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Caudal blockade as the main component of general anesthesia during surgical interventions for necrotic enterocolitis in newborns

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Abstract

Necrotic enterocolitis (NEC) is one of the most complex and least studied problems in neonatal surgery, which significantly affects mortality rates.

Aim of the study: Determination of the safest and most effective method of anesthesia during surgical interventions for necrotic enterocolitis in newborns.

Material and methods of the study: We conducted a study of two variants of anesthesia, namely non-inhalation anesthesia using dormicum and caudal block, as the first option, and propofol in combination with caudal block as the second version of the technique.

The results of the study: The adequacy of caudal anesthesia with lidocaine at a dose of 6 mg/kg was evaluated based on the onset of symptoms of a nociceptive hemodynamic reaction (tachycardia, arterial hypertension, increased stroke volume, and cardiac output). An analysis of the technique of balanced caudal anesthesia, as part of general anesthesia, which we use in surgical interventions for NEC in newborns revealed its high efficiency. The frequency of side effects of caudal blockade and complications in connection with its implementation was insignificant. The listed complications were not threatening the patient's life and the prognosis of the course of the postoperative period. According to the literature, complications associated with the technique of creating the caudal block are quite rare.

Keywords

Caudal Block; Lidocaine; Necrotic Enterocolitis

Introduction

Necrotic enterocolitis (NEC) is one of the most complex and least studied problems in neonatal surgery, which significantly affects mortality rates. Anesthesia in newborns with NEC is often complicated by the presence of concomitant pathology (prematurity, RDS, perinatal damage to the central nervous system, etc.) with multiple malformations, in particular, congenital heart defects [1-4].

Features of emergency surgical interventions, which include operations for necrotic enterocolitis in newborns, require induction into anesthesia with drugs that allow providing the hypnotic and analgesic effect as soon as possible without significant changes in hemodynamics and tracheal intubation. All this makes the search for safer methods of anesthesia urgent since mono anesthesia is far from perfect in neonatal anesthesiology [5-8]. To this end, we compared the two most commonly used methods of non-inhalation anesthesia and caudal anesthesia in newborns with NEC.

Aim of the Study

Determination of the safest and most effective method of anesthesia during surgical interventions for necrotic enterocolitis in newborns.

Material and Methods of the Study

We conducted a study of two variants of anesthesia, namely non-inhalation anesthesia using dormicum and caudal block, as the first option, and propofol in combination with caudal block as the second version of the technique. The first variant of anesthesia was performed in 29 patients operated on for NEC. Induction in anesthesia in patients of this group was carried out using dormicum at the rate of 0.1 mg/kg. In all patients, tracheal intubation was performed after intravenous administration of 1 μg / kg of fentanyl and a muscle relaxant of non-depolarizing action of rocuronium bromide at the rate of 0.5 mg/kg. With the favorable effect of the caudal block, maintenance of anesthesia in patients of this group was carried out using sevoflurane 0.6-0.8% vol. Upon receipt of an effective caudal block to support myoplegia, it was not necessary to administer a maintenance dose of muscle relaxant. In 22 patients of group II, induction anesthesia was carried out with propofol at a dose of 2.0 - 2.5 mg/kg, 1 μg / kg of fentanyl and a muscle relaxant of non-depolarizing action of rocuronium bromide at the rate of 0.5 mg/kg. Then, caudal as in patients of group I was performed.

For all patients of group I and II, caudal block was performed after tracheal intubation and before surgery. The puncture of the caudal space was carried out in the position on the left side with the lower extremities bent at an angle of 90 ° in the hip and knee joints. To calculate the dose of lidocaine, we used the titration method. Using the titration method, we determined the optimal dose of lidocaine 6 mg/kg for the implementation of surgical interventions for NEC in newborns. After completion of the local anesthetic, the needle was removed and the child was laid on his back in a horizontal position. The time from the moment the drug was introduced into the caudal space until the start of the operation (latent period) was at least 10-15 minutes.

The fundamental point of our methodology is the preventive nature of the caudal blockade of afferent nociceptive pathways before the operation, which allows more effective prevention of activation of pain receptors and the development of hypersensitivity of neurons of the horn in response to tissue damage. The effectiveness of intra- and postoperative analgesia, achieved in connection with combined caudal anesthesia, was evaluated on the basis of hemodynamic parameters, as the most dynamic in terms of nociceptive reactions of the body. Nociceptive stimuli induce reflex activation of the sympathetic nervous system, which is considered as part of the body's overall defensive response to stress. To assess the effectiveness of intra- and postoperative analgesia, hemodynamic parameters were determined at the following stages:

Stage I - before anesthesia;
Stage II - after induction in anesthesia;
Stage III - the traumatic moment of the operation;
Stage IV - the end of the operation.

With the restoration of consciousness in the postoperative period, the "pain scale" was used to assess the effectiveness of pain relief. To date, numerous variants of the “pain scale” have been proposed for children of different age groups, based on an objective analysis of changes in the patient’s behavior and registration of individual physiological parameters. In our study, the effectiveness of the caudal block, after recovery, was evaluated on the basis of the “pain scale” proposed by Hannallah R.S., Broadman L.M. et al. (1987).

The authors used this pain scale for a comparative assessment of the effectiveness of analgesia for caudal anesthesia and blockade of n.n, ilioinguinal (iliohypogastricus / iliohypogastricus in children. A dynamic assessment of caudal analgesia using the selected pain scale was carried out from the moment the patient was transferred to the wake-up room and during the 2 hours of the postoperative period, with an interval of 30 minutes, or when changes in the patient's condition appeared. The assessment of the adequacy of analgesia using a pain scale was carried out by an anesthetist. A total score of less than 4 was considered satisfactory analgesia. To assess the adequacy of the body's protection against operational stress in conditions of caudal blockade and mechanical ventilation, we analyzed the parameters of central hemodynamics and stress markers (cortisol and glucose). To assess the adequacy of the body's protection against operational stress in conditions of caudal blockade and mechanical ventilation, we analyzed the parameters of central hemodynamics and stress markers (cortisol and glucose).

The results of the study

The adequacy of caudal anesthesia with lidocaine at a dose of 6 mg/kg was evaluated based on the onset of symptoms of a nociceptive hemodynamic reaction (tachycardia, arterial hypertension, increased stroke volume, and cardiac output). At stage II - after induction in anesthesia, a significant decrease in heart rate by 4.4% ($p < 0.05$), an increase in blood pressure by 2.4%, a decrease in SV by 1% occurred, which was explained by the sympathomimetic effect of dormicum, which was used in induction time. At the III stage of anesthesia, a decrease in central hemodynamics was observed, namely, a decrease in heart rate by 9.2%, SV by 1.5%, minute volume (IOC) by 10.4%, OPSS increased by 12.6% from the initial study. Such changes in the parameters of central hemodynamics testified to the adequacy of the caudal block used by us.

The data of central hemodynamics presented in **(Table-1)** at different stages of anesthesia: the initial data, during induction in anesthesia, the main stage and the end of the operation, confirm the absence of a significant hyperdynamic reaction to nociceptive impulses from the area of the surgical wound. Caudal anesthesia was not effective enough in 4 patients (14.3%). Of these, in 2 patients, the latent period of development of the sensory block, which lasted 10-15 minutes, was not sustained in time. In these cases, in response to a skin incision, an increase in blood pressure, heart rate and a decrease in OPS are noted. Inadequacy of anesthesia was manifested in a significant ($p < 0.05$) increase in SBP by 25 ± 3.2% in response to a skin incision, as well as average heart rates (28 ± 3.8%).

The consumption of fentanyl, which was required

Table-1: Indicators of central hemodynamics when applied caudal block as part of general anesthesia

Stages	SV	TPVR	CO	HR	SBP	DBP	MBP
	ml	D/s/sm^{-5}	l/min	min	mm.m.c.	mm.m.c.	
I	8,54±0,11	724,1±37,1	1,27±0,02	149,2±1,7	70,6±1,5	38,3±1,0	54,1±1,1
II	8,5±0,09	768,2±40,9	1,21±0,02	142,6±2,4 p<0,05*	71,7±1,7	39,4±1,1	55,4±1,3
III	8,41±0,1	815,6±45	1,14±0,02 p<0,001*	135,4±1,9 p<0,001*	70,4±1,2	39,4±1,0	54,6±1,0 p<0,05*
IV	8,5±0,08	799,6±40,9	1,16±0,02 p<0,001	136,2±1,3 p<0,001	72,0±1,2	39,5±1,0	55,8±0,9

to enhance analgesia, was 3 times higher than in the group with adequate caudal anesthesia. It amounted to 4.5 ± 0.3 μg/kg/h.

Our results are quite comparable with the results obtained in other studies. And the dose of 6 mg/kg lidocaine that we use is sufficient for both sensory and motor blockade of the lower thoracic and lumbosacral segments in the surgical area. In patients of group II, in which induction of anesthesia was carried out with propofol at a dose of 2.0 - 2.5 mg/kg, there was not a single case of pain with the introduction of the drug. Loss of consciousness occurred instantly, in rare cases, short-term excitement was noted. Falling asleep was preceded by horizontal nystagmus or floating movements of the eyeballs. The pupils narrowed somewhat, the reaction to light was slowed down, the eyeballs at the end of induction were fixed in the center. The ciliary reflex faded on average after 142 seconds. (2 min. 22 sec.) ± 10.2. The total induction time into anesthesia was 172.3 seconds. (2 min. 52 sec.) ± 6.2. On the respiratory side, there was a decrease in the respiratory rate and a decrease in SpO2 to 92-95%. After hyperventilation with oxygen, the mask of the anesthesia apparatus Spo2 rose to standard values of 98-99%. In 3 patients, after administration of propofol, bronchospasm occurred, requiring immediate tracheal intubation. A significant decrease in the level of cortisol at stages 3 and 4 of the study, as well as glucose levels at the last stage, allows us to confidently talk about the adequacy of the anesthetic protection and to make this type of anesthesia the main method of choice. In patients of group I, in whom anesthetic anesthesia was carried out with dormicum at a dose of 0.1 mg/kg, induction in anesthesia proceeded smoothly, large-scaled horizontal nystagmus, single muscle twitches, and coming hypertension was noted. After 86.5 seconds (1min 26 sec ± 12.4) after intravenous administration of dormicum, a loss of the ciliary reflex was noted. The total induction time into anesthesia was 150 seconds. (2 min. 30 sec. ± 12.5. When the surgical stage of anesthesia is reached, the pupil narrowed, eyeballs were set in the center, and lacrimation was rarely observed. On the breathing side, there was a decrease in respiratory rate, apnea and a decrease in SpO2 to 92-96%. After oxygen hyperventilation the mask of the SpO2 anesthesia apparatus rose to 98-99%. Laryngospasm and bronchospasm were not observed during induction, but all children had hypersalivation.

Thus, the time of induction of anesthesia turned out to be almost the same when using propofol and dormicum. Induction in anesthesia with dormicum was accompanied by an increase in blood pressure, which was due to an increase in CVD by 6.1%. The level of cortisol significantly decreased at the traumatic stage of the operation; statistically significant changes were not observed in the

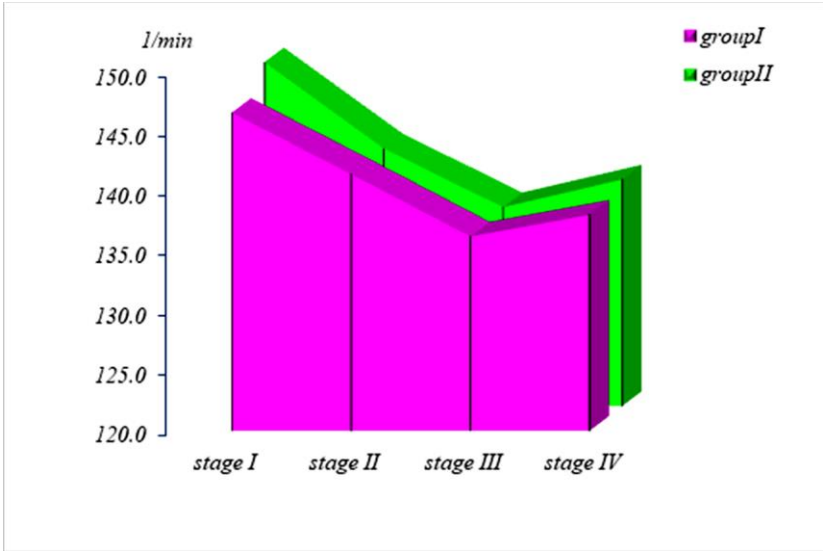

Fig-1: Heart rate dynamics in both groups

dynamics of glucose levels. The study also showed that the inclusion of the caudal block in the composition of general anesthesia led to a significant reduction in the doses of both fentanyl and muscle relaxant rocuronium bromide. Since during the maintenance of anesthesia with adequate caudal block, neither fentanyl nor muscle relaxant was administered, which is very important during anesthesia in newborns and premature babies. Maintenance of anesthesia during surgery was carried out only by an inhaled anesthetic sevoflurane at a concentration of 0.6 - 0.8 vol%. Analysis of hemodynamic changes in both groups showed that, when performing multi-component anesthesia in combination with the caudal block, the main hemodynamic parameters remained relatively stable during the traumatic stage of the operation (**Fig-1**).

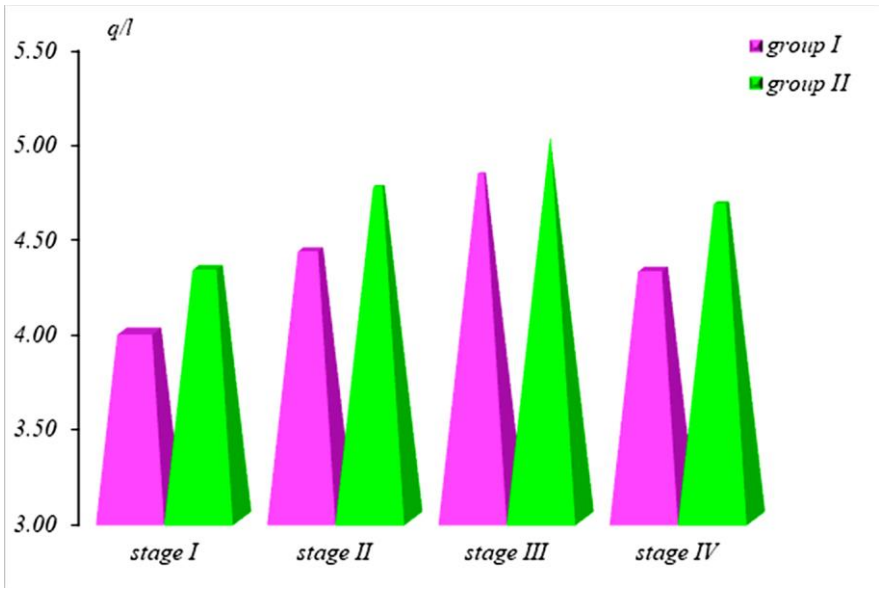

Fig-2: Dynamics of glucose changes in both groups

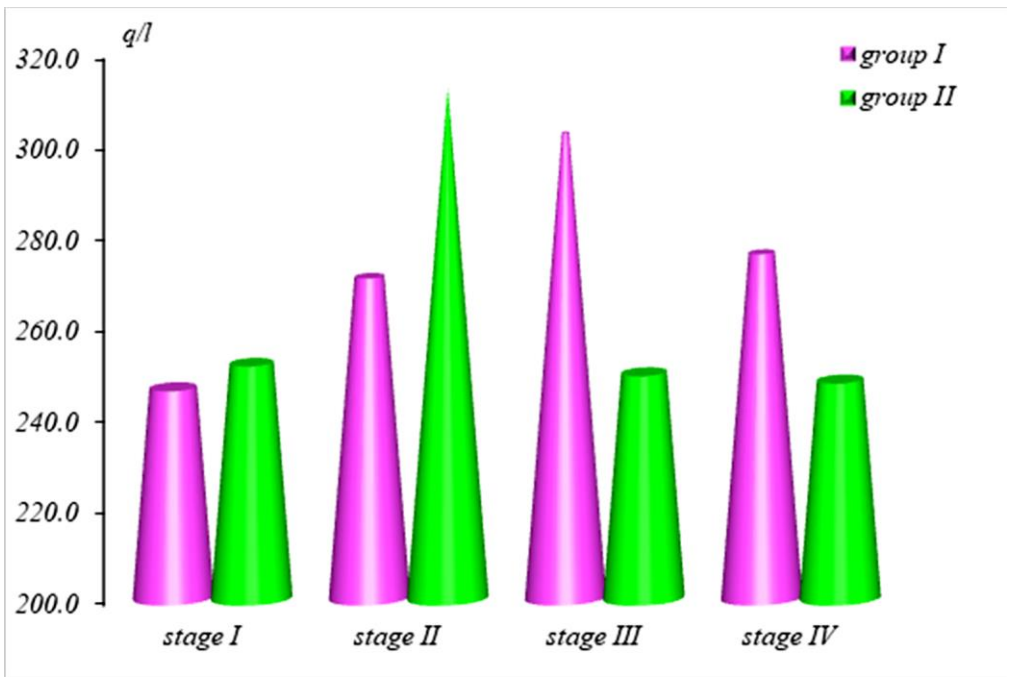

Fig-3: Dynamics of changes in the level of cortisol

Analysis of the dynamics of cortisol and glucose showed a decrease in the level of stress markers in the first and second groups of the studied, at the traumatic stage of the operation and at the end of the study. This speaks in favor of the use of caudal block as part of general anesthesia in newborns operated on for NEC (**Fig-2,3**).

Conclusion

An analysis of the technique of balanced caudal anesthesia, as part of general anesthesia, which we use in surgical interventions for NEC in newborns revealed its high efficiency. Our studies have shown that caudal anesthesia, taking into account the segmental innervation of the surgical field, provides a reliable and effective blockade in the intraoperative period. In our study, 14% were recognized as inadequate anesthesia (in 4 patients). These patients needed the use of additional doses of narcotic analgesics, both during surgery and in the immediate postoperative period. Patients of this group at the third and fourth stages of anesthesia (during a skin incision and at the traumatic stage of the operation) showed distinct hemodynamic reactions due to the ineffectiveness of suppressing nociceptive impulses. The consumption of narcotic analgesic fentanyl was 43% higher than in the group with an effective caudal block. A study of central hemodynamic parameters in newborns under conditions of balanced regional anesthesia confirmed the stability of hemodynamic parameters in the caudal block. The systemic effect of the local anesthetic of lidocaine on the function of the cardiovascular system under conditions of a balanced caudal block was minimal and, according to our data, was not accompanied by significant changes in the indices of central hemodynamics. In no case was an infectious, toxic complication associated with the use of local anesthetic lidocaine. The frequency of side effects of caudal blockade and complications in connection with its implementation was insignificant. The listed complications were not threatening the patient's life and the prognosis of the course of the postoperative period. According to the literature, complications associated with the technique of creating the caudal block are quite rare.

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