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Research Article

Pattern of Post-Operative Blood Glucose Level among Non-Diabetes Patients Receiving General and Spinal Anesthesia at a Tertiary Health Care Facility of Eastern India

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Abstract: Introduction: Surgery is a stressful situation which affects the metabolic 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 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 147 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:** 66.0% of study population received general anesthesia and 34.0% received spinal anesthesia. In postoperative period, 41.5% of study population had their plasma glucose in pre diabetes range and 20.4% had their plasma glucose in diabetes range. Frequency of postoperative hyperglycemia (IFG + Diabetes) was 61.9%. 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, stress hyperglycemia, general anesthesia, spinal anesthesia.

INTRODUCTION:

Surgery is a stressful situation which affects the metabolic and hormonal changes. Almost all types of surgeries promote catabolism due to stress hormones release via activating sympatho-adrenal secretions (Collins, V. J. 1993). 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 (Wilmore, D. W. 1983). Sympathetic over activity blunts insulin secretion and action, increases gluconeogenesis and decreased glucose uptake resulting in hyperglycemia (Diltoer, M., & Camu, F. 1988). Apart from surgical stress, anesthesia related procedures like Tracheal intubation, recovery from anesthesia, and post-operative pain can increase the stress induced hormonal changes (Banerjee, S. *et al.*,). 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-

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operative infections (Chang, J. K. *et al.*, 2003; Wengrovitz, M. *et al.*, 1990; Nicholson, M.L. *et al.*, 1994; Belkin, M; *et al.*, 1995). Halter *et al.*, reported that prevention of stress and anxiety during operation may prevent post-operative hyperglycemia and its possible side effects (Halter, J. B., & Pflug, A. E. 1980). 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 (Veering, B. T. *et al*., 1987; Cheek, T.G. *et al.*, 1999). 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.

METHODS:

An Institution based, Observational; Cross-Sectional study was conducted among patients who were operated at IQ City Medical College & Multispecialty Hospital from January-February 2019. A total of 147 study subjects participated in the study.

Ethical Clearance:

Study was ethically approved by Institutional Ethics Committee, IQ City Medical College & Multispecialty Hospital.

▪ **Study Setting:**

Post-operative wards of IQ City Medical College & Multispecialty Hospital, Durgapur, India.

▪ **Study type:**

Institution Based, Observational

▪ **Study Design:**

Cross-Sectional

▪ **Study Period:**

January-February 2019

▪ **Study Duration:**

2 Months

▪ **Study Population:**

Adult patients undergoing elective surgical procedures at IQ City Medical College & Multispecialty Hospital, Durgapur, India.

▪ **Inclusion Criteria:**

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

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

▪ **Sample Size:**

147

▪ **Sampling Technique:**

Non Probability, Consecutive

▪ **Study Tool:**

a) Pre designed, pre tested, semi structured schedule
b) Relevant medical records.

▪ **Operational definitions:**

1) Fasting Plasma Sugar Classification (American Diabetes Association. 2014; The International Expert Committee. 2009)

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 (World Health Organization. 2008**)**

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 (World Health Organization. 2006). Hyperglycemia was defined and classified as per American Diabetes Association (ADA) (American Diabetes Association. 2014; The International Expert Committee. 2009). Anthropometric measurements were taken as per standard WHO protocols (World Health Organization. 2008).

▪ **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:

Mean age of the study population was 41.1±12.7 Years. 64.6% of the study population were in the age group of 31-60 years followed by 25.9% and 9.5% were in the age group of 18-30 years and ≥ 61 years respectively (Table-1). 53.1% of them were female and 46.9% were male. 36.1% of study population had education up to class VI-X followed by 34.6% and 21.1% who had education up to >class X and up to class V respectively. 8.2% of them were illiterate. 59.9% (Table-1). 59.9% of study population had normal body mass index while 34.0% and 6.1% of them were overweight and obese respectively (Table-1). 27.2% of study population had hypertension and 12.2% had hypothyroidism (Table-1). 66.0% of study population received general anesthesia and 34.0% received spinal anesthesia. In postoperative period, 41.5% of study population had their plasma glucose in pre diabetes range and 20.4% had their plasma glucose in diabetes range. Only 38.1% of them had plasma glucose in normal range during postoperative periods (Fig-1). Frequency of postoperative hyperglycemia (IFG + Diabetes) was 61.9% (Fig-2). 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). 83.3% 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). 90.0% hypertensive and 88.9% 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). 72.2% of the study population who received general anesthesia had postoperative hyperglycemia as compared to only 42.0% 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).

Table-1: Clinico-Social Characteristics of Study Population, n=147

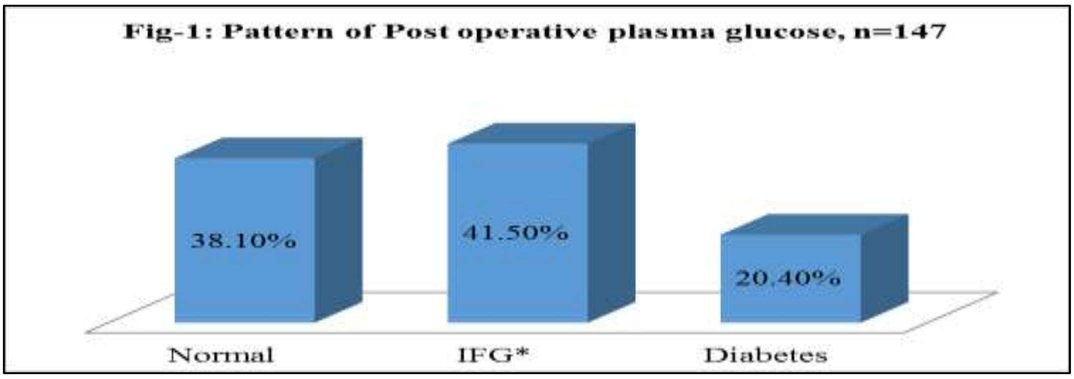
Clinico-Social characteristics	n(%)
Age group	
18-30 years	38 (25.9)
31-60yrs	95 (64.6)
≥61 yrs	14 (9.5)
Sex	
Male	69 (46.9)
Female	78 (53.1)
Educational status	
Illiterate	12 (8.2)
Up to class V	31 (21.1)
Class VI-X	53 (36.1)
>Class X	51 (34.6)
BMI (Kg/m²)	
Normal (18.5-24.99)	88 (59.9)
Overweight (25.00-29.99)	50 (34.0)
Obese (≥30.00)	9 (6.1)
Hypertension	
Present	40 (27.2)
Not Present	107 (72.8)
Hypothyroidism	
Present	18 (12.2)
Absent	129 (87.8)
Type of Anesthesia	
General	97 (66.0)
Spinal	50 (34.0)
Pattern of Post-operative Plasma Glucose	
Normal (<100mg/dl)	56 (38.1)
IFG* (100-125mg/dl)	61 (41.5)
Diabetes (FPG≥126mg/dl)	30 (20.4)
Frequency of hyperglycemia	
Normal FPG	56 (38.1)
Impaired FPG/Diabetes	91 (61.9)

Table-2: Showing association between Clinico-social determinants and hyperglycemia (n=147)

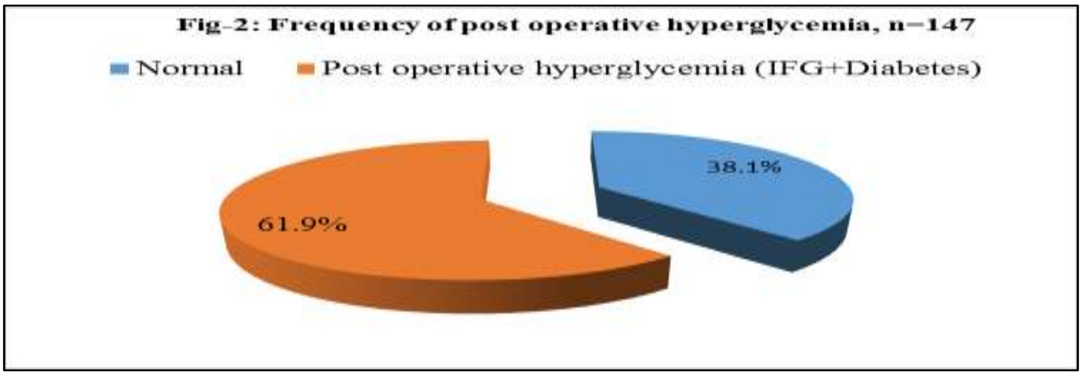
C-S Factors	**Hyperglycemia** Yes (%)	No (%)	**Total** n (%)	χ^2 **(df)**	**p value**
Age Group					
18-30 years	10 (26.3)	28 (73.7)	38 (100.0)		
31-60 years years	68 (71.6)	27 (28.4)	95 (100.0)	29.9 (2)	0.000
≥61 Years	13 (92.9)	1 (7.1)	14 (100.0)		
Sex					
Male	26 (37.7)	43 (62.3)	69 (100.0)		
Female	65 (83.3)	13 (16.7)	78 (100.0)	22.4 (1)	0.000
BMI (Kg/m^2)					
Normal (18.5-24.99)	47 (53.4)	41 (46.6)	88 (100.0)		
Overweight (25.00-29.99)	37 (74.0)	13 (26.0)	50 (100.0)		
Obese (≥30.00)	7 (77.8)	2 (22.2)	9 (100.0)	6.8 (2)	0.034
Hypertension					
Yes	36 (90.0)	4 (10.0)	40 (100.0)		
No	55 (51.4)	52 (48.6)	107 (100.0)	18.4 (1)	0.000
Hypothyroidism					
Yes	16 (88.9)	2 (11.1)	18 (100.0)		
No	75 (58.1)	54 (41.9)	129 (100.0)	6.3 (1)	0.017
Type of Anesthesia					
General	70 (72.2)	27 (27.8)	97 (100.0)		
Spinal	21 (42.0)	29 (58.0)	50 (100.0)	12.7 (1)	0.000

Table-3: Mean post-operative plasma glucose among study population who received general and spinal anesthesia, (n=147)

	Anesthesia	**Number**	**Mean±SD**	**t-test (df)**	**p value**
Plasma glucose	General	97	117.48±25.94	3.193 (145)	0.002
	Spinal	50	104.76±15.22		



IFG*: Impaired Fasting Glucose



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 (Levetan, C. S. *et al.*, 1998). 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.*, 2016). The INDIAB study reported a 13.6% prevalence of diabetes among Chandigarh residents (Ramachandran, A. *et al.*, 2001). The National Urban Diabetes Survey reported a prevalence of 12.1% for diabetes and 14.0% for pre diabetes (Anjana, R. M. *et al.*, 2011). 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. 92.9% of study subjects who were ≥61 years old had postoperative hyperglycemia as compared to 71.6% and 26.3% 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 (Roberts, D. E. *et al.*, 2007; Mokdad, A. H. *et al.*, 2001). 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 (Levetan, C. S. *et al.*, 1998). However, many other studies reported no role of gender in the development of diabetes (Ramachandran, A. *et al.*, 2001; Barik, A. *et al.*, 2016; Goswami, A. K. *et al.*, 2016). 77.8% of obese study population had postoperative hyperglycemia as compared to 74.0% and 53.4% 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.*, 2011; Barik, A. *et al.*, 2016; Meshram, I. I. *et al.*, 2016; Ravikumar, P. *et al.*, 2011).

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.*, 1985) 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 Midha T *et al*., (2015).

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 (Dimitriadis, G. *et al*., 2006; Teixeira, S. S. *et al*., 2012). 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*., (1996) reported a similar significant prevalence of postoperative hyperglycemia among those who received general anesthesia. Kumar *et al*., (1992) 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 (Galet, A. *et al*., 1992). Many studies have reported a significant postoperative blood sugar change with spinal anesthesia than general anesthesia (Greene, N. M. 1983; Kozody, R. *et al*.,1985; Langerman, L. *et al*., 1992). 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.

DECLARATIONS

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