doi: 10.18484/2305-0047.2018.1.66

D.A. SHKURUPII, M.O. HARKAVENKO, D.A. KHOLOD

OPHTHALMOLOGICAL COMPLICATIONS OF GENERAL ANESTHESIA

Ukrainian Medical Stomatological Academy, Poltava,
Ukraine

Цель. Определить частоту и характер офтальмологических нарушений в зависимости от применения средств общей анестезии.

Материал и методы. Организовано проспективное когортное неинтервенционное исследование, в которое было включено 100 пациентов. Проводилось сравнение характера нарушений со стороны органа зрения в зависимости от проведенного вида общей анестезии. Клинические обследования включали стандартный периоперационный мониторинг, констатацию вида и характера фармакологического обеспечения анестезии, периоперационную оценку сатурации, неинвазивного артериального давления с определением его систолического, диастолического и перфузионного компонентов, офтальмологический осмотр, офтальмотонометрию, оценку качества слезной пленки, объема базовой секреции слезы, остроты зрения, цветового ощущения, периферического и бинокулярного зрения.

Результаты. Частота нарушений со стороны органа зрения и зрительного анализатора после проведения общей анестезии составляла 19% (n=19). Из них у 84,2% (n=16) пациентов наблюдалось несколько офтальмологических нарушений. Установлена связь изменений показателей артериального давления и частоты офтальмологических нарушений. При этом развитие офтальмологических нарушений преимущественно было связано с изменением перфузионного артериального давления (p=0,02). Направленность этих изменений зависела от применения определенного наркозного средства. Так, препараты группы гипнотиков (тиопентал натрия, пропофол) уменьшали офтальмотонус, секрецию слезы, стойкость слезной пленки, остроту зрения. Эти эффекты были более выражены у тиопентала натрия. Также доказана способность кетамина повышать офтальмотонус, вызывать слезотечение и нарушать зрительное восприятие за счет нарушения периферического и бинокулярного зрения. Офтальмологические нарушения в связи с применением седативных препаратов (диазепама) и наркотических анальгетиков (фентанила) доказаны не были.

Заключение. Нарушения со стороны органа зрения и зрительного анализатора после проведения общей анестезии носят преходящий характер и составляют 19%, из которых 84,2% случаев – комбинированные офтальмологические нарушения. Их возникновение зависит от показателей артериального давления и фармакологического действия примененных наркозных средств.

Ключевые слова: общая анестезия, осложнения анестезии, офтальмологические нарушения, зрение, острота зрения

Objective. To determine the frequency and nature of ophthalmic disorders, depending on the use of general anesthesia means.

Methods. A prospective cohort non-interventional study was organized, in which 100 patients were included. A comparison was made of the nature of the disturbances of the visual organ, depending on the type of general anesthesia performed. Clinical examinations included standard perioperative monitoring, determination of the type and nature of pharmacological support for anesthesia, perioperative assessment of saturation, noninvasive blood pressure with determination of its systolic, diastolic and perfusion components, ophthalmologic examination, ocular tonometry, quality assessment of tear film, volume of basal secretion of tear, visual acuity, color sensation, peripheral and binocular vision.

Results. The incidence of disturbances of the visual organ and the visual analyzer after general anesthesia was 19% (n=19). Of them, 84.2% (n=16) of patients had several ophthalmic disorders. The relationship between changes in the arterial pressure figures and the frequency of ophthalmic disorders was established. At the same time, the development of ophthalmic disorders was mainly associated with a change in perfusion blood pressure (p = 0.02). The character of these changes depended on the use of a certain anesthetic. Thus, the drugs of the hypnotic group (thiopental sodium, propofol) reduced the ophthalmotonus, tear secretion, tear film resistance, visual acuity. These effects were more pronounced in thiopental sodium. Also, the ability of ketamine to increase the ophthalmotonus, to cause lacrimation and to disturb visual perception due to disorder of peripheral and binocular vision was proved. Ophthalmic disorders resulted from the use of sedatives (diazepam) and narcotic analgesics (fentanyl) were not proven.

Conclusions. Disturbances of the visual organ and visual analyzer after general anesthesia are transient and account for 19%, of which 84.2% of cases are combined ophthalmic disorders. Their occurrence depends on the arterial pressure figures and the pharmacological effect of the anesthetics used.

Keywords: general anesthesia, complications of anesthesia, ophthalmic disorders, vision, visual acuity

Novosti Khirurgii. 2018 Jan-Feb; Vol 26 (1): 66-71
Ophthalmological Complications of General Anesthesia
D.A. Shkurupii, M.O. Harkavenko, D.A. Kholod

Научная новизна статьи
В проспективном когортном неинтервенционном клиническом исследовании изучены новые особенности влияния различных средств общей анестезии на развитие нарушений со стороны органа зрения и зрительного анализатора. Доказано, что такие нарушения после проведения общей анестезии носят преходящий характер и составляют 19%, из которых 84,2% случаев – комбинированные офтальмологические нарушения. Их возникновение зависит от показателей артериального давления и фармакологического действия примененных наркозных средств.

What this paper adds
In a prospective cohort non-interventional clinical study, new features of the influence of various means of general anesthesia on the development of disturbances from the visual organ and the visual analyzer were studied. Such disorders after general anesthesia are proved to be transient and account for 19% of which 84.2% of cases are combined ophthalmologic disorders. Their occurrence depends on the figures of arterial pressure and the pharmacological effect of the anesthetics used.

Introduction

According to official statistics, ophthalmic complications associated with anesthesia take the 11th place among all anesthesia complications (0.09-0.5%) [1]. However, their real frequency is much larger, as evidenced by the high proportion of lawsuits for this reason (2-3%) in Australia, the United Kingdom and the United States of America [2, 3]. Targeted studies demonstrate that during anesthesia, ophthalmologic complications occur in 44-59% of cases, but are not properly recorded [2, 3, 4, 5].

The most frequent complications are lagophthalmus due to a decrease in the tone of the circular eye muscle; hypolacrimation and blockade of spontaneous eye movements, which results in the drying of the cornea; mechanical injuries as a result of damage with anesthetic masks, devices to support airway patency, hands of anesthesiologist when checking the state of eyeballs; chemical traumas, mainly by the solutions of antiseptics [2, 3, 4, 5, 6, 7, 8].

The visual analyzer can be subjected to both direct and indirect effects of anesthetic agents on the receptors of the autonomic nervous system, opiate and gamma-aminobutyric acid antinociceptive systems, hypothalamic structures, cranial nerve nuclei and the visual cortex, triggering functional vision disorders, including blindness against the background of systemic hypotension during anesthesia [9].

Thus, specialists do not exclude the possibility of influencing the local and systemic reactions caused by anesthetic maintenance on the visual analyzer system, but data on their frequency are inconsistent, and information on prevention is limited.

Objective. To determine the frequency and nature of ophthalmic disorders, depending on the use of general anesthesia means.

Methods

A prospective cohort non-interventional study was organized, in which 100 patients were included. The study was conducted during 2015-2017 in medical institutions in Poltava, which are clinical bases of the Department of Anesthesiology with Intensive Therapy of the Ukrainian Medical Stomatological Academy.

During the study, a comparison was made of the nature of the abnormalities of the visual organ, depending on the type of general anesthesia performed. The criteria for inclusion in the study group were: age from 18 to 65 years, planned interventions for non-ophthalmological reasons, informed consent of patients. The criteria for exclusion from this group were: the presence of ophthalmologic pathology at the time of examination, the presence of hemodynamically significant changes in the cardiovascular system, a change in the tactics of anesthetic maintenance during the operation.

Prior to conducting the research, written informed consent were obtained from patients or their legal representatives. During the study, the rights of patients, as required by the 1975 Helsinki Declaration, as amended in 2005, were respected.

Patients in the study group underwent the planned laparoscopic cholecystectomy (diseases related to the headings of the International Classification of Diseases 10th Revision "k80-k83" "Disorders of the gallbladder, biliary tract and pancreas"). The duration of the operations was 2.5±0.6 hours (Me=2.7, 50L=2.1, 50U=3.2).

All patients underwent total intravenous anesthesia with endotracheal intubation and artificial ventilation. As a muscle relaxant, atracurium besilate was used

In the study group, during general anesthesia the combinations of anesthetics were used at this frequency:

- thiopental sodium – 66% (n=66);
- diazepam – 100% (n=100);
- ketamine – 92% (n=92);
- fentanyl – 100% (n=100);
- propofol – 26% (n=26).

All preparations were used in doses corresponding to the manufacturers' instructions approved by the orders of the Ministry of Health of Ukraine.

General clinical trials included standard

perioperative monitoring in accordance with the form of the primary accounting document 003-3/o "Preoperative examination by anesthesiologist and protocol of general anesthesia" approved by the Order of the Ministry of Health of Ukraine 110 dated February 14, 2012, and also a statement of the type and nature of pharmacological support anesthesia.

Instrumental monitoring included perioperative assessment of saturation (SaO2) and noninvasive blood pressure (BP) with determination of its systolic (BPs), diastolic (BPd), and perfusion (BPp) components using a patient monitor YM 300-12 (LLC "Company" Yutas ", Ukraine).

Ophthalmological clinical and instrumental research was conducted before and 2 hours after anesthesia by ophthalmologists of the relevant medical and preventive institutions, and included [10]:

– ophthalmologic examination using the PanOptic panoramic ophthalmoscope Welch Allyn (USA);

– ocular tonometry with the help of indicator of intraocular pressure IGD-02 “PRA” Diathera (Russia), followed by the calculation of perfusion pressure of the eye, which was calculated as the difference between BPp and intraocular pressure;

– evaluation of the quality of tear film from the time of its rupture with the use of portable keratoscope “Placido”;

– evaluation of the volume of basic secretion of tear film by means of Schirmer’s test with a filter paper;

– determination of visual acuity using the Golovin-Sivtsev table and its further calculation by Snellen chart;

– research of color sensation with the help of Rubkin's tables;

– evaluation of peripheral vision by an approximate method of visualizing the object;

– investigation of binocular vision by the method of adjusting motion.

Statistics

The statistical processing of the results was carried out using the Microsoft Office Excel 2003 software package. The nature of the mathematical data distribution was considered to be different from normal, and nonparametric methods of statistical data evaluation were used: median (Me), quartile range (50L, 50U), a criterion for signs with estimation of the sum of atypical shifts with respect to the tabular critical value (Gcrit). The correlation between the phenomena was established using the Spearman’s rank correlation coefficient (R). In the statistical processing of data, the minimum level of error-free forecast was P=0.95 and, accordingly, the level of probability of type I error – $p \leq 0.05$.

Results

Among 100 patients examined, the incidence of abnormalities from the visual organ and visual analyzer after general anesthesia was 19% (n=19). Of them, 84.2% of patients (n=16) had several ophthalmic disorders. Patients noted a feeling of dryness of the cornea, double vision, inability to focus their vision, reduced visual acuity, change of color perception.

These disorders were transitory in nature, did not pose a threat to the development of vital dysfunctions or persistent disability, but affected the quality of patient’s comfort in the post-anesthesia period.

During the general anesthesia, significant changes in blood pressure and SaO2 were not established. However, the correlation analysis showed a direct correlation of the overall frequency of visual impairment with:

– BPs: R=0.3; p=0.06;

– BPd: R=0.4; p=0.05;

– BPp: R=0.6; p=0.02.

At the same time, the increase in BPp was associated not only with an increase in the ophthalmotonus, but also with visual perception, in particular with:

– with a change in color sensation: R=0.4; p=0.04;

– with disorder of peripheral vision (in the form of metamorphopsia): R=0.4; p=0.04;

– with a disorder of binocular vision: R=0.3; p=0.03.

Quantitative indicators of the state of the vision system (Table 1) indicate both the disorder of the

Table 1

Indicators of the state of the vision system in general anesthesia (n=100)

Indicator	Before surgery			Two hours after surgery			Number of shifts			G_{crit}	p
	Me	50L	50U	Me	50L	50U	zeroth	typical	atypical		
Ophthalmotonus, mm Hg	20	18	24	32	29	35	5	72	23	38	<0.05
Perfusion eye pressure, mm Hg	75	61	80	66	62	70	17	48	35	33	>0.05
Time of tear film rupture, s	30	27	34	30	27	36	21	45	34	31	>0.05
Basic secretion of tear film, cm	1.2	1.1	1.3	1.4	1.1	1.5	10	48	42	36	>0.05
Visual acuity, conventional units	1.0	1.0	1.0	0.9	0.9	1.0	9	66	25	36	<0.05

ophthalmotonus and the change in visual acuity during general anesthesia.

The effect of different anesthetics on the formation of ophthalmic disorders is given in Table 2.

Discussion

The results of the above statistical analysis indicate that the incidence of abnormalities of the visual organ obtained in this study (19%, of which 84.2% are combined disorders) is higher than the frequency of such cases according to the literature [1,2,3, 4, 5]. But these cases were of a transitory nature and had no lethal and disabling effects.

The relationship between the change in BPp and the frequency of visual disturbances was established, including changes in the ophthalmotonus and visual impairment (in particular, with a change in color perception, metamorphosis, a disorder of binocular vision). The quantitative indicators of the state of the vision system in the postoperative period such as indicators of ophthalmotonus and visual acuity also changed.

In this case, the direction of these changes depended on the use of a certain anesthetic. Thus, preparations of the hypnotics group reduced ophthalmotonus, secretion of tears, tear film strength, visual acuity. These effects were more pronounced in thiopental sodium. At the same time, the obtained data testify to the ability of ketamine dysplectic to raise the ophthalmotonus, to cause lacrimation and to disturb visual perception due to the disorder of peripheral and binocular vision. The use of sedatives and narcotic analgesics did not have a significant effect on the development of disorders of the vision organ.

Similar results were associated with systemic influence and mechanisms of the central action of anesthesia. Thus, hypnotic drugs caused dryness of the cornea, reducing the time of rupture and secretion of tears, probably due to oppression of the corneal reflex and blinking. In addition, with the use of sodium thiopental, ophthalmotonus decreased and visual acuity decreased, which is explained by its ability to develop arterial hypotension. The absence of a significant decrease in ophthalmotonus with the use of propofol, which also has an antihypertensive effect, is probably associated with the mode of its administration by constant drop infusion [11, 12]. [11, 12].

Ketamine is a representative of the group of dysleptics and has a sympathicotonic effect, which was probably the cause of an increase in the ophthalmotonus and, due to the disregulation of the connections of the nerve (including the visual) centers through the action on the limbic system of the brain, could cause changes in color sensations, and binocular vision. The latter disorder could also arise due to the action on the nuclei of the third and fourth pairs of cranial nerves, which led to the appearance of transient strabismus in the awakening and postoperative period [13, 14].

Thus, ophthalmologic disorders due to anesthesia are manifested more often than conventional indicators state, but they are mostly transient. The use of general anesthesia predominantly influences changes in the visual perception. Taking into consideration the analysis of the actions of anesthetics in people with normal initial vision, one can expect a high incidence of ophthalmological complications after general anesthesia in individuals with diseases of the vision organ; an individual tactic of choosing means for general anesthesia is required.

Table 2

Correlation of the frequency of ophthalmological disorders depending on the type of anesthetic (n=100)

№ п/п	Character of violation	Correlation with the use of:									
		thiopental sodium (n=66)		propofol (n=26)		diazepam (n=100)		fentanyl (n=100)		ketamine (n=92)	
		R	p	R	p	R	p	R	p	R	p
1.	Traumatic injuries	0.1	0.9	0	-	-0.1	0.06	-0.1	0.06	0.1	0.06
2.	Increased ophthalmotonus	0.1	0.06	0.1	0.06	0.4	0.06	0.1	0.06	0.4	0.04
3.	Decreased ophthalmotonus	0.4	0.04	0.3	0.05	0.1	0.06	0.3	0.06	-0.4	0.04
4.	Increased tear film rupture time	0.1	0.06	-0.4	0.07	0.1	0.06	-0.4	0.07	0.4	0.07
5.	Decreased tear film rupture time	0.3	0.04	0.4	0.06	0.3	0.07	0.4	0.06	-0.4	0.07
6.	Increased baseline secretion of tear film	-0.2	0.06	0.1	0.07	-0.2	0.06	0.1	0.07	0.6	0.07
7.	Decreased baseline secretion of tear film	0.4	0.04	0.2	0.04	0.4	0.07	0.2	0.06	-0.6	0.07
8.	Decreased visual acuity	0.3	0.04	-0.2	0.06	-0.1	0.06	-0.2	0.06	-0.2	0.06
9.	Change in color sensation	0.4	0.06	-0.1	0.06	0.4	0.06	-0.1	0.06	0.4	0.04
10.	Impaired peripheral vision (in the form of metamorphopsia)	0.1	0.06	0.1	0.06	0.1	0.06	0.1	0.06	0.7	0.02
11.	Disturbance of binocular vision	0.1	0.06	0.4	0.07	0.1	0.06	0.4	0.07	0.7	0.01

Conclusions

1. Impairments of vision and of visual analyzer after a general anesthesia are transient and account for 19% of which 84.2% of cases are combined ophthalmological disorders.

2. Occurrence of ophthalmological disorders associated with anesthesia depends on the systemic BP values, the change of which changes the ophthalmotonus and perfusion pressure of the eye.

3. The use of hypnotics (mainly - thiopental sodium) with general anesthesia leads to a decrease in ophthalmotonus, tear film resistance, visual acuity.

4. The use of dysleptics (ketamine) indicates its ability to lead to an increase in the ophthalmotonus, cause lachrymation and impair visual perception due to disorder of peripheral and binocular vision.

Funding

The work was carried out in accordance with the plan of scientific works of Ukrainian Medical Stomatological Academy. The authors did not receive financial support from the manufacturers of medicines.

Conflict of interest

The authors declare that they have no conflict of interest.

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Адрес для корреспонденции

36011, Украина,
г. Полтава, ул. Шевченко, д. 23,
ВГУЗ Украины «Украинская медицинская стоматологическая академия»,
кафедра анестезиологии с интенсивной терапией,
тел.: +380 532 60-95-81,
e-mail: d.a.shkurupiy@gmail.com,
Шкурупий Дмитрий Анатольевич

Сведения об авторах

Шкурупий Дмитрий Анатольевич, д.м.н., доцент кафедры анестезиологии с интенсивной терапией, Украинская медицинская стоматологическая академия, г. Полтава, Украина.
http://orcid.org/0000-0003-3803-4444
Гаркавенко Максим Александрович, магистрант кафедры анестезиологии с интенсивной терапией, Украинская медицинская стоматологическая академия, г. Полтава, Украина.
http://orcid.org/0000-0002-1091-0855
Холод Дмитрий Анатольевич, аспирант кафедры анестезиологии с интенсивной терапией, Украинская медицинская стоматологическая академия, г. Полтава, Украина
http:// orcid.org/0000-0001-6381-216X

Информация о статье

Поступила 19 апреля 2017 г.
Принята в печать 28 августа 2017 г.
Доступна на сайте 5 февраля 2018 г.

Address for correspondence

36011, Ukraine,
Poltava, Shevchenko Str., 23,
Ukrainian Medical Stomatological Academy,
Department of Anesthesiology
with Intensive Therapy
Tel: +380 532 60-95-81,
e-mail: d.a.shkurupiy@gmail.com,
Shkurupii Dmytro A.

Information about the authors

Shkurupii Dmytro A., MD, Associate Professor of the Department of Anesthesiology with Intensive Therapy, Ukrainian Medical Stomatological Academy, Poltava, Ukraine.
http://orcid.org/0000-0003-3803-4444
Harkavenko Maxim A., Applicant for Master's Degree of the Department of Anesthesiology with Intensive Therapy, Ukrainian Medical Stomatological Academy, Poltava, Ukraine.
http://orcid.org/0000-0002-1091-0855
Kholod Dmytro A., Post-Graduate Student of the Department of Anesthesiology with Intensive Therapy, Ukrainian Medical Stomatological Academy, Poltava, Ukraine.
http:// orcid.org/0000-0001-6381-216X

Article history

Arrived 19 April 2017
Accepted for publication 28 August 2017
Available online 5 February 2018