

Spinal anaesthesia for caesarean section: plain vs hyperbaric bupivacaine

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Abstract

Objective: To compare the clinical characteristics of sensory and motor block as well as haemodynamic stability using plain and hyperbaric bupivacaine in spinal anaesthesia for caesarean section.

Methods: Two equal groups were formed from a total of 60 patients who were enrolled in this prospective randomised double-blinded study that was done at tertiary care hospital in Karach, during 2005 to 2006. Equal volume of plain and hyperbaric bupivacaine 10mg with 25 mcg of fentanyl was used for spinal anaesthesia in the two groups that were formed on the basis of random allocation. Characteristics of sensory and motor block, episodes of hypotension and bradycardia as well as use of ephedrine and atropine were recorded by blinded investigator.

Results: There was no difference in the onset of block, time to achieve maximum level of block and haemodynamic parameters between the two groups. However, plain bupivacaine took more time for two dermatomes sensory level regression below T4, and resulted in prolonged block duration. No statistically significant difference was found for episodes of hypotension, bradycardia and use of ephedrine and atropine.

Conclusions: In obstetric population, both plain and hyperbaric bupivacaine 10mg, with fentanyl produced adequate anaesthesia for caesarean section without any differences in the time of onset, extent of the block and haemodynamic parameters. However, sensory level regression was delayed in the plain group which may have caused prolonged duration of block.

Keywords: Spinal anaesthesia, Caesarean section, Plain and hyperbaric bupivacaine. (JPMA 62: 807; 2012)

Introduction

Local anaesthetic agent bupivacaine is widely used for spinal anaesthesia mainly as plain or hyperbaric solution.^{1,2} Plain bupivacaine is slightly hypobaric at body temperature, but is frequently referred to as isobaric. In non-obstetric population, hyperbaric bupivacaine is known to achieve higher sensory levels than an equal dose of bupivacaine of other baricities, while plain bupivacaine may cause unpredictable spread and often attains sensory level to cervical dermatomes.³

Both bupivacaine solutions, plain and hyperbaric, have been evaluated for spinal anaesthesia in the obstetric population. The majority of previous work did not show any effect of baricity on the drug spread within the cerebrospinal fluid in the obstetric population.⁴ This is probably due to gravid uterus that causes general flattening of the spinal column with the loss of thoracic depression. However, studies have found that hypobaric bupivacaine produces a higher sensory level than hyperbaric when spinal anaesthesia was induced in sitting position.^{5,6}

Previous controversial results in literature regarding baricity of local anaesthetic solution for spread

of drugs and the current trend of adding lipophilic opioids, e.g. fentanyl, as adjunct to bupivacaine for spinal anaesthesia have shown concerns for the predictability of the sensory level of the block for caesarean section.⁷

For spinal anaesthesia, commercial preparation of plain bupivacaine (slightly hypobaric) and hyperbaric bupivacaine are more popular than hypobaric bupivacaine. This may be due to the erratic availability of commercial hypobaric bupivacaine. Considering this, we designed the study to examine plain and hyperbaric bupivacaine only. In the study, we compared the block characteristic, including onset, level and regression of spinal anaesthesia by plain and hyperbaric bupivacaine solutions with fentanyl in our obstetric population. The motor block characteristic and haemodynamic stability were also compared.

Patients and Methods

The study was conducted in a tertiary care hospital in Karachi, during the year 2005 to 2006. After approval from the hospital ethics committee, informed and written consent from individuals, we enrolled 60 patients in this prospective, randomised, double-blinded study. The sample size of 60 was required to obtain a power of 0.8 to

detect the difference in the spread of local anaesthetic drugs to achieve the desired sensory level for surgical incision.

Patients coming for elective caesarean section without any co-morbid with gestational age of more than 37 weeks were eligible for the study. Patients were excluded from the study if they had history of pre-eclampsia, placenta previa, multiple pregnancy, weight >85kg, height <150cm or >170cm, and any contraindications for regional anaesthesia.

Using sealed envelopes, the patients were randomly allocated to receive either plain bupivacaine (PBB) or hyperbaric bupivacaine (HBB) for spinal anaesthesia induced in sitting position. For blinding purpose, the primary anaesthetist was responsible for patient randomisation and induction of spinal anaesthesia, while the other investigator (unaware of group allocation) was responsible for data collection. For the purpose of double-blinding, the patients were also kept unaware of group allocation.

After the initiation of standard monitoring i.e. non-invasive blood pressure (NIBP), ECG and Pulse oximetry, all patients were preloaded with Ringer's lactate 10-15 ml/kg. Under all aseptic conditions, spinal anaesthesia was instituted in sitting position with a 25-G pencil-point spinal needle at L2-3 or L3-4 inter-space level keeping bevel direction cephalad. After correct needle placement, as identified by free flow of CSF, bupivacaine 10mg (either plain or hyperbaric according to randomisation) with 25mcg fentanyl as 2.5ml solution was given over 5 seconds. The anaesthetic solution, either plain or hyperbaric bupivacaine, was prepared as 2ml of 0.5% w/v commercially available plain or hyperbaric bupivacain with 25mcg of fentanyl in 0.5 ml of normal saline (total volume of 2.5 ml).

Immediately after the spinal injection, the parturients were gently assisted to lie in supine position with left uterine displacement. An investigator, who was blinded to group allocation, recorded sensory, motor and haemodynamic parametres every two minutes for the first 10 minutes, every five minutes until 20 minutes and thereafter every 10 minutes throughout the surgery. These parameters included upper sensory level using loss of sensation to ice, degree of motor block according to the Bromage scale (0= no motor block, 1= inability to raise extended legs, 2= inability to flex knees, 3=inability to flex ankle joints), heart rate and systolic and diastolic blood pressure. We also monitored the patients for other side effects: nausea, vomiting and pruritis.

Surgical incision was allowed as soon as the block achieved T4-T6 level. Supplementary oxygen 4L/min via

a facemask was given. If the systolic blood pressure decreased to values lower than 100 mmHg or by more than 25% of the baseline, ephedrine was given in supplements of 5mg. If the parturient developed bradycardia (HR < 60/min), we treated with atropine 1mg. For intra-operative discomfort, IV fentanyl as an increment of 20mcg or general anaesthesia was kept on standby.

Additional data were also collected in the recovery room as sensory level (2 segments regression), motor block (Bromage scale), blood pressure (systolic, diastolic) and heart rate on arrival and then after 10, 20, 30, 40, 50 and 60 minutes. Injection pethidine 10mg supplement in incremental manner was reserved for rescue analgesia in the recovery room.

The data was gathered and analyzed with the help of the Statistical Package for Social Sciences (SPSS) version 13.0 by the principal investigator. Descriptive statistics in terms of means of standard deviation and standard errors were calculated. Independent samples t-test was used to find the difference in mean for regression in sensory block, duration of motor block, maximum extent in sensory and motor blocks and age, weight and height between the groups. Repeated measures ANOVA was used to compare mean systolic, diastolic blood pressure and heart rate at different times during and after the surgery. Student's t tests were used to compare significance for sensory block at T4 level in study groups. Kaplan Meier was used to estimate the mean duration of surgery for right and left sensory block in the two groups. Difference in frequency of complications was evaluated by Chi-square test. A p value of 0.05 or less was considered statistically significant.

Results

Both the study groups were compared for age, weight, height, body mass index and the duration of surgery (Table-1). The groups were similar for the onset of sensory and motor block (Table-2). In group PBB (plain bupivacain) 28 of the 30 patients and in group HBB

Table-1: Demographic characteristics of the patients and the duration of surgery.

Variables	Group PBB (Mean ± SE)	Group HBB (Mean ± SE)	p-value
Age (years)	28.57 ± 0.81	29.50 ± 0.77	0.405
Weight (kg)	73.33 ± 1.63	70.416 ± 1.93	0.253
Height (cm)	157.906 ± 1.05	156.383 ± 0.998	0.297
BMI (Body Mass Index)	29.4771 ± 0.69	28.776 ± 0.73	0.487
Duration of surgery (minutes)	61.33 ± 1.96	57.67 ± 2.13	0.210
Group size	30	30	

SE = Standard Error, PBB = Plain bupivacaine, HBB = Hyperbaric bupivacaine, BMI = Body mass index.

Table-2: Comparison of sensory and motor block characteristics between the two groups.

Variables	Group PBB (Mean ± SE)	Group HBB (Mean ± SE)	p-value
Time for onset of sensory block (mint)	5.90 ± 2.553	5.00 ± 0.447	0.254
Time for onset of motor block(mint)	3.70 ± 1.567	3.23 ± 2.176	0.760
Time for maximum extent of sensory block(mint)	6.50 ± 0.57	6.97 ± 0.55	0.558
Time for maximum of motor block (mint)	6.03 ± 0.441	6.67 ± 0.526	0.360
Regress of 2 segments sensory block (mint)	86.23 ± 4.677	69.33 ± 3.074	0.004
Duration of motor block (mint)	164.03 ± 5.78	158.90 ± 4.64	0.492

SE = Standard Error, PBB =Plain bupivacaine, HBB = Hyperbaric bupivacaine.

Table-3: Comparison of the number of episodes of hypotension and bradycardia, use of additional fluid boluses and use of ephedrine between PBB and HBB groups.

Variables	Group PBB (Mean ± SE)	Group HBB (Mean ± SE)	p-value
Number of episodes of hypotension	2.33 ± 0.396	2.20 ± 0.468	0.829
No: of episodes of bradycardia	0.10 ± 0.056	0.30 ± 0.236	0.412
Use of ephedrine (mg)	4.50 ± 1.504	5.50 ± 1.815	0.637

SE = Standard Error, PBB =Plain bupivacaine, HBB = Hyperbaric bupivacaine.

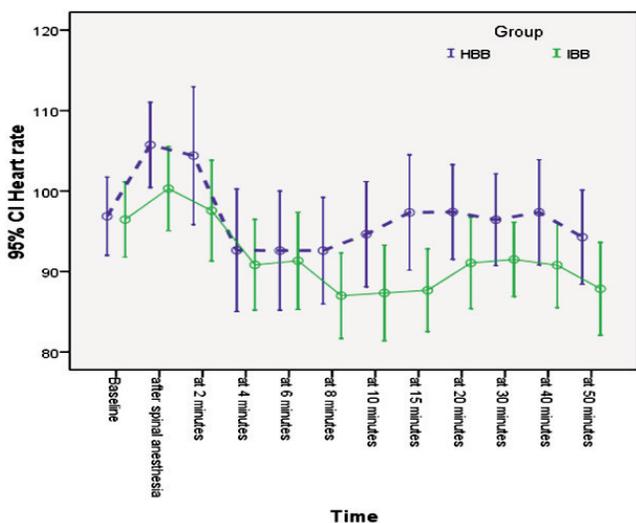


Figure-1: Comparison of mean heart rate between PBB and HBB groups intra-operatively.

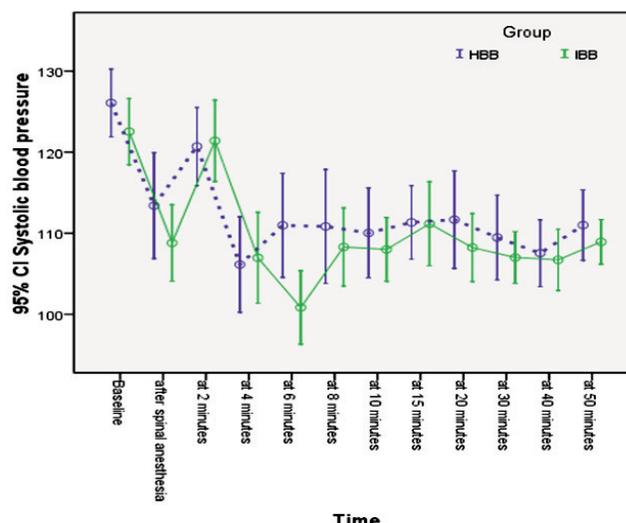


Figure-2: Comparison of mean systolic blood pressure between the two groups intra-operatively.

(hyperbaric bupivacain) 29 out of the 30 achieved T4 level with no statistical significance (p-value>0.9999). In PBB group, the mean time required to achieve maximum extent of sensory block was 6.50 minutes and in HBB 6.97 minutes, with no statistical significance (p value 0.558). All patients in both the groups achieved Bromage scale 3. In group PBB the maximum extent of the motor block was achieved in 6.03 minutes, while in HBB group it took 6.67 minutes with no statistically significant difference (p= 0.360).

No statistically significant difference was found in

the heart rate and systolic blood pressure between the two groups at any stage (Figure-1 and 2). For the diastolic blood pressure, both the groups were very well matched at all study timings. However, significant difference was found from baseline reading to the end of surgery with the passage of time (p =0.001). This trend was matched in both the groups with no statistical difference (p 0.24) (Figure-3). There was no difference between the two groups regarding the number of episodes of hypotension and bradycardia. Similarly, the use of ephedrine was also statistically insignificant (Table-3). None of our patients

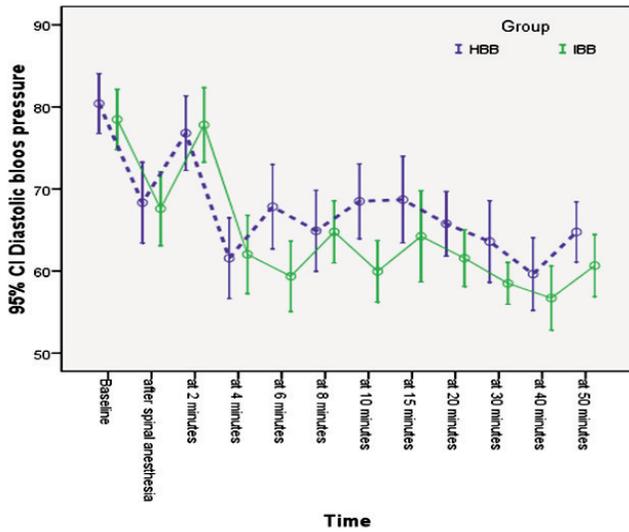


Figure-3: Comparison of mean diastolic blood pressure between the groups intra-operatively.

required supplementary analgesia or atropine in either group.

Two dermatomes regression below T4 was 69.33 minutes for HBB group as compared to 86.23 minutes for PBB. This is statistically significant ($p = 0.004$). Insignificant difference was found in the mean duration of motor block in the recovery room between the two groups ($p = 0.492$) No statistically significant difference was found in the mean heart rate, and the systolic and diastolic blood pressure in the recovery room between the two groups.

Discussion

Our study demonstrated that differences in baricity of local anaesthetic solution bupivacain in sitting position did not influence the spread of drug to achieve T4-6 level anaesthesia for caesarean section. Time for the onset of sensory and motor block and time to achieve maximum sensory and motor block were not clinically significant in the study. The findings were different from the effect of hyperbaric and plain bupivacain in non-obstetric population.⁸ However, they were very similar to a study conducted by Russel et al.⁴ This is relatively an old study comparing the baricity of local anaesthetic solution alone without the use of adjunct, e.g. fentanyl. They used in their study bupivacain alone of 12.5mg, while we used 10mg of bupivacain with fentanyl. This may conclude that adding fentanyl can reduce the dose of the local anaesthetic without influencing baricity that eventually determines the spread intrathecally.

Recently a study was conducted by Stephen et al. to

compare the effect of baricity on intrathecal bupivacain spread to identify any influence of patient posture during the induction of spinal anaesthesia, the sitting and lateral positions.⁶ They found that in sitting position, hypobaric bupivacain results in a higher level of block than hyperbaric and isobaric. They used in their study all the three baricities of bupivacain in combined spinal epidural anaesthesia and high level of block in hypobaric can be explained by the time delay from the spinal injection to getting the position to supine after the placement of epidural catheter.

Previous studies have critically reviewed the behaviour of hyperbaric and hypobaric spinal bupivacain in obstetric patients. When the patients are turned supine immediately after injection in the lumbar region, a hyperbaric solution spreads under the influence of gravity down the slope created by the lumbar spinal curvature⁸ and the plain bupivacain which is slightly hypobaric does not have gravity-dependent spread. Therefore, certain other factors must be responsible for the cephalic spread of hypobaric bupivacain. It has been proposed that positional change after spinal injection plays a major role in promoting cephalic redistribution of hypobaric solution, probably due to CSF dynamics associated with caval compression and epidural venous engorgement in parturient.^{4,9} Distension of the veins of the vertebral plexus causes compression of the dura, reduces CSF volume and encourages greater bulk of spread of the injected solution.⁹ The plain solution, being less viscous, mixes rather freely with CSF and thus moves easily through compressed arachnoid space. This analysis accounts for the comparable level of block in both groups in our study.

For caesarean delivery, an adequate level of dermatome T4 has been generally proposed to achieve a pain-free operation.¹⁰ In our study, the level of anaesthesia at T4 level was achieved in all patients bilaterally except one patient in HBB and two patients in PBB where the maximum level were T5 and T6 respectively. But these patients did not complain of any pain intra-operatively. In our study, one patient in the PBB group complained of pressure sensation intra-operatively at the time of birth although sensory block at T4 level was achieved in that patient.

In this study, we examined the local anaesthetic solution of different baricity with the addition of fentanyl. Current literature shows that addition of fentanyl does not alter the block height or extent.^{5,7} However, it may reduce the supplementary analgesia requirement. In our study, we used fentanyl in both the groups and none of our patients required supplementary analgesia. Recently it has also

been claimed that the addition of fentanyl may prolong the duration of the block with hyperbaric bupivacaine.¹¹ This finding does not match with our results as fentanyl addition prolonged the duration in only the PBB group and not in the HBB group. This also showed that the duration of sensory or motor block or regression of block was related to baricity rather than the addition of fentanyl.

Besides, there was no clinically significant difference between the two groups regarding haemodynamic instability, which is supported by a previous study conducted by Srivastava U et al.¹² However, our findings were not comparable with another study⁶ which reported frequent episodes of hypotension and concomitant ephedrine usage in the hypobaric group reflecting high level of anaesthesia .

Another important finding of our study was the early regression of two segments of sensory block in the HBB group. This finding is supported by previous studies, which also concluded that block vanished faster when hyperbaric bupivacaine was used.^{4,7,8}

Our study was a randomized double-blinded trial at power of 80% and examined the two commonly available bupivacain - plain and hyperbaric - rather than hypobaric or isobaric. The small sample size was a limitation of the study.

Overall, our study demonstrated that baricity had no effect on the spread of both plain and hyperbaric bupivacain in achieving satisfactory level of spinal anaesthesia in obstetric population for caesarean section.

Conclusion

Regardless of baricity, 10 mg of bupivacaine with 25mcg fentanyl produces satisfactory level of anaesthesia

for caesarean section without any differences in the time of onset, extent of sensory and motor block and haemodynamic stability. However sensory level regression is delayed with plain bupivacain which may prolong the analgesia in post-operative period. We recommend further work in this area to authenticate the results for future anaesthesia practice.

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