Original Research Article

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A Comparative Study of Plain and Hyperbaric Solutions of Bupivacaine HCl During Spinal Anaesthesia

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Abstract

Background: Spinal anesthesia is often used for both elective and emergency surgeries. Anesthesia-related mortality is decreased when general anesthesia is avoided. *Aim:* To compare the anaesthetic behaviour and haemodynamic consequences produced by the intrathecal injections of plain and hyperbaric solutions of Bupivacaine with the patients in supine horizontal position. *Materials and methods:* Sixty patients of ASA I – II were divided into 2 groups of 30 each. Group-A was given 3 ml. of -0.5% plain Bupivacaine sub arachnoidally whereas Group-B was given 3 ml. of 0.5% hyperbaric Bupivacaine. *Results:* It was found that extent of sensory blockade was much higher in Group-B as compared to Group-A. The degree of motor blockade was also much more intense in Group-B as compared to Group-A. The duration of analgesia was more in Group-A as compared to Group-B, but the time onset of analgesia was faster in Group-B (hyperbaric). Haemodynamically patients in Group-A were stable due to lesser extent of sympathetic blockade when compared to patients in Group-B. *Conclusion:* Plain Bupivacaine gives a lesser cephalad spread and can be effectively used for lower limb surgeries, it has to be used with caution for lower abdominal surgery as the spread is relatively unpredictable.

Keywords: Bupivacaine; Lower abdominal surgery; Haemodynamic consequences.

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Introduction

Pain is the most common and distressing effect of disease and surgery. It is an unmeasurable entity and has been a challenge and concern for researchers. For good and prolonged analgesia, systemic analgesics are required to be given in high doses and with higher doses the side effects could be disastrous. General anaesthesia mostly necessitates tracheal intubation, administering volatile anaesthetics and muscle relaxants that are potentially dangerous and require a certain degree of expertise in their usage. Centro-neuraxial blocks – spinal & epidural (including caudal) eliminate these problems associated with general anaesthesia and also minimise post-operative complications like vomiting [1,2].

Centro-neuraxial block results in sympathetic blockade, sensory analgesia and motor blockade in that order depending on the dose, concentration and/or volume of local anaesthetic administered. Bupivacaine has emerged as an important local

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anaesthetic drug used for spinal anaesthesia in view of its relatively longer duration of action as compared to Lignocaine and also due to its ability to produce adequate sensory and motor blockade.

In view of substantiating the above studies a study was undertaken with plain 0.5% Bupivacaine and hyperbaric 0.5%, Bupivacaine (with 8% glucose) administered intrathecally in a fixed volume of 3 ml, with the patient in supine horizontal position. Our aim is to evaluate the level of sensory block, the quality of motor block and haemodynamic changes separately with each preparation of Bupivacaine.

Materials and Methods

A clinical study was undertaken using spinal analgesia as an anaesthetic technique and Bupivacaine hydrochloride of 0.5% strength as the local anaesthetic drug of two types of baricity namely plain and hyperbaric.

The baricity of plain solution used was 0.99266 and that of hyperbaric solution was 1.02346. Sixty patients belonging to age groups between 20-50 years of either sex and belonging to ASA I were selected who were undergoing lower abdominal and lower limb surgeries. They had a mean age of 31 years and a mean weight of 54 kg. These patients were divided into 2 groups A & B, consisting of 30 patients each. Patients in group A were given plain Bupivacaine and patients in group B received hyperbaric Bupivacaine. The demographic and pre-anaesthetic haemodynamic data were comparable in both groups.

Detailed history and a complete pre-operative examination were made so as to exclude patients with any systemic disorder, especially neurological disease and bleeding diathesis. All patients were submitted to routine investigations such as urine analysis, complete blood picture, blood sugar, blood urea and blood grouping and tying and informed consent was obtained.

Technical Aspects

Pre-medication, especially with analgesics was avoided as this might influence and modify the haemodynamic changes produced. Pre-operatively the heart rate and blood pressure of the patient was recorded and an intravenous line established with a large bore i.v. cannula in a large peripheral vein and a crystalloid solution such as Ringers lactate infused. Intra-operatively, the heart rate and blood pressure and respirations of the patient were monitored at frequent intervals. Sterility is of vital importance. Since infection introduced from without is a dangerous but completely avoidable complication.

The anaesthesiologist should scrub up as for a surgical operation and wear a sterile gown and gloves. As much as possible of the necessary equipment should be contained in a sterile pack. This includes sterile towels for covering the trolley top and one for the patient, cotton swabs, swab holding forceps, a gallipot for skin cleansing solutions and glass syringes. The patients back should be cleaned widely using spirit and sterile towels draped appropriately.

The patient was placed in the lateral decubitus position with the shoulders and anterior superior iliac spine in straight line, with back parallel to edge of operating table nearest the anaesthesiologist, with thighs flexed on the abdomen and neck flexed. The operating table was adjusted to a horizontal position.

Lumbar puncture was done using midline approach at L 3-4 space using a 24 gauge disposable needle which tends to split or spread the dural fibres rather than cut it, when introduced with the bevel parallel to dural fibres. This was done to decrease the incidence of post-spinal headache.After lumbar puncture was performed and subarachnoid space entered a free flow of CSF was obtained and the drug, either plain or hyperbaric Bupivacaine, 3 ml of 0.5% strength was instilled and the time recorded. The patient was immediately placed in supine position for the rest of the study.

Pre-loading with I.V. fluids consisted of 15 ml/Kg of a crystalloid solution infused over 20-30 minutes. After the injection of local anaesthetic another 8 ml/Kg was given over 30 minutes. Thereafter fluids were administered on the basis of changes in arterial pressure. Blood loss was replaced with a crystalloid solution on a 3:1 basis.

The following variables were measured every 5 minutes during the first 30 minutes after the intrathecal injection.

- Progression and upper level of sensory blockade, evaluate by pinprick after 30 minutes of injection.
- The time taken by drug to produce motor paralysis and the quality of motor blockade according to modified BROMAGE scale, ranging from 0 indicating no motor block to 3 indicating complete motor blockade.
- Duration of sensory blockade, defined by re-appearance of pain at the operative site.

- Duration of motor blockade, defined by return to normal lower limb movement.
- Changes in heart rate, blood pressure, Incidence and amount of vasopressors and/ or anticholinergics used.
- Other complications.

A decrease in systolic arterial pressure of 30% or more below preoperative levels as well as decrease in heart rate of more than 20% were considered significant and treated with 3 mg of mephentermine and 0.6 mg atropine sulphate respectively.

Modified Bromage Scale:

0 - No paralysis (full flexion of knee and feet)

1 - inability to raise extended leg (just able to move knees)

2 - inability to flex knees (able to move feet only)

3 - inability to flex ankle joint (unable to move feet or knees)

All the patients were clinically assessed during their stay in hospital until discharge. Incidence of post-spinal headache was recorded.The results were expressed as the arithmetic mean and standard deviation.

Results

There were 30 patients in each group.

Table 1: Demographic and pre-anaesthetic haemodynamic data in the two groups.

Patient characteristics	Group- A	Group- B
Age (yr.)	32.7±10.3	30±9.8
Weight (Kg)	53.2±7.23	54.7±6.0
Height (Cm)	66.8±2.63	66.5±3.1
ASA±	1	1
Systolic (mm Hg) B.P.	119.3±9.6	117.6±9.2
Heart Rate (bpm)	83.1±5.05	81±4.8

Surgery lasted 134±23 minutes in group A and 124±26 min in group B with no significant difference

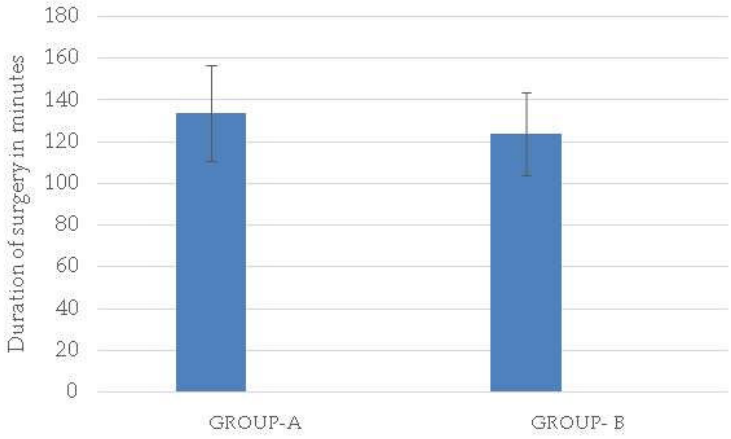

Fig. 1: Duration of surgery in both groups

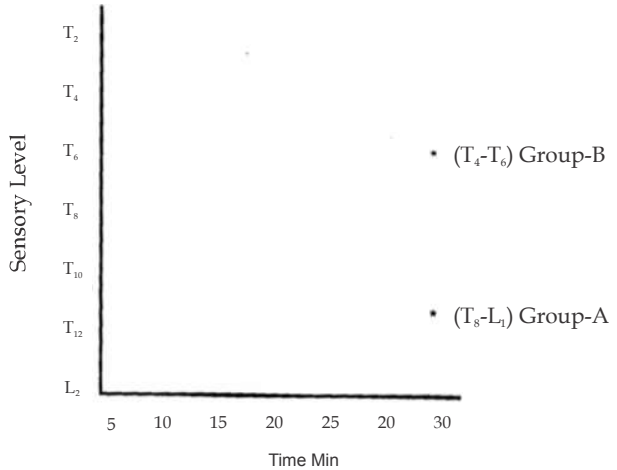

Fig. 2: Comparison between two groups of the spread of sensory level in first 30 minutes, after administration of 3 ml. of 0.5% Bupivacaine.

between groups (Table 1 and Figure 1).

Cephalad spread of sensory blockade, assessed by pinprick was significantly higher at all times with the hyperbaric solution than with plain group. The spread of sensory block was assessed every 5 minutes upto 30 minutes (Figure 2).

Table 2: Degrees of motor blockade assessed on the basis of modified BROMAGE Scale:

Degree of Blockade	Group - A	Group - B
Grade I	0	0
Grade II	17 (58%)	0
Grade III	13 (42%)	30 (100%)

In Group-B (hyperbaric group) all the patients achieved grade 3 blockade (100%) whereas in the Group-A (plain group) 58% had grade 2 blockade and (42%) had Grade 3 (Table 2).

There was a significant difference between the two groups (Figure 3).

Table 3: Haemodynamic Changes

Changes from pre-anaesthetic values in	Group-A	Group-B
Systolic pressure (mean +/- SD)	-15.4 ±5.57	-25.6 ± 7.2
Heart rate (mean SD)	-8 ± 4.56	-11.9 ± 4.7
No. of patients receiving		
a. Me phentermine	5	0
b. Atropine Sulphate	11	0

Significantly greater decrease in systolic arterial pressures and heart rate was observed in Group-B

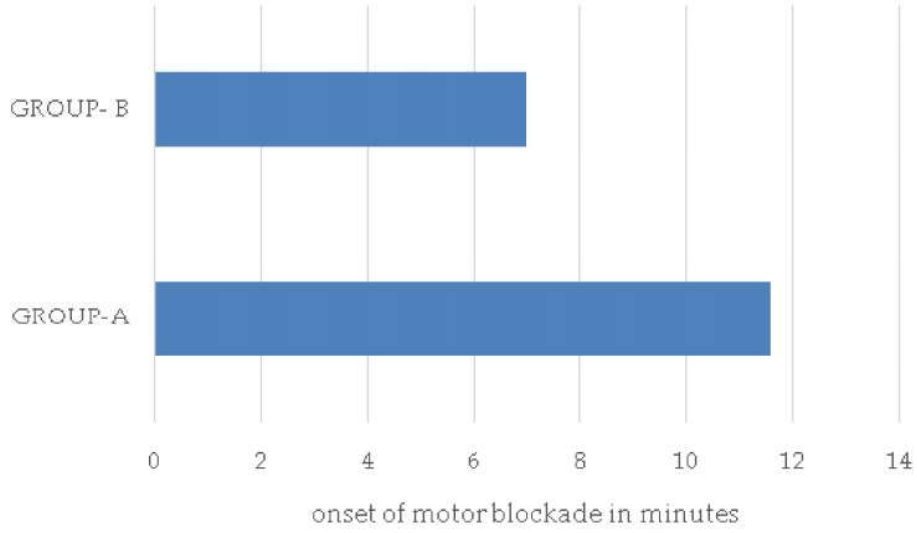

Fig. 3: Time taken for onset of motor blockade from time of intrathecal injection in groups

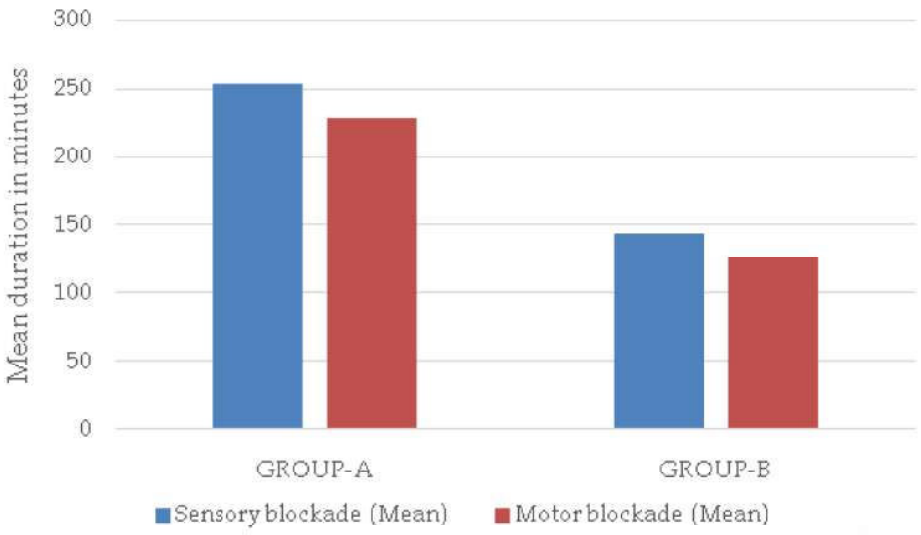

Fig. 4: Duration Sensory blockade and of motor blockade

and consequently more number of patients receiving vasopressors (16%) and anticholinergics (33%) respectively (Table 3).

In the hyperbaric group (i.e. Group-B) the sensory block averaged around 144 Minutes and motor block was around 126 minutes (Figure 4).

In contrast, the sensory blockade in Group-A was around 253 minutes and motor block averaged 228 minutes showing significant difference between the groups. It confirms the feature of Bupivacaine that it can provide significant separation of sensory anaesthesia and motor blockade. The amount of crystalloids administered throughout the study was 2000 ml. in Group-B and 1600 ml. in Group-A indicating significant differences.

No post-spinal headache was observed in any of the sixty patients.

Discussion

Spinal anaesthesia is one of the commonly used anaesthetic technique for lower abdominal and lower limb surgeries. More so in the developing and 3rd world countries where the facilities for general anaesthesia are scarce. Different drugs are being used for spinal anaesthesia of which Lignocaine and Bupivacaine are commonest. Of late Bupivacaine in its different forms as far as its baricity is concerned has been used for spinal anaesthesia.

In our study plain Bupivacaine compared with hyperbaric Bupivacaine was given sub arachnoidallyfor lower abdominal and lower limb surgery. The drug was instilled at the L 3-4 space with the patient in lateral position and then turned supine.

Previous studies (Van Gesseletal) [3] have shown that hyperbaric Bupivacaine results in a higher cephalad spread as compared with plain solution in horizontal supine position. In our study the median height of sensory analgesia in Group-A was T 11(Range T 8 – L 1) as compared to Group –B in which it was T 6 (Range T 4 –T 12). Thus showing the higher spread of hyperbaric solution. Since in the supine position highest patient of spinal column is L 3 an d subarachnoid space is inclined downwards in a cephalad direction it can be understood why there was a lesser cranial spread of the plain solution. The factors which determine intrathecal spread of local anaesthetic agents have been investigated in numerous clinical studies, the results of which have been the subject of a recent review [4]. Many of the factors have a relatively minor influence and manipulation of these is largely beyond the clinician's control. However, the two main factors, the baricity of the injected solution and the patient's position immediately after intrathecal injection, are amenable to alteration by the clinician.

Moller et al. [5] have shown in their study that the onset time of motor blockade was very much dependent on the baricity of solution (that is the percentage of glucose added). In our study the mean onset time of motor blockade in Group-A was 11.6 min. as compared to 7 min. in Group-B. We also compared the degree of motor blockade using the modified Bromage scale and found that in Group-A grade 3 blockade was present in 60% and Grade-2 in 40% whereas in Group-B all the patients (100%) had Grade-3 block thus highlighting the importance of baricity on the degree of motor blockade.

In our study the mean duration of motor blockade in Group- A was 228 min as compared to 126 min. in Group-B which is a very significant finding. This finding is also in accordance with Moller et al [5].

We found that the mean time onset of sensory analgesia as assessed by pinprick method was 8 min. in Group-A when compared to 6 min. in Group-B. Another important finding is that there was a lower blockade with hyperbaric solutions, which is consistent with previous studies [6,7,8,9], while other studies also proposed that hyperbaric solutions may be more suitable to reach the higher thoracic dermatomes as opposed to their plain (i.e., isobaric) [7,10].

Chambers et al. [11] reported in their study that duration of analgesia with 3 ml of 0.5% hyperbaric Bupivacaine was about 2 hrs. And 2.5 – 3 hrs. with plain Bupivacaine. In our study the mean duration of sensory analgesia in Group-A was 253 min. and Group-B 144 min. As previous studies have shown that duration varies with extent of block, we found that in our study, as already mentioned the extent of block was much higher with hyperbaric (Group-B) than plain (Group-A) Bupivacaine.

In our study we also tried to compare the haemodynamic changes in the two groups in the form of heart rate and blood pressure. We found that incidence of hypotension i.e., a fall of systolic presence more than 30% of pre-anaesthetic value, was more in Group-B (16%) as compared to Group-A where there was no significant fall of blood pressure

This is due to the extensive sympathetic block in Group-B patients because of higher spread of hyperbaric solution. In our study 11 patients in Group-B required injection of Atropine sulphate for

the correction of bradycardia whereas bradycardia was not observed in Group-A.

Thus patients in Group-A were more stable haemodynamically than Group-B. The main reason being, a lesser spread of sympathetic block as compared to Group-B this spread was not consistent in all patients in Group-A as reported by Logan Mr, Mc. Clure et al. [12].

Post operatively our patients were followed till time of discharge. None of them complained of any headache nor were there any neurological complaints or sequelae.

Conclusion

Sixty patients of ASA I – II were divided into 2 groups of 30 each. Group-A was given 3 ml. of -0.5% plain Bupivacaine sub arachnoidallywhereas Group-B was given 3 ml. of 0.5% hyperbaric Bupivacaine.

It was found that extent of sensory blockade was much higher in Group-B as compared to Group-A. The degree of motor blockade was also much more intense in Group-B as compared to Group-A. The duration of analgesia was more in Group-A as compared to Group-B, but the time onset of analgesia was faster in Group-B (hyperbaric).

Haemodynamically patients in Group-A were stable due to lesser extent of sympathetic blockade when compared to patients in Group-B. Thus concluding that though plain Bupivacaine gives a lesser cephalad spread and can be effectively used for lower limb surgeries, it has to be used with caution for lower abdominal surgery as the spread is relatively unpredictable. Post- operative complications do not vary with either drug and if they do occur they may be attributed to faulty techniques.

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