The Effect of Height and Weight Adjusted Dose of Intrathecal Hyperbaric Bupivacaine for Elective Caesarean Section

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ABSTRACT

Introduction: The study compared spinal anesthesia using intrathecal hyperbaric bupivacaine between height and weight adjusted dose and fixed dose during caesarean section.

Methods: A hundred parturients, who had given their consent and were scheduled for elective caesarean section under spinal anesthesia, were randomly assigned into two groups. We adjusted the intrathecal dose of heavy bupivacaine (0.5 %) according to the height and weight of patients (Group AD) from Harten's dose chart developed from the Caucasian parturients and the fixed dose (2.2 ml) was used in Group FD patients. Keeping the observer blinded to the study groups, the onset time to sensory block up to T5, haemodynamic changes, side effects, and fetal outcome were observed.

Results: The median onset time of spinal block in Group FD was faster than in Group AD (6 min vs. 4 min; $p = 0.01$). The spinal block level extended above T3 level in a significantly ($p < 0.05$) larger number of patients 12 (24 %) in Group FD than in one (2 %) patient in Group AD. A significantly ($p < 0.05$) larger number of patients, 32, (64 %) in Group FD had hypotension than in 15 (30 %) patients in Group AD. The lowest recorded SAP (101 ± 6 mm Hg) in Group AD was higher than in Group FD (96 ± 6.7 mm Hg). Nausea and vomiting were more pronounced in Group FD patients.

Conclusions: The bupivacaine dose was significantly reduced on its dose adjustment for the body weight and height of patients for cesearean section. This adjusted-dose use suitably restricted spinal block level for cesarean section with a distinct advantage of less hypotension and with a similar neonatal outcome as fixed compared with the dose use.

Keywords: *caesarean section, low-dose hyperbaric bupivacaine, spinal anesthesia*

INTRODUCTION

The commonly observed hypotension during spinal block, if uncorrected, causes adverse effects on the mother[1] and the neonate.[2] The means to reliably prevent maternal hypotension under spinal anesthesia continues to elude the practicing anesthetists. Thus, one of the important methods to reduce haemodynamic changes would be to limit wide spread sympathetic block during spinal anesthesia. This can be achieved by restricting the spinal segment block desired for a caesarean section. While some studies have identified the patient's height and the sensory block level as risk factors for the hypotensive episodes in the mother during caesarean

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section [3,4], others have been inconclusive.[5,6] Nevertheless, the use of a dose of hyperbaric bupivacaine adjusted to patient's weight[7] and height [7,8] has shown to limit the spinal segment block spread. The dose adjustment study has been based on a Caucasian population. No such study has been based on Nepalese women, where height in generally shorter than that of Caucasian women. Thus, the aim of our study was to compare the spinal blockade characteristics, maternal adverse effects and neonatal outcome between adjusted versus fixed dose regimen in women undergoing cesarean section in our university hospital, the BP Koirala Institute of Health Sciences.

METHODS

This prospective, randomized, double-blinded, clinical study was conducted at BP Koirala Institute of Health Sciences, from January 2006 to August 2007. After approval of the study by the Ethics Committee of the institute and obtaining a written informed consent from the mothers, patients in the criterion of the American Society of Anesthesiologists' Physical Status I and II[9] With full term uncomplicated singleton gestation scheduled for elective caesarean delivery under spinal anesthesia were enrolled in the study. Patients with pre-existing or pregnancy-induced hypertension, cardio-respiratory problem and any contraindication to spinal block were excluded from the study. Since the Harten et al table of bupivacaine dose adjustment is limited between 50 to 110 kg body weight and 140 to 180 cms of height, patients out of this range were also excluded from the study.

The patients were divided randomly into two groups of 52 patients each, using a computer-generated random number list. The patients were not aware of the group that they were in and the observer was also kept blinded for the bupicaine dose injected by the independent anaesthesiologist giving the spinal block. Group AD (adjusted dose) received intrathecal heavy bupivacaine (0.5 %) according to the height and weight of patient. a calculated from the Harten's dose chart developed from Caucasian parturients (Table 1), and a fixed dose (2.2 ml, 11 mg) was used in Group FD (fixed dose) patients.

All the patients were premedicated with intravenous metoclopramide (10 mg) and ranitidine (50 mg) injections intravenously, 20 minutes before surgery. In the operation theatre, pulse oximetry, ECG (lead II) and non-invasive blood pressure (NIBP) were monitored. After recording the baseline haemodynamic values, a preloading infusion of Ringer's lactate (10 $ml.kg^{-1}$) was given over 15 minutes through a peripheral 18-gauge intravenous cannula. Oxygen was administered at a flow rate of 5 $L.min^{-1}$ through a Hudson face mask. Under full aseptic precautions and after a skin infiltration with 2 % plain lidocaine, a 25-gauge Quinke spinal needle (Spinocan®; B.Braun, Melsungen, Germany) was inserted into the L_2-L_3 or L_3-L_4 intervertebral space with the in the left lateral position. After confirming a free flow of cerebrospinal fluid (CSF), hyperbaric bupivacaine (0.5 %) was injected at a rate of approximately 0.2 ml/sec intrathecal according to the group allocated by an anesthetist not involved in the study. The patients were then turned to the supine position with a left lateral tilt with a folded towel beneath the right pelvic region.

Table1. Adjusted dose regimen for hyperbaric bupivacaine 0.5 % for caesarean section under spinal anesthesia (values are in milliliters) [8]

Patient Weight (kg)	Patient height (cm)								
	140	145	150	155	160	165	170	175	180
50	1.5	1.7	1.8	1.9					
55	1.5	1.6	1.8	1.9	2				
60	1.4	1.6	1.7	1.8	2	2.1			
65	1.4	1.5	1.7	1.8	1.9	2.1	2.2		
70	1.3	1.5	1.6	1.8	1.9	2	2.2	2.3	
75		1.4	1.6	1.7	1.9	2	2.1	2.3	2.4
80		1.4	1.5	1.7	1.8	2	2.1	2.2	2.4
85			1.5	1.6	1.8	1.9	2.1	2.2	2.3
90			1.4	1.6	1.7	1.9	2	2.2	2.3
95				1.5	1.7	1.8	2	2.1	2.3
100				1.5	1.7	1.8	1.9	2.1	2.2
105					1.6	1.7	1.9	2	2.2
110						1.7	1.8	2	2.2

The sensory block (loss of sensation to pinprick) was assessed along the mid-clavicular line every minute using a 24-gauge sterile needle, SAB for the first 10 minutes, and then at two minutes, interval for the next 20 minutes. The skin incision was allowed when the spinal block reached up to the thoracic (T_5) level. If the desired level of block failed at the end of 10 minutes, the patients were positioned in the 10^0 head down tilt to attain the desired block level of T_5. After the intrathecal injection, heart rate, arterial blood pressure and oxygen saturation were recorded at intervals 2.5 minutes for 15 min and then at five minute intervals till the end of surgery.

Intraoperative pain was assessed with a 10 - cm linear visual analogue scale (VAS), where 0 represented 'no pain' and 10 represented 'most severe pain'. Patients reporting intraoperative pain of VAS 3 - 7 were treated with a 0.25 mg/kg^{-1} intravenous bolus dose of ketamine. If the pain still persisted, (VAS $\geq$ 7), conversion to general anesthesia with a tracheal intubation was done and the patient was excluded from the study. The quality of intraoperative anaesthesia was graded as "excellent" if the patient had no pain during surgery, "good" if there was minimal pain (VAS = 0 - 3) but required no supplementary analgesia, "fair" when VAS > 3 and needed intravenous ketamine 0.25 mg/kg^{-1} and "poor" if conversion to general anesthesia was required.

Lactated Ringer's solution was used as the maintenance fluid during operation. After delivery of the baby and cord clamping, a slow bolus of 5 U of oxytocin was administered followed by an infusion of 10 U hr-1. Hypotension was defined as a fall in systolic arterial pressure (SAP) by more than 20 % from the baseline value and was treated with an intravenous bolus of mephentermine (6 mg). Bradycardia (heart rate < 50 beats.min-1) was treated with intravenous atropine (0.6 mg). The incidence of other adverse effects was also noted. Neonatal outcome was evaluated using Apgar score at 1 and 5 minutes by a pediatrician unaware of the group assigned to the patient.

A prospective power analysis based on a previous study[7] showed that at a power of 0.8 and p < 0.05, a sample size of 50 patients per group would be required to detect a difference of 25 % in the incidence of hypotension between the two groups. To allow for any loss in the number of patients, the sample size was increased to 52 patients in each group. All data were entered in a database of the statistical program SPSS-11.5 for Windows (Chicago, IL) for analysis. The data are presented as median (range), mean (SD) or frequencies as appropriate. Continuous variables were analysed by the one-way ANOVA test. Categorical data were analyzed with Pearson Chi square test or Fisher Exact test as appropriate. Not normally distributed data such as maximum block height were analysed by Mann Whitney U test. A p value of < 0.05 was considered significant.

RESULTS

Out of 132 consecutive eligible patients, 104 consented to participate in the study (Fig 1). Among them, two patients in each group were excluded from the study for the following reasons: spinal failure in three patients, PPH in one patient. Hence, altogether 50 patients in each group were analyzed. The two study groups were similar in terms of patient characteristics (age, weight, and height), blood loss, duration of surgery and baseline SAP (Table 2). On dose adjustment for height and weight, a significantly (p = 0.001) smaller amount of heavy bupivacaine [median (IQR); 9 (8 - 9.5) mg] was given intrathecally than given to the fixed dose group patients [11 (11 - 11) mg] (Table 3).

The median onset time for the target spinal block of T_5 was significantly (P=0.01) prolonged in group AD than in Group FD (6 minutes vs. 4 minutes). In Group FD, the maximum block level extended above T_3 in 12 (24 %) patients while it did so in one (2 %) patient in Group AD (Table 3). Six (12 %) patients in Group AD required a head -down tilt after 10 minutes of intrathecal injection to attain T_5 block height as compared to 1 (2 %) patient in the Fixed Group. Although there were no significant differences between the groups in the quality of intraoperative anesthesia, 4 (8 %) parturients required supplementary analgesia with IV ketamine in Group AD patients (Table 3). However, none of the patients in either group required conversion to GA.

Table 2. Patient characteristics, surgical data and baseline SAP.

	Fixed-dose Group (n = 50)	Adjusted-dose Group (n = 50)	p-value
Age (yrs)	25.1 (4.2)	24.9 (4.3)	0.920
Height (cm)	152.2 (5.1)	150.3 (4.7)	0.653
Weight (kg)	59.3 (7.2)	58.6 (7.3)	0.824
Blood loss (ml)	550 (33.2)	510 (29)	0.724
Maintenance fluid (ml)	1627 (142)	1631 (129)	0.898
Duration of surgery(min)	60.5 (3.4)	60 (3.2)	0.463
Baseline systolic arterial pressure (mmHg)	123.2 (9.1)	122.1 (9.7)	0.768

Values are mean (SD)

Table 3. **Bupivacaine dose, spinal block characteristics and efficacy**

	Fixed-dose Group (n = 50)	Adjusted-dose Group (n = 50)	p-value
Bupivacaine dose (mg)	11 (11 - 11)	9 (8 - 9.5 [7.5 - 10])	0.001
Time to T5 (min)	4 (4 - 6 [3 - 10])	6 (5 - 7 [4 - 12])	0.01
Max cephalad spread	T3 (T2 – T4 [T1 - T5])	T4 (T3 – T5 [T2 - T5])	0.024
Block beyond T3			0.002
T2	9 (18 %)	1 (2 %)	
T1	3 (6 %)	0	
Quality of intraoperative anesthesia			0.113
Excellent	39 (78)	30 (60)	
Good	10 (20)	16 (32)	
Fair	1 (2)	4 (8)	
Use of 100 head down to get desired block	1 (2)	6 (12)	0.112
Supplementary analgesia	1 (2)	4 (8)	0.181

Values are median (IQR [range]) or number (percentage)

Table 4. **Haemodynamic data, adverse effects and APGAR score**

	Fixed-dose Group (n = 50)	Adjusted-dose Group (n = 50)	p-value
Lowest SAP (mm Hg)	96.5 (6.74)	101.6 (6)	0.02
Hypotension episodes	32 (64 %)	15 (30 %)	0.001
Mephentermine (mg)	9 (3-12 [0 - 15])	6 (0 - 9 [0 - 12])	0.003
Nausea	13 (26 %)	4 (8 %)	0.017
Vomiting	8 (16 %)	2 (4 %)	0.045
Bradycardia	5 (10 %)	2 (4 %)	0.240
Shivering	4 (8 %)	2 (4 %)	0.478
Apgar score			
1 (min)	9 (9 - 9 [6 -10])	9 (9 - 9 [7 - 10])	0.326
5 (min)	10 (9 - 10 [8 - 10])	10 (9 - 10 [9 - 10])	0.524

Values are mean (SD), median (IQR [range]), number (percentage)

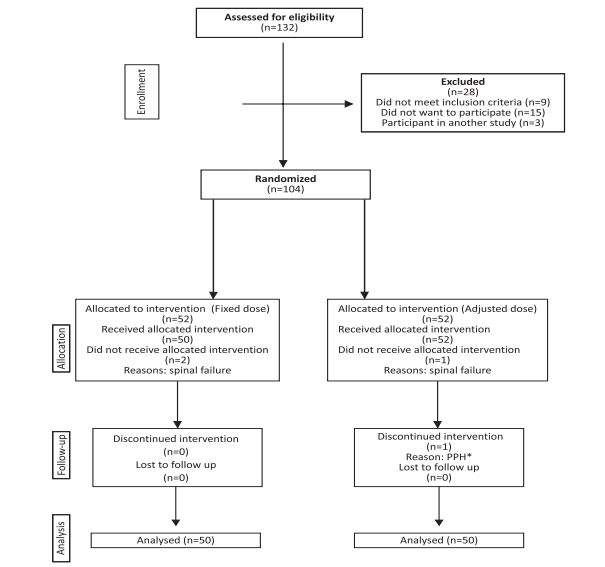

Figure 1. A flow diagram showing inclusion, exclusion and randomization of participants.
*PPH, postpartum haemorrhage

The minimum recorded SAP in Group FD was 96.5 ± 6.74 mm Hg as compared to 101.6 ± 6 mm Hg in Group AD ($p = 0.02$) (Table 4). A significantly ($p < 0.01$) large number of patients in Group FD [32 (64 %)] had hypotension than in Group AD [15 (30 %)]. Vasopressor requirement was more in the FD group (9 mg versus 6 mg in the AD group; $p = 0.003$). Nausea and vomiting were more frequent in Group FD than in Group AD. One patient in the fixed-dose group developed a very high block above T_1 and had difficulty in breathing. The incidence of bradycardia and shivering was similar in patients of both the groups. Apgar scores of the newborns were similar in the two groups at 1 minute and 5 minutes.

DISCUSSION

The main finding of our study was that the dose adjustment of intrathecal heavy bupivacaine on the basis of the Harten chart significantly reduced bupivacaine requirement for caesarean section. It restricted sensory block to the lower spinal segments but delayed the

onset time for the desired spinal block for caesarean section. However, the quality of anesthesia and the baby outcome were similar in both the dose-adjusted and fixed-dose groups. The incidence of hypotension and the need for the use of a vasoconstrictor was more in the fixed dose group patients than in the dose-adjustmented group.

Thoracic block up to T_5 for loss of pinprick sensation has been accepted for caesarean section.[10,11] So the dermatome T_5 block was targeted before allowing surgery. Our observation of a delayed onset time on bupivacaine dose adjustment for the patient's height and weight was similar to the study by Harten et al.[7] Perhaps the lesser spinal doses of heavy bupivacaine in the adjusted group delayed the onset of the block.

Till date, several studies [12-14] have been conducted to establish the minimal but adequate dose of intrathecal bupivacaine for caesarean section to limit the adverse effects related to spinal anesthesia. Nevertheless, the use of the median dose of 9 mg (1.80 ml) in the adjusted group was at the lower normal recommended dose of bupivacaine for spinal anesthesia in cesarean section.[15,16] So the spinal anesthesia was adequate in the majority of our patients. Only three patients in the dose-adjusted group complained of visceral pain during peritoneal closure and there required intravenous ketamine supplementation.

Moreover, Asian women are usually shorter in height than European women.[17] Nagata et al [11] have reported that a smaller dose (8 mg) of bupivacaine (0.5 %) produced an adequate surgical condition for caesarean section in Japanese women, whose frames are generally smaller than that of Caucasian women. Similarly in our patients, who too have smaller body frames, the height-and-weight based median dose of 9 mg of bupivacaine was effective for caesarean section.

The relatively lower dose of bupivacaine use in the adjusted group restricted spinal block segments and the extent of sympathetic block. Thus, it improved the safety margin of haemodynamic effects seen after spinal anesthesia. Other studies have also reported better haemodynamic stability after a dose adjustment of heavy bupivacaine according to the height and weight of patients.[7,8] Although haemodynamic parameters were maintained better in the dose-adjusted group of patients, the babies of both groups demonstrated similar Apgar scores. A similar study with a much larger number of patients and an evaluation more sensitive and more objective than the short-term Apgar score might produce more enlightening results.

Our observation of a higher incidence of hypotension in the fixed-dose group patients with the greater incidence of higher spinal block level (above T_3) again reaffirmed that the high level of spinal block is the potential risk factor for the intraoperative hypotension.[3,4] Other intraoperative side effects like nausea and vomiting during neuraxial anesthesia in caesarean section is multifactorial.[18] The high incidence of nausea and vomiting in the fixed-dose group of our study could be attributed to the greater reduction in arterial blood pressure in the fixed-dose intrathecal block. A dramatic reduction in incidence of nausea and vomiting with controlled arterial blood pressure[19-21] further explains a reduction in the incidence of nausea and vomiting in patients where the bupivacaine dose was adjusted for the height and weight, with better haemodynamics.

A recent study [22] conducted in Thailand revealed that the short stature of the patients and spinal anesthesia performed by non-anesthesia personnel were among the risk factors associated with cardiac arrest following spinal anesthesia. In developing countries like ours, due to a lack of anesthesiologist, regional anaesthesia is still performed by general practitioners (GPs) or inadequately trained personnel. They might be unaware about the life-threatening complications related to spinal anesthesia with the use of an unadjusted dose of bupivacaine in short stature parturients. The use of height and weight dosing charts by them for caesarean section anesthesia can be relatively safe. Our study has the limitation of the small group of patients studied and a multi-centre trial is needed before making any recommendations for the GP practicing spinal anaesthesia and surgery in Nepal.

CONCLUSIONS

Our study has highlighted that the heavy bupivacaine dose adjusted on the basis of the chart of Harten significantly decreased the bupivacaine dose requirement though the chart was developed upon Studies of caucasian women. Yet, it was more effective in our patients for its selective segmental spinal spread of the block than the uniform dose used. The authors wish to suggest use of a modified dose of heavy bupivacaine, according to the weight and height chart, for its distinct advantages of a lesser incidence of hypotension and nausea and vomiting during cesarean delivery.

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