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Post-Operative Blood Glucose Level among Non-Diabetes Patients Receiving General and Spinal Anesthesia

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ABSTRACT

Introduction: Surgery is associated with increased stress response which results in sympathetic activations and the release of pituitary hormones that accelerate glycogenolysis and gluconeogenesis and result in stress hyperglycaemia. Recovery from anesthesia, and post-operative pain can increase the stress induced hormonal changes. **Objective**: To find out the pattern of postoperative blood glucose response among non-diabetes patients receiving either general anesthesia or spinal anesthesia for their surgeries. **Methods**: A Hospital based, Observational; Cross Sectional study was conducted at Department of Anaesthesiology, Gonoshasthaya Samaj Vittik Medical College, Savar, Dhaka, Bangladesh from January to December 2022. A total of 100 study subjects participated in the study was conducted among100 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**: Total 100 patients included in our study. 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 26.0% and 9.0% were in the age group of 18-30 years and ≥ 61 years respectively. 53.0% of them were female and 47.0% were male. 66.0% of study population received general anesthesia and 34.0% received spinal anesthesia. In postoperative period, 42.0% 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 62.0%. 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.

Key Words: *Postoperative Hyperglycemia, Surgical Hyperglycemia, General Anesthesia, Spinal Anesthesia.*

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INTRODUCTION

Surgery is associated with increased stress response which results in sympathetic activations and the release of pituitary hormones that accelerate glycogenolysis and gluconeogenesis and result in stress hyperglycaemia [1]. 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 consensus2.Stress-induced hyperglycaemia is common and more than 50% occurs in previously non-diabetic patients [3,4]. Perioperative stress-induced hyperglycaemia is reported in 20–40% of patients undergoing general surgical procedures [5–7]. 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 [8]. Sympathetic over activity blunts insulin secretion and action, increases gluconeogenesis and decreased glucose uptake resulting in hyperglycemia [9]. Apart from surgical stress, anesthesia related procedures like Tracheal intubation, recovery from anesthesia, and post-operative pain can increase the stress induced hormonal changes [10].The magnitude of stress hyperglycaemia relates to the extent of surgical procedures, the technique of anaesthesia, the anatomic location of the surgery, and the types of intraoperative fluids[11,12].The associated factors for the incidence of stress hyperglycaemia include age, body mass index, duration of surgery, baseline blood glucose level, and intraoperative blood transfusion[3,13,14]. 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 [15-18]. Halter et al. reported that prevention of stress and anxiety during operation may prevent post-operative hyperglycemia and its possible side effects [19]. 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 [20,21]. 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. In addition to contradictory findings on the effect of spinal and general anaesthesia on blood glucose levels, as far as the author's knowledge there is no published previous literature that compares blood glucose levels between the two groups in Africa and also in Ethiopia as ethnicity, race, and genetic affect pain threshold, insulin sensitivity, and hypothalamic pituitary adrenal axis response to stress[22–25].

Materials & Methods

Ahospital based, observational, cross sectional study was conducted at Department of Anaesthesiology, Gonoshasthaya Samaj Vittik Medical College, Savar, Dhaka, Bangladesh from January to December 2022. A total of 100 study subjects participated in the study.

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:

1) Fasting Plasma Sugar Classification [26,27]

a) Normal plasma glucose/ Non Diabetic: Fasting Plasma Glucose (FPG) <100mg/dl.
b) Pre Diabetes/ Impaired Fasting Glucose: FPG 100- 125 mg/dl.
c) Diabetes: FPG≥126 d) Hyperglycaemia: Fasting plasma glucose either in the IFG and/or Diabetes range.

2) BMI Classification [28]

a) Normal Weight: BMI 18.5-24.99
b) Overweight: BMI 25.00-29.99
c) Obese: BMI ≥30

Outcome Variables:

a) Frequency of post-operative hyperglycaemia among study subjects.
b) Factors associated with post-operative hyperglycaemia.

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 [29]. Hyperglycemia was defined and classified as per American Diabetes Association (ADA) [26,27]. Anthropometric measurements were taken as per standard WHO protocols [29].

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

Total 100 patients included in our study. 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 26.0% and 9.0% were in the age group of 18-30 years and ≥ 61 years respectively. 53.0% of them were female and 47.0% were male. 36.0% of study population had education up to class VI-X followed by 34% and 21.0% who had education up to >class X and up to class V respectively. 8.0% of them were illiterate. 60.0% (Table-1). 60.0% of study population had normal body mass index while 34.0% and 6.0% of them were overweight and obese respectively. 27.0% of study population had hypertension and 12.0% had hypothyroidism. 66.0% of study population received general anesthesia and 34.0% received spinal anesthesia. In postoperative period, 42.0% of study population had their plasma glucose in pre diabetes range and 20.0% had their plasma glucose in diabetes range. Only 38.0% of them had plasma glucose in normal range during postoperative periods (Table-4). Frequency of postoperative hyperglycemia (IFG + Diabetes) was 62.0% (Table-1). About 93.0% of the ≥61 years old study population had postoperative hyperglycemia. Increasing age was significantly associated with high risk of postoperative hyperglycemia (Table-2). 83.0% 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). 88.9% hypertensive and 91.7% 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). 71.2% of the study population who received general anesthesia had postoperative hyperglycemia as compared to only 41.2% of those who received spinal anesthesia. General anesthesia was significantly associated with postoperative hyperglycemia (Table-2). Mean postoperative plasma glucose was significantly higher among those who received general anesthesia (Table-3-5).

Table-1: Clinico-Social Characteristics of Study Population, n=100

Clinico-Social characteristics	**n (%)**
Age group	
18-30 yrs	26(26)
31-60yrs	65 (65)
≥61 yrs	9 (9)
Sex	
Male	47 (47)
Female	53(53)
Educational status	
Illiterate	8 (8)
Up to class V	21 (21)
Class VI-X	36 (36)
>Class X	35 (34)
BMI (Kg/m2)	
Normal (18.5-24.99)	60 (60)
Overweight (25.00-29.99)	34 (34)
Obese (≥30.00)	6 (6)
Hypertension	
Present	27 (27)
Not Present	73 (73)
Hypothyroidism	
Present	12 (12)
Absent	88 (88)
Type of Anesthesia	
General	66 (66)
Spinal	34(34)
Pattern of Post-operative Plasma Glucose	
Normal (<100mg/dl)	38(38)
IFG* (100-125mg/dl)	42 (42)
Diabetes (FPG≥126mg/dl)	20 (20)
Frequency of hyperglycemia	
Normal FPG	38 (38)
Impaired FPG/Diabetes	62 (62)

Table-2: Showing association between Clinico-social determinants and hyperglycemia (n=100)

C-S Factors	**Hyperglycemia**		**Total n (%)**	**χ^2 (df)**	**p value**
	Yes (%)	**No (%)**			
Age Group					
18-30 years	7 (26.9)	19 (73.1)	26 (100.0)	29.9 (2)	0.000
31-60 years	46(70.8)	19 (29.2)	65(100.0)		
≥61 Years	8 (88.9)	1 (11.1)	9(100.0)		
Sex					
Male	17 (36.2)	30 (63.8)	47 (100.0)	22.4 (1)	0.000
Female	44 (83.0)	9 (17.0)	53 (100.0)		
BMI (Kg/m2)					
Normal (18.5-24.99)	32(53.3)	28 (46.7)	60 (100.0)	6.8 (2)	0.034
Overweight (25.00-29.99)	25 (73.5)	9(26.5)	34 (100.0)		
Obese (≥30.00)	4 (66.7)	2 (33.3)	6(100.0)		
Hypertension					
Yes	24 (88.9)	3(11.1)	27(100.0)	18.4 (1)	0.000
No	37 (50.7)	36 (49.3)	73 (100.0)		
Hypothyroidism					

Yes	11(91.7)	1 (8.3)	12(100.0)		
No	50 (56.8)	38 (43.2)	88 (100.0)	6.3 (1)	0.017
Type of Anesthesia					
General	47 (71.2)	19 (28.8)	66(100.0)		
Spinal	14 (41.2)	20 (58.8)	34 (100.0)	12.7 (1)	0.000

Table-3: Mean post-operative plasma glucose among study population who received general and spinal anesthesia (n=100)

	Anesthesia	**Number**	**Mean±SD**	**t-test (df)**	**p value**
Plasma glucose	General	66	117.48±25.94	3.193 (145)	0.002
	Spinal	34	104.76±15.22		

Table-4: Pattern of Post-operative plasma glucose (n= 100)

Post-operative plasma glucose	**N=100**	**%**
Normal	38	38.0%
IFG	42	42.0%
Diabetes	20	20.0%

IFG*: Impaired Fasting Glucose

Table-5: Frequency of post-operative hyperglycemia (n -100)

Post-operative hyperglycemia	**N=100**	**%**
Normal	38	38.0%
Post-Operative hyperglycemia (IFG+ Diabetes)	62	62.0%

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. 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 [29]. The prevalence of diabetes among nonsurgical population varies from region to region. 10.8% prevalence of diabetes was reported among rural South Indian populations [30, 31,32]. 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. 88.9% of study subjects who were ≥61 years old had postoperative hyperglycemia as compared to 70.8% and 26.9% of the study population who were in the age group of ≥ 31-60 years and ≥18-30 year's 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 [33, 34]. 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 [29]. However, many other studies reported no role of gender in the development of diabetes [31, 35, 36]. 66.7% of obese study population had postoperative hyperglycemia as compared to 73.5% and 53.3% 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 [32, 35, 37, 38]. Hypertensive study population had significantly higher frequency of postoperative hyperglycemia. While there are many researches [39, 40] 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 [41]. Significantly higher frequency of postoperative hyperglycemia was found among hypothyroid study populations. The relationship between hypothyroidism and diabetes is complex as both regulate each other's 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 [42, 43]. 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. [44] Reported a similar significant prevalence of postoperative hyperglycemia among those who received general anesthesia. Kumar et al [45] 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 [46]. Many studies have reported a significant postoperative blood sugar change with spinal anesthesia

than general anesthesia [47, 48, 49]. 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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