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THE EFFECT OF HEIGHT AND WEIGHT ADJUSTED SUBARACHNOID DOSE OF BUPIVACAINE ON INCIDENCE OF COMPLICATIONS FOLLOWING SPINAL ANAESTHESIA FOR CAESAREAN SECTION

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ABSTRACT

Background: Caesarean section is one of the most commonly performed surgical operations in obstetric practice dating back to 100BC. The caesarean section rate varies around the world from 5% and up to 75%. It is about 15 to 21% in most West African countries. However, in some Teaching Hospitals in Nigeria, the average is about 18%- 27.6%.The use of spinal anaesthesia dates back to 1885. The very first spinal anaesthesia was performed by J. Leonard Corning, a neurologist in New York, USA, using cocaine in 1885. Spinal anaesthesia offers a fast, profound and high quality sensory and motor block in women undergoing caesarean section. The most common complication of spinal anaesthesia for caesarean section is hypotension with a reported incidence of 65% to 80%. The present study compared the adequacy of anaesthesia and the height of block using fixed dose of bupivacaine and an adjusted dose. The rate of complications in both groups was also compared. **Methodology:** This was a prospective, randomized, double-blind study carried out in National Hospital, Abuja over six months period. 140 patients undergoing CS were randomized to receive Bupivacaine in either a fixed dose or dose adjusted to height-weight. The results were analyzed with both descriptive and inferential statistics. **Results:** Significant differences were noted between the two groups. Compared to the height-weight adjusted dose group, patients in the fixed dose group had lower intra-operative mean arterial pressure ($p=0.001$), higher incidence of hypotension (62.9% vs 28.6% with $p<0.001$), and so needed more ephedrine (62.9% vs 28.6%), and more patients reported nausea (15.7 % vs 2.9% at $p=0.009$) but there was no vomiting in either group. Shivering occurred in 24.3% in the fixed dose group compared to 8.6% of patients in the adjusted dose group ($p=0.012$). One patient in the fixed dose group reported peritoneal discomfort compared to five cases reported in the adjusted dose group ($p=0.096$). **Conclusion:** Adjusting the dose of hyperbaric bupivacaine to patients' height and weight for elective caesarean section not only provide adequate analgesia for elective caesarean section, but is also associated with reduced risk of hypotension, shivering and nausea. However, there is a higher risk of peritoneal discomfort. Thus, dose adjustment, where possible, is hereby recommended.

KEYWORDS: Height, weight, adjusted dose, bupivacaine, complication, spinal anaesthesia, caesarian section.

INTRODUCTION

Caesarean section is one of the most commonly performed surgical operations in obstetric practice dating back to 100BC.[1] The caesarean section rate varies around the world from 5% and up to 75%.[2] It is about 15 to 21% in most West African countries.[3] However, in some Teaching Hospitals in Nigeria, the average is about 18%- 27.6%.[3,4]

The indication varies from foetal to maternal or foetomaternal.[3] Foetal conditions are foetal distress, footling breech, macrosomic babies, and foetal abnormalities such as conjoined twins, hydrocephalus, and spinal bifida. Maternal conditions include maternal exhaustion, cephalopelvic disproportion, two or more previous caesarean sections, severe pregnancy induced hypertension with unfavourable cervix, failed induction and failed trial of vaginal delivery after previous caesarean section. Others included a previous caesarean section with other obstetric indications, previous classical caesarean section, previous reconstructive vaginal surgery including vesicovaginal repairs. The rest are an active vulva herpes lesion, retroviral diseases,

major degree placenta prevea, placenta abruption with a live baby as well as maternal request.

The use of spinal anaesthesia dates back to 1885.[5] The very first spinal anaesthesia was performed by J. Leonard Corning, a Neurologist in New York, USA, using cocaine in 1885. Spinal anaesthesia offers a fast, profound and high quality sensory and motor block in women undergoing caesarean section.

The most common complication of spinal anaesthesia for caesarean section is hypotension with a reported incidence of 65% to 80%.[6,7]

Maternal hypotension may have detrimental effect on uterine blood flow, foetal well-being and ultimately neonatal outcome as measured by umbilical artery pH and Apgar scores.[7] Harten et al,[8] in their study of height/weight adjusted dose of hyperbaric bupivacaine for elective caesarean sections, discovered that adjusted doses of spinal anaesthesia provides adequate anaesthesia. There was also less incidence and severity of hypotension. In the same study, the use of fixed dose of 0.5% hyperbaric bupivacaine in patients undergoing caesarean section resulted in a higher incidence of blocks above the first thoracic dermatome, a higher incidence of hypotension and more patients required ephedrine to treat hypotension and a higher dose of ephedrine was required.

Various pharmacological and non-pharmacological methods have been employed in the management of hypotension following spinal anaesthesia. The pharmacological methods include use of fluids (colloids or crystalloids) or drugs (ephedrine and phenylephrine). The non-pharmacological methods include, leg wrappings and elevation, left lateral tilt and use of military anti-shock trousers.[7]

Deaths in regional anaesthesia are primarily related to excessive high regional blocks and toxicity of local anaesthetics. Reduction in doses and improvement in technique to avoid higher block levels and heightened awareness to the toxicity of local anaesthetics have contributed to the reduction of complications related with regional anaesthesia.[9,10]

The present study compared the adequacy of anaesthesia and the height of block using fixed dose of bupivacaine and an adjusted dose. The rate of complications in both groups was also compared. This will help determine the specific dose of heavy bupivacaine required by patients to provide adequate analgesia for elective caesarean section and at the same time prevent or minimize hypotension and other complications sequel to spinal anaesthesia.

METHODOLOGY

Study Design

This was a prospective randomized double-blinded study that was carried out in the Department of Anaesthesia, National Hospital, Abuja (NHA), a 200 bed tertiary hospital located in the capital city of Nigeria. The schedule for data collection spanned 6 months.

Ethical Considerations

The approval of the NHA research and ethical committee was sought and obtained.

Eligibility

Inclusion cliteria

ASA 1 and 2 term gestational patients booked for elective caesarean section with singleton pregnancy and expected to be delivered of a live baby were included in the research.

Exclusion Criteria

Patients with pre-existing hypertension, pregnancy induced hypertension multiple gestation and coagulopathy were excluded. Others excluded were patients with hypovolaemia, local or systemic sepsis as well as those with neurologic diseases. Also patients with body weight <50kg or>110kg as well as height >180cm or <140cm were equally excluded. Finally, patients allergic to local anaesthetic agents, those with intra uterine growth retarded babies, emergency caesarean sections and patients with ASA >2 were likewise excluded.

Procedure

Informed consent was obtained from each patient for the study. Each patient's height was measured in centimeter (cm) using the markings on the wall of the ward. The weight was also measured in kilogram (kg) using the ward weighing scale.

All patients were given antacid prophylaxis with oral ranitidine, 150mg the night before. In the induction room, intravenous access was achieved with a 16 gauge cannula, and 50mg of ranitidine and 10mg of metoclopramide were given intravenously one hour before induction of spinal anaesthesia.

Consenting patients who met the eligibility criteria were randomly allocated by secret balloting to either the study group or the fixed dose group, just before the commencement of spinal anaesthesia. The patient was required to pick a sealed envelope which contained the group to which the patient belonged previously sealed by a non-clinical personnel. The study was conducted in a double-blinded fashion such that the patient and the assessor were unaware of the group allocation of the patient. Only the practitioner administering the spinal anaesthesia knew the group allocation. The investigator was blind to the patient's allocation until the data was analyzed.

A multiparameter (Beneview TS Mindray) monitor (for NIBP, MAP, Pulse Rate, SPO_2; ECG) was attached to the patient and baseline values were obtained and recorded. Preloading with 1000ml of crystalloid (normal saline) over 30 minutes before induction of spinal anaesthesia was also done. Subarachnoid block was done using full aseptic technique. Patients in the Fixed Dose Group were given 2.4ml of 0.5% hyperbaric bupivacaine through the spinal needle intrathecally. On the other hand, patients in the Adjusted Dose Group were given 0.5% hyperbaric bupivacaine through the spinal needle intrathecally as determined by reference in a dosage regimen as per Harten J.M. et al.[8]

Patient was immediately returned to the supine position with a 15 degrees left lateral tilt and a slight head up position until the baby was extracted. Oxygen was given to all patients using nasal prongs at 3L/min and discontinued after delivery of the foetus except when otherwise indicated. Complications such as bradycardia, hypotension, shivering, pain, nausea and vomiting as well as peritoneal discomfort were appropriately managed.

Monitoring of the vital signs were carried out at regular intervals and values obtained were recorded. Immediately after the spinal injection, monitoring was done at 2 minute interval until patient was stable, then recording was every 5 minutes until patient was discharged from the recovery room.

Maximum sensory level of anaesthesia was assessed by bilateral loss of cotton wool sensation. Motor block was assessed by modified Bromage scale. When the sensory block was inadequate 8 minutes after the institution of the spinal anaesthetic, the patient was positioned in a 10 degrees head-down tilt. In cases of inadequate anaesthesia, nitrous oxide 50% in oxygen was administered using a face mask and 30mg pentazocine given when the baby was delivered.
After delivery, a bolus of 5 units of oxytocin was given intravenously slowly, while another 30 – 40 units were added to 500ml of normal saline to run over 4 hours. Blood loss was estimated and urine output assessed. The baby's Apgar score at one minute and five minutes was recorded by an attending paediatrician who was blinded to the patient's group allocation.

Post-operative analgesia comprised of intravenous pentazocine 30mg, 4 hourly and suppository diclofenac 100mg 12 hourly in the first 48 hours thereafter, oral paracetamol 1g 6 hourly and oral diclofenac 50mg 8 hourly was administered.

A standardized proforma was used to document the patients characteristics, age, height, weight, BMI, gestational age, parity, previous caesarean section, indication for caesarean section, baseline systolic and diastolic arterial pressure, MAP, and pulse rate and complications. The use of head up tilt, supplemental analgesia and conversion to general anaesthesia were recorded. Dose of bupivacaine, time from administration of spinal anaesthesia to surgical incision, time from loss of sensation to cold to maximum block height were also documented.

Intra-operative complications and the use of intermittent 3mg – 6mg of ephedrine were recorded. At the end of surgery, patients were transferred to the recovery room where monitoring continued.

The results were analyzed with statistical package for social sciences (SPSS, 18th edition). The height weight adjusted dose of heavy bupivacaine to a standard dose for spinal anaesthesia for elective caesarean section was compared, using Student T Test and Chi Square. P value of<0.05 was taken as statistically significant. Descriptive statistics was presented as mean, median or number.

RESULTS

One hundred and forty (140) patients completed the study and were included in the analysis. Seventy (70) patients in the adjusted dose group received a mean dose of 0.5% heavy bupivacaine of 1.85 ±0.18 ml. Seventy patients in the fixed dose group received heavy bupivacaine 0.5% 2.4 ml (significantly different to the dose given to the adjusted dose group, $p < 0.001$). Patient characteristics are given in Table 1. The mean age was significantly lower for the adjusted dose group compared with the fixed dose group. (P =0.009). Otherwise, no other significant differences were detected in the maternal demographic data in the two groups.

Table 2 shows the dermatomal levels of sensory blockade seen during the study. The time from insertion of spinal anaesthesia to surgical incision in the fixed dose group was faster compared to the adjusted dose group (p =<0.001). The time from loss of sensation to cold to maximum block height was faster in the fixed dose group than in the adjusted dose group (p = <0.001). In the fixed dose group, one patient required a head-down tilt (1.4%) while two patients required a head-down tilt in the adjusted dose group (2.9%). (p=0.563).

Supplementary analgesia with nitrous oxide 50% in oxygen was given to six patients (8.6%) in the adjusted dose group. While no patient in the fixed dose group required supplementary analgesia (p = 0.012). In the fixed dose group one patient had a maximum block height to thoracic vertebra level 4 (T4), sixty three patients to T6 and six patients to T8, while in the adjusted dose group, no patient had a block height to T4, fifty two patients to T6 and eighteen to T8. No patient in either group required conversion to general anaesthesia.

Table 3 presents haemodynamic variables. The difference between baseline and minimum intra-operative mean arterial pressure was less in the adjusted dose group than in the fixed dose group (p=0.001). The incidence of hypotension after spinal anaesthesia was

62.9% in the fixed dose group and 28.6% in the adjusted dose group (p = <0.001). More patients in the fixed dose group were given ephedrine (62.9% vs. 28.6%) than in the adjusted dose group, (p = <0.001), and a larger median dose was administered respectively (6 mg vs. 3 mg, (p =< 0.001). The percentage of patients in the fixed dose group who reported nausea was 15.7%, compared to 2.9% in the adjusted dose group (p = 0.009). Shivering occurred in 24.3% of patients in the fixed dose group and in 8.6% of patients in the adjusted dose group (p=0.012). No patient vomited in either group. Peritoneal discomfort was reported by one patient in the fixed dose group while five patients reported it in the adjusted dose group (p=0.096). Neonatal Apgar score at 1 minute in the fixed dose group was 7 and for the adjusted dose it was 8 (p=0.008) and at 5 minutes it was 9 for both groups (p=1.00)

Table 1: Patient characteristics.

Patient Characteristics	Fixed Dose Group n = 70	Adjusted Dose Group n = 70	P value
Age (years)	33.5 ± 5.50	32.7 ± 6.90	0.009
Height (m)	1.62 ± 0.06	1.61 ± 0.06	0.339
Weight (kg)	80.47 ± 12.79	80.57 ± 1.14	0.961
BMI (kg/m2)	30.65 ± 4.31	31.07 ± 3.86	0.544
Gestation (weeks)	38.81 ± 1.16	38.96 ± 1.13	0.460
Gravida (n)	3 (7)	3 (5)	
Previous C/S (n)	1 (0-4)	1(0-3)	

Values are mean (standard deviation), for the last two, median (range)

Table 2: Bupivacaine dose, block data and supplementary analgesia head down tilt and conversion to general anaesthesia in the two groups studied

	Fixed Dose Adjusted Dose Group N=70 N=70	95% P-Value Confidence Intervals
Dose of bupivacaine 0.5%; ml2.41.85 (± 0.18)0.46 - 0.57<0.001 Time from induction of spinal 4.54 (±1.64)6.46 (±2.46)-2.61 - (-1.22)<0.001 anaesthesia to incision, (min)		
Time from loss of cotton wool 3.66 (±1.54)5.11 (±2.20)-2.09 - (-0.82)<0.001 sensation to max block height		
Head down tilt used: (n)1 (1.4%)		2(2.9%)-0.06 - 0.030.563
Supplementary analgesia given; 0(0%) (n) Max block heightT6(1) T8(63) T10(6)		6(8.6%)-0.15 - (-0.02)0.012 T6(0) T8(52) T10(18)
Conversion to General anaesthesia (n) 0 (0%)		0 (0%)

Values are expressed as mean, (standard deviation) number (percentage), confidence interval and p-value.

Table 3: Haemodynamic variables

	Fixed Dose Adjusted Dose Group N=70	Group N=70	95% Confidence Intervals	P-Value
Baseline systolic pressure mmHg	140.20(±15.09)	141.36(±16.15)	-4.07 – 6.38	0.710
Baseline diastolic pressure mmHg	66.79(±10.22)	69.24(±5.71)	-0.31 – 5.22	0.143
Baseline mean arterial pressure mmHg	90.91(±7.34)	91.99(±6.57)	-1.26 – 3.40	0.910
Difference between baseline and minimum mean arterial pressure mmHg (MAP)	23.7118.712.13 - 7.870.001			
Hypotension; n44 (62.9%)20(28.6%)0.19 - 0.50<0.001				
No of patients requiring Ephedrine(n)	44(62.9%)20 (28.6%)0.19 - 0.50<0.001			
Ephedrine dose given; (mg)6.90 (±6.26)3.00 (±5.10)1.99 - 5.80<0.001				
Nausea; (n)11 (16.7%)2(2.9%)0.03 - 0.220.009				
Shivering (n)17(24.3%)6(8.6%)0.04 - 0.280.012				

Vomiting Nobody vomited in both groups
Peritoneal discomfort; (n)1(1.4%)5(7.1%)-0.01 - 0.120.096

Values are mean (SD) or number (percentage)

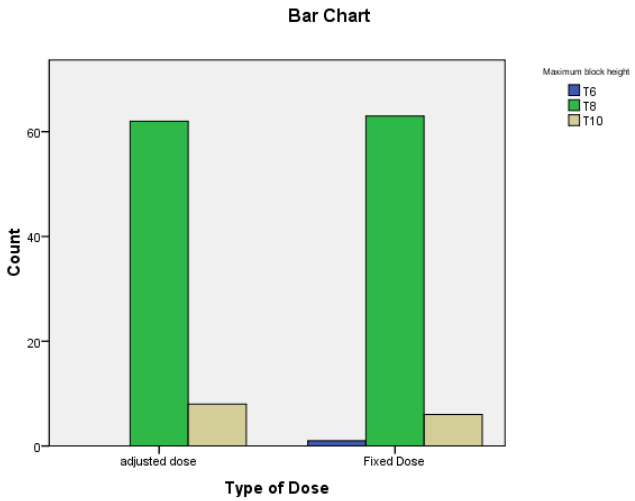
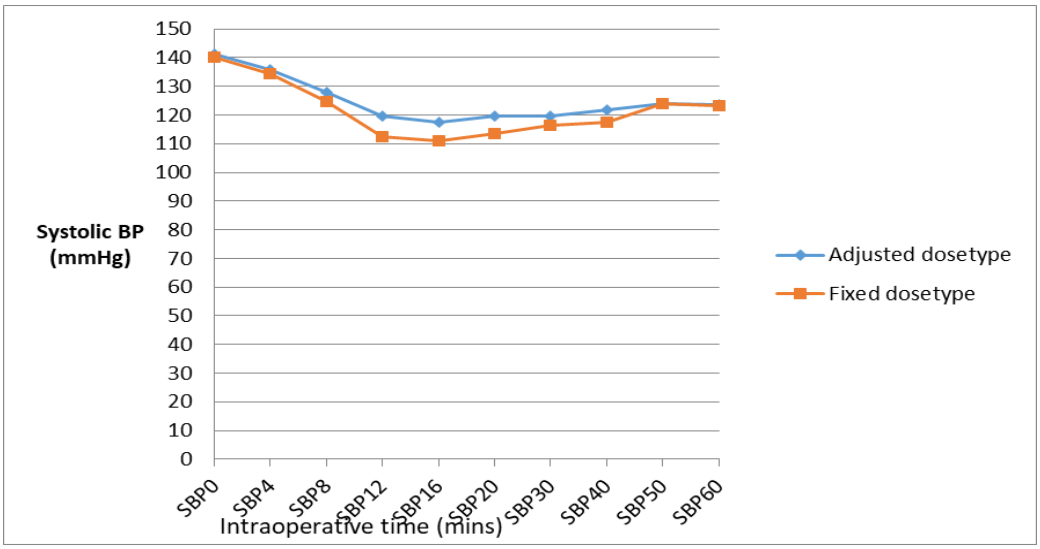
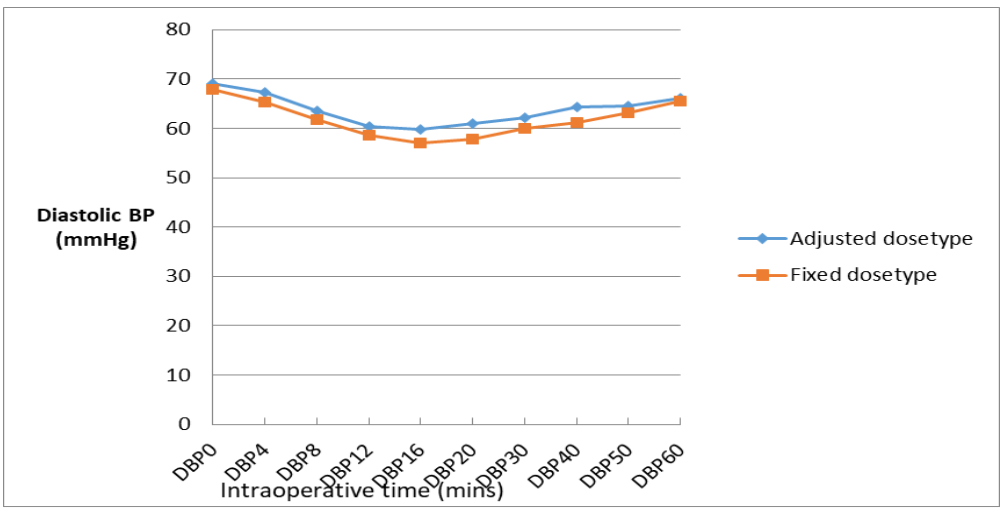


Figure 1: Bar Chart showing Maximum Block Height





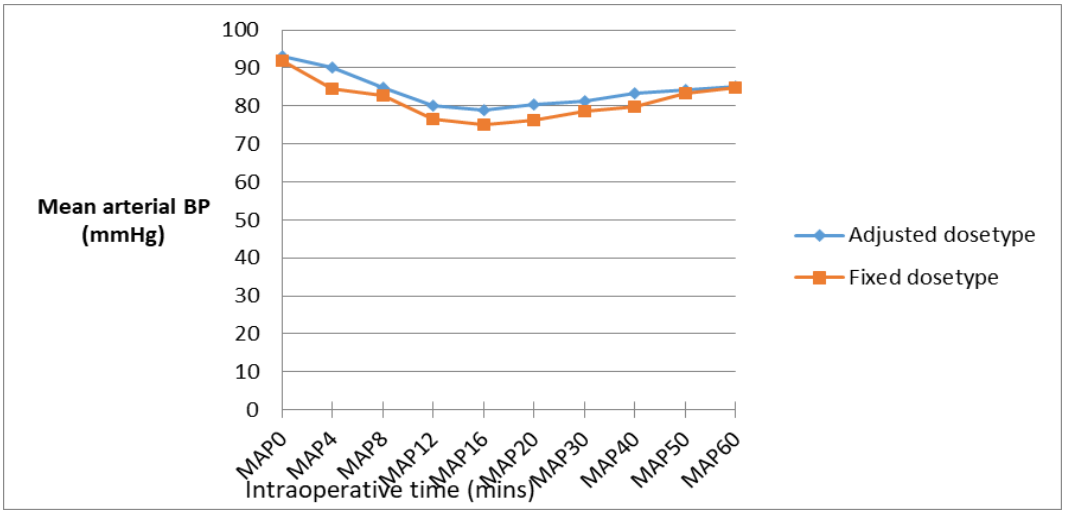


Figure 2: Line graphs showing intraoperative blood pressure variations.

DISCUSSION

The anaesthetic technique for caesarean section can be either general anaesthesia or regional anaesthesia. General anaesthesia is optimal for some emergency situations or when regional anaesthesia is contraindicated. Spinal anaesthesia is a preferred choice for elective caesarean section because of less chances of complications compared to general anaesthesia.[11] Blood loss may be reduced and deep venous thrombosis may be less common. Bupivacaine hydrochloride is the most commonly used drug for spinal anaesthesia in our country. In this study we used height and weight adjusted dose of 0.5% hyperbaric bupivacaine hydrochloride compared it to a fixed dose of 0.5% of hyperbaric bupivacaine. Distribution of hyperbaric solutions in cerebrospinal fluid is governed by age, height, anatomy of the vertebral column, injection site, volume of drug, density and baricity of drug and position of the patient during injection.

Total dose of bupivacaine is more important than volume or concentration of anaesthetic solution in determining spread of local anaesthetic solution in cerebrospinal fluid.[12] Pharmacodynamic data suggests that the onset time for achieving an adequate sensory level for surgery increases linearly with height and decreases with increasing weight. Clinical observations confirmed that weight and height are significant variables in predicting the final level of the block.[8]

This study shows that satisfactory anaesthesia for elective Caesarean section can be provided with doses of bupivacaine that are lower than those usually used in obstetric anaesthetic practice, although six patients required supplementary analgesia. Patients in the Adjusted Dose Group received a median dose of bupivacaine of 9.25 mg (1.85 ml), and the lowest dose administered was 7 mg (1.4 ml). The lower doses of bupivacaine used in the Adjusted Dose Group were associated with a lower incidence of nausea, vomiting, shivering and a higher incidence of peritoneal discomfort as of lower incidence of hypotension. Thermal inputs are integrated at the level of the anterior hypothalamus, which compares peripheral information with a threshold value or a set point. Spinal anaesthesia affect the efficiency of this homeostatic system and may result in different degrees of perioperative hypothermia. Spinal anaesthesia decreases this threshold triggering vasoconstriction and shivering above the level of block. This reduction in threshold is proportional to the number of spinal segments blocked. The incidence of peritoneal discomfort seen in spinal anaesthesia is inversely related to the number of spinal segments blocked. In the adjusted dose group, there is reduction in the number of spinal segments blocked as seen in this study; which explains the higher incidence of peritoneal discomfort seen in this study. The distribution of the anaesthetic drug in cerebrospinal fluid (CSF) is less predictable in the pregnant group, not only because of increased spinal canal pressure,[13] but also as a consequence of the changes in CSF acid-base balance[14] and protein content[15]. Moreover, side effects, including hypotension, nausea, vomiting, and hypersensitivity to intrathecal opiates, are more common.[16]

Danelli *et al.*,[17] in their study, demonstrated that a dose as low as 0.06 mg/cm height represents the dose of intrathecal bupivacaine providing effective spinal block in 95% of women undergoing elective caesarean section. In their study, they supplemented with epidural anaesthesia and no complication was encountered. They determined the minimum effective dose of spinal bupivacaine using a staircase method. In each patient an arbitrary dose of 0.5% hyperbaric bupivacaine in relation to patient height was used. The initial dose was 0.075 mg/cm height, while the outcome of each patient's response determined the dose for the subsequent patient. When successful spinal block was achieved within 20 minutes from spinal injection, the dose of spinal bupivacaine for the next patient was decreased by 0.01 mg/cm height. Conversely, when successful spinal block was not observed, the dose of spinal bupivacaine for the next patient was increased by 0.01 mg/cm height. If

successful spinal block was not achieved within the designed period, a 5-8 ml epidural bolus of 2% lidocaine was given to achieve adequate surgical anaesthesia. No complications were reported during their study unlike reported incidence of complications in this study. The minimal dose used by Danelli *et al*.,[18] is 0.025mg lower than the minimal dose used in this study. They used supplemental epidural anaesthesia with the low doses of 0.5% hyperbaric bupivacaine which could be the reason they did not encounter any complication in their study and yet had adequate anaesthesia in 95% of their cases.

This study compares well with a study by Harten et al[8]; that showed that using adjusted dose of 0.5% heavy bupivacaine as was used in this study provided adequate anaesthesia for elective caesarean section, although they combined the heavy bupivacaine with diamorphine 0.4mg. In their study only two patients required supplemental analgesia with nitrous oxide and alfentanil while in the present study six patients required supplemental analgesia with 50% oxygen in 50% nitrous oxide. The study population in the study conducted by Harten et al,[8] is 54% of the present study population and this could explain in part the differences in the number of patients requiring supplemental analgesia. Harten et al,[8] use 0.5% of heavy bupivacaine in combination with diamorphine 0.4mg could also account for this difference, as only 0.5% heavy bupivacaine was used in this study. Harten et al[8] demonstrated that adjusted dose was associated with a decreased incidence and severity of maternal hypotension, and a satisfactory anaesthesia for elective caesarean section. This agrees well with this study. Another study by Kiran and Singal,[18] demonstrated that a lower dose of 0.5% hyperbaric bupivacaine for elective caesarean section is associated with adequate anaesthesia and less complications like hypotension, bradycardia, nausea, vomiting and high spinal block. The findings of the study undertaken by Sandhya and Kirtinath Sexena,[19] also compared well with the findings in this study, that adjusting the dose of hyperbaric bupivacaine according to patient's height and weight gives adequate anaesthesia for elective caesarean section; and was also associated with less complications as was seen in the present study.

Normally, the level of sympathetic block is two to six levels above the sensory block,[20] however, the level of sensory block needs to rise to T4 in caesarean section for patients to be comfortable during the operation. Thus although the dose of local anaesthetic is decreased, the development of sympathetic block is inevitable as a result of the level of sensory block rising to T4. It is not possible to completely prevent hypotension by just decreasing the dose of local anaesthetic. A combination of techniques was used to prevent spinal-induced hypotension for caesarean delivery in some studies,[21-23] Sensory block of up to T4 is associated with high spinal and more severe hypotension. This study shows that the maximum block height was T4 in the fixed dose group and T6 in the adjusted dose group; and yet there were still incidences of hypotension in the two study groups. Harten et al,[8] noted that there were more spinal block above the first thoracic dermatome in the fixed dose group compared to the adjusted dose group; which led to more patients in their fixed dose group suffering more hypotension compared to the patients in the adjusted dose group. Harten et al study compares well with this study. Studies by Nagata,[24] of Japan and Chung,[25] of Korea also demonstrated that pregnant women require less dose of local anaesthetic than do non-pregnant women and if dose is adjusted according to height of patient then adequate level of anaesthesia is achieved with less maternal hypotension. Nine milligram of either plain or hyperbaric bupivacaine with fentanyl intrathecally provides similar onset, depth and duration of sensory anaesthesia for caesarean delivery with good maternal satisfaction.[26]

In separate studies by Hartwell,[27] and Norris,[28] height, weight and BMI are not related to the level of spinal block during caesarean section. Both studies used 15mg of 0.75% of hyperbaric bupivacaine in parturient women, although, Hartwell found a correlation between the length of the spinal vertebra and level of anaesthesia, and not the height of the patient. Norris,[28] and Hartwell,[27] concluded that height and weight are not necessary to vary the dose of injected hyperbaric bupivacaine used for spinal anaesthesia. The differences seen in the height of block in the reports of Norris and Hartwell and this study may be attributable to differences in the patient population studied and dose of bupivacaine used. They studied women booked for both elective and emergency caesarean section and also used 15mg of hyperbaric bupivacaine for all their patients. Patients for emergency caesarean section who are in labour are less likely to develop hypotension compared to patients booked for elective caesarean section who are haemodynamically optimized before induction of spinal anaesthesia because of release of stress hormones. It should be taken into account that distribution of hyperbaric solutions in cerebrospinal fluid is governed by age, height, anatomy of the vertebral column, injection site, volume of drug, density and baricity of drug and position of the patient during injection as stated earlier.

Baker and Kitachoraet al,[29] in their study suggested that in supine patients hyperbaric local anaesthestic solutions flow to the dependent area of the thoracic spine and achieve similar levels of blockade, regardless of patient height. In their study, Hartwell et al,[27] failed to show correlation between patient's height, weight, BMI and local anaesthetic spread; but showed that the correlation is between the two vertebra measurements C_7-IC (7^{th} cervical vertebrate – iliac crest) and C_7- SH (7^{th} cervical vertebrate – sacral hiatus). In this study, the patient's body height and not the vertebra measurement of C_7- IC and C_7-SH was considerd. Harten et al[8], Varveris et al,[11] and Sandhya et al,[19] used patients' height and not vertebra measurement as was used in this study. They had the same report as in this study; that level of

maximum block height correllates well with the dose of hyperbaric bupivacaine used. The higher the dose of bupivacaine used the higher the level of maximum block height.Adjusting the dose of hyperbaric bupivacaine according to patients' height and weight regulates the maximum block height, offers adequate anaesthesia and reduces incidence of complications.

In this study, the difference between baseline and minimum intra-operative mean arterial pressure was less in the adjusted dose group than in the fixed dose group. The incidence of hypotension after spinal anaesthesia was 62.9% in the fixed dose group and 28.6% in the adjusted dose group. More patients in the fixed dose group were given ephedrine (62.9% vs. 28.6%) than in the adjusted dose group, and a larger median dose was administered (6 mg vs. 3 mg).

Protocols that aim to prevent hypotension during spinal anaesthesia for caesarean delivery may result in better outcomes than those designed to treat hypotension after it had occurred. The efficacy of prehydration has been studied extensively in the prevention of hypotension following spinal anaesthesia for caesarean delivery, but the optimum types and doses of preload solutions remain controversial. Rout et al[20] first challenged the benefit of a crystalloid preload in an open randomized comparison of 20 ml/kg and no preload. They noted that there was a 16% (from 71% to 55%) reduction in the incidence of hypotension in the preload group. Park et al used crystalloid preload volumes of 10, 20 and 30 ml/kg in a double-blind study.[30] Although, there was a trend towards a reduced incidence of hypotension with the larger fluid preloads, this was not statistically significant and neither was there any difference in the amount of ephedrine used. Crystalloid preloading is performed to augment blood volume in an attempt to compensate for the anticipated vasodilatation induced by subarachnoid block.

Hypotension after spinal anaesthesia for caesarean section is common and may result in serious maternal and neonatal complications despite the use of uterine displacement and volume preloading.[24] This study showed an incidence of hypotension to be 62.9% in the fixed dose group and 28.6% in the adjusted dose group. Shivering was 17% in the fixed dose group and 6% in the adjusted dose group, Nausea 11% versus 2%and tightness of chest 5% versus 1%. Edomwonyi et al,[31] reported an incidence of hypotension of 32% in their series, shivering 29.8%, pain 17% nausea and vomiting 4.2%. The pattern of complication is similar in both studies despite the fact that both elective and emergency cases were studied by Edomwonyi et al,[31] and doses between 2.2- 2.4ml were used, while in this study only elective cases and doses between 1.4-2.4ml were used. Comparing Edomwonyi et al,[31] and this study, reducing the doses of hyperbaric bupivacaine resulted in decreasing incidence of hypotension and other side effects except for vomiting seen in Edomwonyi et al's report but not reported in the present study. This could be as a result of variations in the doses of bupivacaine used in the two studies. Akpa et al,[32] studied 98 adult patients who underwent various surgical procedures under spinal anaesthesia noted the following incidence of complications; hypotension 25%, headache 2.04% and trauma to nerves 1.02%. The pattern of complication seen in Akpa et al,[32] (non obstetric surgeries) varied from that seen in Edomwonyi et al and this study. This could be as a result of differences in patients' population used. General surgery cases versus obstetric cases. Akpa et al probably followed up their patients post operatively to get the complications of headache and trauma to the nerves, while in the present study only intra operative complications were observed.

Intraoperative emetic symptoms during abdominal surgery under regional anaesthesia have a multifactorial origin and factors such as psychological changes (anxiety), arterial hypotension, hypoperfusion of the central nervous system, abrupt visceral movements, and concomitant opiate administration,[16] and the use of oxytocin play a role. The incidence of emetic complications during spinal anaesthesia for caesarean section correlated with the presence of arterial hypotension. Intraoperative nausea and vomiting can be best prevented by controlling hypotension, optimizing the use of neuraxial and intravenous opioids, improving the quality of block, minimizing surgical stimuli and judicious administration of uterotonic agents.

The study also demonstrated a lower Apgar score in the fixed dose group at 1 minute, but showed no difference in both groups at 5 minutes. Despite a very high prevalence of maternal hypotension during caesarean sections, term infants tend to tolerate this placental blood perfusion challenge without any major sequel. Interestingly, spinal anaesthesia was still adequate in the Adjusted Dose Group in almost all patients despite the low doses used. Only six patients (8.6%) in this group experienced visceral discomfort, which responded well to supplementary analgesia with nitrous oxide and oxygen and intravenous pentazocine 30mg after extraction of the feotus. No conversion to general anaesthesia was necessary in either group.

Many studies used pharmcological and non phramcological methods to improve maternal hemodynamics during subarachnoid block. They have all failed to eliminate hypotension associated with subarachnoid block. Dasalu etb al,[13] in their study concluded that prophylactic ephedrine was effective in peventing hypotension during spinal anaesthesia for caesarean section, but did not eliminate its occurrence. Shiraz,[33] in his study showed that ephedrine may contribute to maternal tachycardia and hypertension, and could also be responsible for fetal acidemia and electroencephalographic (EEG) abnormalities in newborns. Numerous prophylactic strategies have been tested to prevent spinal induced hypotension. Very few

have been shown to be partially effective: colloid fluid pre-loading, crystalloid co-loading, vasopressors and lower limb compression.[34] The use of pre-loading and/or ephedrine to prevent hypotension was not evaluated in this study. All the patients were preloaded with 1000ml of crystalloid and ephedrine was used to treat hypotension and not to prevent its occurrence.

However the incidence of hypotension can be reduced but hypotension cannot be eliminated.[34] Most studies use doses of spinal bupivacaine of 9-15 mg. Various authors,[8,11,19] have suggested that lowering the spinal dose to less than 7.5 mg of bupivacaine intrathecally might reduce the incidence and severity of hypotension. Lowering the intrathecal dose of bupivacaine seems to be a useful technique in reducing the incidence of hypotension. However no prophylactic technique has successfully eliminated hypotension.Normally, the level of sympathetic block is two to six levels above the sensory block.[20] However, the level of sensory block needs to rise to T4 in caesarean section for patients to be comfortable during the operation. Thus, even though the dose of local anaesthetic is decreased, the development of sympathetic blockade is inevitable as a result of the level of sensory block rising to T4. It is not possible to prevent hypotension completely, just by decreasing the dose of local anaesthetic. The current study has been able to provide adequate anaesthesia using adjusted doses of hyperbaric bupivacaine for elective caesarean section, adjusting the maximum block height to reduce the hemodynamic instability associated with subarachnoid block thereby reducing ephedrine requirement and at the same time reduce the incidence of other associated complications.

CONCLUSION

Adjusting the dose of hyperbaric bupivacaine to patients' height and weight for elective caesarean section not only provide adequate analgesia for elective caesarean section, but is also associated with reduced risk of hypotension, shivering and nausea. However, there is a higher risk of peritoneal discomfort. Thus, dose adjustment, where possible, is hereby recommended.

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