

## ORIGINAL ARTICLE

## Dexmedetomidine versus midazolam for sedation during cataract surgery under regional anesthesia: comparison of cooperation and recovery time

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### ABSTRACT:

**Background:** Cataract surgery under regional anesthesia is commonly performed as a day-care procedure, where optimal sedation should provide anxiolysis and comfort while maintaining patient cooperation and allowing rapid recovery. Midazolam is widely used for monitored anesthesia care; however, variable sedation depth and delayed recovery may occur. Dexmedetomidine, an  $\alpha_2$ -adrenergic agonist, produces cooperative sedation with minimal respiratory depression and may offer advantages in ophthalmic surgery. **Aim:** To compare dexmedetomidine versus midazolam for sedation during cataract surgery under regional anesthesia with respect to intraoperative cooperation and recovery time. **Materials and Methods:** A prospective comparative study was conducted on 68 adult patients (ASA I-II) scheduled for cataract surgery under peribulbar block. Patients were randomly allocated into two equal groups (n=34 each). Group D received intravenous dexmedetomidine (loading dose 1  $\mu\text{g}/\text{kg}$  over 10 minutes followed by maintenance infusion 0.2–0.7  $\mu\text{g}/\text{kg}/\text{h}$  titrated to target sedation), and Group M received intravenous midazolam (0.05 mg/kg bolus with incremental doses if required). Sedation depth was assessed using the Ramsay Sedation Scale. Patient cooperation was graded by the operating surgeon and the requirement for rescue sedation was recorded. Recovery was assessed using time to eye opening, time to verbal response, and time to achieve Modified Aldrete score  $\geq 9$ . Hemodynamic and respiratory adverse events were documented. **Results:** Baseline demographics and ASA distribution were comparable between groups ( $p > 0.05$ ). Group D achieved more consistent intraoperative sedation, with fewer patients remaining lightly sedated (Ramsay score 2: 5.88% vs 20.59%;  $p = 0.03$ ). Cooperation was significantly better with dexmedetomidine (excellent cooperation: 76.47% vs 50.00%; poor cooperation: 2.94% vs 14.70%;  $p = 0.01$ ), and rescue sedation was required less frequently (5.88% vs 23.53%;  $p = 0.04$ ). Recovery was significantly faster in Group D, including time to eye opening (5.21 $\pm$ 1.34 vs 8.64 $\pm$ 2.12 min), time to verbal response (6.03 $\pm$ 1.56 vs 9.47 $\pm$ 2.31 min), and time to Modified Aldrete  $\geq 9$  (9.12 $\pm$ 2.04 vs 13.89 $\pm$ 2.87 min), all  $p < 0.001$ . Respiratory depression occurred only in Group M (0.00% vs 11.76%;  $p = 0.04$ ), while bradycardia was higher in Group D but not statistically significant (11.76% vs 2.94%;  $p = 0.17$ ). **Conclusion:** Dexmedetomidine provided superior intraoperative cooperation, more stable sedation, and faster recovery compared with midazolam for cataract surgery under regional anesthesia, with fewer respiratory adverse events.

**Keywords:** Cataract surgery; Dexmedetomidine; Midazolam; Regional anesthesia; Recovery time

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### INTRODUCTION

Cataract remains the leading cause of reversible blindness worldwide, and phacoemulsification with intraocular lens implantation is among the most frequently performed elective procedures in modern surgical practice. Because the typical cataract patient is elderly and often has systemic comorbidities, anesthesia techniques for cataract surgery have progressively shifted toward approaches that minimize physiological disturbance while preserving patient comfort and surgical conditions. Local and regional techniques (topical anesthesia, sub-Tenon's block, peribulbar block, or combinations) allow avoidance of general anesthesia, reduce airway manipulation, and support early ambulation and discharge. However, even when adequate ocular analgesia is achieved, anxiety, fear of visual

sensations, inability to tolerate drapes, and intolerance to the operating microscope light can compromise cooperation, cause sudden movement, and potentially increase intraoperative risk.<sup>1</sup>The choice between topical anesthesia and regional blocks is influenced by surgeon preference, patient factors, and institutional protocols. Evidence comparing topical versus regional approaches suggests that topical techniques can offer similar surgical outcomes but may be associated with greater pain perception, more inadvertent ocular movement, and a higher requirement for supplemental anesthesia in some settings.<sup>1</sup> This underscores a key practical issue: regardless of the ocular block technique, many patients benefit from monitored anesthesia care and carefully titrated sedation to reduce anxiety and prevent movement while maintaining responsiveness. The ideal sedative should

provide anxiolysis and comfort without over-sedation, should preserve spontaneous ventilation and airway reflexes, and should permit rapid and predictable recovery so that discharge is not delayed. Midazolam, a short-acting benzodiazepine, has been widely used for cataract surgery sedation because of its anxiolytic, amnestic, and sedative properties, rapid onset, and ease of administration. At low doses, it can reduce the distress associated with microscope light and intraoperative visual phenomena, improving the overall patient experience.<sup>2</sup> Dexmedetomidine is a highly selective  $\alpha_2$ -adrenergic agonist that produces sedation resembling natural sleep, provides sympatholysis, and has analgesic-sparing effects, with minimal respiratory depression at clinically used doses. These characteristics have made dexmedetomidine attractive for procedural sedation and monitored anesthesia care where patient arousability and stable ventilation are priorities. In addition, the sedative state produced by dexmedetomidine tends to preserve patient cooperation—patients are often calm, easily rousable, and able to follow commands—an especially valuable feature during microscopic ophthalmic surgery where sudden head or body movement can affect precision steps. At the same time, the sympatholytic profile can lead to bradycardia and hypotension, which must be anticipated in elderly patients, making dosing strategy and monitoring central to safe use.<sup>3</sup> Beyond its systemic sedative effects, dexmedetomidine has also been investigated as an adjuvant in ophthalmic regional anesthesia. When added to local anesthetic mixtures for peribulbar block, dexmedetomidine has been reported to shorten onset and prolong duration of corneal anesthesia and akinesia, while also providing a useful degree of sedation that may facilitate cooperation and operative conditions.<sup>4</sup> Similarly, in sub-Tenon's block for phacoemulsification, dexmedetomidine has been studied as an additive with the intent of improving block characteristics and perioperative comfort, reflecting a broader interest in  $\alpha_2$ -agonists to enhance both analgesia and the perioperative experience in cataract surgery.<sup>5</sup> In topical anesthesia settings, dexmedetomidine has been evaluated as a premedication and as part of monitored anesthesia care, with attention to patient satisfaction and surgeon-rated operating conditions. In a randomized study of cataract surgery under topical anesthesia, dexmedetomidine premedication was associated with improved patient and surgeon satisfaction without major adverse events in the studied cohort, supporting feasibility in ambulatory cataract practice.<sup>6</sup> Importantly, topical anesthesia often requires a higher degree of voluntary stillness compared with regional blocks that provide more reliable akinesia; therefore, sedative choice may have an even greater influence on cooperation and operative flow when topical approaches are used. The concept remains relevant to regional anesthesia as well, because even with a peribulbar block, anxiety

and discomfort can still lead to restlessness and movement, and sedative-induced over-relaxation can compromise the ability to follow instructions.

## MATERIALS AND METHODS

This comparative, prospective clinical study was conducted at a tertiary care hospital to evaluate and compare dexmedetomidine and midazolam for intraoperative sedation in patients undergoing elective cataract surgery under regional anesthesia. The primary outcomes assessed were patient cooperation during surgery and recovery characteristics following sedation. A total of 68 adult patients of either sex, scheduled for elective cataract surgery under regional anesthesia, were enrolled in the study. Patients were classified as American Society of Anesthesiologists (ASA) physical status I or II. Exclusion criteria included known hypersensitivity to study drugs, significant cardiovascular or respiratory disease, hepatic or renal impairment, psychiatric illness, chronic use of sedatives or opioids, communication difficulties, and refusal to participate.

### Methodology

Patients were randomly allocated into two equal groups of 34 patients each using a computer-generated randomization method. Group D received dexmedetomidine for sedation, while Group M received midazolam. Allocation concealment was ensured using sealed opaque envelopes opened just before drug administration.

All patients were kept nil per oral as per institutional protocol and received standard monitoring upon arrival in the operating room, including heart rate, non-invasive blood pressure, respiratory rate, oxygen saturation, and electrocardiography. Regional anesthesia was administered in the form of peribulbar block using a standard mixture of local anesthetic drugs. Supplemental oxygen was provided via nasal cannula at 2–3 L/min throughout the procedure.

In Group D, patients received dexmedetomidine as an intravenous loading dose of 1  $\mu\text{g}/\text{kg}$  administered over 10 minutes, followed by a maintenance infusion of 0.2–0.7  $\mu\text{g}/\text{kg}/\text{hour}$  titrated to the desired level of sedation. In Group M, patients received midazolam as an intravenous bolus dose of 0.05 mg/kg, with additional incremental doses if required. Sedation depth was targeted to achieve a calm, cooperative patient responsive to verbal commands.

Sedation level was assessed using the Ramsay Sedation Scale. Patient cooperation during surgery was evaluated by the operating surgeon using a predefined cooperation score, taking into account patient movement, response to instructions, and overall surgical conditions. The need for additional sedative doses and any interruption of surgery due to patient non-cooperation were also recorded.

Heart rate, systolic and diastolic blood pressure, respiratory rate, and oxygen saturation were recorded at baseline, after sedation, intraoperatively at regular

intervals, and at the end of surgery. Any episodes of hypotension, bradycardia, respiratory depression, or desaturation were noted and managed according to standard protocols.

Recovery characteristics were assessed at the end of surgery using the Modified Aldrete Score. Recovery time was defined as the time taken to achieve a score  $\geq 9$ . Time to eye opening, response to verbal commands, and orientation were also recorded. Postoperative sedation level and adverse effects such as nausea, vomiting, dizziness, or excessive sedation were documented.

### Statistical Analysis

Data were entered and analyzed using appropriate statistical software. Quantitative variables were expressed as mean and standard deviation, while qualitative variables were expressed as frequencies and percentages. Intergroup comparisons were performed using the independent t-test for continuous variables and the chi-square test or Fisher's exact test for categorical variables. A p-value  $< 0.05$  was considered statistically significant.

## RESULTS

### Demographic Characteristics and Baseline Data

As shown in Table 1, the demographic characteristics of patients in both groups were comparable. The mean age in the dexmedetomidine group was  $63.42 \pm 6.18$  years, while in the midazolam group it was  $62.97 \pm 5.84$  years, with no statistically significant difference between the groups ( $p = 0.74$ ). Gender distribution was also similar, with males constituting 52.94% in Group D and 50.00% in Group M ( $p = 0.81$ ). The distribution of ASA physical status was comparable, with ASA I patients accounting for 58.82% in Group D and 55.88% in Group M, and ASA II patients accounting for 41.18% and 44.12% respectively ( $p = 0.81$ ).

### Intraoperative Sedation Level

Table 2 demonstrates the intraoperative sedation levels assessed using the Ramsay Sedation Scale. In Group D, the majority of patients achieved a Ramsay Sedation Score of 3 (58.82%), followed by score 4 in 35.30% of patients. In contrast, Group M showed a higher proportion of patients with a sedation score of 2 (20.59%) compared to Group D (5.88%). A significantly higher proportion of patients in the

dexmedetomidine group attained deeper and more consistent sedation scores (scores 3 and 4) compared to the midazolam group, and this difference was found to be statistically significant ( $p = 0.03$ ).

### Patient Cooperation During Surgery

Patient cooperation during surgery, as presented in Table 3, was significantly better in the dexmedetomidine group. Excellent cooperation was observed in 76.47% of patients in Group D, compared to 50.00% in Group M. Poor cooperation was noted in only 2.94% of patients receiving dexmedetomidine, whereas 14.70% of patients in the midazolam group demonstrated poor cooperation. The difference in cooperation grades between the two groups was statistically significant ( $p = 0.01$ ). Additionally, the requirement for supplemental or rescue sedation was significantly higher in Group M (23.53%) compared to Group D (5.88%), with a p value of 0.04.

### Recovery Characteristics

Recovery profiles of the two groups are summarized in Table 4. Patients in the dexmedetomidine group demonstrated significantly faster recovery across all measured parameters. The mean time to eye opening was  $5.21 \pm 1.34$  minutes in Group D, compared to  $8.64 \pm 2.12$  minutes in Group M ( $p < 0.001$ ). Similarly, the time to verbal response was significantly shorter in Group D ( $6.03 \pm 1.56$  minutes) than in Group M ( $9.47 \pm 2.31$  minutes) ( $p < 0.001$ ). The recovery time to achieve a Modified Aldrete Score of  $\geq 9$  was also significantly lower in the dexmedetomidine group ( $9.12 \pm 2.04$  minutes) compared to the midazolam group ( $13.89 \pm 2.87$  minutes), with a highly significant p value ( $< 0.001$ ).

### Adverse Effects and Hemodynamic Events

The incidence of adverse effects and hemodynamic events is detailed in Table 5. Bradycardia was observed more frequently in the dexmedetomidine group (11.76%) compared to the midazolam group (2.94%), although this difference was not statistically significant ( $p = 0.17$ ). Hypotension occurred in 8.82% of patients in Group D and 5.88% in Group M, with no significant difference between the groups ( $p = 0.64$ ). Respiratory depression was observed exclusively in the midazolam group in 11.76% of patients, and this difference was statistically significant ( $p = 0.04$ ).

**Table 1: Demographic Characteristics and Baseline Data**

Parameter	Group D (Dexmedetomidine) n=34	Group M (Midazolam) n=34	p value
Age (years, mean $\pm$ SD)	$63.42 \pm 6.18$	$62.97 \pm 5.84$	0.74
Gender (Male/Female)	18 (52.94%) / 16 (47.06%)	17 (50.00%) / 17 (50.00%)	0.81
ASA I	20 (58.82%)	19 (55.88%)	0.81
ASA II	14 (41.18%)	15 (44.12%)	0.81

**Table 2: Intraoperative Sedation Level (Ramsay Sedation Scale)**

Ramsay Sedation Score	Group D n (%)	Group M n (%)	p value
Score 2	2 (5.88%)	7 (20.59%)	
Score 3	20 (58.82%)	18 (52.94%)	
Score 4	12 (35.30%)	9 (26.47%)	0.03*

**Table 3: Patient Cooperation During Surgery**

Cooperation Grade	Group D n (%)	Group M n (%)	p value
Excellent	26 (76.47%)	17 (50.00%)	
Good	7 (20.59%)	12 (35.30%)	
Poor	1 (2.94%)	5 (14.70%)	0.01*
Need for additional sedation	2 (5.88%)	8 (23.53%)	0.04*

**Table 4: Recovery Characteristics**

Recovery Parameter	Group D (mean ± SD)	Group M (mean ± SD)	p value
Time to eye opening (min)	5.21 ± 1.34	8.64 ± 2.12	<0.001*
Time to verbal response (min)	6.03 ± 1.56	9.47 ± 2.31	<0.001*
Recovery time to Aldrete ≥9 (min)	9.12 ± 2.04	13.89 ± 2.87	<0.001*

**Table 5: Adverse Effects and Hemodynamic Events**

Adverse Event	Group D n (%)	Group M n (%)	p value
Bradycardia	4 (11.76%)	1 (2.94%)	0.17
Hypotension	3 (8.82%)	2 (5.88%)	0.64
Respiratory depression	0 (0.00%)	4 (11.76%)	0.04*
Nausea/Vomiting	1 (2.94%)	3 (8.82%)	0.30
Excessive sedation	1 (2.94%)	5 (14.70%)	0.09

## DISCUSSION

The present study enrolled comparable patients in both arms (mean age  $63.42 \pm 6.18$  vs  $62.97 \pm 5.84$  years; ASA I: 58.82% vs 55.88%;  $p > 0.05$  for all), which minimizes baseline confounding when interpreting sedation and recovery outcomes. A similar ASA I–II cataract population and balanced baseline characteristics were also reported by Abdelhamid et al (2016), supporting that group comparability is typical and achievable in ophthalmic sedation trials under peribulbar anesthesia.<sup>7</sup>

With respect to intraoperative sedation, dexmedetomidine produced a more consistent “ideal” Ramsay range in our cohort: 94.12% of Group D achieved Ramsay 3–4 (58.82% at score 3 and 35.30% at score 4) compared with 79.41% in Group M (52.94% at score 3 and 26.47% at score 4), and fewer patients in Group D remained lightly sedated at score 2 (5.88% vs 20.59%), yielding a significant intergroup difference ( $p = 0.03$ ). In retinal surgery under regional anesthesia, Yoo et al (2015) similarly demonstrated that dexmedetomidine reliably achieved the intended Ramsay target (3–4 in 59.1%), although a substantial proportion became over-sedated (Ramsay 5–6 in 40.9%), highlighting that careful titration is essential to avoid deeper-than-needed sedation; in contrast, our dexmedetomidine regimen maintained most patients within Ramsay 3–4 without a reported Ramsay 5–6 category in the outcomes table.<sup>8</sup>

Patient cooperation—a key practical endpoint in cataract surgery—was markedly better with dexmedetomidine in this study: “excellent”

cooperation occurred in 76.47% vs 50.00% with midazolam, while “poor” cooperation was uncommon in Group D (2.94%) but higher in Group M (14.70%), with an overall significant difference ( $p = 0.01$ ). This translated into a lower need for rescue sedation with dexmedetomidine (5.88% vs 23.53%;  $p = 0.04$ ). Ayogluet al (2007) also observed that only a small minority required additional dosing after a dexmedetomidine loading regimen (2 patients needed extra doses), which parallels our finding of infrequent rescue sedation in the dexmedetomidine arm and supports its ability to maintain cooperative, procedure-appropriate sedation.<sup>9</sup>

Recovery outcomes in our cohort favored dexmedetomidine, with significantly faster emergence and discharge readiness measures: time to eye opening ( $5.21 \pm 1.34$  vs  $8.64 \pm 2.12$  min), time to verbal response ( $6.03 \pm 1.56$  vs  $9.47 \pm 2.31$  min), and time to Modified Aldrete  $\geq 9$  ( $9.12 \pm 2.04$  vs  $13.89 \pm 2.87$  min), all  $p < 0.001$ . These results differ from Alhashemiet al (2006), who reported delayed readiness for discharge with dexmedetomidine compared with midazolam (median 45 [36–54] vs 21 [10–32] min) despite comparable surgeon satisfaction; the divergence is plausibly explained by differences in technique and dosing (notably the use of a continuing dexmedetomidine infusion in their protocol), whereas our approach emphasized titration to a cooperative state without prolonging sedation beyond surgical need.<sup>10</sup>

Beyond cooperation, the overall “comfort-quality” signal in our dataset (higher excellent cooperation and

less rescue sedation with dexmedetomidine) is directionally consistent with patient-centered outcomes reported in cataract surgery under topical anesthesia. Erdurmuset al (2008) showed dexmedetomidine improved perioperative experience, with lower pain perception scores ( $1.23 \pm 0.72$  vs  $3.64 \pm 1.43$ ) and better surgeon satisfaction than control, indicating that  $\alpha_2$ -agonist sedation can enhance operative conditions while maintaining responsiveness; in our study, this likely manifested as reduced disruptive movement and fewer interruptions for supplemental sedation compared with midazolam.<sup>11</sup>

Hemodynamic trends in our results showed a higher (but statistically non-significant) bradycardia incidence with dexmedetomidine (11.76% vs 2.94%;  $p = 0.17$ ), while hypotension was comparable (8.82% vs 5.88%;  $p = 0.64$ ). This aligns with the known sympatholytic profile of dexmedetomidine and with cataract-block literature where clinically relevant bradycardia may occur but is usually manageable. In Abdelhamid et al (2016), only 2 patients in the IV dexmedetomidine group developed bradycardia, reinforcing that while bradycardia is an expected adverse effect, its frequency is generally low and responsive to standard measures when monitoring is appropriate—similar to the pattern observed in our cohort.<sup>12</sup>

Respiratory safety clearly differentiated the two drugs in our population: respiratory depression occurred only with midazolam (11.76% vs 0.00%;  $p = 0.04$ ). This is clinically important in elderly cataract patients who may be vulnerable to hypoventilation under sedatives, especially when sedation deepens unpredictably. Celiker et al (2007) reported that regimens incorporating midazolam with propofol and fentanyl were associated with reductions in respiratory rate and oxygen saturation after sedation (even though they considered the combination acceptable under monitoring), supporting the broader observation that GABAergic/opioid-based sedation can measurably depress respiration—consistent with our midazolam-group respiratory events.<sup>13</sup>

Finally, our observation that midazolam required more supplemental dosing (23.53%) and produced more “poor” cooperation (14.70%) suggests variability in achieving a stable, cooperative sedation window, even when starting with a standard bolus technique. In the large randomized cataract study by Cok et al (2008), adding fentanyl to midazolam caused a greater decline in alertness/sedation scores without improving procedural parameters, and the authors concluded midazolam alone was generally satisfactory while opioid addition did not meaningfully enhance outcomes; taken together with our findings, this supports favoring sedative strategies that preserve spontaneous ventilation and cooperation with fewer rescue interventions—features more consistently seen with dexmedetomidine in our dataset.<sup>14</sup>

## CONCLUSION

Dexmedetomidine provided more consistent intraoperative sedation and significantly better patient cooperation compared with midazolam during cataract surgery under regional anesthesia. Recovery was faster in the dexmedetomidine group across all assessed recovery parameters. Respiratory depression was observed only with midazolam, while hemodynamic events were comparable between groups and manageable with standard monitoring. Overall, dexmedetomidine appears to be a suitable sedative option for cataract surgery under regional anesthesia where cooperation and early recovery are priorities.

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