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Post-Operative Blood Glucose Level in Various Anaesthetic Techniques (General & Spinal) Among Non-Diabetics Patients

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Abstract **Original Research Article**

Introduction: The metabolic and hormonal responses to anaesthetics and surgery have been a subject of extensive evaluation and discussion for the past many decades. In normal man, anabolism and catabolism are finely balanced. Surgery produces a stress response resulting in various biochemical and hormonal changes. Apart from surgical stress, anesthesia related procedures like Tracheal intubation, recovery from anesthesia, and post-operative pain can increase the stress induced hormonal changes. This study aims to find out post-operative blood glucose level in various anaesthetic techniques (general & spinal) among non-diabetics patients. ***Methods:*** An institution based, observational, cross-sectional study was conducted among patients who were operated at Dept. of Anesthesiology, Anwer Khan Modern Medical College Hospital, Dhaka, Bangladesh from January to December 2022. A total of 120 non diabetes patients who received either general or spinal anesthesia for their surgery. Data was analyzed using SPSS, version 20.0 for windows. Chi-Square test was used to show association between categorical variables and independent sample t-test was used to show mean difference among normally distributed continuous variables. All statistical tests were 2-tailed and a p-value of <0.05 was considered significant. ***Results:*** 65.8% of study population received general anesthesia and 34.2% received spinal anesthesia. In postoperative period, 41.6% of study population had their plasma glucose in pre diabetes range and 20.0% had their plasma glucose in diabetes range. Frequency of postoperative hyperglycemia (IFG + Diabetes) was 61.7%. Mean postoperative plasma glucose was significantly higher among study population who received general anesthesia. Increasing age, female gender, overweight, obesity, hypertension and hypothyroidism was significantly associated with high risk of postoperative hyperglycemia. ***Conclusion:*** There is high prevalence of postoperative hyperglycemia. The frequency of postoperative hyperglycemia was significantly high among those who received general anesthesia than those who received spinal anesthesia.

Keywords: Perioperative Hyperglycemia, Postoperative Hyperglycemia, Surgical Hyperglycemia, General Anesthesia, Spinal Anesthesia.

INTRODUCTION

The metabolic and hormonal responses to anaesthetics and surgery have been a subject of extensive evaluation and discussion for the past many decades. In normal man, anabolism and catabolism are finely balanced. Surgery produces a stress response resulting in various biochemical and hormonal changes. Hormonal interplay is the key role, in the evolution of stress response, which can be estimated as a hyperglycaemic response or variation in catecholamine to different types of surgery and anaesthesia. While afferent impulses from operation sites stimulate the hypothalamic-pituitary axis and facilitate the release of cortisol and growth hormones, the stimulation of efferent impulses of sympatho-adrenal system is associated with higher levels of catecholamine, aldosterone, and glucagon. Stimulation of sympatho-adrenal system is also related with high plasma proteins, sodium retention, potassium loss and increased blood sugar level [1]. Sympathetic over activity blunts insulin secretion and action, increases gluconeogenesis and decreased glucose uptake resulting in hyperglycemia [1,2]. Apart from surgical stress, anesthesia related procedures like Tracheal intubation, recovery from anesthesia, and post-operative pain can increase the stress induced hormonal changes

[3,4]. Risk factors for post operative infections include longer duration of surgery, incision site, body mass index (BMI) female gender, age, chronic steroid use and diabetes mellitus. Post-operative hyperglycemia is a modifiable risk factor for post- operative infections [5,6]. Perioperative morbidity and mortality can be affected by the inadequate glycaemic control in the surgical patients. Disturbances in Nitrogen, carbohydrate and fat metabolism by the various generations of anaesthetics have been the subject of extensive investigations. The most widely known clinical metabolic disturbance is certainly the elevated blood sugar, which occurs during anaesthesia. This may start as early as during premedication or induction of anaesthesia and may vary in severity with the various range of anaesthetics used and the type of surgery. Clinically relevant hyperglycaemic states have been published with various inhalation and intravenous anaesthetics. There are few researchers who reported the role of general anesthesia and spinal anesthesia (SA) in blunting the stress response and consequent blood sugar response but superiority of the either type of anesthesia is yet to be finalized [7,8]. This study aims to find out the pattern of postoperative blood glucose response among non-diabetes patients receiving either general anesthesia or spinal anesthesia for their surgeries.

MATERIALS & METHODS

An institution based, observational, cross-sectional study was conducted among patients who were operated at Dept. of Anesthesiology, Anwer Khan Modern Medical College Hospital, Dhaka, Bangladesh from January to December 2022. A total of 120 non diabetes patients who received either general or spinal anesthesia for their surgery.

Inclusion Criteria

1. ≥18 years, surgical procedure requiring General or Regional anesthesia.

Exclusion Criteria

1. Patients on steroids, chronic liver failure, CKD stage 3B onwards (eGFR <45), patients who received glucose drips during and after recovery from anesthesia.

Operational Definitions: Fasting Plasma Sugar Classification [9,10].
Normal plasma glucose/ Non-Diabetic: Fasting Plasma Glucose (FPG) <100mg/dl

Pre-Diabetes/ Impaired Fasting Glucose: FPG 100-125 mg/dl.
Diabetes: FPG≥126

Hyperglycaemia: Fasting plasma glucose either in the IFG and/or Diabetes range.
BMI Classification [11]

Normal Weight: BMI 18.5-24.99
Overweight: BMI 25.00-29.99
Obese: BMI ≥30

Study Technique: Written informed consent was taken from all study participants. Relevant medical records were reviewed to collect data regarding clinic-social data and past medical records of study subjects. Venous blood sample for fasting blood sugar was collected from study participants who were in fasting state for at least 8 hours prior to operation and did not received glucose drip either during or after recovery from anesthesia till collection of blood samples. Estimation of fasting plasma glucose (FPG) has been done as per World Health Organization (WHO) guidelines [12]. Hyperglycemia was defined and classified as per American Diabetes Association (ADA) [9,10]. Anthropometric measurements were taken as per standard WHO protocols [11].

Statistical Analysis: Data were codified and analyzed using Statistical Package for Social Sciences for windows (SPSS, version 20.0). Frequency of hyperglycemia and other clinic-social variables were calculated. Pie chart and simple bar diagrams were used to show frequency of hyperglycemia and classification of hyperglycemia respectively. Chi-square test was used to show association between categorical variables. Independent sample t-test was used to show mean difference among normally distributed continuous variables. All statistical tests were 2-tailed and a p-value of <0.05 was considered significant.

RESULTS

Table-1: Clinico-social characteristics of study population (N=120)

Clinico-Social characteristics	N (%)
Age group	
18-30 years	31(25.8)
31-60 yrs	78 (65.0)
≥61 yrs	11(9.1)
Sex	
Male	56 (46.6)
Female	64 (53.3)
Educational status	
Illiterate	10 (8.3)
Up to class V	25 (20.8)

Clinico-Social characteristics	N (%)
Class VI-X	43 (35.8)
>Class X	42 (35.0)
BMI (Kg/m2)	
Normal (18.5-24.99)	72(60.0)
Overweight (25.00-29.99)	41 (34.2)
Obese (≥30.00)	7 (5.8)
Hypertension	
Present	33 (27.5)
Absent	87 (72.5)
Hypothyroidism	
Present	15 (12.5)
Absent	105 (87.5)
Type of Anesthesia	
General	79 (65.8)
Spinal	41 (34.2)
Pattern of Post-operative Plasma Glucose	
Normal (<100mg/dl)	46 (38.4)
IFG* (100-125mg/dl)	50 (41.6)
Diabetes (FPG≥126mg/dl)	24 (20.0)
Frequency of hyperglycemia	
Normal FPG	46 (38.3)
Impaired FPG/Diabetes	74 (61.7)

Mean age of the study population was 41.1±12.7 Years. 65.0% of the study population were in the age group of 31-60 years followed by 25.5% and 9.1% were in the age group of 18-30 years and ≥ 61 years respectively (Table-1). 53.3% of them were female and 46.6% were male. 35.8% of study population had education up to class VI-X followed by 35.0% and 20.8% who had education up to >class X and up to class V respectively. 8.3% of them were illiterate. 60.0% (Table-1). 60.0% of study population had normal body mass index while 34.2% and 5.8% of them were overweight and obese respectively (Table-1). 65.8% of study population received general anesthesia and 34.2% received spinal anesthesia. 27.5% of study population had hypertension and 12.5% had hypothyroidism (Table-1).

Table-2: Showing association between clinico-social determinants and hyperglycemia (N=120)

C-S Factors	Hyperglycemia		Total n (%)	χ² (df)	p-value
	Yes (%)	No (%)			
Age Group					
18-30 years	9 (27.2)	24 (72.8)	33 (100.0)		
31-60 years years	54 (72.0)	21(28.0)	75 (100.0)	29.9 (2)	0.000
≥61 Years	11 (91.6)	1 (8.4)	12 (100.0)		
Sex					
Male	21 (36.8)	36(63.2)	57 (100.0)		
Female	52 (82.5)	11 (17.5)	63 (100.0)	22.4 (1)	0.000
BMI (Kg/m2)					
Normal (18.5-24.99)	38 (53.5)	33 (46.5)	71 (100.0)		
Overweight (25.00-29.99)	31 (73.8)	11 (26.2)	42 (100.0)		
Obese (≥30.00)	5 (71.4)	2 (28.5)	7 (100.0)	6.8 (2)	0.034
Hypertension					
Yes	31 (91.1)	3 (8.9)	34 (100.0)		
No	42 (48.8)	44 (51.2)	86 (100.0)	18.4 (1)	0.000
Hypothyroidism					
Yes	13 (86.6)	2 (13.4)	15 (100.0)		
No	61 (58.1)	44 (41.9)	105 (100.0)	6.3 (1)	0.017
Type of Anesthesia					
General	58 (72.5)	22 (27.5)	80 (100.0)		
Spinal	17 (42.5)	23 (57.5)	40 (100.0)	12.7 (1)	0.000

About 91.6% of the ≥61 years old study population had postoperative hyperglycemia. Increasing age was significantly associated with high risk of postoperative hyperglycemia (Table-2). 82.5% of female study population had hyperglycemia, the female gender was found to be a significant risk factor for postoperative hyperglycemia. Increasing BMI was associated with significantly increasing frequency of postoperative hyperglycemia (Table-2). 91.1% hypertensive and 86.6% of the hypothyroid study population had postoperative hyperglycemia. Presence of hypertension and hypothyroidism was found to be significant risk factors for postoperative hyperglycemia (Table-2). 72.5% of the study population who received general anesthesia had postoperative hyperglycemia as compared to only 42.5% of those who received spinal anesthesia. General anesthesia was significantly associated with postoperative hyperglycemia (Table-2).

Table-3: Mean post-operative plasma glucose among study population who received general and spinal anesthesia, (N=120)

	Anesthesia	Number	Mean±SD	t-test (df)	p-value
Plasma glucose	General	79	117.48±25.94	3.193 (145)	0.002
	Spinal	41	104.76±15.22		

Mean postoperative plasma glucose was significantly higher among those who received general anesthesia (Table-3).

Table-4: Pattern of post-operative plasma glucose (N=120)

Plasma glucose	N (%)
Normal	45 (37.6%)
IFG*	50 (41.6%)
Diabetes	25 (20.8%)

In postoperative period, 41.6% of study population had their plasma glucose in pre diabetes range and 20.8% had their plasma glucose in diabetes range. Only 37.6% of them had plasma glucose in normal range during postoperative periods (Table-4).

Table-5: Frequency of post-operative hyperglycemia (N=120)

hyperglycemia	N (%)
Normal	74 (38)
Post-Operative Hyperglycemia	46 (62)

Frequency of postoperative hyperglycemia (IFG + Diabetes) was 62.0% (Table-5).

Discussion

Perioperative stress, anxiety and pain may increase plasma glucose level through sympathetic stimulation and consequent release of stress hormones like epinephrine, nor epinephrine and cortisol. Stress-induced release of hormones such as cortisol, glucagon, epinephrine and growth hormone, among others, appear to be the main mediators. The results of various studies have shown that the choice of anaesthesia technique affects intraoperative stress response and thus significantly affects the outcome and morbidity of surgical patients and the reduction of postoperative pain. The sympathoadrenal stimulation as a consequence of surgery and anaesthesia is associated with severe metabolic changes. Adequate analgesia through anesthesia may reduce perioperative stress and consequent hyperglycemia, especially during post-operative period. In our study we found that about 1/5th and 2/5th of the study population had postoperative blood sugar in diabetes and pre diabetes range respectively. Only about 2/5th of them had their postoperative plasma sugar in normal range as per ADA criteria. A lower 41.1% frequency of preoperative hyperglycemia was reported by Banerjee S & Kumar R. Many research indicated that about 40.0% of surgical patients have undiagnosed diabetes Levetan, C. S. et al., [13]. The prevalence of diabetes among non- surgical population varies from region to region. 10.8% prevalence of diabetes was reported among rural South Indian populations Little, M. et al., [14]. The INDIAB study reported a 13.6% prevalence of diabetes among Chandigarh residents Ramachandran, A. et al., [15]. The National Urban Diabetes Survey reported a prevalence of 12.1% for diabetes and 14.0% for pre diabetes Anjana, R. M. et al., [16]. The prevalence of postoperative hyperglycemia is higher than preoperative hyperglycemia and hyperglycemia among non-surgical patients. High frequency of postoperative hyperglycemia in our study may be due to combined effects of stress, anxiety which might have unmasked undiagnosed hyperglycemia. It may also be due to inadequate pain control during immediate postoperative period and consequent sympathetic over activity which might have blunted the actions of endogenous insulin. Another reason for high frequency of postoperative hyperglycemia may be due to the fact that diabetes patients are more prone to undergo operations than non-diabetic people. 91.6% of study subjects who were ≥61 years old had postoperative hyperglycemia as compared to 72.0% and 27.2% of the study population who were in the age group of ≥31-60 years and ≥18-30 years age group respectively. Increasing age was found to be a significant risk factor for postoperative hyperglycemia in this study. Similar significant role of increasing age on hyperglycemia was reported by many epidemiological researches [17,18]. Female gender had a significant higher frequency of postoperative than their male counterparts. Contrary to this, Banerjee S & Kumar R reported a significant higher male preponderance of preoperative hyperglycemia [13]. However, many other studies reported no role of gender in the development of diabetes [15,19, 20]. 71.4 of obese study population had postoperative hyperglycemia as compared to 73.8% and 53.5% of postoperative hyperglycemia among overweight and normal BMI study populations respectively. High BMI was found to be significant risk factor for postoperative hyperglycemia. High BMI as a significant risk factor for hyperglycemia was reported by many other studies Anjana, R. M. et al., Barik, A. et al., Meshram, I. I. et al., and Ravikumar, P. et al., [16,19,21,22]. Hypertensive study population had significantly higher frequency of postoperative hyperglycemia. While there are many researches Epstein, M., & Sowers, J. R. 1992; Cruickshanks, K. J. et al., [13.24] that highlights the coexistence of hypertension and diabetes there are very few exploring the effect of blood pressure on hyperglycemia. A significant association between high diastolic blood pressure and hyperglycemia was reported by [25]. Significantly higher frequency of postoperative hyperglycemia was found among hypothyroid study populations. The relationship between hypothyroidism and diabetes is complex as both regulate each others metabolism. While diabetes mellitus influences thyroid function either through hypothalamus to control TSH release or by regulating the conversion from T4 to T3 at peripheral tissue level, hypothyroidism is associated with insulin resistance and decrease glucose uptake in to muscle and adipose tissues [27]. Significantly higher frequency of postoperative hyperglycemia was found among those who received general anesthesia than those who received spinal anesthesia. Mean postoperative plasma glucose was significantly higher among study population who received general anesthesia. Chung et al., [28] reported a similar significant prevalence of postoperative hyperglycemia among those who received general anesthesia. Kumar et al., [29] also reported a higher frequency of postoperative hyperglycemia with general anesthesia. Few researchers have compared the effect of general and spinal anesthesia on the postoperative hyperglycemia [30]. Many studies have reported a significant postoperative blood sugar change with spinal anesthesia than general anesthesia [31- 33]. Limitation of the study includes short duration of study, non-probability sampling design and failure to study the effect of individual anesthetic agents on the postoperative plasma sugar levels.

Conclusion

There is high prevalence of postoperative hyperglycemia. Increasing age, female gender, overweight, obesity, hypertension and hypothyroidism was significantly associated with high risk of postoperative hyperglycemia. The frequency of postoperative hyperglycemia was significantly high among those who received general anesthesia than those who received spinal anesthesia.

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