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ORIGINAL RESEARCH

Clinical efficacy of isobaric ropivacaine alone, ropivacaine-fentanyl and ropivacaine-dexmedetomidine in spinal anaesthesia for vaginal hysterectomy: A prospective randomized double-blind comparative study

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ABSTRACT

Aim: To evaluate and compare the onset, duration, and overall clinical efficacy of isobaric ropivacaine alone versus in combination with fentanyl or dexmedetomidine for spinal anesthesia in patients undergoing elective vaginal hysterectomy. **Material and Methods:** This prospective, randomized, double-blind study included 120 female patients (aged 35–65 years, ASA I/II) scheduled for vaginal hysterectomy under spinal anesthesia. Participants were randomized into three equal groups: Group R received 3 mL of 0.75% isobaric ropivacaine alone; Group RF received ropivacaine plus 25 µg fentanyl; and Group RD received ropivacaine plus 5 µg dexmedetomidine. Standard monitoring and assessments were performed intraoperatively and postoperatively, including sensory and motor block characteristics, duration of analgesia, two-segment regression, hemodynamic changes, and adverse effects. **Results:** Baseline characteristics were comparable across all groups. The onset of sensory block was fastest in Group RD (3.5 ± 0.6 min) and slowest in Group R (4.3 ± 0.8 min). Duration of sensory block was longest in Group RD (241.7 ± 28.3 min), followed by Group RF (202.3 ± 26.5 min) and Group R (158.6 ± 22.1 min). Duration of effective analgesia was significantly higher in Group RD (267.8 ± 29.4 min) versus Group RF (224.6 ± 25.1 min) and Group R (172.4 ± 20.2 min). Hemodynamic parameters in Group RD showed a significant but clinically tolerable reduction in HR and BP. Adverse effects were mild; pruritus was seen only in Group RF (15%), and mild sedation was more frequent in Group RD (10%). **Conclusion:** Dexmedetomidine as an intrathecal adjuvant to ropivacaine significantly enhances block quality, prolongs analgesia, and maintains acceptable hemodynamic stability compared to ropivacaine alone or with fentanyl. It is thus a more effective option for high-quality spinal anesthesia in vaginal hysterectomy.

Keywords: Ropivacaine, Dexmedetomidine, Fentanyl, Spinal anesthesia, Vaginal hysterectomy

INTRODUCTION

Spinal anesthesia has long been established as a preferred anesthetic technique for various surgical procedures involving the lower abdomen and lower extremities, owing to its rapid onset, effective sensory and motor blockade, and minimal systemic drug exposure. Among the local anesthetics available for subarachnoid block, ropivacaine has gained significant attention for its favorable pharmacological profile, which includes long duration of action, lesser cardiovascular toxicity compared to bupivacaine, and a lower propensity for motor block at clinically effective concentrations. The introduction of isobaric formulations of ropivacaine has further refined its clinical utility by providing more predictable and uniform distribution within the cerebrospinal fluid, enhancing the reliability and safety of spinal anesthesia in various surgical settings.[1]

Vaginal hysterectomy is a common gynecological procedure often performed under regional anesthesia, including spinal block. Optimal anesthesia for such surgeries necessitates not only adequate intraoperative

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sensory blockade but also prolonged postoperative analgesia to ensure patient comfort and satisfaction. While ropivacaine alone can provide sufficient surgical anesthesia, its combination with intrathecal adjuvants has been explored extensively to augment both the quality and duration of anesthesia and analgesia.[2]

Among the commonly employed adjuvants, opioids such as fentanyl and alpha-2 adrenergic agonists like dexmedetomidine have been widely studied for their synergistic effects when combined with local anesthetics. Fentanyl, a lipophilic opioid, enhances intraoperative analgesia by acting on opioid receptors in the dorsal horn of the spinal cord without significantly increasing motor blockade or recovery time. Its rapid onset and short duration of action make it suitable for ambulatory and short-stay procedures, although its association with pruritus, nausea, and respiratory depression remains a clinical concern.[3]

On the other hand, dexmedetomidine, a highly selective alpha-2 adrenergic agonist, has emerged as a novel adjuvant that exerts its effects by inhibiting norepinephrine release and reducing sympathetic activity. It produces dose-dependent sedation and analgesia without significant respiratory depression. When used intrathecally, dexmedetomidine not only prolongs the duration of sensory and motor block but also enhances the overall quality of anesthesia. Furthermore, it has been associated with hemodynamic stability, reduced shivering, and lower postoperative analgesic requirements.

Several randomized controlled trials and comparative studies have assessed the efficacy of combining ropivacaine with these adjuvants in spinal anesthesia. These studies have demonstrated varying degrees of success in improving block characteristics, extending analgesia, and minimizing side effects. The selection between fentanyl and dexmedetomidine as an adjuvant is often guided by the desired balance between analgesic efficacy and safety profile. Fentanyl remains a favorable option for rapid onset and reliable analgesia, particularly in short-duration procedures, while dexmedetomidine is preferred in cases where extended analgesia and reduced postoperative opioid requirement are prioritized.[4]

The role of isobaric ropivacaine, especially in combination with adjuvants, has been a focal point in efforts to optimize spinal anesthesia protocols. Studies comparing ropivacaine alone to its combinations with fentanyl or dexmedetomidine have consistently reported improvements in anesthesia quality and duration when adjuvants are added. Specifically, the addition of fentanyl tends to reduce the onset time of sensory block and enhance intraoperative analgesia, whereas dexmedetomidine has been shown to prolong both sensory and motor blocks and provide superior postoperative analgesia.[5]

In the context of vaginal hysterectomy, where the duration of surgery is moderate and postoperative pain can be significant, choosing the appropriate anesthetic combination becomes crucial. Ensuring a balance between adequate intraoperative anesthesia and prolonged postoperative analgesia while minimizing side effects is key to enhancing patient recovery and satisfaction. There is a growing emphasis on tailoring anesthetic techniques to the individual needs of patients, considering the surgical duration, comorbid conditions, and anticipated postoperative pain.[6]

Despite the growing body of evidence supporting the use of adjuvants with ropivacaine in spinal anesthesia, there remains a need for comparative studies that evaluate the relative clinical efficacy and safety of these combinations in specific surgical populations. Vaginal hysterectomy presents a unique opportunity to assess these outcomes due to the consistent surgical field and duration, allowing for controlled comparisons. Moreover, the use of isobaric ropivacaine, as opposed to hyperbaric formulations, eliminates the variability associated with baricity and enhances the interpretability of block characteristics.[7]

MATERIAL AND METHODS

This prospective, randomized, double-blind, comparative clinical study was conducted in the Department of Anesthesiology at a tertiary care teaching hospital over a period of one year, between January 2022 and December 2022. The study was initiated after obtaining ethical clearance from the Institutional Ethics Committee. Written informed consent was obtained from all eligible participants prior to inclusion in the study.A total of 120 female patients, aged between 35 to 65 years, scheduled for elective vaginal hysterectomy under spinal anaesthesia were enrolled. The sample size was determined based on previous similar studies to ensure adequate power (80%) and significance (α = 0.05) to detect differences in the duration and quality of block.

Inclusion Criteria

- Female patients aged 35–65 years
- American Society of Anesthesiologists (ASA) physical status I or II
- Planned elective vaginal hysterectomy under spinal anaesthesia
- Provided informed written consent

Exclusion Criteria

- Hypersensitivity to study drugs
- Coagulopathies or patients on anticoagulant therapy
- Infection at the site of spinal injection
- Neurological or psychiatric illness
- Severe cardiovascular, hepatic, or renal disease
- Body Mass Index (BMI) > 35 kg/m²

Methodology

Patients were randomly assigned into three groups (n = 40 per group) using a computer-generated random sequence. Group allocation was concealed using

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sequentially numbered, sealed opaque envelopes.This was a double-blind study: both the patient and the anesthesiologist evaluating outcomes were unaware of group assignments.

Group Allocation

- **Group R (Ropivacaine alone)**: 3 mL of 0.75% isobaric ropivacaine (22.5 mg)
- **Group RF (Ropivacaine + Fentanyl)**: 3 mL of 0.75% isobaric ropivacaine + 25 µg fentanyl (0.5 mL)
- **Group RD (Ropivacaine + Dexmedetomidine)**: 3 mL of 0.75% isobaric ropivacaine + 5 µg dexmedetomidine (0.5 mL)

Each drug combination was diluted with sterile normal saline to a uniform volume of 3.5 mL. Intrathecal administration was performed using a 25G Quincke spinal needle at the L3–L4 interspace under strict aseptic precautions.

All patients were preloaded with Ringer's lactate at a dose of 10 mL/kg prior to administration of the spinal block. Standard intraoperative monitoring included continuous electrocardiography, non-invasive blood pressure measurement, pulse oximetry, and heart rate monitoring. Baseline vital parameters were recorded before administration of the block and were subsequently monitored at regular intervals during the intraoperative period and into the immediate postoperative phase. The primary parameters assessed included the onset and duration of sensory blockade, determined using the pinprick method at the T10 dermatome, and the onset and duration of motor blockade, evaluated by the Modified Bromage Scale. Additionally, the time required for two-segment regression of the sensory block was noted. The duration of effective analgesia, defined as the time interval from intrathecal injection to the patient's first request for rescue analgesia, was carefully recorded. Hemodynamic parameters, including heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP), were documented at baseline and then every 5 minutes for the first 30 minutes, followed by every 15 minutes until the completion of surgery. Any adverse effects such as hypotension, bradycardia, nausea, vomiting, pruritus, or sedation were closely monitored and managed appropriately. Postoperative monitoring continued for a minimum of two hours in the post-anesthesia care unit (PACU). Patients requiring additional analgesia received intravenous diclofenac 75 mg when the Visual Analog Scale (VAS) score was equal to or greater than 4.

Statistical Analysis

Data were compiled using Microsoft Excel and analyzed using SPSS version 25.0. Quantitative variables were expressed as mean ± standard deviation (SD) and analyzed using one-way ANOVA. Categorical variables were compared using Chi-square test or Fisher's exact test as applicable. A p-value < 0.05 was considered statistically significant.

RESULTS

Table 1: Demographic and Baseline Characteristics

The demographic and baseline clinical profiles were comparable across all three groups, indicating effective randomization. The mean age of participants ranged from 48.7 to 49.3 years across groups, with no statistically significant difference ($p = 0.78$). Mean body weight was also similar, ranging from 61.9 to 63.1 kg ($p = 0.65$). The distribution of ASA physical status (I:II) was nearly balanced across groups ($p = 0.89$). The average duration of surgery was approximately 76–78 minutes in all groups, with no statistically significant difference ($p = 0.71$). These findings confirm that baseline variability was minimal and unlikely to influence the intergroup outcomes.

Table 2: Onset and Duration of Sensory and Motor Block

The onset of sensory block was fastest in Group RD (3.5 ± 0.6 minutes), followed by Group RF (3.9 ± 0.7 minutes), and slowest in Group R (4.3 ± 0.8 minutes), showing a statistically significant difference ($p < 0.01$). Similarly, the duration of sensory block was significantly prolonged in Group RD (241.7 ± 28.3 minutes), followed by Group RF (202.3 ± 26.5 minutes), compared to Group R (158.6 ± 22.1 minutes), with a highly significant p-value (<0.001). A similar pattern was observed for motor block onset and duration. Group RD had the quickest onset (5.0 ± 0.8 minutes) and longest duration (213.5 ± 24.1 minutes), followed by Group RF (178.9 ± 21.4 minutes) and Group R (134.2 ± 19.3 minutes), with p-values of <0.01 and <0.001, respectively. These results indicate that adding fentanyl and especially dexmedetomidine significantly enhances the block characteristics.

Table 3: Duration of Effective Analgesia and Time to Two-Segment Regression

The duration of effective analgesia was significantly longer in Group RD (267.8 ± 29.4 minutes), followed by Group RF (224.6 ± 25.1 minutes) and Group R (172.4 ± 20.2 minutes), with a p-value < 0.001. Similarly, the time required for two-segment regression of sensory level was markedly prolonged in Group RD (118.7 ± 15.2 minutes) compared to Group RF (103.4 ± 14.5 minutes) and Group R (81.2 ± 12.3 minutes), also with high statistical significance ($p < 0.001$). These findings support the superior analgesic profile of dexmedetomidine as an intrathecal adjuvant, providing sustained postoperative pain relief and slower sensory regression.

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Table 4: Hemodynamic Parameters at Specified Intervals

Hemodynamic monitoring revealed a consistent trend of lower heart rate and blood pressure in Group RD, especially from 5 minutes onward, with many parameters showing statistically significant differences compared to the other two groups. At baseline, HR was slightly lower in Group RD (76.3 bpm) compared to Group R (80.2 bpm), reaching significance (p = 0.04). This trend continued through all time points, becoming more pronounced, with Group RD consistently showing the lowest HR values (e.g., 65.9 bpm at end of surgery vs. 70.6 bpm in Group R, p = 0.001). Similar trends were noted in SBP, DBP, and MAP. At the end of surgery, SBP in Group RD was 106.4 mmHg, compared to 112.9 mmHg in Group R (p = 0.01); MAP was 76.0 mmHg in Group RD vs. 81.5 mmHg in Group R (p = 0.01). The statistically significant reductions in HR and BP values in Group RD are attributed to the known sympatholytic and sedative effects of dexmedetomidine. However, the changes remained within clinically acceptable limits and were well tolerated.

Table 5: Incidence of Adverse Effects

The incidence of adverse effects was slightly higher in the adjuvant groups, particularly Group RD. Hypotension occurred in 20.0% of Group RD patients, compared to 12.5% in Group R. Bradycardia was more common in Group RD (12.5%) than in Group RF (7.5%) and Group R (5.0%). Pruritus was observed exclusively in the fentanyl group (15.0%), a known opioid-related side effect, and was absent in both Group R and RD. Mild sedation (Grade I) was noted in 10.0% of Group RD patients and only 2.5% in Group RF. Nausea and vomiting occurred sporadically, with no significant pattern. Overall, adverse events were mild and manageable, with no serious complications reported in any group.

Table 1: Demographic and Baseline Characteristics of Study Groups (n = 120)

Parameter	Group R (n = 40)	Group RF (n = 40)	Group RD (n = 40)	p-value
Age (years, Mean ± SD)	49.3 ± 6.1	48.7 ± 5.8	48.9 ± 6.2	0.78
Weight (kg, Mean ± SD)	62.4 ± 7.3	63.1 ± 6.8	61.9 ± 6.9	0.65
ASA I : II (n)	24 : 16	25 : 15	23 : 17	0.89
Duration of surgery (min)	76.5 ± 12.8	78.3 ± 11.9	77.1 ± 13.5	0.71

Table 2: Onset and Duration of Sensory and Motor Block

Parameter	Group R	Group RF	Group RD	p-value
Onset of sensory block (min)	4.3 ± 0.8	3.9 ± 0.7	3.5 ± 0.6	<0.01
Duration of sensory block (min)	158.6 ± 22.1	202.3 ± 26.5	241.7 ± 28.3	<0.001
Onset of motor block (min)	6.1 ± 1.0	5.5 ± 0.9	5.0 ± 0.8	<0.01
Duration of motor block (min)	134.2 ± 19.3	178.9 ± 21.4	213.5 ± 24.1	<0.001

Table 3: Duration of Effective Analgesia and Time to Two-Segment Regression

Parameter	Group R	Group RF	Group RD	p-value
Duration of effective analgesia (min)	172.4 ± 20.2	224.6 ± 25.1	267.8 ± 29.4	<0.001
Time to 2-segment regression (min)	81.2 ± 12.3	103.4 ± 14.5	118.7 ± 15.2	<0.001

Table 4: Comparison of Hemodynamic Parameters (HR, SBP, DBP, MAP) at Specified Time Intervals

Time Point	Parameter	Group R (n=40)	Group RF (n=40)	Group RD (n=40)	p-value
Baseline	HR (bpm)	80.2 ± 5.6	78.5 ± 6.1	76.3 ± 5.3	0.04*
	SBP (mmHg)	125.3 ± 8.4	124.1 ± 7.9	122.8 ± 7.6	0.28
	DBP (mmHg)	76.4 ± 5.3	75.7 ± 4.9	74.8 ± 5.1	0.37
	MAP (mmHg)	92.7 ± 5.6	91.8 ± 6.0	90.9 ± 5.8	0.41
5 min	HR	78.1 ± 5.9	76.3 ± 5.8	73.5 ± 5.1	0.03*
	SBP	121.4 ± 7.9	119.6 ± 7.5	117.1 ± 7.2	0.04*
	DBP	73.8 ± 4.6	72.4 ± 4.7	70.6 ± 4.5	0.03*
	MAP	89.6 ± 5.1	87.8 ± 5.0	85.5 ± 4.8	0.02*
10 min	HR	77.5 ± 5.5	75.1 ± 5.7	72.6 ± 4.9	0.02*
	SBP	120.2 ± 7.7	117.8 ± 7.3	115.3 ± 6.9	0.03*
	DBP	72.6 ± 4.4	71.2 ± 4.3	69.1 ± 4.1	0.02*
	MAP	88.4 ± 4.9	86.3 ± 4.6	84.0 ± 4.3	0.01*
15 min	HR	76.8 ± 5.4	74.5 ± 5.2	71.9 ± 4.7	0.01*
	SBP	119.1 ± 7.5	116.7 ± 7.0	113.8 ± 6.7	0.03*
	DBP	71.4 ± 4.2	69.9 ± 4.0	67.6 ± 3.8	0.01*
	MAP	87.3 ± 4.7	85.1 ± 4.3	82.7 ± 4.0	0.01*
20 min	HR	75.9 ± 5.2	73.8 ± 5.0	70.7 ± 4.5	0.01*

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	SBP	118.2 ± 7.2	115.4 ± 6.9	112.6 ± 6.3	0.02*
	DBP	70.2 ± 4.0	68.4 ± 3.9	66.1 ± 3.7	0.01*
	MAP	86.1 ± 4.4	83.8 ± 4.0	81.3 ± 3.7	0.01*
25 min	HR	75.2 ± 5.0	72.6 ± 4.9	69.8 ± 4.2	0.01*
	SBP	117.5 ± 7.0	114.6 ± 6.7	111.8 ± 6.1	0.02*
	DBP	69.6 ± 3.9	67.7 ± 3.8	65.3 ± 3.5	0.01*
	MAP	85.4 ± 4.2	83.0 ± 3.8	80.7 ± 3.5	0.01*
30 min	HR	74.6 ± 4.9	71.9 ± 4.7	69.1 ± 4.0	0.001*
	SBP	116.2 ± 6.8	113.3 ± 6.4	110.1 ± 5.8	0.01*
	DBP	68.9 ± 3.7	66.7 ± 3.6	64.2 ± 3.3	0.01*
	MAP	84.2 ± 4.0	81.6 ± 3.6	79.3 ± 3.2	0.01*
45 min	HR	73.4 ± 4.7	71.1 ± 4.5	68.3 ± 3.9	0.001*
	SBP	115.4 ± 6.5	112.3 ± 6.1	109.0 ± 5.4	0.01*
	DBP	68.2 ± 3.6	66.0 ± 3.4	63.5 ± 3.1	0.01*
	MAP	83.6 ± 3.8	80.9 ± 3.5	78.5 ± 3.1	0.01*
60 min	HR	72.2 ± 4.6	69.9 ± 4.3	67.5 ± 3.8	0.001*
	SBP	114.6 ± 6.2	111.4 ± 5.9	108.1 ± 5.1	0.01*
	DBP	67.5 ± 3.5	65.3 ± 3.2	62.7 ± 2.9	0.01*
	MAP	82.8 ± 3.6	80.1 ± 3.3	77.6 ± 3.0	0.01*
75 min	HR	71.5 ± 4.4	69.0 ± 4.1	66.7 ± 3.5	0.001*
	SBP	113.8 ± 6.0	110.5 ± 5.6	107.2 ± 4.9	0.01*
	DBP	66.7 ± 3.3	64.4 ± 3.0	61.9 ± 2.8	0.01*
	MAP	82.1 ± 3.4	79.3 ± 3.1	76.7 ± 2.9	0.01*
End of Surgery	HR	70.6 ± 4.3	68.1 ± 4.0	65.9 ± 3.3	0.001*
	SBP	112.9 ± 5.8	109.6 ± 5.4	106.4 ± 4.6	0.01*
	DBP	66.0 ± 3.2	63.5 ± 2.9	61.1 ± 2.7	0.01*
	MAP	81.5 ± 3.2	78.6 ± 2.9	76.0 ± 2.6	0.01*

*Statistically significant ($p < 0.05$)

Table 5: Incidence of Adverse Effects

Adverse Effect	Group R (n=40)	Group RF (n=40)	Group RD (n=40)
Hypotension	5 (12.5%)	6 (15.0%)	8 (20.0%)
Bradycardia	2 (5.0%)	3 (7.5%)	5 (12.5%)
Nausea/Vomiting	4 (10.0%)	6 (15.0%)	3 (7.5%)
Pruritus	0 (0.0%)	6 (15.0%)	0 (0.0%)
Sedation (Grade I)	0 (0.0%)	1 (2.5%)	4 (10.0%)

DISCUSSION

The demographic variables such as age, weight, ASA classification, and duration of surgery were evenly distributed across the three study groups: Group R (ropivacaine alone), Group RF (ropivacaine with fentanyl), and Group RD (ropivacaine with dexmedetomidine). The mean age ranged from 48.7 ± 5.8 years in Group RF to 49.3 ± 6.1 years in Group R ($p = 0.78$), and the mean body weight ranged from 61.9 ± 6.9 kg in Group RD to 63.1 ± 6.8 kg in Group RF ($p = 0.65$). ASA class I:II distribution was similar across groups (24:16 in Group R, 25:15 in Group RF, and 23:17 in Group RD; $p = 0.89$). Average surgery duration was 76.5 ± 12.8 minutes in Group R, 78.3 ± 11.9 minutes in Group RF, and 77.1 ± 13.5 minutes in Group RD ($p = 0.71$). These findings affirm that the groups were comparable at baseline, a critical prerequisite emphasized by Kumar et al. (2017) for minimizing bias in randomized trials involving anesthetic comparisons.[7]

The addition of adjuvants significantly influenced both the onset and duration of spinal block. The onset of sensory block was fastest in Group RD at 3.5 ± 0.6 minutes, followed by Group RF at 3.9 ± 0.7 minutes, and was slowest in Group R at 4.3 ± 0.8 minutes ($p < 0.01$). Similarly, the duration of sensory block was longest in Group RD (241.7 ± 28.3 minutes), followed by Group RF (202.3 ± 26.5 minutes), and shortest in Group R (158.6 ± 22.1 minutes), with $p < 0.001$. For motor block, Group RD also had the shortest onset (5.0 ± 0.8 minutes) and the longest duration (213.5 ± 24.1 minutes), compared to Group RF (178.9 ± 21.4 minutes) and Group R (134.2 ± 19.3 minutes), all statistically significant. These results mirror findings by Dolma et al. (2018) and Grewal et al. (2018), both of whom reported superior block quality with dexmedetomidine-ropivacaine combinations compared to ropivacaine alone or with fentanyl. The faster onset and prolonged action of dexmedetomidine can be attributed to its alpha-2 agonist properties that enhance local anesthetic efficacy at the spinal level.[8,9]

The duration of effective analgesia was markedly prolonged in Group RD (267.8 ± 29.4 minutes), followed by Group RF (224.6 ± 25.1 minutes), and

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shortest in Group R (172.4 ± 20.2 minutes), with a highly significant p-value (< 0.001). Similarly, time to two-segment regression was longest in Group RD (118.7 ± 15.2 minutes), followed by Group RF (103.4 ± 14.5 minutes) and Group R (81.2 ± 12.3 minutes), again with $p < 0.001$. These results demonstrate the prolonged postoperative analgesic benefit of dexmedetomidine, a finding in agreement with Qiu et al. (2019) and Grewal et al. (2018), who documented similar analgesic extensions with intrathecal alpha-2 agonists.[9,10]In contrast, fentanyl provided moderate analgesia without significantly delaying regression, consistent with opioid pharmacokinetics and supported by Culebras et al. (2001). These findings reinforce the clinical decision-making advantage of dexmedetomidine in procedures requiring longer analgesic windows.[11]

Hemodynamic monitoring revealed significant differences in heart rate and blood pressure parameters between groups, especially notable from 5 minutes post-administration onwards. Baseline HR in Group RD was slightly lower (76.3 bpm) compared to Group R (80.2 bpm), and this trend persisted with significant reductions at key time points—e.g., at the end of surgery: Group RD (65.9 bpm) vs. Group R (70.6 bpm), $p = 0.001$. Similarly, systolic blood pressure (SBP) at the end of surgery was lowest in Group RD (106.4 mmHg) compared to Group R (112.9 mmHg), with mean arterial pressure (MAP) values of 76.0 mmHg in Group RD and 81.5 mmHg in Group R ($p = 0.01$). These cardiovascular effects are well documented in studies such as Chatrath et al. (2018), who highlighted the sympatholytic properties of dexmedetomidine.[12]Despite statistical significance, these values remained within safe clinical limits and did not require aggressive pharmacological intervention, reinforcing findings by Leone et al. (2008) that dexmedetomidine can be safely used when properly monitored.[13]

The overall incidence of adverse effects was low and manageable. Hypotension was most common in Group RD (20.0%) compared to Group RF (15.0%) and Group R (12.5%). Bradycardia followed a similar pattern: 12.5% in Group RD, 7.5% in Group RF, and 5.0% in Group R. Notably, pruritus was reported only in Group RF (15.0%), highlighting a known opioid-induced effect, as similarly observed in Koppal et al. (2019).[14] Mild sedation (Grade I) occurred in 10.0% of Group RD patients and only 2.5% in Group RF, aligning with findings from Abdallah et al. (2019), who noted that intrathecal dexmedetomidine often causes light sedation due to central sympatholysis. Nausea and vomiting were rare and randomly distributed across groups. The absence of serious complications in any group indicates that both adjuvants, while having distinct side effect profiles, are clinically acceptable with vigilant monitoring and appropriate patient selection.[15]

CONCLUSION

The present study demonstrates that the addition of dexmedetomidine to isobaric ropivacaine in spinal anesthesia for vaginal hysterectomy significantly enhances the onset and prolongs the duration of sensory and motor blocks, as well as postoperative analgesia, compared to ropivacaine alone or with fentanyl. While both dexmedetomidine and fentanyl improved block characteristics, dexmedetomidine offered superior analgesic efficacy. Hemodynamic changes with dexmedetomidine were statistically significant but clinically well tolerated. Fentanyl, although effective, was associated with a higher incidence of pruritus. Overall, dexmedetomidine is a more effective and reliable intrathecal adjuvant for prolonged and high-quality anesthesia.

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