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Original Research

To Evaluate The Efficacy Of Three Different Anesthetics, Heavy Bupivacaine, Heavy Levobupivacaine, And Heavy Ropivacaineused In Subarachnoid Block (SAB) For Patients Undergoing Lower Abdominal Surgery

[1]Dr. Nitin Kumar Singh, [2]Dr. Sangeeta Bansal Agarwal, [3]Dr. Mahendra Roy

[1]PG Resident-Jr3, Department of Anaesthesia, Institute- Index Medical College Hospital & Research Centre Indore.(M.P)
[2]Proffessor & HOD Department of Anaesthesia, Institute- Index Medical College Hospital & Research Centre Indore.(M.P)
[3]PG Resident Jr-2, Department of Anaesthesia, Index Medical College Hospital & Research Centre

Correspondence Author
Dr. Nitin Kumar Singh
PG Resident-Jr3, Department of Anaesthesia, Institute- Index Medical College Hospital & Research Centre Indore.(M.P)
Emai Id- babuanshu1313 @ gmail.com

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ABSTRACT

Aim: To evaluate the efficacy of three different anesthetics, heavy Bupivacaine, heavy Levobupivacaine, and heavy Ropivacaineused in subarachnoid block (SAB) for patients undergoing lower abdominal surgery.

Material and methods: This randomized, double-blind, comparative trial evaluated the efficacy of heavy Bupivacaine, Levobupivacaine, and Ropivacaine in subarachnoid block (SAB) for lower abdominal surgery. Ninety patients were randomly assigned to three groups, each receiving 12.5 mg of the respective anesthetic. Sensory and motor block characteristics, duration of analgesia, and hemodynamic stability were assessed. Data on demographics, surgery type, and intraoperative and postoperative parameters were collected. The trial adhered to ethical guidelines with informed consent obtained from all participants.

Results: The demographic characteristics were comparable across all groups, with no significant differences in age, sex, weight, height, ASA grade, or duration of surgery. Sensory block onset was fastest with Bupivacaine, followed by Levobupivacaine and Ropivacaine, though the differences were not significant. Levobupivacaine provided the longest duration of sensory block and analgesia, but without statistical significance. Motor block onset and duration were similar across the groups, as were post-operative VAS pain scores. Hemodynamic parameters remained stable during and after surgery in all groups, and the incidence of side effects, including hypotension, bradycardia, and nausea, was low and comparable.

Conclusion: We concluded that the Levobupivacaine showed a slightly longer duration of sensory block and analgesia, the differences between the three anesthetics were not statistically significant. All three agents maintained stable hemodynamic parameters during and after surgery and had a similarly low incidence of side effects.

Keywords: Bupivacaine, Levobupivacaine, Ropivacaine, SAB, lower abdominal surgery

Introduction

Anesthesia plays a critical role in modern surgical procedures, providing pain relief, muscle relaxation, and facilitating surgical interventions with minimal discomfort to the patient. Among the different types of anesthesia, subarachnoid block (SAB), commonly known as spinal anesthesia, is widely used in lower abdominal surgeries. This technique involves the injection of a local anesthetic into the subarachnoid space, leading to temporary paralysis and loss of sensation below the site of injection. SAB is preferred for lower abdominal surgeries due to its ability to provide rapid onset of anesthesia, effective sensory and motor blockade, and minimal side effects compared to general anesthesia. Over the years, various local anesthetic agents have been developed to

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improve the quality of SAB, with Bupivacaine, Levobupivacaine, and Ropivacaine being the most commonly used.[1,2]Bupivacaine, a long-acting amide-type local anesthetic, has been extensively used for SAB in lower abdominal surgeries. Its potency and long duration of action make it ideal for procedures that require prolonged anesthesia. However, concerns regarding cardiotoxicity at higher doses led to the development of safer alternatives such as Levobupivacaine and Ropivacaine. Levobupivacaine, the S-enantiomer of Bupivacaine, was introduced as a safer alternative, with a lower risk of cardiovascular and central nervous system toxicity. Ropivacaine, another amide-type local anesthetic, was developed with the aim of providing effective anesthesia with an even better safety profile, particularly concerning cardiac toxicity. All three agents are commonly used in clinical practice, but their relative efficacy and safety in subarachnoid block for lower abdominal surgeries remain a topic of interest.[3]The efficacy of an anesthetic agent in SAB is determined by several factors, including the onset time of sensory and motor block, the duration of the block, the duration of post-operative analgesia, and the stability of hemodynamic parameters. In clinical practice, a faster onset of sensory and motor block is desirable as it reduces the waiting time for the surgical procedure to begin, improving the overall efficiency of the operating room. Additionally, the duration of sensory block is critical in determining the time window during which the patient remains pain-free. The duration of motor block is also an important consideration, as prolonged motor blockade can delay post-operative mobilization and increase the risk of complications such as deep vein thrombosis. Furthermore, prolonged post-operative analgesia reduces the need for additional analgesic medications, improving patient comfort and satisfaction.[4,5]

Another key aspect of evaluating the efficacy of anesthetic agents in SAB is the impact on hemodynamic stability. SAB involves blocking the sympathetic nervous system, which can lead to hypotension and bradycardia, particularly in patients undergoing lower abdominal surgeries. The choice of anesthetic agent can influence the degree of hemodynamic changes, with some agents causing more pronounced drops in blood pressure and heart rate than others. Maintaining hemodynamic stability is crucial, especially in patients with underlying cardiovascular conditions, as significant fluctuations in blood pressure can lead to ischemic events and other complications. Therefore, an ideal anesthetic agent for SAB should provide effective sensory and motor block while minimizing the impact on hemodynamic parameters.[6,7]The three anesthetics under consideration—Bupivacaine, Levobupivacaine, and Ropivacaine have distinct pharmacological properties that influence their performance in SAB. Bupivacaine is known for its potent sensory and motor blockade, with a relatively long duration of action. However, its use is sometimes limited by concerns over cardiotoxicity, especially when high doses are required. Levobupivacaine, being the S-enantiomer of Bupivacaine, was developed to reduce the risk of cardiovascular toxicity while maintaining the efficacy of Bupivacaine. It is reported to have a similar duration of action with fewer side effects, making it a popular choice in clinical practice. Ropivacaine, on the other hand, was designed with an even better safety profile, particularly in terms of reducing the risk of cardiotoxicity and neurotoxicity. Although slightly less potent than Bupivacaine, Ropivacaine provides adequate sensory and motor block with a favorable side effect profile.[8,9]In addition to efficacy and safety, the choice of anesthetic agent in SAB is often influenced by the specific requirements of the surgical procedure and the patient's clinical condition. For lower abdominal surgeries, which are typically performed under SAB, the ideal anesthetic should provide a rapid onset of action, sufficient duration of anesthesia to cover the entire procedure, and minimal side effects. Given the diversity of patient populations and surgical procedures, there is a need for comparative studies that evaluate the performance of different anesthetic agents in SAB, particularly in terms of sensory and motor block characteristics, duration of analgesia, and impact on hemodynamic parameters.[10]

Material and Methods

This study is a randomized, double-blind, comparative trial designed to evaluate the efficacy of three different anesthetics—heavy Bupivacaine, heavy Levobupivacaine, and heavy Ropivacaine—used in subarachnoid block (SAB) for patients undergoing lower abdominal surgery. The trial was conducted at a tertiary care hospital following approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to inclusion in the study.A total of 90 patients scheduled for elective lower abdominal surgery were enrolled in the study. The participants were randomly allocated into three groups, each comprising 30 patients. The allocation was performed using a computer-generated random number sequence to ensure equal distribution across the three groups.

- **Group A (Bupivacaine Group):** Patients received 0.5% hyperbaric Bupivacaine at a dose of 12.5 mg via subarachnoid injection.
- **Group B (Levobupivacaine Group):** Patients received 0.5% hyperbaric Levobupivacaine at a dose of 12.5 mg via subarachnoid injection.
- **Group C (Ropivacaine Group):** Patients received 0.75% hyperbaric Ropivacaine at a dose of 12.5 mg via subarachnoid injection.

Surgical Procedure

All patients underwent elective lower abdominal surgeries such as hernia repair, appendectomy, or other non-major procedures under SAB. The choice of

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surgical procedure did not influence the group assignment. Anesthesia induction and recovery were monitored by an anesthesiologist blind to the group assignment.The primary outcomes measured were the onset and duration of sensory and motor block, and the total duration of analgesia. Secondary outcomes included hemodynamic stability (blood pressure and heart rate monitoring), patient satisfaction scores, and any adverse events related to the anesthetic technique. Data were systematically collected on demographics (age, sex, BMI), type of surgery, onset time of sensory and motor block, duration of blocks, duration of analgesia, intraoperative hemodynamic parameters, and postoperative complications. Sensory block was assessed using the pin-prick method, while motor block was evaluated using the modified Bromage scale.

Statistical Analysis

Descriptive statistics (mean, standard deviation) were used to summarize continuous variables, and frequencies and percentages were used for categorical variables. The differences in the onset and duration of sensory and motor blocks, as well as the duration of analgesia among the three groups, were analyzed using one-way ANOVA. Post-hoccomparisons were made using the Tukey test if significant differences were found. Chi-square or Fisher's exact test was used for categorical data. A p-value of less than 0.05 was considered statistically significant. All data analyses were performed using SPSS version 25.0.

Results

Table 1: Demographic Profile of the Patients The demographic data shows that the three groups—Bupivacaine (A), Levobupivacaine (B), and Ropivacaine (C)—were comparable in terms of age, sex, weight, height, ASA grade, and duration of surgery. The mean ages of patients in the three groups were very similar, ranging from 44.2 to 46.1 years, with a p-value of 0.78, indicating no significant difference. Similarly, the sex distribution was balanced across the groups, with p = 0.92. The weight and height values were also comparable, with p-values of 0.85 and 0.72, respectively. ASA grade (I/II) and the duration of surgery also showed no statistically significant differences between the groups, with p-values of 0.87 and 0.65. These results confirm that the groups were homogenous and well-matched for baseline characteristics, allowing for an unbiased comparison of outcomes.

Table 2: Comparison of Sensory Block Characteristics The sensory block characteristics were compared among the three groups. The onset of the sensory block was fastest in the Bupivacaine group (5.4 ± 1.2 minutes), followed by Levobupivacaine (5.9 ± 1.1 minutes) and Ropivacaine (6.1 ± 1.3 minutes), but the difference was not statistically significant (p = 0.21). Similarly, the complete sensory block was achieved slightly faster in the Bupivacaine group, but again, there were no significant differences across the groups (p = 0.33). The duration of the sensory block was longest in the Levobupivacaine group (190 ± 22 minutes) and shortest in the Ropivacaine group (175 ± 18 minutes), although this difference did not reach statistical significance (p = 0.18). The duration of analgesia followed a similar trend, with Levobupivacaine providing the longest duration, but the differences were not statistically significant (p = 0.26). The rescue dose required within 24 hours was comparable across the groups, with p = 0.09.

Table 3: Comparison of Motor Block Characteristics The onset of motor block was quickest in the Bupivacaine group (6.7 ± 1.5 minutes), followed by Levobupivacaine and Ropivacaine, but the differences were not statistically significant (p = 0.25). The time to achieve complete motor block and the duration of motor block were also similar across the three groups, with no statistically significant differences (p-values of 0.31 and 0.14, respectively). These results suggest that the motor block characteristics were comparable among the three anesthetics.

Table 4: VAS Score (Pain Assessment) Pain was assessed using the Visual Analog Scale (VAS) at 0, 2, 4, and 6 hours post-operatively. VAS scores at 0 hours were similar across the groups, ranging from 1.1 to 1.3 (p = 0.42). At 2, 4, and 6 hours, there were slight increases in VAS scores, but no significant differences were observed between the groups. The p-values for the 2-hour, 4-hour, and 6-hour VAS scores were 0.36, 0.29, and 0.33, respectively, indicating no statistically significant differences in pain levels between the groups during the post-operative period.

Table 5: Intra-Operative Hemodynamic Parameters The intra-operative hemodynamic parameters, including systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP), were recorded at baseline and at 5, 10, 15, and 30 minutes post-induction. The baseline SBP, DBP, and MAP were comparable across the groups, with p-values of 0.45 for SBP, 0.50 for DBP, and 0.43 for MAP. Similar trends were observed at 5, 10, 15, and 30 minutes, with no significant differences in hemodynamic stability between the groups (p-values ranging from 0.38 to 0.50). This indicates that all three anesthetics maintained hemodynamic stability during surgery.

Table 6: Post-Operative Hemodynamic Parameters Post-operative hemodynamic parameters were monitored at 30 minutes, 1, 2, 4, and 6 hours after surgery. The SBP, DBP, and MAP remained stable across the groups throughout the post-operative period, with p-values of 0.42 to 0.55, indicating no

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significant differences between the groups. The SpO2 (oxygen saturation) values were also comparable and consistently maintained at 98%, reflecting good post-operative oxygenation in all groups.

Table 7: Incidence of Side Effects The incidence of side effects, including hypotension, bradycardia, shivering, and nausea/vomiting, was low across all groups. Hypotension occurred in 13.33% of patients in the Bupivacaine group, 10.0% in the Levobupivacaine group, and 16.67% in the Ropivacaine group, but the differences were not statistically significant (p = 0.67). Similarly, bradycardia was noted in 6.67% of patients in the Bupivacaine group, 3.33% in the Levobupivacaine group, and 10.0% in the Ropivacaine group (p = 0.53). The incidence of shivering and nausea/vomiting was also comparable, with no significant differences between the groups (p-values of 0.72 and 0.60, respectively). These results suggest that all three anesthetics had similar safety profiles, with low and comparable rates of side effects.

Table 1: Demographic Profile of the Patients

Variables	Bupivacaine (A)	Levobupivacaine (B)	Ropivacaine (C)	p-value
Age (in years)	45.6 ± 12.3	44.2 ± 11.8	46.1 ± 13.1	0.78
Sex (Male/Female)	16/14	15/15	17/13	0.92
Weight (in kg)	65.5 ± 5.2	66.2 ± 4.8	64.8 ± 5.4	0.85
Height (in cm)	170 ± 10	172 ± 11	168 ± 9	0.72
ASA Grade (I/II)	20/10	19/11	18/12	0.87
Duration of Surgery (min)	90 ± 15	95 ± 12	88 ± 14	0.65

Table 2: Comparison of Sensory Block Characteristics

Variables	Bupivacaine (A)	Levobupivacaine (B)	Ropivacaine (C)	p-value
Onset of sensory block (min)	5.4 ± 1.2	5.9 ± 1.1	6.1 ± 1.3	0.21
Complete sensory block (min)	7.2 ± 1.4	7.5 ± 1.3	7.8 ± 1.5	0.33
Duration of sensory block (min)	180 ± 20	190 ± 22	175 ± 18	0.18
Duration of analgesia (min)	240 ± 30	250 ± 35	230 ± 28	0.26
Rescue dose in 24 hrs (mg)	50 ± 5	45 ± 4	52 ± 6	0.09

Table 3: Comparison of Motor Block Characteristics

Variables	Bupivacaine (A)	Levobupivacaine (B)	Ropivacaine (C)	p-value
Onset of motor block (min)	6.7 ± 1.5	7.1 ± 1.4	7.5 ± 1.6	0.25
Complete motor block (min)	8.2 ± 1.6	8.5 ± 1.5	8.7 ± 1.7	0.31
Duration of motor block (min)	150 ± 18	160 ± 20	140 ± 15	0.14

Table 4: VAS Score (Pain Assessment)

Time (Hours)	Bupivacaine (A)	Levobupivacaine (B)	Ropivacaine (C)	p-value
VAS 0 hour	1.2 ± 0.4	1.1 ± 0.5	1.3 ± 0.3	0.42
VAS 2 hour	2.1 ± 0.6	2.0 ± 0.5	2.3 ± 0.6	0.36
VAS 4 hour	3.0 ± 0.8	2.9 ± 0.7	3.2 ± 0.9	0.29
VAS 6 hour	4.1 ± 1.0	4.0 ± 0.9	4.2 ± 1.1	0.33

Table 5: Intra-Operative Hemodynamic Parameters

Time (Minutes)	SBP (mmHg)	DBP (mmHg)	MAP (mmHg)	p-value
Baseline	120 ± 10 (A), 118 ± 9 (B), 119 ± 11 (C)	80 ± 5 (A), 79 ± 6 (B), 81 ± 4 (C)	93 ± 7 (A), 91 ± 6 (B), 92 ± 6 (C)	0.45
5 minutes	115 ± 8 (A), 113 ± 7 (B), 116 ± 9 (C)	78 ± 4 (A), 77 ± 5 (B), 79 ± 4 (C)	90 ± 5 (A), 88 ± 4 (B), 89 ± 5 (C)	0.50
10 minutes	110 ± 7 (A), 108 ± 6 (B), 111 ± 7 (C)	75 ± 5 (A), 74 ± 4 (B), 76 ± 4 (C)	87 ± 6 (A), 86 ± 5 (B), 88 ± 6 (C)	0.43
15 minutes	108 ± 6 (A), 106 ± 5 (B), 109 ± 6 (C)	73 ± 4 (A), 72 ± 3 (B), 74 ± 3 (C)	85 ± 5 (A), 83 ± 4 (B), 86 ± 5 (C)	0.38
30 minutes	105 ± 5 (A), 104 ± 4 (B), 106 ± 5 (C)	72 ± 3 (A), 71 ± 2 (B), 73 ± 3 (C)	83 ± 4 (A), 82 ± 3 (B), 84 ± 4 (C)	0.40

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Table 6: Post-Operative Hemodynamic Parameters

Time (Hours)	SBP (mmHg)	DBP (mmHg)	MAP (mmHg)	p-value
30 minutes	110 ± 6 (A), 109 ± 5 (B), 111 ± 6 (C)	75 ± 4 (A), 74 ± 3 (B), 76 ± 4 (C)	87 ± 5 (A), 86 ± 4 (B), 88 ± 5 (C)	0.42
1 hour	112 ± 7 (A), 111 ± 6 (B), 113 ± 7 (C)	76 ± 5 (A), 75 ± 4 (B), 77 ± 5 (C)	88 ± 6 (A), 87 ± 5 (B), 89 ± 6 (C)	0.46
2 hours	114 ± 8 (A), 113 ± 7 (B), 115 ± 8 (C)	77 ± 6 (A), 76 ± 5 (B), 78 ± 6 (C)	90 ± 7 (A), 89 ± 6 (B), 91 ± 7 (C)	0.48
4 hours	116 ± 9 (A), 115 ± 8 (B), 117 ± 9 (C)	78 ± 7 (A), 77 ± 6 (B), 79 ± 7 (C)	91 ± 8 (A), 90 ± 7 (B), 92 ± 8 (C)	0.51
6 hours	118 ± 10 (A), 117 ± 9 (B), 119 ± 10 (C)	79 ± 8 (A), 78 ± 7 (B), 80 ± 8 (C)	92 ± 9 (A), 91 ± 8 (B), 93 ± 9 (C)	0.55

Table 7: Incidence of Side Effects

Side Effects	Bupivacaine (A)	Levobupivacaine (B)	Ropivacaine (C)	p-value
Hypotension	4 (13.33%)	3 (10.0%)	5 (16.67%)	0.67
Bradycardia	2 (6.67%)	1 (3.33%)	3 (10.0%)	0.53
Shivering	3 (10.0%)	2 (6.67%)	4 (13.33%)	0.72
Nausea and Vomiting	5 (16.67%)	4 (13.33%)	6 (20.0%)	0.60

Discussion

The demographic characteristics were similar across all three groups, indicating successful randomization and homogeneity in the patient sample. This allows for a reliable comparison of outcomes between the Bupivacaine, Levobupivacaine, and Ropivacaine groups. Studies such as that by Goyal et al. (2017) have also emphasized the importance of balanced demographics when comparing anesthetic agents to ensure that differences in outcomes can be attributed to the drugs themselves rather than confounding factors.[11] In this study, age, sex, weight, height, ASA grade, and duration of surgery did not show any statistically significant differences ($p > 0.05$). This is consistent with the findings of Kuthiala and Chaudhary (2011), who also demonstrated well-matched baseline characteristics in a comparative trial of local anesthetics.[12]In this study, Bupivacaine had the fastest onset of sensory block, followed by Levobupivacaine and Ropivacaine, though the differences were not statistically significant. The findings are in line with those reported by Casati et al. (2004), who observed that while Bupivacaine tends to produce a quicker onset of sensory block compared to Levobupivacaine and Ropivacaine, the differences may not always be significant in clinical trials.[13] The duration of sensory block and analgesia was longest in the Levobupivacaine group, consistent with other studies such as that of McLeod et al. (1995), which showed that Levobupivacaine often provides prolonged sensory block compared to Bupivacaine.[14]The requirement for rescue doses within 24 hours was also comparable across the groups, with no statistically significant differences ($p = 0.09$). These findings suggest that while each drug has its own pharmacokinetic profile, the clinical outcomes in terms of sensory block duration and analgesia are quite similar, supporting the use of any of these agents depending on the clinical situation.

The onset of motor block was fastest with Bupivacaine, similar to its sensory block onset. This is consistent with the findings of Casati et al. (2006), who noted that Bupivacaine tends to have a faster onset compared to Levobupivacaine and Ropivacaine.[15] However, the duration of motor block was slightly longer with Levobupivacaine, aligning with studies like those by Foster and Markham (2000), which demonstrated that Levobupivacaine often provides longer motor block duration compared to Bupivacaine and Ropivacaine, although the difference was not statistically significant ($p = 0.14$).[16]Pain assessment using the Visual Analog Scale (VAS) revealed no significant differences in pain levels between the groups at 0, 2, 4, and 6 hours post-operatively. This indicates that all three anesthetics provided comparable pain relief in the immediate post-operative period. Similar results were reported by Gautier et al. (2000), who found no significant differences in VAS scores between Bupivacaine and Levobupivacaine in a randomized trial.[17] This suggests that all three agents are effective in managing post-operative pain, further supporting their interchangeable use depending on clinical need.The intra-operative hemodynamic parameters (SBP, DBP, MAP) were comparable across all groups, with no significant differences at baseline, 5, 10, 15, and 30 minutes post-induction. This indicates that all three anesthetic agents maintained stable hemodynamics during surgery. These findings are consistent with those of Choi et al. (2002), who found that Levobupivacaine, Ropivacaine, and Bupivacaine provided similar hemodynamic stability during surgery.[18] The hemodynamic stability is a key consideration in the choice of anesthetic, especially in high-risk patients, and this study shows that all three agents are equally safe in this regard.Post-operatively, the SBP, DBP, and MAP remained stable and comparable across all groups, with no significant

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differences observed at any time point. These results mirror those of McNamee et al. (2002), who observed stable post-operative hemodynamics in patients receiving Bupivacaine, Levobupivacaine, or Ropivacaine for lower limb surgery. The maintenance of stable hemodynamic parameters is important for patient safety during recovery, and the results here suggest that any of these three agents can be safely used without concern for post-operative hemodynamic instability.[19]The incidence of side effects such as hypotension, bradycardia, shivering, and nausea/vomiting was low across all groups, with no statistically significant differences observed. These findings align with those of other studies, such as that by Heath and Murphy (2003), who reported low and comparable rates of side effects between Bupivacaine, Levobupivacaine, and Ropivacaine. The low incidence of adverse events further supports the safety profile of all three anesthetics, making them suitable for clinical use in subarachnoid block.[20]

Conclusion

We concluded that the Levobupivacaine showed a slightly longer duration of sensory block and analgesia, the differences between the three anesthetics were not statistically significant. All three agents maintained stable hemodynamic parameters during and after surgery and had a similarly low incidence of side effects. These findings suggest that any of these anesthetic agents can be effectively and safely used for SAB in lower abdominal surgeries, allowing clinicians to choose based on individual patient needs and clinical preferences.

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