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The Influence Of Body Mass Index On Sensorimotor Block And Vasopressor Requirement During Spinal Anesthesia In Pregnant Women Undergoing Elective Ceasarean Delivery.

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Abstract

Background: Management of obese parturient for cesarean section requires special anesthesia considerations. A subject of debate in obstetric anesthesia is whether local anesthetic dose should be reduced in obese parturient for spinal anesthesia. This prospective observational study was designed to assess the influence of obesity (class I and II) as assessed by body mass index on block height and vasopressor requirement in parturients undergoing cesarean section under spinal anesthesia.

Aims And Objectives: The primary outcomes were to assess the effect of BMI on sensory block height and total vasopressor dose required after spinal anesthesia. Secondary outcomes were changes in peak expiratory flow and time of regression of block, neonatal APGAR scores.

Materials And Methods: Study Design: Prospective observational study. Participants: Two groups of 30 parturients, Group 1 (BMI 25-29.9 kg/m^2) and Group 2 (BMI 30-39.9 kg/m^2) requiring elective caesarean delivery were recruited. Morbid obese parturients (BMI >40 kg/$m^{2)}$ were excluded from the study. Methodology: All participants received 12.5 mg of intrathecal hyperbaric bupivacaine co-administered with 25 micrograms of fentanyl. Dermatomal levels were assessed at 5 min and 30 min after spinal anesthesia and at completion of surgery, using light touch and cold sensation. Hemodynamic parameters were recorded at an interval of 2 min for 20 min followed by 5 min till end of surgery. Relevant time intervals, peak flow rates before and after administration of spinal anesthesia and neonatal parameters were also studied.

Results: There were no significant between group differences in median block height as assessed by touch at 5 or 30 min or by temperature at 30 min. At 5 min, there was a two dermatomal difference in median block height for loss of temperature sensation between group1 and group 2 (T7 vs T9 p value <0.05). No blocks extended to cervical dermatomes. The mean phenylephrine dose was 46.67 micrograms in group 1 and 48.25 micrograms in group 2 and therefore there was no significant difference in vasopressor requirement between the two groups.(p-value>0.05) There were no differences in mean percentage reduction in peak expiratory flow rate after spinal anesthesia. Mean surgical time was longer in group 2 than in group 1(34.03 min vs 48.53 min 48.53 min vs 34.03 min, p-value <0.05). The mean time for recovery of touch sensation to T10 was longer in group 2 than in group 1 (195.9 min vs 185.22 min p-value<0.05)). No analgesic supplementation was required in either of the

groups. Neonatal parameters (APGAR score and acid base balance) were comparable between the two groups(p-value>0.05).

Conclusion: The dose of intrathecal local anesthetic for single shot spinal anesthesia for caesarean section should not be reduced in obese (class I and II) parturients.

Keywords: Obesity, pregnancy, bupivacaine, block height, respiratory function

Introduction

Administration of anesthesia for obstetric and non-obstetric surgery during pregnancy has always been a challenge to the attending anesthesiologists. Cesarean delivery is the most common obstetric surgery in pregnancy. Physiological changes of pregnancy uniquely influence anesthesia for cesarean delivery. Providing a safe effective anesthetic technique for cesarean delivery requires a detailed understanding of the physiologic changes associated with pregnancy. Neuraxial anesthesia for cesarean delivery is preferred to general anesthesia because it minimizes the risk of failed intubation, ventilation and aspiration. In pregnant patients enhanced spread of intrathecal local anesthetic occurs due to the mechanical effect of epidural venous engorgement or alteration of the permeability of neural tissue to local anesthetics as a result of the hormonal changes in pregnancy.[1]

As the prevalence of obesity is increasing, increased number of obese patients are presenting for cesarean delivery and it is important to investigate the impact of obesity on spinal anesthesia in pregnant patients. A reduced lumbar CSF volume in the obese patients has been confirmed by magnetic resonance imaging as well as an inverse correlation between the lumbar CSF volume and the cephalad extent of the block.[2] A higher block height in parturients is associated with increased incidence of hypotension. In obese pregnant patients higher block height is associated with greater reduction in pulmonary function in comparison to non obese patients.[3]

Whether the local anesthetic dose should be further reduced in the obese parturient is still a matter of debate. Some reviews had suggested a spinal dose reduction in the morbidly obese parturient.[4] Clinical studies however, have shown variable results. Hodgkinson R et al cautioned that higher levels of epidural block should be anticipated in obese obstetrical patients in proportion to their obesity.[5]

Lamon AM observed that using standard spinal doses of hyperbaric bupivacaine (≥10.5 mg), there were greater odds of high block in those with BMI ≥50 kg/m^2.[6] Two recent investigations suggest that the median effective dose in 95% of the population (ED50) for spinal bupivacaine in obese patients is similar to that in non obese patients. Lee Y et al observed that the median effective dose in 95% of the population (ED50) for spinal bupivacaine in obese patients is similar to that in non obese patients using variable doses of 0.75% hyperbaric bupivacaine.[7,8] At present, there are no guidelines regarding the dose of hyperbaric bupivacaine for optimum anesthesia in obese parturients undergoing cesarean section spinal anesthesia. Keeping in view the inconsistent study results and lack of definitive guidelines, the present study was designed to compare the responses in terms of sensory and motor block and hemodynamic changes to an identical dose of spinal bupivacaine and fentanyl in non-obese and obese parturients.

Aims & Objectives: The primary outcomes were to study the effect of BMI on sensorimotor block and vasopressor requirement in pregnant patients undergoing cesarean delivery under spinal anesthesia. Secondary outcomes were to assess the effect of BMI on adequacy of anesthesia as measured by requirement for analgesic supplementation and conversion to general anesthesia, respiratory function, maternal side-effects such as nausea and vomiting, neonatal outcomes and APGAR scores.

Methods: This prospective observational study was conducted in the Department of Anesthesiology and Critical Care, at a tertiary care institute in North India for a period of 18 months. The study was approved by the Institute Ethical committee. Written informed consent was obtained at the time of recruitment, at least 12 hours before spinal anesthesia for elective caesarean delivery. Sixty patients were recruited with differing body mass indices to examine the influence

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of body mass index (BMI) on the responses to a specific dose of spinal bupivacaine.

Sample Size Estimation: Sample size estimation was done using G power statistical software (version 3.0.1.0; Fraz Faul Keil Uiversity, Keil, Germay). It was estimated that the minimum sample size required to achieve statistical significance of 0.05 and 90% power was 30. As two groups were studied, a total of 60 patients were taken for the study.

One group comprised women with BMI 25-29.9 kg/m^2 (group 1) and the other group comprised BMI of 30-39.9 kg/m^2 (group 2). Patients were grouped considering their weight and height at the time of their first antenatal visit and were weighed again a day before surgery. Patients with ASA Class II, gestational age 37 completed weeks, singleton pregnancy scheduled for elective caesarean section were included in the study

Patients with BMI $\geq$ 40Kg/m^2, patient refusal, failed spinal anesthesia, any contraindication to spinal anesthesia, multiple pregnancy, urgent or emergency caesarean section, gestational age < 37 completed weeks, patients in whom obstetric haemorrhage was likely, i.e more than 2 previous caesarean sections, placenta previa, labour, inability to understand the procedure for testing for dermatome height of the neuraxial block were excluded from the study.

Pre-anesthetic visit was done one day prior to day of surgery. Testing procedures to determine the dermatome level of the neuraxial block using the modalities of touch and cold sensation were explained to the patients. BMI was measured and patient was advised fasting for 8 hours. On the day of surgery, antibiotic as per hospital protocol, inj metaclopromide 10 mg i.v. and inj ranitidine 50 mg i.v. were given 1 hour prior to surgery. On arrival in the operating room, intravenous access using 18 G i.v. canula was secured. Standard monitoring was applied, consisting of 3-lead electrocardiogram (ECG), arterial oxygen saturation (SPO_2), and noninvasive blood pressure (NIBP) monitoring. An appropriate sized blood pressure cuff for NIBP measurements was applied to the upper arm, allowing only enough room for 1 finger to be inserted between the cuff and skin.

All patients were co-loaded with 20ml/kg of crystalloids. Spinal anesthesia was administered using aseptic technique with the patient in the sitting position using 27 G spinal needle at L4-L5 intervertebral space. Subarachnoid injection consisted of 2.5 ml (12.5mg) hyperbaric, 0.5% bupivacaine, and 25 micrograms of fentanyl within 15 seconds. The patient was immediately turned to supine horizontal position with a wedge placed under the right flank to achieve 15 degree left lateral tilt. Bilateral sensory block height to pin prick was assessed in the midclavicular line according to Hollmen scale[9] (0=an ability to appreciate a pin prick as sharp;1=the perception of a pinprick in blocked areas as less sharp than in unblocked areas; 2=the perception of a pinprick as a touch but not as sharp - analgesia; 3= an inability to feel a pinprick-anesthesia).Motor blockade was assessed according to modified Bromage's scale [10]:1-complete block(unable to move feet or knees); 2-almost complete block(able to move feet only) ;3-Partial block(just able to move knees) ;4-Detectable weakness of hip flexion(between scores 3 and 5) ;5-No detectable weakness of hip flexion while supine(full flexion of knees); 6- able to perform partial knee bend

The attending anesthesiologist assessed the sensory and motor blockade in all cases, at 5, 10,15,20,30,40,50,60 minutes after subarachnoid injection and then continued at 30 min interval until skin sensation at L1 returned to normal. A peak flow meter was used to assess the effect of spinal anesthesia on respiratory function. Peak flow reading was taken in the admission area of the operating room, with the patient in the supine/wedged position (baseline), and again 30 minutes after subarachnoid injection.

Hemodynamic data including heart rate (HR), systolic, diastolic, and mean arterial pressure (SBP, DBP and MAP), were recorded after every 2 minute interval up to 20 minutes after spinal anesthesia followed by 5 minutes interval till the end of surgery. Hypotension was defined as a 20% decrease from baseline systolic blood pressure (SBP) and was treated with i.v. phenylephrine 50 µg. A 30% decrease in SBP, or failure to restore SBP to within 20% of baseline value within the first minute after the administration of 50 µg, was treated with another bolus dose of phenylephrine. Heart rate<55 beats per minute in association with hypotension (SBP decrease by 30% from baseline), was treated with

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ephedrine 5 mg, followed by atropine 0.25–0.5 mg if bradycardia persisted. Cumulative doses of phenylephrine and ephedrine were recorded at the time of delivery, exactly 30 minutes after subarachnoid block injection, and at the time of completed skin closure. Time from arrival in theatre until induction of anaesthesia, time to peak sensory block level, induction to uterine incision time, uterine incision to delivery time and skin incision to closure were noted. Blood loss was estimated in a graded suction bottle and by observation of absorbent material. Neonatal outcome was studied by APGAR score. Umblical cord sample were taken to see neonatal partial pressure of oxygen (PaO_2), partial pressure of carbon dioxide ($PaCO_2$), bicarbonate levels (HCO_3^-) and base excess. Adequacy of Spinal anesthesia was scaled as follows: Grade 1: No supplementation required. Grade 2: Analgesic supplementation required Grade 3: Conversion to general anesthesia required. Any maternal side effects like nausea, vomiting, pain etc. were noted.

Statistical Methods: The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and the data was analysed statistically with the help of statistical software SPSS. All the continuous variables were expressed as Mean + SD and categorical variables were expressed in terms of frequency and percentage. Group comparison was done by using Student t test. Also, the categorical variables were analysed with the help of Chi square, Mann-whitney U test and Fisher's Exact test. Graphically data was presented by bar diagrams, scatter diagrams and line diagrams. All the results were discussed on 5% level of significance i.e p value less than 0.05 was considered significant.

Results: The groups were comparable with respect to age, height and gestational age[Table 1]. There was statistically significant difference between the two groups with respect to weight and BMI [Table 1].

The baseline heart rate (HR) was comparable in two groups. The percentage change in HR from baseline in group 1(non obese) after spinal anesthesia was between 0.1%-10% and in group 2 was 0.2%-11%. (p-value>0.05)[Figure -1a]

Significantly higher values of mean SBP, DBP and MAP were seen in the group 2 (obese) prior to induction of spinal anesthesia. The percentage decrease in SBP from baseline in group 1 (non obese) after spinal anesthesia was between 5%-18% and in group 2 (obese) was 5%-20%. (p-value>0.05).[Figure1b] The percentage decrease DBP from baseline in group 1(non obese) after spinal anesthesia was between 14%-33%and in group 2 (obese) was 17%-33%.(p-value>0.05).[figure 1c]The percentage decrease in MAP from baseline in group 1 (non obese) after spinal anesthesia was between 10%-24% and in group 2 (obese) was 9%-23%. (p-value>0.05)[Figure 1d]]

There was statistically no significant difference in the vasopressor requirement between the two groups.[Table 4]

There was statistically significant difference seen in two groups with respect to highest level of sensory block (temperature) seen at 5 min. The highest level in group 1(non obese) was T7 and in group 2 (obese) was T9.The peak sensory block (temperature) at 30 min was statistically insignificant. The highest level of block was T3 in group 1 (non obese) and T2 in group 2 (obese). There was statistically insignificant difference seen in two groups with respect to highest level of sensory block (touch) seen at 5 min. The highest level in group 1(non obese) was T9 and in group 2 (obese) was T10. The peak sensory block (touch) at 30 min was statistically insignificant. The highest level of block was T5 in group 1(non obese) and T4 in group 2 (obese). Complete motor blockade was achieved in all the patients in both groups.[Tables 2&3]

The percentage change in peak flow rate after spinal anesthesia was comparable in two groups. The mean duration of block was longer in group 2 (obese) and it was statistically significant. Spinal anesthesia was difficult to administer in group 2 (obese) and it was reflected by statistically significant increase in time taken from arrival to needle insertion. There was statistically significant difference seen between the two groups with respect to time taken till uterine incision, baby delivery and total duration of surgery. It took longer time in group 2 (obese) than in group 1(non obese).There was statistically significant increase in blood loss seen in group 2 (obese) than in group 1(non obese).[Table 5]The neonatal outcomes measured by APGAR score, umblical cord PO_2, PCO_2, HCO_3 and base excess were comparable between the two groups.[Table 6]

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Table 1: Comparison of baseline characteristics between the two groups

Parameters	Group 1 (Non – Obese) Mean±SD	Group 2 (Obese) Mean±SD	p-value
Age (years)	29.70±3.175	30.23±1.960	0.437
Weight (Kg)	68.83±6.747	82.30±6.508	<0.001 *
Height (cm)	158.73±4.338	156.90±4.096	0.007*
BMI (Kg/m^2)	27.28±2.173	35.12±2.651	<0.001 *
Gestational age (weeks)	37.53±0.860	37.70±1.022	0.497
Heart Rate (beats/min)	94.97±13.682	94.40±17.097	0.880
SBP (mm Hg)	122.33±9.151	136.87±10.692	<0.001 *
DBP (mm Hg)	74.93±5.539	86.86±7.366	<0.001 *
MAP (mm Hg)	88.59±7.11	101.51±9.04	<0.001 *

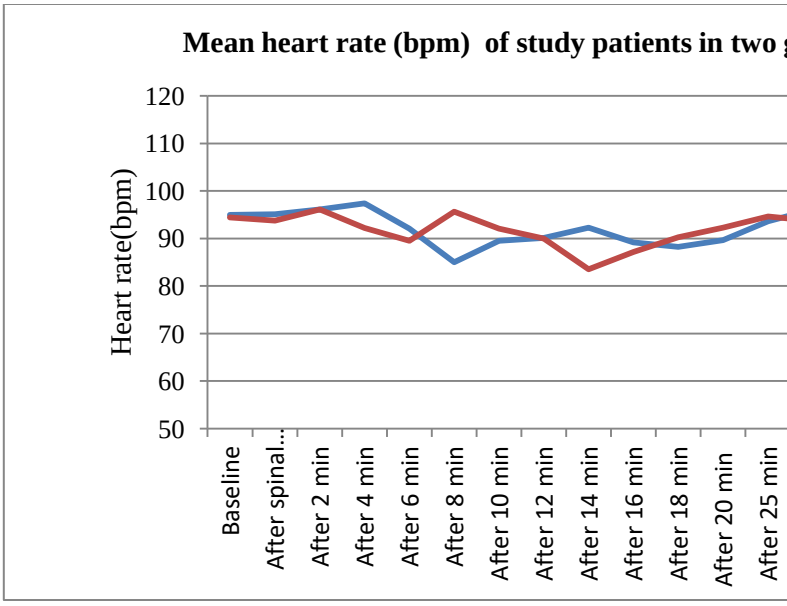

Figure 1a: Comparison of heart rate between the two groups

Figure 1b: comparison of systolic blood pressure between the two groups

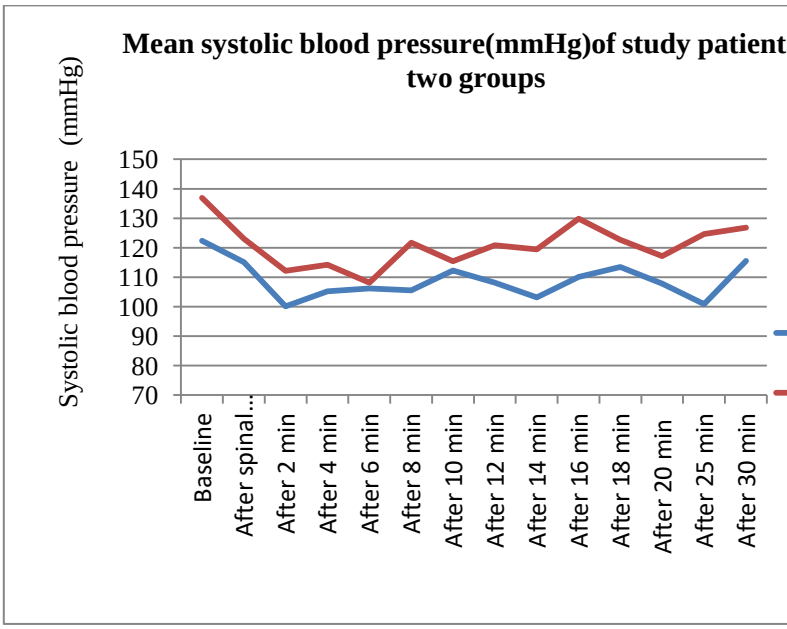

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Figure 1c: Comparison of diastolic blood pressure between the two groups

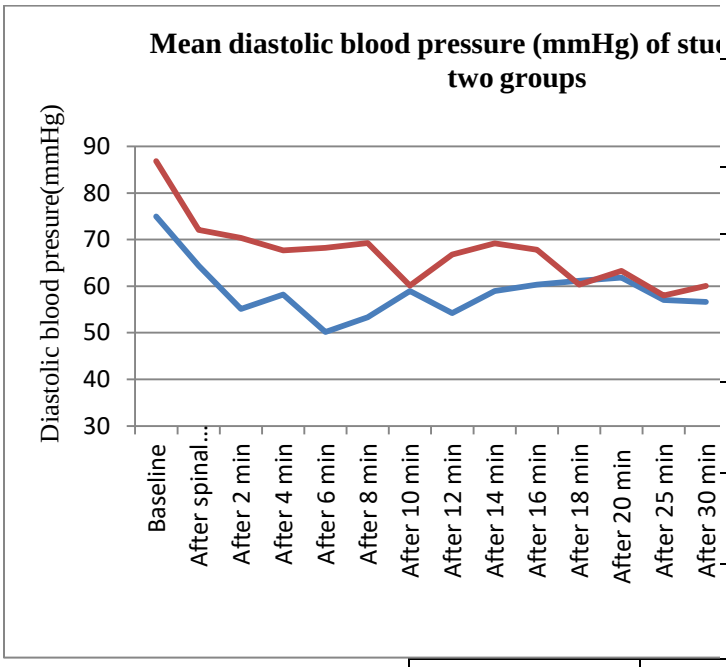

Figure 1d: Comparison of mean arterial pressure between the two groups

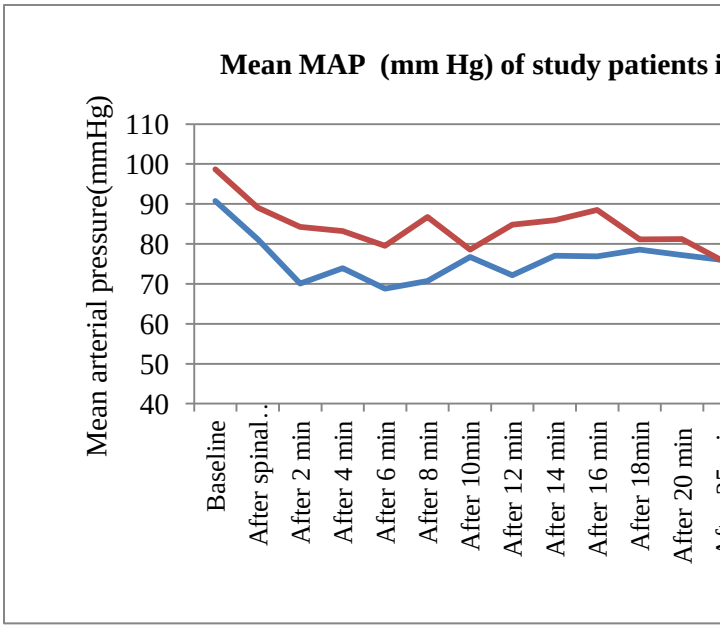

Table 2: Comparison of sensory block between the two groups

	Group 1 (Non Obese)				Group 2 (Obese)			
		Percentile					Percer	
	Range	25th	50th median	75th	Mean	Range	25th	50th medi n
	T6-T12	T 7	T8	T8	T9	T6-T12	T8	T10
	T2-T6	T2	T4	T4	T2	T2-T6	T2	T2
	T8-T12	T8	T10	T10	T10	T6-T12	T10	T10
Touch at 30 Min	T4-T6	T4	T5	T6	T4	T2-T8	T4	T4

Table 3: Comparison of sensory block between the two groups

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REGRESSION OF BLOCK	Group1 (Non-obese)					Group2 (Obese)					p-value
			Percentile					Percentile			
	Mean	Range	25th	50th median	75th	Mean	Range	25th	50th median	75th	
Time Regression block-temp to T6(min)	118.33	110-128	116	118	120	119.4	112-130	116	119	122	0.429
Time Regression block- touch toT10(min)	185.22	170-195	182	186	190	195.9	182-220	191	195	198	0.001*

Table 4 : Comparison of vasopressor requirement between two groups

Vasopressor Dose	Group 1 (Non-Obese) Mean±SD	Group 2 (Obese) Mean±SD	p-value
Phenylephrine dose(micrograms)	46.67±9.10	48.25±16.37	0.081
Ephedrine dose(mg)	17.80±7.954	17.00±9.976	0.733

Table 5: Comparison of relevant time intervals, duration of surgery, blood loss and peak flow rates between the two groups

Parameter		Group 1 (Non-Obese) Mean± SD	Group 2 (Obese) Mean± SD	p-value
Time from arrival to needle insertion(minutes)		6.57±3.66	7.67±3.65	<0.001*
Time from needle insertion to uterine incision(minutes)		9.60±1.22	16.23±5.52	0.002*
Time from uterine incision to baby delivery(seconds)		46.03±11.32	61.00±15.39	0.008*
Duration of surgery (minutes)		34.03±1.60	48.53±3.115	0.002*
Blood loss (mL)		800.00±0.00	853.33±89.95	0.003*
Peak flow rate (L/sec)	Baseline	216.00±15.22	209.33±14.08	0.211
	After spinal anesthesia	190.06±16.59	185.67±13.56	0.206

*--- statistically significant difference.

Table 6: Comparison of neonatal parameters between the two groups

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Neonatal Parameters	Group 1 (Non-Obese) Mean±SD	Group 2 (Obese) Mean±SD	p-value
APGAR score at 1 min	8.00±0.00	8.00±0.00	0.376
APGAR Score at 5 min	10.00±0.00	9.59±0.00	0.321
Umblical vein PO2 (mm Hg)	24.77±5.624	27.87±12.53	0.222
Umblical vein PCO2 (mm Hg)	43.77±5.05	40.80±8.426	0.104
Umblical vein HCO3 (mEq/L)	22.413±2.079	22.010±1.348	0.329
Base excess	-3.113±1.401	-3.433±1.006	0.312

DISCUSSION: Spinal anesthesia is a favoured anesthetic technique in cesarean section. Many factors influence CSF volume and may have a crucial effect on the intrathecal spread of drug. CSF volume is difficult to measure even with radiological imaging. Many patient variables therefore have been suggested as influencing the ultimate spread of sensory blockade following subarachnoid injection of local anesthetics. Studies investigating the relationship between patient BMI and block height in obstetrics are limited and show conflicting results.

The results of the present study suggest that BMI does not have any effect on block height in parturients during spinal anesthesia Previous studies have found conflicting results. In non-pregnant patients, no correlation was found by Pitkanen et al. in patients receiving 15 mg of isobaric or hyperbaric 0.5% bupivacaine for lower extremity orthopedic procedures.[11] A significant correlation was found by McCulloch et al. in patients receiving 20 mg of isobaric 0.5% bupivacaine for urologic procedures.[12] Norris et al studied the influence of BMI on the spread of intrathecal bupivacaine (12 mg or 15 mg) in parturients undergoing cesarean delivery and did not identify any correlation between the drug spread and the weight or BMI of the patients.[13] Patients with increased body mass index generally, but not always have a greater abdominal girth, as body shapes differ among individuals. This variability likely explains the disparate results of studies investigating the correlation between body mass index and the level of spinal anesthesia.[14,15]

The different results could also be explained by difference in baricity of solutions used in these studies. Also, the study outcome variable chosen for comparison between obese and non-obese patients could were different in the studies.. Magnetic resonance imaging of CSF volume in obese patients showed a decreased CSF volume. It was postulated that the decreased volume seen with obesity or pregnancy, may produce more extensive neuraxial blockade through diminished dilution of anesthetic. This was possibly attributed to increased intra abdominal pressure and/or raised epidural venous pressure and compression of the intrathecal space.[2,16] It was also theorized that increased extradural fat deposits in obese patients reduce CSF volume by compressing dural sac.[14] However, endoscopic observation of the epidural space reported that the amount of epidural fat did not appear to be correlated with BMI, thus negating the concept that increased epidural fat deposits in pregnant patients reduced CSF volume by compressing dural sac.[17]

The incidence of hypotension and vasopresseor requirement was similar in non-obese and obese parturients in the present study. Pregnancy is associated with some modifications which place the cardiovascular system of pregnant women under stress and when associated with obesity, it increases even more. The significant increase in cardiac output, especially during and immediately after labour, reaches upto 75% above pre pregnancy levels.[18] It exacerbates even more in the obese patient in whom for every 100g of increase in the adipose tissue the cardiac output increases by 50ml/min. Besides, reduction in after load during pregnancy is less significant in the obese patient due to an increase in peripheral vascular resistance. Besides these specific changes, some hormonal changes (hyperinsulinemia, dyslipidemia,) are exacerbated by obesity, and they can overload the cardiovascular function.[19]

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Imbalance between endogenous vasoactive substances especially a reduction in angiotensin II and increase in prostaglandins and nitric oxide are even or more important than the sympathetic blockade and aortocaval compression in the physiology of hypotension.[20] This might explain the lack of statistical significance in the number of hypotensive episodes and the severity of hypotension among obese patients, i.e. maybe aorto cava compression is less important than possible metabolic and cardiovascular alterations associated with the increased BMI.

It usually takes more time for surgery in obese patients owing to the fact, that there is increased abdominal fat, which poses great difficulty to the operating surgeon. The increase in mean duration of time of spinal anesthesia in obese patients thus, proves to be of great advantage and emphasizes the fact that the dose of intrathecal bupivacaine should not be reduced in obese parturients. The statistically significant difference in pertinent time intervals between the two groups indicate that, spinal anesthesia is more difficult to administer in obese groups. And obese patients usually have longer duration of surgeries.

This study confirmed that BMI (25-39.9 kg/m^2) doesn't have role in determining the spread of spinal anesthesia in parturients undergoing elective caesarean section particularly considering the comparable vasopressor requirements and no significant effect on respiration.

Limitations:

Blinding was not done in the study. Another limitation of the study was that the sample size was not large enough to identify any possible outliers where block might extend to cervical dermatomes. Parturients with extremely high BMI ($\geq$40kg/m^2) were not included in the study and the relationship between abdominal circumference of the parturients and block height was not studied.

Conclusion:

The authors conclude that the intrathecal dose of bupivacaine 12.5 mg and fentanyl 25 µg resulted in clinically equivalent effects in two groups of parturients with widely differing BMI (25-39.9kg/m^2). Notably the affected dermatomes did not extend to the innervation by the cervical nerve roots in either group. However, there was increased time to regression of the block and longer surgical time in obese parturients.

The authors recommend that the dose of intrathecal local anesthetic for single shot spinal anesthesia for caesarean section should not be reduced in obese patients (BMI 30-39.9kg/m^2).

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