



ORIGINAL RESEARCH ARTICLE

Comparative Evaluation of Block Characteristics and Haemodynamic Stability Following Spinal Anaesthesia with Hyperbaric Bupivacaine versus Hyperbaric Ropivacaine in Elective Lower Segment Caesarean Section

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Abstract

Background: Hyperbaric bupivacaine has traditionally been the standard local anaesthetic for spinal anaesthesia in caesarean section, but its use is associated with a relatively high incidence of maternal hypotension. Ropivacaine, with its reported lower cardiotoxicity and motor-sparing profile, has been proposed as an alternative.

Objectives: To compare block characteristics, haemodynamic stability, and neonatal outcome between hyperbaric bupivacaine and hyperbaric ropivacaine for spinal anaesthesia in elective lower segment caesarean section (LSCS).

Methods: This was a prospective, randomised, comparative study of 80 parturients undergoing elective LSCS under spinal anaesthesia, allocated to receive either hyperbaric bupivacaine 0.5% (Group A, n=40) or hyperbaric ropivacaine 0.75% (Group B, n=40).

Results: Onset of sensory block was faster with bupivacaine (3.2 ± 0.8 min) than ropivacaine (4.1 ± 0.9 min, $p=0.001$). Duration of motor block was longer with bupivacaine (145.6 ± 18.2 min) than ropivacaine (118.3 ± 15.7 min, $p<0.001$). Hypotension occurred in 32.5% of the bupivacaine group compared with 15.0% of the ropivacaine group. Neonatal APGAR scores were comparable between groups.

Conclusion: Hyperbaric ropivacaine provides effective spinal anaesthesia for caesarean section with greater haemodynamic stability and a lower incidence of hypotension compared with hyperbaric bupivacaine, albeit with a slightly slower onset and shorter duration of motor block, and represents a suitable alternative in this setting.

Keywords: Spinal anaesthesia, hyperbaric bupivacaine, hyperbaric ropivacaine, caesarean section, hypotension.

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1 | INTRODUCTION

Spinal anaesthesia remains the preferred technique for elective lower segment caesarean section (LSCS) in the majority of obstetric anaesthesia practice, owing to its rapid onset, reliability, and avoidance of the risks associated with general anaesthesia in the pregnant patient. Hyperbaric bupivacaine has long been the standard intrathecal local anaesthetic for this purpose, and multiple studies have confirmed its efficacy in providing dense sensory and motor block sufficient for surgery. (1)

A well-recognised limitation of spinal anaesthesia with bupivacaine in the obstetric population is the high incidence of maternal hypotension resulting from sympathetic blockade, which can compromise uteroplacental perfusion and adversely affect both mother and fetus if not promptly managed. (2) Ropivacaine, a newer amide local anaesthetic structurally related to bupivacaine, has been shown in volunteer and clinical studies to produce comparatively less cardiotoxicity and a greater degree of differential sensory-motor blockade, prompting interest in its use for spinal anaesthesia in obstetric surgery. (3, 4)

Several dose-finding and comparative studies have examined hyperbaric ropivacaine for caesarean delivery, generally finding it to provide adequate surgical anaesthesia, albeit with some reports of a slightly slower onset and shorter duration of motor block compared with equivalent doses of bupivacaine. (2, 3, 5) Given the clinical importance of haemodynamic stability in the parturient, and the relative paucity of comparative data specifically addressing hypotension incidence between these two agents, further comparative evaluation remains clinically relevant.

This study was undertaken to compare block characteristics, haemodynamic stability, and neonatal outcome between hyperbaric bupivacaine and hyperbaric ropivacaine for spinal anaesthesia in patients undergoing elective LSCS.

2 | MATERIALS AND METHODS

2.1 | Study Design and Setting

This was a hospital-based, prospective, randomised, comparative clinical study conducted in the Department of Anaesthesiology of a tertiary care teaching hospital over a defined study period.

2.2 | Study Population

Eighty ASA physical status I or II parturients scheduled for elective LSCS under spinal anaesthesia were enrolled after obtaining informed consent.

2.3 | Inclusion and Exclusion Criteria

Parturients aged 18-35 years, ASA physical status I or II, undergoing elective LSCS at term, were included. Patients with pregnancy-induced hypertension, cardiac disease, coagulation disorders, known allergy to amide local anaesthetics, or contraindication to spinal anaesthesia were excluded.

2.4 | Anaesthetic Technique

Patients were randomly allocated to Group A (hyperbaric bupivacaine 0.5%, 2.0 mL intrathecally) or Group B (hyperbaric ropivacaine 0.75%, 2.0 mL intrathecally). All patients received standard preloading with intravenous crystalloid prior to the block. Spinal anaesthesia was performed at the L3-L4 interspace with the patient in the sitting position using a 25G Quincke spinal needle. Sensory block was assessed by loss of pinprick sensation and motor block by the modified Bromage scale.

Supplementary information The online version of this article ([10.15520/ijmhs/2010--1--8](https://doi.org/10.15520/ijmhs/2010--1--8)) contains supplementary material, which is available to authorized users.

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2.5 | Monitoring and Outcome Assessment

Heart rate, non-invasive blood pressure, and oxygen saturation were monitored continuously and recorded at baseline and at 5, 10, 15, 20, and 30 minutes after intrathecal injection. Hypotension was defined as a fall in systolic blood pressure of more than 20% from baseline or below 90 mmHg, and was treated with intravenous fluid boluses and vasopressors as required. Onset and duration of sensory and motor block, incidence of side effects, and neonatal APGAR scores at 1 and 5 minutes were recorded.

2.6 | Statistical Analysis

Data were analysed using descriptive statistics; continuous variables were expressed as mean $\pm$ SD and compared using the independent samples t-test, and categorical variables were expressed as frequencies and percentages and compared using the chi-square test. A p-value <0.05 was considered statistically significant.

3 | RESULTS

The two groups were comparable at baseline for age, weight, and ASA physical status (Table 1).

Onset of sensory block was significantly faster in the bupivacaine group (3.2 ± 0.8 min) than the ropivacaine group (4.1 ± 0.9 min, $p=0.001$). Duration of motor block was significantly longer with bupivacaine (145.6 ± 18.2 min) than ropivacaine (118.3 ± 15.7 min, $p<0.001$) (Table 2, Figure 1).

Mean arterial pressure fell more markedly in the bupivacaine group compared with the ropivacaine group, particularly between 5 and 15 minutes after intrathecal injection (Table 3, Figure 2).

Hypotension occurred in 13 (32.5%) patients in the bupivacaine group compared with 6 (15.0%) patients in the ropivacaine group (Table 4, Figure 3).

Nausea/vomiting and bradycardia were more frequent in the bupivacaine group than the ropivacaine group (Table 5, Figure 4). Neonatal APGAR scores at 1 and 5 minutes were comparable between the two groups (Table 6).

4 | DISCUSSION

The faster onset and longer duration of motor block observed with bupivacaine compared with ropivacaine in this study is consistent with pharmacological data from volunteer studies, including that of McDonald and colleagues, which demonstrated that hyperbaric ropivacaine produces less intense and shorter-duration motor block than equivalent doses of bupivacaine, attributable to its lower lipid solubility and consequently reduced potency for motor fibre blockade relative to sensory blockade. (6) This differential sensory-motor blocking profile has been proposed as a potential advantage of ropivacaine in the obstetric setting, as it may allow adequate surgical anaesthesia with comparatively preserved motor function and potentially faster postoperative mobilisation. (7, 8)

The lower incidence of hypotension observed with ropivacaine in this study is consistent with findings from Cesur and colleagues and with the broader literature on the comparative haemodynamic profile of these two agents, and likely reflects both the somewhat lower potency of ropivacaine for sympathetic blockade at equianalgesic doses and its more gradual onset of sensory block. (9) This finding has direct clinical relevance in obstetric anaesthesia, given the well-established adverse effects of maternal hypotension on uteroplacental perfusion and, consequently, on neonatal outcome; the comparable APGAR scores observed between groups in this study, despite the different haemodynamic profiles, is reassuring and consistent with the findings of Khaw and colleagues in their dose-finding studies of spinal ropivacaine for caesarean delivery. (10)

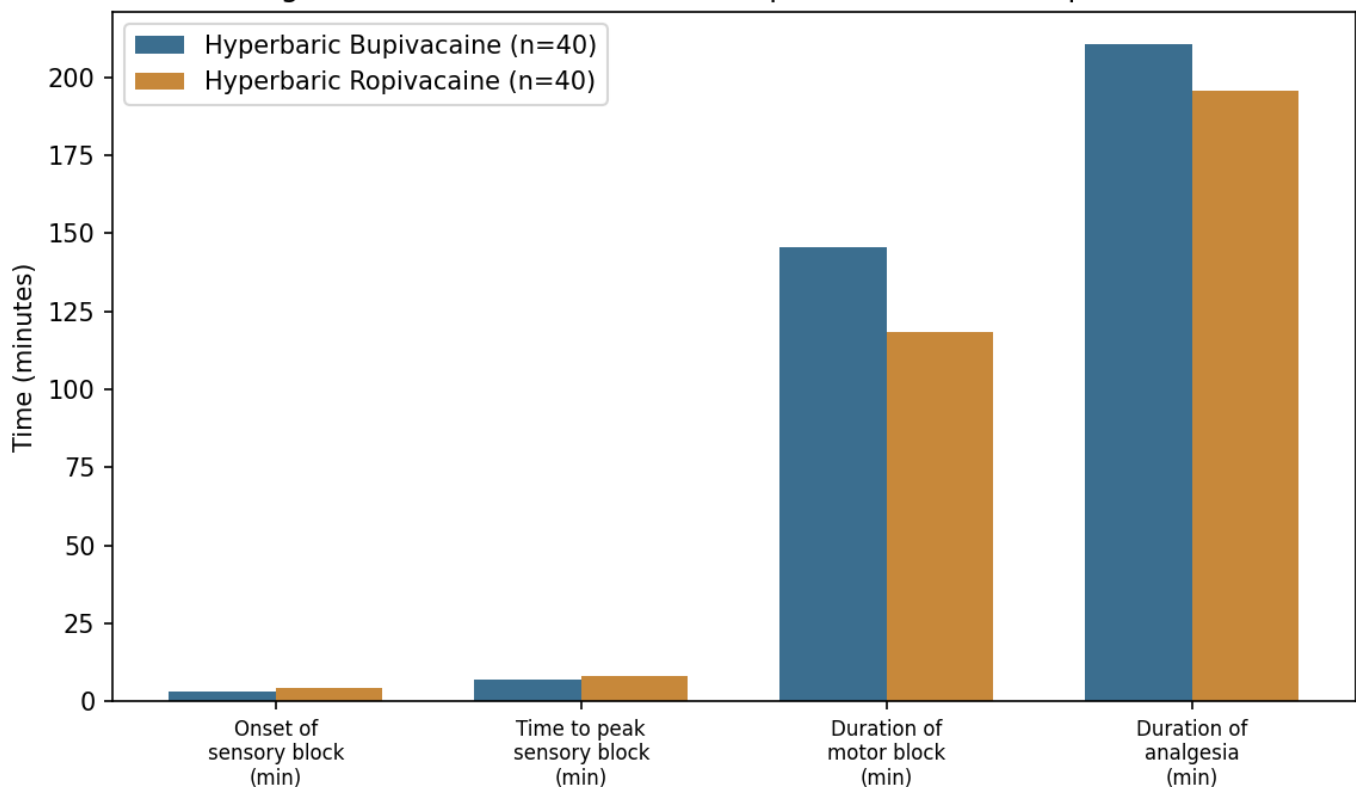
Comparative dose-response data from Danelli and colleagues, examining the minimum effective dose of hyperbaric ropivacaine for caesarean section, and volunteer data from Malinovsky and colleagues comparing intrathecal ropivacaine and bupivacaine, both support the general pattern observed in this study of adequate but somewhat less potent block with ropivacaine relative to bupivacaine at commonly used clinical doses. (5, 10) These findings collectively suggest that hyperbaric ropivacaine represents a clinically useful alternative to bupivacaine

TABLE 1: Demographic and Baseline Characteristics

Parameter	Group A: Bupivacaine (n=40)	Group B: Ropivacaine (n=40)
Age (years), mean $\pm$ SD	26.4 $\pm$ 3.8	27.1 $\pm$ 4.1
Weight (kg), mean $\pm$ SD	62.7 $\pm$ 7.2	61.9 $\pm$ 6.8
ASA physical status I, n (%)	34 (85.0%)	35 (87.5%)
ASA physical status II, n (%)	6 (15.0%)	5 (12.5%)

TABLE 2: Block Characteristics

Block Characteristic	Group A: Bupivacaine	Group B: Ropivacaine	P-value
Onset of sensory block (min)	3.2 $\pm$ 0.8	4.1 $\pm$ 0.9	0.001
Time to peak sensory block (min)	6.8 $\pm$ 1.4	8.2 $\pm$ 1.6	<0.001
Duration of motor block (min)	145.6 $\pm$ 18.2	118.3 $\pm$ 15.7	<0.001
Duration of effective analgesia (min)	210.4 $\pm$ 24.6	195.8 $\pm$ 22.1	0.006

Figure 1: Block Characteristics: Bupivacaine versus Ropivacaine**FIGURE 1:**

HYPERBARIC BUPIVACAINE VERSUS HYPERBARIC ROPIVACAINE IN ELECTIVE LOWER SEGMENT CAESAREAN SECTION

TABLE 3: Trend of Mean Arterial Pressure After Spinal Anaesthesia

Time	MAP Bupivacaine (mmHg)	MAP Ropivacaine (mmHg)
Baseline	92 ± 6	93 ± 7
5 minutes	78 ± 8	85 ± 7
10 minutes	74 ± 9	82 ± 8
15 minutes	76 ± 8	83 ± 7
20 minutes	80 ± 7	86 ± 6
30 minutes	84 ± 6	88 ± 6

Figure 2: Trend of Mean Arterial Pressure After Spinal Anaesthesia

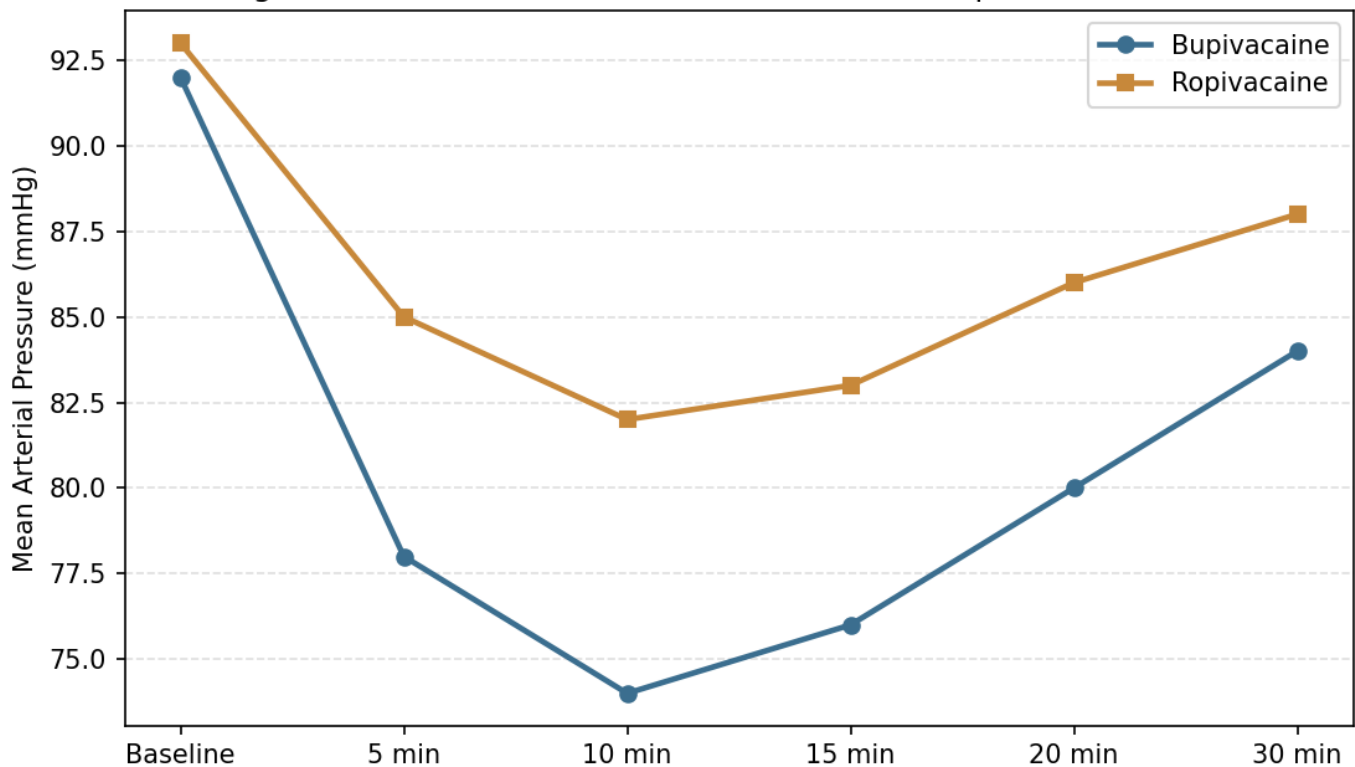


FIGURE 2:

TABLE 4: Incidence of Hypotension

Group	Hypotension Present, n (%)	No Hypotension, n (%)
Group A: Bupivacaine (n=40)	13 (32.5%)	27 (67.5%)
Group B: Ropivacaine (n=40)	6 (15.0%)	34 (85.0%)

TABLE 5: Side Effects by Study Group

Side Effect	Group A: Bupivacaine, n (%)	Group B: Ropivacaine, n (%)
Nausea/vomiting	7 (17.5%)	4 (10.0%)
Bradycardia	5 (12.5%)	2 (5.0%)
Shivering	4 (10.0%)	3 (7.5%)
Pruritus	2 (5.0%)	1 (2.5%)

Figure 3: Incidence of Hypotension by Study Group

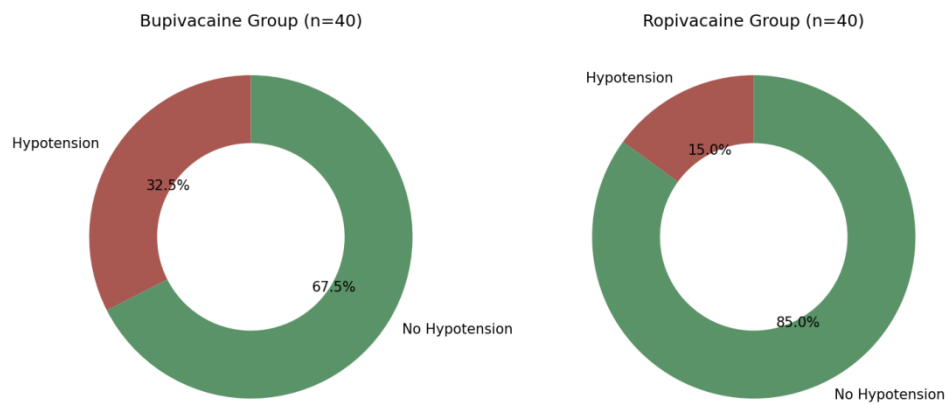


FIGURE 3:

Figure 4: Side Effects by Study Group

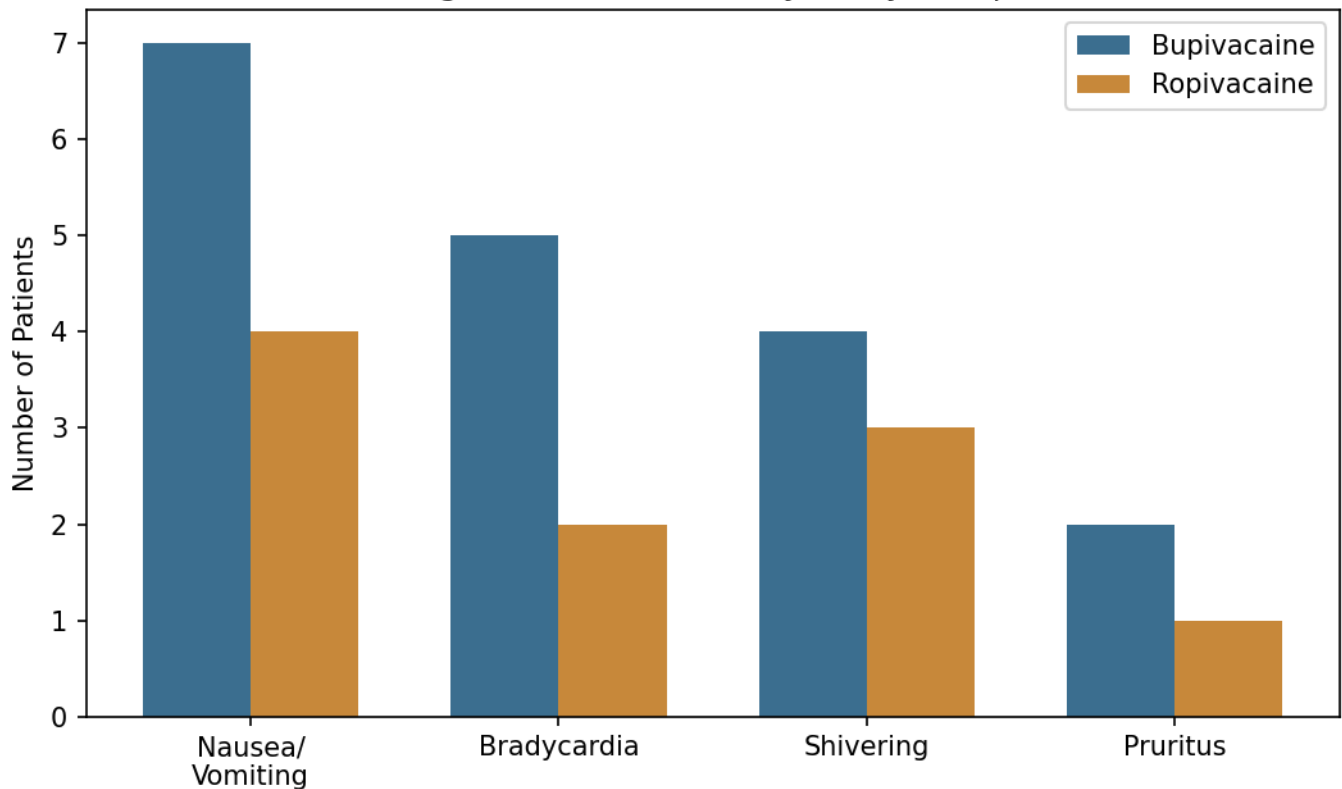


FIGURE 4:

TABLE 6: Neonatal APGAR Scores

APGAR Score	Group A: Bupivacaine	Group B: Ropivacaine
1 minute, mean $\pm$ SD	7.8 $\pm$ 0.6	7.9 $\pm$ 0.5
5 minutes, mean $\pm$ SD	9.1 $\pm$ 0.4	9.2 $\pm$ 0.4

HYPERBARIC BUPIVACAINE VERSUS HYPERBARIC ROPIVACAINE IN ELECTIVE LOWER SEGMENT CAESAREAN SECTION

Figure 5: Study Workflow for Comparison of Spinal Anaesthetic Agents in Elective Caesarean Section

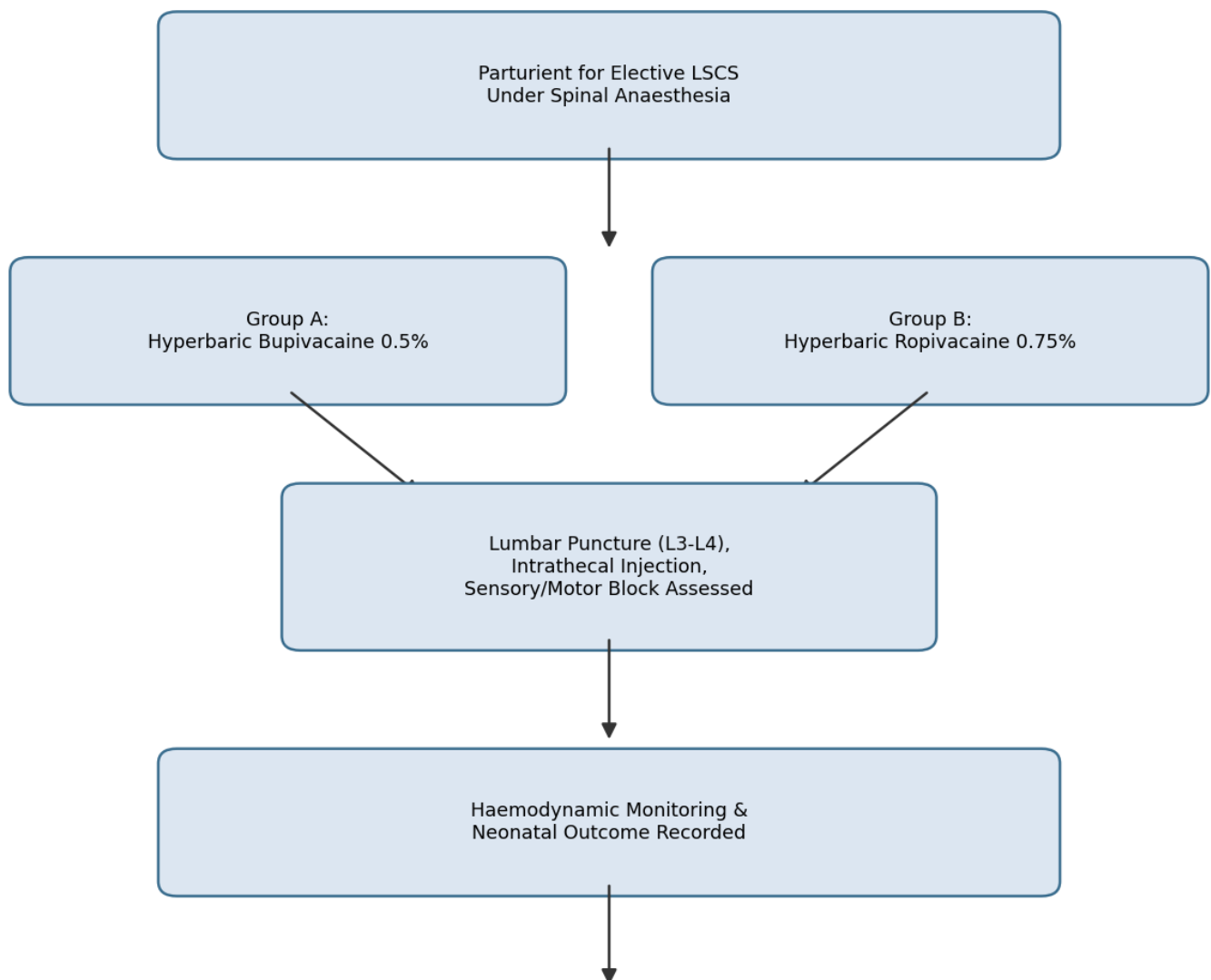


FIGURE 5: Study workflow for comparison of spinal anaesthetic agents in elective caesareansection.

for spinal anaesthesia in caesarean section, particularly in situations where haemodynamic stability is a priority, such as in patients at increased risk of hypotension-related complications.

5 | STRENGTHS AND LIMITATIONS

This study's strengths include its randomised, comparative design and standardised protocol for haemo-

dynamic monitoring and block assessment. Limitations include the absence of a formal sample size calculation described in this template, which should be addressed with a priori power calculation in any real study; the use of fixed doses of each agent rather than a dose-response design; and the relatively short duration of postoperative follow-up, which did not extend to assessment of postoperative analgesic requirements beyond the immediate perioperative period.

6 | CONCLUSION

Hyperbaric ropivacaine provides effective spinal anaesthesia for elective caesarean section with greater haemodynamic stability and a lower incidence of hypotension compared with hyperbaric bupivacaine, at the cost of a slightly slower onset and shorter duration of motor block, and represents a suitable alternative agent in this clinical setting, particularly where minimising maternal hypotension is a priority.

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