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Comparison of the Effects of General Anesthesia & Spinal Anesthesia for Elective Cesarean Section in Diabetic Pregnant Women

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Abstract **Original Research Article**

Introduction: Caesarean section (CS) is now one of the most commonly performed major operations in pregnant women throughout the world. While regional or general anaesthesia (GA) are both acceptable for caesarean delivery, use of GA has decreased dramatically in the past few decades due to a higher risk of anaesthesia-related maternal mortality. As a consequence, spinal anaesthesia (SA) is now the technique of choice for CS. It 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. ***Aim of the study:*** The aim of this study was to compare the effects of general & spinal anesthesia for elective cesarean section in diabetic pregnant women. ***Methods:*** This was a comparative observational study and was conducted in the Department of Anaesthesiology of Holy Family Red Crescent Medical College Hospital, Dhaka, Bangladesh during the period from January,2022 to December,2020.In our study we included 120 pregnant women with diabetes who were given spinal and general anesthesia during C-section surgery. Our patients were equally divided into two groups – i) Group A (Patients were given general anesthesia) & ii) Group B (Patients were given spinal anesthesia). ***Result:*** In total 120 patients from both the groups completed the study. In our study we found the mean age and BMI was 34.48± 11.79 years & 38.48± 14.89 kg/m2 respectively. Among all patients 16%, 58% & 27 % patients had Type 1, Type 2 & gestational diabetes respectively. The mean blood glucose level was significantly lower in SA (80.9 ±17.7) compared to GA (121.1± 17.4) after one hour of surgery. The mean of mother's perioperative difference was significantly lower in SA (4.0 ± 0.19) compared to GA (9.4 ± 0.21). ***Conclusion:*** In our study, we found that general anaesthetic had a substantially higher influence on blood glucose concentrations than spinal anesthesia, indicating that the hormonal stress response is much greater in general anesthesia than in spinal anesthesia. Therefore, it is concluded that SA had a lower effect on the glycemic response during cesarean surgery in diabetic patients.

Keywords: Anesthesia, Diabetes, Pregnancy, Surgery.

INTRODUCTION

Diabetes mellitus (DM) is a multisystem metabolic disease, and the number of diabetic patients increased sharply in recent years [1]. A study showed 2% to 4% surgical patients had diabetes [2]. Perioperative patients with diabetes could lead to a sharp increase of blood glucose, causing the increased incidence of diabetic acute complications and infections, delayed wound healing, and postoperative mortality [3, 4].

Pregnancy in the diabetic patient is associated with increased hazard to mother and fetus. Cesarean section is frequently required in this high risk group [5]. Gestational diabetes mellitus (GDM) is the most common medical complication of pregnancy. It is associated with adverse maternal and infant outcomes [6]. The global prevalence of GDM was 14.7% based on the International Association of Diabetes and Pregnancy Study Groups (IADPSG) criteria, the most used screening method worldwide [7]. The highest pooled prevalence (11.4%) of GDM was in South Asia (Bangladesh, India, and Sri Lanka) compared to the rest of the world (3.6–6.0%) [8]. The overall prevalence of GDM in Bangladesh is 35% [9]. GDM is a pregnancy complication of abnormal glucose metabolism that can be caused by a variety of factors [10] and has many adverse effects on mothers and children in both the short and long terms, such as pregnant hypertension, prematurity, macrosomia, intrauterine death and perinatal asphyxia, and neonatal hypoglycemia [11].

Caesarean section (CS) is now one of the most commonly performed major operations in pregnant women throughout the world. While regional or general anaesthesia (GA) are both acceptable for caesarean delivery [12], use of GA has decreased dramatically in the past few decades due to a higher risk of anaesthesia-related maternal mortality [13]. As a consequence, spinal anaesthesia (SA) is now the technique of choice for CS [14].

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 [15-19]. 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 [20, 21]. 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 [20-23]. Notably, even mild hyperglycemia impairs immunological function and raises the risk of infection [23-25]. Afferent neuronal activity from the site of trauma in surgical patients triggers the stress response. To activate the hypothalamus, these afferent neurons follow sensory nerve roots up the spinal cord and through the dorsal root to the medulla. Afferent nerve impulses are blocked by neuraxial anesthesia, such as spinal or epidural anesthetic, which inhibits the stress response to surgery, including hyperglycemia [20, 21, 26, 27].

Therefore, in this study we aimed to determine and compare the effects of general & spinal anesthesia in pregnant diabetic women.

Objectives of the study

The main objective of the study was to compare the effects of general & spinal anesthesia for elective cesarean section in diabetic pregnant women.

METHODOLOGY & MATERIALS

This was a comparative observational study and was conducted in the Department of Anaesthesiology of Holy Family Red Crescent Medical College Hospital, Dhaka, Bangladesh during the period from January, 2022 to December, 2022. In our study we included 120 pregnant women with diabetes who were given spinal and general anesthesia during C-section surgery. Our patients were equally divided into two groups – i) Group A (Patients were given general anesthesia) & ii) Group B (Patients were given spinal anesthesia).

These are the following criteria to be eligible for the enrollment as our study participants: a) Patients who were aged above 18 years; b)Patients with Pregnancy; c) Patients with DM; d) Patients undergoing cesarean section; e) Patients who were willing to participate were included in the study And a) Patients with duration of surgery >90 min; b) Patients with previous surgical history & complications; c) Patients with known allergy to anesthetic drugs; d) Patients with any history acute illness (e.g., renal or pancreatic diseases, ischemic heart disease etc.) were excluded from our study.

For group A, after breathing oxygen for 3 minutes via a face mask, anesthesia was induced with 2–2.5 mg/kg propofol and 0.6 mg/kg rocuronium to facilitate tracheal intubation and with rapid sequence intubation using a regular 6.5 mm ID endotracheal tube. After delivery of the baby and cutting the umbilical cord, 3 μg/kg fentanyl was given. Before delivery of the baby, anesthesia was maintained with 0.7% isoflurane in 50% oxygen and 50% nitrous oxide, and after delivery and cutting the umbilical cord, anesthesia was maintained with a propofol infusion at a rate of 150 μg/kg/ min and the inhaled anesthetic agents were discontinued. $ETCO_2$ was maintained between 30 mmHg and 40 mmHg throughout the surgery [28].

For group B, spinal anesthesia was administered under aseptic conditions, at the level of L3-L4 or L4-L5 of the spinal column. Spinal anesthesia was performed with 2.3 ml of 0.5% heavy bupivacaine and 0.4 ml of 0.005% fentanyl using 25- or 27-gauge spinal needles; 100% O2 was administered through a simple face mask with a flow of 4 liters per minute [28].

At the end of surgery, anesthetic maintenance was discontinued, and reversal of the neuromuscular blockade consisting of 2.5 mg of neostigmine and 1 mg of atropine was given intravenously (IV). The extubation of the trachea was performed when the patient was breathing spontaneously with a good tidal volume, fully awake, and could sustain head elevation for more than 5 seconds [28].

Upon arrival at the operating theater, both groups received 750 mg of cefuroxime IV, 8 mg of dexamethasone IV, 50 mg of ranitidine IV, and 10 mg of metoclopramide IV before starting anesthesia. After delivery of the baby, both groups received 10 IU oxytocin IV bolus and 20 IU oxytocin infusion over 1 hour. Both groups were given 2000–3000 ml crystalloids IV; half of the amount was 0.9% normal saline, and the other half was Ringer's lactate solution [28].

For the group A, the blood glucose concentration (BGC) was obtained 5 minutes before induction (T1) and 5 minutes after induction (T2). For the group B, the BGC was obtained immediately before the injection of the local anesthetic agent (T1) and 5 minutes after the complete block (T2). For both groups, the blood glucose concentration was measured 5 minutes before the end of surgery, T3, and 30 minutes after the end of surgery in the postanesthesia care unit, T4, using a blood glucose monitoring kit with a lancet device (Joycoo BG-102; Joycoo, Amman, Jordan) [28].

Statistical Analysis: All data were recorded systematically in preformed data collection form and quantitative data was expressed as mean and standard deviation and qualitative data was expressed as frequency distribution and percentage. Statistical analysis was performed by using SPSS 23 (Statistical Package for Social Sciences) for windows version 10. Probability value <0.05 was considered as level of significance. Ethical review board of Holy Family Red Crescent Medical College Hospital, Dhaka, Bangladesh approved the study.

RESULT

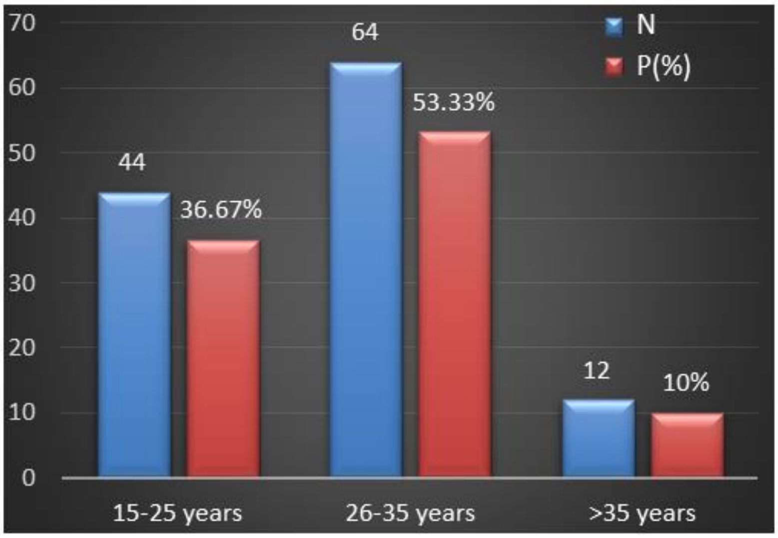

Figure 1: Age distribution of our study respondents

Table 1: Baseline characteristics of our study subjects

Baseline characteristics	**N**	**P(%)**	**P-value**
Age (Years)			
Mean ±SD	34.48± 11.79		0.020
BMI (kg/m^2)			
18-25	46	38.33	
26-35	64	53.33	
>35	10	8.33	
Mean ±SD	38.48± 14.89		0.351
Gravidity			
1	68	56.67	
2	39	32.50	
≥2	13	10.83	
Parity			
0	52	43.33	
1	38	31.67	
2	30	25	
≥2	0	0.00	
Previous CS			

Baseline characteristics	**N**	**P(%)**	**P-value**
0	96	80.00	
1	18	15.00	
≥2	6	5.00	
Previous miscarriage			
0	67	55.83	
1	37	30.83	
≥2	16	13.33	
Gestational age (weeks) at surgery	36.34 ± 1.6		0.010

Table 2: Frequency of diabetes mellitus among our patients

Types	**N**	**P(%)**
Insulin dependent diabetes mellitus (Type 1)	19	15.83
Type 2 diabetes mellitus and adult-onset diabetes (Type 2)	69	57.50
Gestational diabetes	32	26.67

Table 3: Clinical manifestations of our study respondents

Clinical manifestations	**N**	**P(%)**	**P-value**
Baseline SBP (mmHg)			
≥120	48	40	0.000
<120	72	60	
Baseline DBP (mmHg)			
≥80	62	51.67	0.000
<80	58	48.33	
Baseline HR (beats/min)			
60-80	22	18.33	0.000
81-100	68	56.67	
>100	30	25	
Mean blood glucose (mg/dL)	98.8 ± 1.4		0.021
Co-morbidities			
DM	120	100	0.000
HTN	45	37.50	
Hypotension	55	45.83	
Hyperthyroidism	36	30	
Hypothyroidism	39	32.50	
Hyperglycemia	52	43.33	
Hypoglycemia	49	40.83	

Table 4: Comparison of post-operative outcome between general & spinal anesthesia

Variable	**General anesthesia**	**Spinal anesthesia**	**P-value**
Blood glucose level			
5 min before induction	74.2 ±13.7	77.8 ±19.1	0.013
5 min after induction	83.9 ±22.7	79.2 ±17.3	
5 min before the end of surgery	108.4 ±16.7	80.2 ±18.1	
30 min after the surgery	122.1± 17.3	81.9 ±16.7	
1 h after the surgery	121.1± 17.4	80.9 ±17.7	
Postoperative SBP	149.82±28.74	129.72±27.69	0.000
Postoperative DBP	88.21±15.82	84.41±12.79	0.000
Postoperative HR	92.20 ±11.9	88.14 ±10.81	0.000
Preoperative Sugar level (mg/dL)	100.7 ± 1.41	83.6 ± 1.50	0.000
Postoperative Sugar level (mg/dL)	110.1 ± 1.62	87.6 ± 1.31	0.000
Mother's perioperative difference in sugar level (mg/dL)	9.4 ± 0.21	4.0 ± 0.19	0.020

In Figure 1 we showed the age distribution of our study patients. Majority(53.33%) of our patients were aged between 26-35 years old, followed by 36.67% & 10% was found in 15-25 years & above 35 years old patients respectively.

In table 1 we summarized the baseline characteristics of our respondents. We found the mean age and BMI was 34.48± 11.79 years & 38.48± 14.89 kg/m^2 respectively. Most of women (57%) had gravida 1, 43% & 32% women had para 0 & 1 respectively. 80% women had no history of C-section, 15% patients had done surgery before. 56% patients had no miscarriages & 31% had single miscarriage. Gestational age at surgery was 36.34 ± 1.6 weeks.

In table 2 we showed the frequency of diabetes mellitus found in our patients. Type 1 was found in 16%, Type 2 was present in 58% and gestational diabetes was present in 27 % patients.

Table 3 showed the clinical manifestations of study patients. Majority (60%) of our patients had systolic blood pressure less than 120 mmHg, 52% had diastolic blood pressure more than 80 mmHg and 57% had 81-100 heart beats /min. The mean blood glucose was 98.8 ± 1.4 mg/dL. Among all patients we found DM(100%), HTN (38%), hypotension(46%), hypoglycemia (41%) and hyperglycemia (43%).

In Table 4 we compared the post-operative outcome of GA & SA among our patients. Out outcome variables were blood glucose level, SBP, DBP, HR, difference in mother's sugar level. The mean blood glucose level was significantly lower in SA (80.9 ±17.7) compared to GA (121.1± 17.4) after one hour of surgery. The mean of mother's perioperative difference was significantly lower in SA(4.0 ± 0.19) compared to GA(9.4 ± 0.21) .

DISCUSSION

In our study we found majority (53.33%) of our patients were aged between 26-35 years old, followed by 36.67% & 10% was found in 15-25 years & above 35 years old patients respectively (Figure 1). Fakherpour *et al*., found among all respondents 306 patients were 26-35 years age group [29]. Their findings is similar to ours.

In this study we found the mean age and BMI was 34.48± 11.79 years & 38.48± 14.89 kg/m^2 respectively. Most of women (57%) had gravida 1, 43% & 32% women had para 0 & 1 respectively. 56% patients had no miscarriages & 31% had single miscarriage. Gestational age at surgery was 36.34 ± 1.6 weeks (Table 1). D.A Bani Han *et al*., found the average age of mothers included in their study was 31 years, gravida 2 (21.9%) and para 1 (26.5%) were most commonly encountered. Also, most women (67%) had a history of single miscarriage. The average gestational age at time of delivery was 37.4 weeks [30].

In our study Type 1 & Type 2 diabetes was found in 16% & 58% and gestational diabetes was present in 27% patients (Table 2). D.A Bani Han *et al*., found 14 patients with gestational diabetes [30].

Majority (60%) of our patients had SBP less than 120 mmHg, 52% had DBP more than 80 mmHg and 57% had 81-100 heart beats /min. The mean blood glucose was 98.8 ± 1.4 mg/dL. Among all patients we found diabetes mellitus (100%), hypertension (38%), hypotension (46%), hypoglycemia (41%) and hyperglycemia (43%) (Table 3). Fakherpour *et al*., found HTN (71%), hypotension (41%), hypothyroid (44%), High SBP (31%), High DBP (45%) [29]. D.A Bani Han *et al*., found mother sugar before delivery was 93.4 ± 1.1 (mg/dL) [30].

The mean blood glucose level was significantly lower in SA (80.9 ±17.7) compared to GA (121.1± 17.4) after one hour of surgery. The mean of mother's perioperative difference was significantly lower in SA(4.0 ± 0.19) compared to GA(9.4 ± 0.21) (Table 4). D.A Bani Han *et al*., found that pre-operative maternal blood sugar was significantly higher in women who underwent general anesthesia 100.8 mg/dL in comparison with women who underwent spinal anesthesia 83.6 ± 1.5 mg/dL. Also, the post-operative readings were significantly higher in the GA group with a mean sugar level of 110.1 mg/dL and a mean sugar level in the SA group of 87.7 mg/dL. Moreover, the perioperative difference in the sugar level was significantly higher in the GA group [30].

In this study, the effects of general and spinal anesthesia on variations in blood glucose levels following caesarean section in diabetic patients were compared. Although mean blood glucose levels significantly increased proportionally during surgery in both groups, general anesthesia had a far greater impact than spinal anesthesia. These findings of our study suggest that spinal anesthesia is superior to general anesthesia in reducing the hyperglycemic reaction following cesarean section surgery.

Limitations of the study

Our study was a single centre study. We found only a few effects because of our short study period. There are more adverse effects like renal failure, fatigue, nausea, infection needs to be determined & evaluated. After completing the surgery of these patients, we did not follow-up them for a long term and have not known other possible interference that may happen in the long term with these women.

CONCLUSION AND RECOMMENDATIONS

In our study, we compared the effects between SA & GA and found that there was a significant proportional increase in mean blood glucose concentrations from glucose-check timing with both general anesthesia and spinal anesthesia. General anaesthetic had a substantially higher influence on blood glucose concentrations than spinal anesthesia, indicating that the hormonal stress response is much greater in general anesthesia than in spinal anesthesia. Therefore, it is concluded that SA had a lower effect on the glycemic response during cesarean surgery in diabetic patients.

So further study with a prospective and longitudinal study design needs to be done to identify more adverse effects of different anesthesia in diabetic women to ensure pain relief and prevent mortality.

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