

INFLUENCE OF COMBINED SPINAL ANESTHESIA ON HEMODYNAMIC PARAMETERS AND STRESS MARKERS IN PRESCHOOL CHILDREN DURING UROLOGICAL SURGICAL INTERVENTIONS

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Abstract. *Currently, in the practice of “adult” anesthesiologists, spinal anesthesia is a modern and effective method for urological surgical interventions. However, in pediatric anesthesiological practice, until recently, the use of SA was limited due to a number of objective and secondary reasons (anatomical and physiological beginnings of childhood; difficulty in verbal contact with young children; high risk of toxic effects of local anesthesiologists. In addition, spinal anesthesia in children), younger special age is associated with certain technical difficulties. In this connection, we conducted a comparative assessment of the state of central hemodynamics and autonomic status in preschool children during urological surgical interventions performed under combined spinal anesthesia in combination with intravenous sedation with propofol in a comparative aspect with combined general anesthesia based on sevoflurane and fentanyl.*

Keywords: *spinal anesthesia, childhood, hemodynamic parameters, local anesthetics, urological surgical interventions.*

Introduction. Spinal anesthesia (SA) involves the injection of a local anesthetic into the subarachnoid space and generally does not require sedation in adults. Numerous studies have shown convincing results regarding the safety and effectiveness of SA for older children and infants [1-7].

SA in children has many advantages over general anesthesia with minimal cardiorespiratory disturbances, i.e. lower incidence of hypotension and bradycardia [8-14]. Unlike general anesthesia, spinal anesthesia allows children to remain breathing independently throughout the operation with minimal sedation, which avoids respiratory depressant effects and prevents the risk of developing complications such as postoperative apnea and hypoxia [15-20].

Anatomical and physiological characteristics of preschool children.

Newborns have a narrow, about 20 cm, subarachnoid space containing cerebrospinal fluid. The volume of the subarachnoid space rapidly increases to 30 cm in children of 1 year, to 40–50 cm by 5 years, and to 100–140 cm by 8 years. This is important to consider when choosing the type and size of needle. The bevel of the needle should not be more than 2 mm. The volume of cerebrospinal fluid in newborns is 10 ml/kg body weight, in children weighing less than 15 kg - 4 ml/kg, in adults - 2 ml/kg [21-26]. In this connection, the calculation of dosages of local anesthetics in preschool children is higher than in older children and adults. Lumbar lordosis is not pronounced, which increases the risk of spread of local anesthetic in the cranial and caudal directions from the puncture site, providing sensory block over a wider range [27-29].

The purpose of the study was to study the features of systemic hemodynamics and stress markers during urological surgical interventions in conditions of combined SA in preschool children (1-6 years).

Materials and methods.

At the Yunus Obod Medical Center, from 2021 to 2023, spinal anesthesia was performed on 63 children. All patients who took part in the study underwent a detailed pre-anesthesia examination. Patients with coagulopathies, sepsis, cardiovascular failure, spinal deformity, dehydration, local infection at the site of lumbar puncture, refusal of the patient's parents to sign informed consent, emergency and long-term operations were excluded from our study. The duration of preoperative fasting was 6 hours for solid food, 4 hours for breast milk (infant formula) and 2 hours for clear liquid. For data analysis, patients were divided into two age groups: 38 children aged 1 to 3 years, 25 children aged 4 to 6 years. All children were randomized by gender, age, duration and traumaticity of surgical intervention.

Informed consent to participate in the study was obtained from the parents of each patient. Before performing SA, intravenous access was established and all patients were infused with crystalloid solutions or Ringer's lactate. After premedication with midazolam and induction of propofol with ketamine in subnarcotic dosages in 63 urological patients, spinal anesthesia was performed under ultrasound guidance in order to level the risk of trauma and prevent neurological complications. Spinal anesthesia was performed under aseptic conditions, with the patient in the lateral decubitus position, avoiding severe neck flexion to prevent airway obstruction, with humidified oxygen insufflated through nasal cannulas. Spinal anesthesia was performed using an Atraucan® Ped G-26 needle in children of the younger age group and a Pencan® G-26 needle in children of the older age group. After identifying the subarachnoid space by the appearance of transparent cerebrospinal fluid in the needle pavilion, a 0.5% isobaric solution of levobupivacaine was administered at a dose of 0.3-0.8 mg/kg. After removing the needle, patients were placed in a horizontal position, avoiding elevation of the lower extremities. Lumbar puncture was performed at the L4–L5 intervals during urethroplasty and bilateral orchiopexy and at the L3–L4 level during ureteral reimplantation and transurethral ureterolithotripsy. Maintenance of anesthesia with propofol. Children operated on under conditions of combined SA were breathing spontaneously throughout the entire period of anesthesia and surgery.

In the control group (n=47), combined general anesthesia was performed based on sevoflurane in an induction dose of 6-3 vol%, fentanyl 3-4 mcg/kg/h, against the background of myoplegia with Ardoin 60 - 80 mcg/kg/h, with subsequent transfer to mechanical ventilation. Anesthesia was maintained with sevoflurane 3-2.5 vol%, fentanyl 1.5-2 mcg/kg/h, Arduan 30-40 mcg/kg/h. Patients in both groups received identical infusion therapy, which began 20 minutes before induction.

Hemodynamic parameters were studied using Mindray M6 devices, and vegetative status was studied using the immunofluorescent method using a Finecare wondfo device.

Hemodynamic parameters were recorded at five stages of the perioperative period (1 - preoperative stage, 2 stage - induction of anesthesia (induction), stage 3 - 30 minutes after the introduction of bupivacaine into the subarachnoid space, 4 - traumatic stage, stage 5 - end of the operation).

Results and discussion.

Spinal anesthesia was successful in all 63 patients. Adequate analgesia was achieved through careful selection of the puncture level and the amount of anesthetic.

One case of conversion to general anesthesia was due to the surgeons' decision to switch to buccal urethroplasty. To obtain a buccal flap, it was decided to switch to a multimodal anesthesia method. Lumbar puncture was successful on the first attempt.

The initial indicators of heart rate and SBP in both groups of patients exceeded the average age values, which, obviously, was due to the emotional background and a negative reaction to separation from parents. Starting from induction (stage II) and at stage III, mean blood pressure decreased significantly by 6.4%, heart rate by 5.2%, and SVR by 8.7% ($P < 0.05$), relative to the initial values. At stage 5 of the study, BRL, heart rate and MAP remained reduced by 9.5%, 3.2% and 1.7% compared to the preoperative level, thus indicating sufficient stabilization of the main hemodynamic parameters in the intraoperative period.

In patients in the control group, at almost all stages, the indicators of mean blood pressure and heart rate were characterized by a tendency to increase. At stage 3, the increase in SVR corresponded to 9.7%, HR - 7.8% and MAP - 10.3%, respectively, in relation to the initial values. At the traumatic stage of the operation, there was a further increase in SVR, heart rate and MAP by 11.5% ($P < 0.01$), 10% ($P < 0.05$) and 13.5% ($P < 0.05$), respectively, in relation to preoperative values. Further research results showed that at the awakening stage, the parameters of UPS, heart rate and MAP remained elevated compared to the preoperative level by 5.7%, 6.6% and 11%, although a decrease was observed relative to the previous stage.

The SI and FI indicators were absolutely stable, which confirms the reliable suppression of the operational stress response, and even indirectly the stability of volemia against the background of a balanced correction of current losses during urological surgical interventions in children of this group.

Significant differences in the parameters of central hemodynamics and vegetative status were obtained between the studied groups of children. Based on the data obtained, it was concluded that combined SA is the method of choice for urological interventions because it provides more pronounced nociceptive protection.

Hemodynamic stability was demonstrated in both age groups. A statistically significant slowdown in heart rate was indeed observed at 30 minutes, although clinically significant bradycardia requiring correction did not occur. And it recovered spontaneously. Upon completion of the operation, all patients were transferred to the urology department, bypassing the recovery room. Recovery of sensory and motor block was complete in all patients. The frequency of adverse effects of SA was minimal: bradycardia occurred in 2 (2%), chills - in 2 (2%) patients.

In the main group, the preoperative blood cortisol level was 318.1 ± 44.5 nmol/l. Over time, there was a decrease in cortisol to 276.5 at the traumatic stage and to 249.5 nmol/l by the end of the operation.

In children of the control group at the traumatic stage of the operation, its growth by 52.6% was noted. The value reached a level of 399.02 ± 66.06 nmol/l. At the end of the operation, the level of cortisol in the blood returned to its original values, decreasing by 27% compared to the previous stage.

Based on the above-described results, it can be seen that in the main group, anesthetic protection in which was carried out with the use of SA at all stages of the study, a significant decrease was noted, which confirms adequate suppression of the endocrine stress response and the sympathoadrenal system. In turn, in patients of group 2, significant increases in the level of cortisol in the blood were revealed at the stages of the study, which indicates insufficient anti-stress

protection during traumatic abdominal operations under traditional combined general anesthesia based on propofol and fentanyl.

The average age of the patient was 3.62 ± 3.2 years (from 1 month to 7 years). Eighty-nine (89%) patients were boys and only 15 (15%) were women. The average weight of the patients was 18.42 ± 7.57 (5–35) kg. The average duration of the operation was 200.5 ± 16.05 minutes. The average fasting time was 5.92 ± 0.89 hours.

Conclusions.

Combined SA was well tolerated hemodynamically in the pediatric study population. The study showed that the most optimal state of central hemodynamics and heart rate variability was observed in children operated on under conditions of combined SA.

Pediatric spinal anesthesia is a safe and effective method of anesthesia for urological surgeries in children. It has a more pronounced anti-stress effect and provides an adequate level of protection throughout the entire perioperative period. Due to the early restoration of motor activity, this method may be the method of choice for mid-term surgeries in the pediatric population.

When choosing the type of anesthesia in children between total intravenous anesthesia and spinal anesthesia, spinal anesthesia has advantages. Adequate pain relief is achieved by administering a bolus of relatively low doses of local anesthetics. There is no need for mechanical ventilation during operations that are not accompanied by changes in intra-abdominal pressure. This anesthesia method requires only minimal sedation.

Thus, the results of the study showed that QSA creates favorable conditions for the functioning of the cardiovascular system and vegetative status during urological surgical interventions in preschool children.

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