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Practical Considerations for Dexmedetomidine Sedation in Adult Cataract Surgery Under Local/Regional Anesthesia: A Narrative Review

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Abstract

Cataract surgery is predominantly performed under local/regional anesthesia, with or without sedation. The practice pattern of sedation is unknown and seems to vary significantly among institutions and countries, routinely administered in some parts of the world to the other extreme of none at all. The selection of sedative agents and techniques varies widely. Currently, there is no ideal sedative agent. Dexmedetomidine has gained recent attention for sedation in ophthalmic local/regional anesthesia due to its alleged advantages of effective sedation with minimal respiratory depression, decreased intraocular pressure, and reduced pain during the local anesthetic injection; however, they are subject to differing interpretations. Published literature also suggests that although dexmedetomidine sedation for cataract surgery under local/regional anesthesia is potentially useful, its role may be limited due to logistical difficulties in administering the recommended dose.

Keywords: Dexmedetomidine, Sedation, Monitored Anesthesia Care, Cataract Surgery, Local Anesthesia, Regional Ophthalmic Anesthesia

1. Context

Cataract surgery, a common operation among the elderly worldwide, is often of short surgical duration and mostly performed under local/regional anesthesia (1). Several factors might influence the choice of the anesthetic technique, including the preferences of patients, anesthetists, and ophthalmologists, surgical complexity and difficulty, and healthcare facilities. Irrespective of preferences and choice of technique, topical anesthesia and regional anesthesia (i.e., retrobulbar, peribulbar, and sub-Tenon's blocks) should be safe, painless, efficient, and effective (2). Modern cataract surgery, with phacoemulsification and small incision, has significantly reduced the surgical time and the need for akinesia. The improved efficiency and increased turnover of patients under local/regional anesthesia might adversely affect patients, resulting in increased perioperative anxiety and discomfort, and sedation may minimize these conditions (3).

The practice pattern of sedation for cataract surgery is unknown and seems to vary significantly among institutions and countries due to differences in culture, affordability, local practices, skills, and facilities (3). Sedation is administered as a routine in some countries (e.g., Singapore) (4); nevertheless, the sedation rate can be as low as 4.1% (in the UK) (5) or even none at all (in the Netherlands) (6). Several sedative drugs, including propofol, midazolam, fentanyl, remifentanil, ketamine, and others, either alone or in various combinations, have been used for adult cataract surgery (3). Common side effects of these agents include nausea and vomiting, oversedation, respiratory depression, and postoperative neurocognitive dysfunctions (7, 8) and may lead to patient dissatisfaction. Currently, there is no ideal sedative agent without adverse effects (9).

Dexmedetomidine has been widely used in both adults and children as a sedative in intensive care units and procedural sedation (10) and as an adjuvant with different regional anesthetic techniques (11). Dexmedetomidine has also been used for sedation during adult cataract surgery (12-14) due to its alleged advantages of being mild analgesic, sedative, reduction in intraocular pressure (IOP), and improved patient satisfaction (15). In addition, dexmedetomidine has also been used for sedation during awake fibreoptic intubation (16), reducing emergence delirium in children for strabismus surgery (17), premedicating children undergoing dental procedures

(18), reducing the hemodynamic changes during elective colonoscopy (19), improving post-cesarean analgesia (20), sedating patients for closed reduction of nasal fractures (21), providing controlled hypotension during functional endoscopic sinus surgery (22), and reducing postoperative cognitive dysfunction (POCD) after middle ear surgery under hypotensive technique (23). Dexmedetomidine has also been used more importantly as an adjuvant to improve effectiveness of various peripheral nerve blocks, chronic and neuropathic pain and prolong the effects of chronic pain procedures (24).

However, the dose and method of dexmedetomidine administration vary and may influence the incidence of reported adverse effects (15). This narrative review aimed to summarize current knowledge and examine perioperative uses, doses, and methods of administration, clinical and practical considerations, and adverse effects of dexmedetomidine sedation in adult cataract surgery under local/regional anesthesia.

2. Search Strategy

A literature search was conducted in June 2021 using MEDLINE (Ovid), PubMed, Embase, CINAHL, Google Scholar, and Cochrane to identify English language articles published during January 1970 and June 2020. The used search keywords included "Dexmedetomidine" in various combinations with "Sedation", "Cataract", "Local", "Regional", "Anesthesia", and "Surgery". The retrieved articles included randomized control trials (RCT), case reports, and citations of key reference articles. After examining their relevance and quality, 68 articles were included in this narrative review.

3. Pharmacology

Dexmedetomidine is a potent highly selective α-2 adrenoreceptor agonist with an elimination half-life of 2 h. It has hypnotic, analgesic, and sympatholytic properties and causes α-2 selective vasoconstriction (25, 26). Dexmedetomidine, acting on locus coeruleus, produces sedation, anxiolysis, and near-natural sleep (27, 28). Patients remain rousable, with decreased muscle tone, decreased IOP, reduced postoperative pain, and reduced opioid consumption (29). Perineural dexmedetomidine prolonged the analgesic effect of local anesthetic in an animal study (27). One meta-analysis has shown that dexmedetomidine reduced the incidence of delirium in patients under mechanical ventilation (30); nonetheless, another meta-analysis has shown that dexmedetomidine reduced the incidence of postoperative delirium (POD) in noncardiac surgical patients (31). Traditional sedative agents (e.g., benzodiazepines, opioids, and propofol) are associated with delirium through their action on gamma-aminobutyric acid receptors; however, the precise mechanism and efficacy of dexmedetomidine in reducing POD are unclear (31, 32).

4. Doses and Methods of Administration

Dexmedetomidine is generally administered as an infusion with a loading dose and a maintenance dose, typically 1 μg/kg over 10 min and 0.2 - 0.7 μg/kg/h, respectively (10). Ramaswamy and Parimala (33) compared dexmedetomidine 0.5 and 0.25 μg/kg loading doses over 10 min and showed that the lower dose of 0.25 μg/kg provided an adequate level of sedation, more stable hemodynamic, and higher surgeon satisfaction in vitreoretinal surgery. Ayoglu et al. (34) administered dexmedetomidine as patient-controlled sedation (PCS) to 20 patients with an initial infusion of 1 μg/kg over 10 min, followed by PCS at 5 μg bolus dose and 10 min of lockout interval during cataract surgery under a peri-retrobulbar block. The initial infusion was sufficient in all but three patients (n = 17/20, 85%) requiring additional doses by PCS. Ayoglu et al. (34) reported that dexmedetomidine as PCS decreased IOP, reduced pain associated with a local anesthetic injection, and provided effective sedation with minimal respiratory depression.

Other administration methods include intramuscular injection 45 min before surgery (35) and intranasal route in children (36, 37). A systematic review on dexmedetomidine for cataract surgery also obtained similar findings of reduction in IOP, higher pain relief, and higher patient satisfaction but relatively more cardiovascular depression and longer recovery discharge time (15). It was also reported that there were many inconsistencies in doses, methods of administration, and outcome analysis in RCTs on dexmedetomidine and concluded that, instead of routine use, dexmedetomidine should be considered only in individual conditions after careful evaluation (15). Overall, published studies suggest that whichever method is utilized, a lower dose should be used to minimize undesirable adverse effects.

5. Comparative Studies with Other Sedatives

Apan et al. (38), using bispectral index titrated sedation during cataract surgery, reported that dexmedetomidine infusion mildly decreased heart rate in the later surgery period with better pain scores in the postoperative period, compared to midazolam. In a prospective RCT, cataract patients under topical anesthesia received either dexmedeto-

midine (1 μg/kg, followed by 0.05 - 0.7 μg/kg/h) or midazolam (50 μg/kg, followed by 2.5 - 35 μg/kg/h). In the aforementioned study, Muttu et al. (39) observed that the operating condition was slightly better in the dexmedetomidine group; however, pain score and surgeon satisfaction were similar. Muttu et al. also commented that dexmedetomidine was more complicated to administer, compared to midazolam.

In another study comparing dexmedetomidine (1 μg/kg, followed by 0.1 - 0.7 μg/kg/h) to midazolam (20 μg/kg/h with 0.5 mg intermittent boluses as needed) for cataract surgery under a peribulbar block, Alhashemi (40) observed that patients receiving dexmedetomidine had lower heart rate and blood pressure without any adverse sequelae and a longer recovery discharge time. Furthermore, Alhashemi (40) concluded that dexmedetomidine appeared unsuitable for routine sedation in cataract surgery. Ramaswamy and Parimala (33) reported that dexmedetomidine was a safe and effective primary sedative with similar hemodynamics, compared to traditional midazolam-fentanyl combination in vitreoretinal surgery under peribulbar anesthesia.

Yagan et al. (41) compared the sedative properties and hemodynamic and respiratory effects of dexmedetomidine with those of the ketamine-propofol combination. The aforementioned study reported that dexmedetomidine had satisfactory analgesia, more rapid onset of action, and a shorter recovery period without causing significant hemodynamic or respiratory adverse effects. Na et al. (42) compared dexmedetomidine with the propofol-alfentanil combination for monitored anesthesia care in cataract surgery and reported higher satisfaction and a more stable cardiovascular state in patients receiving dexmedetomidine. On the other hand, Altiparmak and Celeb (43) and Park and Kwon (44) compared dexmedetomidine with remifentanil but reported opposite results and conclusions.

6. As an Adjuvant to Local Anesthetic Solution

Dexmedetomidine has been added as an adjuvant to local anesthetic solution in different peripheral nerve blocks (45-47). A meta-analysis of 46 RCTs has shown that the perineural addition of dexmedetomidine to local anesthetic resulted in a longer duration of analgesia, compared to using local anesthetic alone (11). When dexmedetomidine was added to lidocaine and bupivacaine in the peribulbar block for cataract surgery, Channabasappa et al. (48) observed that the onset time was shortened and the duration of action and postoperative analgesia prolonged; however, it also provided sedation enabling the cooperation of the patient and better-operating conditions.

Eskandr et al. (49) reported that the addition of dexmedetomidine (0.5 μg/kg) to local anesthetic for sub-Tenon's block, compared to local anesthetic alone, led to statistically significant changes, faster onset time, longer duration of analgesia, higher sedation score, and reduction in IOP; nevertheless, hemodynamic parameters remained stable. The addition of dexmedetomidine (20 μg) to levobupivacaine during sub-Tenon's block for vitreoretinal surgery, compared to levobupivacaine alone, extended the duration of motor and sensory block and provided more effective postoperative analgesia with improved sleep quality on the first postoperative night in those patients (50).

7. Adverse Effects of Dexmedetomidine

7.1. Hemodynamic Parameters

The administration of dexmedetomidine often leads to cardiovascular depression and a reduction in blood pressure and heart rate that were statistically significant. Although heart rate was preserved in some studies when dexmedetomidine was administered as a bolus (42, 43), one study has observed a significant drop in heart rate, both during and after the operation (40). Other studies have reported bradycardia as an adverse event, often requiring treatment with an anticholinergic (34, 35, 42, 51, 52). The administration of dexmedetomidine by continuous infusion, without initial bolus, has been suggested to minimize these changes (38, 42, 43).

7.2. Respiratory Parameters

Better ventilation, as shown by lower end-tidal carbon dioxide ($ETCO_2$) and increased respiratory rate, was noted in patients receiving dexmedetomidine, compared to patients receiving remifentanil (target site concentration of 1 ng/mL) (44). One study comparing dexmedetomidine (0.4 μg/kg/min) with remifentanil (0.05 μg /kg/min) has shown a statistically significant decrease in oxygen saturation approximately 40 min after induction in dexmedetomidine-treated patients (43). In a systematic review, Jones and Aldwinckle (15) observed no statistically significant differences in oxygen saturation, $ETCO_2$, or respiratory rates reported in studies comparing dexmedetomidine with placebo, midazolam, fentanyl, and propofol-alfentanil or ketamine-propofol combination (41).

7.3. Intraoperative Analgesia

Jones and Aldwinckle (15) reported conflicting pieces of evidence in a systematic review. Some studies have shown better analgesia and lower pain perception during regional block with dexmedetomidine; nevertheless,

other studies have shown no differences in analgesia and pain perception.

7.4. Postoperative Analgesia

Pain after cataract surgery is often considered minimal (53). Numerous studies have reported no statistically significant difference in postoperative analgesia between dexmedetomidine and other study drugs (15). Ophthalmic regional anesthesia often provides sufficient or complete postoperative analgesia after cataract surgery (53).

7.5. Reduction of Sneezing Reflex During Ophthalmic Regional Anaesthesia

Sudden unexpected movement due to sneezing during a needle-based ophthalmic block may increase the risk of globe perforation, optic nerve injury, or periocular hematoma (54). All anesthesia providers should be aware of this unusual and potentially dangerous phenomenon (55). Photic sneeze reflex, an autosomal dominant condition, is sneezing in response to certain stimuli (e.g., looking at bright lights or periocular injection). A combination of propofol with fentanyl, dexmedetomidine, or antihistamines sedation suppresses this reflex during the peribulbar block (56).

7.6. Intraocular Pressure

The reduction of IOP may improve surgical conditions and reduce the risk of IOP-related complications during cataract surgery, especially in patients with complex or challenging pathology (57). Dexmedetomidine reduces IOP by its central action (28). Several studies have shown a significant reduction of IOP with intravenous dexmedetomidine (15). Intramuscular dexmedetomidine was also effective in IOP reduction, with the most significant reductions occurred at 1 - 1.5 μg/kg (35, 52). The intraoperative reduction in IOP with dexmedetomidine did not extend into the postoperative period, possibly related to its half-life of 2 h, short-duration cataract surgery, and therefore short drug infusion period (15). There is a lack of comparative studies performed on IOP between dexmedetomidine and other sedatives.

7.7. Post-Anaesthesia Care Unit Discharge and Recovery

One study has shown that patients receiving dexmedetomidine took longer to fulfill satisfactory recovery room discharge criteria (an Aldrete score of 10), compared to patients receiving midazolam (40). In the aforementioned study, it was concluded that dexmedetomidine seemed unsuitable as a common sedative for short-duration cataract surgery. Prolonged recovery discharge times were also observed in another study comparing dexmedetomidine with the ketamine-propofol combination (41). A recent systematic review has also observed a tendency for delayed recovery in dexmedetomidine-treated patients and questioned its suitability in ambulatory surgery settings (15). On the other hand, one study comparing dexmedetomidine (1 μg/kg over 10 min, followed by PCS at 5 μg bolus) with no sedation has shown no statistically significant differences in Aldrete scores at 30 min after the surgery (34).

7.8. Postoperative Cognitive Dysfunction

The exact incidence of POCD or postoperative neurocognitive dysfunction following cataract surgery is unknown; however, it has been reported as 4.4% in elderly patients and those receiving benzodiazepine premedication (58). Dexmedetomidine has been advocated as a safe sedative agent because it reduced the incidence of POD in older patients after non-cardiac surgery (59); nevertheless, another study has shown more favorable postoperative cognitive status (using the Mini-Mental State Examination) with dexmedetomidine than remifentanil (59, 60).

Both dexmedetomidine and remifentanil were considered appropriate sedatives for obese patients during cataract operation; nonetheless, dexmedetomidine provided better analgesia during surgery (43). However, increased sedation in some dexmedetomidine-treated patients was noted when dexmedetomidine was compared to saline (38, 51, 61). Some studies have shown that dexmedetomidine reduced the incidence of POCD and the duration of mechanical ventilation, compared to other sedatives (62). In another study, there was no significant difference between midazolam and dexmedetomidine in reducing POCD after cataract surgery (63). A limited number of studies have prevented any definitive conclusions between dexmedetomidine and POCD after cataract surgery.

7.9. Postoperative Nausea and Vomiting

In an RCT comparing intramuscular premedication with dexmedetomidine, midazolam, and placebo, there were no differences in self-reporting nausea and no incidence of vomiting among the three groups (35). In another RCT comparing sedation for cataract surgery under topical anesthesia or peribulbar block, vomiting was reported in 5% (n = 2/40) and 0% of patients treated with dexmedetomidine and midazolam-fentanyl, respectively (64). Overall, the incidence of nausea and vomiting associated with dexmedetomidine sedation in cataract surgery is very low.

7.10. Patient and Surgeon Satisfaction

Higher patient and surgeon satisfaction scores during cataract surgery were reported for dexmedetomidine,

compared to those of propofol-alfentanil sedation (42). Other studies also reported a similar finding of higher patient satisfaction with dexmedetomidine, compared to patient satisfaction with no sedation, placebo, and midazolam (34, 40, 51, 65). In retinal surgery, an RCT comparing dexmedetomidine sedation to saline also reported higher patient and surgeon satisfaction and no respiratory compromise, thereby recommending dexmedetomidine as a preferred sedative for retinal surgery (66). However, some studies reported no statistically significant difference in patient satisfaction when dexmedetomidine was compared to the ketamine-propofol combination (41) and remifentanil (44). Overall, dexmedetomidine sedation appears to achieve higher patient and surgeon satisfaction.

8. Safety

The recommended method of administering dexmedetomidine includes loading infusion followed by maintenance infusion; however, the adverse events associated with dexmedetomidine, such as hypertension, hypotension, or bradycardia, usually occur during or shortly after a higher loading dose (67). The adverse events can be minimized by reducing the loading dose, increasing the loading time, or omitting the loading dose, especially in comorbid patients (68).

9. Conclusions

Dexmedetomidine sedation during cataract surgery in adults appears to provide better sedation and analgesia, higher patient satisfaction, reduced IOP, and a good overall safety profile, compared to those reported for commonly used sedatives, hypnotics, and opioids. The aforementioned benefits of dexmedetomidine should be assessed against its known side effects (i.e., hypotension, bradycardia, and respiratory depression), delayed recovery, and discharge time. The recommended administration of dexmedetomidine by intravenous infusion further limits its use for short-duration cataract surgery; however, it can be considered on a patient-by-patient basis. The single or intermittent bolus administration of dexmedetomidine may be a useful alternative technique for sedation during cataract surgery under local/regional anesthesia; nonetheless, there are insufficient data on this method, and further studies are desired.

Footnotes

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