Change in central hemodynamic indicators during hip joint arthroplastic operations in children

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Abstract. The data from the study of the state of central hemodynamics testified to the effectiveness of the used variants of anesthesia with fentanyl in combination with sevoflurane and the variant of anesthesia with fentanyl in combination with propofol in the anesthetic management of congenital hip dislocation. The paper assesses the state of the circulatory system in children with congenital hip dislocation. The development of rational options for pain relief has identified the advantages of combined anesthesia with fentanyl and sevoflurane. The study of indicators of daily monitoring of blood pressure, heart rate, study of indicators of central hemodynamics made it possible to determine the nature and type of regulation of the circulatory system under the conditions of the recommended methods of combined anesthesia for surgical correction of congenital hip dislocation in children.

Keywords: combined anesthesia; hip arthroplasty; sevoflurane; fentanyl; propofol.

Relevance. The problem of adequate anesthetic management of hip joint arthroplasty in children remains relevant. Its relevance is due, on the one hand, to the need to introduce new technologies into the practice of numerous medical hospitals, on the other, there remains the need for this surgical intervention in children.

At the present stage of the concept of effective surgical correction of residual deformities of congenital hip dislocation in children, preference is given to reconstructive extra-articular surgeries, as the most gentle for the hip joint and allowing to obtain the best functional result. The problem under consideration remains relevant and not fully resolved; the need to improve the efficiency and safety of anesthetic protection creates the prerequisites for the search for new methods of anesthetic management. To assess the anesthetic protection from surgical trauma, it is important to study not only the state of hemodynamics and respiration, but also the vegetative status. It is believed that the analysis of heart rate variability using cardiointervalography is an objective and fairly simple way to assess the adequacy of anesthetic protection.

Purpose of the study. Assessment of the state of central hemodynamics to improve the quality of anesthetic management during hip arthroplasty operations in children.

Research materials and methods: The analysis of the results of the study - 46 children aged 3 to 14 years with congenital hip dislocation was carried out. The duration of anesthetic treatment in 6 (13.04%) patients was up to 1 hour, in 18 (39.13%) patients up to 1.5 hours, in 22 (47.82%) patients up to 2 hours.

The patients were divided into groups taking into account the selection of an adequate combination of drugs for anesthesia. As part of premedication, atropine sulfate 0.1% - 0.01 mg / kg of body weight, diphenhydramine 1% solution of 0.1 mg / kg of body weight was prescribed, patients with psychoemotional stress to enhance premedication were additionally prescribed: 0.5% solution of Sibazon in dose of 0.25 mg / kg of body weight and 5% solution of ketamine at a dose of 2.5 mg / kg of body weight.

Patients of the first (main) group, 30 minutes after premedication, received inhalation of sevoflurane at a dose of up to 3.0 vol%; a solution of fentanyl was injected intravenously at a dose of 5 μg / kg of body weight. Anesthesia was maintained by the introduction of fentanyl ½ or 1/3 of the main dose, inhalation of evoflurane at a dose of 1.5 vol%. Patients of the second (control) group, 30 minutes after premedication, received a single intravenous injection of fentanyl solution at a dose of 5 μg / kg body weight and propofol solution at a dose of 3 mg / kg body weight. To maintain anesthesia, fentanyl was re-administered at a dose of ½ or ½ part of main. A continuous infusion of propofol was carried out at a dose of 7.5 mg / kg / hour through an infusion pump.

Patients underwent clinical observation of the introductory period with monitoring of heart rate, blood pressure, blood pressure, blood pressure, oxygen saturation, studies of central hemodynamics by echocardiography, studies of autonomic balance by electrocardiography. The analysis of the results was accompanied by statistical processing..

Research results and their discussion. The data obtained show that premedication with diphenhydramine, atropine, ketamine completely stopped the stress reaction before the forthcoming operation. Indicators of heart rate, blood pressure and oxygen saturation (sP02) during the introductory period of general anesthesia when using sevoflurane and fentanyl with sibazone (n = 18), patients fell asleep smoothly within 60-90 seconds after the bolus administration, while breathing was not observed, skin the covers were warm and had the usual color. The cornea remained moist and shiny, the corneal reflex was moderately reduced, the eyeballs made swimming movements and were fixed centrally. The pupils were moderately constricted while maintaining the reaction to light. Moderate relaxation of the striated muscles was noted.

Moderate relaxation of the striated muscles was noted. Heart sounds remained clear, heart rate increased by 25.46% and there was an insignificant increase in blood pressure by 3.29% and blood pressure by 9.44% compared to the baseline (Table 1).

Table 1. Indicators of heart rate, blood pressure and oxygen saturation (sPO2) during anesthesia with sevoflurane in combination with fentany

Indicators	Research stages				
	Exodus	Premedication	Induction into anesthesia	maintenance period	Awakening period denia
Heart rate	94.0±2.38	117.75±2.87*	117.93±3.93*	132.7±8.41*	136.01±8.45*
BP (mm Hg)	116.50±2.69	117.75±2.87	120.33±4.21	115.75±4.20	113.17±2.40
BPd (mm Hg)	74.17±2.30	77.92±3.51	81.17±4.32	73.83±4.75	71.58±3.33
sPO_2	96.36±0.58	98.58±0.26*	97.67±0.53	97.58±0.5	98.08±0.08*

Note: * - reliability of differences in indicators compared to baseline (P <0.05)

The course of the period of maintenance of anesthesia was characterized by a smooth clinical course. The pupils remained constricted, the sclera were moist, and a weak reaction of the pupils to light remained. Systolic and diastolic blood pressure during the period of maintenance of anesthesia did not change significantly compared to the baseline value. The heart sounds remained clear, the pulse on the peripheral vessels was of average filling and tension. The course of the period of maintenance of anesthesia was characterized by a smooth clinical course. The pupils remained constricted, the sclera were moist, and a weak reaction of the pupils to light remained. Systolic and diastolic blood pressure during the period of maintenance of anesthesia did not change significantly compared to the baseline value. The heart sounds remained clear, the pulse on the peripheral vessels was of average filling and tension.

Patients of the second group, like the first, were prescribed premedication - a combination of atropine sulfate 0.01 mg / kg, diphenhydramine and ketamine 2.5-3 mg / kg.

The applied propofol caused a smooth induction into anesthesia in children, and, depending on the dose and the rate of intravenous administration, caused, to a varying degree, a cardiorespiratory effect in the form of a decrease in blood pressure and a decrease in respiration. At the same time, the doses for the induction of anesthesia and for its maintenance vary depending on the age and the method of induction (the induction dose ranged from 3 mg / kg body weight). Approximately 15-30 seconds after the start of the drug administration, all patients experienced rapid breathing, which then turned into apnea in most patients, and a rapid loss of consciousness was observed. Spontaneous limb movements were observed in 80% of children. After the introduction of fentanyl, the muscle relaxant arduan (0.06 mg / kg) was administered and the trachea was intubated.

The heart rate increased by 3.36% and there was an insignificant increase in blood pressure by 2.24% and in blood pressure by 0.944% compared to the initial state.

The awakening period was short and lasted 8.2 * 0.5 minutes, depending on the total dose. Tracheal extubation is performed when adequate spontaneous breathing appears. The skin of the patients remained pink and warm, the ocular, laryngeal, pharyngeal and cough reflexes, and motor activity were quickly restored. Pupils are equal in size, of normal size, their reaction to light began to appear, blood pressure decreased by 2.86%, blood

pressure by 3.49% compared with the initial data. In the postoperative period, children did not need additional anesthesia for 5-6 hours, their appearance did not change.

Compared with the initial data, the premedication background showed an increase in heart rate by 25.27% and peripheral specific resistance (UPS) by 24.52%. Other indicators changed slightly: during the introductory period of anesthesia, there was a decrease in CI by 10.64%, an increase in heart rate by 15.46%, and an increase in heart rate by 25.58%. Stroke index (SI), mean arterial pressure (SBP), cardiac index (SI) indices changed insignificantly in comparison with the previous period.

During the period of maintenance of anesthesia, certain changes in indicators of central and peripheral hemodynamics were also observed. Thus, in the most traumatic stages of the operation, compared with the previous period, there was a decrease in SI indicators - by 2.38%, SI - by 2.97% and UPS - by 7.55%, while the heart rate increased by 12.52%.

Despite this, it can be argued that hemodynamic parameters remained within optimal values, and there was no risk of ischemia of internal organs, including the brain. Fentanyl caused severe circulatory depression due to decreased vascular tone (Table 2).

Table 2. Indicators of central and peripheral hemodynamics in children during combined analgesia with fentanyl and sevoflurane

Indicators	The initial state	Premedication	Induction period into anesthesia	Traumatic stage of the operation	End of operation
UI, ml / m^2	41.54±1.22	40.49±3.15	41.74±2.01	40.5±3.68	39.63 ±4.19
GARDEN, mm. rt. st	88.85±1.21	91.2±2.93	94.22±3.75	87.81±4.0	85.44±2.56
Heart rate, min^{-1}	94.0±2.38	117.75±2.87*	117.93±3.93*	132.7±8.41*	136.01±8.45*
SI, l / min x m^2	4.7±0.4	5.0±0.5	4.2±0.2	4.1±0.4	4.0±0.4
UPS, conventional units	40.42±5.31	50.33±7.74	50.76±5.85	46.93±5.17	48.16±7.56

Note: *- reliability of differences in indicators compared with the initial value (P <0.05).

The data of similar studies of central and peripheral hemodynamics during combined anesthesia with fentanyl and propofol are presented (in Table 2.) According to available data, it is the change in the regulation of central hemodynamics that determines the level of compensatory capabilities, subsequently forming the hemodynamic profile of patients. Therefore, in our study, we focused on the spectral analysis of patients' hemodynamics. In patients of the first group, the concentration of propofol did not inhibit myocardial contractility, which was not observed to reduce the indicators of SI, SI. The phenomenon of an increase in the minute volume of blood circulation (MCV) and a fall in the UPS is described as a transient initial reaction to the administration of fentanyl. The effect of a drop in MOF is blocked by Ca2 + ions. As a result, there is a pronounced (by 25-40%) drop in blood pressure, which is the most characteristic feature of the hemodynamic profile of the drug (Table 3).

Table 3. Indicators of central and peripheral hemodynamics in children during combined anesthesia with fentanyl and propofol

Indicators	The initial state	Premedication	Induction period into anesthesia	Traumatic stage of the operation	End of operation
UI, ml / m^2	44.86±0.79	51.12±2.14*	49.08±1.91	50.34±2.15*	53.54 ±6.91

GARDEN, mm. rt. st	72.42±2.27	77.03±2.29	77.03±2.4	75.97±2.78	73.03±2.06
Heart rate, min^{-1}	92.14±2.09	125.26±3.07*	122.25±2.13*	130.52±5. 23*	143.75±7.93*
SI, l / min x m^2	4.83±0.35	5.11±0.21	4.91±0.19	6.63±0.48***	8.03±1.39*
UPS, conventional units	71.18±4.74	88.1±10.6	82.24±8.69	83.72±10.6	72.88±4.87

Note: *- reliability of differences in indicators compared with the initial value (P <0.05).
**- reliability of differences in indicators compared with the previous stage of the study (P <0.05).
***- reliability of differences in indicators compared with the initial and previous stages of the study (P <0.05).

The study of indicators of central hemodynamics at various stages using fentanyl and propofol showed the following figures.

During the introductory period of anesthesia, there was an increase in heart rate by 32.68% (P <0.05), CPR by 23.77%, SI by 9.41% in relation to its initial values.

In the most traumatic stages of the operation, there was an increase in CI, HR, SI, respectively, by 37.27%, 41.65% and 12.22% (P <0.05), and compared with the previous stage of the study, these indicators changed insignificantly. At the end of the operation, in comparison with the stage of the traumatic moment of the operation, the indices of central hemodynamics changed insignificantly, which were unreliable.

Despite this, it can be argued that hemodynamic parameters remained within optimal values, and there was no risk of ischemia of internal organs, including the brain. Fentanyl does not cause marked circulatory depression, however, blood pressure often decreases as a result of bradycardia, vasodilation, and suppression of sympathetic reflexes.

Thus, a comparative assessment of the clinical course of anesthesia, changes in the main indicators of central and peripheral hemodynamics, when carrying out two variants of combined anesthesia, showed that, despite the existing small changes in the main vital functions, they provided a smooth course of anesthesia, providing adequate protection of the child's body from operating injury. Combined general anesthesia based on sevoflurane and fentanyl early activity and stable postoperative course.

Analysis of the data obtained allows us to state that the use of fentanyl with sevoflurane and fentanyl with propofol provides controllability, the achievement of a sufficient depth of anesthesia with minimal changes in hemodynamics and respiratory disorders. The effect of fentanyl on the endorphin system of the brain and the mechanism of hallucinations is explained by the ability of the drug to release dopamine in the brain. There is a rapid awakening and restoration of orientation, the absence of mental disorders, minimal toxicity in relation to the liver, kidneys, adrenal glands and hematopoietic organs with repeated repetition, good compatibility with cardiotropic and psychotropic drugs, no persistent loss of appetite with repeated use. Fentanyl, both in combination with sevoflurane and in combination with propofol with its peculiar pharmacokinetic and pharmacodynamic properties, is a valuable tool for various fields of anesthesiology, which can significantly improve the quality of anesthesia, provided that you know the characteristics of its effect on the body and use the optimal tactics of its use in each specific situations. The priority is to modify the version of general anesthesia using sevoflurane and fentanyl, which expand the indications for its use.

CONCLUSIONS

1. Combined variants of anesthesia using fentanyl with sevoflurane and fentanyl with propofol in children are characterized by a smooth clinical course, provide effective anesthetic protection of the child's body from surgical trauma and can be recommended for practical pediatric anesthesiology.

2. Combined variants of anesthesia based on fentanyl with sevoflurane and fentanyl with propofol are accompanied by moderate changes in the main indicators of central hemodynamics without a decrease in heart performance.

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