesthesia and general anesthesia groups before surgery, after surgery, 30 minutes and 60 minutes after surgery, and during recovery.

Intra-group comparisons with the analysis of variance test with repeated measures showed that the average blood sugar at the time of the study was significant only in the spinal anesthesia group. The average blood sugar in this group decreased after surgery compared to before surgery.

4- Discussion

Traumatic injury, surgery, and anesthesia lead to stress responses that cause specific neurophysiological changes by releasing adrenaline, noradrenaline, cortisol, glucagon, and growth hormone [35]. This increase in hormones and cytokines increases the amount of glucose and increases insulin resistance [36].

In patients prone to injury, these changes may lead to a significant increase in blood sugar. In addition, the surgical process, such as food pattern disturbance due to fasting or post-operative nausea, insulin withdrawal, can all lead to glucose homeostasis irregularity around the time of surgery. Increased or irregular glucose levels may ultimately have negative consequences for the patient [49].

Acute increase in blood sugar following traumatic injury and during surgery, which is known as hyperglycemia due to surgical stress, has been noticed in several researches during the last decade. The relative ease of laboratory blood sugar measurement and its use at the bedside has helped a lot in the management of diabetic and non-diabetic patients. The consequences of acute hyperglycemia in non-diabetic patients undergoing surgery have not been sufficiently investigated yet.

Surgical stress hyperglycemia generally refers to the blood sugar increase around the time of surgery. This type of hyperglycemia may actually affect non-diabetic patients in addition to patients with hidden diabetic disorders.

However, few studies have evaluated blood glucose in non-diabetic subjects. Richards *et al.* reviewed the data of orthopedic patients who required acute intervention and did not have significant injuries in other organs. To eliminate the possibility of hidden diabetes, they recorded blood sugar data up to 3 days after surgery. The results showed that increased blood sugar was significantly related to surgical site infection and may be a worrying issue after musculoskeletal trauma.

In the review of studies that paid attention to the blood sugar of orthopedic patients in surgeries with general anesthesia, the background of the research has shown similar results. During the four hours of investigation, the level of serum blood sugar indicated a significant decrease in both groups with a significant linear trend.

However, in the present study, no significant difference in blood sugar levels was seen between the two study groups. This inconsistency of the results can be due to the difference in the type of surgery in the two studies. In fact, as suggested by Kahosi *et al.*, blood sugar concentration is related to the severity of surgical injury.

Accordingly, the usual mechanisms of maintaining glucose homeostasis in the postoperative period are ineffective. Blood sugar increases after surgery because catabolic hormones cause glucose production and relative insulin deficiency occurs along with peripheral insulin resistance. These hypotheses of Kahosi *et al.* are based on their findings from a study on non-diabetic patients with lower limb surgery, the results of which showed that blood sugar levels in the group receiving epidural anesthesia were significantly lower in the 3 hours after the surgery than in the patients receiving anesthesia.

It should be noted that in the present study, the drug used to reduce pain was not investigated, which according to the findings of Kendrisik *et al.* can be an effective factor in determining the level of blood sugar after surgery.

The results of Adipoglou and Celik's study on patients who underwent joint replacement surgery showed that in patients who received spinal anesthesia, cortisol was lower, insulin was higher, and glucose levels were lower. These findings are in line with the results of the present study.

Cortisol and insulin variables were important things and not investigated in this study, which can be measured in the next investigations. Puriamfard *et al.*'s study, similar to the present study, showed that there was no significant difference in blood sugar before the operation in control group (general anesthesia) and case group (spinal anesthesia), but it decreased in the spinal anesthesia group at one and six hours after the operation.

Although the patients of Puriamfred *et al.*'s study underwent elective surgery for inguinal hernia, the results were very similar to the present study, which showed that the acute stress of surgery itself, regardless of the type of surgery, can play an important role in blood sugar fluctuations.

5- Conclusion

Concerning the importance of blood sugar regulation around the time of surgery, the present study found spinal anesthesia to be somewhat preferable to general anesthesia in controlling the patient's blood sugar, but confirmation of this finding requires more detailed studies.

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