Haemodynamic Parameters and Block Characteristics between Fixed Volume and Adjusted Volume of Intrathecal Hyperbaric Bupivacaine In Elective Caesarean Section

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ABSTRACT:
INTRODUCTION: Hypotension after induction of spinal anaesthesia may compromise uteroplacental circulation in parturients. To decrease such incidence among Nepalese parturients along with simultaneous adequate block effect, fixed volume and calculated volume of intrathecal Bupivacaine were compared.

METHOD: Sixty singleton term parturients undergoing elective caesarean section under spinal anaesthesia were enrolled in this prospective; single blind randomized controlled study conducted in Kathmandu Medical College Teaching Hospital. In fixed group (FD), fixed volume of 2.2 ml 0.5% hyperbaric Bupivacaine was given. In adjusted group (AD), volume of 0.5% hyperbaric Bupivacaine was calculated according to height and weight from the Harten’s chart. The haemodynamic parameters, onset of grade IV motor block according to modified Bromage scale and onset of sensory block at T6 level of both groups were studied and compared.

RESULT: The haemodynamic parameters throughout the surgery were similar in both groups, but the numbers of hypotensive episodes were higher in FD (63.33%) than that in AD (50%). However, this was statistically insignificant (p-value = 0.29). The time of achieving sensory block at T6 level and complete motor block were statistically insignificant (p-value = 0.61 and 0.55 respectively).

CONCLUSION: There were no significant differences in the hemodynamic parameters and block characteristics adjusting the volume of intrathecal 0.5% heavy Bupivacaine according to Harten’s chart, as compared to administering the fixed volume of 2.2 ml of 0.5% hyperbaric Bupivacaine for spinal anaesthesia in elective caesarean section.

KEY WORDS: Adjusted volume; Caesarean section; Fixed volume; Hyperbaric Bupivacaine; Spinal anaesthesia

INTRODUCTION
Spinal anaesthesia in caesarean section has benefits of rapid and profound motor and sensory block, effective analgesia as well as anaesthesia, avoidance of airway instrumentation, and also allows mother to be awake, interact and enjoy her motherhood immediately with her baby.

The commonly used drug in subarachnoid block is hyperbaric 0.5% Bupivacaine which is a local anaesthetic drug belonging to amino amide group with duration of action of 90-120 minutes. The most common problem associated with spinal anaesthesia for caesarean section is the rapid onset of hypotension with an incidence over 50% with associated adverse effects to both mother and baby. A range of strategies like proper maternal position with the uterus displaced off the venacava, the infusion of fluids and use of ephedrine or phenylephrine are currently used to minimize or prevent hypotension. Various studies have also been done in an effort to reduce incidence of intraoperative hypotension after spinal anaesthesia by instituting the minimum dose of local anaesthetic agent which is required for producing adequate blockade, yet maintain hemodynamic stability.

Spinal anaesthesia has been performed with the volume of 2.2 ml of 0.5% hyperbaric Bupivacaine in Kathmandu Medical College Teaching Hospital (KMCH). The current study is the first study conducted in Kathmandu University and KMCH which studied the effects of the adjusted volume of 0.5% hyperbaric Bupivacaine intrathecally, according to the height and

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weight of the parturient in comparison to the fixed volume (2.2 ml) in elective caesarean section. The calculated volume of 0.5% hyperbaric Bupivacaine was derived from Harten’s chart of the article by JM Harten and colleagues. This study was conducted to study the aforementioned benefits of adjusted dose after spinal anaesthesia in elective caesarean section within Nepali parturients by using Harten’s chart.

**METHOD**

Patients admitted in Kathmandu Medical College, Teaching hospital were enrolled in this prospective, single blinded controlled randomized study after obtaining ethical clearance from the hospital ethics and research committee. Sixty parturients planned for elective caesarean section with gestational age of 37-41 weeks, age group of 18-45 years, 50-110 kg weight and 140-180 cm height (according to the Harten’s chart) and American Society of Anaesthesiologists physical status (ASA-PS) class I and II were included in this study. Exclusion criteria were emergency caesarean section, patient not willing to be a part of the study, patient’s refusal for spinal anaesthesia, patient with conditions contraindicating spinal anaesthesia, pre-existing hypertension or pregnancy induced hypertension, and combination of height and weight not falling in the Harten’s Chart.

Height and weight of the parturient were noted during her pre-anesthesia evaluation a day before the surgery along with informed consent. Patients were fasted for eight hours (solid food) and two hours (plain glucose water) before the operation. Patients were pre-medicated with tablets Metoclopramide 10 mg and Ranitidine 150 mg two hours before the surgery. On the day of surgery, in the operation theatre, parturient’s identification was re-checked and confirmed; routine monitoring of non-invasive blood pressure, electrocardiogram, pulse oximeter and heart rate was initiated. Pre-procedural baseline haemodynamic parameters were recorded. The patient was pre-loaded with 10 ml/kg of crystalloid via 18 Gauge intravenous cannula 15 minutes before the performance of spinal anaesthesia.

The patient was allocated randomly to one of the following two groups using sealed envelope method by non-researcher anaesthesiologist:

1) **Fixed dose group (FD):** fixed volume of 2.2 ml 0.5% hyperbaric Bupivacaine

2) **Adjusted dose group (AD):** volume of 0.5% hyperbaric Bupivacaine adjusted according to height and weight from the Harten’s chart (Table 1).

<table>
<thead>
<tr>
<th>Patient weight</th>
<th>Patient height (cm)</th>
<th>Adjusted dose (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>1,150</td>
<td>1.5</td>
</tr>
<tr>
<td>60</td>
<td>1,300</td>
<td>1.3</td>
</tr>
<tr>
<td>70</td>
<td>1,450</td>
<td>1.2</td>
</tr>
<tr>
<td>80</td>
<td>1,600</td>
<td>1.1</td>
</tr>
<tr>
<td>90</td>
<td>1,750</td>
<td>1.0</td>
</tr>
<tr>
<td>100</td>
<td>1,900</td>
<td>0.9</td>
</tr>
<tr>
<td>110</td>
<td>2,050</td>
<td>0.8</td>
</tr>
</tbody>
</table>

The patients were unaware of the group allocated. Both the performance of subarachnoid block and data collection was done by the researcher. Under all aseptic technique, L₄-L₅ interspace in midline was infiltrated with 3 ml of 1% plain Lignocaine with left lateral position of the patient. After confirming correct placement of 27 Gauge Whitacre spinal needle in the subarachnoid space (by witnessing free flow of CSF in all four quadrants), the study drug was injected over a period of 0.2 ml/sec. Patient was immediately placed back to the supine position. Oxygen supplementation was given if required and a 15 degree wedge was kept under the right hip to prevent aorto-caval compression.

Sensory and motor assessments were done after one minute of the subarachnoid block and every minute thereafter till complete (Grade IV) motor blockade and T₆ level of sensory block were achieved. If the sensory blockade was limited to T₁₀ level even after 10 minutes, the table was positioned in 10 degree head down tilt and repositioned back to horizontal after achievement of T₆ sensory block. The surgery was allowed to commence after attaining T₆ sensory block and grade IV motor block. Both sensory and motor assessments were done every five minutes after surgical incision till the end of surgery. Haemodynamic parameters (heart rate, systolic and diastolic blood pressure, and mean arterial pressure) were noted every minute after spinal anaesthesia for first 20 minutes, and then every five minutes till the end of surgery.
Motor blockade was assessed using modified Bromage scale (Table 2). The onset of motor block was defined as time taken to achieve complete (Grade IV) motor block after performing subarachnoid block.

Sensory block was assessed by pin prick with blunt bevel needle in midclavicular line. The onset of sensory block was also noted. Hypotension was defined as a decrease in non-invasive systolic blood pressure (SBP) > 20% of baseline or < 90 mmHg or mean arterial pressure (MAP) < 60 mmHg and was treated with intravenous crystalloid (200 ml) bolus and Ephedrine 50 mcg (if associated with tachycardia) or Phenylephrine 6 mg (if associated with bradycardia) or intravenous Midazolam 0.03 mg/kg and incremental dose of intravenous Fentanyl 25 mcg if the patient complained of pain after delivery of baby.

Data was analyzed using Statistical Package for Social Sciences (SPSS) version 17. Numerical variables such as age, weight, height, HR, SBP, DBP, MAP, Apgar score were compared between two groups by independent samples t-test. Chi-square test was applied for qualitative measurements between groups. Value of p < 0.05 was considered to be statistically significant. Results were expressed as mean ± standard deviation (SD).

RESULT

In our study, age, height, weight and preoperative haemodynamic values were comparable between the two groups (table 3). In dose adjusted group, patients had received 1.63 ± 0.16 ml after adjusting according to the weight and height of the patient but statistically not significant as compared with the fixed volume of 2.2 ml (p = 0.029). The time taken to achieve T6 sensory level and grade IV motor block were similar (p > 0.05) in both the groups (table 4). The maximum cephalad spread was T3 level in both the groups. The duration of surgery was also similar in both the groups (p > 0.05).

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**Table 2: Modified Bromage scale**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Criteria</th>
<th>Degree of block</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Free movement of legs and feet</td>
<td>Nil (0%)</td>
</tr>
<tr>
<td>II</td>
<td>Just able to flex knees with free movement of feet</td>
<td>Partial (33%)</td>
</tr>
<tr>
<td>III</td>
<td>Unable to flex knees with free movement of feet</td>
<td>Almost complete (66%)</td>
</tr>
<tr>
<td>IV</td>
<td>Unable to move legs or feet</td>
<td>Complete (100%)</td>
</tr>
</tbody>
</table>

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**Table 3: Patient’s characteristics and preoperative haemodynamic data**

<table>
<thead>
<tr>
<th>Variables</th>
<th>FD (mean)</th>
<th>AD (mean)</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>27.40 ± 4.68</td>
<td>26.77 ± 3.93</td>
<td>0.57*</td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>61.73 ± 6.70</td>
<td>63.47 ± 10.08</td>
<td>0.43*</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>150.72±4.63</td>
<td>150.98 ± 6.03</td>
<td>0.85*</td>
</tr>
<tr>
<td>Volume (ml)</td>
<td>2.2</td>
<td>1.63 ± 0.16</td>
<td>0.029*</td>
</tr>
<tr>
<td>Preoperative Heart rate</td>
<td>98.4</td>
<td>98.2</td>
<td>0.78†</td>
</tr>
<tr>
<td>Preoperative Systolic BP</td>
<td>120</td>
<td>118.6</td>
<td>0.48†</td>
</tr>
<tr>
<td>Preoperative Diastolic BP</td>
<td>75.8</td>
<td>72.3</td>
<td>0.24†</td>
</tr>
<tr>
<td>Preoperative MAP</td>
<td>90.7</td>
<td>87.9</td>
<td>0.32†</td>
</tr>
</tbody>
</table>

*Independent samples t-test applied, † Chi-square test applied
Table 4: Spinal block characteristics and surgical data

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>FD (mean)</th>
<th>AD (mean)</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to T₆ sensory level</td>
<td>8.23 ± 4.84</td>
<td>9.41 ± 4.88</td>
<td>0.61</td>
</tr>
<tr>
<td>Time to complete motor block</td>
<td>3.2 ± 1.51</td>
<td>3.46 ± 1.92</td>
<td>0.55</td>
</tr>
<tr>
<td>Duration of surgery</td>
<td>45.47 ± 9.90</td>
<td>48.77±16.07</td>
<td>0.34</td>
</tr>
</tbody>
</table>

*Independent samples t-test applied.

Three patients (10%) from AD group were converted to general anaesthesia with rapid sequence induction due to inadequate block. Six out of 30 patients (20%) of group FD and 13 out of 27 patients (46.1%) of group AD required supplemental analgesics intraoperatively which was statistically insignificant by Chi-Square test (p = 0.052). The Apgar score at 1 minute [7.3 ± 0.46 (FD) vs. 7.23 ± 1.50 (AD), p = 0.81] and 5 minutes [8.50 ± 0.50 (FD) vs. 8.20 ± 1.64 (AD), p = 0.34] were similar in both the groups.

Nineteen patients (63.33%) from group FD and 15 patients (50%) from group AD developed hypotension. The distribution of number of patients experiencing hypotension was similar in both groups (p = 0.29). None of the patients from group FD had bradycardia intraoperatively. Two patients (6.66%) from group AD developed bradycardia (lasted <10 seconds). Six patients (20%) from both group developed nausea. Two patients (6.66%) from group FD and one patient (3.33%) from group AD had vomiting intraoperatively. None of the patient experienced shivering.

DISCUSSION

Spinal anesthesia is commonly performed and widely acceptable technique for conducting caesarean section, which avoids risk of failed endotracheal intubation as well as aspiration pneumonitis in parturients. But this technique also has disadvantage of hypotension which affects both mother and the baby. Our study showed insignificant hypotensive episodes as well as variation in sensory and motor block characteristics between fixed volume and adjusted volume of intrathecal hyperbaric Bupivacaine. This finding is in contrast with the study of Harten et al’. In this Harten’s study, they administered either Diamorphine 0.4 mg in 0.5% hyperbaric Bupivacaine 2.4 ml (fixed dose group) or Diamorphine 0.4 mg in a volume of 0.5% hyperbaric Bupivacaine adjusted according to the patient’s height and weight (adjusted dose group). This difference with our findings might be due to the drug and volume received in the current study where the parturients received sole 0.5% hyperbaric Bupivacaine and the mean volume received in AD group was 1.63 ± 0.16 ml which was statistically significant in comparison to volume of 2.2 ml.

Our study showed the time taken to achieve T₆ sensory level and grade IV motor block were similar (p > 0.05) in both the groups. Surgeries were allowed to start after achieving sensory blockade at T₆ dermatomal level keeping in mind that there would still be cephalad spread of the drug because the fixing time of intrathecal bupivacaine is approximately 25 to 30 minutes post spinal anaesthesia. There was insignificant difference in the mean time of sensory block to T₆ level between the two groups [8.23 ± 4.84 minutes (FD) vs.9.41 ± 4.88 minutes (AD), p = 0.61]. But unlike in our study, Harten et al observed that the time to loss of pinprick sensation to T₆ level was faster with the fixed dose regimen (p = 0.01). This difference with our findings might be due to use of Diamorphine as an adjuvant and a larger volume of hyperbaric bupivacaine (2.4 ml). Both these factors may contribute to the early loss of sensation at T₆ in their study. Similar observation has been reported by Subedi et al who used sole 0.5% hyperbaric Bupivacaine either fixed dose (11 mg) or adjusted dose according to height and weight of parturient from Harten’s chart. In their study, the median onset time for the target spinal block of T₆ was significantly (p = 0.01) prolonged in adjusted dose (6 minutes vs. 4 minutes) which might be due to little more volume (1.8 ml) than our study (1.63 ± 0.16 ml).

Three patients (10%) from AD group were converted to general anaesthesia due to inadequate block. Failure to attain T₆ level might have been due to inadequate volume of local anaesthetic in that particular patient. This result is found to be different from the studies of Harten et al and Subedi et al where the conversion to general anesthesia was nil. As the drug was prepared and injected with standard technique without encountering any problem with lumbar puncture, inadequate blockade in our study might have happened due to low volume, inadequate drug spread and failure of drug action on the nerves.
Analgesics were supplemented on patients’ demand in 20% of FD group and 43.33% of AD group which were requested mainly due to rectus muscle traction or epigastric pain during uterine manipulation. However, distribution of patients requiring supplemental analgesics was statistically insignificant (p=0.052). This finding is comparable to the study done by Harten et al and Subedi et al. Ketamine and Fentanyl were chosen for intraoperative supplementation of analgesia. In low dose, Ketamine produces minimal maternal respiratory depression and does not depress the neonate.

Hypotensive episodes were noted in 63.33% of FD group and 50% in AD group of the current study, however, the distribution was statistically insignificant (p = 0.29). Despite having hypotensive episodes, acceptable and similar Apgar scores at 1 minute and 5 minutes of the newborns were noted. However, Harten et al and Subedi et al found less hypotensive episodes in the adjusted dose group.

In the present study conducted in parturient, despite having presumably low CSF volume due to pregnancy, the parturients in the adjusted dose group had a wide variability in the spread of intrathecal hyperbaric Bupivacaine, ranging from high block to inadequate block. These findings may be explained by individual peculiarities in the parturients’ spinal anatomy, changes in lumbar lordosis and in the volume and density of the CSF. Studies aimed at determining the effect of three interdependent variables- dose, volume and concentration- on block height are difficult to conduct and interpret because it is not possible to change one variable without simultaneously changing another. It is estimated that CSF volume accounts for 80% of the variability in peak block height and regression of sensory and motor blockade. High CSF volume probably dilutes the given intrathecal drug and contributes to less spread of the drug so in conditions where CSF volume is low, the spread should be more. In a prospective study done by Danelli et al, they demonstrated that a dose as low as 0.06 mg of intrathecal Bupivacaine per cm of height was sufficient for providing effective spinal block in 95% of parturients undergoing elective caesarean section.

Several limitations have been noted in this study. First of all, the visual analog scale (VAS) was not assessed intraoperatively when the patients complained of pain because they were anxious and uncooperative. Quality of intraoperative surgical anaesthesia was not studied. The umbilical blood gas analysis of the newborn was not done due to economical factor. Last but not the least, regressions of sensory dermatomal levels and motor blockade were not noted.

The volume of local anaesthetic used in this study by utilizing Harten’s chart might not be adequate in our subset of population which led to intraoperative distress (secondary to traction pain) in the patients. So, we would like to recommend the use of conventional volume of hyperbaric Bupivacaine except for extremes of height and weight or the use of adjuvants along with local anaesthetics to decrease associated visceralgia. Further large multicenter randomized control trial along with the use of adjuncts in height and weight adjusted volume of Bupivacaine may need to draw better result.

CONCLUSION

It can be concluded that there were no significant differences in the haemodynamic parameters and block characteristics between adjusting the volume of intrathecal 0.5% hyperbaric Bupivacaine according to Harten’s chart, as compared to administering the fixed volume for spinal anaesthesia in elective caesarean section. The risk of intraoperative hypotension did not significantly decrease in adjusted volume group. The suitable dose of 0.5% hyperbaric Bupivacaine for adequate spinal anaesthesia in our context is yet to be established.

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REFERENCES


