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Role of anesthesia type on cognitive functions in adults undergoing cataract surgery

Katarakt cerrahisi geçiren yetişkinlerde anestezi tipinin bilişsel işlevler üzerindeki rolü

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Abstract

Aim: Postoperative cognitive dysfunction (POCD) is a major concern for anesthesiologists and surgeons. However, the relationship between anesthesia type and postoperative cognitive functions has not been clearly identified. The aim of this study is to compare the impact of three anesthetic methods, local, topical, and general anesthesia, on the development of POCD in patients undergoing cataract surgery.

Methods: Patients aged between 19-64 years who underwent cataract surgery were enrolled in this prospective observational study. All patients were assigned to one of three anesthesia groups: General (n=27), local (n=23), and topical (n=27). Cognitive status was assessed preoperatively and postoperatively (1st hour, 1st day, 1st week), using Blessed Orientation-Memory-Concentration (BOMC) test.

Results: Except age, the three anesthesia groups were similar in baseline patient characteristics and hemodynamic data (P>0.05). Age was significantly different between the groups: Patients in general anesthesia group were the youngest and those in local anesthesia group were the oldest (P<0.001). All postanesthetic BOMC scores in local and topical groups decreased compared to baseline values (P>0.05). However, the 1st hour BOMC score showed an insignificant increase in the general anesthesia group (P=0.554). Baseline mean BOMC score was higher in local anesthesia group than in other groups (P=0.037), whereas postoperative BOMC scores were similar between the three groups (P>0.05).

Conclusions: Local, topical, and general anesthesia had no different effects on postoperative cognitive functions in adult patients undergoing cataract surgery. There was also no statistical difference in postoperative BOMC scores between the three anesthesia methods.

Keywords: Anesthesia, Cataract surgery, Postoperative cognitive dysfunction

Öz

Amaç: Postoperatif bilişsel işlev bozukluğu (POCD), anesteziyologlar ve cerrahlar için büyük bir endişe kaynağıdır. Ancak anestezi tipi ile postoperatif bilişsel işlevler arasındaki ilişki net olarak belirlenememiştir. Katarakt cerrahisi geçiren hastalarda POBD gelişimi üzerine üç anestezi yönteminin (lokal, topikal ve genel anestezi) etkisini karşılaştırmak.

Yöntemler: Bu prospektif gözlemsel çalışmaya katarakt ameliyatı geçiren 19 ve 64 yaşlarındaki hastalar alındı. Tüm hastalar üç anestezi grubundan birine atandı; genel (n=27), yerel (n=23) ve topikal (n=27). Bilişsel durum ameliyat öncesi ve sonrası (1. saat, 1. gün, 1. hafta) Blessed Orientation-Memory-Concentration (BOMC) testi kullanılarak değerlendirildi.

Bulgular: Üç anestezi grubu, yaş hariç, temel hasta özellikleri ve hemodinamik veriler açısından benzerdi (P>0,05). Yaş, gruplar arasında anlamlı olarak farklıydı ki bunlar arasında genel anestezi grubundaki hastalar en genç, lokal anestezi grubundakiler ise en yaşlılardı (P<0,001). Lokal ve topikal gruplarda tüm anestezi sonrası BOMC skorları başlangıç değerlerine göre azaldı (P>0,05). Ancak 1. saat BOMC skoru genel anestezi grubunda istatistiksel olarak anlamlı olmayan bir artış gösterdi (P=0,554). Lokal anestezi grubunda bazal ortalama BOMC skoru diğer gruplara göre daha yüksekti (P=0,037), postoperatif BOMC skorları ise üç grup arasında benzerdi (P>0,05).

Sonuç: Katarakt cerrahisi geçiren yetişkin hastalarda lokal, topikal ve genel anestezinin postoperatif bilişsel işlevler üzerinde farklı bir etkisi yoktu. Üç anestezi yöntemi arasında postoperatif BOMC skorlarında da istatistiksel bir fark yoktu.

Anahtar kelimeler: Anestezi, Katarakt cerrahisi, Postoperatif bilişsel işlev bozukluğu

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Introduction

Postoperative cognitive dysfunction (POCD) is a clinical entity characterized by progressive hypomnesia, personality changes, impaired orientation, attention, perception, consciousness, and judgment [1]. The severity of this phenomenon ranges from mild disease to a serious life-threatening form, with a reported incidence of up to 60% [2]. Therefore, POCD has become one of the most important criteria in the selection of anesthesia type in surgical patients.

In general, the incidence of POCD is higher in patients undergoing general anesthesia than those receiving other types of anesthesia. Li et al. explained this with the cholinergic disturbance related to inhalation anesthetics whereas other authors pointed out the dose of anesthesia agents [3-5]. In recent studies, some local anesthetic agents (e.g., lidocaine) have been shown to cause cognitive dysfunction due to their neurotoxic effects [6,7]. However, the impact of anesthesia type on cognitive functions has not been clearly identified yet.

Cataract surgery is one of the most frequently performed surgeries in routine practice, and can be performed under local, topical, or general anesthesia. Few studies investigated the effect of anesthesia type on POCD in patients undergoing cataract surgery in the literature, with most reporting conflicting results [8,9]. In this context, determining the impact of anesthesia type on cognitive functions following cataract surgery is of foremost importance for the accurate perioperative management of these patients.

This study aimed to investigate the impact of three anesthetic methods, including local, topical, and general anesthesia, on the development of POCD in adult patients undergoing cataract surgery.

Materials and methods

General data

Following the approval from the Ethics Committee of the Eskişehir Osmangazi University (number 24, 10 September 2019), patients who underwent elective cataract surgery at Osmangazi University between September 2019 and March 2020 were enrolled in this prospective observational study. All patients were preoperatively informed about the steps of the procedures. Written informed consent was obtained from each participant. All patients were routinely evaluated before the operation. Demographic characteristics including age, gender, and educational level, American Society of Anesthesiologist (ASA) physical status, procedural data, anesthetic techniques, and perioperative anesthesia-related complications were recorded.

Inclusion and exclusion criteria

The inclusion criteria were as follows: ASA physical status I-III, aged between 18 and 65 years, and a sufficient level of education for completion of neuropsychological tests. Patients with significant cardiovascular, respiratory, renal, hepatic, neurological disorders, serious hearing, or visual impairment, those using psychiatric drug (benzodiazepine, antidepressant, etc.) or alcohol, and allergic to the drugs involved in the study were excluded.

Anesthetic techniques

The fasting time was at least 8 hours before the operation. Patients did not have any premedication. Standard monitoring included five-lead electrocardiogram, noninvasive blood pressure measurement, pulse oximetry, and monitoring inspiratory/expiratory gas concentrations. Preanesthetic heart rate (HR) and mean arterial pressure (MAP) were noted. Patients were assigned to one of three anesthesia groups: General anesthesia (Group G), local (retrobulbar) anesthesia (Group L), and topical anesthesia (Group T).

General anesthesia was induced by propofol (2-3 mg kg^{-1}) and remifentanil (0.5 µg kg^{-1}). Following adequate loss of consciousness, airway control was provided by laryngeal mask airway (LMA). The patients received sevoflurane inhalation (2-3%) in 4 L min^{-1} medical air (50%) and oxygen (50%) and remifentanil infusion (0.1-0.2 µg kg^{-1}) to maintain anesthesia. Minimal alveolar concentration value was set at 1-1.2 throughout the surgery.

Local (retrobulbar) anesthesia was performed by the surgeon. In supine position, the inferolateral point of the inferior orbital margin was palpated while the patient's nose pointed towards the ceiling of the room. Thereafter, a blunt 25-gauge needle was inserted into subcutaneous tissue at the junction of the middle and lateral third of the orbit in the lower eyelid. While the patient was looking supranasally perpendicularly, the needle was inserted 35 mm towards the apex of the muscle cone. After aspiration to prevent intravascular injection, 3-4 ml of local anesthetic (equal mixture of 2% lidocaine and 0.5% bupivacaine) were injected. For proper distribution of the local anesthetic, the injection site was patted for 2-5 minutes.

Topical anesthesia was performed in supine position by the surgeon. Proparacaine hydrochloride (0.5%, single dose) was dropped into the conjunctival sac. Subsequently, 1% lidocaine (without additive) was applied into the anterior chamber.

HR, MAP, peripheral oxygen saturation, and end-tidal carbon dioxide were monitored continuously during the surgical procedure. Intraoperative HR and MAP values were recorded at 10^{th}, 15^{th}, and 30^{th} minutes. After the procedure, all patients were followed up in the recovery room for at least 30 minutes.

Evaluation of cognitive function

Cognitive status was evaluated by Blessed Orientation-Memory-Concentration test (BOMC), with scores ranging from 0 to 28 [10]. Each wrong answer scored one point, meaning that higher scores were associated with worse cognitive levels. The BOMC is a short cognitive screening tool, available in the public domain, which can be completed in a few minutes. This diagnostic tool consists of three main items: *Orientation* is evaluated with patient report of the current year, month, and time of day. *Concentration* is evaluated by having the patient count backward from twenty to one and say the months in reverse order. *Memory* is evaluated through delayed recall of a brief phrase. A Turkish version of BOMC test was used in the study population [11]. The patients were evaluated by BOMC test four times throughout the study: Preoperatively (baseline), and at the 1^{st} postoperative hour, day, and week.

Statistical analysis

A power analysis (G power 3.01) showed that a sample size of 15 patients per group was required to achieve 90% power with a 5% significance level and moderate effect size (0.25) to evaluate the differences in BOMC scores between the groups. The standard version of the Statistical Package for the Social Sciences (SPSS 23.0 software, IL-Chicago-USA) was used for statistical analysis. Descriptive data were presented as number (%) and mean (SD) for categorical and continuous variables, respectively. Kruskal-Wallis and one-way ANOVA tests were used to evaluate the differences between the three groups. A *P*-value of <0.05 was considered statistically significant.

Results

A total of 77 patients with a mean age of 50.9 years (19-64 years) were included in the study. There were 42 (54.5%) females and 35 (45.5%) males. All patients were classified into three groups according to the type of anesthesia: General anesthesia group (Group G, n=27), local (retrobulbar) anesthesia group (Group L, n=23), and topical anesthesia group (Group T, n=27).

Statistically, the three patient groups were similar in gender, ASA physical status, and educational level ($P>0.05$). However, age was significantly different between the groups. Patients in the general anesthesia group were the youngest and those in the local anesthesia group were the oldest ($P<0.001$). The comparison of baseline patient characteristics is presented in Table 1.

Table 1: Comparison of baseline characteristics between the groups

	Group G (n=27)	Group L (n=23)	Group T (n=27)	*P*-value
Age (year)	42.1 (11.5)	57.6 (5.5)	54 (7.9)	<0.001
Gender				0.665
female	13 (48.1%)	14 (60.9%)	15 (55.6%)	
male	14 (51.9%)	9 (39.1%)	12 (44.4%)	
ASA status				0.282
ASA 1	10 (37%)	4 (17.4%)	12 (44.4%)	
ASA 2	16 (59.3%)	18 (78.3%)	15 (55.6%)	
ASA 3	1 (3.7%)	1 (4.3%)	0	
Educational status				0.252
elementary	15 (55.5%)	18 (69.6%)	17 (63%)	
high school	8 (29.6%)	2 (8.7%)	4 (14.8%)	
university	4 (14.8%)	3 (13%)	5 (18.5%)	
missing	0	0	1 (3.7%)	

Data are presented as mean (standard deviation) for age, n (%) for other variables

All postoperative BOMC scores in local and topical anesthesia groups were less than the baseline values. However, the postoperative 1st hour BOMC score in the general anesthesia group was insignificantly higher compared to baseline value ($P=0.554$, Wilcoxon test). A graphical representation of the mean preoperative (baseline) and postoperative BOMC scores among the three anesthesia groups is presented in Figure 1.

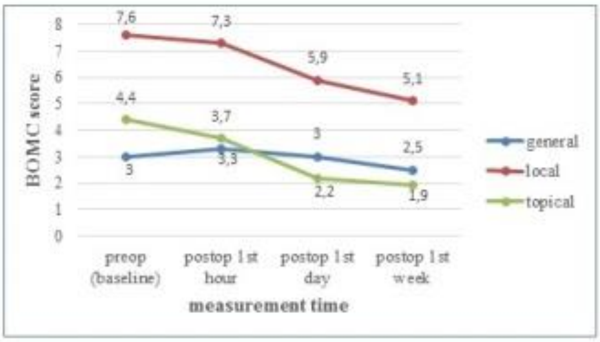

Figure 1: The mean preoperative (baseline) and postoperative (1st hour, 1st day, and 1st week) BOMC scores in three anesthesia groups

The three groups were compared with each other in terms of all HR values, MAP values, and BOMC sores (Table 2). No significant differences in baseline HR and MAP values were found between the patient groups ($P>0.05$). On the other hand, intraoperative HR and MAP values at 10th, 15th, and 30th minutes were significantly lower in general anesthesia patients compared to those in local and topical groups ($P<0.05$). Baseline mean BOMC score was higher in local anesthesia patients than in other groups ($P=0.037$) whereas postoperative BOMC scores were similar between the three groups ($P>0.05$).

Table 2: Comparison of intraoperative hemodynamic data and BOMC scores between the groups

	Group G (n=27)	Group L (n=23)	Group T (n=27)	*P*-value
HR (baseline)	74.6 (13.8)	82.8 (13.9)	80.5 (14.2)	0.083
HR (10th min)	65.4 (9.7)	78.9 (12.7)	75.3 (11.7)	<0.001
HR (15th min)	65.1 (9.8)	78.6 (13.6)	74.5 (11.1)	<0.001
HR (30th min)	65.8 (10.2)	78.6 (12.6)	73.3 (11.3)	0.001
MAP (baseline)	101.5 (17.7)	108.8 (20.1)	105.8 (11.5)	0.359
MAP (10th min)	70.2 (11.1)	105.2 (16.2)	103 (12.7)	<0.001
MAP (15th min)	69.6 (10.7)	105.1 (17.4)	101.2 (12.4)	<0.001
MAP (30th min)	68.5 (11)	106.1 (17.3)	102.1 (12.3)	<0.001
BOMC (baseline)	3 (3.9)	7.6 (6.7)	4.4 (4)	0.037
BOMC (1st hour)	3.3 (3.8)	7.3 (6.5)	3.7 (3.7)	0.050
BOMC (1st day)	3 (3.7)	5.9 (5.9)	2.2 (2.6)	0.079
BOMC (1st week)	2.5 (3.8)	5.1 (6)	1.9 (2.5)	0.219

Data are presented as mean (standard deviation) for all variables

Discussion

The present study showed that three anesthesia methods, general, local, and topical anesthesia, did not significantly affect cognitive functions in adult patients undergoing cataract surgery. Despite some methodological differences, this result was consistent with the study by Campbell et al. [9]. In another study conducted on patients undergoing cataract surgery, no differences in most cognitive testing results were found between general and local anesthesia. However, the authors showed a generalized reduction in memory performance across both anesthesia groups, contrary to our results [8]. In addition to that study, there are a limited number of studies indicating the worse effect of general anesthesia on cognitive functions in comparison to other anesthesia methods [12-14]. On the other hand, most clinical studies comparing general anesthesia with regional anesthesia types in terms of developing POCD showed no significant differences [15].

Although there is some evidence that supports the potential relationship between exposure to general anesthesia and development of neurocognitive impairment, the differences between the methodologies of the studies, including patient characteristics, variable POCD definitions, and non-standardized diagnostic tests, were the major limitations to reaching a definitive judgment on this subject [16-18]. In routine practice, the diagnosis of POCD is made by psychometric evaluation using specific neuropsychological scales such as the short BOMC test. This diagnostic scale is known to be superior to other similar tests because it is short, easy-to-understand, and based on simple scoring system [11]. It has been also shown that BOMC test has a high sensitivity rate in detecting cognitive dysfunction [19]. The other potential pitfall of the previous studies is the variable demographic characteristics of the patient cohorts. To us, pediatrics and geriatrics should differ from adults due to their special cognitive status. In the present study, patients aged between 18 and 65 years old were included to avoid possible age-related effects. We also tried to provide homogeneity of the patient groups. For this reason, anesthesia protocols were standard in each study group. Statistically, all anesthesia groups were similar in basic characteristics including gender, educational level, preoperative ASA status, preoperative HR, and MAP values. However, patients who received general anesthesia were statistically younger than those in the other two groups. This can be explained by the traditional tendency of general anesthesia in younger and healthy individuals. In parallel to this statistical significance in age distribution, preanesthetic BOMC score was lower in general anesthesia group while the local anesthesia patients had higher scores. The fact that almost all postoperative BOMC scores were less than preoperative values was one of the most important results obtained from the present study, indicating that type of anesthesia did not have any significant effect on early postoperative cognitive status. It should be noted here that there was a mild increase in postoperative 1st hour BOMC score in the general anesthesia group, probably due to the early anesthetic effect of inhalation agents. This mild impairment in cognitive status was expected and consistent with the previous reports [20,21]. In our opinion, lower postoperative BOMC scores can be explained by the increased attention of the patients to the test questions and the absence of geriatric and pediatric patients in the study population.

In general, no sufficient evidence to recommend the use of non-general anesthesia instead of general anesthesia has been reported in a current guideline for perioperative brain health [22]. In daily practice, non-general anesthesia techniques such as local and topical anesthesia are frequently used for many surgical procedures including cataract surgery, especially in elderly or comorbid patients. The geriatric patients were beyond the scope of the present study. However, the fact that patients with general anesthesia were statistically younger than those who received topical or local anesthesia was consistent with this general approach. Indeed, the main reason for excluding patients over 65 years of age was the low preference of general anesthesia for cataract surgery in this age group due to the potential anesthesia-related morbidities, as well as providing a homogenous study cohort.

Limitations

Several limitations of the present study should be noted. First, the study was conducted in a single center, which may limit the generalization of the statistical results. Second, the relatively small number of patient groups may make it difficult to interpret subgroup findings. However, considering the limited data regarding the impact of anesthesia type on POCD in patients undergoing cataract surgery, we hope that the results obtained from the present study can contribute to the current literature. In addition, the standard anesthesia protocols and homogeneity of the patient groups were the strengths of the present study, because cognitive dysfunction following surgery is not only associated with anesthetic factors. Patient- and surgery-related factors may also contribute to this complicated entity. Finally, future large-scale studies may be required to validate the results obtained from the present study.

Conclusion

The present study showed that local, topical, and general anesthesia had no different effect on cognitive functions in adult patients undergoing cataract surgery. There was also no statistical difference in postoperative BOMC scores between the three anesthesia methods.

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