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Original Article

Anaesthesia Section

The Correlation between Body Mass Index and Vasopressor Need after Spinal Anaesthesia for Cesarean Section

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ABSTRACT

Introduction: Hypotension is one of the common complications of spinal anaesthesia in mothers undergoing cesarean delivery. Vasopressor such as ephedrine or phenylephrine are the most common drugs employed to treat hypotension induced by spinal anaesthesia. Obese women have a limited physiological reserve and usually show remarkably greater complications of pregnancy and anaesthesia.

Aim: To compare the requirement of vasopressor therapy for spinal anaesthesia-induced hypotension, between parturients with BMI ≥30 kg/m^2 and those with BMI <30 kg/m^2 in cesarean section.

Materials and Methods: The study population included 160 healthy singleton pregnant women aged between 18 and 40 years of age with term pregnancy who underwent elective cesarean section with spinal anaesthesia. Spinal anaesthesia was performed, using 10 mg of hyperbaric bupivacaine 0.5% plus 10 µg of fentanyl. Any fall of >20% in Mean Arterial Pressure (MAP) or reduction of systolic blood pressure below 100 mmHg was considered as hypotension; it was treated with intravascular fluid, ephedrine, or phenylephrine. At the end of the study, the participants were divided, based on their Body Mass Index (BMI), into normal and obese groups (BMI <30 kg/m^2 or ≥30 kg/m^2, respectively). Using SPSS statistical software, authors compared numbers of hypotension episode, need for vasopressor, and newborn status between the two groups.

Results: The mean±SD BMI of all patients was 33.24±5.73 kg/m^2. In 51 mothers (31.9%), the BMI was below 30 kg/m^2 and mean±SD BMI was 27.24±2.24 kg/m^2. In 109 mothers (68.1%), the BMI was ≥30 kg/m^2 and mean±SD BMI was 36.11±4.54 kg/m^2. In 126 (79.7%) cases, the main indication for cesarean section was a previous experience of cesarean child-birth. Spinal anaesthesia failed in two cases (with BMI ≥30 kg/m^2) and was changed to general anaesthesia. These mothers were excluded from the study, and the data were obtained from 158 cases. Intraoperative fluid requirement and blood loss were similar in normal and obese mothers. Hypotension rate was similar; however, in the majority of the cases, MAP was low in obese mothers. Ephedrine was administered more frequently and with high doses in obese mothers. Phenylephrine was employed in the similar manner. The newborn Apgar scores and umbilical cord acidosis rate were similar in both the groups.

Conclusion: It was found that the fall in arterial blood pressure was more severe in obese mothers after spinal anaesthesia. Vasopressor was required more frequently and in high doses in these obese mothers. Furthermore, a good newborn outcome can be delivered with appropriate haemodynamic management.

Keywords: Cesarean delivery, Maternal hypotension, Neuraxial anaesthesia, Obesity

INTRODUCTION

Obesity is a pandemic disease that is more prevalent in females than in males. (Organisation, 2000 #8) [1]. A report In 2007-2008 estimated the prevalence of obesity (BMI ≥30 kg/m^2) in adults as 33.8% overall; 32.2% among men, and 35.5% among women. In this report, the estimated prevalence of overweight and obesity combined (BMI≥25) was 68.0% [2]. Maternal mortality is increasing due to obesity; its complications include hypotension, diabetes, respiratory disease, thromboembolism, and cardiomyopathy, and the higher incidence of the need for cesarean section [3-6]. Obesity and cesarean section are considered as independent factors for maternal morbidity and mortality [7,8].

Neuraxial anaesthesia, owing to lower morbidity and mortality rates, is regarded as the most prevalent method of anaesthesia selected for caesarean section. Hypotension after neuraxial anaesthesia is one of the widespread complications with an approximate prevalence of 15-33% in the general population, which is closely associated with morbidity and mortality [9]. Therefore, maternal treatment and early intervention are necessary steps to take in order to prevent secondary fetal damage resulting from maternal hypotension [10]. Despite applying different treatment methods such as the use of crystalloid and colloid and the avoidance of aortocaval compression, approximately 40-60% of patients still need to use vasopressor agents such as phenylephrine or ephedrine [11].

Sympathomimetic agents such as ephedrine (5-10 mg), with positive inotrope effects and venous contraction, are utilised as the first-line treatment in order to maintain blood pressure during the initial minutes after spinal anaesthesia [12]. Rodrigues FR and Brandão MJN studied the techniques of local anaesthesia in 350 obese women undergoing a cesarean section. In their research, approximately 25% of the patients had hypotension during cesarean delivery [5]. They reported that the incidence of hypotension is strongly associated with the increased BMI [5]. In another study conducted by Siddiqui KM et al., it was indicated that adjustment of the dose of bupivacaine with patient's height and weight reduces the maternal hypotension rate and need for ephedrine in spinal anaesthesia for cesarean section [13].

Due to the growing number of obese pregnant women who need cesarean section delivery and high incidence of hypotension after spinal anaesthesia in these parturient and the inadequate researches in this field, authors conducted the present study to compare the need of vasopressor therapy after spinal anaesthesia for cesarean section in obese and non-obese parturients.

MATERIALS AND METHODS

This prospective comparative cross-sectional study performed from June 2016 to September 2016 in a referral university gynaecological hospital. Initially, the pilot study with 10 mothers showed a 4/6 ratio of

non-obese to obese mothers. Thus, the sample size was calculated considering Type I error probability 5%, power of study 80%, the ratio of non-obese to obese subjects 1:2 and an increase to need for vasopressor from 25% to 50% in obese mothers comparing to non-obese mothers (n=42). After the approval of the local Institute Ethics Committee, written informed consent obtained from all of the patients. Finally, 160 healthy full-term singletons pregnant ASA Class I women aged 18-40-year-old who were candidates for elective cesarean section under spinal anaesthesia, were studied. The mothers who had the following conditions were excluded from the study: emergency cesarean delivery, hypertensive disorder of pregnancy, any absolute contraindication to spinal anaesthesia, and any co-morbid underlying diseases (cardiac, respiratory, hepatic, etc.,).

Initially, 4-6 litres per minute of supplementary oxygen was started, using a nasal cannula; afterwards, standard monitoring, including Non-Invasive Blood Pressure (NIBP), ECG, and pulse oximetry were applied to the Patients. A wide bore 18 G Intravenous (IV) catheter was then inserted, and all patients received 10-15 mL/kg of dextrose-free crystalloid solution in 15-20 minutes. First, the skin was infiltrated with lidocaine 1%, using a fine insulin needle. Then, spinal block was performed with 10 mg of hyperbaric bupivacaine 0.5% plus 10 μg of fentanyl (total volume of 2.1 mL) which was injected at 5-10 seconds. The block was performed in the sitting position, using the midline approach with a 25 G Quincke needle at the L2-3 or L3-4 intervertebral space. The patients were immediately lied down in the supine position with mild elevation of their left buttocks by using a small pillow and surgical table rotation. Oxygen 4-6 litres/minute was given through the venti mask until the end of the surgery. The level of sensory block was considered appropriate at T5-6 and assessed by response to cold sensation by alcohol swab. The maternal haemodynamic parameters {arterial Blood Pressure (BP), Heart Rate (HR) and peripheral blood oxygen saturation (SpO2)} were monitored every two minutes until delivery or up to the 10th minute after the block and then every five minutes until the end of the operation.

Hypotension was defined as a reduction of more than 20% in baseline MAP or systolic blood pressure <100 mmHg [15,16]. Any episode of hypotension was initially managed with rapid infusion of 250 mL of crystalloid solution. If it persisted, it was managed with intermittent IV bolus of ephedrine 5-10 mg (if HR<70 bpm) or phenylephrine 50-200 ug (if HR≥70 bpm). Amount of the intraoperative blood loss at the end of the surgery was estimated as follows: the amount of blood absorbed in the sponges used (weight of wet sponges minus the same number of dry sponges by translating g to mL) plus suctioned blood volume (irrigation volume in canisters minus the irrigation solution volume used).

The following data were recorded: demographic information and calculated BMI, baseline HR, MAP, and SpO2 were recorded every two minutes until delivery or up to the 10th minute after block and then every five minutes until the surgery ended. Episodes of hypotension, I.V. fluid volume, numbers and total doses of vasopressor administered, total amount of calculated intraoperative bleeding, the newborn acidosis (pH≤7.15), and Apgar score at the first and fifth minutes. Moreover, any intraoperative complication (such as nausea/vomiting, restlessness, loss of consciousness, respiratory depression, and visceral or somatic pain) were recorded.

At the end of the surgery, the patients were transferred to the post anaesthesia care unit. Additionally, subsequent to stabilisation of haemodynamic status and regression of sensory and motor block below the dermatome of T12, they were transferred to the ward.

STATISTICAL ANALYSIS

The statistical analysis was done using SPSS statistical software version 16.0. The mothers were allocated into two groups based on their calculated BMI: the normal control group with BMI <30 kg/m^2 and the study group with BMI ≥30 kg/m^2. Continuous data (age, weight, height, BMI, MAP, HR, prescribed serum volume, bleeding volume, and total dosage used) were first tested by Kolmogorov-Smirnov test for normal distribution and then were compared between both groups, using independent Student's t-test. Categorical data (numbers of ephedrine and Phenylephrine administration, numbers of hypotension episode, and complication rate) were analysed by χ^2 test and Fisher's-exact test. The continuous and categorical data were expressed as mean±SD or frequency (%), respectively. Haemodynamic changes in both groups were examined and compared, using repeated measures of ANOVA test. All comparisons were made by considering two tail tests. p-value <0.05 was considered statistically significant.

RESULTS

During a three-month period, 160 healthy full-term singleton pregnant women were enrolled in this study. In 51 mothers (31.9%), the BMI was below 30 kg/m^2. In 109 mothers (68.1%), the BMI was ≥30 kg/m^2. Two mothers from the obese group were excluded from the study due to the conversion of the regional anaesthesia to general anaesthesia because of failed spinal anaesthesia.

The [Table/Fig-1] indicates the demographic and basic preoperative data. Both groups were similar in terms of their age; however, obese patients were shorter in stature (p-value=0.002) and had more previous history of pregnancy (p-value=0.016). The duration of surgery was same in the two groups. Basic MAP, heart rate, and SpO2 were similar in both groups. The mean (SD) BMI of all patients was 33.24 (5.73) kg/m^2. In the normal and obese groups, it was 27.24 (2.24) and 36.11 (4.54) kg/m^2, respectively. In the majority of the mothers (79.7%), the main indication of cesarean section was the previous experience of cesarean childbirth. The chi-square or fisher's-exact tests revealed similar indications of cesarean section in both groups [Table/Fig-1].

Variables		BMI group		Total (N=158)	p-value*
		BMI <30 kg/m^2 (N=51)	BMI ≥30 kg/m^2 (N=107)		
Age (y) [mean±SD]		31.84±7.316	32.22±6.850	32.10±6.983	0.751
Height (cm) [mean±SD]		164.89±6.414	161.52±6.001	162.61±6.317	0.002†
BMI (kg/m^2) [mean±SD]		27.24±2.24	36.11±4.54	33.24±5.73	---
Number of pregnancy		2.08±1.060	2.55±1.176	2.40±1.158	0.016†
Reason for cesarean section	Previous history n (%)	37 (72.6%)	89 (83.1%)	126 (79.7%)	0.124
	CPD n (%)	3 (5.9%)	8 (7.5%)	11 (7.0%)	
	Breach presentation n (%)	3 (5.9%)	6 (5.6%)	9 (5.7%)	
	Dilation arrest	2 (3.9%)	2 (1.9%)	4 (2.5%)	
	Sustained FHR decrease	4 (7.8%)	2 (1.9%)	6 (3.8%)	
	Uterus myoma n (%)	2 (3.9%)	0 (0%)	2 (1.3%)	
Baseline heart rate (beat per minute)		92.85±15.069	97.50±16.454	96.00±16.120	0.090
Basic MAP (mmHg)		101.12±12.260	99.12±11.477	99.77±11.734	0.317
Baseline SpO2 (%)		98.20±1.533	98.13±1.479	98.15±1.492	0.797
Duration of surgery (minute)		61.61±10.87	64.09±9.56	63.29±10.04	0.146

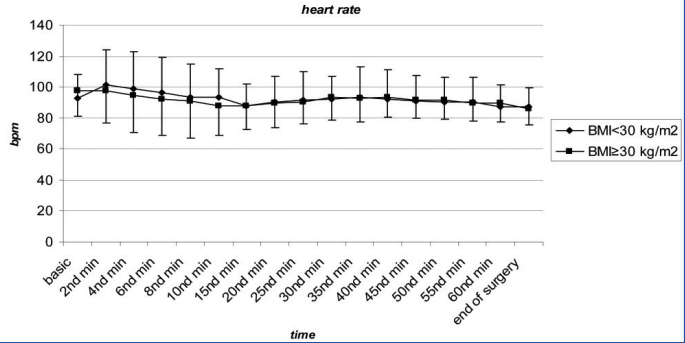
[Table/Fig-1]: Demographic and basic preoperative data of the mothers and their BMI values.
BMI: Body mass index; CPD: Cephalopelvic disproportion; MAP: Mean arterial pressure
*The student t-test and χ^2 or Fisher's-exact tests were used for continuous and categorical variables comparison, respectively.
†Obese patients were shorter in stature and had more history of pregnancy.

The [Table/Fig-2] depicts the mother's intraoperative characteristics based on their BMI values. The intraoperative fluid administered and the blood loss was similar in both groups. The numbers of hypotension episode (defined as a fall of 20% in baseline MAP or SPB <100 mmHg) was similar in both groups (p-value=0.361). The complication rate (not including hypotension) was high in obese mothers; this was mainly due to high nausea/vomiting rate in this group [Table/Fig-2]. Twelve patients had more than one complication.

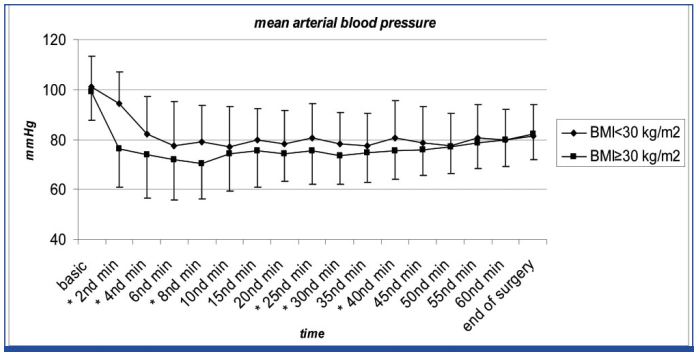
[Table/Fig-3-5] presents the trend of heart rate, mean arterial blood pressure and SpO2 at various periods. The heart rate at all times was similar in the two groups; however, at the 2nd, 4th, 8th, 25th, 30th, and 40th minutes after spinal anaesthesia, MAP was low in patients with BMI ≥30 kg/m^2. The numbers of the needs for phenylephrine administration and the total amount used were similar; nevertheless, both of the needs for ephedrine administration and the total amount of the drug used were high in obese mothers (p-value=0.042 and 0.049, respectively). At the 10th, 20th, 25th, 35th, 40th, 45th, 50th, 60th minutes and at the end of surgery after spinal anaesthesia, the SpO2 was low in patients with BMI ≥30 kg/m^2.

Variables		BMI group		Total (N=158)	p-value*
		BMI <30 kg/m^2 (N=51)	BMI ≥30 kg/m^2 (N=107)		
Intraoperative fluid (mL) {mean±SD}		2386.27± 370.281	2420.09± 337.853	2409.18± 347.825	0.569
Intraoperative bleeding (mL) {mean±SD}		776.47± 159.171	794.86± 164.823	788.92± 162.742	0.508
Hypotension rate n (%)		33 (64.7%)	77 (72.0%)	110 (69.6%)	0.361
Total dose of ephedrine (mg) {mean±SD}		4.02±6.326	6.31±6.982	5.57±6.842	0.049†
Total dose of phenylephrine (µg) {mean±SD}		1.96±9.802	6.54±16.941	5.06±15.132	0.075
Mothers requiring ephedrine administration n (%)		21 (41.2%)	63 (58.9%)	84 (53.2%)	0.042†
Mothers requiring phenylephrine administration n (%)		2 (3.9%)	14 (13.1%)	16 (10.1%)	0.093
Mothers with complications n (%)		10 (19.6%)	38 (35.5%)	48 (30.4%)	0.03†
Complications n (%)‡	Nausea/ vomiting	6 (11.8%)	36 (33.6%)	42 (26.6%)	0.002†
	Agitation/ restlessness	4 (7.8%)	3 (2.8%)	7 (4.4%)	0.152
	Pale lips	0 (0%)	7 (6.5%)	7 (4.4%)	0.061
	Respiratory depression	0 (0%)	3 (2.8%)	3 (1.9%)	0.308

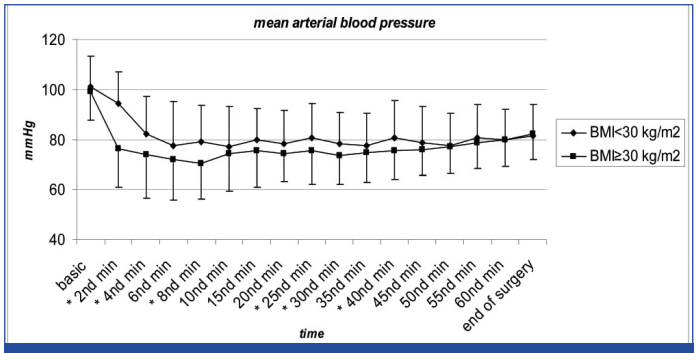
[Table/Fig-2]: The mother's intraoperative characteristics based on their BMI values.
BMI: Body mass index; hypotension defined as a fall of 20% in baseline MAP or SPB <100 mmHg
*The student t-test and χ^2 or Fisher's-exact tests were used for continuous and categorical variables comparison, respectively; †Significant difference between both groups; ‡Twelve patients had more than one complication



[Table/Fig-3]: Heart rate trend at various time laps of the study period based on the mother's BMI values.
*The heart rate was the same in both groups throughout the study



[Table/Fig-4]: The trend of mean arterial blood pressure (MAP) at various time laps of the study period in the mothers based on their BMI values.
*At the 2nd, 4th, 8th, 25th, 30th, and 40th minutes after spinal anaesthesia, MAP was low in patients with BMI ≥30 kg/m^2



[Table/Fig-5]: The trend of SpO2 at various time laps of the study period in the mothers based on their BMI values.
*At the 10th, 20th, 25th, 35th, 40th, 45th, 50th, 60th minutes and at the end of surgery after spinal anaesthesia, SpO2 was low in patients with BMI ≥30 kg/m^2

The [Table/Fig-6] demonstrates the newborn characteristics. The Apgar score of the first and the fifth minutes was similar. The pH, PO_2, and PCO_2 values were not different because of the same incidence of the newborn acidosis (pH ≤7.15); however, the HCO3- was low, and base excess was more deficient in obese mothers.

		BMI group		Total (N=158)	p-value*
		BMI<30 kg/m2 (N=51)	BMI≥30 kg/m2 (N=107)		
Apgar score (1stmin)		8.69±.616	8.75±.551	8.73±.572	0.530
Apgar score (5th min)		9.73±.827	9.82±.430	9.79±.587	0.333
Newborn arterial blood gas parameters	pH	7.2637± .05272	7.2536± .07202	7.2568±.06641	0.370
	PO_2 (mmHg) {mean±SD}	20.77± 11.219	24.02±9.911	22.97±10.427	0.067
	PCO_2 (mmHg) mean±SD {mean±SD}	47.84± 12.161	48.17± 11.934	48.06±11.970	0.873
	Hco3- meq/lit	22.3412± 3.50931	20.4290± 3.99566	21.0462± 3.93771	0.040†
	Base excess (meq/lit) {mean±SD}	-4.586± 2.9824	-6.219± 4.0165	-5.692±3.7830	0.011†
Incidence of acidosis (pH≤7.15) n (%)		1 (2.0%)	11 (10.3%)	12 (7.6%)	0.105

[Table/Fig-6]: The newborns characteristics based on their mothers' BMI values.
* The student t-test and χ^2 or Fisher's-exact tests were used for continuous and categorical variables comparison, respectively.
†Significant difference between the two groups.

DISCUSSION

The present study compared the rate of fall in the MAP in obese (BMI ≥30 kg/m^2) pregnant mothers after spinal anaesthesia with normal (BMI <30 kg/m^2) mothers. They were candidates for

cesarean section; the fall in the MAP in most cases was more severe in obese mothers. In support of this finding, Rodrigues FR and Brandão MJN found a relationship between the incidence of hypotension and an increase in BMI as they reviewed the neuraxial anaesthesia in obese women undergoing cesarean section [5,14,15]. Furthermore, Rodrigues FR and Brandão MJN reported a direct correlation between the incidence of excessive bleeding and patient's BMI. In the present study, the need for intravascular fluid and the rate of bleeding were similar in normal and obese mothers. This discrepancy may be due to the higher heterogeneity in anaesthetic management in the study done by Rodrigues FR and Brandão MJN [5]. The study conducted by Nani FS and Torres MLA revealed that hypotension occurred more often in patients with high pre-gestational BMI (BMI ≥25 kg/m^2) and they usually require higher doses of vasopressor [9,16]. They concluded that the cause of this hypotension in obese women, in comparison with the normal-weight women, is multifactorial. Nonetheless, the two main mechanisms justifying this low pressure are anatomic distortion and insufficient preload volume [9].

In the obese pregnant women near term pregnancy, an increase in the intra-abdominal pressure will increase the pressure on the vena cava and reduce the volume of the epidural space. Increase in the pressure consequently reduces the required dose of local anaesthetic. In addition, due to the incresed intravascular volume and cardiac output in obese pregnant women as compared to women with normal BMI, inadequate volumetric preload in these women can lead to hypotension during cesarean delivery [17]. The present study illustrated that there is a statistically significant difference between the normal and overweight groups with respect to the number of needs for vasopressor injection. The total dose of ephedrine was significantly higher in the overweight group. There was no statistically significant difference between the two groups regarding the need for phenylephrine. Siddiqui KM et al., compared the dosage of bupivacaine in spinal anaesthesia based on height and weight versus height alone [13]. The study, designed according to the UK obstaetric anaesthetic practice, using fixed doses of bupivacaine [14]. Authors of the study wanted to assess the correlation between BMI and the need for vasopressor, thus used fixed doses of bupivacaine. Recently some investigators have presented phenylephrine as a safer vasopressor than ephedrine; however, there is no general agreement on this subject [18]. Phenylephrine is not the front-line vasopressor for hypotension treatment in cesarean delivery, and ephedrine is usually the routine and effective selection [19]. This practice may be the reason for the present finding with regards to phenylephrine. To some extent, present finding supports the study carried out by Nani FS and Torres MLA on the relationship between pre-gestational obesity and maternal hypotension after spinal anaesthesia for cesarean section. They reported the high hypotension rate and further need for vasopressor in these women [9]. Wanyama DJN et al., reported the similar finding for obese women (BMI >25 kg/m^2) in cesarean section with spinal anaesthesia. They concluded that in obese women, the hypotension is more severe, necessitating higher vasopressor consumption [17]. In supporting of present finding, Wanyama JN et al., reported the similar need for intravascular fluid administration.

In addition to haemodynamic effects, present study indicated some aspects of the newborns' status. Generally, obesity did not have any adverse effect on Apgar score in the first or the fifth minute; the rate of umbilical acidosis was similar in both groups. However, HCO3-was low, and base excess was more deficient in the obese mother's newborn. This may point to the more severe stress (mother's hypotension) on these mother's newborn babies. These results, together with the data obtained from the previous studies, suggest that high BMI is a risk factor for the hypotension in the pregnant women who are under spinal anaesthesia [20].

LIMITATION

Although, authors used the fixed dosed method; however, it is a common recommendation to adjust the dose according to patient height. In the present study, the obese pregnant women were shorter in stature. However, this difference can be a source of bias in final conclusion but considering the significant changes in body size and shape (e.g., increased lordosis and stature loss) across pregnancy is important [16,21-23]. The severity of these changes may be affected by pre and intra-pregnancy habits and physical activity. Thus, however it has not been proved, the shorter stature may be the result of extra obesity. Finally, it can be an important limitation of the present study; however the pre-pregnancy height may resolve this problem.

These results reveal that the standard anaesthesia measures taken for the women with normal BMI cannot be generalised to obese women. Maybe the reduction of the dose of local anaesthetic drugs with some prophylactic measures for these women could prevent severe hypotension. Although these prophylactic measures usually assist us, the most powerful intervention is to treat maternal hypotension rapidly and effectively during spinal anaesthesia for cesarean section [24,25]. The relatively small size of studied sample is another limitation.

CONCLUSION

Obesity is a risk factor for the hypotension in pregnant mothers after spinal anaesthesia. The fall in the arterial blood pressure is extremely severe, and vasopressor is required in high doses and more frequently. However, a good newborn outcome can be delivered through appropriate haemodynamic management.

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