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Original Article / Оригинални рад

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The role of regional anesthesia in the postoperative analgesia in pediatric patients

Улога регионалне анестестезије у постоперативној аналгезији педијатријских пацијената

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SUMMARY

Introduction/Objective The pain is a disturbing experience associated with existing or potential tissue damage, with a sensory, emotional, cognitive and social component.

The aim of this study was to show the efficiency of regional anesthetic techniques in postoperative pain in children.

Methods The retrospective cohort study, was conducted on a group of 564 pediatric patients during the period from 2013 to 2016. Types of regional anesthesia were classified into 6 groups: caudal, epidural, spinal block, upper limb blocks, lower limb blocks, and truncal nerve block. From statistical methods we used descriptive statistical methods of absolute and relative numbers, measurements of variability, central tendencies for numerical features and methods of inferential statistics. We used the χ^2 test for the attributive features of observations.

Results In relation to the postoperative time when an analgesic was required, a statistically significant difference was observed in the age of children ($p = 0.000$), disease diagnosis ($p = 0.000$), type of block ($p = 0.000$), type of local anesthetic ($p = 0.000$), and type of anesthesia or sedation preoperatively ($p = 0.005$).

Conclusion Postoperative analgesia was most needed by older children and children who were awake during surgery. Children with the injuries and tumors need postoperative analgesia earliest. The longest postoperative analgesia was recorded in the patients who received caudal block. Longest postoperative analgesia can be seen in patients in who received the levobupivacaine, bupivacaine or levobupivacaine combined with lidocaine to perform the block.

Keywords: regional anesthesia, child, pediatric patient, postoperative analgesia

САЖЕТАК

Увод/Циљ Бол представља узнемирујуће искуство које је повезано са постојећим или потенцијалним оштећењем ткива, са сензорном, емоционалном, когнитивном и социјалном компонентом.

Циљ ове студије је приказ ефикасности техника регионалне анестезије на постоперативни бол код деце.

Методе Ретроспективна кохортна студија је спроведена на групи од 564 педијатријских пацијената у периоду од 2013 до 2016. године. Врсте регионалне анестезије су класификоване у 6 група: каудална, епидурална, спинална, блокови горњих екстремитета, доњих екстремитета и блок трупа. Користили смо дескриптивне статистичке методе апсолутних и релативних бројева за атрибутивна обележја посматрања, мере варијабилитета, централне тенденције за нумеричка обележја и методе инференцијалне статистике. Избор тестова за нумеричка обележја посматрања зависиће од расподеле података. За атрибутивна обележја посматрања користили смо χ^2 тест.

Резултати У односу на постоперативно време када је био потребан аналгетик, статистички значајна разлика уочена је у узрасту деце ($p = 0{,}000$), дијагнози болести ($p = 0{,}000$), врсти блока ($p = 0{,}000$), врсти коришћеног локалног анестетика ($p = 0{,}000$) као и врсти периоперативне анестезије или седације ($p = 0{,}005$).

Закључак Постоперативна аналгезија је најпотребнија старијој деци и деци која су била будна током хируршке интервенције. Најранија постоперативна аналгезија је потребна деци са повредама и туморима. Најдужа постоперативна аналгезија је забележена код пацијената који су добили каудални блок, као и пацијената који су примили левобупивакаин, бупивакаин или левобупивакаин у комбинацији са бупивакаином за извођење блока.

Кључне речи: регионална анестезија, дете, педијатријски пацијент, постоперативна аналгезија

INTRODUCTION

Pain, according to the new definition, is a disturbing experience associated with existing or potential tissue damage, with a sensory, emotional, cognitive and social component [1]. During childhood, pain has numerous adverse effects - prolonging hospital stay and even increase incidence of death due to the onset of the systemic inflammatory response [2]. Inadequate treatment of acute pain is one of the important prerequisites for the development of chronic pain. Repetition of painful procedures determines the threshold for pain for the whole life [3].

In pediatric patients, less local anesthetic (LA) concentration is more effective than in adults [4]. The effect of the block is faster and shorter. In children under one year of age, nerve fibers are thinner, myelination is scarce, and Ranvier's knots are closer. The volume of distribution is higher [5, 6], clearance is smaller [7], and the free drug fraction is higher [5], so the doses are almost the same as in adults. Cytochrome CYP1A2 that catalyses the metabolism of ropivacaine matures around the age of 4-7 years, and CYP3A4 /7 that catalyses the metabolism of levobupivacaine matures at the end of the 1st year [4].

The goal of analgesia in the postoperative period is to reduce or eliminate pain with minimal additional harmful effects. Adequate postoperative analgesia, especially during the first 48 hours, reduces the organism stress response to the surgical procedure, thereby affecting endocrine, metabolic and inflammatory changes, which improves the outcome of surgical treatment [3, 8–11].

METHODS

We performed retrospective review of pediatric patients (1-14 years), who had been operated in regional anesthesia techniques, between January 2013 and December 2016. Patients were divided into four groups: children younger than 3 years old, aged 3-7, aged 7-14 years, and older than 14 years. All patients were classified by the American Association of Anesthesiologists (ASA) classification and all belonged to groups of 1 to 3.

Regional anesthesia techniques were performed during general anesthesia, analgosedation or in the waking state of the patients. We used bupivacaine, lidocaine and levobupivacaine and combinations that consisted of lidocaine with levobupivacaine and lidocaine with bupivacaine.

Types of applied regional anesthesia techniques were classified into 6 groups: caudal block, epidural, spinal, upper limb blocks, lower limb blocks, and truncal nerve block. The diagnosis of patients involved in the study included injuries, tumors, congenital anomalies, arteriovenous (AV)

fistula and appendicitis. Pulse, blood pressure and oxygen saturation were used as standard anesthesia monitoring.

Postoperatively patients were diagnosed with pain based on a scale for age-related pain by nurses who were trained for this follow-up after 2, 4, 6, 8, 10, 12 and 14h. The time when analgesia caused by regional anesthesia became insufficient and when it was necessary to apply the analgesic was recorded and patients classified accordingly into one of the following groups: < 3h, 3-6h, 6-9h, 9-12h, > 12h.

Also, we analyzed the postoperative occurrence and we measured intensity of pain by different methods in different ages of children: ≤ 12 months we used CRIES scale [3], in children ≤3 years by using FLACC scale [12], in children 3-5 years old we used Wong scale with facial expressions, and in older children we used linear scales [13].

The exclusion criteria were: patients with hypotension, thrombocytopenia, coagulopathy, sepsis, myelodysplasia and sacral dysgenesis.

The study was approved by the University Children's Hospital Ethics Committee (N^0 26/343-017).

Descriptive statistical methods of absolute and relative numbers were used for attribute observation marks, variability measures, central tendencies for numerical labels and methods of inferential statistics. The selection of tests for numerical markings depended on the distribution of data. We used the χ^2 test for the attributive features of observations. Statistical analysis was performed with SPSS for Windows (version 17.0, Inc, Chicago, IL, USA).

RESULTS

During the four year period between January 2013 and December 2016. The summarized patient characteristics, gender, age, indications for surgery, type of local anesthetics and regional anesthesia techniques are shown in Table 1.

There was no statistically significant difference between type of regional anesthesia techniques and pulse, blood pressure and oxygen saturation during the operation. After administration of the block as well as during the surgical procedure, all vital signs were within the limits of the reference values for the patient's age in all our patients.

There was a significant difference between the age of children and the reduction in the time of postoperative analgesia (Table 2). There were no statistically significant difference between gender and the time of administration of analgetics postoperatively.

There was a significant difference between the time for postoperative analgetics requirements and the preoperatively diagnosis. The shortest time to administer analgetics was in patients with injuries and tumors. AV fistula was made in only 3 patients and the first dose of analgesics was given to all in the period 3-6 hours after intervention (Table 3).

There was a significant difference between the type of block and the first dose of analgetics. The longest postoperative analgesia was recorded in the group with the caudal and truncal nerve blockade. Spinal anesthesia and blocks of the lower extremities were the following successive blocks in terms of postoperative analgesia. The shortest analgesic time was observed in patients with epidural and upper limb blocks (Table 4).

There was a significant difference between the type of local anesthetic and the first dose of analgesics that was given postoperatively. Longer postoperative analgesia was seen in children in whom the levobupivacaine, bupivacaine or levobupivacaine combined with lidocaine was used to perform the block.

There were significant differences between the blocks under sedation and blocks under general anesthesia and the first time of giving postoperative analgesia. The shortest time of giving the first analgesic postoperatively was in patients who were awake during surgery.

DISCUSSION

Only a few decades ago it was considered that pain was a normal "price" for successfully performed surgery. It was also thought that the newborn did not feel pain, and surgical interventions during the first few days of life were mostly performed without any anesthesia [14]. Today, we consider that surgical pain not only that hurts but can have effects that compromise recovery. Since it is generally accepted that even small children feel pain, analgesia must be ensured for all and after all painful procedures. It has been proven that adequate perioperative analgesia reduces the metabolic response to the trauma, the possibility of chronic pain, and morbidity and mortality [15]. It has been clearly demonstrated that poor postoperative pain control in children leads to emotional disorders [16]. It can also lead to more immediate complications; hypoventilation after thoracotomy, an increase in arterial and intracranial pressure.

Regional anesthesia can provide good perioperative pain control. The pre-surgery block contributes to intraoperative analgesia and reduces the need for other analgetics. There has long been evidence that postoperative pain is lower if general anesthesia is given in combination with regional, although regional anesthesia has not yet found full application in pediatric patients [17].

The concept that regional and general anesthesia are complementary rather than competitive is fundamental to comprehensively comprehending the role of regional anesthesia in children and dates back to the early 1990s [18].

In our study, regional anesthesia was performed in pediatric patients, in analagosedation or in general anesthesia. We show that postoperative analgesia was needed earlier in patients who were conscious.

All of our patients were completely hemodynamic and respiratory stable during and after the operation, which contributed to faster release from the hospital. It has been explained long time ago why even very small children maintain hemodynamic stability even after central blocks. The reasons why very small children maintain hemodynamic stability even after central blocks has been explained by the immaturity of the sympathetic nervous system, relatively lower volume of lower extremities and compensatory vasoconstriction in unblocked blood vessels [19, 20].

In our study, we show that the earliest use of postoperative analgetics was needed in children who were operated of injuries or tumors. This is evident how much the psychological component of pain in children, i.e. suffering because of consciousness about the severity of the disease or potential disfiguration is important in the feeling of pain.

In this study, the effect of the dose and volume of LA on postoperative analgesia were not studied, because doses and volume were applied on the basis of consensus adopted [9]. However, statistically significantly longer analgesia was achieved when long-acting LA (levobupivacaine, bupivacaine or levobupivacaine in combination with lidocaine) were used. It is understandable that the duration of the block will depend on the pharmacodynamics of the drug used.

Analgesia was the longest after the caudal and truncal nerve blockade, which is in accordance with the literature data [4]. Shorter analgesia was after spinal anesthesia and blocks of the lower extremities. One of the described defects in spinal anesthesia during childhood is just a shorter time [4]. It is not entirely clear why the shortest analgesia was after epidural anesthesia. The only explanation is that this type of block was applied in the eldest age group where additional analgesia was needed at the earliest, most likely because of the psychological, social and cognitive component of the pain affected [21].

But if we analyze the literature data on the isolated influence of the age on the pain, they are extremely controversial. From the fact that the feeling of pain is greatest in the youngest population, until that the age is not significant [21, 22].

There are many controversies in the literature between the pain and gender [21, 23, 24]. In our study, we did not find statistically significant differences between gender and pain. One of the reasons may be that we had significantly more boys than girls, or that the influence of gender on the pain occurs much later.

Good postoperative analgesia reduces the risk of postoperative anxiety and delirium, which fall into significant complications of anesthesia, especially in the pediatric population [25]. The costs were significantly reduced due to the reduced need for intraoperative use of expensive inhalation anesthetics, and postoperatively due to the reduced need for the addition of analgesics. This decreased the potential side effects of systemic analgesics that could also prolong hospitalization.

CONCLUSION

Good analgesia reduces the need for postoperative analgesics and secures better comfort in the postoperative period. Postoperative analgesia is most needed by older children and in patients who were awake during surgery, probably due to the most developed cognitive, psychological and social component of the pain. Children with the injuries and tumors need postoperative analgesia earliest. The longest postoperative analgesia was recorded in the patients who received caudal block. Longest postoperative analgesia can be seen in patients in who received the levobupivacaine, bupivacaine or levobupivacaine combined with lidocaine to perform the block.

The goal of a physician should always be to minimize the psychological and physical trauma of the patient, regardless of how young and immature he is. From an ethical point of view, it is not justifiable to allow the child to suffer pain, when simple and safe techniques of regional anesthesia are easily complementing or replacing conventional-general anesthesia.

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Table 1. Patient characteristics, indications for surgery, type of local anesthetics and regional anesthesia techniques

Number (%)	**Male**	**377 (66.8%)**
	Female	**187 (33.2%)**
Age (years)	< 3	84 (14.9%)
	3–7	139 (24.6%)
	7–14	224 (39.7%)
	> 14	117 (20.7%)
Diagnosis	Tumors	101 (17.9%)
	Injury	201 (35.6%)
	AV fistula	3 (0.5%)
	Appendicitis	21 (3.7%)
	Congenital anomaly	237 (42%)
Type of regional anesthesia techniques	Caudal block	168 (29.8%)
	Epidural	20 (3.5%)
	Spinal	12 (2.1%)
	The upper limb block	179 (31.7%)
	The lower limb block	163 (28.9%)
	The hull block	22 (3.9%)
Type of local anesthetic	Bupivacaine	213 (37.8%)
	Lidocaine	13 (2.3%)
	Bupivacaine + Lidocaine	287 (50.9%)
	Levobupivacaine	28 (5%)
	Levobupivacaine + Lidocaine	23 (4.1%)

Table 2. Time to first dose of postopertive analgetic in relation to age

Age (years)	< 3 hours	3–6 hours	6–9 hours	9–12 hours	> 12 hours	Significance
< 3	6 (7.1%)	9 (10.7%)	28 (33.3%)	33 (39.3%)	8 (9.5%)	[a]p = 0.000*
3–7	9 (6.05%)	27 (19.4%)	50 (36%)	46 (33.1%)	7 (5%)	
7–14	20 (8.9%)	72 (32.1%)	73 (32.6%)	44 (19.6%)	15 (6.7%)	
> 14	14 (12%)	42 (35.9%)	30 (25.6%)	23 (19.7%)	8 (6.8%)	

*Statistically significant difference;

[a]χ^2-test

Table 3. Time to first dose of postopertive analgetic in relation to diagnosis

Diagnosis	< 3 hours	3–6 hours	6–9 hours	9–12 hours	> 12 hours	Significance
Tumors	14 (13.9%)	29 (28.7%)	27 (26.7%)	21 (20.8%)	10 (9.9%)	[a]p = 0.000*
Injury	19 (9.5%)	79 (39.3%)	61 (30.3%)	35 (17.4%)	7 (3.5%)	
AV fistula	0 (0%)	3 (100%)	0 (0%)	0 (0%)	0 (0%)	
Appendix	0 (0%)	0 (0%)	5 (23.8%)	14 (66.7%)	2 (9.5%)	
Congenital anomalies	16 (6.8%)	39 (16.5%)	88 (37.1%)	75 (31.6%)	19 (8.0%)	

*Statistically significant difference;

[a]χ^2-test

Table 4. Time to first dose of postopertive analgetic in relation to type of regional anesthesia

Block	< 3 hours	3–6 hours	6–9 hours	9–12 hours	> 12 hours	Significance
Caudal	8 (4.8%)	19 (11.3%)	71 (42.3%)	59 (35.1%)	11 (6.5%)	[a]p = 0.000*
Epidural	6 (30%)	6 (30%)	5 (25%)	3 (15.0%)	0 (0%)	
Spinal	1 (8.3%)	3 (25%)	5 (41.7%)	3 (25%)	0 (0%)	
Upper limb	20 (11.2%)	75 (41.9%)	51 (28.5%)	28 (15.6%)	5 2.8%)	
Lower limb	14 (8.6%)	47 (28.8%)	44 (27%)	38 (23.3%)	20 (12.3%)	
Truncal	0 (0%)	0 (0%)	5 (22.7%)	15 (68.2%)	2 (9.1%)	

*Statistically significant difference;

[a]χ^2-test

