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EFFICACY OF BLOCK AND HAEMODYNAMIC CHANGES OF INTRATHECAL BUPIVACAINE VERSUS ROPIVACAINE IN PATIENTS UNDERGOING INFRAUMBILICAL ELECTIVE SURGERY

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ABSTRACT

Background: Intrathecal local anaesthetics remain the cornerstone of anaesthesia for infraumbilical surgeries. Bupivacaine, the traditional agent, provides dense and prolonged sensory and motor blockade but carries a higher risk of hemodynamic instability. Ropivacaine, with its lower lipid solubility and motor-sparing profile, may offer comparable analgesia with better safety. This study aimed to compare the efficacy of block characteristics and hemodynamic changes produced by intrathecal hyperbaric bupivacaine versus ropivacaine in patients undergoing elective infraumbilical surgery. **Materials and Methods:** A prospective, randomized, double-blind study was conducted in 108 ASA I–II patients undergoing infraumbilical elective surgeries under spinal anaesthesia. Patients were allocated into two groups (n=54 each) to receive 3 mL of either 0.5% hyperbaric bupivacaine (Group B) or 0.75% hyperbaric ropivacaine (Group R). Onset and duration of sensory and motor block, time to first rescue analgesia, quality of block, intra- and postoperative hemodynamic parameters, and adverse effects were recorded and analysed using Student's t-test and Chi-square test. **Result:** Group B demonstrated significantly faster onset of sensory block (4.8 ± 1.1 vs. 5.5 ± 1.2 min; p=0.011) and motor block (6.2 ± 1.3 vs. 6.9 ± 1.4 min; p=0.003), along with longer sensory block (181.2 ± 27.5 vs. 161.4 ± 25.2 min; p<0.001), motor block (146.5 ± 29.8 vs. 126.7 ± 27.9 min; p<0.001), and total analgesia duration (210.5 ± 34.2 vs. 186.8 ± 31.5 min; p<0.001). Intraoperative MAP, SBP, and DBP were significantly lower in Group B at early time points (p<0.05), though postoperative hemodynamics were comparable. Incidences of hypotension and bradycardia were higher in Group B but not statistically significant. Quality of block and patient satisfaction were high and comparable between groups. **Conclusion:** Intrathecal bupivacaine provides faster onset and longer duration of sensory and motor blockade compared to ropivacaine but is associated with greater early hemodynamic changes. Ropivacaine offers more stable hemodynamics and earlier motor recovery, making it a suitable choice for day-care and high-risk patients. The choice of agent should be individualized based on surgical requirements and patient comorbidities.

INTRODUCTION

Spinal anesthesia is one of the most commonly employed techniques for infraumbilical elective surgeries due to its simplicity, rapid onset, profound sensory and motor blockade, and favorable safety profile compared to general anesthesia.[1] It avoids airway manipulation, reduces systemic drug exposure, and allows faster postoperative recovery, making it particularly suitable for outpatient or day-care surgeries.[2] Among local anesthetics, Bupivacaine has remained the gold standard, providing reliable and dense sensory and motor block. Typical onset times are 4–6 minutes for sensory block and 6–8 minutes for motor block, with a duration of analgesia ranging from 150–240 minutes depending on the dose and patient characteristics.[3] However, bupivacaine is associated with dose-dependent cardiovascular and neurological side effects, including hypotension (15–33%),

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bradycardia (10–15%), and in rare cases, cardiotoxicity.[4] These effects are particularly concerning in elderly, hypovolemic, or comorbid patients.

Ropivacaine, a newer S-enantiomer amide local anesthetic, has emerged as a potential alternative due to its lower cardiotoxic potential and favorable differential blockade profile. It produces adequate sensory block with relatively less motor blockade, allowing earlier mobilization without compromising analgesia.[5] Studies have reported that motor block regression with ropivacaine occurs approximately 30–40 minutes earlier than with bupivacaine, while sensory block duration remains comparable.[6,7] Hemodynamic stability is also improved, with lower incidences of hypotension and bradycardia reported in several studies.[8]

Given these differences, evaluating intrathecal Bupivacaine and Ropivacaine in terms of onset and duration of sensory and motor block, total duration of analgesia, and hemodynamic effects is essential. Such an assessment will not only inform drug selection for infraumbilical surgeries but also help optimize perioperative safety and efficiency. Additionally, recording incidental findings and the quality of the block provides insight into patient comfort, adequacy of anesthesia, and potential complications, which are critical for clinical decision-making.[9,10]

Despite previous comparative studies, there remains a need for systematic evaluation in the context of elective infraumbilical procedures, where rapid onset, effective surgical anesthesia,[8-10] prolonged analgesia, and hemodynamic stability are all important. This study aimed to analyze the efficacy and safety profile of intrathecal Bupivacaine versus Ropivacaine, thereby guiding anesthesiologists in tailoring anesthesia to individual patient needs and improving overall perioperative outcomes.

MATERIALS AND METHODS

Study Design and Setting: This study was designed as an interventional, prospective conducted at the department of Anaesthesiology of College of Medicine & JNM Hospital (COMJNMH), Kalyani. The study aimed to compare the efficacy and hemodynamic changes of intrathecal Bupivacaine and Ropivacaine in patients undergoing infraumbilical elective surgeries. Ethical clearance was obtained from the institutional ethics committee, and written informed consent was obtained from all participants prior to enrollment.

Study Population: The study population comprised non-obstetric patients aged 18–65 years, with ASA physical status I or II, a body mass index (BMI) ≤ 30 kg/m², and a height of 150–180 cm, scheduled for elective infraumbilical procedures under spinal anesthesia. Patients with contraindications to spinal anesthesia, those requiring general anesthesia supplementation, obstetric patients, and patients unable to communicate adequately were excluded. The target population included all eligible patients posted for infraumbilical elective surgeries during the study period at COMJNMH who consented to participate.

Sample Size and Randomization: Based on findings from Swetha Purohit et al., where the mean duration of motor block was 148.7 ± 35.4 minutes in the Bupivacaine group and 126.3 ± 38.3 minutes in the Ropivacaine group, the sample size was calculated using a 95% confidence interval, 80% power, and detectable difference of 20 minutes.[11] The calculated sample size was 108 patients, with 54 patients in each group (Winpepi Software version 3.8). Patients were randomly allocated to either Group B (Bupivacaine) or Group R (Ropivacaine) using a computer-generated random numbers table. Allocation concealment was achieved through sequentially numbered opaque sealed envelopes. Both the patient and the investigator assessing outcomes were blinded to group allocation to minimize bias.

Intervention and Drug Preparation: Group B received 3 ml of 0.5% hyperbaric Bupivacaine, and Group R received 3 ml of 0.75% hyperbaric Ropivacaine, administered intrathecally. Spinal anesthesia was performed by a second anesthesiologist (A2) who was not involved in the assessment of outcomes. Patients were placed in the sitting position for the procedure, and spinal puncture was performed below the L2 vertebral level using a 25G Quincke spinal needle. Following injection, patients were positioned supine, and oxygen was administered via facemask at 2–4 L/min.

Preoperative and Intraoperative Management: All patients underwent a pre-anesthetic evaluation, including medical history, physical examination, and routine laboratory investigations such as complete hemogram, blood grouping, serology, and any additional tests as indicated. Patients were advised to remain nil per oral for at least six hours before surgery. An 18G intravenous cannula was secured, and lactated Ringer's solution was infused at 10 ml/kg/hr preoperatively. Standard monitoring was instituted, including ECG, SpO_2, respiratory rate, and non-invasive blood pressure (SBP, DBP, MAP). Baseline parameters were recorded prior to spinal injection.

Intraoperative parameters, including heart rate, blood pressure, respiratory rate, SpO_2, and ECG changes, were recorded every 2 minutes for the first 10 minutes, and then every 5 minutes for the remainder of surgery. Hypotension was defined as SBP <90 mmHg or >30% decrease from baseline and treated with IV Mephentermine 6 mg bolus, while bradycardia was defined as HR <60 bpm and treated with IV Glycopyrrolate 0.2 mg. Other adverse events such as nausea, vomiting, and respiratory distress were documented and managed appropriately.

Assessment of Block and Analgesia: Sensory block was evaluated using the Hollmen scale, with onset defined as the time from intrathecal injection to

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attainment of maximum sensory block (Hollmen score = 4), and duration defined as the time from maximum block until regression to Hollmen score <2. Motor block was assessed using the Modified Bromage Scale, with onset measured from the time of injection to the first detectable motor block, and duration from complete motor block (score = 3) to partial recovery (score >1). Total analgesia duration was calculated from intrathecal injection to a VAS score >4, with rescue analgesia (IV Paracetamol 1 g) administered as needed. Patient satisfaction was assessed on a 0–10 scale, where 0 indicated complete dissatisfaction and 10 indicated full satisfaction with the procedure.

Postoperative Monitoring: Following surgery, patients were monitored in the Post-Anesthesia Care Unit (PACU). Sensory and motor block assessments were repeated every 30 minutes until complete recovery. Standard care and monitoring continued postoperatively, and any complications were documented and managed accordingly.

Statistical Analysis: All data were entered and analyzed using SPSS version 20.0. Continuous variables were expressed as mean ± SD and compared using independent t-tests, while categorical variables were expressed as frequencies and analyzed using Chi-square tests. A p-value <0.05 was considered statistically significant.

RESULTS

The mean age of patients was 38.5 ± 10.8 years in Group B and 37.9 ± 10.2 years in Group R (p=0.678). The male-to-female ratio was similar across groups (59.3% vs 55.6%, p=0.765). Mean BMI was 24.3 ± 2.8 kg/m² in Group B and 24.1 ± 3.0 kg/m² in Group R (p=0.595). ASA grade distribution was comparable, with majority of patients belonging to Grade I (74.1% vs 77.8%, p=0.676). The presence of co-morbidities (22.2% vs 20.4%, p=0.799) and duration of surgery (71.8 ± 17.5 min vs 70.5 ± 16.3 min, p=0.458) showed no statistically significant difference [Table 1].

Table 1: Demographic and baseline characteristics of patients undergoing infraumbilical elective surgery under spinal anesthesia with bupivacaine (Group B) or ropivacaine (Group R).

Parameter	Group B (Bupivacaine) (n=54)	Group R (Ropivacaine) (n=54)	P-value
	Frequency (%)/mean ± SD		
Age (years)	38.5 ± 10.8	37.9 ± 10.2	0.678
Gender			
Male	32 (59.3%)	30 (55.6%)	0.765
Female	22 (40.7%)	24 (44.4%)	
BMI (kg/m²)	24.3 ± 2.8	24.1 ± 3.0	0.595
ASA Grade I/II			
I	40 (74.1%)	42 (77.8%)	0.676
II	14 (25.9%)	12 (22.2%)	
Co-morbidities	12 (22.2%)	11 (20.4%)	0.799
Duration of Surgery (min)	71.8 ± 17.5	70.5 ± 16.3	0.458

The onset of sensory block was significantly faster with bupivacaine (4.8 ± 1.1 min) compared to ropivacaine (5.5 ± 1.2 min, p=0.011). The maximum sensory level achieved was similar in both groups (T6). The duration of sensory and motor blocks was significantly longer in the bupivacaine group (181.2 ± 27.5 min vs 161.4 ± 25.2 min, p<0.001 and 146.5 ± 29.8 min vs 126.7 ± 27.9 min, p<0.001, respectively). Time to first rescue analgesic and total analgesic duration were also longer in Group B (both p<0.001). Quality of block was excellent in a higher proportion of patients in Group B (81.5% vs 74.1%), though this difference was not statistically significant (p=0.323) [Table 2].

Table 2: Comparison of sensory and motor block onset, duration, analgesia profile, and quality of block between the two groups.

Parameter	Group B (Bupivacaine) (n=54)	Group R (Ropivacaine) (n=54)	P-value
	Frequency (%)/mean ± SD		
Onset of sensory block (min)	4.8 ± 1.1	5.5 ± 1.2	0.011
Maximum sensory level (dermatome)	T6.0 ± 0.5	T6.0 ± 0.6	0.807
Duration of sensory block (min)	181.2 ± 27.5	161.4 ± 25.2	<0.001
Onset of motor block (min)	6.2 ± 1.3	6.9 ± 1.4	0.003
Duration of motor block (min)	146.5 ± 29.8	126.7 ± 27.9	<0.001
Time to first rescue analgesic (min)	210.5 ± 34.2	186.8 ± 31.5	<0.001
Total analgesia duration (min)	210.5 ± 34.2	186.8 ± 31.5	<0.001
Quality of block			
Excellent	44 (81.5%)	40 (74.1%)	0.323
Good	9 (16.7%)	12 (22.2%)	
Fair	1 (1.9%)	2 (3.7%)	
Poor	0 (0.0%)	0 (0.0%)	

Group B demonstrated slightly lower pulse rate, MAP, SBP, and DBP compared to Group R at most time points, with statistically significant differences observed between 2–15 min for MAP (p<0.05), SBP

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(p<0.05), and DBP (p<0.05). Although these changes were statistically significant, they remained within clinically acceptable limits and did not require major intervention [Table 3].

Table 3: Intraoperative hemodynamic parameters (pulse, MAP, SBP, DBP) measured at baseline and 0–20 minutes following subarachnoid block.

Time (min)	Group B (Bupivacaine) (n=54)	Group R (Ropivacaine) (n=54)	P-value
	Frequency (%)/mean ± SD		
Pulse (beats/min)			0.042
0	78.5 ± 10.2	77.8 ± 10.8	0.672
2	74.2 ± 9.0	75.8 ± 9.5	0.314
5	72.1 ± 8.2	74.6 ± 8.7	0.048
10	71.5 ± 7.8	74.0 ± 8.1	0.041
15	72.0 ± 7.9	74.1 ± 7.7	0.063
20	72.5 ± 7.7	74.3 ± 7.5	0.081
MAP (mmHg)			0.038
0	93.1 ± 8.9	91.9 ± 8.5	0.458
2	83.7 ± 7.5	86.8 ± 7.1	0.033
5	81.6 ± 7.0	84.5 ± 6.8	0.029
10	79.8 ± 6.5	82.6 ± 6.3	0.022
15	81.1 ± 6.4	83.8 ± 6.1	0.031
20	82.0 ± 6.3	84.7 ± 6.0	0.027
SBP (mmHg)			0.041
0	122.3 ± 12.4	121.5 ± 11.9	0.719
2	110.5 ± 11.0	114.8 ± 10.5	0.047
5	108.2 ± 10.3	112.4 ± 10.0	0.042
10	106.5 ± 9.8	110.2 ± 9.7	0.038
15	107.8 ± 9.9	111.0 ± 9.6	0.041
20	109.2 ± 10.2	112.0 ± 9.5	0.056
DBP (mmHg)			0.033
0	78.4 ± 7.8	77.6 ± 8.2	0.654
2	70.2 ± 6.9	72.8 ± 7.3	0.038
5	68.3 ± 6.6	71.5 ± 6.8	0.032
10	66.5 ± 6.2	69.8 ± 6.5	0.027
15	67.8 ± 6.3	70.2 ± 6.4	0.041
20	68.5 ± 6.2	71.0 ± 6.1	0.039

Pulse, MAP, SBP, and DBP at all observed intervals (15–180 min) were comparable, with no statistically significant differences (p>0.05). Both drugs maintained satisfactory cardiovascular stability during the recovery period [Table 4].

Table 4: Postoperative hemodynamic parameters recorded at 15, 30, 60, 120, and 180 minutes post-surgery.

Time (min)	Group B (Bupivacaine) (n=54)	Group R (Ropivacaine) (n=54)	P-value
	Frequency (%)/mean ± SD		
Pulse (beats/min)			0.628
15	76.3 ± 7.8	77.2 ± 8.1	0.544
30	77.0 ± 7.5	77.5 ± 7.8	0.731
60	77.8 ± 7.6	77.8 ± 7.5	0.986
120	78.2 ± 7.5	78.0 ± 7.3	0.853
180	78.5 ± 7.6	78.2 ± 7.2	0.794
MAP (mmHg)			0.603
15	88.3 ± 6.9	89.3 ± 6.7	0.461
30	89.4 ± 6.6	89.9 ± 6.3	0.705
60	90.5 ± 6.2	90.5 ± 6.0	0.992
120	91.8 ± 5.9	91.2 ± 5.7	0.653
180	92.4 ± 5.8	91.7 ± 5.6	0.577
SBP (mmHg)			0.589
15	116.4 ± 9.8	117.8 ± 9.4	0.512
30	117.8 ± 9.5	118.6 ± 9.0	0.685
60	119.5 ± 9.2	119.8 ± 8.7	0.883
120	121.5 ± 8.9	120.8 ± 8.5	0.726
180	122.3 ± 8.7	121.5 ± 8.2	0.663
DBP (mmHg)			0.571
15	74.3 ± 6.2	75.0 ± 6.5	0.561
30	75.2 ± 6.1	75.5 ± 6.0	0.814
60	76.0 ± 6.0	75.8 ± 6.0	0.867
120	77.0 ± 5.8	76.5 ± 5.9	0.698
180	77.5 ± 5.7	76.8 ± 5.8	0.622

Hypotension occurred in 27.8% of Group B and 18.5% of Group R (p=0.189), while bradycardia was noted in 14.8% vs 7.4% (p=0.196). Incidence of nausea/vomiting was low and statistically non-

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significant (p=0.485). No episodes of respiratory distress were recorded. Patient satisfaction scores were high in both groups (8.7 ± 1.0 vs 8.5 ± 1.1, p=0.427) [Table 5].

Table 5: Incidence of adverse events (hypotension, bradycardia, nausea/vomiting, others) and mean patient satisfaction scores between the two groups.

Parameter	Group B (Bupivacaine) (n=54)	Group R (Ropivacaine) (n=54)	P-value
	Frequency (%)/mean ± SD		
Adverse Event			
Hypotension	15 (27.8%)	10 (18.5%)	0.189
Bradycardia	8 (14.8%)	4 (7.4%)	0.196
Nausea/Vomiting	5 (9.3%)	3 (5.6%)	0.485
Respiratory distress	0 (0.0%)	0 (0.0%)	-
Other	2 (3.7%)	1 (1.9%)	0.505
Patient satisfaction (0–10)	8.7 ± 1.0	8.5 ± 1.1	0.427

DISCUSSION

In this study, we compared intrathecal hyperbaric bupivacaine (0.5%) and hyperbaric or high-dose ropivacaine (0.75%) in patients undergoing infraumbilical elective surgery. Our primary outcomes — onset and duration of sensory and motor block, total analgesic duration — as well as secondary outcomes (hemodynamic changes, adverse events, quality of block) yielded several clinically meaningful differences.

We observed that Group B (bupivacaine) had faster onset of sensory block (4.8 ± 1.1 min) than Group R (5.5 ± 1.2 min; p = 0.011), and similarly for motor block (6.2 ± 1.3 vs. 6.9 ± 1.4 minutes; p = 0.003). These findings are consistent with those in studies by Sorout et al., Chatterjee et al., and Dar et al., in lower limb orthopedic surgeries, where bupivacaine (0.5%) produced sensory onset in ~2.96 min vs. ropivacaine in ~3.60 min, and motor onset 4.68 vs. 5.29 min, respectively (p < 0.001 for both).[12-14] Another meta-analysis of non-obstetric populations by Khalil et al., similarly found that onset of motor block is faster with bupivacaine, though sensory onset differences were smaller or sometimes non-significant depending on dose and baricity.[15]

In our data, bupivacaine outperformed ropivacaine in the duration of both sensory block (181.2 ± 27.5 vs. 161.4 ± 25.2 min; p < 0.001) and motor block (146.5 ± 29.8 vs. 126.7 ± 27.9 min; p < 0.001). Also, time to first rescue analgesic and total analgesia duration were significantly longer in the bupivacaine group (≈ 210.5 ± 34.2 vs. 186.8 ± 31.5 min; p < 0.001). These findings echo those in the meta-analysis by the Khalil et al., and Xie et al., which found significantly longer sensory block, motor block, and analgesia durations with bupivacaine vs. ropivacaine (P < 0.001 for block durations, P = 0.003 for analgesia).[15,16] Also, the comparative studies by Kharat et al., Jalgaonkar et al., and Singh et al., (ropivacaine 0.75% vs bupivacaine 0.5%) found similar sensory block durations, but significantly shorter motor block with ropivacaine (P < 0.05).[17-19]

Thus, our findings are in strong agreement with peer studies: bupivacaine gives more rapid block onset, more prolonged sensory and motor blockade, and extended postoperative analgesia. The difference in motor block duration is especially relevant for early mobilization; several studies Suddapally et al., and Bennur et al., including meta-analyses by Khalil et al., and Xie et al., have highlighted that ropivacaine's shortened motor block vs. bupivacaine (often by ~30-40 minutes) is a consistent advantage.[15,16,20,21]

Our study showed that intraoperatively, parameters such as MAP, SBP, DBP, and pulse rate were lower in the bupivacaine group compared to ropivacaine, with statistically significant differences in the early period (2-15 minutes) after spinal injection. These differences, while modest, reflect a greater sympathetic blockade effect of bupivacaine. This aligns with study by Jeyakumaar et al., and the meta-analysis by Khalil et al., and Xie et al., reported significantly higher incidence of hypotension with bupivacaine (P = 0.02), as well as more frequent bradycardia episodes compared to ropivacaine.[15,16,22] In the study by Surana et al., SBP was significantly lower in the bupivacaine group at several time points (P < 0.05).[23] Postoperatively (15-180 min), we found no statistically significant differences in pulse, MAP, SBP, or DBP between groups. This indicates that while early sympathetic blockade is more pronounced with bupivacaine, both agents stabilize over time in ASA I-II patients undergoing infraumbilical surgery. This plateauing effect has been seen in other studies by Nath et al., and Vyas et al., as well, and supports the safety of both drugs in low-risk populations, especially beyond the first hour post-block.[24,25]

We observed higher incidence of hypotension (27.8% vs 18.5%) and bradycardia (14.8% vs 7.4%) in the bupivacaine group, though these were not statistically significant (p = 0.189, p = 0.196 respectively). Nausea/vomiting were also somewhat more frequent with bupivacaine. Quality of block was rated "Excellent" more often in group B (81.5% vs. 74.1%), though again the difference was not statistically significant (p = 0.323). Patient satisfaction was very high in both groups and similar (8.7 ± 1.0 vs 8.5 ± 1.1; p = 0.427). These adverse event rates are broadly in line with earlier reports by Bakshi et al., and Bhardwaj et al., found increased hypotension with bupivacaine (P = 0.02) but noted that most episodes were manageable and did not lead to severe morbidity; and also noted non-significant higher bradycardia and hypotension with bupivacaine (13.3% vs 3.3% etc).[26,27]

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Clinical Implications

For longer infraumbilical surgeries where prolonged sensory block and postoperative analgesia are desired, bupivacaine is clearly advantageous.[23] If early motor recovery or mobilization is needed — e.g., day care surgeries or patients at risk of immobility complications — ropivacaine offers substantial benefit due to shorter motor block.[28] In patients with cardiovascular comorbidities (e.g., hypertension, borderline cardiac reserve), or in scenarios where hypotension would be risky (elderly, hypovolemia) ropivacaine may be the safer option. Even though block quality and incidence of adverse events differ, patient satisfaction remains high with both agents — suggesting that with appropriate monitoring and management, both drugs are clinically acceptable.[23]

Limitations and Future Directions

Our study was limited to ASA I–II patients; higher risk populations (ASA III-IV, elderly, or with compromised cardiac function) may show larger differences, especially in hemodynamic responses. We used fixed drug volumes and concentrations; exploring dose titration or lower doses of bupivacaine (or adjuvants) could optimize the balance between blockade duration and hemodynamic instability. The sample size, while adequate for primary outcomes, may not have been large enough to detect differences in less frequent adverse events (e.g., severe hypotension, bradycardia requiring intervention). Baricity and positioning (all patients supine after block) can influence spread; future studies could explore positional effects or mixed baricity, or combining with adjuncts (e.g., fentanyl) to modulate duration or side-effects.

CONCLUSION

In summary, our results reinforce that intrathecal bupivacaine yields faster onset and longer durations of both sensory and motor blockade and superior postoperative analgesia compared to ropivacaine in infraumbilical elective surgery, but with a trade-off in terms of modestly greater early hemodynamic disturbance. Ropivacaine, on the other hand, offers more stable hemodynamic profiles and earlier motor recovery. The choice between these agents should be individualized, balancing the needs for surgery duration, analgesia, patient mobility, and cardiovascular risk.

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