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The Efficacy of the Volume of Hyperbaric Bupivacaine Used and Its Influence on Spinal Anaesthesia Induced Hypotension during Caesarean Section

I. U. Ilori[1*]

[1]Department of Anaesthesiology, University of Calabar / University of Calabar Teaching Hospital, Calabar, Nigeria.

Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

Aims: To audit the spinal anaesthesia practice among physician anaesthetists and to determine the lowest effective volume of hyperbaric bupivacaine that could minimise the incidence of spinal anaesthesia induced hypotension during caesarean section.
Study Design: It was a prospective observational study of patients undergoing caesarean section. Patient recruitment was by convenient sampling.
Place and Duration of Study: The study was carried out at the Obstetric theatre of the University of Calabar Teaching Hospital, Calabar, Nigeria between March and June 2015.
Methodology: One hundred and thirty one (131) patients who met the inclusion criteria were recruited for the study. Patients with antepartum haemorrhage, pregnancy-induced hypertension or patients on any antihypertensive agents and those with contraindications to spinal anaesthesia were excluded. The spinal anaesthesia was instituted at L_3 L_4 interspace in the sitting position. The maximum height of sensory block and the number of patients that were hypotensive (systolic blood pressure less than 90 mmHg) in relation to the volume of hyperbaric bupivacaine used were noted. Simple descriptive and inferential statistics was used to determine the association between the

**Corresponding author: E-mail: iniabasi25@gmail.com;*

volumes of hyperbaric bupivacaine used, the height of block and incidence of hypotension.
Results: The volumes of 0.5% hyperbaric bupivacaine used ranged from 1.5– 2.7 millilitres (mls). Sixty-eight (51.9%) patients received treatment for hypotension. The incidence of hypotension was related to volume of bupivacaine used and height of sensory block. The incidence of hypotension was more in patient that had 2 mls (62.9%). Less than 2mls was associated with lower incidence of hypotension (32.5%) but with a high risk of intraoperative analgesic requirement (22.5%). A block height below T6 was a risk factor for supplementary intraoperative analgesic requirement and above T6 risk factor for hypotension. The maximum height of sensory block did not have any significant relationship with the volume of the hyperbaric bupivacaine used, (P = 0.1).
Conclusion: Spinal anaesthesia-induced hypotension is a complication that may not be eliminated. The incidence during caesarean section in this study was influenced more by height of block than volume of the drug used. The used of 1.5 mls (7.5 mg) of 0.5% hyperbaric bupivacaine and a block height of T6 could provide adequate anaesthesia for caesarean section and reduce the incidence of hypotension.

Keywords: Spinal anaesthesia; caesarean section; volume; efficacy; height of block; hypotension.

1. INTRODUCTION

Spinal anaesthesia is becoming the main anaesthetic technique for caesarean deliveries in developing countries. The technique is attractive especially in resource poor setting where there are paucity of facilities and dearth of physician anaesthetists. It is cost effective, requires minimal equipment and easy to administer. The endpoint is certain so it can easily be taught [1]. It also avoids the problem of airway management which is a major cause of anaesthetic related maternal morbidity and mortality. Despite these advantages, a major adverse effect is hypotension, which if not treated could have grave consequences for both the mother and the baby. The reported incidence of hypotension varies depending on the definition used but could be above 80% [2,3]. Several methods have been used in an attempt to prevent its occurrence. These include the use of both physical and pharmacological methods. The most common methods being the use of intravenous fluid, both colloid and crystalloid, [4-8] vasopressors either prophylactically or therapeutically in bolus or continuous infusion, [9-11] with limited success. Recently, height adjusted dose, reduction in the volume or dose of local anaesthetic used either alone or in combination with an opioid have been reported by some authors to reduce the incidence of spinal anaesthesia induced hypotension during caesarean section [12–17]. The addition of opioid to low dose bupivacaine is reported to improve its analgesic efficacy and minimised the incidence of hypotension [18-22]. However, opioid and vasopressors are often not easily accessible especially in some developing environment. The aim of this study was to audit the spinal anaesthesia practice among physician anaesthetists in a tertiary hospital in Nigeria to determine the lowest effective volume of hyperbaric bupivacaine that could minimise the incidence of spinal anaesthesia induced hypotension during caesarean section.

2. PATIENTS AND METHODS

This was a prospective observational study. One hundred and thirty one (131) patients who met the inclusion criteria and had caesarean section under spinal anaesthesia between March and June 2015 were enrolled into the study. The sample size was calculated using the formula for comparison of means of systolic blood pressure and the percentage hypotension between the low and the conventional doses [14,20]. A minimum sample size of 18 patients for each group was needed. Both emergency and elective cases were included. The exclusion criteria were patients with antepartum haemorrhage, pregnancy-induced hypertension or patients on any antihypertensive agents, contraindications to spinal anaesthesia like coagulopathy, hypovolaemia, infection at the site of injection or generalised sepsis as well as allergy to bupivacaine.

All patients were assessed preoperatively and written informed consent obtained from all. For elective cases the patient where fasted for 6-8 hours for solid and 2 hours for clear fluids. The attending anaesthetist determined the volume of 0.5% of hyperbaric bupivacaine to be injected. This was determined based on how the anaesthetist view patient's height to be short, average or tall (personal communication) but it was not standardised. The baseline vital signs taken included systolic and diastolic blood

pressures, pulse rate and oxygen saturation. Patients were preloaded with 500 mls of 0.9% saline solution for 10 to 15 minutes. Under asepsis the spinal block was instituted at L3L4 interspace in the sitting position and the predetermined volume was injected. The patients were immediately placed horizontally in the supine position with a wedge under the right buttock for left lateral displacement of the uterus. The vital signs were immediately taken again and thereafter every 3 minutes for 15 minutes, then every 5 minutes till end of surgery. The height of block was assessed every minute for five minutes and the maximum height of sensory block in response to pin prick was noted. Spinal anaesthesia induced hypotension was taken as systolic blood pressure below 90 mmHg occurring before the delivery of the baby, that is approximately the first 15 minutes after the induction of spinal anaesthesia. Hypotension was treated with intravenous fluid and 3 mg aliquots of ephedrine or 10 ug epinephrine when ephedrine was not available. Bradycardia was taken as pulse rate of 60 or below and was treated with 0.6 mg of atropine. Descriptive and inferential statistics was used to determine the association between volumes of the hyperbaric bupivacaine used, the height of block and hypotension and is presented in tabular form as figures and percentages. Pearson correlation was used to determine if there is any association between the volume of hyperbaric bupivacaine used with the patient's height though it was not standardised. A P value of less than 0.05 was taken as significant.

3. RESULTS

A hundred and thirty-one (131) patients that met the inclusion criteria were studied. The mean age was 30.5 ± 4.6 years (yrs), range 17 – 42 yrs. Emergency cases were 84(64.1%) and elective 47(35.9%). The volume of 0.5% hyperbaric bupivacaine injected ranged from 1.5 millilitres (mls) (7.5 mg) – 2.7 mls (13.5mg). The volume of hyperbaric bupivacaine used was dependent on the anaesthetist estimation of patient height. Only 88 patients had their height measured. This is because some emergency cases did not attend routine antenatal clinic where their height could have been measured. Analysis of these 88 patients that had their height measured showed a positive correlation (0.396) with the volume of bupivacaine used having a P value of 0.000.

Table 1 shows the distribution of the volume 0.5% hyperbaric bupivacaine injected grouped into less than 2 mls (<10 mg), 2 mls (10 mg) and more than 2 mls (>10 mg). Two millilitres being the standard volume that was normally used for obstetric patients was the most frequently volume used. It was used in 70(53.4%) patients and 44(62.9%) of them received treatment for hypotension. The other variation in volumes was based on if the patient was viewed to be short stature approximately about 155 cm or less would be given less than 2 mls of bupivacaine and more than 2 mls for patient whose height were assumed to be more than 165 cm (tall). The height of those that were measured ranged from 120 cm to 176 cm. In all, 68 (51.9%) of the patients were hypotensive. The study participants that received less than two mls of bupivacaine injected had the least number of patients 13(32.5%) that were hypotensive but nine (22.5%) of them received supplementary intraoperative analgesia of 25 – 50 mg of ketamine because of intraoperative discomfort. No case, however, was converted to general anaesthesia.

A comparative analysis of the systolic blood pressure of the different volume groups showed significant difference between 2 mls and <2 mls with a P value of 0.000. The comparison between >2 mls with 2 mls and >2 mls with<2 mls gave a P value of 0.064 and 0.082 respectively.

Table 1. Efficacy and Influence of the volume of 0.5% hyperbaric Bupivacaine used on spinal anaesthesia induced hypotension

Volume of bupivaciane injected	Frequency (%)	Maximum sensory block height	Mean systolic blood pressure (mmHg)	Number hypotensive (%)	Supplementary analgesia (%)
< 2 mls(<10 mg)	40(30.5)	T4-T10	127.5	13(32.5)	9(22.5)
2 mls (10 mg)	70(53.4)	T2-T8	121.5	44(62.9)	0
>2 mls (>10 mg)	21(16.0)	T2-T8	124.6	11(52.4)	0
Total	131			68(51.9)	9(22.5%)

Table 2 shows the efficacy and the incidence of hypotension of the different volumes of less than 2 mls (10 mg) used. There was no difference in maximum sensory block in the 1.5 mls (7.5 mg) - 1.7 mls (8.5 mg) (T5). With the 1.8 mls (9 mg) the maximum sensory block extended a dermatome higher to T4. The 1.5 mls had only one out of seven of the patients that were hypotensive but with 5 of them requiring intraoperative analgesia. On the other hand, 1.8 mls had seven of 21 patients that were hypotensive with none requiring intraoperative supplementary analgesia showing that hypotension may be dependent on volume of hyperbaric bupivacaine used.

Table 3 shows the influence of the height of sensory block on incidence of hypotension. The height of block was directly related to the incidence of hypotension. It also shows that all the patients that had the maximum block height at T10 and some that had a block height of T8 and T6 received intraoperative analgesia. No patient with a height of block higher than T6 required any intraoperative supplementary analgesia.

Fig. 1 shows the distribution of the maximum sensory block in relation to volume of hyperbaric bupivacaine used. The maximum sensory block did not have any significant relationship to the volume of the hyperbaric bupivacaine used. The block height for 2 mls or more varied between T2 and T8 and for less than 2mls T4 to T10 (P = 0.1). More patients in all the groups had a maximum sensory block height of T6.

Table 4 shows that the percentage of patients that were hypotensive were more in the elective cases than the emergencies. Both the systolic and diastolic blood pressures and peripheral oxygen saturation were significantly different between the elective and emergency cases with emergency having higher values.

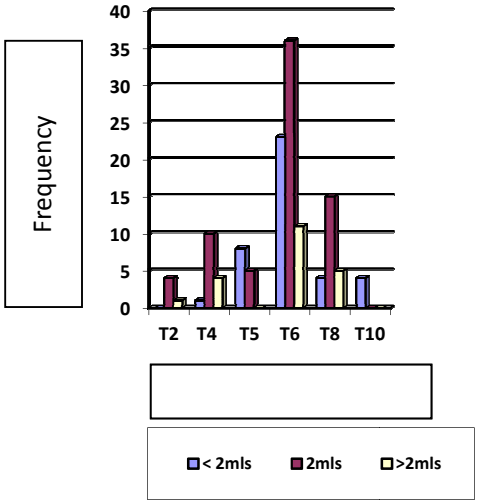

Fig. 1. Maximum height of sensory block in relation to volume

Table 2. The efficacy and the Incidence of hypotension of the different volumes of less than 2 mls (10 mg) of hyperbaric bupivacaine

Volume of bupivacaine used (mg)	Range of maximum sensory block	Total number of patients	Number hypotensive	Supplementary analgesia
1.5 mls (7.5 mg)	T5 – T10	7	1	5
1.6 mls (8 mg)	T5 – T6	8	3	2
1.7 mls (8.5 mg)	T5 –T8	4	2	2
1.8 mls (9 mg)	T4 – T6	21	7	0

Table 3. Influence of the height of sensory block on hypotension and its efficacy

Level of sensory block	No of patients	No hypotensive	Percentage hypotensive	Supplementary analgesia
T2	5	5	100	0
T4	15	12	80	0
T5	13	10	76.9	0
T6	70	36	51.4	2
T8	24	5	20	3
T10	4	0	0	4

Table 4. Comparison of haemodynamic parameters between elective and emergency cases

Parameter	Elective (%)	Emergency (%)	P value
Number of patients	47(35.9)	84(64.1)	
Number hypotensive	27(57.4%)	41(48.8)	
Mean systolic blood pressure (mmHg)	119.7	129.0	.000
Mean diastolic blood pressure	71.2	74.6	.000
Pulse rate	95.8	95.1	.660
Peripheral oxygen saturation (SpO_2)	97.9	98.0	.023

4. DISCUSSION

This study shows that hypotension occurred in all the groups with the incidence related to the volume of 0.5% hyperbaric bupivacaine used and the height of block. The percentage of patients that were hypotensive were more in patients that had more than or equal to two millilitres (mls) of hyperbaric bupivacaine 52.4% and 62.9% compared to 32.5% in patients that had less than 2 mls of the local anaesthetic agent. Obstetric patients have been reported to have a greater incidence of hypotension than the non-parturient. This is due to engorgement of the epidural veins and reduction in spinal cerebrospinal fluid (CSF) volume resulting in enhancement of local anaesthetic spread. This results in higher segmental block for an equivalent dose in non-pregnant patients [23]. It was observed that though the incidence of hypotension was related to the volume used, there was no significant difference in the mean systolic blood pressure of the different volumes except between 2 mls (10 mg) and less than 2 mls (P = 0.000,). Doses of 10 -15 mg (2-3 mls) of 0.5% hyperbaric bupivacaine have been suggested to provide adequate anaesthesia for caesarean section [17]. However, this dose is associated with a high incidence and severity of hypotension. Turhanoglu et al. [15] in a study of 20 patients each used 10 mg (2 mls) and 4 mg (0.8 ml) of hyperbaric bupivacaine and reported 100% and 75% incidence of hypotension respectively. This may have prompted a lot of research to identify the dose or volume of local anaesthetic that will provide adequate anaesthesia and minimised the incidence of spinal anaesthesia induced hypotension. Thus the concept of low dose spinal anaesthesia was evolved. Various authors have used different doses ranging from 4 mg (0.8 ml) to 10 mg (2 mls) of 0.5% hyperbaric bupivacaine as a representative of low dose spinal anaesthesia. Turhanoglu et al. [15] used 4mg though in combination with 25 ug of fentanyl while Kiran and Singal [14] studied three different doses 7.5 mg (1.5 mls), 8.75 mg (1.75 mls) and 10 mg (2 mls) of 0.5% hyperbaric bupivacaine and reported that the incidence of hypotension was more with the 8.75 mg and 10 mg group. Arzola et al. [16] in their meta-analysis used 8mg (1.6 mls) as low dose and more than 8mg as conventional dose. They concluded that low-dose bupivacaine in spinal anaesthesia reduces the incidence of hypotension but with a high grade evidence of risk of intraoperative analgesic supplementation. Similarly, Harsoor et al. [19] reported that rescue analgesia was given to 14% of the patients they studied that had 8 mg of bupivacaine for spinal. This was a similar finding in this study as all the patient that required intraoperative supplementary analgesia belong to the less than 2 mls (10 mg) group. Qiu et al. [21] in their meta-analysis reported that less than 10 mg hyperbaric bupivacaine for spinal anaesthesia decreased the incidence of intraoperative hypotension but with less satisfactory analgesia. Further analysis of less than two mls group in this study showed that in the 1.5 mls (7.5 mg) one out of seven patients were hypotensive but with five of them requiring intraoperative analgesia. On the other hand, 1.8 mls (9 mg) had seven of 21 patients that were hypotensive with none requiring any intraoperative supplementary analgesia (Table 2). Similarly, Kiran et al. [14] in their study using 7.5 mg of 0.5% hyperbaric bupivacaine reported that 6 out the 20 patients (30%) experienced intraoperative discomfort that required treatment with an analgesic though with a 20% incidence of hypotension. However, they reported that a significant number of patients that had the 7.5mg (1.5 mls) of bupivacaine required an increase head down tilt of 20° at four minutes after the spinal injection to extend the block beyond T8 (P= 0.0157). Santos et al. [1] in their study of 7.5 mg – 10 mg also reported that 18 out 22 patients studied required a 20 degree head down tilt to extend the block height above T8. In this study five out of seven patients that were given 1.5 mls (7.5 mg) dose of spinal bupivacaine, had a maximum block height of T8. This might have contributed to a smaller number of one out of seven patients receiving treatment for hypotension and also 5 of them receiving

supplementary intraoperative analgesia. On the contrary, Dhumal et al. [24] in a study of 7.5 mg (1.5 mls) of bupivacaine had a 36% incidence of hypotension and no reported incidence of supplementary intraoperative analgesia. The peak level of analgesia in their study was T6. Rucklidge et al in their editorial review wrote that defining the cut-off at which a dose can be described as 'low' is not straightforward. They further documented that an optimal dose of subarachnoid local anaesthetic is the dose in which there is no intraoperative pain which they opined to be 11 mg for hyperbaric bupivacaine. Any dose below this may be taken as low dose spinal anaesthesia [17]. This is contrary to Arzola et al. [16] recommendation of 8mg (1.6 mls) or less in their meta-analysis as low dose. In this study two millilitres (10 mg) of hyperbaric bupivacaine was the conventional dose as it was received by 70(53.4%) of the patients studied while 1.8 mls (9 mg) could be said to be the optimal dose as none of the patients that had the 1.8 mls (9 mg) of hyperbaric bupivacaine experience any intraoperative pain. However, like the 2mls it was associated with a high incidence of hypotension about 33% (7out 21 patients). Kiran et al. [14] documented a 45% incidence of hypotension with 10 mg and recommended that it should not be used because of its potential for adverse effect. They recommended the use of 7.5 mg (1.5 mls) that though associated with high incidence of intraoperative discomfort this can easily be managed with analgesic. A similar finding was observed in this study, in that the intraoperative discomfort was effectively managed with 25-50 mg of ketamine with no conversion to general anaesthesia.

Table 3 shows that all the patients that had a maximum block height at T10 and a few that had a block height of T8 and T6 received intraoperative supplementary analgesia. No patient with the block height higher than T6 required intraoperative supplementary analgesia. This is similar to Kiran et al. [14] study where the two out of the three patients that required intraoperative analgesia up to 50mg ketamine had a block height that was below T6. In Santos et al. [1] study, the patient that required intraoperative ketamine and meperidine (pethidine) had a block height of T7.

Ohpasanon et al. [25] in their study of eight hundred and seven full term pregnant women identify the level of sensory analgesia equal to or higher than T5 as a risk factor for increased incidence of hypotension. They reported a correlation of circulatory instability with higher cephalic levels of neuraxial blockade. When the level of analgesia reaches or exceeds T4, sympathetic cardio-acceleratory fibres are blocked, resulting in reductions of both venous return and systemic vascular resistance. In another study in the same hospital, Chinachoti et al. reported high dose of heavy bupivacaine (2.3 mls) and level of sensory blockage equal to or higher than T5 as modifiable risks factor for hypotension during spinal anaesthesia [26]. This was a similar finding in this study. In relation to level of sensory block, more than 75% of the participants that had a block height of equal to or higher than T5 received treatment for hypotension (Table 3). However, it was observed that there was no relationship between height of sensory block and the volume used (P = 0.1, Table 1 and Fig. 1). This could be due the varying volume of hyperbaric bupivacaine used in this study which was dependent on the height of patient based on the Anaesthetist discretion. Though, this was not standardised, analysis of the volume used compared to the height of patients showed a significant positive correlation (0.396) having a P value of 0.000. This may also have contributed for there not being any significant correlation, though positive (P = 0.1), between the volume of bupivacaine used and the height of block.

This study also reveals that the incidence of hypotension was more among elective than emergency caesarean sections. The difference in their systolic and diastolic blood pressures was significant with a P value of 0.000 with emergency having higher values (Table 4). This is in contrary to Ljubicic et al. [27] findings of no statistically difference between the systolic blood pressures of elective and emergency cases.

5. CONCLUSIONS

Spinal anaesthesia-induced hypotension is an established complication that may not be eliminated. This study shows that the incidence during caesarean section is related to the volume of 0.5% hyperbaric bupivacaine used and the height of block. Small volume of 1.5 mls (7.5 mg) is associated with less hypotension but with a high probability of supplementary intraoperative analgesia especially when the height of block is below T6. The used of 1.5 mls (7.5 mg) of 0.5% hyperbaric bupivacaine with the patient lying in a horizontal plane for the level of sensory block in response to painful stimulus to be up to T6 then patient is placed in a slight head up to limit

further cephalad spread of hyperbaric bupivacaine could provide adequate analgesia for caesarean section and reduce the incidence of hypotension. This could make spinal anaesthesia with fluid load a safe technique for caesarean section especially in an underserved environment where vasopressors to treat spinal anaesthesia induced hypotension may not be available.

ETHICAL APPROVAL

It is not applicable.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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