ECRONICON OPEN ACCESS

EC PAEDIATRICS
Review Article

Our Experience with the Use of Sevoflurane Inhalation Anesthetic in One-Day Surgery in Children

Nasibova EM*

Azerbaijan Medical University, Baku, Azerbaijan

***Corresponding Author**: Nasibova EM, Azerbaijan Medical University, Baku, Azerbaijan.

Received: January 28, 2020; **Published:** February 19, 2020

Abstract

Introduction: The choice of the optimal method of anesthesia in one-day surgery in children to this day remains open and relevant.

Aim of the Study: To determine the advantages and disadvantages of the use of sevoflurane in one-day surgery in children and to develop a methodology for anesthesia with it.

Materials and Methods: The study was conducted in the surgical clinic of the Azerbaijan Medical University from 2014 to 2018. The study included 106 children aged 0 to 16 years with a risk of ASA grade I and II anesthesia, who were operated on as planned in one-day surgery in the departments neonatal surgery, abdominal surgery, urology, maxillofacial, ophthalmology, laryngotorhinology, neurosurgery, traumatology and orthopedics. Induction anesthesia and maintenance of anesthesia in patients of this group was carried out by inhalation of sevoflurane through a facial mask and a bolus of fentanyl. Depending on age, this group was divided into 3 subgroups: IA (n = 56) age 0 - 3 years, IB (n = 24) - 4-7 years, IC (n = 26) - 8 - 16 years. At the time of anesthesia with sevoflurane, the children did not have concomitant severe systemic neurological, cardiovascular and bronchopulmonary diseases and the general condition was assessed as satisfactory.

Results of the Study: Our own practical experience in one-day surgery in children allowed us to develop and successfully use the algorithm of various anesthesia options with sevoflurane in children:

1. Features of step-by-step (step-by-step) anesthesia with sevoflurane with oxygen without preliminary filling of the respiratory circuit.
2. "Bolus" induction with preliminary filling of the anesthesia apparatus circuit with a mixture containing 6 - 8 vol% sevoflurane.

Conclusion: The anesthesia technique of sevoflurane + fentanyl was fast and safe for the patient and operating personnel, with the correct observance of the algorithm for its implementation:

1) The correct filling of the respiratory circuit, maintaining the parameters of the gas flow and the concentration of anesthetic on the evaporator and in the circuit;
2) Thorough tightness of the system "patient-anesthesia apparatus";
3) Maintaining a high gas flow in the respiratory circuit for another 2 minutes after the end of the induction of anesthesia and the transition to a maintenance concentration of anesthetic.

Keywords: *Sevoflurane; One-Day Surgery; General Anesthesia*

Introduction

In order to objectively assess the state of vital functions of the body in the examined patients, as well as for a comparative analysis of various anesthesia techniques using sevoflurane in children, the following criteria and research methods were used:

- Assessment of the comfort of anesthesia;
- Assessment of the rate of loss of consciousness and the development of the surgical stage of anesthesia;
- Assessment of the manifestation of critical incidents with the use of sevoflurane;
- Determination of heart rate;
- Non-invasive determination of systolic, diastolic, mean blood pressure;
- Determination of respiratory rate;
- Pulse oximetry (SpO_2).

The time of loss of consciousness is from the moment the mask is applied to the face until the termination of contact with the child.

Lack of response to pain during catheterization of the vein and motor reaction.

The presence of critical incidents during the induction of anesthesia in children who did not receive premedication (to exclude the influence of other drugs): the incidence of cough, apnea, motor excitement, laryngospasm, hypersecretion and vomiting was evaluated.

The study of the functions of the cardiovascular and respiratory systems. In all patients who underwent induction of anesthesia with sevoflurane, continuous monitoring of electrocardiography was performed in standard II lead, heart rate, pulse oximetry (SpO_2), respiratory rate, capnometry.

The study in patients of this group was carried out at the following stages of anesthesia:

- Stage I - Before sedation;
- Stage II - After sedation;
- Stage III - Induction into anesthesia;
- Stage IV - Skin incision;
- Stage V - The most traumatic moment of the operation;
- Stage VI - The awakening of the patient.

For an objective assessment of the data obtained upon awakening of patients, a system was used to evaluate the level of respiration, motor activity and consciousness recovery according to the scale proposed by Aldret. Indicators were recorded at 5, 10, 15 and 20 minutes after the end of the operation. According to this system, a score of 8 or higher is considered a completely reliable indicator for transferring a patient to a general ward.

One of the main points when conducting anesthesia with sevoflurane is the psychological preparation for the induction of anesthesia. The anesthetist in the presence of parents explained to the child the need for anesthesia, showed a mask, offered to hold it in his hands. If the child was aware of the need for the upcoming operation, they explained to him that in the operating room he would "breathe a mask, sleep soundly, feel nothing, and wake up in the room in the presence of his mother". And if the child did not admit the fact of the forthcoming surgical intervention and kept it from him, then they explained to him the need for "inhalation with sweet air" or offered "to play astronauts". Upon receipt of the child in the hospital, he was re-examined by an anesthetist. Systemic hemodynamic parameters were recorded before premedication and 30 minutes after the action of the drugs, after which the child was transported to the operating room for surgery. It should be noted that the age norm of a number of indicators, such as heart rate, stroke volume of the heart, mean arterial pressure, respiratory rate and tidal volume has a fairly wide variability. Deviations within +/- 20% were accepted as normal. Changes in indicators of the above values were regarded as pronounced and these patients were excluded from the subsequent study.

Premedication as a routine method of pre-narcotic preparation was carried out only in patients with severe psycho-emotional lability, negative reaction to the environment and medical personnel. In all patients of this group, the vegetative Kerdo index was determined. With a positive value of the Kerdo index (> 7), midazolam 0.4 mg/kg was used orally 20 - 30 minutes before the start of anesthesia. Because this meant a predominance of sympathetic tone due to stress. In all children of this group, induction of anesthesia was carried out in a mask way. Induction of anesthesia was carried out in a mask method with a high gas flow (5 - 6 liters per minute) through a half-closed breathing circuit, since this allows you to quickly control the alveolar concentration of the anesthetic, then with a transition to a low stream of fresh gas (a mixture of oxygen and air 1: 2, with a flow of 2 l/min) during the period of maintaining anesthesia, using an anesthetic apparatus Drager Fabius Plus with an evaporator for sevoflurane. The drug "Sevoran" was used (Abbott, USA, 250 ml bottles). Patient spontaneous breathing was maintained at all stages of surgery.

We have applied the following induction techniques:

1. Stepwise (stepwise) induction of anesthesia with sevoflurane in an oxygen stream without first filling the respiratory circuit. Anesthetic delivery began as a mixture containing 1% sevoflurane with oxygen with a gradual increase in the concentration of anesthetic on the evaporator by 1 vol% for every 3-4 breaths of the patient.

2. Quick induction with pre-filling the anesthesia apparatus circuit with a mixture containing 6-8 vol% sevoflurane.

Results of the Study

Our own practical experience in one-day surgery in children allowed us to develop and successfully use the algorithm of various anesthesia options with sevoflurane in children.

Features of step-by-step (step-by-step) anesthesia with sevoflurane with oxygen without preliminary filling of the respiratory circuit.

With this anesthesia technique, the following algorithm of action was used:

- Turn on oxygen with a flow of 8 l/min;
- Put a mask on the patient's face and ask him to breathe calmly;
- Set 2 -3% vol. On the sevoflurane evaporator, then every 3 - 4 breaths of the patient increase the value of the sevoflurane concentration indicator on the evaporator by 1 vol% until the maximum value of 8 vol% is reached.

- Continue induction on the background of the patient's calm breathing until there are signs of the development of the surgical stage of anesthesia (central location of the pupils, calm, even breathing, lack of motor reaction during venipuncture and peripheral vein catheterization).

In our clinical practice, we encountered the following negative aspects of this technique:

- Slower technique;
- Prolongs the phase of excitation;
- A higher level of cough and agitation compared to other methods.

"Bolus" induction with preliminary filling of the anesthesia apparatus circuit with a mixture containing 6 - 8 vol% sevoflurane.

This technique is carried out in two ways:

1. Induction initiated by rapid saturation with a mixture containing 6-8 vol% sevoflurane (used in contact children older than 5 years old, able to take a deep breath and hold their breath at the height of the inspiration);
2. Induction with a mixture containing 6-8% vol. sevoflurane with calm breathing of the patient ("over-pressure") was used in all other children.

The main feature of the "bolus" method of induction by sevoflurane, which ultimately determines the speed, safety, frequency of critical incidents and the cost of induction anesthesia, is that even with the first inhalation, at the induction stage, the patient receives a mixture containing high concentration of sevoflurane. For this, it is necessary first of all to fill the respiratory circuit of the anesthesia apparatus with this mixture. When conducting induction in this way, one of the main issues facing us is how to properly fill the respiratory circuit:

1. Set the safety valve of the anesthesia apparatus to the position of 30 cm water column.
2. Set the fresh gas flow to 5 - 6 l/min.
3. Set the concentration of sevoflurane on the evaporator to 8 vol%.
4. Seal the tee (connector outlet) of the circuit to the patient mask tightly.
5. Squeeze the bag of the reservoir of the respiratory circuit with your hands after filling it at least 2 - 3 times (or just squeeze for 2 minutes).
6. Do not use the "Presh" button to speed up bag filling - gas flow bypasses the evaporator.

As can be seen from table 1, the filling of the respiratory circuit with a gas mixture occurs unevenly.

Index	**The concentration of sevoflurane in the circuit Fi Sev,%**			
Time	1 minute	2 minute	3 minute	4 minute
Gas flow 8 l/min	5,1	6,9	7,4	7,8
Gas flow 4 l/min	3,1	5,0	6,2	6,9

Table 1: The values of the concentration of sevoflurane when filling the respiratory circuit depending on time.

According to the gas analyzer screen, when initially setting the concentration of sevoflurane on the evaporator is 8 vol% and the gas flow on rotameters is 8 l/min after 1 min. the anesthetic concentration in the circuit increased rapidly and amounted to 5.1 vol%, after 2 minutes 6.9%, then the process slows down and by the end of 3 minutes the concentration of sevoflurane in the circuit rises to 7.4%, and after 4 minutes is 7.8%. The slowdown in the saturation of the circuit with anesthetic over time is exponential, since the filling rate is a derivative of the pressure gradient between the evaporator and the circuit.

At the same time, there was no clinical difference in the rate of induction of anesthesia with the concentration of sevoflurane in the circuit 6.9% (after 2 minutes from the beginning of filling) or 7.8% (after 4 minutes from the beginning of filling). But filling the circuit with a gas mixture containing lower concentrations of sevoflurane or reducing the gas flow when filling the circuit led to a significant lengthening of the saturation time of the circuit and increased consumption of sevoflurane.

It should also be noted that this technique of induction of anesthesia with preliminary "bolus" filling of the respiratory circuit to high concentrations of sevoflurane (8 vol%), induction while maintaining a high concentration for 2 - 4 minutes, using a high flow of fresh gas (6 - 8 l/min) and a small positive pressure at the end of exhalation in the respiratory circuit (5 cm water column) is called the "over-pressure" method. This technique reflects the desire to accelerate the saturation of the alveolar space, blood and tissues with anesthetic and, therefore, helps to accelerate the loss of consciousness and the development of anesthesia. This is an advantage of this technique both for the patient, who sometimes does not even have time to remember the smell of the drug - psychological comfort, and for the anesthetist (quick induction, compared in speed with intravenous anesthesia to propofol). If at the same time, at the moment of induction, the child can take a deep breath from the circuit filled with a high concentration of inhaled anesthetic and hold his breath at the inspiratory height for several seconds, while loss of consciousness will occur at the end of 2 - 4 breaths of the gas-narcotic mixture from the respiratory circuit This method is also called "bolus" induction, which is used specifically for the induction of anesthesia with sevoflurane.

Algorithm for induction of anesthesia with sevoflurane according to the induction method, initiated by rapid saturation of the lungs:

1. Turn on the oxygen flow of 8 l/min, set the concentration of sevoflurane on the evaporator to 8 vol%, tightly close the "tee", set the safety valve (APL) of the anesthesia apparatus to 30 cm of water.

2. Fill the breathing circuit with a mixture of sevoflurane and oxygen to a FiSev value of 6 - 8% on the gas analyzer screen (squeeze the reservoir bag by hand after filling 3 - 4 times).

3. Immediately before applying the mask to the patient's face, the safety valve of the anesthesia apparatus is set to 5 cm water column.

4. The patient is asked to exhale as deeply as possible, then they put a mask on his face and are asked to take as deep a breath as possible, after which he can hold his breath for as long as possible. And until they lose consciousness, they are asked to repeat deep breaths.

With this technique, the induction of anesthesia lasts 2 - 5 minutes. After 2 minutes, venipuncture and catheterization are performed, if this is not done in the ward. Next, the concentration of sevoflurane is reduced to 1 - 3 vol% and fentanyl is administered at a dose of 2 - 3 μg/kg. The maintenance concentration of sevoflurane is 1-1.5 MAK. On the rotameters of the anesthesia apparatus, a high flow of fresh gas of 6 - 8 l/min is maintained for 2 minutes after the "bolus" induction of anesthesia. After 2 minutes, the oxygen supply is reduced to 2 l/min and the skin incision begins.

The algorithm of the technique is "fast induction" of anesthesia during spontaneous breathing of the patient:

1. Turn on the oxygen flow of 8 l/min.

2. The respiratory circuit is saturated with sevoflurane to FiSev values of 6 - 8 vol% on the gas analyzer screen, as described in the previous procedure.

3. Apply a mask to the patient's face.

4. The patient breathes calmly, evenly.

5. Further actions, as with the previous method, but each stage is extended by an average of 1 minute.

6. After the child is completely asleep, a transition to a maintenance concentration of anesthetic and 2 l/min oxygen flow is carried out.

7. Start of operation.

This technique is simpler than the previous one, since it does not require the participation of the patient and is convenient especially when conducting anesthesia in children under 5 years of age. The rate of redistribution of gases between different spaces (respiratory circuit, alveolar space, blood, brain) is directly dependent on their partial pressure in them. Therefore, the higher the concentration of anesthetic in one space, the faster it will increase in the desire to equalize in another space. In practice, when conducting inhalation induction of anesthesia with an increase in the concentration of anesthetic in the respiratory circuit and, accordingly, in the alveolar space, the concentration in the blood and brain will increase. Due to the physicochemical properties of sevoflurane (low blood/gas distribution coefficient), the concentration of anesthetic in brain tissue during bolus anesthesia induction will increase very quickly. At the end of the anesthesia induction period, the concentration of sevoflurane in the respiratory circuit, alveolar space and brain tissue remains very high. Maintaining a high gas flow for 2 minutes after the end of induction and switching to maintaining anesthesia with sevoflurane is necessary to quickly reduce the concentration of anesthetic in the respiratory circuit and alveolar space. If this recommendation is not followed, an anesthetic overdose and the development of toxic effects of sevoflurane, such as arterial hypotension, arrhythmia, as a result of continued redistribution of a high concentration of sevoflurane from the alveolar space into the blood and brain tissue along the concentration gradient with a decrease in gas flow and slowing the leaching of the anesthetic from the respiratory circuit, are possible.

Thus, the inhalation induction of anesthesia with sevoflurane was quick and safe for the patient and medical personnel with the correct observance of the algorithm for its implementation: 1) proper filling of the respiratory circuit, maintaining gas flow parameters and indicators of the concentration of sevoflurane on the evaporator and in the circuit; 2) thorough tightness of the system "patient-anesthesia apparatus"; 3) maintaining a high gas flow in the circuit for another 2 minutes after the end of induction anesthesia and switching to a maintenance concentration of anesthetic.

Clinic of the course of anesthesia in patients of group I (sevoflurane + fentanyl)

Induction in anesthesia in patients of this group was started with one of the two methods described above by sevoflurane. The comfort of anesthesia was assessed by the stories of sensations in patients who did not receive premedication - contact children aged 7 to 16 years. During introductory anesthesia by the method of "bolus" induction, 12 children from the IC subgroup (11.3%) did not notice discomfort at all when applying the mask and willingly breathed a mixture of oxygen and 8% sevoflurane. A pronounced negative reaction (screaming, attempts to remove the mask from the face) was noted in 13 children (12.3%) from the IC subgroup and 15 children (62.5%) from the IB subgroup (n = 24), and 10 children (9, 4%) of the total number of patients I (n = 106) had a negative psychoemotional status before admission to the operating room and a categorical refusal from intramuscular or oral premedication.

In the IC subgroup of patients aged 7 to 16 years, 12 patients after appropriate psychological preparation underwent inhalation induction of anesthesia with sevoflurane according to the fast induction method. All patients complied with the recommendations of the an-

esthesiologist (immediately after applying the mask to the face, take a deep breath and hold the breath), while in all the studied patients, loss of consciousness occurred on 3 - 4 breaths of the inhalation mixture with a high concentration of anesthetic. In 3 patients aged 10 - 15 years, loss of consciousness occurred at the end of the 2nd inspiration, which was probably due to the possibility of a longer delay (3 - 6 seconds) of the inhalation mixture with a high content of sevoflurane at the inspiration height. After awakening, these patients did not remember the smell of the anesthetic. The highest percentage of a calm and positive subjective attitude towards the induction of anesthesia with sevoflurane (i.e. a subjective assessment of the method as comfortable, acceptable, desirable) was noted in children aged 10 - 16 years (contact children without premedication, and normal psychological mood and adequate perception of the environment).

Most often, a negative attitude to induction of anesthesia was noted in young and young children. Most often, the negative reaction in this group was associated not so much with the fact of mask induction itself, but with the impossibility of normal contact with a small child, his separation from his mother. It should be noted that the predominance of the number of negative psycho-emotional reactions in young children was more related to their attitude to the environment, and not specifically to the process of induction of anesthesia. The very induction of anesthesia by sevoflurane proceeded quickly, which significantly contributed to a decrease in the duration of prenarcotic psychoemotional agitation in this group of children and ensured the rapid onset of anesthesia. At the same time, it is difficult to judge that in case of a negative reaction to the induction of anesthesia through the mask, the child experiences longer and more pronounced psychoemotional stress than that which he experiences with a painful intramuscular injection of drugs for sedation.

When assessing the time of loss of consciousness and the development of anesthesia, the method of anesthesia induction and the conduct or absence of sedation were taken into account. Premedication was carried out either by intramuscular injection 30 minutes before the start of anesthesia and included, as a sedative, midazolam at a dose of 0.3 mg/kg, or orally 0.4 mg/kg.

With "bolus" (fast) induction, anesthesia developed much faster than with "step by step". Loss of consciousness occurred within 30 - 40 seconds, with the appointment of midazolam before anesthesia, consciousness during the induction period was lost in 15 - 20 seconds, practically by 4 - 5 breaths using the "over-pressure" method or by the end of 2 - 3 breaths with "bolus" induction. In this case, contact children did not express feelings of pronounced discomfort when inhaling a gas-narcotic mixture. It should be noted that the application of the method of rapid induction of anesthesia in groups of children with and without sedation was characterized by the only significant difference - this is the time of loss of consciousness. In children with premedication, the time of loss of consciousness was significantly less on average for 18.5%. Other indicators (the central location of the pupils and the absence of motor reaction to the puncture of the peripheral vein) did not have significant differences in time. In our opinion, the difference in time of loss of consciousness between subgroups (with and without sedation) is determined in absolute terms by no more than 20 seconds during the rapid inhalation induction of anesthesia with sevoflurane, which is not so significant from the point of view of the child experiencing discomfort and psychoemotional stress, than what he experiences after intramuscular or oral premedication.

With "step by step" induction, the consciousness of children was lost for 2 - 3 minutes from the start of the delivery of sevoflurane. Practically, all contact children, older noted discomfort associated with prolonged inhalation of the narcotic mixture. The stage of excitation in the form of involuntary movements of the limbs was observed in almost all cases of anesthesia induction by this method. In all children without premedication, the duration of this phase ranged from 30 to 60 seconds. At the same time, the ability to catheterize the peripheral vein without a pronounced motor reaction occurred only at 10 minutes in patients without premedication, and by 3 - 6 minutes in patients receiving premedication with midazolam. The time of loss of consciousness in all subgroups during the induction of anesthesia by the "step-by-step" method significantly exceeded the same indicator in children who underwent rapid inhalation induction of anesthesia (Table 2 and 3).

Patient groups	Research stages		
	Time of loss of consciousness in minutes	The time of the central location of the pupils in minutes	The absence of motor response to venipuncture in min
I (without sedation) n = 37	0,4 ± 0,12	2,6 ± 0,4	3,8 ± 1,2
I (with sedation) n = 20	0,32 ± 0,12	2,4 ± 0,6	3,4 ± 0,8

Table 2: Values of anesthesia onset time Sevoflurane with "bolus" induction.

Patient groups	Research stages		
	Time of loss of consciousness	Pupil central location	The absence of motor response to venipuncture
I (without sedation) n = 37	2,4 ± 1,2	11,2 ± 1,2	12,1 ± 2,6
I (with sedation) n = 20	1,7 ± 0,12	5,2 ± 1,6*	7,1 ± 2,1*

Table 3: Sevoflurane with" stepwise" induction Values of anesthesia onset time.
*Note: *: Statistical significance of differences in relation to group IA ($p < 0.05$).*

Significant differences in the time of the onset of the central location of the pupils and the lack of motor reaction during puncture and catheterization of the vein were observed in patients with premedication for a group of children without premedication with the "step by step" method of induction of anesthesia. These differences averaged 2 - 2.5 times. It should be noted that during the study we found that under the conditions of induction anesthesia with sevoflurane during fast "bolus" induction, there was no clear correspondence between the development of anesthesia and halothane anesthesia stages. This discrepancy was expressed in the absence of an initial stage, loss of consciousness occurred very quickly, after the first 2 - 3 breaths of the mixture with a high concentration of sevoflurane a short-term breath holding lasting 10 - 15 seconds developed. In this case, independent breathing was restored after 2 - 4 auxiliary breaths with a bag of anesthesia apparatus. The excitation phase developed at the end of the first minute (at 40 - 60 seconds from the beginning of induction), short-term slightly pronounced involuntary movements of the limbs, as well as small changes in the heart rate and increase in respiratory rate by 20 - 25% of the initial values were noted, while breathing became more shallow. During the first minute, in most patients, eyeballs were observed with gaze down or up without constricting the pupils. Fixation of the eyeballs, central location and narrowing of the pupils, corresponding to the onset of the surgical stage of anesthesia, occurred only by the third minute from the beginning of induction. In this case, puncture and catheterization of the peripheral vein was possible. By the end of 3 minutes from the beginning of induction, in all subgroups there were stable indicators of blood pressure and heart rate close to the initial level. At the same time, breathing became more superficial.

In patients of group I, the following critical incidents were recorded during the study: agitation, cough, breath holding, stridor breathing, agitation in the form of motor reactions, hypersecretion. During a fast "bolus" induction with sevoflurane, excitation signs were present in 46% of patients and these were slightly expressed reactions in the form of involuntary movements of the limbs within a few seconds immediately after loss of consciousness. When carrying out "step-by-step" induction, 76% of patients had pronounced motor activity for several seconds with attempts to remove the mask from the face. Coughing was observed in 15% of children with "bolus" induction (2 - 3 cough movements) during 1 - 2 inspirations with a gas-narcotic mixture with a high content of sevoflurane (8 vol%). With the "step by step" technique, the frequency of this critical incident was 8%. Respiratory depression as a delay in the first 30 seconds was observed in

11% of patients with rapid induction. At the same time, a decrease in the concentration of anesthetic in the inhaled mixture quickly led to the restoration of spontaneous breathing. Since a decrease in the concentration of sevoflurane is undesirable during the induction period, manual assisted ventilation of the lungs with a bag of the anesthesia apparatus was carried out with the development of breath-holding, without changing the supplied concentration of anesthetic on the evaporator for the first 3 - 4 minutes from the start of anesthesia, so as not to interrupt the saturation of tissues with anesthetic. In this case, after 3 - 4 artificial breaths with a bag of anesthesia apparatus, the patients' independent breathing was restored. With "step by step" induction, respiratory arrest was observed in 1 patient 2 minutes after the start of anesthetic delivery, when its concentration in the circuit was 6%.

During induction of anesthesia with sevoflurane, no cases of vomiting and hypersecretion were observed in any patient. With the "bolus" method of induction in 20%, and with the "step-by-step" method in 18% of cases, narrowing of the glottis and the appearance of noisy breathing were most pronounced in children over the age of 3 years. Stridor breathing usually developed within 30 - 40 seconds from the start of inhalation of the drug at high concentration and weakened as anesthesia deepened and completely disappeared by the end of the first minute after loss of consciousness. At the same time, a slight decrease in SpO_2 saturation to 95 - 96% was noted. Short-term tonic muscle tension of the limbs was observed in 2% of cases with bolus induction of anesthesia. This critical incident appeared immediately after loss of consciousness within 10 - 15 seconds and passed as anesthesia deepened.

Thus, a comparative assessment of the clinical course of various anesthesia techniques with sevoflurane revealed that the time of the onset of the surgical stage of anesthesia, characterized by a central location of the pupils and the lack of response to mild pain stimuli (venous puncture), is significantly shorter than the "step-by-step" "anesthesia induction", And this was more pronounced in subgroups of patients who did not do premedication. The frequency and severity of manifestations of arousal in children who underwent a "stepwise" induction of anesthesia with sevoflurane were significantly greater than with the "bolus" method. The method of "stepwise" induction of sevoflurane was significantly inferior in speed and comfort before rapid inhalation anesthesia. Therefore, we considered it more appropriate to use the technique of "bolus" induction by sevoflurane in "small" surgical interventions in "one-day" surgery in children.

Changes in the parameters of central hemodynamics, the function of external respiration when using sevoflurane and fentanyl with small surgical interventions in children in the age groups of 0 - 3 years

During induction in anesthesia, there was a significant increase in respiratory rate by 7.6% ($p < 0.01$) and a decrease in tidal volume by 20.7% ($p < 0.001$) with SpO_2 of 97.4 ± 0.1. Despite the increase in respiratory rate during the induction of anesthesia by sevoflurane, when evaluating capnography indices, it was noted that $PetCO_2$ (40.6 ± 0.2 mm Hg) was practically unchanged compared to the initial value (38.2 ± 0.1 mmHg.). Thus, it can be considered that the increase in respiratory rate during the period of rapid inhalation induction of anesthesia with sevoflurane in children of this age group was compensatory in nature as a result of a decrease in tidal volume (more shallow breathing) under the influence of high concentrations of inhalation anesthetic at the beginning of induction by this method with a slight increase in concentration $PetCO_2$. Moreover, since the $PetCO_2$ and SpO_2 indices remained within the physiological values, it can be indirectly considered that this compensation was adequate. In the table 4 shows that at the induction stage, the UO increased by 0.1% from the initial values, and the heart rate significantly increased by 7.7% ($p < 0.001$) from the initial one. As a result, IOC significantly increased by 7.8% ($p < 0.01$), SBP significantly increased by 2.8% ($p < 0.01$) and OPSS decreased by 4.2% ($p < 0.05$) compared to the original. By the beginning of surgery after intravenous administration of fentanyl at the rate of 3 μg/kg, heart rate decreased by 0.3% from the initial stage. The RO decreased by 1.0% compared with the first stage, and also remained reduced compared to the initial data. As a result, the IOC decreased by 0.9% compared with the initial stage.

Index	Stage I (before sedation)	II stage (after sedation)	Stage III (induction of anesthesia)	Stage IV (during the cut skin)	V stage (traumatic moment of operation)	VI stage (awakening)
HR (min)	126,3 ± 1,0	123,6 ± 1,1	136,1 ± 1,0 ***	125,6 ± 1,1	130,6 ± 1,1**	130,1 ± 1,0*
Mean arterial pressure (mmHg)	62,3 ± 0,4	58,6 ± 0,4***	64,1 ± 0,4*	64,9 ± 0,5***	64,0 ± 0,4*	63,2 ± 0,4
stroke volume (ml)	24,2 ± 0,3	25,1 ± 0,4	24,2 ± 0,3	24,0 ± 0,3	24,6 ± 0,4	24,6 ± 0,4
Minute volume of blood circulation (l/min)	3,05 ± 0,04	3,10 ± 0,05	3,29 ± 0,05**	3,01 ± 0,04	3,21 ± 0,05*	3,19 ± 0,05
Total peripheral vascular resistance (dyn × sec × cm^{-5})	2196,2 ± 33,0	2037,8 ± 33,9**	2104,3 ± 30,8*	2333,5 ± 35,1*	2170,5 ± 34,6	2147,0 ± 33,3
Breathing rate (min)	28,1 ± 0,4	26,8 ± 0,4*	30,3 ± 0,5**	24,8 ± 0,5***	29,2 ± 0,5	28,9 ± 0,4
Tidal volume (ml)	95,5 ± 3,2	94,3 ± 3,2	75,8 ± 2,5***	87,3 ± 2,7	86,4 ± 2,7*	95,2 ± 3,1
PetCO2 (mm Hg)	38,2 ± 0,1	39,0 ± 0,1***	42,6 ± 0,2***	43,6 ± 0,3***	42,8 ± 0,2***	38,7 ± 0,3
SpO2	98,8 ± 0,1	97,7 ± 0,2***	97,4 ± 0,1***	96,5 ± 0,1***	96,2 ± 0,1***	96,8 ± 0,1***
RPP	104,6 ± 0,7	96,4 ± 0,7***	116,5 ± 0,9 ***	109,0 ± 1,0***	112,2 ± 0,9 ***	110,1 ± 0,7 ***

Table 4: *Hemodynamics and external respiration in patients of group IA (sevoflurane + fentanyl) in the age group 0 - 3 years. Note: statistical significance of differences in indicators with respect to the initial data: *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$.*

At the V (traumatic) stage of the operation, there was a slight increase in heart rate by 3.4% ($p < 0.01$) compared with stage I. Mean arterial pressure remained elevated, amounting to 2.7% ($p < 0.05$) of the initial numbers. Indicators of total peripheral vascular resistance remained unreliably reduced and amounted to 1.2% of the original. The parameters of external respiration at the traumatic stage of the operation changed as follows: the tidal volume remained reduced to 9.6%, despite the increased respiratory rate of 3.7% of the initial values. By the end of the surgery, the stroke volume increased and amounted to 1.7% of the initial data, the heart rate also tended to increase to 3.0% of the initial values, RPP increased by 5.2% ($p < 0.05$), which was connected by awakening the patient. As a result, the minute volume of blood circulation compared to the initial stage amounted to 4.7% of the initial. The indicators of external respiration during awakening increased, the respiratory rate amounted to 2.9% of the first stage, the tidal volume approached the initial data and amounted to 0.3% of the initial figures. Analyzing the obtained results, it should be noted that during the induction of sevoflurane, the heart rate increased by 7.7% ($p < 0.001$) from the initial values. As a result, the minute volume of blood circulation significantly increased by 7.8% ($p < 0.001$). Induction with sevoflurane caused an increase in mean arterial pressure by 2.6% ($p < 0.05$) from the initial values, which led to a significant decrease in total peripheral vascular resistance by 4.5% ($p < 0.05$) from the first stage. The characteristic imbalances in the main parameters of the volumetric blood flow indicate hemodynamic stress due to the hypodynamic type of blood circulation against the background of the action of sevoflurane.

By the time the surgical intervention was completed, these heart rate and stroke volume remained increased, which kept the min volume of blood circulation increased. Mean arterial pressure remained above the original numbers, and total peripheral vascular resistance tended to decrease. This state of central hemodynamics is favorable, characterizing the patient's exit from anesthesia and does not need pharmacological correction.

Indicators of external respiration indicate moderate hypoventilation against the background of the action of inhaled anesthetics. Although SpO_2 remained at a satisfactory level (96 - 98%). The indices of external respiration increased slightly at the initial stage and at the most traumatic moment of the surgical intervention but remained significantly lower than the initial data. In the period of awakening, the indicators of external respiration tended to increase and approached the initial values.

Thus, the induction of sevoflurane proceeded with a hypodynamic type of blood circulation. During surgery, hemodynamic parameters were hyperdynamic type of blood circulation associated with surgical trauma. At the traumatic time of the operation, the indicators of central hemodynamics in all age groups tended to increase. By the time the surgery ended, the heart rate and stroke volume remained increased, which kept the minute volume of blood circulation increased, but with a tendency to decrease. The mean arterial pressure remained above the initial figures, and the total vascular resistance was peripheral with a tendency to decrease, which was characteristic of all groups and the differences between age groups were unreliable. This state of central hemodynamics characterizes the patient's exit from anesthesia and does not need medical correction (Figure 1-3).

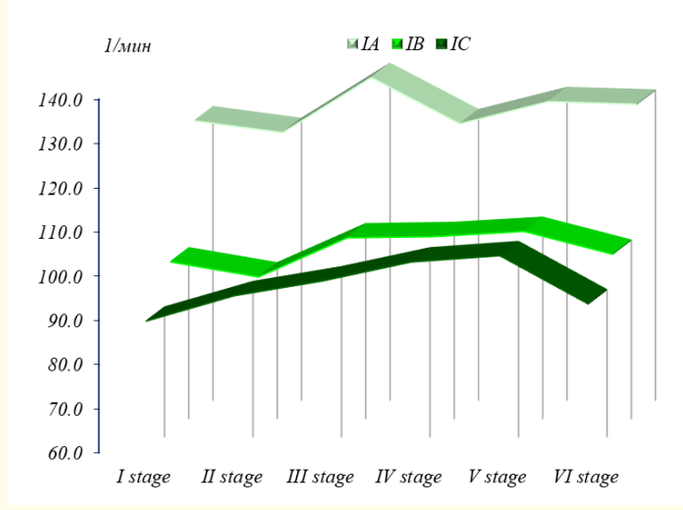

Figure 1: *The dynamics of changes in heart rate in children of group I.*

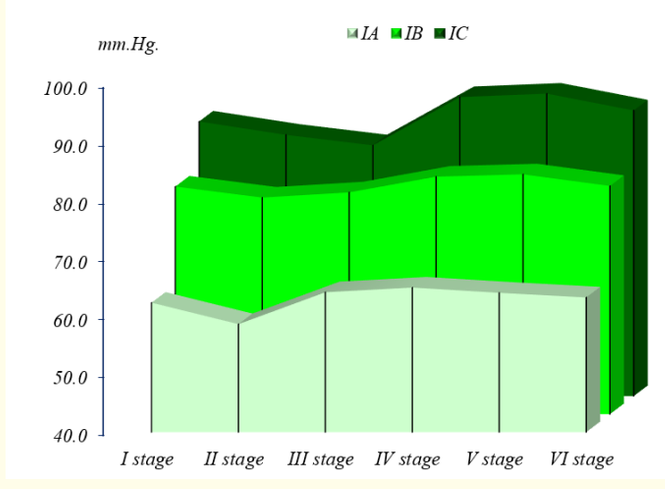

Figure 2: *Dynamics of changes in blood pressure in children of group I.*

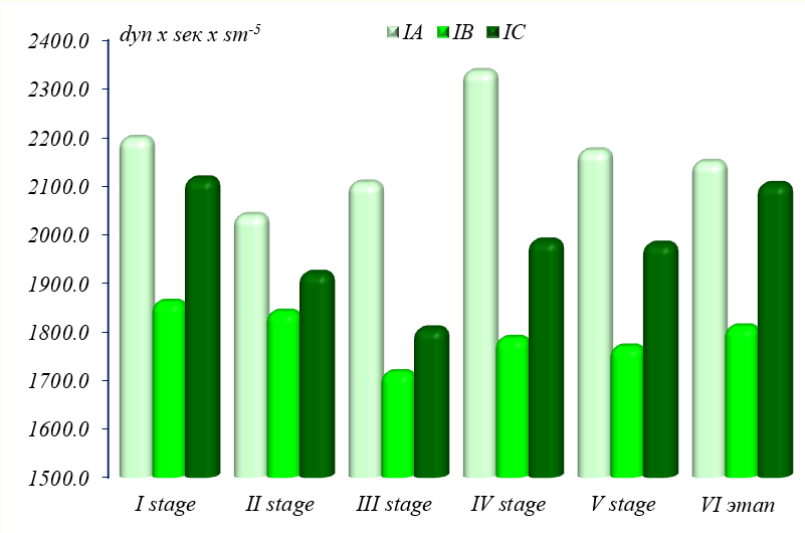

Figure 3: *The dynamics of changes in total peripheral vascular resistance in children of group I.*

Indicators of external respiration indicate moderate hypoventilation in the presence of sevoflurane. The decrease in the function of external respiration in terms of tidal volume was more pronounced in older age groups. The indices of external respiration increased slightly at the initial stage and at the most traumatic moment of the operation, but remained significantly lower than the initial data. In the period of awakening, the indicators of external respiration tended to increase and approached the initial values. In case of sevoflurane anesthesia, although the studied parameters decreased, the SpO_2 data were at a satisfactory level of 96 - 99%.

Conclusion

The anesthesia technique of sevoflurane + fentanyl was fast and safe for the patient and operating personnel, with the correct observance of the algorithm for its implementation:

1) The correct filling of the respiratory circuit, maintaining the parameters of the gas flow and the concentration of anesthetic on the evaporator and in the circuit;

2) Thorough tightness of the system "patient-anesthesia apparatus";

3) Maintaining a high gas flow in the respiratory circuit for another 2 minutes after the end of the induction of anesthesia and the transition to a maintenance concentration of anesthetic.

Bibliography

1. Ali M and Abdellatif A. "Prevention of sevoflurane related emergence agitation in children undergoing adenotonsillectomy: A comparison of dexmedetomidine and propofol". *Saudi Journal of Anaesthesia* 7 (2013): 296-300.

2. August D and Everett L. "Pediatric ambulatory anesthesia". *Anesthesiology Clinics* 32.2 (2014): 411-429.

3. Campagna J., *et al*. "Mechanisms of actions of inhaled anesthetics". *New England Journal of Medicine* 348.21 (2003): 2110-2124.

4. Chavan S., *et al*. "Comparison of sevoflurane and propofol for laryngeal mask airway insertion and pressor response in patients undergoing gynecological procedures". *Journal of Anaesthesiology Clinical Pharmacology* 33 (2017): 97-101.

5. Chen H., *et al*. "Comparison of sevoflurane versus propofol under auditory evoked potential monitoring in female patients undergoing breast surgery". *Biomedical Journal* 36.3 (2013): 125-131.

6. Costi D., *et al*. "Effects of sevoflurane versus other general anaesthesia on emergence agitation in children". *Cochrane Database of Systematic Reviews* 9 (2014): CD015894.

7. Hönemann C., *et al*. "Inhalational anaesthesia with low fresh gas flow". *Indian Journal of Anaesthesia* 57.4 (2013): 345-350.

8. Lin D., *et al*. "Early-life single-episode sevoflurane exposure impairs social behavior and cognition later in life". *Brain and Behavior* 6.9 (2016): e00514.

9. Mudakanagoudar M and Santhosh M. "Comparison of sevoflurane concentration for insertion of proseal laryngeal mask airway and tracheal intubation in children (correlation with BIS)". *Revista Brasileira de Anestesiologia* 66.1 (2016): 24-28.

10. Murphy K., *et al*. "Exposure to sevoflurane anesthesia during development does not impair aspects of attention during adulthood in rats". *Neurotoxicology and Teratology* 60 (2017): 87-94.

Volume 9 Issue 3 March 2020