INTRATHECAL ISOBARIC VERSUS HYPERBARIC BUPIVACAINE FOR ELECTIVE CAESAREAN SECTION

SADQA AFTAB, HAMID ALI, SAFIA ZAFAR, MURTAZA SHEIKH, S. TIPU SULTAN
Department of Anaesthesiology & Surgical Intensive Care Unit, Dow University of Health Sciences and Civil Hospital, Karachi

ABSTRACT
Objective: *To compare the results of isobaric bupivacaine (0.5%) with hyperbaric bupivacaine (0.75%) in cases of elective Caesarean Section, in respect of time to sensory analgesia, highest level of sensory block, haemodynamic effects, and complications.*
Design & Duration: *Interventional, experimental study from March 2003 to March 2004.*
Setting: *Department of Anaesthesiology and Surgical Intensive Care Unit, Dow University of Health Sciences and Civil Hospital, Karachi.*
Patients: *Sixty pregnant patients scheduled for elective Caesarean Section.*
Methodology: *The patients were randomly assigned to receive either 0.5% isobaric bupivacaine (Group-IB) or 0.75% hyperbaric bupivacaine (Group-HB) via intrathecal route. The time of onset of block, highest level of sensory block, cardio-respiratory data, duration of analgesia and complications were recorded during surgery.*
Results: *The time taken to reach T4 sensory analgesia in Group-IB was 6±6.43 minutes as compared to 6.93±.7.8 minutes in Group-HB, while the highest sensory level achieved in Group-IB was T1 and in Group-HB T2. The lowest systolic blood pressure recorded in Group-IB was 83.27±12.69 mmHg and in Group-HB 114.33±13.83 mm Hg, the difference being significant ($p<0.05$). There was a higher incidence of complications in Group-IB as compared to Group-HB like high spinal analgesia, vomiting and discomfort.*
Conclusion: *Intrathecal block showed a greater reduction in the systolic blood pressure, and associated complications, with Isobaric Bupivacaine as compared to Hyperbaric Bupivacaine.*

KEY WORDS: *Intrathecal Anaesthesia, Bupivacaine, Elective Caesarean Section*

INTRODUCTION

Intrathecal anaesthesia is very popular for the Caesarean section because it offers a profound and a symmetrical sensory and motor block of high quality, and had many advantages including simplicity, rapid onset, dense blockade and cost effectiveness[1].

Transient neurological symptoms associated with spinal lidocaine are an important factor for the popularity of bupivacaine in spinal anesthesia. Besides, spinal bupivacaine has a longer duration of action than lidocaine[2].

Baricity differences between spinal anaesthetic solutions are thought to produce differences in the distribution of the anaesthetic within the subarchnoid space. Such differences would be expected to effect the extent, onset and duration of the sensory block, as well as side effect and post-operative analgesia.

It is commonly believed that hyperbaric solutions would probably reach a higher thoracic dermatome as opposed to their plain i.e. isobaric equivalents, though practically they reach a lower level. Bupivacaine, especially the isobaric variety, produces anaesthesia which is unpredictable as regards to the extent and duration. The factors which influence the extent of spinal anaesthesia include physical characteristics of the cerebrospinal fluid, such as the volume and density, thus affecting the distribution of the local anaesthetic solution in the subarachnoid

Correspondence:
Dr. Sadqa Aftab, Associate Prof. of Anaesthiology, Dow University of Health Sciences, Karachi.
Res: B-70, Block-L, North Nazimabad, Karachi.
Phones: 0332-3102060.
E-mail: S.T.Sultan@hotmail.com

space, and hence the peak sensory level of spinal anaesthesia[3,4].

Intrathecal anaesthesia with the plain solution is characterized by great variation in the cephalad spread of the block. Report of an excessive rostral spread, even total spinal anaesthesia, after the use of isobaric bupivacaine may explain why its hyperbaric solution is favoured in obstetric anaesthesia[5]. In addition, it has been demonstrated by comparative studies that, unlike non-pregnant patients, the height of a spinal block may not differ with either types of bupivacaine[6,7].

Bupivacaine solutions available in our country are hyperbaric (0.75%) or isobaric (0.5%). This study was undertaken to test the hypothesis that the choice of isobaric versus hyperbaric bupivacaine influences the clinical characteristic of the intra-operative subarachnoid anaesthesia and postoperative analgesia for elective Caesarean section[8].

PATIENTS & METHODS

This quasi expermental, interventional study was conducted by the Department of Anaesthesiology and Surgical Intensive Care at Civil Hospital, Karachi from March 2003 to March 2004 with the approval of the institutional ethical committee.

Sixty pregnant patients (weight 50-80 Kg and height 150-170 cms) undergoing elective Caesarean section were randomized to receive either 0.5% isobaric bupivacaine (Group-IB) or 0.75% hyperbaric bupivacaine (Group-HB) intrathecally, after written, informed consent. Patients with systolic blood pressure greater than 150 mm Hg and with co-morbid diseases were excluded from study.

All patients were given aspiration prophylaxis and preloaded with a crystalloid solution (15ml/Kg); baseline blood pressure, pulse and oxygen saturation were recorded. The patient were placed in the sitting position, and anaesthetized using a 25 gauge Quincke Babcock needle introduced at L3-L4 or L4-L5 interspace via midline approach. After the injection of bupivacaine, the patients were immediately asked to lie down in the supine position with a wedge on the right side. All patients received oxygen by mask throughout surgery and verbal contact maintained at all time during surgery.

Detailed data of all the patients was collected including the age, weight, height, highest sensory analgesia level, time to T4 sensory analgesia, cardiorespiratory status and duration of surgery (skin incision to closure). Blood pressure, heart rate and oxygen saturation were recorded every three minutes for 30 minutes, then every five minutes till the end of surgery. Special note is made of any hypotension (systolic blood pressure <90 mm Hg or fall by more than 20% from baseline value), use of extra fluids and vasoconstrictor agents.

The analgesic level was defined as the cephalad most dermatome at which the patient had no sensation. This was tested by moving a blunt needle below upwards in the posterior midline. The motor block of the lower limb was assessed by Bromage score (0=no block, 1=unable to flex the hip, 2=unable to flex the knee, 3=unable to flex the ankle). Failure to achieve a block and the time period to first analgesia after Caesarean section was also noted.

Statistical analysis was performed using SPSS. Quantitative variables were expressed as mean ± SD (standard deviation), while qualitative variables were expressed as percentages. The demographic data was analyzed by using student t-test and chi-square, while hemodynamic data were analyzed by using repeated measure analysis of variance (ANOVA) for intra-group comparison and student t-test for inter-group comparison. A p-value less than 0.005 was considered significant.

RESULTS

Out of the total 60 patients included in the study, 30 in Group-IB received 0.5% isobaric bupivacaine while the remaining 30 in Group-HB received 0.75% hyperbaric bupivacaine for intrathecal anaesthesia for elective Caesarean section. Both groups were comparable as regards to the age (p-0.473), weight (p-0.831), height (p-0.142) and duration of surgery (p-0.236); significant p-value taken as <0.05 (Table I).

The time to T4 sensory analgesia in Group-IB was 6± 0.64 minutes as compared to 6.93±0.78 minutes in the Group-HB. The volume of bupivacaine used was 2.80± 0.249 and 1.49±0.149 ml in Group-IB and Group-HB respectively. Five (16.6%) patients in Group-IB and one (3%) patient in Group-HB had a failed block. The

Table I. Demographic Data (Mean ± SD)

Character	Gp-IB (30)	Gp-HB (30)
Age (years)	27.33± 2.54	27.50± 4.99
Weight (Kg)	68.13± 9.82	64.10±11.18
Height (cms)	154.70± 5.53	157.07± 4.98
Surgery (mins)	37.44±18.18	33.82±15.97

Variable	Gp-IB (n=30)	Gp-HB (n=30)
Time to T4 sensory analgesia (minutes)	6.00 ± 0.64	6.93 ± 78
Volume of bupivacaine (ml)	2.83 ± 0.24	1.63 ± 0.18
Highest sensory analgesic level	T1	T2
Supplemental analgesic administration	1	--
Failed spinal	5(16.6%)	1(3%)
High spinal (>T3)	2(3%)	--
Intraoperative nausea / vomiting	6	2
Discomfort	8	5
Ephedrine administration	4	2
Time of first request of analgesic postop. (mins)	232 ± 63.97	220 ± 65.6

Table II. Comparison of Outcome (Values are expressed as Mean ± SD)

highest sensory level was T1 in isobaric group and T2 in hyperbaric group (Table II).

The mean systolic blood pressure recorded in Group-IB was 83.27±12.69, which is significantly ($p<0.05$) lower than that in Group-HB (114.33±13.83 mm of Hg); the maximum fall in systolic blood pressure from baseline was 23% in Group-IB and 6.6% in Group-HB. There was no significant difference between heart rate, respiratory rate and oxygen saturation in both the groups (Table III). Indications for Caesarean section in both the groups were mainly cephalopelvic disproportion and malposition (Fig.1).

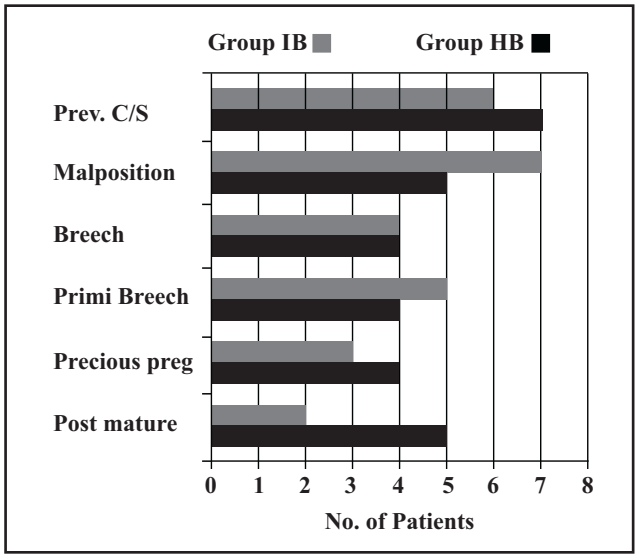

Fig. 1. Indications for Caesarean section

DISCUSSION

Bupivacaine is widely used for intrathecal anaesthesia, mainly as a isobaric 0.5% for Caesarean section, while 0.75% hyperbaric bupivacaine is no longer used in the

Table III. Findings of Intraoperative Cardio-respiratory Monitoring
Values are expressed in Mean±Standard deviation; Significant P-value <0.05;
SBP=Systolic blood pressure; HR=heart rate; R/R=respiratory rate

Variables	Group IB (n=30)	Group HB (n=30)	P-value
Hypotension (SBP <90 mm Hg or <20% from baseline)	83.27±12.69	115.33±13.94	0.01
Bradycardia (HR<60/minute)	82.90±12.87	92.93±11.38	0.10
Respiratory depression (RR<9/minute)	13.63± 1.97	13.70± 1.99	0.21
O2 Saturation (%)	97.97± 1.77	98.03± 1.43	0.19

European countries, though still used in United States and available in Pakistan. Plain bupivacaine is less frequently used for spinal anaesthesia and in principle should be isobaric, but in fact it is slightly hypobaric at 37º C[9,10].

In our study, both 0.75% hyperbaric bupivacaine and 0.5% isobaric bupivacaine produced adequate spinal anaesthesia for elective Caesarean section, though some studies have claimed that the distribution of both solutions within the cerebrospinal fluid seems to be poor. Hence the reason for using generous doses (12.5-15mg) to guarantee desirable surgical anesthesia[11]. Doses less than 10mg carry a substantial risk of inadequate block during Caesarean section, thus necessitating supplementary analgesia because of visceral pain during surgery[12,13]. In this study we used 12 to 15mg of bupivacaine according to the height of the patients ranging from 150 to 160cms respectively.

Clinical effects associated with bupivacaine like the time to sensory analgesia, highest sensory analgesia level, inadequate block, duration of analgesia and complications are thought to be the direct effects of the local anaesthetic present in the subarachnoid space[14]. The time to T4 sensory analgesia in our study was 6±0.64 minutes in Gp IB and 6.93±0.78 minutes in Gp HB. Martin et al[15] concluded that the onset of spinal block was more rapid with isobaric than with hyperbaric bupivacaine. Another study concluded that the addition of fentanyl as an adjunct to hyperbaric bupivacaine shortens the time to achieve the highest sensory level[16,17].

Regarding the behaviour of hyperbaric and isobaric solutions, it is surmised that hyperbaric bupivacaine redistribute to the dependant area of the subarachnoid space and is thus drawn cephalad into the dependant thoracic kyphosis to pool down to lowest part of thoracic curvature, situated around T4-5, while cephalad spread with isobaric bupivacaine is less[18]. The movement of the hyperbaric drug is unaffected by the lumbar interspace chosen for subarachnoid injection. Isobaric solution has been regarded as the most unpredictable of the solutions[19]; excessive rostral spread and even total spinal anaesthesia has been reported with plain bupivacaine, thus explaining why hyperbaric bupivacaine is favoured for obstetric anaesthesia[19]. Isobaric solution consistently redistribute to non-dependent areas, the lumbar lordosis restricts further cephalad redistribution once the supine position is assumed[20].

In our study the highest sensory analgesia level with isobaric bupivacaine was at T1 as compared to T2 with hyperbaric bupivacaine. This could be explained by the fact that the upright position during drug injection is a major factor in promoting cephalad redistribution of the isobaric drug[12]. In pregnant patients the factors effecting distribution of the local anaesthetic solution in cerebrospinal fluid depends on the height of the patient, anatomy of spine, volume and baricity of local anesthetic soluiton and the position of the patient. Altered cerebrospinal fluid dynamics associated with the caval compression, epidural venous engorgement and positional changes plays a major role in promoting the cephalad redistribution of isobaric bupivacaine.

A high level of sensory block observed in the Gp IB in our study as compared to the Gp HB is not unexpected as our patients, who were in a sitting position during injection, were repositioned supine with left tilt, which further contributes to the cephalad progression of the block[18]. Infante et al[21] also confirm that the position of the patient not only influences the spread but also the duration of spinal blockade, as longer duration is associated with restrictive spread of the drug by 30º elevation of torso.

Isobaric and hyperbaric bupivacaine, both produced adequate block as the requirement of supplemental intraoperative analgesic was not significantly different in them; only a single patient in the Gp IB required supplemental intra-operative analgesia i.e. 10mg nalbuphine intravenously.

The duration of analgesia assessed by noting the time to first request for pain medication during the postoperative period was 232±63.97 in the Gp IB and 220 ±65.6 minutes in the Gp HB, which is not significant statistically, a finding similar to that of the study conducted by Richardson et al[6]. Massimo et al[22] on the other hand concludes that the time to first request for pain medication was significantly shorter in the 1% hyperbaric bupivacaine as compared with 0.75% hyperbaric bupivacaine.

Hypotension is the most common complication of spinal anaesthesia for Caesarean section. Vercauteran et al[23] have questioned the value of volume preloading. Attention has been focused on the use of colloids rather than crystalloids as they maintain oncotic pressure of plasma and reduce volume requirement, and hydroxyethyl starch 6% (HES) may reduce the incidence of hypotension during spinal anesthesia to 10%. Russell et al[20] suggested that despite crystalloid preloading and ephedrine 20 mg given prophylactically by the intramuscular route, hypotension was noticed in more than 50% of the patients regardless of the baricity used[24,25]. In our study we used crystalloids 15 ml/Kg, in both the groups. The mean systolic blood pressure recorded in Group-IB was 83.27±12.69 mmHg, while it was 114.33±13.83 mm

Hg in Group-HB, which was statistically significant as the p-value was < 0.05. Phelan et al[5], on the contrary, noted a greater incidence of hypotension in pregnant patients with hyperbaric bupivacaine.

In our study isobaric bupivacaine was associated with an increased requirement of ephedrine, discomfort and vomiting as compared to the hyperbaric bupivacaine. There were two cases of high spinal in Gp IB in comparison to none in the Gp HB, which could be related to higher spread of isobaric solution.

CONCLUSION

The present study demonstrates that both isobaric and hyperbaric bupivacaine offers adequate surgical anaesthesia in patients undergoing elective Caesarean section. There was a higher incidence of hypotension with the isobaric solution. The clinical effects evaluated in our study were unable to detect significant advantages of one preparation over the other.

REFERENCES

1. Kiestin IG. Spinal anaesthesia in obstetrics. Br J Anesth 1991; 66: 596-607.

2. Jankowsk A, Veillette Y. Comparison of differential blockade during spinal anesthesia using Isobaric Vs Hyperbaric Lidocaine 2%. Can J Anesth 2000; 47: 137-42.

3. Higuchi H, Hirata JI, Adachi Y, Kazama T. Influence of lumbosacral CSF density, velocity and volume on extent and duration of Plain Bupivacaine spinal anesthesia. Anesth 2004; 100: 104-14.

4. Gregory H, Johnson N. Density determination of local anesthetic opioid mixture for spinal anesthesia. Can J Anesth 1998; 45: 341-6.

5. Phelan DM, MacEvilly M. A comparison of Hyperbaric and Isobaric solution of Bupivacaine for subarchnoid block. Anesth Intensive Care 1984; 12: 101-7.

6. Richardson MG, Collins HV, Wissler RN. Intrathecal Hypobaric versus Hyperbaric Bupivacaine with morphine for Cesarean section. Anesth Analg 1998; 87: 336-40.

7. Malinovsky JM, Renaud G, LeCorre P, Charles F, Lepage JY, Mainge M, Cozlan A, Bouchet O, Pinaud M. Intrathecal Bupivacaine in humans; influence of volume & baricity of solution. Anesth 1999; 91: 1260-6.

8. DeSimon CA, Leighton BL, Morris MC. Spinal anesthesia for Cesarean delivery: A comparison of two doses of Hyperbaric Bupivacaine. Reg Anesth 1995; 20: 90-4.

9. Lui ACP, Polis TZ, Circutti NJ. Densities of cerebrospinal fluid and spinal anesthestic solution in surgical patient at body temperature. Can J Anesth 1998; 45: 297-303.

10. Richardson MG, Wissler RN. Densities of dextrose free intrathecal local anesthetic, opioid and combination measured at body temperature. Anesth Analg 1997; 84: 95-9.

11. Liu SS, Ware PD, Allen HW, et al. Dose response characteristic of spinal Bupivacaine in volunteers. Anesthesiol 1996; 85: 729-36.

12. Chung CJ, Bae SH, Chae KY, Chin YJ. Spinal anesthesia with 0.75% Hyperbaric Bupivacaine for Cesarean section: Effect of volume. Br JAnesth 1996; 77: 145-9.

13. Chan V, Peng P, Herbert C, Stephen L, Jeremy W, Suzsana K. Determining minimum effective anesthetic concentration of Hyperbaric Bupivacaine for spinal anesthesia. Anesth Analg 2000; 90: 1135-40.

14. Eckert S, Standl T. A comparison of 0.5% Isobaric Bupivacaine with 4% Hyperbaric Mepivacaine mixture and 0.75% Hyperbaric Bupivacaine for single box spinal anesthesia. The Anesthetist 1997; 46: 121-5.

15. Martin R, Frigon C, Chrétien A, et al. Onset of spinal block is more rapid with Isobaric than Hyperbaric Bupivacaine. Can J Anesth 2000; 47: 43-46.

16. Bano F, Shabbar S, Zafar S, Rafiq N, Iqbal MN, Haider S, Aftab S, Sultan ST. Intrathecal Fentanyl as adjunct to Hyperbaric Bupivacaine in spinal anesthesia for Cesarean section. J Coll Physicians Surg Pak 2006; 16: 87-90.

17. Parlow JL, Phyllis M, Philip C, Jemifer R, Brian M. Addition of opioid alter the density and spread of intrathecal local anesthetic? A vitro study. Can J Anesth 1999; 46: 66-70.

18. Huabayashi Y, Shimizu R, Saitoh K, Fakuda H, Igarashi T, Furuse M. Anatomical Configuration of the spinal column in the supine position: Comparison

of adolescent and adult volunteer. Br J Anesth 1996; 76: 508-510.

19. Logan MR, McClure JH, Wildsmith JA. Plain Bupivacaine-an unpredictable spinal anesthetic agent. Br J Anesth 1986; 58: 292-6.

20. Russell IF, Holmqvist EL. Subarchnoid analgesia for Cesarean section: Double blind comparison of Plain and Hyperbaric Bupivacaine 0.5%. Br J Anesth 1989; 59: 347-53.

21. Infante K, Nicoline E, VanGessel E, et al. Extent of hyperbaric spinal anesthesia influence the duration of spinal block. Anesth 2000; 92: 1319-23.

22. Massimo R, Alessandro A, Monica T, Marze H, et al. Spinal anesthesia using Hyperbaric 0.75% versus Hyperbaric 1% Bupivacaine for Cesarean section. Anesth Analg 1998; 87: 1099-104.

23. Vercuateren M, Hoffman V, Copperjan HL, et al. Hydroxyethylstarch compared with modified gelatin as volume preload before spinal anesthesia for Cesarean section. Br J Anesth 1996; 76: 731-3.

24. Jackson R, Reid JA, Thorburn T. Volume preloading is not essential to prevent Spinal induced hypotension of Cesarean section. Br J Anesth 1995; 75: 262-5.

25. Arndt JO, Bomer W, Krauth J, Marquardt B. Incidence of time course of cardiovascular side effects during spinal anesthesia after prophylactic administration of intravenous fluid or vasoconstrictor. Anesth Analg 1998; 87: 347-54.