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Original Article

Anaesthesia Section

Comparative Evaluation of Two Doses of Intrathecal Dexmedetomidine (3 µg vs 5 µg) as an Adjuvant to Hyperbaric Ropivacaine in Caesarean Section: A Randomised Double-blind Controlled Trial

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ABSTRACT

Introduction: Spinal anaesthesia is commonly used for caesarean sections because of its rapid onset, reliable sensory and motor blockade, and excellent analgesia. Ropivacaine is preferred for its improved safety profile and reduced motor block.

Aim: To assess the impact of adding dexmedetomidine (3 µg vs 5 µg) to intrathecal hyperbaric ropivacaine in patients undergoing elective caesarean section.

Materials and Methods: This randomised, double-blind, controlled study was conducted at the Department of Anaesthesiology, Government Medical College, Gondia, Maharashtra, India, from July 2023 to January 2025. A total of 90 parturients were enrolled and received spinal anaesthesia with 12.5 mg of intrathecal ropivacaine. Participants were randomly assigned to one of three groups: ropivacaine alone (R group), ropivacaine with 3 µg dexmedetomidine (RD3 group), and ropivacaine with 5 µg dexmedetomidine (RD5 group). The study evaluated intraoperative sensory and motor block characteristics, haemodynamics, postoperative analgesia, and adverse events. Statistical analysis was performed using the Chi-square test and one-way Analysis of Variance (ANOVA).

Results: The demographic characteristics of patients in all three groups were comparable regarding age, Body Mass Index (BMI), height, and gestational age (p-value >0.05). Addition of dexmedetomidine to intrathecal ropivacaine significantly enhanced anaesthetic efficacy. Both RD3 and RD5 groups showed faster onset of sensory block to T10, T4, and peak levels compared to the R group (p-value <0.05). Sensory regression times and duration of motor block were significantly longer in the RD3 and RD5 groups, with RD5 showing the longest motor recovery time (207.9±22.38 vs 121.82±2.56 mins in R group; p-value <0.001). Motor block onset was faster in the dexmedetomidine groups (p-value <0.001). Intraoperative conditions, including visceral traction tolerance and muscle relaxation, were superior in the RD3 and RD5 groups. Postoperative VAS scores at 12 hours were lower in RD3 and RD5 than in the R group. All three groups experienced a decline in systolic blood pressure after spinal anaesthesia; however, the RD5 group exhibited the greatest fall.

Conclusion: Intrathecal dexmedetomidine, when used as an adjuvant to ropivacaine, enhanced intraoperative somatovisceral sensory block quality and improved postoperative analgesia, particularly at a dose of 3 µg. Although the 3 µg dose produced fewer side-effects compared to 5 µg, it was associated with significant prolongation of motor block duration—though less than that observed with 5 µg—making it a suitable and balanced dose for clinical use.

Keywords: Anaesthesia, Analgesia, Haemodynamics, Pain, Postoperative, Obstetrical, Spinal

INTRODUCTION

Spinal anaesthesia remains the technique of choice for caesarean sections due to its rapid onset, predictable efficacy, and favourable maternal and foetal safety profile. The relatively short duration of local anaesthetics often limits postoperative analgesia. Ropivacaine is known to have a lower risk of central nervous system and cardiac toxicity compared to bupivacaine. It is also less potent and tends to produce a shorter-lasting motor block, making hyperbaric ropivacaine a preferred option for spinal anaesthesia during caesarean sections [1]. However, due to its relatively brief duration of action—particularly in managing visceral pain—additional analgesic support is often required during surgery or shortly postoperatively to ensure adequate pain control [2]. While intrathecal opioids are commonly used to enhance analgesia, they are frequently associated with side-effects such as nausea [3], vomiting [4], and pruritus [5,6], which can be distressing for parturients and may delay postoperative recovery.

Dexmedetomidine, a highly selective α2-adrenergic agonist, has emerged as a valuable intrathecal adjuvant capable of prolonging both sensory and motor block while preserving haemodynamic stability. Previous studies have primarily examined its use with bupivacaine, leaving limited evidence regarding its combination with ropivacaine, particularly in obstetric anaesthesia [5,6]. The optimal intrathecal dose of dexmedetomidine that achieves effective analgesia with minimal adverse effects during caesarean sections remains undetermined. This study evaluates two doses of intrathecal dexmedetomidine (3 µg and 5 µg) as adjuvants to hyperbaric ropivacaine, thereby providing novel data to guide safe and effective dosing in clinical practice. Recent studies have suggested that intrathecal dexmedetomidine in caesarean sections can reduce postanaesthetic shivering, accelerate the onset of spinal anaesthesia, and enhance the efficacy of local anaesthetics without significant neonatal or maternal adverse effects [7,8].

Additionally, dexmedetomidine may promote uterine contractions, indicating its safety for postcaesarean analgesia [9]. However, the optimal intrathecal dose remains unclear. Therefore, this study was designed to evaluate different doses of dexmedetomidine combined with ropivacaine for spinal anaesthesia in caesarean delivery, with

an aim of identifying the optimal dosage and supporting its clinical application. The primary objective of this study was to determine the optimal intrathecal dose of dexmedetomidine for spinal anaesthesia in caesarean sections. The secondary objectives were to compare maternal side-effects and assess differences in postoperative analgesia.

MATERIALS AND METHODS

This randomised, double-blind, controlled study was conducted in the Department of Anaesthesiology, Government Medical College, Gondia, Maharashtra, India, from July 2023 to January 2025, after obtaining approval from the Institutional Ethics Committee (GMC/GONDIA/PHARMACOLOGY/IEC/07/2023) and written informed consent from all participants. The study strictly adhered to the ethical principles outlined in the Declaration of Helsinki (revised 2024) for biomedical research involving human subjects.

Sample size: Sample size estimation was based on a previous study [10] evaluating the effect of intrathecal dexmedetomidine on sensory and motor block characteristics. The sample size for the present study was calculated using the duration of analgesia as the primary outcome, employing data reported in the cited study. In that study, the mean (±SD) time for sensory block regression to T10 was 1.98±1.01 h in the ropivacaine group (R), 3.87±1.60 h in the ropivacaine plus 3 µg dexmedetomidine group (RD3), and 3.99±1.06 h in the ropivacaine plus 5 µg dexmedetomidine group (RD5). These values yielded an effect size of f=0.74 for a three-group one-way ANOVA. Using α=0.05 and 80% power, the calculated minimum required sample size was 30 participants per group.

$n=2(Z_{\alpha/2}+Z_{\beta})2\sigma^2/\Delta^2$

Where:

- n= sample size per group
- $Z_{\alpha/2}$= 1.96 for α = 0.05 (two-sided)
- Z_{β}= 0.84 for 80% power
- σ= Standard Deviation (SD)
- Δ= expected mean difference between groups

$$n=\frac{(2(7.84)(600.25)}{324}$$

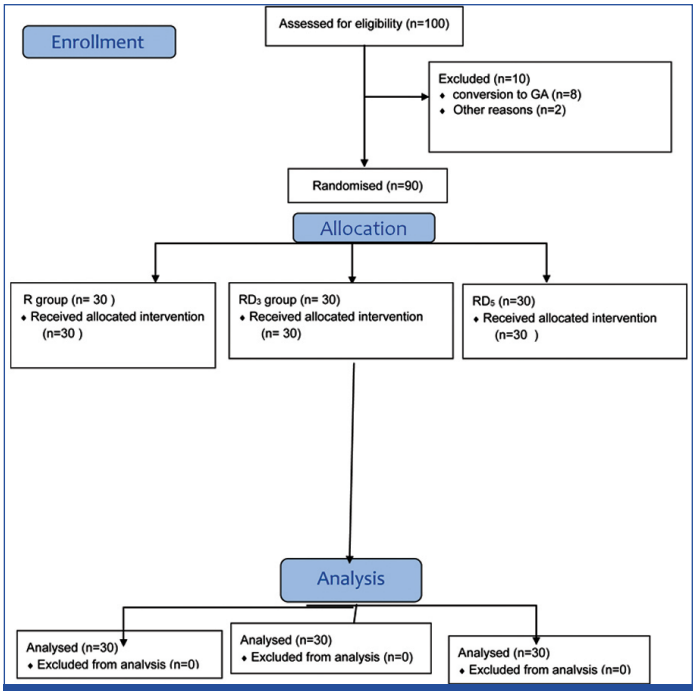
$$n=\frac{9419.92}{324}=29.1$$

n≈30 per group

Inclusion criteria: Parturients aged 18-35 years, of American Society of Anaesthesiologists (ASA) physical status grade I or II, with singleton pregnancies, a height between 150-170 cm, and a weight between 50-80 kg, undergoing elective caesarean section under spinal anaesthesia were included in the study.

Exclusion criteria: Parturients younger than 18 years of age, had a height >170 cm, hypertension, multiple gestation, antepartum haemorrhage, foetal distress in utero, contraindications to regional anaesthesia, heart rate <50 bpm, cardiac conduction or rhythm abnormalities, or a history of allergy to study drugs were excluded from the study.

A computer-generated randomisation list was used to allocate participants into three groups of 30 patients each, using sealed opaque envelopes to maintain allocation concealment [Table/Fig-1]. In this study, double blinding was implemented to minimise bias and ensure the reliability of results. Both the participants and the investigators assessing outcomes were unaware of group allocations. The study drugs—different doses of intrathecal dexmedetomidine (3 µg and 5 µg) combined with ropivacaine—were prepared by an independent anaesthesiologist who was not involved in patient care or data collection. Identical syringes with equal total volumes were used to maintain concealment. Thus, neither the patients nor the anaesthetists performing the block or recording data knew which dose was administered, thereby preserving the study's objectivity.



[Table/Fig-1]: CONSORT flow diagram.

The three groups were:

- **Group R:** Intrathecal (I/T) 0.75% hyperbaric ropivacaine 12.5 mg (1.6 mL) + preservative-free normal saline (0.9 mL);
- **Group RD3:** Intrathecal hyperbaric ropivacaine 12.5 mg (1.6 mL) + dexmedetomidine 3 µg (0.03 mL) + preservative-free normal saline (0.87 mL);
- **Group RD5:** Intrathecal hyperbaric ropivacaine 12.5 mg (1.6 mL) + dexmedetomidine 5 µg (0.05 mL) + preservative-free normal saline (0.85 mL).

An insulin syringe (1 mL) was used to measure volumes <1 mL [6]. The total intrathecal volume administered to all patients was kept constant at 2.5 mL.

All patients were evaluated according to institutional protocol. They were kept nil per oral for eight hours for solids and two hours for clear fluids. In the Operating Room (OR), patients were positioned supine with a left lateral tilt. Standard monitors including electrocardiography, pulse oximetry (SpO_2), and Non Invasive Blood Pressure (NIBP) were applied, and baseline vital parameters were recorded. Following intravenous cannulation with a 20-gauge cannula for fluid administration and emergency medication if required, patients were preloaded with Ringer's Lactate (RL) 5 mL/kg. Oxygen was routinely administered via nasal prongs at 2 L/min.

With strict aseptic precautions, intrathecal injection was administered in the sitting position at the L3-L4 intervertebral space using a 25-gauge Quincke spinal needle via the midline approach. The total volume of drug was injected over 10-15 seconds (0.2 mL/s). Patients were immediately placed supine with a 15° left lateral tilt by inserting a wedge under the right buttock to reduce the risk of supine hypotension syndrome. Sensory changes were assessed bilaterally along the midclavicular line using a needle, and the onset time of sensory block to T10 and T4 was recorded. Motor block was assessed using the modified Bromage scale. Surgery was initiated once a sensory block up to T6 and Bromage grade 3 motor block were achieved.

The onset and duration of sensory and motor blocks were recorded. Sensory block onset was defined as the time from intrathecal injection to loss of nociception at T8, assessed every two minutes, while duration was measured until regression to S1. Motor block onset was defined as the time to Bromage grade I, and duration

as the time to full recovery (grade IV). (Bromage scores: Grade I: complete block, unable to move ankle and knee; Grade II: almost complete block, able to move ankle only; Grade III: partial block, able to move knee and ankle; Grade IV: no motor block).

Haemodynamic parameters (SBP, DBP, HR) were recorded at baseline and at predetermined intervals up to 60 minutes. Visceral traction response was graded as Grade I (no response), Grade II (mild response not affecting surgery), or Grade III (strong response requiring intervention) [11]. Intraoperative visceral pain was treated with intravenous fentanyl 0.5 µg/kg as required. Patient VAS scores at 2, 4, 6, and 12 hours post-surgery were recorded.

Hypotension (SBP <100 mmHg or >20% fall) was treated with phenylephrine 80 µg; bradycardia (HR <60 bpm) with atropine 0.6 mg. Nausea and vomiting were treated with ondansetron 4 mg IV. Postoperative analgesia included diclofenac 75 mg every eight hours, with tramadol 50 mg for shivering. All adverse events and interventions were documented according to standard protocols.

STATISTICAL ANALYSIS

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) 23.0 statistical software. Data were expressed as means with standard deviations, medians with ranges, or numbers with percentages. For categorical data, the Chi-square test or Fisher's exact test was used. Continuous data (age, weight, height, duration of pregnancy, characteristics of spinal anaesthesia, and adverse effects) were compared using ANOVA. When the p-value was significant, post hoc comparisons among the repeated measures in each group were conducted using the Tukey HSD method. Differences in hemodynamic changes were compared using repeated-measures ANOVA. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 100 parturients were enrolled in the study, of whom eight required conversion to general anaesthesia due to inadequate block level, and two developed foetal distress in utero. The demographic characteristics of the patients in all three groups were comparable with respect to age, BMI, height, and gestational age (p-value >0.05). There were no significant differences in time to onset of surgery, delivery time, or duration of surgery [Table/Fig-2].

Parameter	R (n=30)	RD3 (n=30)	RD5 (n=30)	p-value
Age (years)	23.9±1.4	24.0±1.8	23.3 ±1.5	0.067
BMI (kg/m²)	30.1±2.7	30.5±2.6	29.8±2.1	0.525
ASA I: II	8:22	10:20	7:23	0.68
Gestational week	38.2±0.9	38.2±1.2	38.6±0.9	0.219
Height in cm	150.63±3.55	149.47±3.08	151.17±2.28	0.088
Start of surgery (mins)	14.9±1.1	14.2±0.7	14.7±1.0	0.16
Baby delivery (mins)	20.5±1.2	19.9±1.0	20.0±0.8	0.21
Duration of surgery (mins)	43.5±4.5	42.5±2.6	43.4±1.5	0.45

[Table/Fig-2]: Demographic and surgical characteristics.
Values are presented as mean±Standard Deviation (SD). R- Ropivacaine group; RD3- Ropivacaine with 3 µg dexmedetomidine; RD5- Ropivacaine with 5 µg dexmedetomidine; The p-value <0.05 was considered statistically significant.

The RD3 and RD5 groups demonstrated significantly shorter onset times for sensory block to T10, T4, and peak level compared with the R group (p-value <0.0001). For motor blockade, the median time to achieve Bromage 3 was considerably shorter in both the RD3 (8 minutes) and RD5 (7 minutes) groups than in the R group (15 minutes) (p-value <0.0001). Additionally, the time for the sensory block level to regress by two segments and reach T10 was significantly longer in the RD3 and RD5 groups compared with the R group (p-value <0.0001). The RD5 group also showed a longer time for two-segment regression than the RD3 group (p-value <0.0001).

With regard to motor blockade recovery, the RD5 group required significantly more time to return to Bromage 0 (full movement of hip, knee, and ankle) compared with both the R and RD3 groups (p-value <0.0001). A greater number of patients in the RD5 group (30) had no visceral traction response, compared with the RD3 (25) and R (5) groups [Table/Fig-3].

Parameter	R (n=30)	RD3 (n=30)	RD5 (n=30)	p-value	Post-hoc significance
Onset time of sensory block to T10 (mins)	6.03± 0.81	3.77±0.77	3.13±0.78	<0.0001	R vs RD3: p<0.0001; R vs RD5: p<0.0001; RD3 vs RD5: p = 0.009
T4 (mins)	10.60 ±0.86	7.57±1.07	6.80±0.71	<0.0001	R vs RD3: p<0.0001; R vs RD5: p<0.0001; RD3 vs RD5: p =0.0078
Tpeak (mins)	13.93± 1.14	13.50±1.04	11.00±0.79	<0.0001	R vs RD3: NS; R vs RD5: p<0.0001; RD3 vs RD5: p<0.0001
Onset time of motor block B3B3 (mins)	14.63± 1.13	8.30±0.65	6.90±0.80	<0.0001	R vs RD3: p<0.0001; R vs RD5: p<0.0001; RD3 vs RD5: p<0.0001
Recovery to 2 segments (mins)	43.57± 1.63	57.87 ±1.33	71.1±3.08	<0.0001	R vs RD3: p<0.0001; R vs RD5: p<0.0001; RD3 vs RD5: p<0.0001
Recovery to T10 (mins)	100.26± 12.17	204.43± 6.53	299.36± 5.44	<0.0001	R vs RD3: p<0.0001; R vs RD5: p<0.0001; RD3 vs RD5: p<0.0001
Motor recovery (mins)	121.82± 2.56	202.73± 6.85	207.9± 22.38	<0.0001	R vs RD3: p<0.0001; R vs RD5: p<0.0001; RD3 vs RD5: NS
Visceral traction response					
Grade I n (%)	5 (20)	25 (83.3)	30 (100)		R vs RD3: p<0.0001; R vs RD5: p<0.0001; RD3 vs RD5: NS
Grade II n (%)	20 (60)	5 (17.6)			
Grade III n (%)	5 (20)				

[Table/Fig-3]: Characteristics of spinal block.
Values are presented as mean±Standard Deviation (SD). R: Ropivacaine group; RD3: Ropivacaine with 3 µg dexmedetomidine; RD5: Ropivacaine with 5 µg dexmedetomidine; p<0.05 was considered statistically significant. B3B3 complete motor block

Postoperative VAS scores were significantly lower in both dexmedetomidine groups compared with the ropivacaine-only group at all time points (p-value <0.001). Post hoc analysis revealed that at 2 hours, both RD3 and RD5 had significantly lower scores than R, with no significant difference between RD3 and RD5. At 4, 6, and 12 hours, all pairwise comparisons were significant, indicating progressively improved analgesia with increasing dexmedetomidine dose [Table/Fig-4].

All three groups showed a decline in Systolic Blood Pressure (SBP) after spinal anaesthesia. However, the R group had a modest and relatively stable decrease, while the RD3 group exhibited a slightly greater reduction between 2 and 15 minutes. The RD5 group demonstrated the most prominent fall in SBP between 2 and 30 minutes [Table/Fig-5]. Diastolic Blood Pressure (DBP) followed a similar pattern, but with less fluctuation.

Injection Mephentermine 6 mg was administered to patients who developed hypotension. Ten patients in the R group, 10 in the RD3 group, and 12 in the RD5 group required vasopressor support.

Time point	R (n=30)	RD3 (n=30)	RD5 (n=30)	p-value	Post-hoc significance
VAS score at 2 hrs	3.00±0.00	2.00±0.00	2.00±0.00	<0.001	R vs RD3: p<0.001 R vs RD5: p<0.001 RD3 vs RD5: NS
VAS score at 4 hrs	3.50±0.00	3.00±0.00	2.50±0.00	<0.001	R vs RD3: p<0.001 R vs RD5: p<0.001 RD3 vs RD5: p<0.001
VAS score at 6 hrs	3.50±0.00	3.00±0.00	2.50±0.00	<0.001	R vs RD3: p<0.001 R vs RD5: p<0.001 RD3 vs RD5: p<0.001
VAS score at 12 hrs	4.00±0.00	3.50±0.00	3.00±0.00	<0.001	R vs RD3: p<0.001 R vs RD5: p<0.001 RD3 vs RD5: p<0.001

[Table/Fig-4]: VAS score comparison over time.
Data are presented as mean±SD. Post hoc pairwise comparisons were performed using Tukey's HSD test. p<0.001 indicates a statistically significant difference between groups. NS = Not significant.

Time (mins)	R SBP (mean±SD)	RD3 SBP (mean±SD)	RD5 SBP (mean±SD)	p-value
0	127.2±3.9	127.6±6.3	128.6±3.1	0.49
2	111.6±9.2	115.1±8.5	107.7±9.3	0.041
5	111.8±10.6	108.6±10.8	109.4±7.9	0.54
7.5	113.4±10.8	107.5±10.1	108.7±10.1	0.30
10	115.2±11.3	113.1±11.4	109.7±12.2	0.61
15	113.1±8.7	112.8±11.6	105.2±11.9	0.11
20	109.6±10.3	113.0±11.0	111.5±14.3	0.52
25	115.4±9.9	112.9±11.0	109.7±7.4	0.61
30	115.3±11.1	112.0±9.1	106.6±6.8	0.15
40	109.6±8.8	113.4±9.7	114.3±7.0	0.084
50	113.1±8.8	115.4±10.0	112.7±8.0	0.20
60	114.3±7.8	115.1±10.6	110.3±8.7	0.25

[Table/Fig-5]: Systolic Blood Pressure (SBP) variation amongst three groups.
p-values were calculated using a one-way analysis of variance (ANOVA) comparing Systolic Blood Pressure (SBP) among the three groups (R, RD3, and RD5) at each time point. Values are expressed as mean±Standard Deviation (SD). A p-value <0.05 was considered statistically significant

Heart rate trends are shown in [Table/Fig-6]. Baseline heart rates were comparable among groups. Following spinal anaesthesia, heart rate declined gradually—most markedly in RD5 (ropivacaine + 5 µg dexmedetomidine), followed by RD3 (3 µg), and least in R (ropivacaine alone)—indicating a dose-dependent bradycardic effect of dexmedetomidine, likely mediated by α2-adrenergic receptor–induced sympathetic inhibition. Statistically significant differences were noted at 7.5, 10, 30, 50, and 60 minutes (p-value <0.05). However, all values remained clinically acceptable, and no patient required atropine. Heart rates stabilised between 40 and 60 minutes, with RD5 maintaining slightly lower values.

Time point (mins)	R (mean±SD)	RD3 (mean±SD)	RD5 (mean±SD)	p-value
HR (0)	110.2±8.9	108.4±6.8	106.0±18.2	0.42
HR (2)	105.4±12.6	104.7±18.4	103.1±8.9	0.81
HR (5)	101.9±11.2	96.3±22.7	95.2±28.3	0.45
HR (7.5)	99.4±11.8	96.5±19.9	84.8±24.7	0.011
HR (10)	99.3±13.0	90.2±19.3	88.1±21.9	0.049
HR (15)	98.6±12.0	98.7±21.6	97.2±19.1	0.94
HR (20)	100.0±11.0	95.6±16.4	98.4±17.5	0.53
HR (25)	100.3±11.8	92.4±22.3	92.1±23.6	0.20
HR (30)	98.5±11.8	95.3±19.0	85.3±24.4	0.025
HR (40)	100.2±11.4	93.9±17.4	97.5±22.3	0.38
HR (50)	104.7±11.3	96.2±22.6	88.3±24.4	0.010
HR (60)	103.6±12.0	98.8±19.7	85.4±22.1	0.0007

[Table/Fig-6]: Heart rate variation among the three groups.
p-values were calculated using a one-way Analysis of Variance (ANOVA) comparing Heart Rate (HR) among the three groups (R, RD3, and RD5) at each time point. Values are expressed as mean±Standard Deviation (SD). A p-value < 0.05 was considered statistically significant

There were no statistically significant differences in the incidence of adverse effects—including hypotension, bradycardia, nausea/vomiting, and shivering—across the three study groups (p-value >0.05), as shown in [Table/Fig-7]. The requirement for intraoperative vasopressor support was significantly higher in the RD5 and RD3 groups compared with the R group, with the highest requirement in RD5. Fentanyl requirement was significantly higher in the R group (p-value <0.001).

Parameter	R group (n=30)	RD3 group (n=30)	RD5 group (n=30)	p-value
Nausea and vomiting	5	3	2	0.484
Hypotension	4	7	9	0.29
Bradycardia	0	0	0	0
Shivering	2	1	1	0.29
Fentanyl requirement in mg	0.083± 0.037	0.017 ± 0.037	0.0 (0.0-0.0)	<0.001 R vs RD3: p<0.001; R vs RD5: p<0.001; RD3 vs RD5: p<0.001
Vasopressor requirement	25	32	47	<0.05 R vs RD3: NS; R vs RD5: p<0.05; RD3 vs RD5: NS
Atropine requirement	0	0	0	0

[Table/Fig-7]: Incidence of adverse reactions, fentanyl and vasopressor requirement.
Values are presented as number of patients or median (interquartile range) for Fentanyl requirement. p-values were calculated using Chi-square or Kruskal–Wallis test as appropriate.

DISCUSSION

In this study, the addition of dexmedetomidine to hyperbaric ropivacaine not only accelerated the onset of sensory and motor block, but also enhanced block quality, as evidenced by improved visceral traction response during surgery. Importantly, the 3 µg dose provided effective analgesia and block characteristics comparable to the 5 µg dose, without further prolongation of motor recovery or increasing the incidence of side-effects. Postoperative analgesia was significantly improved in both dexmedetomidine groups, resulting in lower early postoperative pain scores and reduced requirements for rescue analgesics. Moreover, haemodynamic stability was maintained, with only a modest increase in vasopressor requirement in the higher-dose group, suggesting that 3 µg dexmedetomidine may offer an optimal balance between efficacy and safety. Notably, the 3 µg dose did not significantly prolong motor recovery, supporting early mobilisation after caesarean delivery. These findings are consistent with Bi YH et al., who reported that intrathecal dexmedetomidine (3 µg and 5 µg) shortened the onset of sensory block to T10, T4, and peak levels, prolonged sensory regression to two segments and to T10, and accelerated motor block onset while maintaining comparable motor recovery [10]. Similarly, Farokhmehr L et al., demonstrated that dexmedetomidine hastened onset and prolonged block duration without notable adverse effects, supporting the clinical efficacy of low-dose intrathecal dexmedetomidine [12].

Postoperative analgesia was significantly improved with dexmedetomidine, as evidenced by lower VAS scores at all time points (2-12 h) in both RD3 and RD5 groups (p-value <0.001). Post hoc analysis revealed that at 2 hours, both dexmedetomidine groups had lower VAS scores than ropivacaine alone, with RD5 providing slightly superior analgesia at later time points. These results align with Bi YH et al., and Zhang Q et al., who reported that intrathecal dexmedetomidine reduced postoperative pain scores and prolonged analgesia [10,13]. The consistency across studies suggests a dose-dependent analgesic effect, with even the lower 3 µg dose providing meaningful pain relief without increasing adverse outcomes.

Intrathecal dexmedetomidine markedly improved abdominal muscle relaxation and reduced visceral traction responses, with complete attenuation observed in the RD5 group. These findings are in concordance with Bi YH et al., who reported improved visceral traction response and abdominal relaxation with both 3 µg and 5 µg doses [10]. The reduction in visceral pain likely contributes to improved patient comfort and reduced intraoperative sympathetic stimulation, consistent with prior reports that effective spinal analgesia mitigates discomfort from uterine manipulation and peritoneal traction [14-18].

In the present study, there were no significant differences in SBP or heart rate among the groups, although phenylephrine requirements were higher in the RD3 and RD5 groups. No patient experienced clinically significant bradycardia or hypotension, and no atropine was required. These findings are consistent with previous studies demonstrating that low-dose intrathecal dexmedetomidine maintains haemodynamic stability while slightly increasing vasopressor requirements at higher doses [13,19]. The incidence of nausea, vomiting, and shivering did not differ significantly between groups, supporting the safety of intrathecal dexmedetomidine at 3 µg and 5 µg, consistent with earlier reports [20-25].

The observed effects of intrathecal dexmedetomidine are likely mediated by multiple mechanisms. Dexmedetomidine potentiates local anaesthetic action via α2-adrenergic receptor activation, inhibition of spinal ERK1/2 signalling, and modulation of sodium and potassium currents, thereby prolonging both sensory and motor blockade [26-29]. Vasoconstrictive effects may also enhance local retention of ropivacaine. These pharmacologic actions, combined with favourable analgesic and haemodynamic profiles, support its use as a low-dose spinal adjuvant in caesarean delivery, optimising block quality, postoperative analgesia, and patient comfort without significant side-effects.

Limitation(s)

This study had a few limitations. First, accurately measuring the small doses of dexmedetomidine—5 µg (0.05 mL) and 3 µg (0.03 mL)—posed a challenge, even when using 1 mL insulin syringes. This limitation could have introduced dosing inaccuracies, potentially leading to bias in the outcomes observed for the RD3 and RD5 groups. Second, the study did not evaluated the effects of intrathecal dexmedetomidine at doses higher than 10 µg. Therefore, the safety and efficacy of higher doses in the context of caesarean section remain unclear and warrant further investigation.

CONCLUSION(S)

The addition of 3 µg or 5 µg dexmedetomidine to intrathecal ropivacaine in caesarean delivery significantly accelerated the onset of sensory and motor block while prolonging the duration of sensory blockade. Postoperative analgesia was markedly improved, with consistently lower VAS scores up to 12 hours, enhancing patient comfort. Dexmedetomidine also reduced visceral traction responses and improved abdominal muscle relaxation without increasing adverse effects such as hypotension, bradycardia, nausea, or vomiting. The 3 µg dose provided effective analgesia and block quality without significantly prolonging motor recovery, supporting early postoperative mobilisation. These findings demonstrate that low-dose intrathecal dexmedetomidine is a safe and effective adjuvant to ropivacaine, optimising spinal anaesthesia for caesarean section. Overall, intrathecal dexmedetomidine improves anaesthesia quality, prolongs postoperative analgesia, and maintains haemodynamic stability.

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