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OPTIMIZATION OF COMBINED GENERAL ANESTHESIA FOR ORTHOPEDIC SURGERY IN CHILDREN

Satvaldieva E.A., Yusupov A.S., Ismailova M.U.

Tashkent Pediatric Medical Institute, Tashkent, Uzbekistan

Resume

The purpose of the study was to improve the quality of anesthesia during orthopedic operations in children using the opioid-sparing anesthesia technique.

Materials and methods. The course of anesthesia was analyzed in 48 patients aged 3 to 14 years, during orthopedic operations in children. The distribution of patients into groups was carried out depending on the technique of anesthesia. Group 1 (main) consisted of 25 children who underwent general anesthesia using low doses of fentanyl, sevoflurane and propofol. group 2 (control) - 23 children who underwent general anesthesia with fentanyl and propofol. Echocardiography was used to determine hemodynamic parameters. The dynamics of changes in the level of cortisol in the blood and the concentration of catecholamines (adrenaline, norepinephrine, dopamine) in daily urine was studied.

Results. In children of the first group, during the introductory period of anesthesia, there was a decrease in CI, an increase in heart rate and UPS. Stroke index (SI), mean arterial pressure (MAP), cardiac index (CI) changed insignificantly compared to the previous stage of the study. In the children of the second group in the most traumatic stages of the operation, there was an increase in SI, HR, and AI.

In the most traumatic stages of the operation and after the operation in children of the first group, there was a tendency to increase cortisol, in the second group of patients, an increase in cortisol was noted.

Key words: opioids, general anesthesia, fentanyl, sevoflurane, propofol, orthopedic surgery.

ОПТИМИЗАЦИЯ КОМБИНИРОВАННОЙ ОБЩЕЙ АНЕСТЕЗИИ ПРИ ОРТОПЕДИЧЕСКИХ ОПЕРАЦИЯХ У ДЕТЕЙ

Сатвалдиева Э.А., Юсупов А.С., Исмаилова М.У.

Ташкентский педиатрический медицинский институт

Резюме

Цель исследования улучшение качества обезболивания при ортопедических операциях у детей применением методики опиоидсберегающей анестезии.

Материалы и методы. Проанализировано течение анестезии у 48 больных в возрасте от 3 до 14 лет, при ортопедических операциях у детей.

Распределение больных на группы осуществляли в зависимости от методики проводимой анестезии. 1 группу(основная) составляли 25 детей, которым проводилась общая анестезия с использованием малых доз фентанила, севофлурана и пропофола. 2 группу (контрольная) - 23 детей, которым проводилась общая анестезия фентанилом и пропофолом. Для определения показателей гемодинамики применялась Эхокардиография. Изучалась динамика изменения уровня кортизола в крови и концентрации катехоламинов (адреналин, норадреналин, дофамин) в суточной моче.

У детей первой группы на вводном периоде анестезии отмечалось снижение СИ, увеличение ЧСС и УПС. Показатели ударного индекса (УИ), среднего артериального давления (САД), сердечного индекса (СИ) изменялись незначительно по сравнению с предыдущим этапом исследования. У детей второй группы в наиболее травматичные этапы операции отмечалось увеличение СИ, ЧСС, УИ.

В наиболее травматичные этапы операции после операции у детей первой группы отмечалась тенденция к увеличению кортизола, во второй группе больных отмечалась увеличение кортизола.

Ключевые слова: опиоиды, общая анестезия, фентанил, севофлуран, пропофол, ортопедические операции.

БОЛАЛАР ОРТОПЕДИК ОПЕРАЦИЯЛАРИДА КОМБИНИРЛАНГАН УМУМИЙ АНЕСТЕЗИЯНИ ОПТИМАЛЛАШТИРИШ

Сатвалдиева Э.А., Юсупов А.С., Исмаилова М.У.

Тошкент педиатрия тиббиёт институти, Ўзбекистон

Резюме

Тадқиқот мақсади: болалар ортопедик операцияларида опиоидсақловчи анестезия усулини қўллаб оғриқсизлантириши сифатини яхшилаш.

Материал ва услублар 3 ёшдан 14 ёшгача бўлган 48 та беморда ортопедик операцияларда анестезиянинг кечиши ўрганилди.

Анестезия усулига кўра 1чи гуруҳга(асосий) 25 та бемор киритилиб, уларга кичик дозада фентанил ва севофлуран, пропофол қўлланилди, 2чи гуруҳда (назорат) 23 та беморга фентанил ва пропофол билан умумий анестезия ўтказилди. Гемодинамик кўрсаткичларни аниқлаш учун Эхокардиография усули қўлланилди. Қонда кортизол ва суткалик пешобда катехоламинлар (адреналин, норадреналин, дофамин) даражасини ўзгариши ўрганилди.

1 чи гуруҳдаги болаларда анестезияга кириш даврида ЮИ нинг пасайиши, ЮҚС ва НПК нинг ортиши кузатилди. ЗИ, ЎАБ, ЮИ кўрсаткичлари тадқиқотнинг аввалги босқичига нисбатан ўзгариши кузатилди. 2 чи гуруҳдаги беморларда травматик босқичда ЮИ, ЮҚС, ЗИ кўрсаткичлари ортди.

Жарроҳлик муолажасининг энг травматик босқичида 1 чи гуруҳда кортизолни ошишига мойиллик кузатилди, 2 чи гуруҳда эса кортизол миқдорининг ортиши қайд этилди.

Калит сўзлар: опиоидлар, умумий анестезия, фентанил, севофлуран, пропофол, ортопедик операциялар.

Relevance

Surgical treatment in pediatric orthopedics is characterized by high trauma and significant blood loss. At the same time, anesthesia methods must meet the requirements of safety, reliability, low invasiveness and provide adequate conditions for the work of the operating team [1,13]. The volume and invasiveness of orthopedic surgical interventions in children require effective and safe anesthesia. For this purpose, intravenous anesthesia preparations are widely used [3,12]. However, these drugs at recommended doses often have a number of negative effects, and dose reduction leads to inadequate pain relief [2,8].

Opioids have long been the "gold standard" of perioperative pain management in both adult and pediatric patients [4,14]. However, excessive use of opioid analgesics slows postoperative awakening, causes drowsiness, and is associated with a higher risk of postoperative nausea and vomiting, as well as other side effects that are associated with the development of a number of negative effects, such as respiratory depression, muscle rigidity, pruritus, and tolerance [5,7,9]. The use of high doses of opioid analgesics can cause opioid-induced postoperative hyperalgesia. It develops as a result of nociceptive sensitization caused by neuroplastic changes in the peripheral and central nervous system and a significant decrease in the pain threshold [14]. Inadequate

intraoperative analgesia significantly increases the risk of chronic postoperative pain and complications. This increases the length of the patient's stay in the hospital and the cost of treatment [7].

The maximum use of the possibilities of opioid-sparing technologies in traumatic operations in children are elements of a global ant nociceptive strategy for the use of opioids. In this regard, for pain management in the perioperative period, it is relevant to use all kinds of methods to minimize the use of opioids in children [11]. The increasing introduction into surgical practice of the principles of accelerated postoperative rehabilitation of patients, designated in the form of the modern concept of "Enhanced Recovery after Surgery (ERAS)", is the use in the schemes of anesthetic management of drugs that do not adversely affect the speed of postoperative rehabilitation of patients, preventing excessive sedation, postoperative nausea and vomiting [6]. At present, the need to reduce the doses of opioid analgesics in the perioperative period seems obvious. From this position, the widespread use of drug combinations is very attractive, which can significantly reduce the need for opioid analgesics, providing an opioid-sparing effect [15].

Today, the issue of using dexamethasone is being studied, which reduces local tissue edema in the area of damage [10]

The purpose of the study was to improve the quality of anesthesia during orthopedic operations in children using the opioid-sparing anesthesia technique.

Material and methods

The course of anesthesia was analyzed in 48 patients aged 3 to 14 years who were hospitalized at the TashPMI clinic for planned surgery for congenital pectus excavatum (22 patients) and congenital dislocation of the hip joint (26 patients). The data are presented in tab. 1. The duration of the operations in which the studies were carried out ranged from 105.2 ± 11.2 minutes.

The distribution of patients into groups was carried out depending on the technique of anesthesia. Group 1 (main) consisted of 25 children who underwent general anesthesia using low doses of fentanyl, sevoflurane and propofol. group 2 (control) - 23 children who underwent general anesthesia with fentanyl and propofol. In both groups, premedication was used, consisting of atropine sulfate with diphenhydramine in age dosages. In the main group of patients, anesthesia was carried out under the conditions of opioid-sparing technology: 40 minutes before surgery, dexamethasone 2-4 mg was added to the premedication.

Induction was carried out by introducing: fentanyl-0.005% - 2 µg/kg, propofol 1% -2.5 mg/kg and sevoflurane 3 vol.%, arduan-0.2% (0.06 mg/kg) and transfer of patients to mechanical ventilation . IVL was carried out by the Fabius plus device (Germany) in the normoventilation mode with PetCO2 37-38 mm Hg. The gas mixture was supplied in a volume of

2 l/min. Sevoflurane 1-2 vol.% was used to maintain anesthesia. The control group was anesthetized with fentanyl 5 µg/kg and propofol 3 mg/kg. After intravenous administration of the muscle relaxant arduan 0.06 mg/kg, the patients were transferred to mechanical ventilation. After the first bolus administration, repeated doses of fentanyl were 3-2 µg/kg.

The following indicators were determined: systolic blood pressure (BPs), diastolic blood pressure (BPd), mean arterial pressure (BPmean), oxygen saturation (SaO2), heart rate (HR) on the multifunctional BLD monitor (China).

The analysis of the dynamics of central hemodynamic parameters was carried out at 5 key points: the 1st stage - before the operation, the 2nd stage - after premedication, the 3rd stage - induction, the 4th stage - the most traumatic moment of the operation and the 5th stage - the end surgery. The severity of surgical stress was determined by the level of stress hormone cortisol in 3 stages: before surgery, at the most traumatic stage and immediately after surgery. The dynamics of the concentration of catecholamines (adrenaline, norepinephrine, dopamine) in daily urine was studied in two stages: before surgery and in the postoperative periods.

Result and discussion

For this purpose, hemodynamic parameters were studied during anesthesia using fentanyl in combination with propofol and sevoflurane. The results of studies of the BP indicator are presented in Table 2. In both groups, the maximum increase in BP was noted at the stage of induction. At this stage of the study, in children of the second group, blood pressure increased by 9.8% more than in children of the first group.

Table 1 Patient characteristics

	Groups		%
	1	2	
Age	7,76±0,5	6,78±0,59	7,88
Body mass	24,58±1,56	22,54±1,72	8,25
Operation duration	61±3,38	73,09±3,65	19,82*

Note: sign * - reliability of differences in the indicators of the second group to the first group at P<0.05.

Table 2. BP indicators in children of the study groups

Groups	Indicato	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
1	BPs., mm Hg	92±1,9	101±1,2	107,5±1,9	101±1,7	101±0,8
	BDD, mm Hg	55±1,3	61,5±1,3	63,5±1,9	59±0,8	61±1,7
2	BP, mmHg	105,4±7,3	110,2±7,58	118±7,0	113,6±6,35	107,1±4,99
	BDD, mm Hg	68,1±7,1	72,3±7,25	77,2±7,08	74,2±6,23	69,9±5,57

Studies of central hemodynamic parameters in children of the first group showed the following. Compared with the initial data on the premedication background, there was an increase

in heart rate by 9.78% and specific peripheral resistance (RPS) of the vessels by 24.51%. Other indicators changed slightly (Table 2).

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

Indicators	Outcome	premedication	introductory period	traumatic stage of the operation	end of the 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
SAD, mm Hg Art.	78,85±1,21	81,2±2,93	84,22±3,75	77,81±4,0	75,44±2,56
Heart rate, min ⁻¹	84,0±2,38	107,75±2,87*	107,93±3,93*	122,7±8,41*	126,01±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, r.u.	30,42±5,31	40,33±7,74	40,76±5,85	36,93±5,17	38,16±7,56

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

During the introductory period of anesthesia, there was a decrease in CI by 10.63%, an increase in heart rate by 25.45% and an increase in UPS by 25.58%. Stroke index (SI), mean arterial pressure (MAP), cardiac index (CI) changed insignificantly compared to the previous stage of the study.

During the maintenance period of anesthesia, certain changes in the indicators of central and peripheral hemodynamics were also observed. So, at the 4th stage of the study, compared with the 3rd stage of the study, there was a certain trend towards a decrease in CI indicators - by 12.76%, CI by 2.5%, while heart rate increased by 41.1%, UPSS - by 16.1%. Despite this, it can be argued that the hemodynamic parameters remained within the optimal values.

In connection with the use of low doses of fentanyl, there was no pattern of pronounced circulatory depression due to a decrease in vascular tone. Clinical concentrations of propofol did not inhibit myocardial contractility. The

increase in UPS was associated with a transient initial response to the administration of drugs; subsequently, a return of UPS closer to the initial value was observed.

Sevoflurane during the induction period provided suppression of pharyngeal and laryngeal reflexes, after which tracheal intubation was performed. The applied low dose of Fentanyl as part of combined anesthesia did not cause severe circulatory depression, however, there was a moderate decrease in blood pressure as a result of vasodilation, inhibition of sympathetic reflexes and relative bradycardia. Apparently, this occurred due to the activation of the opiate receptor (mu) by inhibition of presynaptic release and postsynaptic interaction of excitatory neurotransmitters (acetylcholine) of nociceptive neurons.

Data from similar studies of central hemodynamics during combined anesthesia in children of the second group are presented in Table 3.

Table 4. Indicators of central hemodynamics in children during combined anesthesia with fentanyl and propofol

Indicators	Outcome	premedication	introductory period	traumatic stage of the operation	end of the 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
SAD, mm. rt.st	62,42±2,27	67,03±2,29	67,03±2,4	65,97±2,78	63,03±2,06
Heart rate, min ⁻¹	82,14±2,09	115,26±3,07*	112,25±2,13*	120,52±5,23*	133,75±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, r.u.	31,18±4,74	48,1±10,6	42,24±8,69	43,72±10,6	32,88±4,87

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

During the introductory period of anesthesia, there was an increase in heart rate by 32.67% (P<0.05), UPS by 15.53%, AI by 9.4% relative to its initial values.

In the most traumatic stages of the operation, there was an increase in SI, HR, SI, respectively, by 37.26%, 41.65% and 12.21% (P<0.05), and compared with the previous stage of the study, these indicators changed unreliably. At the end of the operation, compared with the stage of the traumatic moment of the operation, the indicators of central hemodynamics changed insignificantly.

Thus, the use of low doses of fentanyl in combination with sevoflurane and propofol as part of combined anesthesia was accompanied by minor and compensated changes in the main indicators of central hemodynamics, which

indicated that effective anesthetic protection of children was ensured.

In children of the first group after the operation, there was a decrease in adrenaline in the urine by 16.69%. At the same time, there was a slight decrease in the concentration of norepinephrine and dopamine in the urine (Table 4). A decrease in the excretion of dopamine apparently indicates a decrease in the initial substrate for dopamine, which in turn leads to a slowdown in the conversion of tyrosine into dopamine. When the body is exposed to stress factors of various etiologies and severity, followed by activation of the hypothalamic-pituitary-adrenal system, which may have led to an increase in the concentration of glucocorticoids and catecholamines.

Table 5 Urinary catecholamine concentrations during combined anesthesia with fentanyl, sevoflurane and propofol

Catecholamines, mcg/day	Before surgery	After surgery
Adrenalin	5,39±0,88	4,49±0,65
Norepinephrine	10,97±1,40	10,76±1,53
Dopamine	112,69±5,15	108,63±3,75

The dynamics of the concentration of catecholamines in the daily urine during general anesthesia with fentanyl and propofol are shown in Table 6. In patients of the second group, the concentration of catecholamines in the urine -

adrenaline and norepinephrine tended to decrease in the postoperative period. At the same time, the concentration of dopamine tended to increase (Table 5).

Table 6 Urinary Catecholamine Concentrations During Combined Anesthesia with Fentanyl and Propofol

Catecholamines,	mcg/day Before surgery	After surgery
Adrenalin	6,19±0,99	6,74±0,85
Norepinephrine	14,49±2,27	14,58±2,38
Dopamine	124,64±4,92	125,57±2,7

Studies have shown that during general anesthesia using fentanyl, sevoflurane and propofol, there was a decrease in the

concentration of catecholamines in the postoperative period.

The study noted minor changes in the concentration of cortisol. In the most traumatic

stages of the operation and after the operation, the children of the first group showed a tendency to increase cortisol, in the second group of patients in the most traumatic stages of the operation there was an increase in cortisol by

14.59% more than in the children of the 1st study group. In the postoperative period, the cortisol of the 2nd group increased by 15.75% than the cortisol of the 1st study group.

Table 7. Change in cortisol concentration (nmol/l) in the postoperative period

Groups	Before surgery	Traumatic moment	After operation
1 группа	323,5±12,3	326,8±10,9	321,1±11,1
2 группа	346,2±14,9	374,5±11,6	371,7±11,1

Analysis of the obtained data shows that the opioid-sparing variant of combined general anesthesia used by us makes it possible to prevent excessive tension of the sympathoadrenal system and provide adequate protection of patients from surgical stress. The stability of the studied parameters in the main group indicates a more reliable antinociceptive protection. This variant of anesthesia also made it possible to limit the total doses of fentanyl by almost two times.

Conclusions

1. General anesthesia with fentanyl, sevoflurane and propofol provides adequate protection for patients in the intraoperative period, causing a slight activation of the hormonal status, which should be considered as a favorable factor that does not require correction.

2. The introduction of dexamethasone 40 minutes before surgery, in contrast to the sedation of the second group, prevents an increase in the level of catecholamines in daily urine against the background of a decrease in the excretion of their precursors.

3. The use of an opioid-sparing version of general anesthesia in the scheme of anesthesia management aimed at minimizing doses can significantly limit the side effects of surgical stress and improve the reliability, safety and quality of anesthesia during orthopedic operations in children.

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