Foroughi *et al. BMC Anesthesiology* (2025) 25:35
https://doi.org/10.1186/s12871-025-02897-3

BMC Anesthesiology

SYSTEMATIC REVIEW

Open Access

The effect of anesthesia on postoperative cognitive dysfunction in adults undergoing cataract surgery: a systematic review

Elaheh Foroughi[1], Etrusca Brogi[2*], Francesco Forfori[3] and Seyyed Taghi Hashemi[4*]

Abstract

Background We systematically reviewed the evidence on the effect of anesthetic methods and drugs on the incidence of postoperative cognitive dysfunction (POCD) after cataract surgery.

Methods The Web of Science, PubMed, and Scopus databases were searched for relevant English reports published from 2000 to August 2024. After full-text screening and checking the quality assessment of each article using the JBI checklist, 9 relevant articles were included in this study. The included articles were reviewed to explain how different anesthetic modalities and drugs may affect the incidence of POCD after cataract surgery. Our study aimed to systematically investigate the relationship between various methods of anesthesia and POCD for people undergoing cataract surgery.

Results We included 9 clinical trials with 1014 participants, which analyzed the incidence of POCD after anesthetic interventions. Four articles compared the effect of anesthetic modality interventions on POCD and five studies compared the effect of anesthetic drugs on POCD. The studies used various cognitive measurement scales, including the Mini-Mental State Examination, Neurobehavioral Rating Scale, Blessed Orientation-Memory-Concentration Test, Iowa Satisfaction with Anesthesia scale, PALT, and VF test. All articles that compared local and topical anesthesia found no statistically significant difference in the incidence of cognitive dysfunction at postop days 1 and 7. General anesthesia may cause POCD approximately twofold than local anesthesia. Ketamine, Midazolam, or Dexmedetomidine seemed to reduce postoperative cognitive complications compared to the control group.

Conclusions This systematic review investigates how different anesthetic techniques and drugs may affect the incidence of POCD. The available literature is far from being conclusive and further studies are needed to reach any significant conclusions. It is necessary to adopt an appropriate anesthesia method for elderly and high-risk patients, especially people who have a history of cognitive problems undergoing elective cataract surgery, to reduce cognitive complications after surgery.

Keywords Postoperative cognitive dysfunction (POCD), Cataract surgery, Anesthetic modalities, Anesthesia, Cognition complications

*Correspondence:
Etrusca Brogi
etrusca.brogi@ospedaleniguarda.it
Seyyed Taghi Hashemi
st_hashemi@med.mui.ac.ir
Full list of author information is available at the end of the article

© The Author(s) 2025. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by-nc-nd/4.0/.

Background

Postoperative cognitive dysfunction (POCD) is defined as a progressive decline in cognitive performance from baseline patients' status associated with surgical procedures. POCD can be characterized by a variety of severities, from subtle to considerable and disabling cognitive changes. Even if the cognitive decline is generally transient, it may significantly influence the patient's quality of life with a consequent increase in healthcare costs [1, 2]. The reported incidences of POCD varied greatly between studies. Incidence is particularly high after cardiac (i.e., 50–70%) or orthopedic surgery (i.e., 20–50% 1-week post-surgery) [3–5]. Furthermore, the incidence increases with age and concomitant cardiovascular and cerebrovascular diseases [6]. About 10%-54% of patients who appeared to be cognitively normal before surgery might develop post-operative cognitive dysfunction [1].

POCD may manifest as a loss in verbal or visual memory, executive function, language comprehension, attention, concentration, and failure to perform simple cognitive tasks following surgery which might last in different degrees of severity for weeks, months, or even years [2]. Furthermore, personality and social behavior changes may occur [7]. POCD has negatively impacted various aspects of quality of life, including physical health, role, pain, general health, vitality, social functioning, emotional role, and mental health [8].

Postoperative cognitive dysfunction has multiple risk factors, including older age, major surgery, type of anesthesia, neurological diseases, pulmonary disease, alcohol abuse, electrolyte abnormalities, and neurological diseases (as shown in Table 1) [7, 9–11]. Unfortunately, the etiology and the pathophysiological mechanisms of POCD have not been entirely comprehended, and effective prevention programs still need to be developed [12, 13].

Cataract surgery is one of the most common ophthalmic procedures in medical settings, which can be performed under sedation, local, topical, or general anesthesia [14]. With the progress in surgical technique, the duration of surgery has become shorter, and different kinds of anesthetic strategies can be implemented. Even with conflicting results, previous clinical trials have investigated whether different anesthetic modalities can influence the incidence of POCD; several studies have found significantly different cognitive performance using different anesthetic drugs (e.g., dexmedetomidine, remifentanil), while others studies have reported no difference [2, 12, 15–24].

Considering the high importance and prevalence of cognitive disorders after surgery, a deeper understanding of how anesthetics affect cognitive function after cataract surgery would be essential for implementing effective perioperative care [25]. In this systematic review, we aim to investigate the relationship between different methods of anesthesia and POCD for people undergoing cataract surgery.

Table 1 Predisposing and precipitating factors associated with POCD

Predisposing
Increased age
Major surgery
Surgical trauma
Anesthesia
Male sex
Preexisting cognitive impairment
Sensory damage (visual, auditory)
Delirium
Multiple medicines
Benzodiazepine or narcotic use
Alcohol abuse
Neurological diseases
Precipitating
Benzodiazepine
Infection
Hypoxia
Shock
Dehydration
Hypothermia
Fever
Metabolic abnormalities
Insufficient nutritional intake
Pain
Anemia
Surgery
Electrolyte abnormalities
Pulmonary disease
Coronary bypass surgery

Method

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses(PRISMA) guidelines are followed in this study [26]. This research has also been registered in the PROSPERO database with the registration number: CRD42024588625.

Before beginning the research, all authors evaluated the study's inclusion and exclusion criteria, as well as the search terms used to discover relevant information.

Search strategy

The Web of Science, PubMed, and Scopus databases were searched for relevant English reports published from 2000 to August 2024. The search strategy included the following terms: “Postoperative Cognitive Complications” OR”Cognitive Dysfunction” OR “Cognitive Complications” OR “postoperative cognitive dysfunction” OR “cognition” AND “cataract” OR “Cataract extraction” AND “Anesthesia” OR “local anesthesia” OR “general anesthesia” OR “anesthetic modality”. The reference lists of the included articles and selected systematic reviews were manually searched by two reviewers (EF and STH) for additional eligible studies. The methodological quality of each included paper was assessed separately using a Joanna Briggs Institute checklist. We searched for and analyzed the titles and abstracts of potential study publications using the inclusion and exclusion criteria to eliminate irrelevant articles. Table 2 shows the search strategy and number of screened papers for this systematic review.

Eligible criteria

Original English studies comparing the effect of anesthetic drugs on the risk of postoperative cognitive dysfunction after cataract surgery were considered eligible for this systematic review. For this review, various types of anesthesia (i.e., general, local, topical anesthesia, and sedation) are included in our review. Postoperative cognitive dysfunction refers to any acute change in neurocognitive status following surgery, such as mental deterioration, delirium, or confusion. Only comparative studies including at least two different anesthetic modalities or drugs were deemed eligible and included in this study. Case series and articles that assessed POCD with a single drug or anesthetic modality were excluded. Reviews, case reports, case series, letters to the editor, animal research, and in vitro, other than English studies, and duplicate publications were among the exclusion criteria.

Data extraction and quality assessment

Two authors (EF and STH) evaluated the titles and abstracts of the selected articles separately. To find the final inclusions, we reviewed the whole text of the remaining articles. End Note software (V.9) excluded the duplicate studies. Contemplating Joanna Briggs Institute (JBI)-based reviews, each article was evaluated by assigning a of 3, 2, 1, or 0 based on answers “Yes,” “Unclear,” “Not applicable,” or “No,” accordingly. For quality assessment, we used JBI Critical Appraisal Tool for Cross-sectional. This tool has been developed by the JBI and collaborators and approved for the valuation of risk of biases in quantitative studies. Questions of the checklist are indexed in the table as Q1-Q13, and are written here; Q1) Was true randomization used for the assignment of participants to treatment groups? Q2) Was allocation to treatment groups concealed? Q3) Were treatment groups similar at the baseline? Q4) Were participants blind to treatment assignment? Q5) Were those delivering treatment blind to treatment assignment? Q6) Were outcomes assessors blind to treatment assignment? Q7) Were treatment groups treated identically other than the intervention of interest? Q8) Was follow-up complete and if not, were differences between groups in terms of their

Table 2 Search strategy

Search engine	Search strategy	Additional filters	Results
PubMed	(((((“Cognitive Dysfunction/complications”[Mesh] OR “Cognitive Dysfunction/ethnology”[Mesh] OR “Cognitive Dysfunction/etiology”[Mesh] OR “Cognitive Dysfunction/physiopathology”[Mesh] OR “Cognitive Dysfunction/prevention and control”[Mesh] OR “Cognitive Dysfunction/surgery”[Mesh])) OR “Postoperative Cognitive Complications”[Mesh]) AND “Cataract”[Mesh]) OR “Cataract Extraction”[Mesh]) AND “Anesthesia”[Mesh]	English MEDLINE (From 2000 to August 2024)	165
Scopus	(TITLE-ABS-KEY (cognitive AND dysfunction) OR TITLE-ABS-KEY (postoperative AND cognitive AND complications) OR TITLE-ABS-KEY (postoperative AND cognitive AND dysfunction) OR TITLE-ABS-KEY (cognition) AND TITLE-ABS-KEY (cataract) OR TITLE-ABS-KEY (cataract AND extraction) AND TITLE-ABS-KEY (anesthesia) OR TITLE-ABS-KEY (anesthesia AND general) OR TITLE-ABS-KEY (local AND anesthesia))	English (From 2000 to August 2024)	25
Web Of Science	(((((((((TS = (Postoperative Cognitive Complications)) OR TS = (cognitive dysfunction)) OR TS = (postoperative cognitive dysfunction)) OR TS = (cognition)) AND TS = (cataract)) OR TS = (Cataract Extraction)) AND TS = (anesthesia)) OR TS = (local anesthesia)) OR TS = (general anesthesia)) OR TS = (anesthetic modalit*)	English Web Of Science Categories: Ophthalmology/ Anesthesiology/ research management science/ exclude review articles/ Keywords: cataract- anesthesia (From 2000 to August 2024)	550
Google Scholar	cataract anesthesia “cognitive dysfunction” “postoperative cognitive dysfunction”	English (From 2000 to August 2024)	576

follow-up adequately described and analyzed? Q9) Were participants analyzed in the groups to which they were randomized? Q10) Were outcomes measured in the same way for treatment groups? Q11) Were outcomes measured in a reliable way? Q12) Was appropriate statistical analysis used? Q13) Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial? The articles defined at least 28 scores were included in the study (see Table 3).

Data collection

Data from the included papers were extracted as follows:

(1) Study details; authors, publication date, and study design;
(2) Study participant details; total number, male/female number, and mean age;
(3) Investigations and anesthetic method; medication given for anesthesia;
(4) Post-operative cognitive dysfunction *assessment tools* and time points;
(5) Key findings and effect of each investigation on vital signs during and post-surgery.

Results

Literature search

A total of 1316 articles were found by searching online databases. After eliminating duplicates, 1169 articles were selected for title and abstract screening by EF and STH. Disagreements between reviewers were resolved by asking the third reviewer (EB). 20 manuscripts were selected for full-text assessment, and 9 articles were connected to the inclusion criteria in this systematic review after the screening process. No eligible studies were found by manually checking references of related articles. Figure 1 reported the PRISMA flow chart with the details of the search process. Studies that evaluated the effect of anesthesia intervention or anesthetic drug association on the incidence of postoperative cognitive dysfunction after cataract surgery were included in this study [2, 12,

Table 3 Quality assessment score [15, 17, 20, 22, 23]

Articles	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Total Score
Poorzamany Nejat Kermany, Iran, 2016	✓	✓	✓	✓	✓	!	✓	–	✓	✓	✓	✓	–	32
Naghibi, Iran, 2016	✓	✓	✓	✓	✓	✓	✓	!	✓	✓	✓	✓	✓	35
Fathy, Egypt, 2019	✓	✓	✓	✓	✓	✓	✓	–	✓	✓	✓	✓	✓	34
Fathy, Egypt, 2019	✓	✓	✓	✓	✓	!	✓	–	✓	✓	✓	✓	–	31
Mansouri, Iran, 2019	✓	✓	✓	✓	✓	!	✓	–	✓	✓	✓	✓	–	31
Yeliz, Turkey, 2020	✓	✓	✓	!	!	!	✓	–	✓	✓	✓	✓	!	30
Elsaid, Egypt, 2021	✓	✓	✓	!	!	✓	✓	✓	✓	✓	✓	✓	✓	35
Yeliz, Turkey, 2021	✓	✓	!	!	!	!	✓	✓	✓	✓	✓	✓	!	31
E Oriby, Egypt, 2023	✓	✓	✓	✓	✓	!	✓	✓	✓	✓	✓	✓	✓	35

JBI Critical Appraisal Tool for Cross-sectional. Questions of the checklist are indexed in the table as Q1-Q13, and are written here; Q1) Was true randomization used for the assignment of participants to treatment

groups? Q2) Was allocation to treatment groups concealed? Q3) Were treatment groups similar at the baseline? Q4) Were participants blind to treatment assignment? Q5) Were those delivering treatment blind to treatment assignment? Q6) Were outcomes assessors blind to treatment assignment? Q7) Were treatment groups treated identically other than the intervention of interest? Q8) Was follow-up complete and if not, were differences between groups in terms of their follow-up adequately described and analyzed? Q9) Were participants analyzed in the groups to which they were randomized? Q10) Were outcomes measured in the same way for treatment groups? Q11) Were outcomes measured in a reliable way? Q12) Was appropriate statistical analysis used? Q13) Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?

Each question is answered in three ways: (Yes=✓, No=✗, and Unclear=!, Not applicable=–)

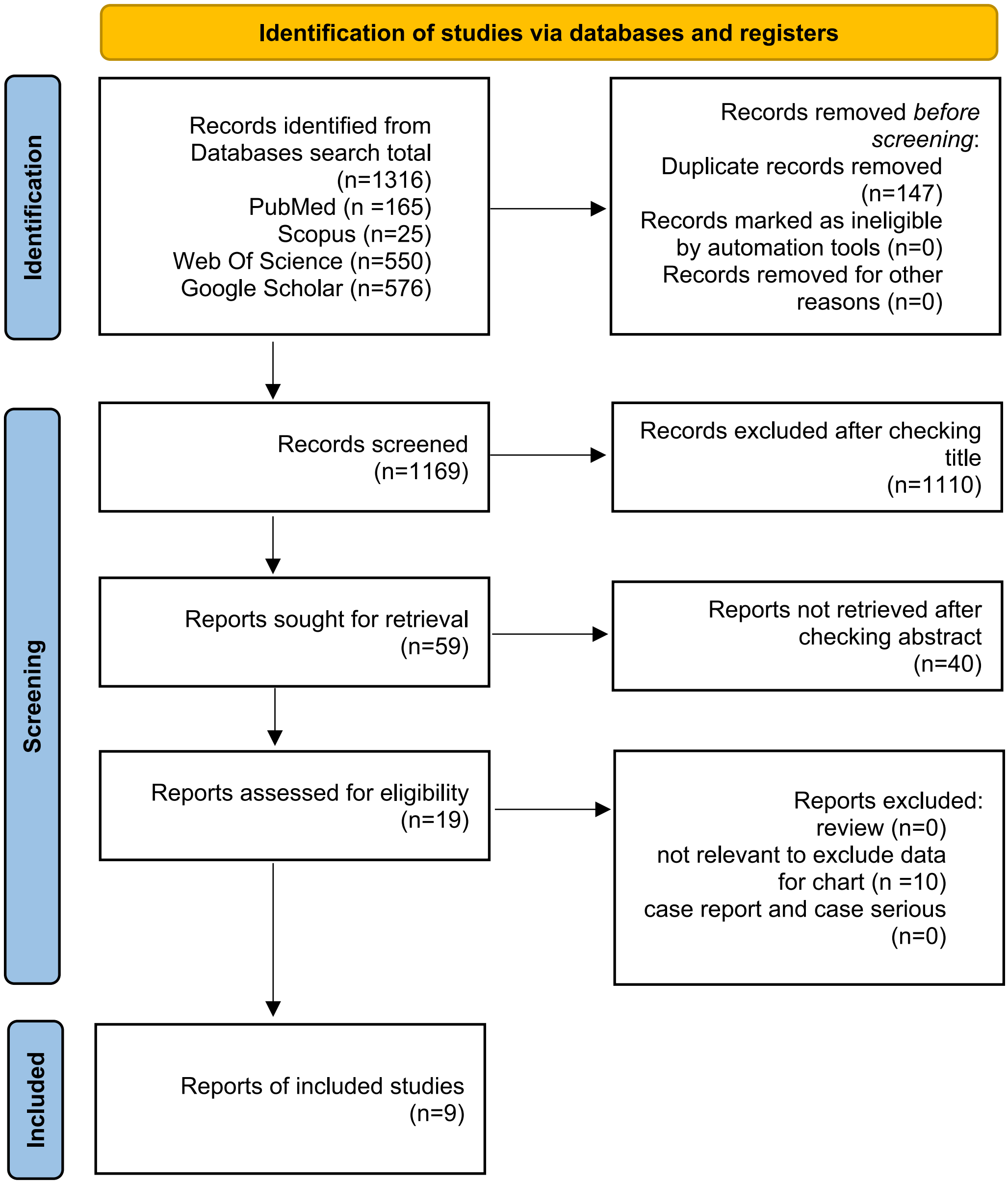

Fig. 1 PRISMA

15–24]. This systematic review included 9 clinical trial studies.

The included studies involved 1014 patients overall. Four articles compared the effect of anesthetic modality interventions on POCD [15, 17, 19, 21]; and five studies compared the impact of different anesthetic drugs on POCD [2, 18, 20, 22, 23]. The participants' mean age ranged from 50.9 to 75.6.

Epidemiologically, tree studies were carried out in Iran [2, 15, 22], four studies in Egypt [17, 18, 20, 23], and two studies in Turkey [19, 21]. Several cognitive measurement scales were utilized in the studies; three studies used the Mini-Mental State Examination (MMSE) [2, 15, 22], tow employed the Neurobehavioral Rating Scale (NRS) [18, 20], two used the Blessed Orientation-Memory-Concentration Test (BOMC) [19, 21], one used the Iowa Satisfaction with Anesthesia scale (ISAS), paired associate learning test (PALT) and category verbal fluency (VF) test [17]; and the last article employed PALT and VF test [23]. Details of the included studies are reported in Table 4.

Table 4 Baseline characteristics of the included studies and key findings

Author	Year	Duration of study	Country	Type of Study	Comparison	Total Participants (M/F)	Total age	Group 1		Group 2		Group 3		Cognitive variable evaluated	Assessment time	Are differences found between groups?	Key findings
								Intervention	Number of patients	Intervention	Number of patients	Intervention	Number of patients				
Mahtab Poorzamany Nejat Kermany [2]	2016	2012–2013	Iran	Double-blind randomized control trial	Remifentanil and Dexmedetomidine	100(56/44)	51 ± 10	remifentanil	50	dexmedetomidine	50	-	-	MMSE	Postop 2 h	Yes	• MAP and HR were significantly lower in the Dexmedetomidine group both during and after surgery (P = 0.01 and 0.009, respectively), • there was no significant difference in SpO2 between the two groups
Khosrou Naghibi	2016	2015	Iran	clinical trial	General anesthesia and Local anesthesia	360(218/142)	75.6 ± 7.8	General anesthesia	180	Local anesthesia	180	-	-	MMSE	Preop, postop day 1, day 7	Yes	• MAP and HR were significantly lower in the local anesthetic group
Wael Fathy	2019	2018	Egypt	prospective randomized clinical trial	local anesthesia with lidocaine 2% and topical anesthesia	60(25/35)	54.3	local anesthesia with lidocaine 2%	30	topical anesthesia	30	-	-	ISAS, PALT, VF	Preop, postop day 7	Yes	• Not reported
Wael Fathy	2019	2018	Egypt	prospective randomized trial	lidocaine and bupivacaine	61(24/37)	53.82	lidocaine	28	bupivacaine	33	-	-	PALT, VF	Preop, postop day 7	No	• Not reported
Neda Mansouri	2019	2017–2018	Iran	double-blind controlled clinical trial	Midazolam, dexmedetomidine and normal saline (control)	150(69/81)	64.7	Midazolam	50	dexmedetomidine	50	control	50	MMSE	Preop, postop 1 day, 7 days	No	• BP, HR, and O2sat: up to 24 h after the surgery showed no significant difference between the midazolam, dexmedetomidine, and control groups (P > 0.05)
Kılıç, Yeliz [21]	2020	2019–2020	Turkey	prospective observational study	General and local and topical	77(35/42)	50.9	General anesthesia	27	Local anesthesia	23	Tropical anesthesia	27	BOMC	Preop, postop 1 h, 1 day, 7 days	No	• similar in baseline patient characteristics and hemodynamic data (P > 0.05)
Mohamed Arafa Elsaid	2021	2021	Egypt	Retrospective clinical trial	ketamine and dexmedetomidine and control	75		ketamine	25	dexmedetomidine	25	control	25	NRS, Ramsay sedation score	Postop 2 h and 4h	No	• Not reported

Table 4 (continued)

Author	Year	Duration of study	Country	Type of Study	Comparison	Total Participants (M/F)	Total age	Group 1		Group 2		Group 3		Cognitive variable evaluated	Assessment time	Are differences found between groups?	Key findings
								Intervention	Number of patients	Intervention	Number of patients	Intervention	Number of patients				
Yeliz Kılıç [19]	2021	2019–2020	Turkey	clinical trial	Tropical and local	41(21/20)	71	retrobulbar blockade	25	topical	16			BOMC	Preop, postop 1st hour, 1st day, and 1st week	No	• Not reported
Mohamed E Oriby [18]	2023	-	Egypt	A randomized controlled trial	Ketamine and Dexmedetomidine and control	90	72.24	Ketamine	30	Dexmedetomidine	30	control	30	NRS, Ramsay sedation score	Preop, postop month 1 and 3	No	• there was no difference between the groups in the changes in the mean arterial blood pressure, oxygen saturation, or respiration rate (P > 0.05) • The heart rate was decreased in the dexmedetomidine group than in control and ketamine group

The use of different anesthetic modalities

Three studies assessed the prevalence of cognitive dysfunction after cataract surgery under topical and local anesthesia [17, 19, 23], and one compared the POCD in general versus local anesthesia [15]. One of the studies contains three groups of investigation (local, topical, and general anesthesia) [21]. Three studies reported no statistically significant difference in cognitive function between the groups after cataract surgery [17, 19, 21]. All the articles assessed cognitive function preoperative, one day, and one week after surgery.

Local versus topical

Fathy et al. conducted a prospective randomized clinical trial with 60 patients undergoing cataract surgery using local anesthesia versus topical anesthesia. Local anesthetic was administered to the first group using lidocaine 2% (total volume 6 mL) and 30 IU of hyaluronidase, In contrast, topical anesthesia was administered to the second group using oxybuprocaine (benoxinate hydrochloride 0.4%) three times per minute before to the procedure. The two groups did not differ statistically significantly regarding ISAS ($P=0.071$). They also measured the difference between pre-operative and post-operative cognition scores in both groups with VF and PALT 1 week after surgery. Regarding both VF and PALT, the postoperative total scores in local anesthesia were significantly lower than the preoperative scores ($P=0.005$, $P=0.01$ respectively); while there was no statistically notable difference in the topical group [17].

Kılıç et al. 2021 also contrasted topical (Proparacaine hydrochloride 0.5%, single dose, and 1% lidocaine) and local (3–4 ml of a mixture of 2% lidocaine and 0.5% bupivacaine) techniques and they didn't find any difference according to BOMC scores ($P>0.05$) [19].

All articles that compared local and topical anesthesia didn't find a significant difference in the incidence of cognitive dysfunction at postop days 1 and 7 [17, 19, 21].

Local versus general anesthesia

In 2016, Naghibi et al. conducted a double-blind clinical study on 360 patients over 65 years to evaluate the cognitive effect of local anesthesia versus general anesthesia after cataract surgery [15]. The patients participating in the study were divided into four age groups: 65 to 70 years, 71 to 75 years, 76 to 80 years, and over 81 years. The authors analyzed the data of two groups of patients; general anesthesia (Sodium Thiopental 0.6 mg/kg/h, Atracurium 0.6 mg/kg/h, Fentanyl 2 µg /kg/h, Morphin 0.1 mg/kg/h and Propofol 100 µg /kg/h to maintaining anesthesia) and local anesthesia (Tetracaine and Midazolam drop 2 mg, and Propofol 10 µg /kg/min). The results reported a higher rate of POCD in general anesthesia (6.66%) versus local anesthesia (3.88%) and lower mean arterial pressure and heart rate in the general anesthesia group. POCD was higher in male patients (74% of total incidences) [15]. Contrarily, in 2020, Kılıç Yeliz et al. found that the postoperative BOMC score was similar between (propofol 2–3 mg/kg, remifentanil 0.5 µg/kg, and remifentanil infusion 0.1–0.2 µg/kg as maintenance), local (3–4 ml of equal mixture of 2% lidocaine and 0.5% bupivacaine) and topical (hydrochloride 0.5% single dose and 1% lidocaine in anterior chamber) in patients aged between 18 to 65 years (mean was 50.9 years) ($P>0.05$) [21]. The authors found that intraoperative HR and MAP were considerably lower in patients under general anesthetic than in those under local and topical anesthesia ($P<0.05$).

The use of different anesthetic drugs

Five articles investigate the effect of dexmedetomidine in comparison with ketamine [18, 20], remifentanil [2], and midazolam [22] on the incidence of POCD. One of the articles looked into the effect of lidocaine versus oxybuprocaine.

Ketamine and Dexmedetomidine and control

Elsaid et al. 2021, retrospectively evaluated the neuroprotective effect of ketamine and dexmedetomidine on POCD. The authors analyzed the data of three groups of patients: ketamine group (0.3 mg/kg/h), dexmedetomidine group (0.5 µg/kg/h), and control group. POCD was significantly higher among control than in ketamine or dexmedetomidine groups (56% versus 28.0% or 16.0%) [20]. The sedation score was higher in the Ketamine and Dexmedetomidine groups. Oriby, M.E et al. compared the effect of dexmedetomidine vs ketamine vs control group in geriatric patients undergoing cataract extraction; ketamine dosage was 0.3 mg/kg/h, whereas dexmedetomidine was administered at a rate of 0.5 µg/kg/h. The authors found that dexmedetomidine groups showed a reduced number of POCD events ($P<0.0001$), a reduced pain score ($P=0.038$), and an increase in Ramsay sedation Score in comparison with the control group. Ketamine and Dexmedetomidine groups were comparable. No significant alteration in parameters and complications were observed between the three groups [18].

Remifentanil and Dexmedetomidine

Kermany et al. (2016) examined the incidence of POCD after cataract surgery using Dexmedetomidine and Remifentanil [2]. They performed a double-blind randomized study. Loading doses of dexmedetomidine (0.5 µg/kg) and remifentanil (0.1 µg/kg) were given ten and five minutes before topical anesthesia, respectively. The maintenance dose was 0.2 µg/kg/hour in the

Dexmedetomidine group and 0.05 μg/kg/minute in the Remifentanil group. They found significant differences between MMSE scores in the two groups, both in patients younger than 65 years ($P=0.03$) and in patients older than 65 years ($P=0.0001$). The dexmedetomidine group had a more favorable postoperative cognitive status than the remifentanil group [2].

Midazolam and Dexmedetomidine and control

Mansouri et al. 2019 evaluated the effect of intravenous administration of Midazolam (0.1 mg/kg) and Dexmedetomidine (1 μg /kg) in elders undergoing cataract surgery. The post-operative cognition state was measured by the MMSE assessment scale in a total of 300 patients. According to the findings, the frequency of cognitive impairment in the midazolam, dexmedetomidine, and control groups were 6%, 10%, and 4% respectively ($P=0.47$) [22]. After 24 h after surgery, the frequency of cognitive impairment was 14% in the midazolam group, 12% in the dexmedetomidine group, and 24% in the control group ($P=0.031$). After 1 week after surgery, the frequency of cognitive impairment was 8% in the midazolam group, 12% in the dexmedetomidine group, and 20% in the control group ($P=0.042$).

Local anesthetics

In the study of Fathy et al. cataract surgery was performed under local anesthesia using lidocaine 2% and bupivacaine 0.5% as an intervention drug. According to PALT and VF assessments, both lidocaine and bupivacaine caused postoperative cognitive impairment. Lidocaine had a more regrettable impact on cognitive function than bupivacaine, but there was no statistically significant difference between both groups.

Discussion

In this systematic review, we included nine RCTs investigating the effect of anesthesia on POCD in cataract surgery. The first description of postoperative cognitive impairment and its potential relationship with surgery under general anesthesia was published in 1955 [27]. Since that time, a noticeable number of articles have been published on postoperative cognitive disorders, especially on cardiac and major non-cardiac surgeries. However, due to several differences between major and minor surgeries (e.g., duration of anesthesia, duration of surgical stress, incidence, and duration of hypotension, hypovolemia), which may play an essential role in different etiology and incidence of POCD, it is imperative to highlight the need of a deeper understanding of the incidence of PCOD during minor surgery procedures. The clinical implication in reducing POCD are several and worth to discuss. Reducing POCD carries significant clinical implications that enhance patient care and healthcare outcomes. POCD, a common and serious complication, can lead to prolonged cognitive impairment, functional decline, and increased mortality. Its prevention and management promote quicker cognitive recovery and improve overall survival rates [28]. Patients who avoid POCD experienced better functional outcomes, often regaining independence more rapidly. Reducing the incidence of POCD shortens hospital stays, decreases the need for post-acute care, and lowers overall healthcare costs, with less readmission rate or extended rehabilitation, which alleviates the burden on resources. Furthermore, the prevention of POCD may reduce the risk of long-term complications (i.e., dementia and chronic cognitive decline, safeguarding patients' quality of life in the months and years following surgery) [29]. The emotional and psychological well-being of patients and their families also improves. POCD can be distressing and disorienting, and its reduction enhances the overall surgical and recovery experience. By focusing on strategies such as medication optimization, multimodal perioperative protocols, and early mobility, healthcare providers can effectively minimize the incidence of POCD, leading to better outcomes for patients and a more efficient healthcare delivery system.

According to the recently published literature, increased awareness has been raised regarding the link between cognitive impairment in the early postoperative phase and general anesthesia [15, 30, 31]. Based on the International Study of Postoperative Cognitive Dysfunction (IS-POCD), patients under general anesthesia exhibited a delayed reaction to mental activity 24 h after surgery. Still, the incidence of POCD in the elderly was not significantly affected by either spinal or general anesthesia [31]. Furthermore, additional studies revealed that persons who got general anesthesia had a significantly higher prevalence of POCD than those who received spinal anesthesia [32]. Thus, one of the most substantial aspects of preventing POCD is choosing an adequate and effective anesthetic method [33]. A systematic review published in 2020 shows that patients undergoing general anesthesia have a higher prevalence of postoperative pain and depression (POCD) three days after surgery, but no significant difference exists within seven days. Early intervention and therapy can reduce POCD frequency, and patients at high risk may recover more quickly [33]. Preoperative education is also crucial.

Currently, few studies have investigated the influence of anesthetic techniques on post-operative cognitive impairments in minor ophthalmic surgeries such as cataract specimens. Certainly, Surgeons and healthcare organizations face every day the responsibility to improve the efficiency of elective cataract surgery care and minimize adverse effects. While the previous RCT assessed the influence of anesthetic modalities and assigned drugs on POCD in major surgery, cognitive impairment represents one of the most important and frequent side events following cataract surgery especially in older patients [18]. Consequently, we decided to carry out a systematic review aiming to investigate the relationship between the anesthetic technique and the incidence of cognitive performance after cataract surgery.

We found that general anesthesia may be associated with early postoperative cognitive dysfunction. Both anesthetic modalities and anesthetic drugs appear to influence the incidence of POCD. Evidence suggests that general anesthesia can increase the incidence of cognitive dysfunction in the early postoperative period. The choice of local and topical anesthesia did not significantly influence the incidence of POCD. However, both local and topical are preferable to general anesthesia to reduce adverse effects of postoperative cognition. Dexmedetomidine seemed to have a positive effect on the number of POCD events Ketamine seemed to show similar results.

Some clinical investigations have examined ketamine's effects on cognitive function and concluded that it might reduce mental disorders [18, 34] while a systematic review and meta-analysis by Zhou et al. didn't find any statistically significant reduction of POCD by administrating Ketamine [35]. Rascón-Martínez et al. 2016 discovered that, in older individuals having ophthalmological procedures, intravenous ketamine (0.3 mg/kg) considerably enhanced early postoperative cognitive function without changing intraocular pressure or hemodynamic parameters [36]. According to another study, ketamine decreased the amount of opioids required, suggesting the connection between pain and cognitive function [37]. A network meta-analysis by Lichi et al. 2023 examined how ketamine, dexmedetomidine, ulinastatin, parecoxib, and midazolam affected older individuals having non-cardiac surgery in terms of their ability to avoid POCD. For older patients undergoing non-cardiac surgery, ketamine plus ulinastatin may be more effective in preventing POCD [38].

To date, the efficacy of multimodal anesthetic or sedation techniques on POCD is of interest. A multimodal approach that incorporates anesthesia, surgical treatment, patient characteristics, and perioperative care can be used to reduce POCD [39]. Shorter surgical procedures, lowering stress, the release of inflammatory mediators, and the use of sedatives and analgesics are examples [40]. Multimodal anesthetics allow the reduction of the use of opioids using single-shot or continuous peripheral nerve blocks, as well as nonsteroidal anti-inflammatory medications. Furthermore, when narcotic medicines are used, surgeons and anesthesiologists should use non-morphine agents and switch to oral opioids as soon as feasible to limit the risk of postoperative cognitive impairment [30].

It is known that older age and prior cognitive deterioration, enhance the chance of postoperative delirium [41, 42]. However, further studies are needed to define major risk factors better to detect high-risk patients and more sensitive and decisive evidence is required to choose an appropriate drug to reduce cognitive impairment and complications in patients undergoing elective cataract surgery. Multimodal anesthesia protocols may reasonably reduce the event of POCD by decreasing the usage of narcotic analgesic drugs. Optimization of vital signs such as heart rate and mean arterial pressure during general anesthesia may also be beneficial for estimating the post-operation cognition decline and cognitive prognosis.

Our systematic review presented several limitations. The use of different anesthetic techniques and analgesic procedures, as well as the variability in the diagnosis and evaluation methods of POCD, limited the interpretation of our results and we couldn't conduct a meta-analysis. Even more, the heterogeneity of patient populations, and of the time points of postoperative evaluation represented further elements that influenced the understanding of our results. On the other hand, some included studies did not clarify the criteria for diagnosing confusion or cognitive impairment.

Furthermore, we should consider that several publications did not include comorbidity (i.e., hypertension, ESRD, uremic condition, pulmonary disease) or drug consumption (e.g., benzodiazepines), which might represent susceptible risk factors. In addition, the depth of anesthesia and sedation have not been reported in detail in some articles. Another limitation is defined by the fact that information on cognitive conditions and mental health status in patients before cataract surgery was not available. Consequently, we could not evaluate the effect of these factors on postoperative cognitive disorders. Considering the above limitations, it is recommended that future studies consider the clinical conditions of patients and their underlying diseases. It seems that more studies are necessary to confirm the effect of anesthesia on cognitive disorders in minor surgeries. Nevertheless, considering all the listed limitations, we believe that the current study provides valuable and relevant insight into this topic for both ophthalmologists and anesthesiologists.

Conclusions

To our knowledge, this systematic review is the first to evaluate the impact of different anesthetic modalities and anesthetics on POCD incidence in adults undergoing cataract surgery. We found that local and topical seemed to be a better choice than general anesthesia to reduce postoperative cognition adverse effects. Dexmedetomidine represents an interesting option for POCD reduction. It is important to stress the necessity to adopt a favorable anesthesia method for elderly and high-risk patients, especially patients who have a history of cognitive impairment and undergoing elective cataract surgery, to reduce cognitive complications after surgery.

Abbreviations

POCD	Post-operative cognitive dysfunction
MMSE	Mini-Mental State Examination
NRS	Neurobehavioral Rating Scale
BOMC	Blessed Orientation-Memory-Concentration Test
ISAS	Iowa Satisfaction with Anesthesia scale
PALT	Paired associate learning test
VF	Category verbal fluency

Acknowledgements
The authors would like to thank the researchers whose articles were included in this systematic review.

Research involving human participants and/or animals
Not applicable.

Support
None.

Permission Tables /Figure
Not applicable, original data.

Clinical trial number
Not applicable.

Availability of supporting data
Not applicable.

Authors' contributions
E.F wrote the main manuscript text, extracted data, searches systematically, analysed and interpretated the data, drafted the manuscript, and controled all aspects of the work. E.B analysed and interprated the data, revised the manuscript, controlled all aspects, and resolved. F.F revised the manuscript, controlled all aspects, and resolved. ST.H extracted the data, controlled all aspects, and resolved.

Funding
None.

Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
IRB Information: not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Student Research Committee, Isfahan University of Medical Sciences, Isfahan, Iran. [2]Neuroscience Intensive Care Unit, ASST Grande Ospedale Metropolitano Niguarda, Milan, Italy. [3]Department of Surgery, Universita di Pisa, Medical, Molecular, and Critical Area Pathology, Pisa, Italy. [4]Department of Anaesthesia and Critical Care, Isfahan University of Medical Sciences, Isfahan, Iran.

Received: 25 November 2024 Accepted: 6 January 2025
Published online: 23 January 2025

References

1. Urits I, Orhurhu V, Jones M, Hoyt D, Seats A,Viswanath OJTjoa, et al. Current perspectives on postoperative cognitive dysfunction in the ageing population. 2019;47(6):439.
2. Poorzamany Nejat Kermany M, Dahi M, Yamini Sharif R, Radpay B. Comparison of the effects of dexmedetomidine and remifentanil on cognition state after cataract surgery. Anesth Pain Med. 2016;6(3):e33448. https://doi.org/10.5812/aapm.33448.
3. Zhu S-H, Ji M-H, Gao D-P, Li W-Y. Yang J-JJUjoms. Association between perioperative blood transfusion and early postoperative cognitive dysfunction in aged patients following total hip replacement surgery. 2014;119(3):262–7.
4. O'Gara BP, Mueller A, Gasangwa DVI, Patxot M, Shaefi S, Khabbaz K, Banner-Goodspeed V, Pascal-Leone A, Marcantonio ER, Subramaniam B. Prevention of Early Postoperative Decline: A Randomized, Controlled Feasibility Trial of Perioperative Cognitive Training. Anesth Analg. 2020;130(3):586–95. https://doi.org/10.1213/ANE.0000000000004469.
5. Li WX, Luo RY, Chen C, Li X, Ao JS, Liu Y, Yin YQ. Effects of propofol, dexmedetomidine, and midazolam on postoperative cognitive dysfunction in elderly patients: a randomized controlled preliminary trial. Chin Med J (Engl). 2019;132(4):437-45. https://doi.org/10.1097/CM9.0000000000000098.
6. Ancelin M-L, DeRoquefeuil G, Scali J, Bonnel F, Adam J-F, Cheminal J-C, et al. Long-term post-operative cognitive decline in the elderly: the effects of anesthesia type, apolipoprotein E genotype, and clinical antecedents. 2010;22(s3):S105–13.
7. Peng W, Lu W, Jiang X, Xiong C, Chai H, Cai L, et al. Current progress on neuroinflammation-mediated postoperative cognitive dysfunction: an update. 2023;23(10):1077–86.
8. Borges J, Moreira J, Moreira A, Santos A. Abelha FJJRBdA. Impact of postoperative cognitive decline in quality of life: a prospective study. 2017;67(4):362–9.
9. Inouye SK. Delirium in older persons. N Engl J Med. 2006;354(11):1157-65. https://doi.org/10.1056/NEJMra052321. Erratum in: N Engl J Med. 2006;354(15):1655.
10. Deiner S, Silverstein JH. Postoperative delirium and cognitive dysfunction. Br J Anaesth. 2009;103 Suppl 1(Suppl 1):i41-46. https://doi.org/10.1093/bja/aep291.
11. Hall TA, McGwin G Jr. Owsley CJJotAGS. Effect of cataract surgery on cognitive function in older adults. 2005;53(12):2140–4.
12. Dorofeeva GJMP. The influence of the chosen method of anesthesia on the severity of postoperative cognitive dysfunction in patients with ophthalmic surgery. 2021;26(1):122.
13. Smith GT, Chen TJ, Shah NM, Agrest B. Grotticelli JJFiA. Anesthesia-mediated neuroinflammatory sequelae in post operative cognitive dysfunction: mechanisms and therapeutic implications. 2024;3:1281034.
14. Karhunen U, Jönn G. A comparison of memory function following local and general anaesthesia for extraction of senile cataract. Acta Anaesthesiol Scand. 1982;26(4):291–6.
15. Naghibi K, Shafa A, Hirmanpour A. Sabaghi BJJoIMS. The impact of general anesthesia vs local anesthesia with intravenous sedation on the incidence of postoperative cognitive dysfunction after cataract surgery in elderly patients. 2016;34(372):134–42.
16. Zhang Y, Shan G-J, Zhang Y-X, Cao S-J, Zhu S-N, Li H-J, et al. Propofol compared with sevoflurane general anaesthesia is associated with decreased delayed neurocognitive recovery in older adults. 2018;121(3):595–604.
17. Fathy W, Hussein M, Khalil H. Comparative effect of local anesthesia with lidocaine 2% versus topical anesthesia on cognitive function in ophthalmic surgery. Anesthesiol Pain Med. 2019;9(6):e97172.
18. Oriby ME, Elrashidy AA, Elsharkawy A, Ahmed SA. Effects of ketamine or dexmedetomidine on postoperative cognitive dysfunction after cataract surgery: A randomized controlled trial. Indian J Anaesth. 2023;67(2):186–93.
19. Kılıç Y, Bilgeç MD, Sarıoğlan BT, Kayhan GE, Güleç MS, Özer AJEMJ. Impact of topical and local anesthesia on postoperative cognitive functions in geriatrics undergoing cataract surgery. 2021;111–7.

20. Elsaid MA. Elgazar AFJTSJoMS. Ketamine versus Dexmedetomidine for Postoperative Cognitive Dysfunction after Cataract Surgery: A retrospective Study. 2021;2021(1):23–8.
21. Kılıç Y, Bilgeç M, Sarıoğlan B, Kayhan GE, Güleç M,Özer AJJoS, et al. Role of anesthesia type on cognitive functions in adults undergoing cataract surgery. 2020;4(12):1112–5.
22. Mansouri N, Nasrollahi K, Shetabi H. Prevention of Cognitive Dysfunction after Cataract Surgery with Intravenous Administration of Midazolam and Dexmedetomidine in Elderly Patients Undergoing Cataract Surgery. Adv Biomed Res. 2019;8(1):6.
23. Fathy W, Hussein M, Khalil H. Effect of local anesthesia (with lidocaine vs bupivacaine) on cognitive function in patients undergoing elective cataract surgery. Local Reg Anesth. 2018;12:1-6. https://doi.org/10.2147/LRA.S185367.
24. Naghibi K, Shetabi H, Nasrollahi K. Mansouri NJJoIMS. The effect of intravenous midazolam and dexmedetomidine on prevention of cognitive dysfunction after cataract surgery in the elderly patients under general anesthesia compared with the control group. 2018;36(504):1395–400.
25. Askarianfard N, Nasrollahi K, Shetabi H. Naghibi KJJoIMS. A Comparative Study of the Effects of Two Different Levels of End-Tidal Carbon Dioxide Pressure on Cognitive Dysfunction in Elderly Patients, after Cataract Surgery under General Anesthesia. 2019;37(533):747–53.
26. Moher D, Liberati A, Tetzlaff J, Altman DG, medicine PGJAoi. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Ann Intern Med. 2009;151(4):264–9.
27. Prince M, Wimo A, Guerchet M, Ali G-C, Wu Y-T, Prina M. World Alzheimer Report 2015. The Global Impact of Dementia: An analysis of prevalence, incidence, cost and trends: Alzheimer's Disease International; 2015.
28. Suraarunsumrit P, Srinonprasert V, Kongmalai T, Suratewat S, Chaikledkaew U, Rattanasiri S, et al. Outcomes associated with postoperative cognitive dysfunction: a systematic review and meta-analysis. 2024;53(7):afae160.
29. Smith P, Blumenthal J, Hoffman B, Davis RD. Palmer SJAJoT. Postoperative cognitive dysfunction and mortality following lung transplantation. 2018;18(3):696–703.
30. Zywiel MG, Prabhu A, Perruccio AV, Gandhi RJCO. Research® R. The influence of anesthesia and pain management on cognitive dysfunction after joint arthroplasty: a systematic review. 2014;472:1453–66.
31. Mandal S, Basu M, Kirtania J, Sarbapalli D, Pal R, Kar S, et al. Impact of general versus epidural anesthesia on early post-operative cognitive dysfunction following hip and knee surgery. 2011;4(1):23–8.
32. Mason SE, Noel-Storr A. Ritchie CWJJoAsD. The impact of general and regional anesthesia on the incidence of post-operative cognitive dysfunction and post-operative delirium: a systematic review with meta-analysis. 2010;22(s3):S67–79.
33. Gao Y, Liu L, Zhao B, Wang Y, Yu S, Wang HJJCPSP. Effect of general and non-general anesthesia on postoperative cognitive dysfunction. 2020;30(4):407–11.
34. Hudetz J, Iqbal Z, Gandhi S, Patterson K, Byrne A, Hudetz A, et al. Ketamine attenuates post-operative cognitive dysfunction after cardiac surgery. 2009;53(7):864–72.
35. Zhou N, Chen C, Liu Y, Yu Z, Chen Y. Efficacy of intraoperative subanesthetic dose of ketamine/esketamine in preventing postoperative cognitive dysfunction: a systematic review and meta-analysis. Ther Adv Psychopharmacol. 2023;13:20451253231200260.
36. Rascón-Martínez DM, Fresán-Orellana A, Ocharán-Hernández ME, Genis-Zarate JH, Castellanos-Olivares AJA. Analgesia. The effects of ketamine on cognitive function in elderly patients undergoing ophthalmic surgery: a pilot study. 2016;122(4):969–75.
37. Bell RFJP. Ketamine for chronic non-cancer pain. 2009;141(3):210–4.
38. Xu L, Xu S, Zhang Y, Huang YJB. Behavior. Effects of anesthetic adjunctive agents on postoperative cognitive dysfunction in elderly patients undergoing noncardiac surgery: A Bayesian network meta-analysis. 2023;13(8):e3149.
39. Lamperti M, Romero CS, Guarracino F, Cammarota G, Vetrugno L, Tufegdzic B, et al. Preoperative assessment of adults undergoing elective noncardiac surgery: Updated guidelines from the European Society of Anaesthesiology and Intensive Care. 2025;42(1):1–35.
40. Pecorella G, De Rosa F, Licchelli M, Panese G, Carugno JT, Morciano A, et al. Postoperative cognitive disorders and delirium in gynecologic surgery: Which surgery and anesthetic techniques to use to reduce the risk? 2024.
41. Chaput AJ. Bryson GLJCJoAJcda. Postoperative delirium: risk factors and management: continuing professional development. 2012;59(3):304–20.
42. Contin A, Perez-Jara J, Alonso-Contin A, Enguix A, Ramos FJIjogp. Postoperative delirium after elective orthopedic surgery. 2005;20(6).

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.