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Original Research Article

Hospital Based Clinical Assessment of Perioperative Effect of Spinal Anaesthesia on Hyperglycemia in Diabetic Patients Undergoing Lower Limb Orthopaedic Surgeries

Sushant Satya Priya[1], Anshuman[2], Krishna Kumar[3]

[1]Senior Resident, Department of Anesthesiology,
Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar, India
[2]Senior Resident Department of Anaethesiology,
Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar, India
[3]Assistant Professor and HOD, Department of Anesthesiology,
Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar, India

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Corresponding Author: Dr. Anshuman
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Abstract

Aim: The aim of the present study was to assess the effect of spinal anaesthesia on perioperative hyperglycemia in diabetic patients undergoing lower limb orthopaedic surgeries and also to state the trend of perioperative hyperglycemia.

Material & Methods: A prospective study conducted in the Department of Anaesthesia for the duration of 20 months including 200 patients having either Type I or Type II Diabetes Mellitus controlled on either oral hypoglycaemic drugs or injectable insulin aged 30 to 65 years, belonging to either sex and American Society of Anesthesiologists (ASA) physical status II and III undergoing elective lower limb orthopaedic surgeries under spinal anaesthesia.

Results: The mean age, weight, height and duration of anaesthesia was 52.54±14.6 6 years, 64.6±6.4 kg, 161.9±4.7 cm and 105.5±11.6 respectively. Mean BG value preoperatively or 10 min before induction was 112.56±12.088. Then at SI, there was statistically significant decrease in BG value to mean value 107.83±12.58. 30 min after SI, mean BG value was 109.71±16.94. This value was lower as compared to the pre-operative BG value, but not statistically significant. 1hr after SI, BG value was 111.59±13.237. This value was also lower as compared to the pre-operative BG value, but not statistically significant. 2hrs after SI, BG value increased to mean value 122.88±16.444. Even, 3 hrs after SI, BG value continued increasing and the mean value became 125.15±15.005. 4 hrs after SI, BG value was maximum with the value being 127.23±16.384. There was statistically significant difference (p=.000). Blood glucose (BG) value decreases till 1hr after surgical incision (SI), and then increases till 4th hr after SI. This change in blood glucose values is statistically significant at SI, 2nd hr after SI, 3rd hr after SI and 4th hr after SI.

Conclusion: Spinal anaesthesia blunts surgical stress response and hence, at SI, BG values decrease. But, BG values increase at other times in perioperative period owing tothe regression of sensory analgesia.

Keywords: Spinal Anaesthesia, Perioperative, Hyperglycemia, Diabetic.

Introduction

Spinal anesthesia has become the preferred anesthetic technique when providing anesthesia for patients undergoing elective cesarean section as the risk of maternal and fetal complications associated with spinal anesthesia is less than with general anesthesia. [1-5] Every surgical procedure is associated with a stress response which comprises a number of endocrine, metabolic, and immunological changes triggered by neuronal activation of the hypothalamic-pituitary-adrenal axis. [6,7]

The overall metabolic effect of the stress response to surgery includes an increase in secretion of catabolic hormones, such as cortisol and catecholamine, and a decrease in secretion of anabolic hormones, such as insulin and testosterone. The increase in levels of catabolic hormones in plasma stimulates glucose production, and there is a relative lack of insulin together with impaired tissue insulin sensitivity and glucose utilization, which is called insulin resistance. Consequently, blood glucose concentrations will increase, even in the absence of preexisting diabetes. [6-9]

Observational studies show that in the surgical patient, diabetes is associated with a higher rate of

peri-operative complications such as need for transfusion, pneumonia, delayed discharge, surgical site infections, and in-hospital mortality. [10] These poorer outcomes are in part due to higher rates of co-morbid conditions such as ischemic heart disease, renal impairment, and hypertension in patients with diabetes. [11] Dysglycemia, which encompasses hyperglycemia, hypoglycemia, stress-induced hyperglycemia, and excessive glucose variability, is increasingly observed and associated with poorer post-operative outcomes even in those without a prior diagnosis of diabetes. In fact, several studies have shown postoperative complications occur more frequently in people with stress-induced hyperglycemia with no prior diagnosis of diabetes than in those with diabetes. [12-14]

Stress hyperglycaemia 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. [15] Stress-induced hyperglycaemia is common and more than 50% occurs in previously non-diabetic patients. [16,17] Perioperative stress-induced hyperglycaemia is reported in 20–40% of patients undergoing general surgical procedures. [18-20]

Hence the aim of study was to assess the effect of spinal anaesthesia on perioperative hyperglycemia in diabetic patients undergoing lower limb orthopaedic surgeries and also to state the trend of perioperative hyperglycemia

Material & Methods

A prospective study conducted in the Department of Anaesthesia, Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar, India for the duration of 20 months including 200 patients having either Type I or Type II Diabetes Mellitus controlled on either oral hypoglycaemic drugs or injectable insulin aged 30 to 65 years, belonging to either sex and American Society of Anesthesiologists (ASA) physical status II and III undergoing elective lower limb orthopaedic surgeries under spinal anaesthesia.

Inclusion Criteria

Only patients having preoperative blood glucose level between 80-120mg/dl were included in the study.

Methodology

Patients on recent intravenous or oral steroid therapy within 30 days, although inhaled steroids were permitted, known case of chronic obstructive respiratory disease and asthma on intravenous steroid therapy; having coagulation abnormalities, hypovolemia or hypotension, pre-existing severe bradycardia, or ejection fraction 20% from basal HR) and hypotension (mean atrial pressure 20% from basal BP) were recorded and managed as per the standard protocols. When blood glucose concentrations exceeded 180mg/dL, it was treated as hyperglycaemia as per continuous insulin infusion (CII) protocol. When blood glucose concentrations lowered below 60mg/dl, it was treated as hypoglycaemia as per the standard protocol.

Statistical analysis

Statistical testing was conducted with the statistical package for the social science system version (SPSS Statistics for Windows, Version 17.0. Chicago: SPSS Inc.,). Ages, weight, height, duration of anaesthesia and blood glucose (BG) values were reported as mean ± standard deviation. Comparison of BG before, during and after surgery was done using Student's t-test. For statistical test, $P < 0.05$ was taken to indicate a significant difference.

Results

Table 1: Demographic characteristics (age, weight, and height) and duration of anaesthesia

Variables	Mean±SD
Age in years	52.54±14.66
Weight (kg)	64.6±6.4
Height (cm)	161.9±4.7
Duration of anaesthesia (min)	105.5±11.6

The mean age, weight, height and duration of anaesthesia was 52.54±14.6 6 years, 64.6±6.4 kg, 161.9±4.7 cm and 105.5±11.6 respectively.

Table 2: Blood glucose (BG) values (mg/dl)

Time	**Mean±SD**
10 min before induction	112.56±12.088
SI	107.83±12.58
30 min after SI	109.71±16.94
1hr after SI	111.59±13.237
2hr after SI	122.88±16.444
3hr after SI	125.15±15.005
4hr after SI	127.23±16.384

Mean BG value preoperatively or 10 min before induction was 112.56±12.088. Then at SI, there was statistically significant decrease in BG value to mean value 107.83±12.58. 30 min after SI, mean BG value was 109.71±16.94. This value was lower as compared to the pre-operative BG value, but not statistically significant. 1hr after SI, BG value was 111.59±13.237. This value was also lower as compared to the pre-operative BG value, but not statistically significant. 2hrs after SI, BG value increased to mean value 122.88±16.444. Even, 3 hrs after SI, BG value continued increasing and the mean value became 125.15±15.005. 4 hrs after SI, BG value was maximum with the value being 127.23±16.384. There was statistically significant difference (p=.000).

Table 3: Trend of blood glucose (BG) values taking BG value at 10min before induction as reference value (mg/dl)

Time	Mean±SD	P Value
SI	4.746±7.843	.007
30 min after SI	.903±12.488	.743
1hr after SI	.929±15.275	.740
2hr after SI	-10.234±23.097	.014
3hr after SI	-12.512±14.076	.000
4hr after SI	-17.633±14.636	.000

Blood glucose (BG) value decreases till 1hr after surgical incision (SI), and then increases till 4th hr after SI. This change in blood glucose values is statistically significant at SI, 2nd hr after SI, 3rd hr after SI and 4th hr after SI.

Discussion

Spinal anesthesia (SA) is a commonly performed regional anesthesia technique in current practice. Drops of cerebrospinal fluid during SA provide an objective criterion for application field compared to other neuraxial anesthesia procedures. Even so, failure of SA is observed depending different causes (failed lumbar puncture, dose selection, drug solution error, anatomical abnormalities, solution= density, inactive local anesthestic solution and local anesthetic resistance). [21]

The stress of surgery results in increased levels of gluco-regulatory hormones (catecholamines, cortisol, glucagon, and growth hormone) and excessive release of interleukin-6 and interleukin-1. The counter-regulatory response produces alterations in carbohydrate metabolism, including insulin resistance, increased hepatic glucose production, impaired peripheral glucose utilization, and relative insulin deficiency. [22,23] The mean age, weight, height and duration of anaesthesia was 52.54±14.6 6 years, 64.6±6.4 kg, 161.9±4.7 cm and 105.5±11.6 respectively. Mean BG value preoperatively or 10 min before induction was 112.56±12.088. Then at SI, there was statistically significant decrease in BG value to mean value 107.83±12.58. 30 min after SI, mean BG value was 109.71±16.94. This value was lower as compared to the pre-operative BG value, but not statistically significant. 1hr after SI, BG value was 111.59±13.237. This value was also lower as compared to the pre-operative BG value, but not statistically significant. 2hrs after SI, BG value increased to mean value 122.88±16.444. Even, 3 hrs after SI, BG value continued increasing and the mean value became 125.15±15.005. 4 hrs after SI, BG value was maximum with the value being 127.23±16.384. There was statistically significant difference (p=.000). During anesthesia induction and surgery, insulin concentration may decrease due to α adrenergic inhibition of β-cell secretion. Plasma glucose concentrations increase in perioperative period. In fact, anaesthesia itself results in hyperglycemia, which is then further aggravated by the surgical procedure. The initial increase in plasma glucose after injury is due to activation of glycogenolysis. But later hepatic gluconeogenesis becomes the major factor in liver glucose release because liver glycogen stores are limited. The usual mechanisms that maintain glucose homeostasis are ineffective in the perioperative period and catabolic hormones promote the production of glucose, thereby resulting in hyperglycemia. [24-26]

Blood glucose (BG) value decreases till 1hr after surgical incision (SI), and then increases till 4th hr after SI. This change in blood glucose values is statistically significant at SI, 2nd hr after SI, 3rd hr after SI and 4th hr after SI. Poon et al [27] achieved better stress response control by combining epidural anesthesia with general anesthesia. Opioids also suppress the stress response by inhibiting hypothalamic pituitary gland function. In a study of lower abdominal surgery, 50 μg/kg fentanyl suppressed the stress response by reducing growth hormone, cortisol, and glucose concentrations. But, systemic opioids may be insufficient to suppress this response in upper abdominal surgeries. In other study of cholecystectomies using 100 μg/kg fentanyl, the stress response was suppressed; however, patients also required postoperative ventilator support. Most studies of neural blocks have assessed the effect of epidural anesthesia, but, few have addressed spinal anesthesia and stress.

Moller et al [28] (1984) compared stress responses following spinal and general anesthesia in abdominal hysterectomies, and reported that spinal anesthesia had a temporary inhibitory effect, which was correlated with the sensorial block level. According to Basem et al [29] (2013) for all patients combined, mean glucose increased slightly from preoperative to incision, substantially from incision to surgery midpoint, and then remained high and fairly stable through emergence, with nondiabetic patients showing a greater increase. For nondiabetics, the mean increase in glucose concentration was more in patients given dexamethasone than placebo. However, there was no dexamethasone effect in diabetics. They assessed this response in patients undergoing non-cardiac surgery under general anaesthesia. [30]

Conclusion

Spinal anaesthesia blunts surgical stress response and hence, at SI, BG values decrease. But, BG values increase at other times in perioperative period owing to the regression of sensory analgesia.

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