EFFICACY AND SAFETY OF HYPERBARIC ROPIVACAINE (0.75%) VERSUS BUPIVACAINE (0.5%) IN SPINAL ANESTHESIA FOR LOWER ABDOMINAL SURGERIESIN A TERTIARY C ARE HOSPITAL

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Abstract:

Background: Spinal anaesthesia is widely used for lower abdominal surgeries due to its rapid onset and effective neural blockade. Hyperbaric bupivacaine is the conventional agent, but concerns regarding prolonged motor block and cardiotoxicity have led to the exploration of alternatives such as hyperbaric ropivacaine, which offers a better safety profile and faster recovery.

Aim: To compare the efficacy and safety of hyperbaric bupivacaine 0.5% and hyperbaric ropivacaine 0.75% in spinal anaesthesia for lower abdominal surgeries.

Materials and Methods: This prospective randomized study included 60 patients (ASA I–II) undergoing elective lower abdominal surgeries. Patients were divided into two groups: Group B received 0.5% hyperbaric bupivacaine (3 mL), and Group R received 0.75% hyperbaric ropivacaine (3 mL). Parameters assessed included onset and duration of sensory and motor block, time to two-segment regression, hemodynamic changes, and adverse effects.

Results: The onset of sensory and motor block was significantly faster in Group B ($p < 0.01$). Group B also demonstrated a longer duration of both sensory and motor blockade. However, Group R showed significantly shorter motor block duration and faster regression ($p < 0.001$). Hemodynamic stability was better in Group R, with a lower incidence of hypotension and bradycardia.

Conclusion: While bupivacaine provides faster onset and prolonged anaesthesia, ropivacaine offers better hemodynamic stability and quicker recovery, making it more suitable for ambulatory and short-duration procedures.

Introduction:

Spinal anaesthesia is one of the most commonly employed regional anaesthetic techniques for lower abdominal, pelvic, and lower limb surgeries owing to its rapid onset, reliable neural blockade, and minimal systemic drug exposure. It provides excellent intraoperative conditions with effective sensory and motor blockade, while also reducing perioperative stress response and postoperative complications (1). Its simplicity, cost-effectiveness, and high success rate make it a preferred choice in both elective and emergency surgical procedures.

Among the various local anaesthetic agents available, hyperbaric bupivacaine 0.5% has traditionally been considered the gold standard for spinal anaesthesia. Its widespread use is attributed to its potent and long-lasting sensory and motor blockade, predictable spread in the cerebrospinal fluid, and ability to provide satisfactory surgical conditions for a wide range of procedures (2). The addition of dextrose to bupivacaine increases its baricity, allowing better control over the level of block based on patient positioning. However, despite these advantages, bupivacaine is associated with several limitations, particularly when used in higher doses or in vulnerable populations.

One of the major concerns with bupivacaine is its dose-dependent cardiotoxicity and central nervous system toxicity. Accidental intravascular injection or systemic absorption can lead to severe complications such as arrhythmias, hypotension, and even cardiac arrest (3). Additionally, the prolonged motor blockade associated with bupivacaine may delay postoperative mobilization, increase the risk of thromboembolic events, and prolong hospital stay (4). These drawbacks have prompted the search for safer alternatives that provide adequate anaesthesia while facilitating faster recovery.

Ropivacaine, a long-acting amide local anaesthetic, has emerged as a promising alternative to bupivacaine. It is the pure S(-)-enantiomer and is structurally similar to bupivacaine but exhibits lower lipid solubility, which contributes to its reduced penetration into large myelinated motor fibers. This property results in a greater degree of sensory-motor differentiation, allowing effective analgesia with less intense motor blockade (5). Furthermore, ropivacaine has a significantly improved safety profile, with lower potential for cardiotoxicity and neurotoxicity compared to bupivacaine.

When used in spinal anaesthesia, ropivacaine has demonstrated favorable characteristics, including adequate sensory block, stable hemodynamic profile, and faster recovery of motor function. However, due to its slightly lower potency compared to bupivacaine, higher concentrations such as 0.75% are often employed to achieve comparable anaesthetic effects (6). The use of hyperbaric formulations of ropivacaine has further improved its clinical applicability by enhancing the predictability of block spread within the subarachnoid space.

Several clinical studies have compared hyperbaric ropivacaine with hyperbaric bupivacaine for spinal anaesthesia in lower abdominal surgeries. These studies have shown that ropivacaine provides a similar level of sensory blockade, although the onset may be slightly slower in some cases. Importantly, ropivacaine is associated with a shorter duration of motor blockade, which is beneficial in promoting early ambulation and reducing postoperative complications (7). This characteristic makes it particularly suitable for day-care surgeries and enhanced recovery protocols.

In addition to improved recovery profiles, ropivacaine has been associated with better hemodynamic stability. Hypotension and bradycardia, which are common complications of spinal anaesthesia due to sympathetic blockade, tend to be less pronounced with ropivacaine compared to bupivacaine (8). This is especially advantageous in elderly patients and those with cardiovascular comorbidities. Furthermore, the reduced intensity of motor blockade with ropivacaine enhances patient comfort and facilitates earlier discharge from the hospital.

Despite these advantages, the choice between bupivacaine and ropivacaine continues to be influenced by factors such as surgical duration, required depth of anaesthesia, and institutional preferences. While bupivacaine remains the agent of choice for longer procedures due to its prolonged action, ropivacaine is increasingly being favored for shorter procedures where rapid recovery is desirable. Therefore, a direct comparison between hyperbaric bupivacaine 0.5% and hyperbaric ropivacaine 0.75% is essential to determine their relative efficacy, safety, and suitability for lower abdominal surgeries.

In this context, the present study aims to compare the clinical effects of hyperbaric bupivacaine 0.5% and hyperbaric ropivacaine 0.75% in spinal anaesthesia for lower abdominal surgeries, focusing on parameters such as onset and duration of sensory and motor blockade, hemodynamic changes, and recovery characteristics. The findings of this study may help guide anaesthesiologists in selecting the most appropriate agent for optimizing patient outcomes.

Aim

To compare the efficacy and safety of hyperbaric bupivacaine 0.5% and hyperbaric ropivacaine 0.75% in spinal anaesthesia for patients undergoing lower abdominal surgeries.

Objectives

To compare the onset, level, and duration of sensory blockade between hyperbaric bupivacaine 0.5% and hyperbaric ropivacaine 0.75%.

To evaluate and compare the onset and duration of motor blockade in both groups.

To assess intraoperative hemodynamic parameters such as heart rate and blood pressure.

Materials and Methodology:

This prospective, randomized comparative study was conducted at Sree Mookambika Institute of Medical Sciences over a period of one year from May 2024 to May 2025. After obtaining approval from the Institutional Ethics Committee and written informed consent from all participants, patients scheduled for elective lower abdominal surgeries under spinal anaesthesia were enrolled in the study.

A total of 60 patients belonging to American Society of Anesthesiologists (ASA) physical status I and II, aged between 18 and 65 years, were included. Patients with contraindications to spinal anaesthesia, known allergy to local anaesthetics, coagulopathy, infection at the injection site, significant cardiovascular or neurological disorders, and those unwilling to participate were excluded from the study.Participants were randomly allocated into two groups of 30 patients each using a computer-generated randomization method. Group B received 3 mL of 0.5% hyperbaric bupivacaine, while Group R received an equivalent dose of 0.75% hyperbaric ropivacaine for spinal anaesthesia.

All patients were preoperatively evaluated and counseled regarding the procedure. In the operating room, standard monitoring including non-invasive blood pressure, electrocardiogram, and pulse oximetry was instituted. Intravenous access was secured and patients were preloaded with appropriate intravenous fluids as per institutional protocol.Under strict aseptic precautions, spinal anaesthesia was administered in the sitting position at the L3–L4 or L2–L3 interspace using a 25G or 26G Quincke spinal needle. After confirmation of free flow of cerebrospinal fluid, the study drug was injected intrathecally according to group allocation. Patients were then positioned supine immediately after drug administration.

Sensory blockade was assessed using pinprick method at regular intervals to determine the onset time, highest level achieved, and duration of sensory block. Motor blockade was evaluated using the Modified Bromage Scale. Hemodynamic parameters including heart rate,

systolic and diastolic blood pressure, and oxygen saturation were monitored at baseline and at regular intervals intraoperatively and postoperatively.

The duration of analgesia was defined as the time from intrathecal injection to the first request for rescue analgesia. Postoperative pain was assessed using the Visual Analogue Scale (VAS). Rescue analgesia was provided with intravenous analgesics when VAS score exceeded 4. Patients were also monitored for adverse effects such as hypotension, bradycardia, nausea, vomiting, shivering, and urinary retention, and were managed appropriately.Time to recovery of motor function, time to ambulation, and patient satisfaction were also recorded. Patients were followed up in the postoperative period until complete recovery.

Data were entered into a Microsoft Excel spreadsheet and analyzed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation, and categorical variables were presented as frequencies and percentages. The independent Student's t-test was used to compare continuous variables between the two groups, while the Chi-square test or Fisher's exact test was used for categorical variables. A p value of less than 0.05 was considered statistically significant.

Results:

Atotal of 60 patients were enrolled and completed the study, with 30 patients in each group. Thedemographicdata,includingage,weight,height,anddurationofsurgery,werecomparable betweenthetwogroupsandshowednostatisticallysignificantdifference(p>0.05)(Table1). The onset of sensory block was significantly faster in Group B (3.2 ± 0.6 minutes) compared toGroupR(4.0±0.7minutes),(p<0.001).Similarly,theonsetofmotorblockwasquickerin Group B (4.8 ± 0.9 minutes) than in Group R (6.1 ± 1.0 minutes), (p < 0.01) (Table 2).

Group R showed a shorter duration of motor block (130 ± 10 minutes) compared to Group B (160 ± 12 minutes), (p < 0.001). However, duration of sensory block was longer in Group B (180 ± 15 minutes) than in Group R (165 ± 13 minutes), (p = 0.002). Time for two-segment regressionwas alsoshorterinGroupR(82±9minutes)versusGroupB(96±11minutes),(p =0.001)(Table 3).

HemodynamicstabilitywasbettermaintainedinGroupR.Theincidenceofhypotensionwas higherinGroupB(26.7%)thaninGroupR(10%),andbradycardiawasobservedin3patients in Group B and 1 patient in Group R (Table 4).

Table1.DemographicCharacteristicsofStudyParticipants

Parameter	GroupB(n=30)	GroupR(n=30)	*p*-value
Age(years)	38.4 ± 10.2	37.8 ± 9.6	0.78
Weight(kg)	64.3 ± 8.5	65.1 ± 9.2	0.66
Height(cm)	165.2 ± 6.4	166.1 ± 7.1	0.59
Durationofsurgery(min)	72.4 ± 14.1	70.9 ± 13.6	0.61

Table2.OnsetTimeofSensoryandMotorBlock

Parameter	GroupB	GroupR	*p*-value
Onset of sensoryblock(min)	3.2 ± 0.6	4.0 ± 0.7	<0.001
Onsetofmotorblock(min)	4.8 ± 0.9	6.1 ± 1.0	0.004

Table3.DurationofBlocksandRegression

Parameter	GroupB	GroupR	*p*-value
Duration of sensoryblock(min)	180 ± 15	165 ± 13	0.002
Durationofmotorblock(min)	160 ± 12	130 ± 10	<0.001
Timetotwo-segmentregression(min)	96 ± 11	82 ± 9	0.001

Table4.HemodynamicEvents

Event	GroupB(n=30)	GroupR(n=30)	*p*-value
Hypotension(%)	8 (26.7%)	3 (10.0%)	0.09
Bradycardia (%)	3 (10.0%)	1 (3.3%)	0.30
Nausea/Vomiting	2 (6.7%)	1 (3.3%)	0.55

Interpretation: As seen in Tables 2 and 3, while bupivacaine had a faster onset and longer duration of both sensory and motor blocks, ropivacaine offered quicker recovery and better hemodynamic stability (Table 4), making it more suitable for short-stay or ambulatory procedures.

Discussion:

Spinal anaesthesia remains a cornerstone technique for lower abdominal surgeries due to its rapid onset, dense neural blockade, and favorable safety profile. The present study compared hyperbaric bupivacaine 0.5% with hyperbaric ropivacaine 0.75% in terms of block characteristics, hemodynamic effects, and overall clinical utility. The findings provide valuable insights into the relative advantages and limitations of these two commonly used local anaesthetic agents.

In this study, demographic parameters such as age, weight, height, and duration of surgery were comparable between the two groups, indicating adequate randomization and minimizing confounding variables. Similar baseline characteristics have been reported in previous comparative studies, ensuring that differences observed in outcomes are attributable primarily to the pharmacological properties of the study drugs (11).

The onset of both sensory and motor blockade was significantly faster in the bupivacaine group compared to the ropivacaine group. This finding is consistent with earlier studies that have demonstrated the higher potency and faster onset of bupivacaine due to its greater lipid solubility and stronger affinity for nerve membranes (12,13). The rapid onset of bupivacaine makes it particularly suitable for procedures where quick establishment of surgical anaesthesia is required. In contrast, the slightly delayed onset observed with ropivacaine may be related to its lower lipid solubility and reduced penetration into nerve fibers (14).

With respect to the duration of blockade, bupivacaine produced a significantly longer duration of both sensory and motor block compared to ropivacaine. While prolonged sensory blockade can be advantageous for extended analgesia, prolonged motor blockade may delay postoperative mobilization and increase the risk of complications such as deep vein thrombosis and urinary retention (15). In the present study, ropivacaine demonstrated a shorter duration of motor block, which is a desirable characteristic in modern anaesthetic practice, particularly in ambulatory and short-stay surgeries. These findings are in agreement with previous studies that have highlighted the differential block profile of ropivacaine, with earlier recovery of motor function compared to bupivacaine (16,17).The time to two-segment regression was also significantly shorter in the ropivacaine group, indicating a faster regression of sensory blockade. This supports the concept that ropivacaine allows earlier recovery of both sensory and motor functions, facilitating quicker postoperative rehabilitation. Studies have shown that faster regression of spinal block contributes to improved patient turnover and reduced hospital stay, especially in day-care surgical settings (18).

Hemodynamic stability is an important consideration in spinal anaesthesia, as sympathetic blockade can lead to hypotension and bradycardia. In the present study, ropivacaine demonstrated better hemodynamic stability compared to bupivacaine, with a lower incidence of hypotension and bradycardia. Although the differences were not statistically significant, the trend toward fewer hemodynamic disturbances in the ropivacaine group is clinically relevant. This may be attributed to its lesser degree of sympathetic blockade and reduced systemic toxicity (19). Similar findings have been reported in other studies, where ropivacaine was associated with more stable cardiovascular parameters compared to bupivacaine (20).

The incidence of adverse effects such as nausea and vomiting was low in both groups, with no statistically significant difference observed. This suggests that both drugs are well tolerated when used in appropriate doses. Importantly, no serious complications such as respiratory depression or neurological deficits were noted in either group, further confirming the safety of both agents in spinal anaesthesia.Overall, the results of this study highlight a clear distinction between the two agents. Bupivacaine offers the advantage of rapid onset and prolonged duration of anaesthesia, making it suitable for longer surgical procedures. However, its association with prolonged motor blockade and higher incidence of hemodynamic instability may limit its use in certain patient populations. On the other hand, ropivacaine provides a more favorable recovery profile with shorter motor blockade duration and better hemodynamic stability, making it an attractive option for ambulatory surgeries and enhanced recovery protocols.

These findings are in line with contemporary anaesthetic practice, which emphasizes early mobilization, reduced hospital stay, and improved patient satisfaction. The choice between bupivacaine and ropivacaine should therefore be individualized based on the type and duration of surgery, patient comorbidities, and desired recovery profile. Further large-scale studies may help to establish standardized dosing regimens and expand the clinical applications of hyperbaric ropivacaine in spinal anaesthesia.

Conclusion:

Hyperbaric bupivacaine provides faster onset and longer duration of sensory and motor blockade, whereas hyperbaric ropivacaine offers shorter motor block and better hemodynamic stability. Ropivacaine is more suitable for ambulatory and short procedures, while bupivacaine remains preferred for longer surgeries requiring prolonged anesthesia and sustained analgesia.

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