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Original Research Article

INTRATHECAL ROPIVACAINE VERSUS HYPERBARIC BUPIVACAINE WITH FENTANYL FOR CAESAREAN SECTION: EFFECTS ON SENSORY BLOCK, MOTOR RECOVERY, AND HAEMODYNAMICS

Aparna Chandramohan[1], Pooja Nair[2], Nishana S[3], Sonia M Lal[4], Sandhya Sudheer[5], Madhu Velayudhen[6]

[1]Assistant Professor, Department of Anesthesiology, Jubilee Mission Medical College and Research Institute, Thrissur, Kerala, India
[2]Assistant Professor, Department of Anesthesiology, Sree Gokulam Medical College & Research Foundation, Trivandrum, Kerala, India
[3]Assistant Professor, Department of Anaesthesiology, Sree Gokulam Medical College and Research Foundation, Venjaramoodu, Trivandrum, Kerala, India
[4]Associate Professor, Department of Anesthesiology, Sree Gokulam Medical College and Research Foundation, Trivandrum, Kerala, India
[5]Specialist Anesthetist, Department of Anesthesiology, NMC Specialty Hospital, Dubai., India
[6]Professor, Department of Anaesthesiology, Sree Gokulam Medical College, and Research Foundation, Trivandrum, Kerala, India

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Corresponding Author:
Dr. Aparna Chandramohan,
Email: draparnasreekumar@gmail.com

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ABSTRACT

Background: Spinal anaesthesia is the preferred technique for caesarean section, and the choice of intrathecal local anaesthetic significantly influences block characteristics and recovery profile. Ropivacaine has been suggested as a safer alternative to bupivacaine due to its differential sensory–motor blockade and reduced toxicity. The objective is to compare intrathecal 0.75% ropivacaine with 20 µg fentanyl and 0.5% hyperbaric bupivacaine with 20 µg fentanyl in patients undergoing elective caesarean section, with respect to sensory and motor block characteristics, haemodynamic changes, and postoperative recovery. **Materials and Methods:** Sixty ASA I and II subjects scheduled for elective caesarean section under spinal anaesthesia were randomly allocated into two equal groups. Group I received 1.5 ± 0.4 mL of 0.5% hyperbaric bupivacaine with 20 µg fentanyl, while Group II received 1.5 ± 0.4 mL of 0.75% ropivacaine with 20 µg fentanyl. Sensory block onset and height, motor block using the Modified Bromage scale, haemodynamic parameters, time to complete motor recovery, and time to first postoperative analgesic requirement were recorded and analysed. **Result:** Both groups achieved adequate sensory blockade with comparable maximum block height and haemodynamic stability. Bupivacaine produced a faster initial sensory block, whereas ropivacaine was associated with significantly less intense motor block and a shorter time to complete motor recovery. The time to first postoperative analgesic requirement was similar between the two groups. **Conclusion:** Intrathecal ropivacaine with fentanyl provides effective spinal anaesthesia for caesarean section with the advantage of faster motor recovery, making it a suitable alternative to hyperbaric bupivacaine in obstetric anaesthesia.

INTRODUCTION

Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage. Effective management of acute postoperative pain is a fundamental component of perioperative care, as inadequately treated pain can adversely affect almost every organ system, thereby increasing postoperative morbidity and mortality.[1] Surgical stress, resulting from tissue injury, anaesthesia, and operative manipulation, triggers a complex neuroendocrine and metabolic response that serves as a homeostatic defense mechanism. However, exaggerated physiological responses, particularly in patients with coexisting medical conditions, may become detrimental and potentially life-threatening.[2]General anaesthesia alone does not completely abolish this stress response.

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Regional anaesthetic techniques, especially neuraxial blocks, significantly attenuate the surgical stress response, particularly during lower abdominal surgeries.[2] In addition, regional anaesthesia favourably influences early postoperative recovery parameters, including faster return of consciousness, reduced incidence of postoperative nausea and vomiting, and earlier restoration of cognitive function. Furthermore, regional techniques provide superior quality analgesia and prolong the time to first supplemental analgesic requirement when compared to systemic opioid administration.[3]These advantages have made spinal anaesthesia the preferred technique for caesarean section.

Bupivacaine has been extensively used for spinal anaesthesia for over three decades; however, its use is associated with drawbacks such as prolonged motor blockade and potential cardiovascular and central nervous system toxicity, prompting the search for safer alternatives.[4] Ropivacaine, the pure S-enantiomer amide local anaesthetic, has been shown to produce effective sensory blockade with relatively less motor block and reduced cardiotoxicity and neurotoxicity.[5] Several studies have demonstrated its safety and efficacy when used intrathecally for surgical anaesthesia.[6] Owing to its favourable pharmacological profile and ability to provide differential sensory-motor blockade, ropivacaine has emerged as a promising alternative to bupivacaine.[7]The present study was designed to compare the clinical efficacy of intrathecal 0.75% ropivacaine with 20 µg fentanyl and 0.5% hyperbaric bupivacaine with 20 µg fentanyl in patients undergoing caesarean section under spinal anaesthesia.

MATERIALS AND METHODS

This prospective, randomized, controlled trial was conducted in the Department of Anaesthesiology at Sree Gokulam Medical College and Research Foundation, Trivandrum, Kerala, India, after obtaining approval from the Institutional Ethical Committee (CTRI/2018/05/014004). The study was carried out from January 2012 to June 2013 and included 60 subjects belonging to ASA physical status I and II scheduled for elective lower segment caesarean section under spinal anaesthesia. Written informed consent was obtained from all patients. Participants were randomly allocated into two equal groups of 30 each based on the intrathecal local anaesthetic used. Group I received 1.5 mL ± 0.4 mL of 0.5% hyperbaric bupivacaine with 20 µg fentanyl, while Group II received 1.5 mL ± 0.4 mL of 0.75% ropivacaine with 20 µg fentanyl.

Patients aged between 5 and 6 feet, BMI <40 kg/m², and posted for elective LSCS were included. Exclusion criteria comprised patient refusal, ASA physical status III or higher, emergency caesarean section, coagulopathy, neuromuscular disease, spinal deformities, local infection at the injection site, known allergy to study drugs, use of potent antiplatelet or anticoagulant therapy, and poor myocardial contractility. All patients underwent a detailed preoperative assessment, including a comprehensive history, general and systemic examination, airway and spine evaluation, and relevant laboratory investigations. Standard fasting guidelines were followed, and antiaspiration prophylaxis with oral metoclopramide 10 mg and ranitidine 150 mg was administered on the night before and the morning of surgery.

On arrival in the operating room, patients were preloaded with Ringer's lactate at 10–15 mL/kg through two wide-bore intravenous cannulae and monitored with ECG (lead II), non-invasive blood pressure, heart rate, and pulse oximetry. Spinal anaesthesia was performed in the lateral position under strict aseptic precautions at the L2–L3 interspace using a 25-gauge spinal needle after infiltration with 2 mL of 2% lignocaine. Following confirmation of free flow of cerebrospinal fluid, the study drug was injected slowly over 10–15 seconds without barbotage. Patients were immediately positioned supine with a slight left lateral tilt, and oxygen was administered via Venturi mask at 4 L/min.

Sensory block was assessed bilaterally using a pin-prick method at regular intervals until fixation and thereafter every 15 minutes until the end of surgery. The onset of sensory block was defined as loss of pin-prick sensation at T10, and the maximum sensory level achieved was recorded. Motor block was assessed using the Modified Bromage scale. Hemodynamic parameters were recorded at baseline, every 2 minutes until delivery, and every 5 minutes thereafter. Hypotension (systolic blood pressure <90 mmHg or >30% fall from baseline) was treated with intravenous ephedrine, and bradycardia (heart rate <50/min) with atropine. Postoperatively, time to complete motor recovery and time to first analgesic request were noted. Data were analysed using SPSS version 12.0, with unpaired t-test for numerical variables and chi-square or Fisher's exact test for categorical variables; a p-value <0.05 was considered statistically significant.

RESULTS

A total of 60 patients belonging to ASA physical status I and II undergoing elective LSCS were randomly allocated into two equal groups of 30 each. Group I received 0.5% hyperbaric bupivacaine with fentanyl, while Group II received 0.75% ropivacaine with fentanyl. Both groups were comparable with respect to demographic parameters. The mean age was 26.3 ± 3.2 years in Group I and 25.7 ± 4.3 years in Group II (p = 0.523). Mean body weight was 70.2 ± 3.6 kg in Group I and 69.0 ± 3.1 kg in Group II (p = 0.173),

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while mean height was 157.1 ± 2.3 cm and 156.3 ± 2.0 cm, respectively (p = 0.137)

Heart rate and systolic blood pressure changes were comparable at baseline between the two groups. However, heart rate was significantly higher in Group I compared to Group II from 2 minutes to 25 minutes after spinal anaesthesia, with statistically significant differences at multiple time points ($p < 0.05$). Between 30 and 35 minutes, no significant difference was observed, while heart rate again showed a significant increase in Group I at 40 and 45 minutes, following which values became comparable. Systolic blood pressure showed no significant difference between groups until delivery of the baby (up to 8–10 minutes), after which Group I consistently demonstrated higher systolic blood pressure values than Group II, with statistically significant differences noted from 10 minutes onwards ($p < 0.05$). Diastolic blood pressure did not show any statistically significant difference between the two groups at any measured interval.

The sensory block characteristics differed initially between the two groups. At 2 minutes, Group I attained a higher level of sensory blockade compared to Group II, with 66.7% of patients in Group I achieving T6 level, whereas in Group II, only 30% reached T6, and some patients remained at T8 and T10 levels (p = 0.003). However, from 5 minutes onwards, both groups achieved comparable sensory block levels, with nearly all patients attaining a T6 block, and no statistically significant difference thereafter. Motor block assessment revealed a consistently denser motor block in Group I at all measured intervals. Mean Bromage scores were significantly higher in Group I compared to Group II at 2, 5, 10, 25, 40, and 55 minutes ($p < 0.01$ at all intervals), indicating a more profound motor blockade with hyperbaric bupivacaine.

Postoperative parameters showed a clear difference in motor recovery between the groups. The mean time to complete motor recovery was 3.1 ± 0.4 hours in Group I and 1.6 ± 0.3 hours in Group II, with the difference being highly statistically significant ($p < 0.001$), demonstrating faster motor recovery with ropivacaine. However, the time to first postoperative analgesic requirement was comparable between the two groups, being 2.6 ± 0.5 hours in Group I and 2.5 ± 0.4 hours in Group II (p = 0.178), indicating no significant difference in postoperative analgesic duration.

Table 1: Comparison of groups based on age, weight and height

	Group 1N (%)	Group 2N (%)	p-Value
Age group			
<20	0	2(6.7)	
21–30	27(90)	24(80)	
>30	3(10)	4(13.3)	
Age (Mean ± SD)	26.3 ± 3.2	25.7 ± 4.3	0.523
Weight (Mean ± SD)	70.2± 3.6	69.0±3.1	0.173
Height (Mean ± SD)	157.1±2.3	156.3±2	0.137

Table 2: Comparison of HR, SBP and DBP at different intervals between groups

	0 min	2 min	4 min	6 min	8 min	10 min	15 min	20 min	25 min	30 min	35 min	40 min	45 min	50 min	55 min
HR															
Group 1 Mean ± SD	77.5 (6.2)	78.8 (6.4)	80.5 (6.2)	79.6 (5.7)	79.4 (5.5)	78.4 (6.0)	76.8 (5.4)	76.2 (4.8)	75.4 (4.4)	74.5 (4.4)	73.5 (4.1)	73.9 (4.1)	73.8 (4.0)	73.8 (3.9)	73.6 (4.1)
Group 2 Mean ± SD	75.5 (7.2)	75.1 (7.8)	75.0 (7.7)	74.7 (8.1)	74.3 (8.2)	73.7 (7.9)	73.0 (7.4)	72.6 (6.8)	72.3 (6.5)	71.9 (6.4)	71.3 (6.2)	71.0 (6.4)	70.8 (5.9)	71.2 (6.2)	71.1 (6.3)
SBP															
Group 1 Mean ± SD	121.2 (6.0)	113.1 (6.7)	110.6 (6.5)	110.1 (5.0)	109.8 (4.2)	110.0 (3.9)	110.3 (4.0)	110.0 (4.1)	110.4 (3.6)	111.2 (3.9)	112.0 (4.0)	112.5 (4.3)	112.6 (4.3)	112.5 (4.0)	113.4 (4.5)
Group 2 Mean ± SD	119.2 (7.9)	111.7 (6.6)	108.9 (5.7)	108.1 (4.5)	107.6 (4.3)	107.0 (3.7)	107.4 (3.6)	107.6 (2.7)	108.2 (2.4)	108.4 (2.5)	108.7 (3.7)	108.5 (3.6)	109.4 (4.3)	109.8 (3.8)	110.0 (4.1)
DBP															
Group 1 Mean ± SD	77.1 (6.1)	71.0 (4.7)	69.3 (4.3)	67.7 (4.3)	67.7 (4.4)	68.3 (4.2)	67.9 (3.8)	68.1 (3.3)	67.3 (4.0)	67.4 (3.9)	68.4 (3.5)	67.7 (3.4)	68.7 (3.6)	68.3 (3.6)	68.1 (3.6)
Group 2 Mean ± SD	74.7 (5.9)	67.6 (12.1)	67.6 (4.6)	66.9 (3.4)	66.8 (3.6)	67.4 (4.6)	66.6 (4.2)	67.0 (4.7)	66.9 (4.0)	67.1 (3.7)	67.1 (3.1)	67.0 (3.5)	67.3 (3.6)	66.5 (3.7)	68.0 (4.8)

HR-Heart rate, SBP-Systolic blood pressure, DBP-Diastolic blood pressure

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Table 3: Comparison of the level of sensory blockade based on groups

Level		2 min	5 min	10 min	25 min	40 min	55 min
T6	Group 1	20 (66.7)	30 (100)	30 (100)	30 (100)	30 (100)	30 (100)
	Group 2	9 (30.0)	29 (96.7)	30 (100)	30 (100)	30 (100)	27 (90)
T8	Group 1	10 (33.3)	0	0	0	0	0
	Group 2	14 (46.7)	1 (3.3)	0	0	0	3 (10)
T10	Group 1	0	0	0	0	0	0
	Group 2	7 (23.3)	0	0	0	0	0
p-value		0.003	0.313				0.076

Table 4: Comparison of the level of motor blockade at different intervals between groups

Time	Group 1 Mean(SD)	Group 2 Mean(SD)
2 min	2.6(0.5)	1.5(0.5)
5 min	3.0	2.0(0.2)
10 min	3.0	2.1(0.3)
25 min	3.0	2.1(0.3)
40 min	3.0	2.1(0.3)
55 min	3.0	2.0(0.3)

Table 5: Comparison of the time of first postoperative analgesic requirement based on groups

Group	Mean(SD)	p-value
Group 1	2.6(0.5)	0.178
Group 2	2.5(0.4)	

Table 6: Comparison of the time of complete motor recovery based on groups

Group	Mean (SD)	p-value
Group 1	3.1(0.4)	<0.0001
Group 2	1.6(0.3)	

DISCUSSION

The present randomized controlled study compared intrathecal 0.5% hyperbaric bupivacaine with fentanyl and 0.75% ropivacaine with fentanyl for spinal anaesthesia in elective caesarean section. The findings demonstrate that both drug combinations provided adequate and reliable spinal anaesthesia, with comparable maximum sensory block height and haemodynamic stability. However, ropivacaine was associated with a shorter duration and lesser intensity of motor blockade, making it a potentially advantageous alternative in obstetric anaesthesia where early mobilization is desirable.

With regard to sensory blockade, the present study showed that bupivacaine produced a more rapid cephalad spread in the initial 2 minutes, with a significantly higher proportion of patients achieving a T6 level compared to ropivacaine. However, beyond this early period, the maximum sensory level attained was comparable between both groups. These observations are consistent with previous studies by Gautier et al., Surjeet Singh et al., Kallio et al. and Whiteside et al., which demonstrated a slower onset but similar quality of sensory blockade with ropivacaine when compared to bupivacaine.[7-10] The differential sensory-motor block characteristic of ropivacaine may explain this initial delay while still ensuring satisfactory surgical anaesthesia.

Motor blockade characteristics clearly favoured ropivacaine in the present study. The degree of motor block was significantly lower and the time to complete motor recovery was markedly shorter with ropivacaine (1.6 hours) compared to bupivacaine (3.1 hours), a finding in agreement with studies by Surjeet Singh et al., Koltka et al., Gautier et al., and Nuray et al.[7,10,11] Haemodynamic parameters, including heart rate and blood pressure, remained stable and comparable in both groups throughout the procedure, corroborating observations by Koltka et al., Gautier et al., and Whiteside et al.[7,10-13] The similar time to first postoperative analgesic requirement further confirms that ropivacaine provides effective analgesia while offering the advantage of faster motor recovery, which is beneficial for early ambulation and reduced postoperative morbidity.

CONCLUSION

Intrathecal 0.75% ropivacaine with fentanyl and 0.5% hyperbaric bupivacaine with fentanyl both provide effective and reliable spinal anaesthesia for elective caesarean section with comparable sensory block and haemodynamic stability. However, ropivacaine is associated with a significantly shorter duration and lesser intensity of motor blockade, resulting in faster postoperative motor recovery. These characteristics make ropivacaine a suitable and potentially preferable alternative to bupivacaine in obstetric spinal anaesthesia, where early ambulation is desirable.

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