

Application of Different Options of Combined Inhalation Anesthesia for Intraocular Interventions in Children

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Abstract Prevention and elimination of increased intraocular pressure is one of the most important tasks of an anesthesiologist during ophthalmic operations, therefore, the search for optimal anesthesia schemes is an urgent problem of modern anesthesiology. The aim of the work was to evaluate the effectiveness of combined methods of anesthesia in intraocular surgery in children by analyzing hemodynamic parameters. We examined 46 children who needed ophthalmological operations. The following anesthesia schemes were used: sevoflurane + fentanyl (group 1), propofol + fentanyl (group 2). Anesthesia effectiveness was assessed on the basis of clinical data with monitoring of the main hemodynamic and respiratory parameters. The results showed that the anesthesia regimens used were characterized by a smooth clinical course, while maintaining the stability of the main hemodynamic parameters.

Keywords Anesthesia, Children, Hemodynamics, Intraocular pressure, Ophthalmic operations

1. Relevance

Ophthalmic operations, like any surgical interventions, require anesthesia and elimination of discomfort for the patient associated with the necessary manipulations. Anesthesia allows for both short-term outpatient and complex long-term surgical procedures, the purpose of which is restoration of vision, reconstruction of the orbit, and elimination of cosmetic defects. The specificity of intraocular operations is associated with the problems of local hemostasis, blood circulation, regulation of ophthalmotonus, which requires special training from the anesthesiologist [1,2,3,4]. In pediatric anesthetic practice, the problem of anesthesia remains associated with the development of possible complications, the development of an oculocardial reflex (slowing heart rate up to cardiac arrest), oculogastric (hiccups, vomiting) or oculo-respiratory (breath holding, laryngospasm) [5,8,12]. A wide selection of drugs for anesthesia (fentanyl and inhalation anesthetics) in the first positions, requires their adequate combinations, maintaining the stability of the state of central hemodynamics, taking into account their both positive and negative characteristics, as well as noting the ability of drugs to reduce intraocular pressure, which is important in pediatric ophthalmosurgery [6,9,10]. In this regard, the choice of various options for combined anesthesia that adequately provides anesthesia and does not have negative

effects on the body of children with intraocular interventions remains relevant [7,11].

Purpose of references: Improving the anesthetic protection of children using inhalation anesthesia with sevoflurane for intraocular interventions.

2. Material and Methods

To provide anesthetic protection in 46 sick children during ophthalmic surgery, the following combinations were used: fentanyl with sevoflurane - group 1 - 24 patients (52.2%), fentanyl with propofol - group 2 - 22 patients (47.8%).

Children aged 3-6 years accounted for 34.8% of the total number of patients, 7-10 years old - 34.8% and older (11-14 years old) - 30.4%.

Anesthesia was performed during operations with opening the anterior chamber of the eye (congenital glaucoma); congenital and traumatic cataracts with artificial lens implantation; cataract extraction; the duration of anesthesia in 59.4% of patients was up to 1 hour, in 40.6% - up to 2 hours.

Patients of group 1 after premedication started inhalation of sevoflurane up to 3 vol%. Fentanyl was administered intravenously at a dose of 0.003 µg / kg.

During induction, patients of the second group were started with intravenous administration of propofol at a dose of 3 mg / kg, and a solution of fentanyl at a dose of 0.004 µg / kg was administered. Patients of both groups underwent tracheal intubation against the background of the administration of arduan at a dose of 0.006 mg / kg. The mechanical ventilation was carried out by the device Drager - "Fabius Plus" (Germany) along a semi-closed circuit.

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Muscle relaxation was supported by the introduction of 1/3 of the main dose of Arduan. Anesthesia was maintained by repeated administration of fentanyl at a dose of 50% or 25% of the initial dose. In the first group, anesthesia was maintained by inhalation of sevoflurane at a dose of 1.0-1.8 vol% and repeated fractional administration of fentanyl (50% or 25% of the initial dose), in the second group, anesthesia was maintained by intravenous administration of propofol through a lineomat at a dose of 7.5 mg / kg / hour and repeated fractional administration of fentanyl (50% or 25% of the initial dose). Infusion therapy was carried out at a rate of 5-7 ml / kg / hour. After the end of the operation, tracheal extubation was performed against the background of adequate spontaneous breathing. The average awakening time for patients in the first group was 11.8 ± 0.8 minutes, for patients in the second group it was 15.5 ± 2.2 minutes.

The study of hemodynamic parameters was carried out on a SonoScape echocardiograph (Italy) with a 3.5 MHz transducer according to the standard protocol. To assess the functional state of the cardiovascular system during anesthesia, the following indicators were studied: stroke index (SI), cardiac index (CI) and total peripheral vascular resistance (OPSS). Stroke index (ml / m^2) = Stroke volume of the heart / Body surface area. Cardiac Index ($\text{L} / \text{min} / \text{m}^2$) = Circulatory Minute / Body Surface Area. Total peripheral vascular resistance = Systolic blood pressure / Heart index. The expulsion fraction indicator - (PI) of the left ventricle (LV) is an integral measure of myocardial contractility, which characterizes the value of the volume of ejected LV blood in relation to its diastolic volume.

The measurement of intraocular pressure was carried out according to A.N. Maklakov before and after surgery [6]. Normal IOP is 16-23 mm Hg. Art.

The results of clinical and functional studies were processed by the method of variation statistics Student's t-test.

3. Research Results and Their Discussion

The results of the study of hemodynamic parameters in children of group I (fentanyl + sevoflurane) are presented in

table 1.

Compared with the initial data, against the background of premedication, there was an increase in heart rate by 17.5% and a decrease in specific peripheral resistance (UPS) by 20.7%. It should be noted that the patients of the first group reacted more significantly to the induction of anesthesia and anesthesia. Even before the induction of anesthesia, they had tachycardia and a moderate rise in blood pressure, which was associated with the psychoemotional stress of the patients. Other indicators changed slightly. After the introduction of fentanyl, hemodynamic parameters such as SI, CI, PI and heart rate decreased in comparison with those of the premedication period, respectively, by 14.2% ($P < 0.05$), 3.4%, 8.6%, 4.2% and 2.3, excluding OOPS. The revealed significant differences in the response of systemic hemodynamics are associated with the characteristics of the pharmacological action of both fentanyl and sevoflurane. 10 minutes after intubation, there was a significant increase in SI by 20.4%, CI by 21.7%, at the same time, there was a decrease in UPS by 13.86% ($p < 0.05$).

There is a tendency towards a decrease in the expulsion fraction (EF).

Under the influence of drugs for premedication in patients of the second group (Table 2), the following hemodynamic changes were observed: an increase in heart rate by 6.5% ($p < 0.05$), SI by 2.5%, CI by 2.3%, UPS by 2.74% and PI by 1.11% ($P > 0.05$) associated with emotional discomfort before surgery and exposure to premedication drugs.

At the stage of induction of anesthesia, slight changes in hemodynamic parameters were observed, for example: UI, HR, SI by 1.44%, 2.42%, 1.48%, respectively. At the same time, UPS and PI increased insignificantly - by 0.1% and 0.13%, respectively, which turned out to be statistically insignificant ($P > 0.05$). A significant decrease in comparison with the premedication stage was revealed in relation to the heart rate, which decreased by 12.01% ($p < 0.05$). Considering the hypotensive effect of fentanyl, sevoflurane and propofol, infusion therapy was started without waiting for a critical drop in blood pressure, regardless of its initial value, at a minimum rate. This approach made it possible to prevent, and in some cases completely neutralize the critical drop in blood pressure at all stages of anesthetic treatment.

Table 1. Hemodynamic parameters during combined anesthesia with fentanyl and sevoflurane ($M \pm m$)

Indicators	Research stages (n = 10)				
	Exodus	Premewildtion	Induction into anesthesia	Traumatic stage	End of the operations
UI, ml / m^2	42,14±0,99	39,34±1,69	33,75±0,96***	39,22±2,11	41,33±1,04
Heart rate, min^{-1}	113,0±6,64	132,8±5,9	129,1±3,15	124,9±6,15	117,7±5,89
SI, $\text{l} / \text{min} \times \text{m}^2$	4,82±0,41	4,9±0,28	4,48±0,29	4,66±0,26	4,83±0,27
UPS, conv. units	18,18±1,57	14,41±1,07	17,0±0,73	17,63±1,44	15,57±1,48
FI, %	62,73±1,66	65,09±2,89	62,36±2,7	63,19±3,16	65,57±2,24

*- reliability of differences in indicators compared with the baseline value ($p < 0.05$)

** - reliability of differences in indicators compared with the previous stage of the study ($p < 0.05$).

Table 2. Changes in hemodynamic parameters during general anesthesia with fentanyl in combination with propofol (M ± m)

Indicators	Stages of surgery and anesthesia (n = 30)				
	Exodus	Premedication	Induction into anesthesia	Traumatic the first stage of the operation	End of operation
UI, ml / m ²	47,26±1,61	48,44±1,59	46,58±1,3	47,14±1,41	47,38±3,27
Heart rate, min ⁻¹	119,13±1,82	126,81±2,2*	119,06±2,25**	120,54±2,06	123,94±2,02
SI, l / min x m ²	4,73±0,16	4,84±0,16	4,66±0,13	5,61±0,23***	5,97±0,51*
UPS, conv. units	68,29±5,03	70,16±5,39	68,36±4,82	68,13±5,05	72,72±8,13
FI,%	63,76±0,57	64,47±0,72	63,84±0,48	63,51±0,55	63,73±0,47

* - reliability of differences at $p < 0.05$ compared with the baseline value

** - reliability of differences at $p < 0.05$ compared with the previous stage of the study

At the end of the operation, hemodynamic parameters remained stable. The changes in the studied indicators at the stages of the operation, ascertained by us, were unreliable, except for the SI indicator. In relation to their initial value, there was some change, which was expressed by an increase in SI by 26.2% ($p < 0.05$).

Intraocular pressure was studied. Table 3 shows the results of measuring intraocular pressure.

Table 3. The value of intraocular pressure depending on the option of anesthetic aid

Type of anesthesia	Before surgery, mm Hg Art.	After surgery, mm Hg Art.
Fentanyl + Sevoflurane	26,8±1,67	23,2±1,37
Fentanyl + Propofol	24,2±1,21	22,4±1,39

In patients of the first group in the postoperative period, there was a slight decrease in IOP by 13.43%, in group 2 - by 7.44% ($P < 0.05$).

In the discussion, it should be noted that the indicators of central hemodynamics in patients of group 1 indicated the presence of moderate hypodynamia of blood circulation. Sevoflurane mainly affected the tone of the peripheral vascular bed, causing vasoplegia. At the same time, fentanyl decreased cardiac output, increasing vascular vasoplegia. This condition was eliminated against the background of infusion therapy. In children of the second group, the reasons for the decrease in the SI indicator were the presence of rigidity of the microvasculature, limited contractile capabilities of the heart muscle, and a relative deficit of the BCC. With the use of fentanyl and sevoflurane, patients fell asleep smoothly and quickly, without signs of agitation, the stability of hemodynamic parameters during all periods of anesthesia and in the early post-narcotic period. The postoperative period was uneventful - the awakening of patients occurred without pronounced signs of excitement, changes in hemodynamics. This made it possible to perform early extubation of patients and transfer them to the ophthalmology department for further treatment. With the combination of sevoflurane with fentanyl, there was no increase in intraocular pressure, and general anesthesia occurred predictably quickly, proceeded stably, followed by a quick and smooth recovery of consciousness and somatic functions without straining and vomiting. Thus, combined

anesthesia with fentanyl and sevoflurane makes it possible to create the most adequate conditions for surgical correction, minimize the negative effects of its individual components, and maximize the specific tasks of anesthesia during ophthalmic operations in children.

4. Conclusions

1. Changes in hemodynamic parameters depending on the method of anesthesia during intraocular ophthalmic operations in children were insignificant and were of a compensatory nature, which indicated the effective anesthetic protection of the child's body from surgical trauma.
2. Anesthesia based on inhalation anesthetics in combination with fentanyl is accompanied by a decrease in intraocular pressure, which creates optimal conditions for surgical interventions in children with increased intraocular pressure.

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