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Original article

Comparison of Postoperative Analgesic Outcomes with Intravenous Midazolam and Dexmedetomidine in Patients Undergoing Abdominal Hysterectomy Under Spinal Anaesthesia

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ABSTRACT
Background: Spinal anesthesia is widely preferred for lower abdominal surgeries due to its rapid onset, dense neural block, and minimal systemic effects. Sedation and stable hemodynamics are critical to patient comfort and safety during surgery. Adjuvants like midazolam and dexmedetomidine are commonly administered intravenously to enhance sedation while maintaining hemodynamic stability.
Objective: To compare the sedation quality and hemodynamic effects of intravenous midazolam and dexmedetomidine in patients undergoing abdominal hysterectomy under spinal anesthesia.
Methods: A prospective, single-blind, randomized controlled study was conducted on 150 patients (ASA I–II) undergoing abdominal hysterectomy. Patients were randomly assigned to Group D (Dexmedetomidine 1 µg/kg IV) or Group M (Midazolam 0.05 mg/kg IV), administered over 10 minutes. Sedation was assessed using the Ramsay Sedation Score (RSS), while hemodynamic parameters (heart rate, systolic and diastolic blood pressure, respiratory rate, and SpO_2) were monitored at 0, 15, 30, 45, 60, 75, and 90 minutes.
Results: Baseline demographic and hemodynamic characteristics were comparable between groups. Post 45 minutes, mean RSS was significantly higher in Group D compared to Group M ($p<0.05$), indicating deeper sedation. Heart rate, blood pressure, respiratory rate, and SpO_2 remained stable and comparable between groups throughout the procedure ($p>0.05$). No significant adverse events related to hemodynamics were observed.
Conclusion: Intravenous dexmedetomidine provides superior sedation quality compared to midazolam while maintaining stable hemodynamics during abdominal hysterectomy under spinal anesthesia. Dexmedetomidine is a preferable adjuvant for achieving optimal intraoperative sedation without compromising patient safety.

Keywords: Dexmedetomidine, Midazolam, Spinal Anesthesia, Sedation, Hemodynamic Stability, Abdominal Hysterectomy

1. INTRODUCTION

Spinal anesthesia is one of the most commonly employed anesthetic techniques for lower abdominal and lower limb surgeries due to its rapid onset, profound sensory and motor block, and minimal systemic effects. It provides an economical, safe, and technically straightforward alternative to general anesthesia (GA), especially in patients with comorbidities (1,2). In gynecological surgeries such as abdominal hysterectomy, spinal anesthesia offers predictable anesthesia and low failure rates, enhancing patient comfort and procedural efficiency (3).

Despite its advantages, spinal anesthesia often requires adjuncts to improve intraoperative sedation and prolong patient comfort. Sedation during surgery is essential for anxiolysis, amnesia, and patient cooperation. Moreover, the choice of sedative adjuvant should preserve hemodynamic stability, minimize respiratory depression, and avoid postoperative cognitive dysfunction (4–6).

Dexmedetomidine, a highly selective α2-adrenergic agonist with an α2/α1 selectivity ratio of 1620:1, has gained attention for its sedative, analgesic, and sympatholytic properties. Originally introduced as an ICU sedative, it has been demonstrated to enhance the effects of local anesthetics and prolong sensory and motor block when administered intravenously or neuraxially (7). Dexmedetomidine provides sedation resembling natural sleep, with minimal respiratory depression, making it ideal for use during spinal anesthesia.

Midazolam, a water-soluble benzodiazepine introduced in 1976, is widely used in anesthesia for its rapid onset, predictable sedation, anxiolytic, and amnesic properties. It has a short recovery time, minimal accumulation, and a favorable safety profile (8,9). While both midazolam and dexmedetomidine are effective sedatives, their comparative

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efficacy in producing intraoperative sedation with stable hemodynamics during abdominal hysterectomy remains inadequately explored (10,11).

This study aims to evaluate the sedation quality and hemodynamic stability of intravenous dexmedetomidine versus midazolam in patients undergoing abdominal hysterectomy under spinal anesthesia. We hypothesize that dexmedetomidine will provide superior sedation while maintaining comparable hemodynamic stability compared to midazolam.

2. MATERIAL AND METHODS

Study Design and Setting: This prospective, single-blind, randomized controlled study was conducted from November 2019 to May 2021 at a tertiary care hospital after approval from the Institutional Ethical Committee.

Participants: A total of 150 patients scheduled for abdominal hysterectomy under spinal anesthesia, aged 40–70 years and graded ASA I–II, were included. Written informed consent was obtained. Exclusion criteria were: ASA > II, co-morbid conditions requiring ongoing treatment, bleeding disorders, hypersensitivity to study drugs, obstructive sleep apnea, psychiatric disorders, recent use of hypnotics, renal impairment, coagulation disorders, spinal deformities, or local infection at the injection site.

Randomization: Patients were randomly assigned to:

- **Group D:** Dexmedetomidine 1 µg/kg IV in 10 mL normal saline
- **Group M:** Midazolam 0.05 mg/kg IV in 10 mL normal saline over 10 minutes

Preoperative Preparation: All patients underwent pre-anesthetic evaluation including history, physical examination, airway assessment, systemic examination, and baseline laboratory investigations. Patients received alprazolam 0.5 mg the night before surgery and were kept nil per oral on the day of surgery.

Anesthesia Technique: Intravenous access was secured and patients were preloaded with 500 mL Ringer's lactate or normal saline. Under aseptic precautions, spinal anesthesia was administered using 0.5% hyperbaric bupivacaine. Oxygen was supplied at 4 L/min via face mask.

Monitoring: Hemodynamic parameters (heart rate, systolic and diastolic blood pressure, respiratory rate, and SpO_2) were recorded at baseline, 0, 15, 30, 45, 60, 75, and 90 minutes. Sedation was assessed using the Ramsay Sedation Score (RSS) at the same intervals.

Outcome Measures:

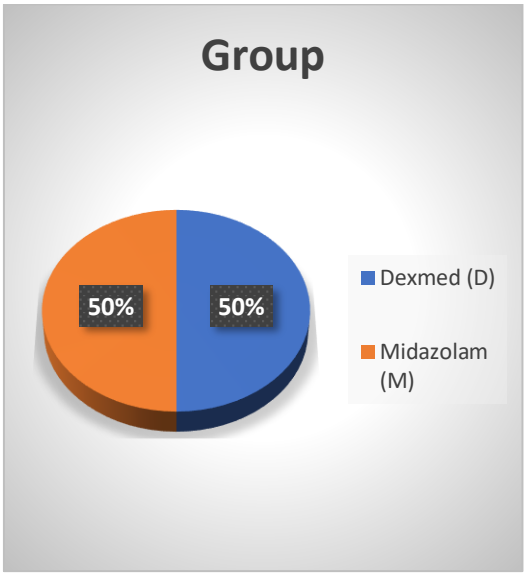
1. **Primary:** Sedation quality measured by RSS
2. **Secondary:** Hemodynamic stability (heart rate, blood pressure, respiratory rate, SpO_2) and adverse events

Statistical Analysis: Data were recorded on a pre-designed proforma. Qualitative data were expressed as frequencies and percentages, and association was analyzed using Chi-square or Fisher's exact test. Quantitative data were expressed as mean ± SD and compared using unpaired t-test or Mann-Whitney test depending on normality. A p-value <0.05 was considered statistically significant. SPSS Version 21 and Microsoft Excel 2010 were used for analysis and graphical representation.

3. RESULTS

Demographic and Baseline Characteristics

A total of 150 patients undergoing abdominal hysterectomy under spinal anesthesia were randomly allocated into two groups: **Group D** (Dexmedetomidine, n=75) and **Group M** (Midazolam, n=75). The mean age of the study population was 56.65 ± 8.4 years, with no statistically significant difference between the two groups (p=0.44). In terms of ASA physical status, 67.3% of patients were classified as ASA I and 32.7% as ASA II, with no significant difference between groups (p=1.0). This indicates that both groups were comparable in baseline demographic and clinical characteristics.



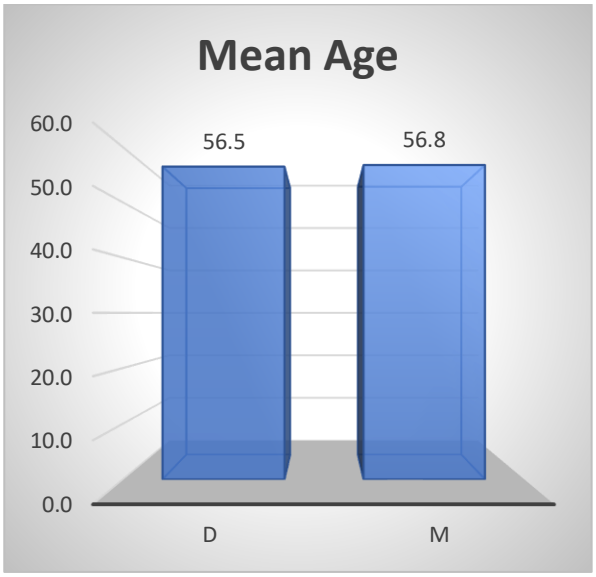


Figure 1. Demographic characteristics **Figure 2. Mean Age groups**

As shown in Figure 1&2, The distribution of participants between the Dexmed (D) and Midazolam (M) groups was equal (50% each)

Sedation Scores

Sedation was assessed using the Ramsay Sedation Score (RSS) at intervals of 0, 15, 30, 45, 60, 75, and 90 minutes. At baseline (0 min) and during the during the intraoperative period.

Table 1. Comparison of Ramsay Sedation Scores between Group D and Group M

Time (min)	Group D (Dexmed) Mean ± SD	Group M (Midazolam) Mean ± SD	p-value
0	2.00 ± 0.00	2.00 ± 0.00	NA
15	2.00 ± 0.00	2.00 ± 0.00	NA
30	2.00 ± 0.00	2.00 ± 0.00	NA
45	2.00 ± 0.00	2.00 ± 0.00	NA
60	2.20 ± 0.41	2.00 ± 0.00	<0.05
75	2.57 ± 0.31	2.01 ± 0.02	<0.05
90	3.11 ± 0.45	2.15 ± 0.15	<0.05

The comparison of sedation scores between Group D (Dexmedetomidine) and Group M (Midazolam) over time is presented in Table 1.

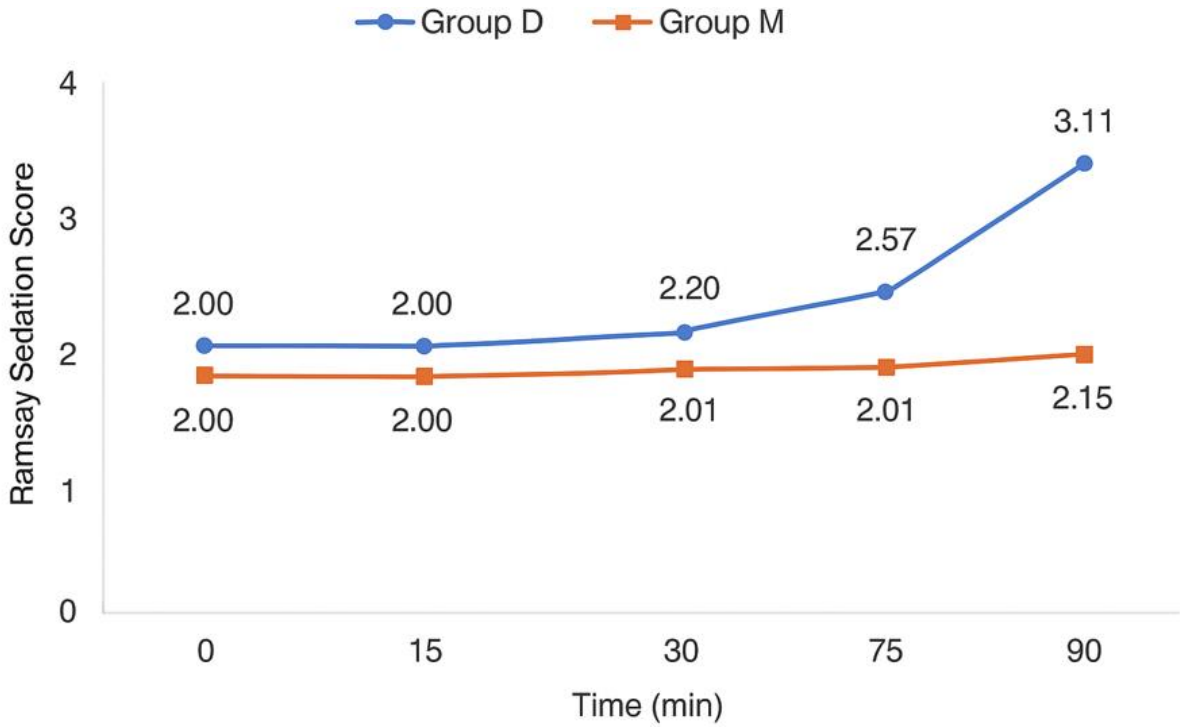


Figure 3. Intraoperative Ramsay Sedation Scores Over Time

The Ramsay Sedation Scores for both Group D and Group M are illustrated in Figure 1, showing their trends over time.

From 60 minutes onward, patients in Group D demonstrated significantly higher sedation scores compared to Group M. At 60 minutes, mean sedation score was 2.20 ± 0.41 in Group D compared with 2.00 ± 0.00 in Group M ($p < 0.05$). At 75 minutes, the mean RSS was 2.57 ± 0.31 in Group D versus 2.01 ± 0.02 in Group M ($p < 0.05$). By 90 minutes, Group D had a mean RSS of 3.11 ± 0.45, significantly higher than the mean of 2.15 ± 0.15 in Group M ($p < 0.05$). These findings indicate that sedation levels increased progressively in the dexmedetomidine group beyond 45 minutes, while remaining stable in the midazolam group.

Hemodynamic Parameters

Heart Rate (HR)

The intraoperative hemodynamic data for Heart Rate (HR) showed that both groups maintained comparable mean heart rates throughout the surgical procedure, including at baseline, with no statistically significant difference observed between them ($p>0.05$). The trend analysis, as depicted in Figure 2, confirmed this stability, indicating that mean HR remained consistent and within a normal range at all measured time points (0, 15, 30, 45, 60, 75, and 90 minutes). Crucially, the stability of the heart rate was clinically significant as no instances of clinically significant bradycardia (slow HR) or tachycardia (fast HR) were recorded in either group, suggesting adequate and stable cardiovascular management during the surgery.

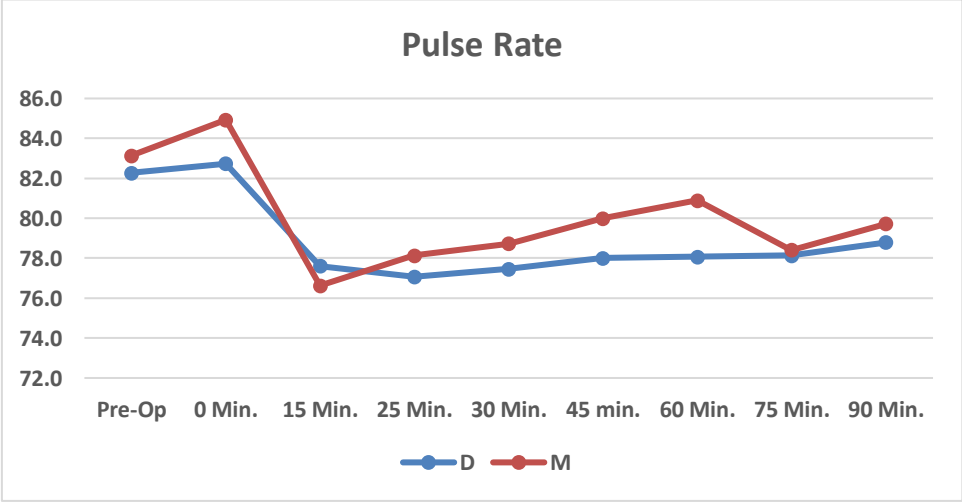


Figure 4. Intraoperative Heart Rate Trends

The intraoperative hemodynamic data for Heart Rate (HR) showed that both groups maintained comparable mean heart rates throughout the surgical procedure, including at baseline, with no statistically significant difference observed between them (p>0.05).

Systolic Blood Pressure (SAP)

Table 2. Mean Systolic Blood Pressure (mmHg) during Surgery

Time (min)	Group D Mean ± SD	Group M Mean ± SD	p-value
Pre-op	121.6 ± 5.8	120.7 ± 6.4	0.58
0	123.2 ± 4.9	121.6 ± 6.1	0.27
15	115.0 ± 3.9	117.6 ± 5.4	0.19
25	118.0 ± 4.4	120.9 ± 5.7	0.06
30	121.9 ± 5.5	121.3 ± 5.3	0.67
45	122.5 ± 5.3	120.7 ± 5.3	0.18
60	116.7 ± 4.5	118.8 ± 5.5	0.09
75	119.0 ± 4.4	121.1 ± 5.8	0.10
90	118.0 ± 4.3	120.1 ± 5.9	0.17

The intraoperative hemodynamic data for Heart Rate (HR) showed that both groups maintained comparable mean heart rates throughout the surgical procedure, including at baseline, with no statistically significant difference observed between them (p>0.05).

The data concerning Mean Systolic Blood Pressure (SBP) indicates that this hemodynamic parameter remained stable and comparable between both Group D and Group M throughout the entire surgical procedure. A comparison of the mean SBP values at baseline (Pre-op) and all subsequent time points (0, 15, 25, 30, 45, 60, 75, and 90 minutes) showed no statistically significant difference between the groups, as evidenced by p-values consistently greater than 0.05. The table provided shows that the mean SBP values were tightly maintained, suggesting effective and equivalent hemodynamic control in both patient groups for systolic pressure.

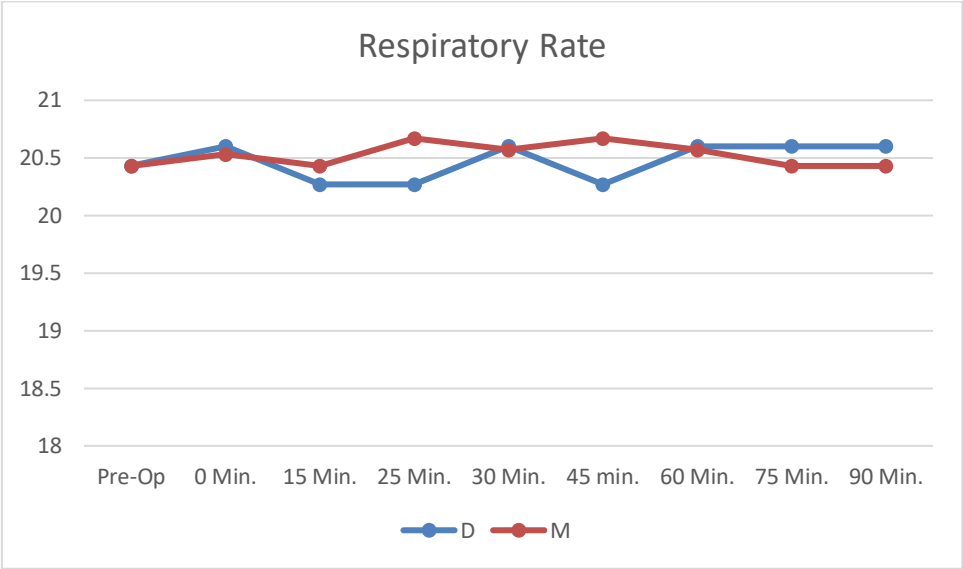
Diastolic Blood Pressure (DAP)

Table 3. Mean Diastolic Blood Pressure (mmHg) during Surgery

Time (min)	Group D Mean ± SD	Group M Mean ± SD	p-value
Pre-op	79.4 ± 3.9	79.7 ± 3.6	0.73
0	79.7 ± 3.9	79.9 ± 3.5	0.84
15	77.2 ± 3.6	79.6 ± 3.1	0.11
25	77.3 ± 3.1	79.6 ± 3.9	0.09
30	79.1 ± 4.0	79.7 ± 3.3	0.48
45	78.9 ± 3.4	79.8 ± 3.8	0.32
60	77.3 ± 3.5	79.5 ± 3.7	0.09
75	77.3 ± 3.1	79.5 ± 3.7	0.10
90	77.6 ± 3.0	78.5 ± 3.2	0.11

The intraoperative hemodynamic data for Heart Rate (HR) showed that both groups maintained comparable mean heart rates throughout the surgical procedure, including at baseline, with no statistically significant difference observed between them (p>0.05).

Based on the observation and Table 3 data, the Diastolic Blood Pressure (DAP) remained stable and well-maintained throughout the surgical procedure in both Group D and Group M. Analysis showed that the mean DAP values were statistically comparable between the two groups at all measured time points, including pre-operatively, as indicated by a p-value greater than 0.05 (p>0.05). Specifically, the mean DAP for both groups consistently stayed within a narrow range, typically between approximately 77.2 and 79.9 mmHg for Group D and 78.5 and 79.9 mmHg for Group M. This stability suggests that the anesthetic and surgical management strategies effectively maintained diastolic pressure within clinically acceptable limits without any significant inter-group differences.



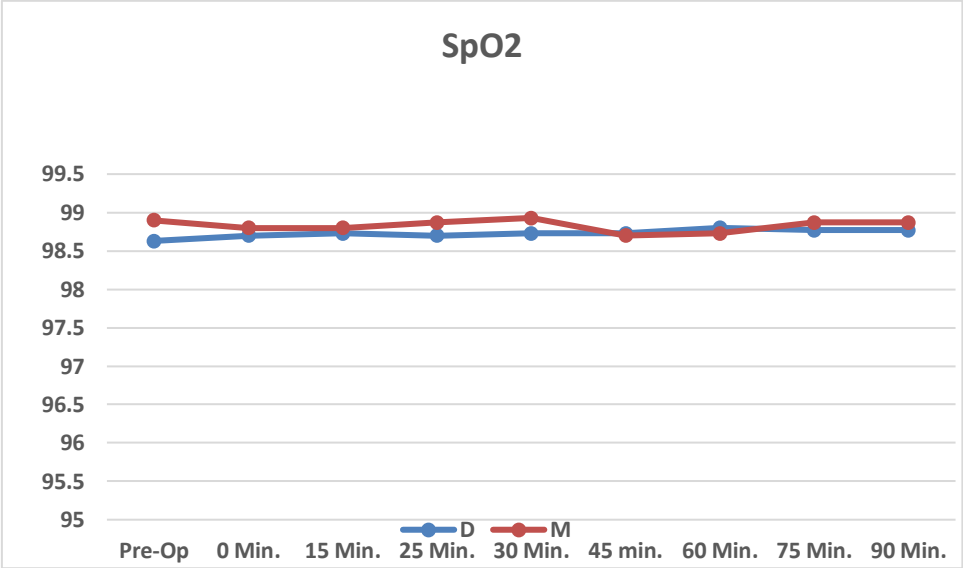


Figure 5. Respiratory Rate (RR) and Oxygen Saturation (SpO_2)

A detailed comparison of the mean respiratory rate and peripheral oxygen saturation (SpO2) between Group D and Group M is visually represented over time in Figure 5

The assessment of Respiratory Rate (RR) and Oxygen Saturation (SpO2) revealed excellent stability and comparability between both groups throughout the surgical procedure. The mean values for both parameters were statistically similar at all measured time intervals ($p>0.05$), indicating no significant difference in respiratory function attributable to either group's treatment. This stability is visually supported by Figure 3, which plots the mean RR and SpO2 trends for both groups D and M, showing consistent values. Furthermore, the clinical outcomes were optimal, as there were no observed episodes of respiratory depression, oxygen desaturation, or the need for supplemental oxygen adjustments in either group, confirming stable and effective respiratory management.

Discussion

Interpretation of Sedation and Hemodynamic Findings

The study demonstrated a clear advantage for dexmedetomidine over midazolam in achieving deeper and more sustained sedation during spinal anesthesia for abdominal hysterectomy. While initial sedation scores were comparable between Group D (dexmedetomidine) and Group M (midazolam), a statistically significant difference emerged after the 45-minute mark, with the dexmedetomidine group maintaining a higher mean sedation score until 90 minutes. This suggests that dexmedetomidine provides more reliable and prolonged anxiolysis and sedation, which is highly desirable for patient comfort during surgery under regional anesthesia. Regarding hemodynamic parameters,

both groups exhibited excellent stability. Heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), respiratory rate (RR), and oxygen saturation (SpO2) remained comparable throughout the procedure ($p>0.05$). Critically, neither group experienced clinically significant episodes of bradycardia, tachycardia, hypotension, or respiratory depression, indicating that both adjuvants are safe and well-tolerated in terms of cardiovascular and respiratory stability.

Comparison with Previous Literature

Our findings regarding sedation are strongly consistent with existing literature. The observation that dexmedetomidine provided superior maximum sedation scores compared to midazolam aligns with the study by Kaya FN et al..(12) Furthermore, similar to the findings of Patel VH et al. (13)and Anandam A et al. (14), our results support that dexmedetomidine offers a faster onset and a higher quality of sedation than midazolam. Concerning hemodynamics, our conclusion that both groups maintained stability is also corroborated by prior research. Specifically, the findings mirror those of Liang Y et al. (11), who observed no significant differences in heart rate, mean arterial pressure (MAP), or RR between the dexmedetomidine and midazolam groups. Al-Arnous M et al. (15) also reported comparable hemodynamic stability, reinforcing the idea that neither drug compromises intraoperative cardiovascular control when used as a sedative adjuvant to spinal anesthesia.

Clinical Significance for Anesthetic Choice during Hysterectomy

The results provide compelling evidence supporting the choice of intravenous dexmedetomidine as a preferred sedative adjuvant for patients undergoing abdominal hysterectomy under spinal anesthesia. The significantly longer duration of sensory and motor block, combined with a greater duration of postoperative analgesia and reduced total analgesic consumption (358.9 vs 269.8 minutes; $p<0.05$), strongly favors dexmedetomidine's use. The high quality and prolonged nature of sedation, particularly after 45 minutes, ensures patient comfort throughout potentially lengthy procedures. Given that both drugs demonstrated equivalent and excellent hemodynamic stability, the decisive factors shift to the superior block characteristics, enhanced sedation profile, and improved postoperative pain management offered by dexmedetomidine. This profile makes it an ideal choice for enhancing the effectiveness and patient experience of regional anesthesia for major gynecological surgeries.

Study Limitations and Future Research Suggestions

Despite the clear benefits demonstrated, this study has certain limitations. First, while the sedation scale (presumably Ramsay Sedation Score, as referenced in the literature) provided objective data, the degree of patient anxiety and overall satisfaction could have been further assessed using a visual analog scale (VAS) for anxiety. Second, although the study was powered to detect differences in block characteristics and sedation, the use of a single, fixed dose for both dexmedetomidine and midazolam may not capture the full dose-response profile of each drug. Future research should explore the effects of varying doses of intravenous dexmedetomidine to determine the minimal effective dose required to achieve maximum sedation without increasing the risk of adverse hemodynamic effects, such as hypotension or profound bradycardia. Furthermore, studies focusing on long-term postoperative outcomes, such as time to ambulation and incidence of chronic pain, would provide a more complete picture of dexmedetomidine's overall benefit in this surgical population.

Conclusion

Intravenous dexmedetomidine provided superior, prolonged sedation compared to midazolam during abdominal hysterectomy under spinal anesthesia. Critically, both adjuvants maintained excellent, comparable hemodynamic stability (HR, BP, RR, SpO2, $p>0.05$). Dexmedetomidine also significantly enhanced spinal block quality, prolonging sensory block and postoperative analgesia ($p<0.05$). Based on these superior clinical efficacy benefits combined with hemodynamic safety, dexmedetomidine is recommended as the preferred sedative adjuvant. This choice optimizes patient comfort and extends pain relief following this surgical procedure.

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