Original Research Article

Comparative study of perioperative blood glucose levels in various anaesthetic techniques (general, spinal and epidural) in non-diabetics and diabetics (controlled)

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Abstract

Background: Surgery produces a stress response resulting in various biochemical and hormonal changes. The most widely known metabolic disturbance is elevated blood sugar. Perioperative morbidity and mortality are affected by the inadequate glycaemic control. There are variations in hyperglycaemic response with various anaesthetic agents and techniques. Among the factors affecting genesis of hyperglycaemia Diabetes stands as a strong pillar. **Aim:** The aim of the study is to evaluate degree of rise of blood sugar levels as a measure of stress during anaesthesia and surgery, under various anaesthetic techniques between non-diabetics and diabetics (controlled). **Patients and Methods:** The study was conducted at Deccan college of medical sciences, Hyderabad in ninety adult patients (30 to 55 years age), undergoing various elective surgeries of 60 to 90 minutes duration under three aesthetic techniques (General Anaesthesia (GA), Epidural (EA), and spinal Anaesthesia (SA)). 45 of these patients were not diabetic and 45 are controlled diabetics. Rise of blood sugar was compared among three techniques in each group and among similar techniques between both groups. For estimating blood glucose levels, preoperative,4 intraoperative and 2 postoperative venous blood samples were collected. Results: In diabetics and non-diabetics, the blood sugar fluctuation is less with regional techniques and furthermore, less under SA.

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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. 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 many variations in hyperglycaemic response with

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various anaesthetic agents and techniques. Not only do the stress of surgery and anaesthesia initiate hyperglycaemia, but also other factors like state of the patient of co-existing diseases have a rule in the genesis of this response. Among the many factors ‘ Diabetes' stands as a strong pillar, which has many contributions. The catabolic effects compound the state of absolute/relative insulin deficiency and can potentially lead to metabolic decompensation in the patient. Surgical stress inflicted on a diabetic patient has had a wide range of complications. Which include ketosis, academia, electrolyte imbalance, ultimately culminating in cardiac arrest. Both animal and human studies also suggest that hyperglycaemia exacerbates ischemic brain damage. In addition, hyperglycaemia interferes with leukocyte chemotaxis and phagocytosis. There are also data indicating impaired wound strength and wound healing when plasma glucose levels are greater than 200 mg %. Adequate perioperative glycaemic control is in fact a challenge especially in diabetic patients. The evidences have shown that the mortality in patients with non-cardiac surgeries was 24% at one year. Ischemic heart disease, urgent surgery, higher American Society of Anaesthesiologists (ASA) physical status score and hyperglycaemia were the major predictors of increased perioperative mortality. Perioperative blood sugar control was the major component of anaesthetic care that may need more stringent control. Diabetic patients have a 50% chance of undergoing surgery at some time during their life. Adopting a diabetic patients’ therapeutic regimen to accommodate a surgical procedure is a challenging problem. Unfortunately, there is no consensus on the optimal manner in which to manage the metabolic changes that occur during the surgery in patients with diabetes. Surgery is usually associated with increased stress response which is characterized by increased secretion of pituitary hormones and activation of the sympathetic nervous system. Surgery itself causes a reduction in insulin sensitivity leading to hyperglycaemia, which is proportional to the length and technique of the procedure. This study involves an effort into the insight of the hyperglycaemic fluctuations taking place in anaesthetic and surgical stress environment on the diabetics in comparison with non-diabetic patients.

AIM OF THE STUDY

The study is aimed at evaluating the degree of rising of blood sugar levels as a measure of stress during anaesthesia and surgery, under various anaesthetic techniques between non-diabetics and diabetics (controlled). It aims at following the anaesthesiologist to decide on the appropriate technique for various surgeries in diabetic groups with minimal stress inflictions and patient safety.

PATIENTS AND METHODS

The study was conducted on diabetic and non-diabetic patients during anaesthesia and surgery, under three anaesthetic techniques (General Anaesthesia, Epidural, and spinal Anaesthesia), to evaluate the degree of rising of blood sugar intraoperatively and postoperatively. The rise of blood sugar was compared among the three techniques in each group and among similar techniques between both groups. The study was conducted in ninety (90) adults of either sex between 30 to 55 years age group, undergoing various elective surgical procedures of 60 to 90 minutes duration Forty-five (45) of these patients were not diabetic and (45) controlled diabetics. Patients studied belonged to ASA grade – I and grade – II, with informed consent taken before the study. Patients underwent a procedure like a laparotomy, thyroidectomy, hysterectomy and lower limb Orthopaedic procedures.

All patients were assessed pre-operatively and investigated to exclude other systemic diseases. In diabetics, insulin and anti-diabetic agents were precluded from midnight before the operation.

Inclusion criteria:

- Patients undergoing elective surgical procedure of 60-90 minutes duration ASA Grade 1 and 2 with informed consent.
- The study was conducted in 90 adults of either sex.

Exclusion criteria:

- Patients with ASA Grade 3 and 4.
- Patient with blood sugar less than 60mg%
- Uncontrolled diabetes
- Surgeries more than 2 hours.

The study was undertaken in six – group; of fifteen patients in each group and then categorised as:

Group – I: General anaesthesia
Group – II: Epidural analgesia
Group – III: Spinal analgesia
In Diabetic Patients:
Group – I: General anaesthesia
Group – II: Epidural analgesia
Group – III: Spinal analgesia

After securing intravenous access pre-operatively, normal saline was used as a maintenance fluid. Diabetic patients were put under no insulin, no glucose protocol, for assessing variations in blood sugar.

Patients receiving general anaesthesia in either group were given a standard regimen with inj. Fentanyl (2 µg/kg) and glycopyrrolate as premedication, induction with inj. propofol (2mg/kg), intubating dose of vecuronium and maintenance with vecuronium, nitrous oxide, oxygen (in ratio 5:3 Lit/min) and inhalational agent. Postoperative analgesia was supplemented by diclofenac sodium, intramuscularly. In patients

receiving regional techniques in either group, co-loading was done with normal saline (10 ml/kg). In patients undergoing epidural technique, continuous epidural analgesia was given under strict aseptic condition in left lateral position in L4 – L5 space, using Lidocaine 1.5% by loss of resistance technique and analgesia maintained at T4 technique. In patients undergoing spinal technique under strict aseptic conditions, spinal was conducted at L4 – L5 space and 0.5% Bupivacaine (heavy) was administered. A T4 level of analgesia was achieved.

MONITORING

Patients have monitored preoperatively and throughout procedure using.

Non-invasive blood pressure monitor

Pulse oximeter:

Pulse rate, blood pressure, and oxygen saturation were monitored for all patients throughout the procedure.

BLOOD SUGAR ESTIMATION:

For estimating blood glucose levels, venous blood samples (two ml) were collected into disposable syringes and transferred into sterile bottles (with added NaF + EDTA to prevent glycolysis and coagulation). In all, seven samples were collected from each patient at the following intervals.

- Preoperatively – fasting blood sugar.
- After intubation / after achieving T4 segment in regional analgesia
- Followed by samples at 20, 40 and 60 minutes.
- Postoperatively two samples at 20, and 40 minutes.

  Samples were sent for analysis immediately after collection (within 10 – 15 minutes) and analyzed by an autoanalyzer (911 HITACHI AUTO ANALYSER).

The results were studied statistically. The data was analyzed using Statistical Software IBM SPSS statistics Version 16. Continuous data were presented as mean and standard deviation whereas categorical data were presented as frequency and percentage. Paired t test was used to compare mean for continuous data and Chi square test was used for categorical data. P value > 0.05 was considered statistically significant.

OBSERVATION AND RESULTS

DEMOGRAPHIC DATA SHOWING AGE, WEIGHT AND SEX IN THREE GROUPS IN DIABETIC PATIENTS

Table 1

GROUP	AGE (Yrs)	Mean± SD	Wt (Kgs)	Mean± SD	Sex ratio M: F
General Anaesthesia	30 – 58	43.86±6.20	46 – 60	52.13±6.4	7 : 8
Epidural Anasthesia	37 - 52	44.33 ±5.0	44-64 kgs	56.80±6.15	11 : 4
Spinal Anaesthesia	30 - 52	44.66±5.12	45 – 70	55.40±4.70	6: 9

The Demographic data were comparable without any statistical significance P> 0.05.

PREOPERATIVE BLOOD SUGAR VALUES IN NON-DIABETIC AND DIABETIC PATIENTS

Table 2

GROUP	NON-DIABETIC MEAN ± SD	DIABETIC MEAN ± SD
General Anaesthesia	89.60 ± 19.47	112.20 ± 15.27
Epidural Anaesthesia	94.53 ± 16.80	121.26 ± 13.16
Spinal Analgesia	95.53 ±14.71	113.00 ± 10.20

The above data were comparable without any statistical significance (P > 0.05).

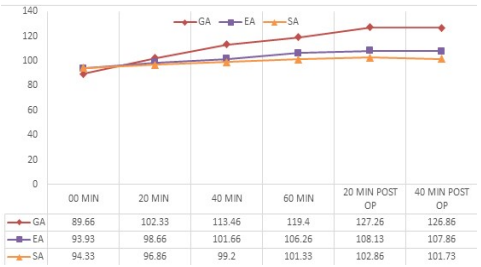
RISE IN BLOOD SUGAR LEVEL (% INCREASED) AT VARIOUS TIME INTERVALS – IN NON-DIABETICS AND DIABETICS

Table 3

	Group	00 min	20 min	40 min	60 min	20 min	40 min
GA	ND	0.06%	13.34	25.81	32.46	42.40	42.19
	D	0.48	14.82	25.41	39.13	39.61	40.40
EA	ND	0.21	5.06	7.86	13.14	16.27	14.98
	D	-0.01	6.89	12.87	18.53	19.60	19.28
SA	ND	1.23	1.34	3.86	6.17	7.76	6.56
	D	-1.6	3.71	7.21	10.50	10.79	9.19

ND= non diabetic; D= diabetic

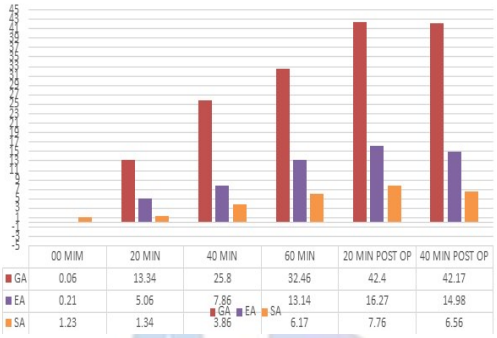
TRENDS OF BLOOD SUGAR LEVELS AT VARIOUS TIME INTERVALS IN NON-DIABETICS



	00 MIN	20 MIN	40 MIN	60 MIN	20 MIN POST OP	40 MIN POST OP
GA	89.66	102.33	113.46	119.4	127.26	126.86
EA	93.93	98.66	101.66	106.26	108.13	107.86
SA	94.33	96.86	99.2	101.33	102.86	101.73

Figure 1:

RISE IN BLOOD SUGAR LEVEL (% INCREASED) AT VARIOUS TIME INTERVALS – DIABETICS



	00 MIM	20 MIN	40 MIN	60 MIN	20 MIN POST OP	40 MIN POST OP
GA	0.06	13.34	25.8	32.46	42.4	42.17
EA	0.21	5.06	7.86	13.14	16.27	14.98
SA	1.23	1.34	3.86	6.17	7.76	6.56

Figure 2:

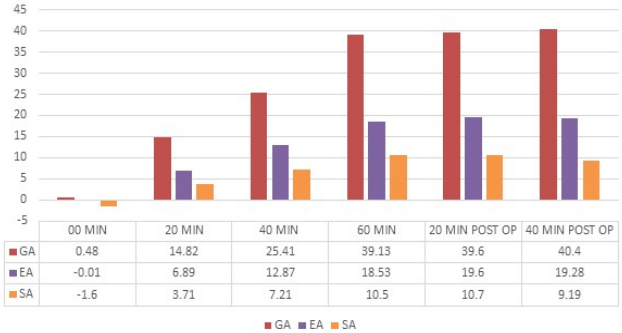
The above results show an increase n blood sugar by 32% at the end of surgery in GA, whereas by 13.14% increase in epidural and 6.17% increase in Spinal Analgesia. The blood sugar levels continued to rise up to 20 minutes postoperatively in all techniques.

TRENDS OF BLOOD SUGAR LEVELS AT VARIOUS TIME INTERVALS IN DIABETICS GROUPS

	00 MIN	20 MIN	40 MIN	60 MIN	20 MIN POST OP	40 MIN POST OP
GA	112.93	128.13	139.53	154.86	155.53	157
EA	121.06	129.13	136.4	143.26	144.73	144.33
SA	111.2	117.13	121.13	124.86	125.2	123.4

Figure 3:

RISE IN BLOOD SUGAR LEVEL (% INCREASED) AT VARIOUS TIME INTERVALS – DIABETICS



	00 MIN	20 MIN	40 MIN	60 MIN	20 MIN POST OP	40 MIN POST OP
GA	0.48	14.82	25.41	39.13	39.6	40.4
EA	-0.01	6.89	12.87	18.53	19.6	19.28
SA	-1.6	3.71	7.21	10.5	10.7	9.19

Figure 4:

The above results show an increase in blood sugar by 39.13% at end of surgery in the GA group increases by 18.53% rise in the epidural group and 10.50% rise in the spinal group.
The blood levels continued to rise postoperatively up to 40 mts in GA and up to 20 mts in epidural and spinal analgesia.

TABLE SHOWING A COMPARISON OF BLOOD SUGAR RISE (%) BETWEEN NON DIABETICS AND DIABETICS AT END OF SURGERY (60 MTS)

Table 4:

Group	Non-Diabetic	Diabetic
GA	32.46% ±21.46	39.13±13.80
EP	13.14% ± 7.31	18.53±5.86
SP	6.17±2.07	10.50±1.69

GA = General Anaesthesia, EP = Epidural Anaesthesia, SP = Spinal Anaesthesia

- Values are mean with SD

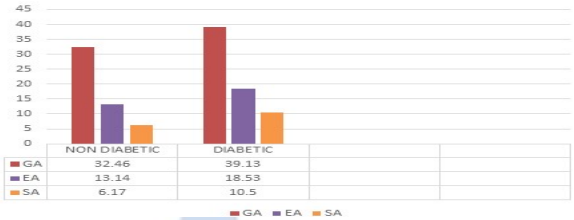


Figure 5:

The above results show a 6.67% risk of blood sugar in diabetics under GA when compared with the non-diabetic group. The diabetic epidural group shows a rise of 5.39% over non-diabetic while the diabetic spinal group shows 4.33% rise over a non diabetic spinal group.

DISCUSSION

This stress-induced hyperglycaemia represents a complex metabolic syndrome that compromises insulin resistance, reduced glucose clearance and relative insulinopenia. The degree of insulin resistance after general surgery increases with the degree of surgical trauma. 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. Simultaneous with these changes, there is marked inhibition of insulin secretion. This is present during operation and is associated with marked glucose intolerance. Some of the drugs used for anaesthetic premedication act on the neural mechanism controlling ACTH secretion, to increase the output of this hormone, while others inhibit the secretion. The SA produces significant sympathetic blockage which attenuates the stress induced physiological changes in cardiovascular and endocrine system. The inhibition of sympathetic system during SA results in significant decrease in cortisol level, decrease in adrenergic activity and inhibition of renin angiotensin aldosterone system which ultimately helps to maintain a stable blood glucose level during surgery. Epidural analgesia blunts the cortisol response but not the epinephrine or norepinephrine response. This response is sufficient to increase blood sugar level but still less than that under general anaesthesia. In the epidural group of non-diabetic patients, the blood sugar level after achieving T4 segment level increased by 0.25% While in the diabetic group it decreased by 0.01% below base value. The increase in 0.21% could be due to fear and stress of position during the technique and during administration of technique. In the spinal group the blood sugar values decreased below basal values. The decrease being more in the diabetic group. This is in agreement with *Hammond et al.* (1958) that spinal anaesthesia does not increase the blood cortisol or adrenaline levels. The further decrease in diabetics could mean that regional techniques suppress stress responses far better in diabetics and should be practised wherever indicated. In this study post-intubation blood sugar values showed an increase of only 0.06% in non-diabetics this is attributed to suppression of stress response of intubation by FENTANYL.

The study observed that stress response induced by induction of anaesthesia and surgical stimulus was poorly inhibited by GA. This ongoing stress response increased the secretion of adrenaline, noradrenaline, cortisol level and resistance to insulin which resulted in poor control on blood glucose level during GA. *Tetsuchiro sakai,David O' Flaaharty et al..* (1995) showed that circulating cortisol

was significantly suppressed by Propofol and completely abolished the response of circulating cortisol to surgery. In this study post intubation blood sugar levels showed a decrease of 1.064% in non-diabetic that is attributed to suppression of stress response of intubation by fentanyl and Propofol. Fentanyl can prevent ACTH release and attenuate pituitary–adrenal response to stress

RECOMMENDATION

As the stress response to surgery is comparatively less in spinal anaesthesia, glycaemic control is better in spinal anaesthesia as compared to general anaesthesia. We recommend spinal anaesthesia over epidural and general anaesthesia whenever possible in reducing surgical stress response.

LIMITATIONS OF THE STUDY

The study didn't address other various factors that can affect the stress response and the blood glucose level. Blunting of stress response during endotracheal intubation, pain during intra operative period could be the possible reason for increase in blood glucose level in general anaesthesia which were not explained in the study.

CONCLUSION

The degree of rising of blood sugar due to surgical stress is highest in general anaesthesia 32.46% and still higher in controlled diabetics 39.13%.

The response to surgical stress is low in regional techniques, least in spinal anaesthesia 6.17% in non-diabetics and 10.50% in diabetics. Moderate in epidural analgesia 13.l4% in non-diabetics and 18.55% in diabetics. Surgical stress is higher in all techniques in the diabetic group when compared with a similar technique in the non-diabetic group. Response to surgical stress in a diabetic can be minimized by regional techniques wherever possible. The requirement of intraoperative insulin regimen may not rule in all surgeries but depends more on the duration of surgery and its severity.

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