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Comparison of Efficacy and Haemodynamic Changes of 0.5% Isobaric Levobupivacaine and 0.5% Hyperbaric Bupivacaine in Spinal Anaesthesia

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Abstract

Background: Spinal anaesthesia is widely used for lower abdominal and lower-limb surgeries. Bupivacaine provides reliable and prolonged blockade, while Levobupivacaine may offer effective anaesthesia with a potentially favourable safety profile. This study compared the efficacy and Haemodynamic effects of 0.5% isobaric Levobupivacaine and 0.5% hyperbaric Bupivacaine.

Methods: This prospective comparative clinical study was conducted in the Department of Anaesthesiology, Yenepoya Medical College Hospital, Mangalore. A total of 130 patients aged 18–60 years with ASA physical status I–III undergoing elective lower abdominal or lower-limb surgery under spinal anaesthesia were included and allocated equally into two groups.

Group L (n=65) received 3 mL of 0.5% isobaric Levobupivacaine, while Group B (n=65) received 3 mL of 0.5% hyperbaric Bupivacaine intrathecally. Sensory and motor block onset and duration, heart rate and blood pressure were assessed. Statistical analysis was performed using appropriate parametric and non-parametric tests, with $p<0.05$ considered statistically significant.

Results: Hyperbaric Bupivacaine produced a significantly faster onset of sensory and motor blockade than isobaric Levobupivacaine. Sensory and motor block developed within 0–5 minutes in all patients receiving Bupivacaine, compared with 5–10 minutes in all patients

receiving Levobupivacaine (p=0.0001). Sensory and motor block durations were significantly longer with Bupivacaine, lasting 2–3 hours compared with 1–2 hours with Levobupivacaine (p=0.0001). No significant differences in heart rate or blood pressure were observed immediately after spinal anaesthesia or at 6 hours, although significant differences were reported at 1, 2 and 3 hours.

Conclusion: 0.5% hyperbaric Bupivacaine provides a faster onset and longer duration of sensory and motor blockade than 0.5% isobaric Levobupivacaine. Levobupivacaine remains an effective alternative when a shorter duration of spinal blockade is desirable.

Keywords: Spinal anaesthesia; Levobupivacaine; Bupivacaine; Hyperbaric Bupivacaine; Sensory block; Motor block; Haemodynamic changes.

Introduction

Spinal anaesthesia is one of the most commonly employed regional an aesthetic technique for lower abdominal, pelvic and lower-limb surgery because it provides effective sensory and motor blockade, reduces the requirement for systemic an aesthetic agents and allows the patient to remain awake during surgery. However, the extent and duration of spinal block and the associated Haemodynamic response are influenced by several factors, including the dose and concentration of local an aesthetic, baricity of the solution, patient position, and site of injection and individual patient characteristics. Sympathetic blockade produced by spinal anaesthesia may result in arterial and venous vasodilatation, leading to hypotension and, in some patients, bradycardia.[1,2]

Bupivacaine is a long-acting amide local an aesthetic that has traditionally been widely used for spinal anaesthesia because of its reliable sensory and motor blockade and relatively prolonged duration of action. The baricity of intrathecal Bupivacaine is an important determinant of its cephalad spread and block characteristics. Hyperbaric Bupivacaine, generally prepared with glucose, is denser than cerebrospinal fluid and its distribution is influenced substantially by patient position and gravity. Consequently, hyperbaric solutions may produce a relatively rapid and predictable establishment of spinal block, although extensive sympathetic blockade and Haemodynamic changes may occur depending on the dose and level of block.[3]

Despite its extensive clinical use, racemic Bupivacaine is associated with greater cardio toxic potential than several newer long - acting local an aesthetics. Levobupivacaine is the pure S (-) - enantiomer of Bupivacaine and was developed with the objective of retaining the desirable clinical characteristics of Bupivacaine while reducing its potential cardiovascular and central nervous system toxicity. Experimental and clinical pharmacological studies have demonstrated a more favourable toxicity profile for Levobupivacaine, particularly with respect to myocardial depression and arrhythmogenic potential.[4–6]

Intrathecal Levobupivacaine has subsequently been investigated as an alternative to racemic Bupivacaine. Previous randomized studies have demonstrated that isobaric Levobupivacaine can provide effective spinal anaesthesia for lower abdominal, lower-limb and orthopaedic procedures, with broadly comparable sensory and motor blockade to Bupivacaine. However, differences have been reported in the onset and regression of sensory and motor block depending on the dose, baricity and surgical population studied.[7–9]

The baricity difference between the two agents is particularly relevant in the present comparison. The

study evaluates 0.5% isobaric Levobupivacaine against 0.5% hyperbaric Bupivacaine administered in equal volumes (3 mL). Thus, the comparison incorporates not only the pharmacological differences between Levobupivacaine and racemic Bupivacaine but also the influence of solution baricity on Intrathecal spread. Recent evidence indicates that hyperbaric Bupivacaine may produce a faster onset of block than isobaric solutions, while the effect of baricity on hypotension remains variable across studies.[10],[11]

A randomized study comparing isobaric Levobupivacaine and racemic Bupivacaine for lower abdominal and lower - extremity surgery reported differences in the onset of motor block and other block characteristics, supporting the clinical relevance of direct comparison between these agents.[7] Similarly, studies comparing isobaric Levobupivacaine with Bupivacaine during knee arthroscopy have demonstrated faster onset of sensory and motor blockade with Bupivacaine while showing broadly similar Haemodynamic characteristics and block duration.[8] More recent comparative work involving 0.5% Levobupivacaine and hyperbaric Bupivacaine has also demonstrated a faster onset with hyperbaric Bupivacaine, highlighting the importance of baricity in determining the clinical profile of spinal anaesthesia.[11]

Therefore, the present study was undertaken to compare the efficacy and Haemodynamic changes associated with Intrathecal administration of 3 mL of 0.5% isobaric Levobupivacaine and 3 mL of 0.5% hyperbaric Bupivacaine in patients undergoing elective lower abdominal and lower-limb surgery. The study specifically assessed the onset and duration of sensory and motor blockade and evaluated changes in heart rate and blood pressure following spinal anaesthesia. The findings may help determine whether isobaric Levobupivacaine provides a clinically useful alternative to hyperbaric Bupivacaine while potentially offering advantages related to Haemodynamic stability and safety.

Materials and Methods

Study Design and Setting

The present study was conducted in the Department of Anaesthesiology, Yenepoya Medical College Hospital, Mangalore, Karnataka, India, after obtaining approval from the Institutional Ethics Committee. The study was designed as a prospective comparative clinical study to evaluate the characteristics of spinal anaesthesia produced by 0.5% hyperbaric Bupivacaine and 0.5% isobaric Levobupivacaine in patients undergoing lower abdominal and lower limb surgeries.

Study Population and Sample Size

A total of 130 patients aged 18–60 years, belonging to American Society of Anesthesiologists (ASA) physical status I, II, or III, and scheduled for elective lower abdominal or lower limb surgery under spinal anaesthesia were included. Patients were randomly allocated into two equal groups of 65 each according to the Intrathecal local an aesthetic administered.

- **Group B (n = 65):** received 3 mL of 0.5% hyperbaric Bupivacaine intrathecally.
- **Group L (n = 65):** received 3 mL of 0.5% isobaric Levobupivacaine intrathecally.

Preoperative Assessment

All patients underwent a detailed preoperative evaluation, including history, general physical examination, airway assessment, cardiovascular and respiratory system examination, and examination of the spine. Relevant medical history, including hypertension, diabetes mellitus, cardiac disease, ischemic heart

disease, endocrine disorders, bronchial asthma, chronic obstructive pulmonary disease, smoking, bleeding disorders, use of anti-platelet or anticoagulant medication, hepatic or renal dysfunction, neurological disorders, previous an aesthetic exposure, drug intake, and drug allergies, was recorded.

Baseline vital parameters, including pulse rate, blood pressure, respiratory status, oxygen saturation, and temperature, were documented. Routine investigations included complete blood count, coagulation profile, liver and renal function tests, blood glucose estimation, and electrocardiography as clinically indicated.

Patients were counseled regarding the spinal anaesthesia procedure, and written informed consent was obtained before enrolment. Standard preoperative fasting instructions were followed. Solid food was withheld for 8 hours before surgery, while clear fluids were permitted up to 2–3 hours before induction, according to institutional practice. Anti-aspiration prophylaxis with ranitidine 150 mg and anxiolytic medication (alprazolam 0.5 mg) was administered as prescribed on the previous night and on the morning of surgery. Regular medications were continued until the morning of surgery when appropriate.

An aesthetic Technique

Patients were transferred to the operating room approximately 30 minutes before the planned procedure. An 18-gauge intravenous cannula was secured in the forearm, and Ringer's lactate solution was administered at approximately 10 mL/kg over 20 minutes.

Standard intra operative monitoring included non-invasive blood pressure, heart rate, and peripheral oxygen saturation.

Patients were positioned in the lateral position for spinal anaesthesia. After aseptic preparation of the back with povidone-iodine and spirit, the L2–L3 or L3–L4 intervertebral space was identified using Tuffier's line as the anatomical landmark. Following local infiltration with 2 mL of 2% lignocaine, a 25-gauge Quincke spinal needle was introduced through the midline approach. Correct Intrathecal placement was confirmed by free flow of cerebrospinal fluid. The assigned study drug was then injected intrathecally over approximately 10 seconds. Following completion of the injection, patients were placed in the supine position.

Assessment of Sensory Block

Sensory block was assessed using the pinprick method. The onset of sensory block was defined as the time from completion of Intrathecal drug administration to loss of pinprick sensation at the predetermined dermatome level. The maximum cephalad level of sensory block was recorded.

Sensory block level was assessed at 2 and 5 minutes after spinal injection and subsequently at regular intervals until the block level became stable. Once two consecutive assessments demonstrated the same sensory level, the level was considered fixed. Further assessments were performed at 15-minute intervals.

Assessment of Motor Block

Motor blockade was assessed concurrently with sensory blockade using the modified Bromage scale:

- **Grade 0:** Full movement of the legs.
- **Grade 1:** Inability to raise the extended leg.
- **Grade 2:** Inability to flex the knee but able to flex the ankle.
- **Grade 3:** Complete inability to move the lower limbs.

The onset and degree of motor blockade were recorded for comparison between the two study groups.

Respiratory Monitoring

Peripheral oxygen saturation was monitored continuously using pulse oximetry. Oxygen saturation was recorded at baseline before spinal anaesthesia and subsequently at 5-minute intervals until completion of the surgical procedure. Supplemental oxygen was administered through a Hudson face mask at a flow rate of 4 L/min.

Haemodynamic Monitoring

Heart rate and non-invasive blood pressure were recorded at baseline, immediately following administration of the spinal block, and at predefined postoperative intervals. Haemodynamic changes occurring during and after spinal anaesthesia were documented.

Hypotension was defined as a decrease in mean arterial pressure (MAP) of more than 30% from the pre-an aesthetic baseline or an MAP below 65 mmHg. Hypotension was treated with intravenous mephentermine in 6 - mg increments according to clinical requirement. Bradycardia was defined as a heart rate below 60 beatsmin and was treated with intravenous atropine 0.6 mg when clinically indicated.

Inclusion Criteria

1. Patients aged 18–60 years.
2. Patients of either sex.
3. Patients belonging to ASA physical status I, II, or III.
4. Patients scheduled for lower abdominal or lower limb surgery under spinal anaesthesia.
5. Patients willing to participate and providing written informed consent.

Exclusion Criteria

1. Patients with severe spinal or vertebral abnormalities that could interfere with spinal anaesthesia.
2. Patients with absolute contraindications to spinal anaesthesia.
3. Patients with known allergy or hypersensitivity to the study drugs.
4. Patients in whom spinal anaesthesia failed or was only partially effective.
5. Patients unwilling to participate in the study.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 22.0. Continuous variables were expressed as mean ± standard deviation or median with interquartile range, as appropriate, while categorical variables were expressed as frequencies and percentages.

The independent Student's t-test was used for comparison of normally distributed continuous variables between the two groups. The Mann–Whitney U test was used for comparison of non-normally distributed variables. Categorical variables were compared using appropriate tests.

The duration, onset, efficacy, and level of sensory and motor blockade were compared between Group B and Group L. A p-value<0.05 was considered statistically significant. Results were presented using appropriate tables and graphical representations, including bar diagrams where applicable.

Results and Observations

The present study compared the efficacy, sensory and motor block characteristics, duration of block, and Haemodynamic changes associated with 0.5% isobaric Levobupivacaine and 0.5% hyperbaric Bupivacaine administered intrathecally for spinal anaesthesia.

A total of 130 patients were included, with 65 patients in each treatment group.

Demographic Characteristics

The demographic characteristics of the two study groups are presented in Table 1. The Levobupivacaine group comprised 42 males and 23 females, whereas the Bupivacaine group comprised 49 males and 16 females. Overall, there were 91 male and 39 female participants, with males constituting the majority of the study population.

The mean age of the participants was 40.74 ± 10.79 years. The mean age was 40.98 years in the Levobupivacaine group and 40.49 years in the Bupivacaine group.

Table 1: Comparison of study groups according to gender and age

Variable	Levobupivacaine (n=65)	Bupivacaine (n=65)	Total (n=130)
Male, n (%)	42 (64.62)	49 (75.38)	91 (70.00)
Female, n (%)	23 (35.38)	16 (24.62)	39 (30.00)
Mean age (years)	40.98	40.49	40.74
SD	42.52*	11.52	10.79

*The reported SD of 42.52 years in the levobupivacaine group should be verified against the original dataset because it is unusually large in relation to the reported mean.

Distribution According to Age Group

The age-group distribution is shown in Table 2. The largest proportion of participants belonged to the 31–40-year age group (32.31%), followed by the 41–50-year group (29.23%). In the Levobupivacaine group, 33.85% of patients were aged 31–40 years, while 30.77% of patients in the Bupivacaine group belonged to the same age category.

Table 2: Distribution of participants according to age group

Age group (years)	Levobupivacaine n (%)	Bupivacaine n (%)	Total n (%)
20–30	8 (12.31)	11 (16.92)	19 (14.62)
31–40	22 (33.85)	20 (30.77)	42 (32.31)
41–50	19 (29.23)	19 (29.23)	38 (29.23)
51–60	13 (20.00)	14 (21.54)	27 (20.77)
≥61	3 (4.62)	1 (1.54)	4 (3.08)
Total	65 (100.00)	65 (100.00)	130 (100.00)

Observation

The presence of participants aged ≥61 years is inconsistent with the stated inclusion criterion of 18–60 years and should be verified from the source data.

Comparison of Sensory Block Onset

The onset of sensory block differed significantly between the two groups. All patients receiving hyperbaric bupivacaine developed sensory block within 0–5 minutes, whereas all patients receiving isobaric Levobupivacaine developed sensory block within 5–10 minutes. Thus, Bupivacaine demonstrated a significantly faster onset of sensory blockade compared with Levobupivacaine ($\chi^2 = 130.00$, $p = 0.0001$).

Table 3: Comparison of sensory block onset time

Sensory onset time	Levobupivacaine n (%)	Bupivacaine n (%)	Total n (%)
0–5 minutes	0 (0.00)	65 (100.00)	65 (50.00)
5–10 minutes	65 (100.00)	0 (0.00)	65 (50.00)
Total	65 (100.00)	65 (100.00)	130 (100.00)

Chi-square = 130.00; p = 0.0001.

Comparison of Motor Block Onset

A similar pattern was observed for the onset of motor blockade. All patients in the Bupivacaine group achieved motor block within 0–5 minutes, whereas all patients in the Levobupivacaine group achieved motor block within 5–10 minutes. The difference between the groups was statistically significant ($\chi^2 = 130.00$, p = 0.0001), indicating a faster onset of motor blockade with hyperbaric Bupivacaine.

Table 4: Comparison of motor block onset time

Motor onset time	Levobupivacaine n (%)	Bupivacaine n (%)	Total n (%)
0–5 minutes	0 (0.00)	65 (100.00)	65 (50.00)
5–10 minutes	65 (100.00)	0 (0.00)	65 (50.00)
Total	65 (100.00)	65 (100.00)	130 (100.00)

Chi-square = 130.00; p = 0.0001.

Heart Rate at Different Time Points

Heart rate measurements were compared between the two groups at immediate, 1-hour, 2-hour, 3-hour, and 6-hour time points using the Mann–Whitney U test.

There was no statistically significant difference between the groups immediately after spinal anaesthesia (p = 0.0983) or at 6 hours (p = 0.0841). However, statistically significant differences were observed at 1, 2, and 3 hours, with p = 0.0001 at each time point.

Table 5: Comparison of heart rate between the study groups at different time points

Time point	Levobupivacaine Mean ± SD	Median (IQR)	Bupivacaine Mean ± SD	Median (IQR)	U-value	Z-value	p-value
Immediate	3.63 ± 0.89	4.00 (0.50)	3.34 ± 0.67	3.00 (0.50)	1757.50	-1.6530	0.0983
1 hour	3.63 ± 0.89	4.00 (0.50)	2.48 ± 0.66	3.00 (0.50)	727.50	-6.4490	0.0001
2 hours	3.63 ± 0.89	4.00 (0.50)	2.48 ± 0.66	3.00 (0.50)	727.50	-6.4490	0.0001
3 hours	3.63 ± 0.89	4.00 (0.50)	2.48 ± 0.66	3.00 (0.50)	727.50	-6.4490	0.0001
6 hours	3.63 ± 0.89	4.00 (0.50)	3.32 ± 0.69	3.00 (0.50)	1741.50	-1.7275	0.0841

Statistically significant at p < 0.05.

Observation

The supplied heart-rate values appear to represent coded categories rather than actual beats/minute. The original coding scheme should therefore be retained or converted back to actual heart-rate values before publication.

Blood Pressure at Different Time Points

Blood pressure observations were compared between the two groups at immediate, 1-hour, 2-hour, 3-hour, and 6-hour intervals.

No statistically significant difference was observed immediately after spinal anaesthesia (p = 0.4059) or at 6 hours (p = 0.4423). Significant differences were observed at 1, 2, and 3 hours, with p = 0.0197 at each time point.

Table 6: Comparison of blood pressure between the study groups at different time points

Time point	Levobupivacaine Mean ± SD	Median (IQR)	Bupivacaine Mean ± SD	Median (IQR)	U-value	Z-value	p-value
Immediate	4.38 ± 1.41	4.00 (1.50)	4.62 ± 1.45	4.00 (1.25)	1934.00	-0.8312	0.4059
1 hour	4.38 ± 1.41	4.00 (1.50)	3.74 ± 1.42	4.00 (1.00)	1611.50	-2.3328	0.0197
2 hours	4.38 ± 1.41	4.00 (1.50)	3.74 ± 1.42	4.00 (1.00)	1611.50	-2.3328	0.0197
3 hours	4.38 ± 1.41	4.00 (1.50)	3.74 ± 1.42	4.00 (1.00)	1611.50	-2.3328	0.0197
6 hours	4.38 ± 1.41	4.00 (1.50)	4.60 ± 1.46	4.00 (1.25)	1947.50	-0.7683	0.4423

Statistically significant at $p < 0.05$.

Duration of Sensory Block

The duration of sensory blockade differed significantly between the two groups. All patients in the Levobupivacaine group had a sensory block duration of 1–2 hours, whereas all patients in the bupivacaine group had a duration of 2–3 hours.

The difference was statistically significant ($\chi^2 = 130.00$, p = 0.0001), demonstrating a longer duration of sensory blockade with hyperbaric Bupivacaine.

Table 7: Comparison of duration of sensory block

Duration of sensory block	Levobupivacaine n (%)	Bupivacaine n (%)	Total n (%)
1–2 hours	65 (100.00)	0 (0.00)	65 (50.00)
2–3 hours	0 (0.00)	65 (100.00)	65 (50.00)
Total	65 (100.00)	65 (100.00)	130 (100.00)

Chi-square = 130.00; p = 0.0001.

Duration of Motor Block

The duration of motor blockade showed a pattern similar to that of sensory blockade. All patients receiving Levobupivacaine had a motor block duration of 1–2 hours, whereas all patients receiving Bupivacaine had a motor block duration of 2–3 hours.

The difference was statistically significant ($\chi^2 = 130.00$, p = 0.0001).

Table 8: Comparison of duration of motor block

Duration of motor block	Levobupivacaine n (%)	Bupivacaine n (%)	Total n (%)
1–2 hours	65 (100.00)	0 (0.00)	65 (50.00)
2–3 hours	0 (0.00)	65 (100.00)	65 (50.00)
Total	65 (100.00)	65 (100.00)	130 (100.00)

Chi-square = 130.00; p = 0.0001.

Discussion

The present prospective comparative study evaluated the efficacy, sensory and motor block characteristics, duration of blockade and Haemodynamic changes associated with 0.5% isobaric Levobupivacaine and 0.5% hyperbaric Bupivacaine administered intrathecally in patients undergoing lower abdominal and lower-limb surgery. A total of 130 patients were included, with 65 patients receiving Levobupivacaine and 65 receiving hyperbaric Bupivacaine. The principal findings were that hyperbaric Bupivacaine produced a significantly faster onset of both sensory and motor blockade and a longer duration of sensory and motor blockade, whereas differences in Haemodynamic parameters were observed at selected postoperative time points.

Demographic characteristics

The two study groups were broadly comparable with respect to age and sex distribution. The overall mean age was 40.74 years, with a predominance of male participants. The largest proportion of patients belonged to the 31–40-year age group, followed by the 41–50-year group. Such demographic comparability is important because age, sex, physical status and type of surgery may influence the spread and physiological effects of spinal anaesthesia.

However, the reported Levobupivacaine-group standard deviation for age (42.52 years) appears inconsistent with the mean age of 40.98 years and should be verified against the original dataset before publication. Similarly, four participants were reported to be ≥61 years of age despite the stated inclusion criterion of 18–60 years. These discrepancies should be corrected in the final dataset and manuscript because methodological consistency is essential for interpretation of the study findings.

Onset of sensory blockade

A marked difference was observed in the onset of sensory blockade. All patients receiving hyperbaric Bupivacaine achieved sensory block within 0–5 minutes, whereas all patients receiving isobaric Levobupivacaine achieved sensory block within 5–10 minutes. The difference was statistically significant ($\chi^2 = 130.00$, $p = 0.0001$), demonstrating a faster onset with hyperbaric Bupivacaine.

This finding is consistent with previous research. A randomised study comparing isobaric Levobupivacaine and racemic Bupivacaine for lower abdominal and lower-extremity surgery found that Bupivacaine produced a faster onset of motor blockade.[7] Similarly, in patients undergoing knee arthroscopy, Bupivacaine demonstrated significantly faster onset of both sensory and motor blockade than isobaric Levobupivacaine.[8]

The faster onset observed with hyperbaric Bupivacaine in the present study may be explained partly by the physical characteristics of the Intrathecal solutions. Hyperbaric solutions are denser than cerebrospinal fluid, and their distribution is influenced by gravity and patient positioning. This may facilitate more rapid and predictable spread within the subarachnoid space. Recent randomised evidence has also demonstrated a faster onset of maximum sensory block with hyperbaric compared with isobaric bupivacaine.[10]

Importantly, the present comparison should be interpreted as a comparison of both drug and baricity, because the Levobupivacaine solution was isobaric whereas the Bupivacaine solution was hyperbaric. Therefore, the observed difference cannot be attributed exclusively to the pharmacological difference between Levobupivacaine and Bupivacaine.

Onset of motor blockade

The onset of motor blockade followed a pattern similar to sensory blockade. All patients in the hyperbaric Bupivacaine group developed motor block within 0–5 minutes, whereas all patients receiving isobaric Levobupivacaine developed motor block within 5–10 minutes. This difference was statistically significant (χ^2 = 130.00, p = 0.0001).

The finding agrees with previous comparative studies showing a faster onset of motor block with Bupivacaine than with isobaric Levobupivacaine.[7],[8] The rapid establishment of motor blockade with hyperbaric Bupivacaine may be advantageous when a rapid and dense surgical block is required.

However, faster onset is not necessarily synonymous with overall superiority. In ambulatory or short-duration surgery, prolonged motor blockade may delay mobilization and recovery. Thus, the optimal Intrathecal agent depends on the desired balance between rapid establishment of surgical anaesthesia, block density, duration and postoperative recovery.

Duration of sensory blockade

In the present study, sensory block lasted 1–2 hours in all patients receiving Levobupivacaine and 2–3 hours in all patients receiving hyperbaric Bupivacaine. The difference was statistically significant (χ^2 = 130.00, p = 0.0001), indicating a longer sensory blockade with hyperbaric Bupivacaine.

The finding differs from some earlier studies in which isobaric Levobupivacaine and Bupivacaine demonstrated comparable durations of sensory blockade. In a randomised study of patients undergoing major orthopaedic surgery, no significant difference was observed between 0.5% isobaric Levobupivacaine and 0.5% isobaric Bupivacaine with respect to the duration of sensory or motor blockade. [9]

Another study involving knee arthroscopy similarly reported comparable sensory and motor block duration between isobaric Levobupivacaine and Bupivacaine. [8]

The longer duration observed with Bupivacaine in the present study may therefore be related not only to the intrinsic pharmacological properties of the agents but also to the use of hyperbaric Bupivacaine. Hyper baricity affects Intrathecal distribution and may influence the density and duration of clinically useful blockade. Differences in dose, surgical duration, patient position, assessment methodology and definition of block regression can also contribute to variation between studies.

Duration of motor blockade

A significant difference was also observed in motor block duration. All patients receiving Levobupivacaine had motor block lasting 1–2 hours, whereas all patients receiving hyperbaric Bupivacaine had motor block lasting 2–3 hours (χ^2 = 130.00, p = 0.0001).

The shorter motor block observed with Levobupivacaine may be clinically relevant, particularly in procedures where early postoperative mobilization is desirable. Earlier recovery of motor function may facilitate postoperative neurological assessment and potentially improve suitability for shorter-stay or ambulatory procedures.

Nevertheless, previous studies using equivalent isobaric preparations have not consistently demonstrated a significant difference in motor block duration between the two agents. [8], [9] Therefore, the longer motor blockade observed in the present study should be interpreted in the context of the use of hyperbaric Bupivacaine rather than

being attributed solely to an inherent difference between the two local an aesthetics.

Heart rate changes

The present study found no statistically significant difference in heart rate immediately after spinal anaesthesia ($p = 0.0983$) or at 6 hours ($p = 0.0841$). Significant differences were reported at 1, 2 and 3 hours ($p = 0.0001$).

Spinal anaesthesia can influence heart rate through sympathetic blockade and alterations in venous return. Brady cardia is recognized as a potential manifestation of significant Haemodynamic compromise following spinal anaesthesia. [2] The absence of a significant immediate difference between the two groups suggests that the early heart-rate response was broadly comparable.

However, the numerical heart-rate values presented in the supplied table appear to be coded values rather than physiological heart rates in beats/minute. Values such as 3.63 ± 0.89 and 2.48 ± 0.66 cannot represent actual heart rate measurements. Consequently, the statistical findings should not be interpreted clinically until the original coding system or raw heart-rate data are verified. This is an important data-quality issue that should be resolved before publication.

Blood pressure changes

Similarly, blood pressure showed no significant difference immediately after spinal anaesthesia ($p = 0.4059$) or at 6 hours ($p = 0.4423$), whereas statistically significant differences were reported at 1, 2 and 3 hours ($p = 0.0197$).

Haemodynamic changes following spinal anaesthesia are primarily related to sympathetic blockade, which produces vasodilatation and reduction in venous return[2,12]. The extent of these effects depends on the level of sympathetic blockade, Intrathecal dose, baricity, patient position and baseline cardiovascular status.

The present findings should be interpreted cautiously because statistical significance alone does not establish clinically important Haemodynamic instability. In addition, the supplied blood-pressure values also appear to be coded rather than actual systolic and diastolic blood pressure measurements. Therefore, the raw values, units and coding scheme should be checked before concluding hypotension or Haemodynamic superiority.

The available literature concerning baricity and Haemodynamic effects is not uniform. A recent systematic review of randomised trials in non-obstetric surgery found a trend toward a greater incidence of hypotension with hyperbaric bupivacaine, but the difference was not statistically significant. The authors emphasised substantial heterogeneity related to dose, volume, spinal technique and definitions of hypotension.[10] This supports the need to interpret the present Haemodynamic findings in the context of the exact dose, baricity and monitoring protocol used.

Overall efficacy and clinical interpretation

Taken together, the present study demonstrates a clear difference in the pharmacodynamic profile of the two spinal an aesthetic regimen. Hyperbaric Bupivacaine provided a faster onset and longer sensory and motor blockade, whereas isobaric Levobupivacaine produced a comparatively slower onset and shorter duration of blockade.

These findings are broadly compatible with previous research demonstrating that Levobupivacaine is an effective Intrathecal local an aesthetic but may have a somewhat different block profile from Bupivacaine.[4,7–9] A recent randomized study comparing equal volumes of 0.5% Levobupivacaine, isobaric Bupivacaine and

hyperbaric Bupivacaine found rapid sensory block with hyperbaric Bupivacaine and a slower onset with Levobupivacaine, although the overall efficacy of Levobupivacaine remained clinically useful.[11]

The potential safety advantage of Levobupivacaine is an important consideration. Levobupivacaine, being the S-enantiomer of Bupivacaine, has demonstrated lower cardiovascular and central nervous system toxicity in experimental and human pharmacological studies.[4–6] Nevertheless, reduced toxicity does not imply absence of toxicity, and appropriate monitoring remains mandatory during regional anaesthesia.

Comparison with previous literature

The present results are partly consistent and partly different from previous studies. The faster onset of sensory and motor block with Bupivacaine agrees with randomised comparisons of isobaric Levobupivacaine and Bupivacaine.[7,8] However, studies using equal-baricity preparations have frequently reported similar duration and Haemodynamic profiles between the two agents.[8,9] This discrepancy emphasises that baricity is a major confounding factor in the current comparison.

Indeed, the present study compares an isobaric solution of Levobupivacaine with a hyperbaric solution of Bupivacaine. Consequently, the results demonstrate the clinical differences between these two specific spinal an aesthetic regimen rather than establishing that Bupivacaine is intrinsically superior to Levobupivacaine. Future randomised studies using equivalent baricity, dose and volume of the two drugs would provide a more direct pharmacological comparison.

Conclusion

In the present study, 0.5% hyperbaric Bupivacaine produced a significantly faster onset and longer duration of sensory and motor blockade than 0.5% isobaric Levobupivacaine. Isobaric Levobupivacaine provided effective spinal anaesthesia with a shorter duration of blockade, which may be advantageous when early postoperative recovery is desired. Haemodynamic differences were observed at selected time points, although no significant immediate difference was noted. Overall, both agents are effective for spinal anaesthesia, with the choice depending on the required onset, duration of block and Haemodynamic considerations.

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