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A COMPARATIVE STUDY OF TWO DIFFERENT DOSES OF DEXMEDETOMIDINE AS AN ADJUVANT TO LOCAL ANESTHETIC IN PERIBULBAR BLOCK FOR CATARACT SURGERY

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ABSTRACT

Background: Peribulbar block is widely used for cataract surgery; however, its relatively slow onset and limited duration of postoperative analgesia remain important limitations. Dexmedetomidine has emerged as a promising adjuvant to local anesthetics, although the optimal perineural dose remains uncertain.

Aim: To compare the efficacy and safety of 25 µg versus 50 µg dexmedetomidine as an adjuvant to local anesthetics in peribulbar block for cataract surgery.

Materials and Methods: This prospective, randomized, double-blind comparative study included 100 patients (ASA I–III) undergoing elective phacoemulsification cataract surgery. Patients were allocated into two equal groups. Group D25 received 25 µg dexmedetomidine, whereas Group D50 received 50 µg dexmedetomidine combined with lidocaine, bupivacaine, and hyaluronidase for peribulbar block. The primary outcome was onset of globe akinesia. Secondary outcomes included onset and duration of sensory and motor block, duration of postoperative analgesia, supplemental block requirement, Ramsay Sedation Score, intraoperative Visual Analog Scale (VAS) pain score, surgeon and patient satisfaction, hemodynamic parameters, and adverse events.

Results: Baseline characteristics were comparable between groups. Group D50 demonstrated significantly faster onset of globe akinesia (5.8±1.2 vs. 7.2±1.4 min; $p<0.001$) and sensory block (3.1±0.8 vs. 3.8±0.9 min; $p<0.001$), along with longer sensory block (336.8±38.6 vs. 282.6±32.8 min), motor block (296.9±35.2 vs. 241.7±28.4 min), and postoperative analgesia (389.6±46.3 vs. 322.8±39.4 min) (all $p<0.001$). It also required fewer supplemental blocks (2% vs. 12%; $p=0.049$), produced lower intraoperative pain scores, higher sedation, and superior surgeon and patient satisfaction (all $p<0.001$). Hemodynamic parameters remained stable in both groups, with only a modest reduction in heart rate in Group D50. Adverse events were infrequent and comparable between groups.

Conclusion: Perineural dexmedetomidine 50 µg provides superior block quality, faster onset, prolonged postoperative analgesia, reduced supplemental anesthetic requirement, and greater patient and surgeon satisfaction compared with 25 µg, while maintaining acceptable hemodynamic stability and a favorable safety profile.

Keywords: Cataract Surgery, Peribulbar Block, Dexmedetomidine, Regional Anesthesia, Globe Akinesia, Postoperative Analgesia, Ophthalmic Anesthesia.

INTRODUCTION

Cataract remains the leading cause of reversible blindness worldwide and is responsible for nearly half of all cases of visual impairment, particularly among the elderly population.

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Advances in phacoemulsification techniques and foldable intraocular lenses have transformed cataract surgery into a safe, effective, and predominantly ambulatory procedure. Since most patients undergoing cataract surgery are elderly and often have multiple comorbidities, regional ophthalmic anesthesia is preferred over general anesthesia because it provides excellent operating conditions while minimizing systemic complications and facilitating rapid postoperative recovery [1].

Among regional anesthetic techniques, the peribulbar block is one of the most widely used methods for cataract surgery. Compared with retrobulbar anesthesia, the peribulbar approach offers a lower risk of serious complications such as optic nerve injury, globe perforation, retrobulbar hemorrhage, and inadvertent brainstem anesthesia. However, its relatively slower onset, occasional incomplete akinesia, requirement for larger volumes of local anesthetics, and limited duration of postoperative analgesia remain important limitations. Consequently, several pharmacological adjuvants have been investigated to enhance block characteristics while maintaining patient safety [2].

Dexmedetomidine, a highly selective α₂-adrenergic receptor agonist, has gained considerable interest as an adjuvant to regional anesthesia because of its sedative, analgesic, anxiolytic, and sympatholytic properties with minimal respiratory depression. Perineural administration of dexmedetomidine enhances local anesthetic action through inhibition of norepinephrine release, hyperpolarization of nerve fibers, and modulation of nociceptive transmission. In ophthalmic anesthesia, dexmedetomidine has also been shown to reduce intraocular pressure, improve patient cooperation, and provide favorable surgical conditions, making it an attractive adjunct for peribulbar block [3].

Several randomized controlled trials have demonstrated that adding dexmedetomidine to local anesthetics in peribulbar block shortens the onset of sensory and motor blockade, prolongs akinesia and postoperative analgesia, decreases the need for supplemental anesthetic injections, and improves both surgeon and patient satisfaction. A recent meta-analysis including 16 randomized controlled trials involving over 1,200 patients confirmed significant improvements in block duration, postoperative analgesia, intraocular pressure, and overall surgical conditions with dexmedetomidine compared with local anesthetic alone. However, the optimal perineural dose remains uncertain because higher doses may increase the incidence of bradycardia, hypotension, and excessive sedation without providing proportional clinical benefits [4, 5].

Although different doses of dexmedetomidine have been evaluated in previous studies, direct comparisons between lower and higher perineural doses are limited, and no consensus has been established regarding the dose that provides the best balance between efficacy and safety. Determining the optimal dose is particularly important in elderly cataract patients, who are more susceptible to cardiovascular adverse effects and excessive sedation.

Therefore, the present study was undertaken to compare two different doses of dexmedetomidine as an adjuvant to local anesthetics in peribulbar block for cataract surgery. The study aims to evaluate their effects on onset and duration of sensory and motor blockade, quality of akinesia, intraoperative sedation, hemodynamic stability, postoperative analgesia, surgeon and patient satisfaction, and adverse events, thereby identifying the dose that provides the most favorable efficacy–safety profile.

MATERIALS AND METHODS

Study Design and Setting: This prospective, randomized, double-blind, comparative study was conducted in the Department of Anaesthesiology in collaboration with the Department of Ophthalmology at a tertiary care teaching hospital over a period of 12 months. Patients scheduled for elective cataract surgery under peribulbar block were screened for eligibility.

Inclusion Criteria

- Patients aged 40–80 years, either sex.
- American Society of Anesthesiologists (ASA) physical status I–III.
- Scheduled for elective phacoemulsification cataract surgery with intraocular lens implantation under peribulbar anesthesia.
- Willingness to participate with written informed consent.

Exclusion Criteria

- Allergy or contraindication to lidocaine, bupivacaine, or dexmedetomidine
- Coagulopathy or anticoagulant therapy contraindicating regional block
- Infection at the injection site
- Glaucoma or severe ocular pathology requiring an alternative anesthetic technique
- Refusal to participate.

Randomization and Blinding: 100 Participants were randomly allocated into two equal groups.

Group D25 (n = 50): Received peribulbar block consisting of 5 mL of 2% lidocaine, 5 mL of 0.5% bupivacaine, hyaluronidase 150 IU, and dexmedetomidine 25 µg, with the total volume adjusted to 10.5 mL using normal saline

Group D50 (n = 50): Received peribulbar block consisting of 5 mL of 2% lidocaine, 5 mL of 0.5% bupivacaine, hyaluronidase 150 IU, and dexmedetomidine 50 µg, with the total volume adjusted to 10.5 mL using normal saline

Outcome Measures: The primary outcome was the onset time of globe akinesia. Secondary outcomes included the onset and duration of sensory block, duration of motor block (akinesia), requirement for supplemental block, Ramsay Sedation Score, intraoperative pain assessed using the Visual Analog Scale (VAS), surgeon and patient satisfaction scores (5-point Likert scale), hemodynamic parameters (heart rate, systolic and diastolic blood pressure,

mean arterial pressure, and oxygen saturation), and the incidence of adverse events such as bradycardia, hypotension, hypoxia, nausea, vomiting, excessive sedation, and orbital complications.

Assessment of Sensory Block: Corneal sensation was assessed every 30 seconds using a sterile cotton wick until complete loss of sensation.

Motor Block: Akinesia was evaluated by ocular movements in four directions (superior, inferior, medial, and lateral gaze). Each direction was graded: 0 = No movement, 1 = Partial movement & 2 = Normal movement

Hemodynamic Monitoring; Heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, respiratory rate, and SpO_2 were recorded

Postoperative Assessment: Pain was evaluated using the Visual Analog Scale (VAS) at 1, 2, 4, and 6 hours after surgery. The duration of analgesia was defined as the interval between completion of the block and the first request for rescue analgesia. Intravenous paracetamol (1 g) was administered when VAS ≥4.

Statistical Analysis: Data were analyzed using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) and compared using the independent Student's *t*-test or Mann–Whitney *U* test, depending on data distribution. Categorical variables were presented as frequencies and percentages and analyzed using the Chi-square test or Fisher's exact test. A two-tailed p-value <0.05 was considered statistically significant. \

RESULTS

The baseline demographic and clinical characteristics were comparable between the two groups. There were no significant differences in age, sex distribution, body mass index, or ASA physical status (all p>0.05), indicating successful randomization [Table: 1].

Table 1: Baseline Demographic and Clinical Characteristics

Variable	Group D25 (n=50)	Group D50 (n=50)	p-value
Age (years), Mean ± SD	64.2 ± 8.6	65.1 ± 7.9	0.61
Male, n (%)	28 (56.0)	30 (60.0)	0.68
Female, n (%)	22 (44.0)	20 (40.0)	
BMI (kg/m²), Mean ± SD	24.3 ± 3.1	24.7 ± 2.8	0.52
ASA I, n (%)	18 (36.0)	16 (32.0)	0.84
ASA II, n (%)	24 (48.0)	26 (52.0)	
ASA III, n (%)	8 (16.0)	8 (16.0)	

Patients receiving 50 µg dexmedetomidine (Group D50) demonstrated a significantly faster onset of globe akinesia and sensory block, along with significantly prolonged sensory block, motor block, and postoperative analgesia compared with 25 µg dexmedetomidine (Group D25) (all p<0.001) [Table: 2].

Table 2: Block Characteristics among both the study groups

Parameter	Group D25	Group D50	p-value
Onset of globe akinesia (min)	7.2 ± 1.4	5.8 ± 1.2	<0.001
Onset of sensory block (min)	3.8 ± 0.9	3.1 ± 0.8	<0.001
Duration of sensory block (min)	282.6 ± 32.8	336.8 ± 38.6	<0.001
Duration of motor block (min)	241.7 ± 28.4	296.9 ± 35.2	<0.001
Duration of analgesia (min)	322.8 ± 39.4	389.6 ± 46.3	<0.001

Group D50 required significantly fewer supplemental blocks and showed lower intraoperative pain scores, higher Ramsay sedation scores, and greater surgeon and patient satisfaction than Group D25 (p<0.05) [Table: 3].

Table 3: Comparison of Intraoperative Outcomes between the groups

Variable	Group D25	Group D50	p-value
Supplemental block required, n (%)	6 (12.0)	1 (2.0)	0.049
Ramsay Sedation Score	2.2 ± 0.5	2.8 ± 0.6	<0.001
VAS Pain Score	1.5 ± 0.8	0.9 ± 0.6	<0.001
Surgeon Satisfaction Score	4.3 ± 0.6	4.8 ± 0.4	<0.001
Patient Satisfaction Score	4.2 ± 0.7	4.7 ± 0.5	<0.001

Hemodynamic parameters remained stable in both groups throughout the study. Although heart rate was slightly lower in Group D50, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and oxygen saturation were comparable between the groups [Table: 4].

Table 4: Comparison of Hemodynamic Parameters between the groups

Parameter	Group D25	Group D50	p-value
Heart Rate (beats/min)	71.8 ± 8.2	68.4 ± 7.6	0.041
SBP (mmHg)	128.7 ± 10.4	125.6 ± 9.8	0.13
DBP (mmHg)	76.5 ± 7.1	74.8 ± 6.5	0.21
MAP (mmHg)	93.9 ± 7.6	91.7 ± 6.9	0.16
SpO_2 (%)	98.6 ± 0.8	98.5 ± 0.7	0.72

The incidence of adverse events was low in both groups. Mild bradycardia and hypotension occurred slightly more frequently in Group D50, but the differences were not statistically significant. No patient developed hypoxia or orbital complications [Table: 5].

Table 5: Comparison of Adverse Events between the groups

Adverse Event	Group D25 (n=50)	Group D50 (n=50)	p-value
Bradycardia	1 (2.0)	3 (6.0)	0.31
Hypotension	1 (2.0)	2 (4.0)	0.56
Excessive sedation	0 (0.0)	2 (4.0)	0.15
Nausea/Vomiting	2 (4.0)	1 (2.0)	0.56
Hypoxia	0 (0.0)	0 (0.0)	—
Orbital complications	0 (0.0)	0 (0.0)	—

Overall, 50 µg dexmedetomidine produced superior block characteristics, longer postoperative analgesia, reduced need for supplemental anesthesia, and higher surgeon and patient satisfaction compared with 25 µg, while maintaining an acceptable safety profile [Table: 6].

Table 6: Summary of Primary and Secondary Outcomes

Outcome	Group D25	Group D50	p-value
Faster globe akinesia	7.2 ± 1.4 min	5.8 ± 1.2 min	<0.001
Faster sensory block	3.8 ± 0.9 min	3.1 ± 0.8 min	<0.001
Longer sensory block	282.6 ± 32.8 min	336.8 ± 38.6 min	<0.001
Longer motor block	241.7 ± 28.4 min	296.9 ± 35.2 min	<0.001
Longer postoperative analgesia	322.8 ± 39.4 min	389.6 ± 46.3 min	<0.001
Better surgeon satisfaction	4.3 ± 0.6	4.8 ± 0.4	<0.001
Better patient satisfaction	4.2 ± 0.7	4.7 ± 0.5	<0.001

DISCUSSION

The present study demonstrated that increasing the perineural dose of dexmedetomidine from 25 µg to 50 µg significantly improved the quality of peribulbar block for cataract surgery. Patients receiving 50 µg exhibited a faster onset of globe akinesia and sensory blockade, prolonged sensory and motor block duration, extended postoperative analgesia, reduced need for supplemental anesthesia, and greater surgeon and patient satisfaction without a clinically significant increase in adverse events.

One of the principal findings was the significantly faster onset of globe akinesia and sensory block with 50 µg dexmedetomidine. These observations are consistent with those reported by Gupta et al., who demonstrated that dexmedetomidine accelerates the onset of ophthalmic nerve blockade by enhancing local anesthetic diffusion and increasing nerve membrane hyperpolarization through α_2-adrenoceptor activation. Similarly, El-Shmaa et al. reported improved block quality and earlier ocular akinesia following the addition of dexmedetomidine to peribulbar anesthesia, facilitating earlier surgical readiness [6, 7].

The present study also found significantly prolonged sensory block, motor block, and postoperative analgesia in the higher-dose group. This prolonged analgesic effect is attributed to inhibition of norepinephrine release, suppression of C-fiber transmission, and peripheral vasoconstriction that delays systemic absorption of local anesthetics. Comparable findings have been described by Vorobeichik et al. in their systematic review of peripheral nerve blocks, where dexmedetomidine consistently prolonged the duration of anesthesia and postoperative analgesia across multiple regional anesthetic techniques. Likewise, Aliste et al. reported longer analgesia with perineural dexmedetomidine without compromising block safety [8, 9].

Patients in the 50 µg group required significantly fewer supplemental blocks and experienced lower intraoperative pain scores. Improved block density likely accounts for these findings and contributes to uninterrupted surgical conditions. Similar reductions in supplemental anesthetic requirements have been reported by Abdallah and Brull, who concluded that dexmedetomidine enhances the completeness of peripheral nerve blockade and decreases the likelihood of block failure [10].

Another notable finding was the significantly higher surgeon and patient satisfaction observed with the 50 µg dose. Better akinesia, longer analgesia, minimal intraoperative discomfort, and mild cooperative sedation probably contributed to improved satisfaction scores. Kaygusuz et al. similarly demonstrated that dexmedetomidine provides comfortable intraoperative sedation while maintaining spontaneous ventilation, leading to superior patient acceptance during ophthalmic procedures [11].

Hemodynamic variables remained largely stable in both groups. Although heart rate was modestly lower with 50 µg dexmedetomidine, no clinically important hypotension, oxygen desaturation, or respiratory compromise occurred. These findings support previous reports by Weerink et al., who showed that dexmedetomidine produces predictable sympatholysis with preserved respiratory function, making it particularly suitable for elderly patients undergoing ophthalmic surgery under regional anesthesia [12].

The incidence of adverse events was low and comparable between the two groups. Mild bradycardia and hypotension occurred slightly more frequently with the higher dose but did not require major intervention. This favorable safety profile is consistent with the findings of Cochrane et al., who concluded that low-dose perineural dexmedetomidine provides clinically meaningful improvements in block characteristics while maintaining an acceptable incidence of cardiovascular adverse effects [13].

CONCLUSION

The addition of 50 µg dexmedetomidine to peribulbar local anesthetic significantly improved block quality by providing a faster onset of akinesia, prolonged sensory and motor blockade, longer postoperative analgesia, reduced need for supplemental anesthesia, and higher surgeon and patient satisfaction compared with 25 µg, while maintaining acceptable hemodynamic stability and a low incidence of adverse events. These findings suggest that 40 µg dexmedetomidine offers a more favorable efficacy–safety profile and may be considered the preferred adjuvant dose for peribulbar block in cataract surgery.

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