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A COMPARATIVE EVALUATION OF HYPERBARIC ROPIVACAINE 0.75% VERSUS HYPERBARIC BUPIVACAINE 0.5% FOR ELECTIVE LOWER ABDOMINAL SURGERIES UNDER SPINAL ANAESTHESIA

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ABSTRACT **Background:** Bupivacaine in spinal anaesthesia poses risks of cardiotoxicity and prolonged motor block. Ropivacaine 0.75%, a newer hyperbaric anaesthetic, was introduced to provide safer and more reliable spinal anaesthesia with faster motor recovery. Aim: To compare the efficacy and safety of hyperbaric Ropivacaine 0.75% with hyperbaric Bupivacaine 0.5% in elective lower abdominal surgeries under Spinal anaesthesia. **Materials and Methods:** Ninety ASA grade I and II patients, aged 18-60, were randomly divided into two groups receiving either Bupivacaine or Ropivacaine intrathecally. Key parameters such as the onset and duration of sensory and motor block, hemodynamic stability, and side effects like hypotension and bradycardia were analyzed. **Results:** Ropivacaine demonstrated a slower onset of sensory and motor block, but with a significantly shorter motor block duration (133.91 ± 22.623 min vs. 171.73 ± 11.197 min). Both groups achieved similar levels of sensory block, but Ropivacaine exhibited better hemodynamic stability, with a lower incidence of hypotension compared to Bupivacaine. **Conclusion:** The findings conclude that while both anaesthetics are effective, Ropivacaine offers a superior safety profile with faster motor recovery and fewer hemodynamic disturbances.

KEYWORDS : Hyperbaric Bupivacaine 0.5%, Hyperbaric Ropivacaine 0.75%, Spinal anaesthesia.

INTRODUCTION

Spinal anaesthesia has been a cornerstone of modern anaesthesiology since August Bier introduced it in 1899, initially using Cocaine as the primary agent. However, the adverse effects of early local anaesthetics, such as Cocaine and Lignocaine, led to the development of Bupivacaine. Despite its common use, Bupivacaine raises concerns about re-entrant arrhythmias, cardiac depression, and central nervous system (CNS) toxicity, creating a need for alternative agents.[1,2]

Ropivacaine, a newer amide local anaesthetic, is gaining attention for its reduced cardiotoxicity and lower CNS toxicity compared to Bupivacaine.[3] The introduction of hyperbaric preparations has further refined spinal anaesthesia by providing more predictable spread and higher sensory blocks. Historically, Ropivacaine was available only in isobaric formulations, which required manual addition of dextrose, increasing the risk of infection.[4] Recently, hyperbaric Ropivacaine 0.75% has become commercially available, prompting a critical evaluation of its efficacy and safety compared to hyperbaric Bupivacaine 0.5%.

Clinical studies have highlighted Ropivacaine's favorable pharmacokinetic and pharmacodynamic profiles, demonstrating its reduced cardiovascular and CNS toxicity.[5,6] Comparative studies have provided insights into the onset and duration of motor and sensory block, key parameters for surgical anaesthesia.[7] By assessing parameters such as onset level, duration of motor and sensory block, haemodynamic stability, postoperative analgesic effect, and complication incidence, this study seeks to optimize patient care in regional anaesthesia and contribute to evidence-based clinical practice. Thus this research aim is to compare the efficacy and safety of hyperbaric Ropivacaine 0.75% with hyperbaric Bupivacaine 0.5% in elective lower abdominal surgeries under Spinal anaesthesia.

METHODOLOGY

STUDY PERIOD

This study was conducted over a two-year period, from August 2022 to July 2024.

STUDY DESIGN AND SETTING

This prospective comparative study was conducted across Bapuji Hospital, Chigateri General Hospital, and the Women and Children Hospital, all of which are affiliated with J.J.M. Medical College, Davangere.

INCLUSION CRITERIA:

The study included patients aged 18 to 60 years, classified under ASA grade I and II, and comprised both male and female participants. It focused on individuals undergoing lower abdominal surgeries who had provided valid, informed, written consent for participation.

EXCLUSION CRITERIA:

Patients with a history of allergy to anaesthetic medications, spinal deformities, a history of seizures or neurological deficits, and patients using sedatives, hypnotics, or other CNS depressant drugs were excluded. Additionally, those with coagulopathies, local site infections, pregnancy, or any other contraindications to spinal anaesthesia were excluded from participation.

SAMPLE SIZE ESTIMATION

$$\text{Sample size} = \frac{2*S^{2*}(Z_{1-\frac{\alpha}{2}}+Z_{1-\beta})^2}{(M_1-M_2)^2}$$

Where, S, the pooled standard deviation of the duration of surgery was

7.37, the Z value associated with a 95% confidence interval was 1.64, and the power of the study was set at 95%, represented by a Z value of 0.84. The mean motor block onset in Group A was 9.00 minutes, while in Group B, it was 13.00 minutes. This was rounded up to 42. However, to enhance the power of the study, the minimum Sample size was established at 90 (45 in each group).

STUDY PROCEDURE

The study was conducted following approval from the institutional ethical committee and obtained written informed consent from each patient. A total of 90 patients were randomly divided into two groups: Group B, comprising 45 patients, received 15 mg (3 ml) of Hyperbaric Bupivacaine 0.5% intrathecally, while Group R included 45 patients who received 22.5 mg (3 ml) of Hyperbaric Ropivacaine 0.75% intrathecally.

Prior to the procedure, a thorough pre-anesthetic evaluation was conducted, encompassing physical examination, a detailed medical history, and systemic assessment. Airway assessment, Local spine examination, and relevant preoperative investigations, including complete hemogram, ECG, renal function tests, random blood sugar, and screenings for HIV and HBsAg, were performed. The coagulation profile was confirmed to be within normal limits, and the patients weight and height were recorded.

Patients were briefed on the subarachnoid block procedure and premedicated with 0.5 mg of oral Alprazolam and 40 mg of oral Pantoprazole the night before surgery. On the procedure day, patients were positioned on the operating table, and intravenous access was established using an 18 or 20 G cannula. Lactated Ringer's solution was infused at a rate of 8-10 ml/kg prior to the spinal block. Standard monitoring including pulse oximetry, non-invasive blood pressure, and ECG was initiated upon arrival in the operating room, with intravenous fluid maintenance continued. Baseline parameters, including PR, RR, SBP, DBP, MAP, SpO2 and ECG were recorded.

In the left lateral position, the back was prepared and draped under strict aseptic conditions. The L3-L4/L2-L3 intervertebral space was identified using Tuffier's line, and a midline approach for lumbar puncture was executed with a 26G Quincke Babcock needle. After confirming free flow of clear cerebrospinal fluid (CSF), either 15 mg of Hyperbaric Bupivacaine 0.5% (for Group B) or 22.5 mg of Hyperbaric Ropivacaine 0.75% (for Group R) was administered intrathecally. Post-administration, patients were positioned supine and received supplemental oxygen at 4 l/min via a face mask during surgery, along with sedation from 30 mg of Pentazocine and 2 mg of midazolam.

Following the administration of intrathecal drugs, various parameters were evaluated in patients undergoing surgery. For motor blockade assessment, the quality of the motor block was evaluated using the Modified Bromage Scale, and the duration was documented from the onset until the patient could lift the leg freely (modified Bromage grade 0).

Vital parameters were continuously monitored, including non-invasive blood pressure, pulse oximetry, and ECG. Heart rate, systolic and diastolic blood pressure, mean arterial pressure, SpO2, and respiratory rate were recorded at intervals: every 3 minutes for the first 15 minutes, every 10 minutes for the next 30 minutes, and every 15 minutes thereafter during surgery. Hypotension was managed with intermittent IV boluses of Ephedrine (6 mg), while IV Midazolam (1-2 mg) was administered intraoperatively for anxiolysis. Bradycardia was treated with IV Atropine (0.6 mg), and respiratory depression through bag-mask ventilation or endotracheal intubation as necessary. Postoperatively, vital signs were monitored every 15 minutes for the first hour, every 30 minutes for the second hour, and hourly for the subsequent six hours, with additional assessments at the 12th and 24th hours.

The duration of analgesia was recorded from the complete administration of the drug until the patient requested rescue analgesics postoperatively. Pain intensity was assessed using the Visual Analogue Scale (VAS). Patients with VAS score exceeding 3, received rescue analgesia in the form of intravenous Diclofenac (75 mg) after 2 hours post-surgery. Additionally, patients were monitored for side effects such as nausea, vomiting, hypotension, bradycardia, and cardiac arrhythmias.

STATISTICAL ANALYSIS

Data was entered into Microsoft Excel and analyzed using SPSS 26.0. Descriptive statistics summarized demographic characteristics, including age, gender, ASA status, and medical history, with continuous variables presented as mean ± standard deviation and categorical variables expressed as frequencies and percentages. To assess differences between the groups independent t-tests were used, while chi-square tests analyzed categorical variables like the incidence of hypotension and bradycardia. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Out of a total of 90 participants, 48 (53.3%) are male, and 42 (46.7%) are female. Both Group B and Group R consist of 45 participants each, representing 50% of the total sample. In each group, 24 participants (53.3%) are male, and 21 participants (46.7%) are female as represented in Table 1. Based on ASA physical status classification, Group R consisted of 45 individuals, with 25 (55.6%) classified as ASA I, and 20 (44.4%) classified as ASA II. In contrast, Group B also had 45 individuals, but 20 (44.4%) are ASA I and 25 (55.6%) are ASA II, showing a slightly higher proportion of individuals with mild systemic conditions compared to Group R.

Table 1. Demographic details of the study participants

Variable	Total n (%)	Group B n (%)	Group R n (%)
No. of participants	90 (100%)	45 (50%)	45 (50%)
Gender			
Male	48 (53.3%)	24 (53.3%)	24 (53.3%)
Female	42 (46.7%)	21 (46.7%)	21 (46.7%)

The comparative analysis between Group B and Group R reveals several important differences in both demographic and clinical parameters. The mean age, height, and weight of participants were comparable between the two groups, with no statistically significant differences ($p > 0.05$), indicating homogeneity in baseline characteristics. Significant differences were observed in clinical outcomes. Group B exhibited a significantly faster time to onset of sensory block (2.711 minutes) compared to Group R (3.800 minutes) ($p < 0.001$). Additionally, the duration of sensory block was notably longer in Group B (171.73 minutes) than in Group R (153.16 minutes) ($p < 0.001$). The time to complete motor block was shorter in Group B (11.51 minutes) compared to Group R (12.58 minutes) ($p = 0.001$), while the duration of motor block was also significantly longer in Group B (171.73 minutes) than in Group R (133.91 minutes) ($p = 0.001$). (Table 2)

Although the time to peak sensory block was similar between the groups ($p = 0.469$), the time for two-segment regression was comparable ($p = 0.188$), suggesting no significant difference in sensory block regression between the two groups. Lastly, the time to rescue analgesia was significantly prolonged in Group B (138.84 minutes) compared to Group R (125.02 minutes) ($p < 0.001$). (Table 2) This suggests Group B demonstrated superior clinical efficacy, with faster onset, longer duration of both sensory and motor block, and a delayed need for rescue analgesia, suggesting that the intervention administered to Group B provided more effective and sustained anesthesia compared to Group R.

Table 2. Evaluation of Sensory and Motor Block Characteristics in Group B versus Group R

Variable	Group B Mean + SD	Group R Mean + SD	P value
Age	40.02+12.66	38.15+12.85	0.489
Height	159.80+5.35	159.84+4.93	0.961
Weight	60.73+7.88	58.71+5.60	0.164
Time to onset of sensory block (in min)	2.711+0.58	3.800+0.49	<0.001*
Time to peak sensory block (in min)	13.87+1.10	13.71+0.92	0.469
Duration of sensory block	171.73+11.19	153.16+9.43	<0.001*
Time for two segment regression	92.71+2.77	92.00+2.29	0.188
Time to complete motor block	11.51+1.33	12.58+1.67	0.001*
Duration of motor block	171.73+11.19	133.91+22.62	0.001*
Time of rescue analgesia	138.84+8.05	125.02+9.63	<0.001*

Bromage Grade of Motor Block were assessed revealing notable outcomes for Group B compared to Group R. In Group B, 41 individuals (91%) achieved a Grade 3 motor block, indicating a complete inability to move the feet or knees, while only 4 individuals (8%) were classified as Grade 2, allowing for movement of the feet only. In contrast, Group R had 35 individuals (77%) with a Grade 3 motor block and 6 individuals (13%) with a Grade 2 block. Importantly, neither group recorded any instances of Grade 1 or Grade 0 motor blocks, highlighting that both treatments primarily resulted in substantial motor block among the majority of participants.

These findings suggest that the intervention for Group B is more effective in inducing a higher level of motor block than that observed in Group R. With regard to hemodynamic parameters, at baseline, the HR was significantly lower in the Bupivacaine group (84.70 ± 4.16 bpm) compared to the Ropivacaine group (87.95 ± 14.51 bpm) with a p-value of 0.161, indicating no significant difference at this point. However, over time, particularly at 3, 6, and 35 minutes, the Bupivacaine group showed a statistically significant decrease in HR, suggesting a more pronounced bradycardic effect from Bupivacaine compared to Ropivacaine. The consistent decline in HR in the Bupivacaine group, reaching as low as 70.19 bpm by 165 minutes ($p < 0.001$), raises concerns about its cardiovascular stability. (Table 3)

SBP measurements indicated that Ropivacaine maintained better blood pressure stability. The Bupivacaine group experienced significant drops in SBP at various intervals, particularly noticeable at 3 minutes ($p < 0.001$), indicating hypotension in this group. In contrast, Ropivacaine's SBP changes remained within a more stable range suggesting better hemodynamic control. Similar to SBP, DBP was significantly lower in the Bupivacaine group across several time points. (Table 3)

Table 3. Comparison of Mean Heart rate, Systolic and Diastolic Blood Pressure between the groups at various time intervals

Time line	Group	HR		SBP		DBP	
		Mean + SD	p value	Mean + SD	p value	Mean + SD	p value
Baseline	B	84.70+4.16	0.161	126.37 +13.30	0.132	52.84+9.44	<0.001*
	R	87.95+14.51		121.95 +13.67		60.26+8.96	
3 minutes	B	79.44+3.76	0.090	109.53 +14.15	<0.001*	52.79+8.99	<0.001*
	R	81.63+7.46		119.44 +11.79		59.81+7.79	
6 minutes	B	75.91+6.96	<0.001*	106.09 +11.94	<0.001*	55.49+10.28	0.077
	R	83.91+3.21		117.14 +10.10		58.98+7.55	
9 minutes	B	78.98+5.58	0.590	106.05 +12.62	<0.001*	51.49+12.09	<0.001*
	R	79.49+2.69		116.86 +9.94		59.44+7.11	
15 minutes	B	78.90+7.75	0.250	106.05 +13.03	<0.005*	50.00+11.50	<0.001*
	R	77.16+6.04		114.42 +13.70		59.91+7.50	
25 minutes	B	79.02+9.13	0.411	107.30 +12.22	<0.008*	50.28+10.27	<0.001*
	R	80.33+4.84		114.63 +12.75		61.67+8.53	
35 minutes	B	75.30+6.82	<0.001*	107.81 +13.74	0.132	50.56+8.63	<0.001*
	R	80.47+7.02		112.40 +14.17		62.56+9.25	
45 minutes	B	76.93+7.11	0.083	109.12 +12.43	0.453	51.49+7.69	<0.001*
	R	79.86+8.33		111.40+ 15.44		63.26+9.79	
60 minutes	B	78.56+7.92	0.130	110.37 +11.11	0.4	51.16+6.43	<0.001*
	R	76.33+5.36		112.51 +12.30		62.09+9.57	
75 minutes	B	80.60+7.24	0.101	109.77 +11.17	0.355	52.14+6.75	<0.001*
	R	78.33+5.36		112.19 +12.88		60.93+9.56	
90 minutes	B	80.33+6.87	1.000	111.30+ 12.23	0.514	51.58+5.56	<0.001*
	R	80.33+5.36		112.95 +11.08		57.58+7.53	
105 minutes	B	74.28+6.44	<0.001*	113.16 +13.07	0.741	51.58+5.12	<0.001*
	R	81.91+5.29		114.00 +10.12		57.49+6.63	
120 minutes	B	78.74+6.68	0.148	111.81+ 12.28	0.344	50.98+5.28	<0.001*
	R	80.79+6.33		114.05 +9.28		58.00+6.35	
135 minutes	B	78.42+7.57	<0.006*	109.53 +10.61	<0.046*	52.70+5.64	<0.001*
	R	74.33+5.82		113.88 +9.21		57.35+6.26	
150 minutes	B	71.77+4.68	<0.001*	110.93 +9.13	0.114	56.00+4.47	0.074
	R	78.84+5.56		114.21 +9.89		58.00+5.71	
165 minutes	B	70.19+5.48	<0.001*	113.35 +9.13	0.174	52.70+5.64	<0.001*
	R	79.95+5.44		116.00 +8.79		57.35+6.26	
180 minutes	B	70.47+4.84	<0.001*	113.44 +10.02	<0.058*	56.00+4.47	0.074
	R	80.33+4.78		117.30 +8.51		58.00+5.71	

The data demonstrates that Mean Arterial Pressure (MAP) was consistently lower in the Bupivacaine group compared to the Ropivacaine group at all time points, with statistically significant differences ($p < 0.001$), indicating that Ropivacaine is associated with more stable hemodynamics. Oxygen saturation (SPO2) remained comparable between both groups, showing no significant differences. Respiratory rates (RR) were also similar, with no substantial variation observed throughout the study. Overall, these results suggest that while both anesthetics maintain adequate oxygenation and respiratory stability, Ropivacaine offers superior hemodynamic control. (Table 4) The distribution of adverse effects is represented in Figure 1.

Table 4. Comparison of Mean arterial pressure, SpO2 and Respiratory rate between the groups at various time intervals

Time line	Group	MAP		SPO2		RR	
		Mean + SD	p value	Mean + SD	p value	Mean + SD	p value
Baseline	B	65.63±6.36	<0.001*	99.60±0.58	1.000	15.37+2.19	0.182
	R	72.98±4.31		99.60±0.58		15.35+2.32	
3 minutes	B	64.74±5.74	<0.001*	99.30±0.94	1.000	13.02+1.18	0.185
	R	70.84±4.39		99.30±0.94		13.16+1.09	
6 minutes	B	64.65±8.06	<0.001*	99.84±0.37	1.000	14.74+0.98	0.571
	R	70.70±3.95		99.84±0.37		14.79±0.99	
9 minutes	B	64.70±8.26	<0.001*	99.23±0.43	1.000	13.91+2.31	0.827
	R	72.98±4.03		99.23±0.43		14.00±2.39	

15 minutes	B	64.84±8.95	<0.001*	99.81±0.39	1.000	14.09+1.57	0.855
	R	73.67±4.23		99.81±0.39		14.14±1.47	
25 minutes	B	65.12±8.44	<0.001*	99.51±0.55	1.000	12.74+0.98	0.888
	R	75.58±5.62		99.51±0.55		12.79±0.99	
35 minutes	B	64.51±7.88	<0.001*	99.02±0.67	1.000	13.91+1.23	0.827
	R	75.16±5.88		99.02±0.67		13.86±1.26	
45 minutes	B	62.70±6.93	<0.001*	99.12±0.32	1.000	12.98+1.01	0.863
	R	71.91±2.09		99.12±0.32		12.88±1.00	
60 minutes	B	64.88±6.96	<0.001*	98.67±0.47	1.000	14.33+0.75	0.670
	R	71.53±4.55		98.67±0.47		14.33+0.75	
75 minutes	B	63.23±6.73	<0.001*	98.60±0.85	1.000	13.07+1.01	1.000
	R	72.79±4.64		98.60±0.85		13.07+1.01	
90 minutes	B	64.37±6.42	<0.001*	98.09±0.65	1.000	14.00+0.00	1.000
	R	72.67±4.29		98.09±0.65		14.00+0.00	
105 minutes	B	66.42±7.40	<0.001*	98.95±0.30	1.000	14.05+1.72	0.808
	R	72.14±5.49		98.95±0.30		13.95±1.83	
120 minutes	B	65.81±5.47	<0.001*	98.53±0.59	1.000	13.58+0.82	0.153
	R	74.00±6.43		98.53±0.59		13.30±0.96	
135 minutes	B	66.37±4.12	<0.001*	98.84±0.53	1.000	13.81+1.50	0.153
	R	70.74±3.18		98.84±0.53		13.35±1.49	
150 minutes	B	65.95±5.34	<0.001*	98.74±0.44	1.000	13.16+1.17	0.705
	R	69.02±3.84		98.74±0.44		13.07±1.10	
165 minutes	B	65.63±4.71	<0.001*	98.35±0.84	1.000	13.74+1.45	0.162
	R	70.88±3.91		98.35±0.84		13.37±1.49	
180 minutes	B	65.35±4.40	<0.001*	98.26±0.73	1.000	13.36+1.15	0.709
	R	71.35±5.10		98.26±0.73		13.27±1.30	

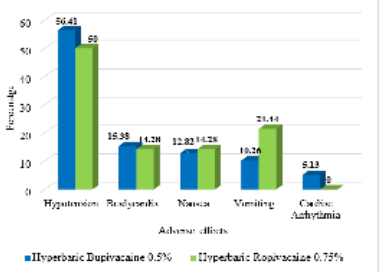

Figure 1.Distribution of adverse effects in the study participants

DISCUSSION:

Spinal anaesthesia remains the predominant technique for lower abdominal surgeries, predominantly employing hyperbaric Bupivacaine 0.5%, a racemic local anaesthetic. However, the advent of newer amide agents, notably Ropivacaine and Levobupivacaine, has transformed clinical practice.[8] Ropivacaine's distinctive pharmacological profile, characterized by lower lipophilicity compared to Bupivacaine, diminishes the likelihood of penetrating large myelinated motor fibres,[9] resulting in a reduced motor blockade and enhanced motor-sensory differentiation. The recent introduction of hyperbaric Ropivacaine 0.75% provides an additional therapeutic option for practitioners. This study sought to systematically compare the efficacy and safety profiles of intrathecal hyperbaric Bupivacaine 0.5% and hyperbaric Ropivacaine 0.75% in the context of lower abdominal surgeries, with 45 patients allocated to each group.

The demographic variables-including mean age, gender distribution, height, weight, and ASA physical status-demonstrated comparability between the two groups. This homogeneity in demographic characteristics effectively mitigates potential confounding factors, thereby enabling a more robust assessment of the anaesthetic effects. Notably, the onset of sensory block occurred significantly more rapidly in the Bupivacaine group (2.711 ± 0.588 min) in contrast to the Ropivacaine group (3.800 ± 0.493 min), with a p-value of < 0.001 indicating statistical significance. This rapid onset underscores Bupivacaine's advantageous profile for procedures necessitating prompt anaesthetic effect, corroborated by findings from Mahajan et al.[10]

In terms of time to peak sensory block, both groups exhibited comparable results, with the Bupivacaine cohort averaging 13.87 ± 1.100 minutes and the Ropivacaine cohort 13.71 ± 0.920 minutes (p = 0.469). This suggests that while the onset times may diverge, the peak efficacy remains consistent, aligning with the observations of Whiteside et al.,[11] Penmetsa UR et al.[12] and McDonald et al.[5]. Furthermore, the duration of sensory block was significantly prolonged in the Bupivacaine group (171.73 ± 11.197 min) compared to Ropivacaine (153.16 ± 9.427 min), with a p-value < 0.001. These findings resonate with prior research by Penmetsa UR et al. [12] and Gaikwad et al.[13], both of which documented longer sensory block durations with Bupivacaine.

Interestingly, no significant disparities were observed regarding the time for two-segment regression, with the Bupivacaine group exhibiting a mean regression time of 92.71 ± 2.769 minutes compared to the Ropivacaine group at 92.00 ± 2.296 minutes (p = 0.188). Additionally, the comparison of the highest level of sensory block achieved yielded no statistically significant difference (p = 1.000), underscoring the equivalent efficacy of both Bupivacaine and Ropivacaine in attaining sufficient sensory blockade for lower abdominal procedures. These findings are further corroborated by the studies conducted by Kulkarni et al.[14] and Mahajan et al.,[10] reinforcing the validity of this research.

The onset of motor block was significantly faster in the Bupivacaine group, achieving complete motor blockade in 11.51 ± 1.325 minutes compared to 12.58 ± 1.672 minutes for Ropivacaine (p < 0.001). Furthermore, the motor block duration was markedly longer in the Bupivacaine group (171.73 ± 11.197 min) than in the Ropivacaine group (133.91 ± 22.623 min, p < 0.001). These observations align with the findings of Penmetsa UR et al.[12] and Mahajan et al.,[10] who reported similar outcomes in infraumbilical and lower limb surgeries. Ropivacaine's reduced lipophilicity results in less potent effects on motor nerves and enhanced motor-sensory differentiation, facilitating early ambulation, a characteristic noted in previous studies by Whiteside et al.[11] and Kulkarni et al.[14]

Analysis of Bromage grade of motor block showed no significant difference between the groups (p = 1.000), indicating both agents effectively achieve the requisite degree of motor blockade for surgical procedures. Gupta et al. reported similar findings, with Grade III motor blockade rates of 66.7% for Ropivacaine and 86.67% for Bupivacaine. Although Ropivacaine demonstrated a delayed onset and shorter duration of both sensory and motor blocks, it remains adequate for surgery without necessitating prolonged anaesthesia, corroborated by Chung CJ et al.[3] in elective caesarean deliveries. Kalbande et al.[7] further confirmed that hyperbaric Ropivacaine 0.75% (22.5 mg) provides effective spinal anaesthesia, despite a shorter duration of

motor block. Our study revealed that hyperbaric Bupivacaine 0.5% significantly prolonged the time before rescue analgesia was required compared to hyperbaric Ropivacaine 0.75% (138.84 ± 8.051 min vs. 125.02 ± 9.626 min, $p < 0.001$), a trend supported by Gaikwad et al.[13] in infraumbilical surgery.

In terms of hemodynamic parameters, the Ropivacaine group exhibited more stable readings, consistent with Gupta et al.,[15] who noted minimal fluctuations in hemodynamic parameters. For instance, at 6 minutes, MAP was significantly higher in the Ropivacaine group (70.98 ± 4.702 mmHg) compared to the Bupivacaine group (65.02 ± 8.131 mmHg, $p < 0.001$). Additionally, Ropivacaine maintained higher heart rates at various intervals (6, 35, 105, 135, 180 mins) compared to Bupivacaine ($p < 0.001$), possibly due to the absence of the R-enantiomer in Ropivacaine. While hypotension occurred more frequently in the Bupivacaine group (56.41%) versus the Ropivacaine group (50%), the overall adverse effects were comparable. These findings echo those of Dar et al.[16] and Kulkarni et al.,[14] who identified hypotension as a predominant side effect associated with Bupivacaine. Some patients required interventions such as vasopressors and atropine to manage complications, underscoring the hemodynamic instability associated with Bupivacaine. However, both hyperbaric Ropivacaine 0.75% and hyperbaric Bupivacaine 0.5% demonstrated similar effects on respiratory rates, indicating negligible impact on respiratory function. Mahajan et al.[10] also highlighted Ropivacaine's superior hemodynamic stability relative to Bupivacaine, noting fewer episodes of hypotension and bradycardia. This characteristic renders Ropivacaine particularly advantageous for patients at risk of hemodynamic instability during surgical procedures. Overall, both anaesthetics exhibit relatively safe adverse effect profiles, with Ropivacaine potentially offering a slight edge due to a lower incidence of cardiac arrhythmia and hypotension.

However the study is not without limitations. The study was conducted at a single center, which could introduce site-specific biases, potentially limiting the generalizability of the findings to other clinical settings. Additionally, the follow-up period was confined to the duration of the surgery and the immediate postoperative phase, neglecting the assessment of long-term outcomes and possible late complications. The study population exhibited relative homogeneity, which may not accurately represent the diverse patient demographics encountered in broader clinical practice. While immediate adverse effects, including hypotension and bradycardia, were closely monitored, other potential complications, such as neurotoxicity or delayed onset effects, were not thoroughly investigated, raising concerns about the comprehensiveness of the safety profile evaluated.

CONCLUSION:

Thus, both Hyperbaric Ropivacaine 0.75% and Hyperbaric Bupivacaine 0.5% are effective for spinal anaesthesia in surgical procedures. Ropivacaine has a better safety profile, with fewer cases of hypotension and faster recovery of motor function. Its commercially prepared hyperbaric form allows for consistent blockade height and offers greater sensory-motor differential blockade with shorter motor block duration. Thus, Hyperbaric Ropivacaine 0.75% is preferable for lower abdominal surgeries due to its reduced cardiotoxicity. Ultimately, the choice between Ropivacaine and Bupivacaine should be guided by clinical context, with Bupivacaine suited for longer procedures and Ropivacaine ideal for patients requiring early ambulation.

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