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A Comparative Study of Anaesthetic Efficacy of Intrathecal Isobaric 0.5% Ropivacaine and 0.5% ISOBARIC Bupivacaine in Lower Abdominal Surgeries

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Abstract: ***Introduction: Spinal anesthesia remains a popular and effective technique for lower abdominal surgeries, providing reliable sensory and motor blockade. Among local anesthetics, bupivacaine has been widely used due to its prolonged action, though its cardiovascular and central nervous system toxicity are concerns. Ropivacaine, a relatively newer agent, offers less toxicity and a more favorable recovery profile. This study aims to compare the anesthetic efficacy of intrathecal 0.5% isobaric ropivacaine with 0.5% isobaric bupivacaine in lower abdominal surgeries. Objective: To compare the onset, duration of sensory and motor block, and the hemodynamic effects of intrathecal 0.5% isobaric ropivacaine and 0.5% isobaric bupivacaine in patients undergoing lower abdominal surgeries. Materials and Methods: A prospective, randomized, double - blind study was conducted with 90 patients undergoing elective lower abdominal surgeries. The patients were divided into two groups of 45 each: Group IR received 3 ml of 0.5% isobaric ropivacaine, and Group IB received 3 ml of 0.5% isobaric bupivacaine. Onset and duration of sensory and motor block were recorded, along with hemodynamic parameters and any adverse effects. Results: The onset of both sensory and motor block was significantly faster in Group IB compared to Group IR. However, the duration of sensory and motor block was longer in Group IB. Both groups showed stable hemodynamics with no significant differences in adverse effects, such as bradycardia and hypotension. Conclusion: Intrathecal 0.5% isobaric ropivacaine offers a shorter duration of motor blockade, making it a favorable option for shorter procedures, while 0.5% isobaric bupivacaine is more suited for surgeries requiring prolonged anesthesia due to its longer duration of action.***

Keywords: Intrathecal anesthesia, isobaric ropivacaine, isobaric bupivacaine, sensory block, motor block, lower abdominal surgery

1. Introduction

The changing trend of surgical practice from an inpatient to outpatient convention has urged us to modify our anesthetic technique to suit the ambulatory setting. The primary goal of ambulatory anesthesia is rapid recovery leading to early patient discharge with minimal side effects. With the availability of rapid, short - acting anesthetic, analgesic, sympatholytic and muscle relaxant drugs, as well as improved monitoring devices, it has been possible to minimize the adverse effects of anesthesia on the recovery process. [1]

In 1898, Karl August Bier brought spinal anesthesia into the realm of clinical practice. The method is still commonly used today, more than a century later, for a variety of surgical operations, such as urological, orthopedic, and lower abdominal surgery, as well as Caesarean sections. [2] Since it provide sufficient post - operative pain relief with a lower risk of nausea and vomiting, neuraxial anesthesia is preferred over general anesthesia. [3]

Spinal anesthesia (SA), also known as spinal analgesia or subarachnoid block (SAB), is a type of regional anesthesia that includes injecting a local Anesthetic into the cerebrospinal fluid (CSF) using a small needle. SA is a frequently used, cost - effective, and efficient method that offers quick and dependable anesthesia with muscle relaxation for individuals undergoing lower abdominal surgery. [4, 5] Several types of local anesthetics are frequently utilized for spinal anesthesia including lignocaine, bupivacaine, levobupivacaine, and ropivacaine. [6, 7] Lignocaine was previously a popular choice for spinal anesthesia, but its usage has significantly decreased because of worries about temporary neurological symptoms. [8]

Aim: The aim of the present study is to compare the anesthetic efficacy of intrathecal 0.5% isobaric Ropivacaine and 0.5% isobaric bupivacaine in lower abdominal surgeries. Objectives: The objectives of the current study are as follows.

Primary objectives:
- Onset and duration of sensory block
- Onset and duration of motor blockade
- Hemodynamic parameters.

Secondary objectives:

- To look for adverse reaction, if any such as Bradycardia and Hypotension.

2. Material and Methods

Study design and setting: It was a Prospective, Randomized, Interventional, double blind, non - placebo study. The study took place from August 2023 to July 2024, over a period of 1 year at the Department of Anesthesiology & Critical Care, Moti Lal Nehru Medical College, Prayagraj.

Study Participants and Eligibility Criteria: The patients were evaluated to determine their eligibility for the study based on the following criteria - Inclusion criteria: Patients of either sex aged between 18 and 60 years, Patients under ASA Grade I and II, Patients undergoing elective lower abdominal surgeries, Patients giving valid informed and written consent. Exclusion criteria: Patient's refusal, Infections at the site of spinal anaesthesia administration, ASA Grade III and above, Coagulopathies, Morbid Obesity (BMI >40kg/m2), Severe cardiovascular disease, Cerebrovascular diseases, Renal & Hepatic insufficiencies, Uncontrolled Diabetes Mellitus, Severe Respiratory diseases, Known allergy to study drug

Sample size: The sample size was calculated on the basis of mean duration of sensory block as the primary outcome measure

Formula used for sample size calculation:

k=n1n2=1 n1=12+22z1 2+z1 - 2Δ2
n1=13.972+14.1421.96+0.842155.77 - 170.292
n1=395.10057.84214.522
n1=14.69≅15
n2=k*n1=15

Although the calculated sample size at 95% confidence and 80% power is 15 in each group. However, in order to increase the confidence of study, we intended the sample size to be 45 in each group.

Where,
Δ=1 - 2 = absolute difference between means of Group - IR and Group - IB 1, 2 standard deviations of Group - IR and Group - IB respectively
n1 = sample size for Group - IR n2 = sample size for Group - IB
α =probability of type I error (usually 0.05)
β =probability of type II error (usually 0.2)
z=critical Z value for a given α or β

Randomization: Patients were randomized on the basis of a computer - generated table of random numbers generated by using Microsoft Excel Version 24.0.

3. Data Collection and Intervention

Pre- anaesthetic Evaluation: A thorough pre- anaesthetic evaluation was conducted for all patients scheduled for lower abdominal surgery. During the pre - anaesthetic assessment, a thorough examination was conducted, including a general and systemic evaluation, as well as an assessment of the airway. As part of the study, all patients underwent a comprehensive range of medical tests including Complete Blood Count, Blood Grouping, Blood sugar, Kidney Function Test, Liver Function Test, 12 Lead ECG, and Chest X - Ray. Patients were provided with information regarding spinal anaesthesia.

Spinal anaesthesia Techniques: A lumber puncture was conducted using a 25G spinal needle, following strict aseptic measures. The procedure was performed at either the L2 - L3 or L3 - L4 interspace, using a midline approach while the patient was in a lateral or sitting position. Once the CSF flow was confirmed, the drug was administered and the patient was promptly positioned on their back.

Outcome Assessment: For the study, the time of intrathecal injection was designated as the starting point. Various factors were measured and documented, including sensory block (onset and duration of recovery), motor block (onset, block and duration of recovery), vitals (heart rate, spo2 and blood pressure), and any side effects (such as hypotension, bradycardia).

Data Analysis: The study parameters' raw data were entered into a Microsoft Excel spreadsheet version 24 and analyzed using IBM SPSS software (Version 25.0, IBM Corp., Armonk, New York City, and USA). The study included the presentation of continuous variables as mean ± standard deviation, while categorical variables were represented as number and percentage. The qualitative data underwent analysis using the Chi - square test, while the quantitative data were analyzed using the independent sample t - test. A significance level of $P < 0.05$ was used to determine statistical significance.

4. Observations and Result

Table 1: Demographic data in studied cases (N=90)

Parameters		Group IR (n=45)	Group IB (n=45)	Test value	P value
Mean Age (in years)		39.89± 11.47	38.00± 13.72	.708[1]	0.481
SEX	Male	26 (57.77%)	33 (73.33%)	2.411[2]	0.120
	Female	19 (42.23%)	12 (26.67)		
ASA Grade	I	30 (66.66%)	28 (62.22%)	.194[2]	0.659
	II	15 (33.34%)	17 (37.78%)		

As shown in Table 1, in Group IR, the mean age of the participants was 39.89± 11.47 years, while in Group IB, the mean age was 38.00± 13.72 years. There was no statistically significant difference between the groups in terms of age (t value=.708, p=0.481).

As shown in Table 1, in group IR, 57.77% of participants were males and 42.23% were females, while in group IB, 73.33% were males and 36.67% were females. However, there was no statistically significant difference between the groups in terms of gender distribution ($\chi 2=2.411$, p=0.120).

As shown in Table 1, in group IR, ASA grade I patients were 66.66% and ASA grade II patients were 33.34%, as compared to group IB, where 62.22% were ASA grade I and 37.78%. However, there was no statistically significant difference between the groups in terms of ASA grading ($\chi 2$=0.194, p=0.659).

Table 2: Comparison of Onset of Sensory Block (in minutes) (N=90)

Parameters	Group IR (n=45)	Group IB (n=45)	t Value	P value
Onset to Sensory Block (in minutes)	5.44± 1.035	4.49± 0.843	**4.803**	**0.001**

Table 2 shows the Comparison of Onset of Sensory Block (in minutes) as mean difference between the groups. The mean±SD overall onset of Sensory Block (in minutes) in group IR, and group IB were 5.44± 1.035, and 4.49± 0.843, respectively. There was a statistically significant difference between the groups in terms of the onset of sensory block (in minutes), with the onset of sensory block being quicker in group IB than group IR (t = 4.803, p = 0.001)

Table 3: Comparison for Onset of Motor Block (in minutes) (N=90)

Parameters	Group IR (n=45)	Group IB (n=45)	t Value	P value
Onset to Motor Block (in minutes)	6.56± 1.05	5.78± 0.876	3.801	0.001

Table 3 shows the Comparison of Onset of Motor Block (in minutes) as mean difference between the groups. The mean±SD overall Onset of Motor Block (in minutes) in group IR and group IB was 6.56± 1.05, and 5.78± 0.876, respectively. There was a statistically significant difference between the groups in terms of the onset of motor block (in minutes), with the onset of motor block being quicker in group IB than group IR (t = 3.801, p = 0.001).

Table 4: Comparison for Duration (in minutes) of Sensory Block (N=90)

Parameters	Group IR (n=45)	Group IB (n=45)	t Value	P value
Duration of Sensory Block (in minutes)	157.16± 8.096	166.31± 11.29	**- 4.419**	**0.001**

Table 4 shows the Comparison of Duration (in minutes) of Sensory Block as mean difference between the groups. The mean±SD overall duration (in minutes) of Sensory Block in group IR and group IB was 157.16± 8.096 and 166.31± 11, respectively. However, there was a statistically significant difference between the groups in terms of duration (in minutes) of sensory Block (t = - 4.419, p=0.001) with duration of sensory block longer in group IB when compared to IR.

Table 5: Comparison of Duration of Motor Block (in minutes) (N=90)

Parameters	Group IR (n=45)	Group IB (n=45)	t Value	P value
Duration of Motor Block (in minutes)	143.60± 7.835	152.56± 10.197	- 4.672	0.001

Table 5 shows the Comparison of Duration (in minutes) of motor Block as mean difference between the groups. The mean±SD overall duration (in minutes) of motor Block (in minutes) in group IR, and group IB were 143.60± 7.835 and 152.56± 10.197, respectively. However, there was a statistically significant difference between the groups in terms of duration (in minutes) of motor Block (t = - 4.672, p=0.001) with longer duration of motor block longer in group IB when compared to IR.

Table 6: Comparison of Side effects (N=90)

Parameters	Group IR (n=45)	Group IB (n=45)	$\chi 2$ value	P value
Bradycardia	5 (11.11%)	8 (17.77%)	0.809	.368
Hypotension	4 (8.88%)	7 (15.55%)	0.932	.334

Table 6 illustrates the relationship between side effects and participant groups. As shown in the above table, 11.11% of participants in group IR and 17.77% in group IB experienced bradycardia. The association between bradycardia and the group of participants did not reveal any statistically significant results ($\chi 2$ = 0.809, p =.368).

5. Discussion

Subarachnoid block is a frequently used anesthetic technique for conducting surgeries on the lower limbs and abdomen. This technique is not only safe and cost - effective, but also simple to administer. Patients also report a high level of satisfaction after undergoing this procedure. The technique is simple, with a quick onset and a high level of reliability. This technique helps to avoid the risks associated with general anesthesia, such as mishaps related to airway management, aspiration, and polypharmacy.

Bupivacaine is commonly used as a local anesthetic for lower abdominal surgeries due to its strong effectiveness and limited impact on the nervous system. When choosing a drug for spinal anesthesia, it's important to consider factors such as the quality of sensory blockade, motor blockade, hemodynamic changes, and side effect profile. While cardio toxicity is not a concern in subarachnoid block, these other considerations play a significant role. [43]

Ropivacaine and the S - enantiomers of Bupivacaine are becoming more commonly utilized for spinal anesthesia in various surgeries, such as cesarean sections, lower abdominal procedures, perineal surgeries, and lower limb surgeries. [51, 52] The advantages that have been claimed include a shorter duration of motor block while maintaining similar sensory block properties compared to Bupivacaine. This helps to reduce the psychological discomfort that can arise from being immobile for extended periods of time. Furthermore, a significant benefit of Ropivacaine is its reduced cardiotoxicity in comparison to Bupivacaine. With this background, this study was conducted to evaluate the sensory and motor effects of Ropivacaine in lower abdominal surgeries for spinal anesthesia.

6. Conclusion

The study demonstrated that both isobaric ropivacaine and bupivacaine are effective for spinal anesthesia in lower abdominal surgeries. However, significant differences were observed between the two drugs in terms of onset and

duration of sensory and motor blockades. The sensory and motor blockades were established faster and lasted longer with bupivacaine compared to ropivacaine. Despite these differences, ropivacaine showed a more favorable hemodynamic profile, with fewer incidences of hypotension and bradycardia. This finding suggests that while bupivacaine may provide longer - lasting anesthesia, ropivacaine may be preferable in cases where hemodynamic stability is a priority, especially in patients with cardiovascular concerns.

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