INDICATORS OF CENTRAL HEMODYNAMICS, VENTILATION, OXIMETRY AND BLOOD FILLING OF THE BRAIN DURING INDUCTION OF ANESTHESIA WITH SEVOFLURANE IN CHILDREN

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Abstract

Sevoflurane belonging to the group of halogen-containing inhaled anesthetics suggests that it is capable of increasing intracranial pressure. There are reports of the effect of sevoflurane on the central nervous system. However, there is no data that would indicate the nature and severity of the effect of sevoflurane on the oxygen status and blood filling of the brain in children. The study of hemodynamic parameters, as well as blood filling and oxygen status of the brain was conducted in 22 children aged 3 months and older. up to 12 years of age during rapid inhalation induction of anesthesia by a mask method with preliminary filling of the respiratory contour of the anesthesia apparatus with a mixture containing 6-8% sevoflurane in the normooxic gas stream during catheterization of the main vessels.

Ключевые слова: FiCO2 - the concentration of carbon dioxide in the inhaled mixture, Fi O_2 - oxygen concentration in the inhaled mixture, FiAA - concentration of anesthetic in the inhaled mixture, ННЬ – deoxyhemoglobin, MAC -minimal alveolar concentration (minimum alveolar concentration of anesthetic), O_2НЬ – oxyhemoglobin, RSat — regional saturation (of brain tissues with oxygen), tHB — total hemoglobin content.

Introduction.

The outstanding achievements of modern anesthesiology are largely due to the introduction of new drugs and new methods of anesthesia into clinical practice. In everyday practice, this may be due to a number of methodological, technical, financial and psychological problems that can be solved only if there is appropriate motivation. New technologies should change the quality of work of anesthesiologists, facilitate their work, increase the comfort and safety of anesthesia.

The purpose of the work:

To increase the effectiveness and improve the quality of introductory anesthesia with sevoflurane in children of different age groups.

Indicators of cerebral oximetry during induction of anesthesia with sevoflurane.

When assessing the dynamics of cerebral oximetry indicators (Table.1) the most pronounced changes in HHb values were noted. The level of deoxyhemoglobin decreased statistically significantly throughout the study. By the end of the 1st minute after the start of sevoflurane inhalation, its values were lower than the initial values by an average of 6%, and by the 8th minute - by 12%. Changes in oxyhemoglobin were also statistically significant at all stages of the study. However, they were less pronounced than the changes in deoxyhemoglobin, and had a maximum increase in comparison with the baseline level in the range of 5.4% at 8 minutes from the start of sevoflurane inhalation. The values of total hemoglobin changed slightly in the direction of increase throughout the period of induction of anesthesia. The dynamics of these changes was statistically unreliable, which indicated an insignificant increase in blood filling of the brain in the considered version of anesthesia induction in children. In the assessment of rSAT, which is an integral indicator of oxygenation of brain tissues, in all examined children, its significant dynamic increase was noted throughout the entire period of induction of anesthesia G-th minute after the start of sevoflurane inhalation. It acquired the maximum value at 8 minutes and exceeded the initial value by 3%. This increase was mainly due to a decrease in the fraction of restored hemoglobin, since the nominal dynamics of its values underwent the greatest changes.

Values of cerebral oximetry indices during monoinduction of sevoflurane anesthesia in normooxic gas-narcotic mixture in children by the "over-pressure" method *(M±o, n=22)*

Table 1

Indicators	**Exodus. meaning.**	**Stages of min research**							
		1	2	3	4"	5	6	7	8
HHb, $McmA^{-1}$	87,54 ±3,02	82,17 ±3,10*	81,07 ±2,05*	80,01 ±3,31*	78,87 ±3,64*	78,62 ±3,49*	77,92 ±3,43*	77,27 ±2,12*	76,94 ±2,02*
O_2HЬ, $^{McmA-1}$	233,15 ±9,17	238,75 ±7,24*	239,91 ±8,32*	241,38 ±8,37*	243,00 ±9,16*	243,34 ±8,61*	244,28 ±7,39*	244,41 ±8,45*	245,85 ±9,34*
tHb, $^{McmA-1}$	320,69 ±8,31	320,92 ±9,62	320,98 ±8,24	321,39 ±8,71	321,87 ±9,77	321,96 ±9,17	322,20 ±8,29	321,68 ±8,48	322,79 ±8,48
rSAT, %	69,80 ±0,44	71,00 ±0,49*	71,57 ±0,50*	71,68 ±0,58*	71,72 ±0,61*	71,79 ±0,62*	71,83 ±0,57*	71,90 ±0,58*	71,91 ±0,61*

Note: * **-** statistically significant difference from the initial value, $p<0,05$.

The obtained data of cerebral oximetry testified to a weakly pronounced effect of sevoflurane on the oxygen status of the brain and its blood supply during spontaneous respiration with a normooxic gas-narcotic mixture, characterized by a significant increase in rSat due to a decrease in HHb against the background of almost unchanged tHb and a significant increase in O_2HЬ. It is noteworthy that the dynamic decrease in systemic mean blood pressure (Table. 2) in no way affected blood filling and regional oxygen saturation of brain tissues. It is known that the blood filling of the brain is directly dependent on ADsr, which causes perfusion pressure in the brain. Since tHb' is an indirect indicator of blood filling of the brain and in the study it changed slightly, it can be stated that it did not depend on ADsr, which changed in the redistribution of values that do not affect the perfusion pressure autoregulation system.the brain. The same provision is legitimate in the interpretation of the relationship. ADsr and rSat, which nevertheless statistically significantly increased.

Thus, it can be argued that the obtained significant changes in cerebral oximetry were due not to changes in hemodynamic parameters and in particular pressure, but directly to the direct influence of sevoflurane, manifested in a decrease in the deoxyhemoglobin fraction and an increase in regional saturation. The explanation of this fact is that sevoflurane, like other halogen-containing anesthetics, reduces the level of metabolism in the brain, due to which there was a decrease in the fraction of deoxyhemoglobin and an increase in regional oxygen saturation of brain tissues (rSat). In addition, a significant change in O2N with a more pronounced significant decrease in HHb indicated not only a change in the oxygen content in its connection with hemoglobin, but also indirectly (according to the integral indicator - rSat) indicated an increase in its content in the total brain tissues with a decrease in metabolism.

Assessment of hemodynamics and respiration.

Table 2 presents data on hemodynamics, hemoglobin oxygen saturation and respiration. The absolute values of the studied indicators presented in the table have an average character and cannot characterize a specific age period, because the group of examined patients had a significant variation in age and, accordingly, in the age values of the evaluated indicators. However, it was of fundamental importance in the study to determine the trend of changes in the estimated indicators and the reliability of these changes during induction and anesthesia.

Values of hemodynamic parameters of hemoglobin oxygen saturation and ventilation during monoinduction of anesthesia by sevoflurane inhalation in children by rapid inhalation induction *(M±o, n=22)*

Table 2

Indicators	Stages of min research								
	Exodus	1	2	3	4	5	6	7	8
ADs, mm.rt.st.	110,4± 21,79	98,00± 11,51*	90,40± 20,17**	88,00± 20,05**	78,67± 26,76**	84,67± 12,68**	87,07± 10,83**	87,20± 10,39**	89,20± 10,99**
ADd, mm.rt.st.	64,56± 24,25	51,06± 8,19**	45,06± 14,21**	44,81± 18,26**	42,69± 16,09**	39,12± 9,62**	41,94± 13,76**	39,94± 10,50**	45,44± 12,75**
ADsr, mm.rt.st.	73,00± 21,82	60,63± 9,41*	55,81± 15,81"	50,81± 10,20**	50,13± 9,54**	50,81± 10,15**	52,81± 9,03**	53,13± 9,34**	55,44± 13,65**
ChЧСС, ud min	109,31 ±21,99	116,08 ±25,25	115,77 ±27,51	106,16 ±20,99	102,08 ±20,64	100,15 ±20,17	99,62 ±21,66	98,92 ±22,88-	100,07 ±18,96
$sHbO_2$, **%**	99± 0,91	98± 1,17	97± 1,23	95± **	95± 1,25	95± 1,14**	96± 2,16	96± 2,37	96± 2,47
ChD	28,56± 6,12	26,81± 4,91	34,01± 3,46**	35,67± 3,61**	35,75± 3,78**	32,15± 3,92	31,13± 4,09	32,17± 4,03	32,5± 3,87
$etC0_2$, mm.rt.st.	39,42± 1,29	41,17± 2,47	44,56± 1,27	44,82± 1,56**	45,02± 0,91**	44,96± 1,05**	43,11± 1,39**	43,24± 1,31**	43,16± 1,28

Note: * - statistically significant difference from the previous stage (p<0,05), ** - statistically significant difference from the initial indicator (p<0,05).

When assessing hemodynamics, it was noted that the inter-stage differences in all blood pressure indicators were statistically unreliable, with the exception of the value of the first minute after the start of sevoflurane inhalation. However, with respect to the initial value at the first minute after the start of sevoflurane inhalation, the ADs decreased by 11%, ADd.-20.9% and ADsr-16.9%. The tendency to decrease blood pressure persisted throughout the entire period of induction of anesthesia, and by the 8th minute from the beginning of the ADs decreased by 19%, ADd by 29.6% and ADsr by 24.1%. These changes were statistically significant in relation to the initial values of the studied indicators ($p<0.05$).

The dynamics of heart rate was characterized by a slight increase in values during the first two minutes after the start of sevoflurane inhalation with a subsequent decrease throughout the entire period: induction of anesthesia. Changes in heart rate values at all stages of the study were statistically unreliable with respect to the initial values, as well as with respect to the previous stage of the study (p>0;05).

Throughout the induction period, $sHbO_2$ tended to decrease, which was statistically significant with respect to the initial value at the 3rd and 5th minutes from the start of sevoflurane inhalation. At the same time, the saturation of hemoglobin with oxygen remained within normal values and did not require any correction.

The respiratory rate during the induction of anesthesia statistically significantly increased by 19.1% at the 2nd minute after the start of anesthesia induction compared to the initial value, reaching the maximum at the 4th minute (an increase of 25.2%), and subsequently a slight decrease by the 8th minute. The inter-stage differences were statistically unreliable. Despite the increase in the respiratory rate during the induction of anesthesia with sevoflurane, when evaluating the capnometry indicators, it was noted that by the end of 1 minute from the start of induction, the etCO value (41.17+2.47 mmHg.) practically did not change in comparison with the initial value (39.42+1.29 mmHg). At the 2nd minute, the concentration of CO2 on exhalation statistically significantly increased by an average of 13%, at the 4th minute by 13.7% compared to the initial value and subsequently did not undergo significant changes until the 8th minute. The inter-stage differences in the indicators were not statistically significant, while the absolute values of etCO2 did not exceed the permissible upper limit. Thus, it can be assumed that the increase in respiratory rate during the period of rapid inhalation induction of sevoflurane anesthesia in children was compensatory in nature as a result of a decrease in respiratory volume (more shallow breathing) under the influence of high concentrations of sevoflurane in the first minutes of induction according to this technique, which is confirmed by the dynamics of etCO2 concentration. At the same time, since the etCO2 and $sHbO_2$ indicators remained within the physiological values, it can be indirectly assumed that this compensation was adequate.

It should be noted that the revealed changes on the part of the studied hemodynamic and ventilation parameters were comparable with previously published data from other researchers.

Examples are presented as confirmation of the obtained data on cerebral oximetry.

Example 1. Figure 1 shows the dynamics of cerebral oximetry indicators of patient N., 1g.9months, I.B. 16436-s/2007, who underwent catheterization of the subclavian vein under sevoflurane monoanesthesia (rapid induction) with spontaneous breathing. From left to right along the abscissa axis, the 1st label indicates the beginning of sevoflurane inhalation, after which there was a dynamic increase in rSat, tHb, O_2Hb and a decrease in HHb. During the induction of anesthesia, 3 minutes after its start (mark 2), a sharp decrease in rSat was noted due to the fact that the anesthetic ran out in the evaporator, which was confirmed by the indications of the gas analyzer. The multidirectional dynamics was noted in the values of tHb, O_2Hb, which began to decrease, and HHb increased. After sevoflurane was poured into the evaporator and anesthesia induction resumed (mark 3), regional saturation increased again and continued to increase throughout the entire period of anesthesia induction. The decrease in the values of tHb, O2N was replaced by an increase again, and the increase in HHb - a decrease. This record of the dynamics of cerebral oximetry indicators gives a visual representation of the nature of the change in the oxygen status of the brain and the effect of sevoflurane on it when inhaled in the air stream during spontaneous breathing.

The following two examples also confirm the unidirectionality of the dynamics of the studied indicators of cerebral oximetry.

In the operating room, a sensor of the cerebral oximetry monitor was applied to the child before the induction of anesthesia and the registration of indicators of the oxygen status of the brain was started. During the anesthesiological manual (fast, induction) - and the manipulation performed, the indicators of pulse oximetry, hemodynamics and gas composition of the arterialized. The blood levels were within acceptable normal values. The graph (Fig. 11) shows that the initial rSat value before inhalation of the anesthetic was 65.7% (arrow 1). From the beginning of inhalation-anesthetic, the value of the indicator increased dynamically and by the time when effective depression of consciousness was noted according to clinical signs (27 seconds from the beginning of induction of anesthesia), it corresponded to 67.8% (arrow 2), which exceeded the initial value by 2%. By the end of the 1st minute from the beginning of inhalation, rSat increased to 68.4% (arrow 3), i.e. by 2.7% of the initial value.

Example 2. Patient C, 4 years old, medical history, 3628-c/2007, diagnosed with retroperitoneal neuroblastoma. The child was admitted for planned surgical treatment. Induction of anesthesia was performed by inhalation through a face mask of a normooxic gas-narcotic mixture including 8 vol% sevoflurane. The induction time of anesthesia was 4 minutes, the time of loss of consciousness, determined by clinical criteria (the patient's lack of response to auditory, visual and tactile stimuli) was 20 seconds. On the graph, the moment of the beginning of the inhalation of the anesthetic is marked with arrow 1, the rSat value corresponded to 68.1%. Almost immediately, a dynamic increase in the recorded indicator was noted, which at the 20th second was 70.3% (arrow 2), and by the end of the 1st minute from the beginning of inhalation increased to 71.8% (arrow 3). A change of more than 2% of the initial value of rSat corresponded to the period of loss of consciousness by the patient, which was recorded according to clinical signs - there was no response when contacting the patient, he did not react when directing a beam of light at the pupils and at the moment of touching him.

Conclusions.

Evaluation of step-by-step and rapid ("bolus") methods of inhalation induction of anesthesia with sevoflurane showed that the latter is safe, comfortable, effective in children of different age groups. According to clinical signs, the methods of rapid inhalation induction of BIIZHEL and "over-pressure" have no significant differences in practical significance. When using the step-by-step method of introductory anesthesia, the frequency of manifestations of arousal is 1.6 times higher and the time of loss of consciousness and the time of onset of the surgical stage exceeds that with the "bolus" method by 2-2.5 times, which levels the positive qualities of sevoflurane.

1. During the period of rapid induction of anesthesia with sevoflurane in children, the heart rate significantly increases by 25.2%, the blood pressure significantly decreases by 16.9%, the heart rate changes slightly.

2. The oxygen status and blood filling of the brain with rapid induction of anesthesia with sevoflurane in children are characterized by a significant increase in regional saturation by an average of 3% due to a significant decrease in deoxyhemoglobin by 12% and an increase in oxyhemoglobin by 5.4%, while the indicators of total hemoglobin have no statistically significant changes, which indicates a weakly pronounced effect of sevoflurane on blood filling of the brain.

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