

Use and costs of pain management in cesarian section

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Abstract

Aim. To study the use of drugs for pain management for cesarean section and their cost on time and the first day after surgery.

Methods. A retrospective analysis of 117 anesthesia cards and childbirth histories of women after a cesarean section was performed. We analyzed drug therapy aimed at reducing pain during 1 day after cesarean section and performed a comparative analysis of the cost of drugs used in spinal and epidural anesthesia.

Results. Regional methods of anesthesia, epidural and spinal, were used in 95% of all cases. Spinal anesthesia was performed in 77 women, epidural — in 34 women. The frequency of prescribing opioid analgesics was higher with spinal anesthesia compared with epidural: trimeperidine (intramuscular) was used in 62 (83%) of 77 patients for spinal anesthesia and 1 (3%) of 34 for epidural anesthesia ($p < 0.05$). There were no differences in the use of ketoprofen in the postoperative period with epidural and spinal anesthesia. The total cost of medicines used to control pain during and on the 1st day after surgery, with epidural anesthesia, was almost 10 times higher than that of spinal anesthesia: 938 and 98 rubles, respectively.

Conclusion. To control pain during cesarean section, in addition to local anesthetics, trimeperidine was used more often with spinal than epidural anesthesia; in the postoperative period, ketoprofen and trimeperidine were used with the equal frequency with greater use of ropivacaine with epidural anesthesia through a stored catheter; this has caused a higher cost of pain management during and in the first day after cesarean section with epidural anesthesia.

Keywords: cesarean section, drugs, spinal and epidural anesthesia, frequency of use, cost.

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Background

In the last two decades, the frequency of cesarean sections has increased significantly, and it is currently the most frequent surgical procedure in the world [1,2]. In Russia, the frequency of cesarean sections has increased more than three times over the past decades and is performed at an average of 20% of all births [3]. A cesarean section is usually accompanied by mild or severe pain for 48 hours [4]. Anesthetics and analgesics are used to maximize the effectiveness of pain relief. However, many patients still suffer from mild and severe postoperative pain after a cesarean section because of insufficient pain relief [5]. Anesthesia and postoperative pain relief should be effective and safe for both the mother and child and be cost-effective.

The pharmacoeconomic effectiveness of analgesics and anesthetics in a cesarean section is usually not described as well as the cost of the agents used for maternity patients after surgery. The annu-

al increase in the frequency of cesarean sections has serious economic consequences. The cost of a cesarean section and the drug therapy associated with complications is usually more expensive for the health system than the cost of a vaginal delivery. In addition, the effect of drugs on a woman's quality of life connected with her health after surgery remains a major unresolved issue for health systems [2].

Pain control is considered one of the main tasks in analgesia. So, during a cesarean section and in the postoperative period [6] in addition to anesthetics, adjuvants are prescribed that prolong and deepen anesthesia and analgesia. It is essential to understand how various types of regional anesthesia differ [2,7], their costs, and many additional funds (adjuvants) are required to achieve complete pain control, both regarding the drug load and total cost.

Our research was the first to investigate this issue in the Russian Federation.

The aim of this study is to evaluate the frequency of prescribing anesthetics and analgesics and compare the cost of drug therapy for spinal and epidural anesthesia during a cesarean section and on the first day after the operation.

Materials and methods

This study was conducted at the Perinatal Center of the Republican Clinical Hospital of the Ministry of Health of the Republic of Tatarstan. The information sources were anesthetic charts and histories of women giving birth after planned and emergency cesarean sections. We conducted a complete review of anesthetic charts and histories of women giving birth after cesarean sections performed in June 2016. We conducted a retrospective evaluation of drug therapy for 117 women during and within one day after surgery.

We created an electronic database for the research. Information about pharmacotherapy and the condition of women during the operation and within one day after a cesarean section from anesthesia charts and birth histories was entered manually. The electronic record for each woman in the database includes age, diagnosis, gestational age at the delivery, duration of surgery, type of anesthesia, duration of anesthesia, prescribed agents (doses, routes of infiltration, and duration of use), indicators of the mother's clinical condition (blood pressure before and after surgery), the ASA index (from the American Society of Anesthesiologists; the ASA index assesses the physical status of patients), and the state of the child according to the Apgar scale at the first and fifth minutes after birth.

The statistical analysis included the calculation of average values (median), a range of values (minimum and maximum values), relative values [percentage (%) of the total number of patients]. The criterion for Fisher's exact test was used for the evaluation of the reliability of differences in relative indicators. The differences between samples were considered reliable at a value of $p < .05$. The criterion for Fischer's exact test is mainly used for comparing small samples and two relative indicators. Statistical processing was performed using the Microsoft Excel software package

The volume of consumption of analgesics (Trimeperidine and Ketoprofen) as additional means for pain relief, or adjuvants used during and after surgery, was assessed using the ATC/DDD (Anatomical Therapeutic Chemical Classification System With Defined Daily Doses) methodology with the calculation of the number of defined daily doses (DDD-from the English language-DDD) per maternity patient [8,9].

The calculation of DDD/maternity patient was made using the formula:

$$\begin{aligned} \text{DDD/maternity patient} &= \\ &= \frac{\text{Total analgesic dose (mg)/DDD (mg)}}{\text{Number of maternity patients who received an analgesic}} \end{aligned}$$

The calculation of the DDD of Trimeperidine was made using Ketobemidone (DDD = 50 mg), a relative representative of the chemical group (phenylpiperidine derivatives) since Trimeperidine itself is not included in the ATC classification. To calculate the volume of Ketoprofen consumption, we used its DDD = 150 mg.

Results

The age of the patients included in the study ranged from 20 to 42 years [IU (min-max) = 29 (20-42) years], the demographic characteristics of women are presented in Table 1.

We found no differences in the demographic characteristics of women in the spinal and epidural anesthesia groups. Yes, there is no difference. Thank you very much. Maternity patients did not differ in age, gestational age at the time of delivery, and the number of previous births. Spinal anesthesia was made for biparous (mono - and dichorionic) ($n = 7$) and induced in vitro fertilization ($n = 3$), which was not the case in the epidural anesthesia group.

When analyzing the frequency of various types of anesthesia, it was noted that 77 patients received spinal anesthesia, and 34 women received epidural anesthesia. For four patients, a cesarean section was made under combined spinal and epidural anesthesia; in two cases, the spinal anesthesia was transferred to general anesthesia because of an unsuccessful spinal block.

Further analysis of the practice of prescribing drugs was made in two groups of spinal anesthesia and epidural anesthesia. In all cases, spinal anesthesia was made with a 0.5% solution (5 mg/ml) of Bupivacaine at an average dose of 15 (13-17) mg, for epidural anesthesia, a 0.75% solution (7.5 mg/ml) of Ropivacaine in an average dose of 120 (113-128) mg was used.

Opioid analgesics (Trimeperidine and Fentanyl) and central depressant agents Ketamine, Propofol, and Diazepam were also prescribed to control pain adequately and increase women's satisfaction with the quality of anesthetic support. In this study, we call these medications additional pain relief agents or adjuvants. The results are presented in Table 2.

During a cesarean section, the frequency of opioid analgesics was higher for spinal anesthesia compared with epidural anesthesia. Trimeperidine (intramuscularly) for spinal anesthesia was pre-

Table 1. Demographic characteristics of women who delivered by a cesarean section using spinal and epidural anesthesia, and all women in the sample

Demographic characteristics	Spinal anesthesia (n = 77)	Epidural anesthesia (n = 34)	Combined spinal-epidural anesthesia (n = 3)	Spinal anesthesia with the transition to general anesthesia (n = 3)
Age, Me (min–max), years	29 (20–42)	29 (22–41)	29 (22–35)	30 (23–36)
Gestational age, weeks	29–42	27–41	36–39	34–39
First-born, n (%)	31 (40%)	15 (44%)	1 (25%)	1 (34%)
Multipara, n (%)	46 (60%)	19 (56%)	2 (50%)	2 (67%)
Repeaters, n (%) Multiple pregnancies (mono-and dichorionic twins), n	7	0	0	0
In vitro fertilization, n	3	0	0	0

Table 2. Intraoperative prescription of additional agents for pain relief during spinal and epidural anesthesia, n (%)

Agent	Spinal anesthesia (n = 77)	Epidural anesthesia (n = 34)
Fentanyl	46 (60%)	24 (71%)
Trimeperidine	62 (83%)	1 (3%)*
Ketamine	3 (4%)	1 (3%)
Propofol	1 (1.3%)	1 (3%)
Diazepam	1 (1.3%)	1 (3%)
Without additional funds	0	9 (26%)
With additional funds	77 (100%)	25 (74%)*
Total	77 (100%)	34 (100%)

Note: statistically significant differences * $p < .05$.

scribed for 62 (83%) of 77 patients and only one (3%) of 34 for epidural anesthesia ($p < .05$). We found no differences in the frequency of administration of Fentanyl (intravenous) and the drugs used for anesthesia (Ketamine, Propofol, and Diazepam).

In the postoperative period, analgesia was mainly performed with Ketoprofen (intramuscularly), Trimeperidine (intramuscularly), and Ropivacaine. For epidural anesthesia, 59% of patients (22 of 34) received 0.2% Ropivacaine solution through a preserved epidural catheter, whereas for spinal anesthesia, this type of anesthesia was used for only one patient ($p < .05$). During spinal and epidural anesthesia, there were no differences in the frequency of use after surgery of Ketoprofen and Trimeperidine (Promedol).

The doses of Ketoprofen prescribed after a cesarean section made with spinal [200 (100–400) mg] and epidural [200 (100–300) mg] anesthesia also did not differ (Table 4).

Table 3. Postoperative (day 1) prescription of additional agents for pain relief during spinal and epidural anesthesia, n (%)

Agent	Spinal anesthesia (n = 77)	Epidural anesthesia (n = 34)
Ketoprofen	63 (81%)	26 (77%)
Trimeperidine	6 (8%)	1 (3%)
Ropivacaine	1 (1%)	22 (59%)*
Diazepam	0	2 (6%)
Without additional funds	13 (17%)	6 (17%)
With additional funds	64 (83%)	28 (83%)
Total	77 (100%)	34 (100%)

Note: statistically significant differences * $p < .05$.

We calculated the volume of use of additional agents used to control pain during and after surgery in the DDD using the DDD methodology: Trimeperidine (Promedol) and Ketoprofen (Table 5). We showed that with spinal anesthesia, it was necessary to use 43 times higher doses of Trimeperidine, and a quarter higher doses of Ketoprofen to control pain.

The next stage of the study was a comparative analysis of the cost of agents for the two types of anesthesia being compared. The analysis included only the cost of agents. We did not include the cost of medical devices and consumables that were used during the cesarean section for anesthesia and analgesia and did not consider the cost of medical staff and specialists.

Table 6 shows the name, concentration, volume, and several ampoules in the package of agents. It also has the cost of packaging and the price of one ampoule of the agent that is used during a cesarean section and for performing our calculations.

Table 4. Doses of agents prescribed for pain relief after surgery (day 1) for spinal and epidural anesthesia, IU (min–max)

Agent	Spinal anesthesia (n = 77)	Epidural anesthesia (n = 34)
Ketoprofen, mg	200 (100–400)	200 (100–300)
Trimeperidine, mg	10 (10–20)	10
Ropivacaine, mg	60	80 (40–120)

Table 5. The volume of analgesic use during and after surgery in established daily doses per person

Agent	Spinal anesthesia (n = 77)	Epidural anesthesia (n = 34)
Trimeperidine (according to Ketobemidone)	0.26	0.006
Ketoprofen	1.15	0.92

Table 6. Price characteristics of additional agents (adjuvants) used for pain control

Name of agent	Concentration of solution, %	Volume, ml	Dose, mg/ml	Number of ampoules per package	Price of one package, rub	Price of one ampoule, rub
Bupivacaine	0.5	4	5	5	120	24
Ropivacaine	0.75	10	7.5	5	1109	222
	0.2	100	2	5	2970	594
Fentanyl	0.005	2	0.05	5	105	21
Trimeperidine	2	1	20	10	460	46
Ketamine	5	2	50	5	187	38
Diazepam	0.5	2	5	50	842	17
Propofol	1	50	10	1	360	360
Ketoprofen	0.05	2	50	10	60	6

Table 7. The cost of the most expensive case of drug therapy during and on the first day after surgery with spinal and epidural anesthesia

Types of anesthesia	Spinal anesthesia		Epidural anesthesia	
	During the operation	On day 1 after the operation	During the operation	On day 1 after the operation
Cost of drug therapy for the most expensive case, rub.	472	70	507	634
Total	542		1141	

We performed a comparative analysis of the cost of anesthetics and all additional means for pain relief during spinal and epidural anesthesia that were applied during (in addition to the main anesthetics) and on the first day after the operation. The analysis was conducted based on the purchase prices of these agents at the medicoprophyllactic institution at the time of their use.

In Tables 7–9, we present the cost of drug therapy during surgery and on the first day after surgery for the most expensive and the least expensive cases of spinal and epidural anesthesia, and the average cost.

It should be noted that we calculated the cost of 0.2% Ropivacaine solution in the volume of 100 ml completely for one patient. After opening the vial, regardless of the injected dose, it is forbidden to use the surplus for another patient. The frequency of injection and the volume of 0.2% Ropivacaine solution varied depending on the in-

tensity of pain, the maximum volume injected reached 60 ml, and the minimum volume reached 20 ml.

The most expensive case of spinal anesthesia during surgery.

Bupivacaine: 1 ampoule (0.5% - 3 ml), 24 rub.

Fentanyl: 4 ampoules (0.005% — 2 ml), 84 rub.

Trimeperidine (Promedol): 1 ampoule (2% — 1 ml), 46 rub.

Propofol: 1 bottle, 360 rub.

Total: 472 rub.

The most expensive case of spinal anesthesia on day 1 after surgery.

Ketoprofen: 4 ampoules (0.05% — 2 ml), 24 rub.

Trimeperidine (Promedol): 1 ampoule (2% — 1 ml), 46 rub.

Total: 70 rub.

The total cost of the most expensive case of spinal anesthesia during and on the first day after surgery was **542 rubles**.

Table 8. Cost of the least expensive case of drug therapy during and on the first day after the operation for spinal and epidural anesthesia

Types of anesthesia	Spinal anesthesia		Epidural anesthesia	
	During the operation	On day 1 after the operation	During the operation	On day 1 after the operation
Cost of drug therapy for the least expensive case, rub.	45	6	444	6
Total	51		450	

Table 9. The average cost of drug therapy during and on the first day after the operation for spinal and epidural anesthesia

Types of anesthesia	Spinal anesthesia		Epidural anesthesia	
	During the operation	On day 1 after the operation	During the operation	On day 1 after the operation
Average cost of drug therapy, rub.	82	12	464	475
Total	98		939	

The most expensive case of epidural anesthesia during surgery.

Ropivacaine: 2 ampoules (0,75% — 16 ml), 444 rub.

Fentanyl: 3 ampoules (0.005% — 2 ml), 63 rub.

Total: 507 rub.

The most expensive case of epidural anesthesia on day 1 after surgery.

Ropivacaine: 1 bottle (0.2% — 100 ml), 594 rub.

Promedol: 1 ampoule (2% — 1 ml), 46 rub.

Total: 634 rub.

The total cost of the most expensive case of epidural anesthesia during and on the first day after surgery was **1141 rub.**

The least expensive case of spinal anesthesia during surgery.

Bupivacaine: 1 ampoule (0.5% — 3 ml), 24 rub.

Fentanyl: 1 ampoule (0.005% — 2 ml), 21 rub.

Total: 45 rub.

The least expensive case of spinal anesthesia on day 1 after surgery.

Ketoprofen: 1 ampoule (0.05% — 2 ml), 6 rub.

Total: 6 rub.

The total cost of the least case of spinal anesthesia during and on the first day after surgery was **51 rub.**

The least expensive case of epidural anesthesia during surgery.

Ropivacaine: 2 ampoules (0,75% — 16 ml), 444 rub.

Total: 444 rub.

The least expensive case of epidural anesthesia on day 1 after surgery.

Ketoprofen: 1 ампула (0.05% — 2 ml), 6 rub.

Total: 6 rub.

The total cost of the least case of epidural anesthesia during and on the first day after surgery was **450 rub.**

The average cost of drug therapy for spinal and epidural anesthesia during and on the first day after

surgery was significantly different: the cost of epidural anesthesia was 10 times higher.

Discussion

It is believed that there is no "gold standard" for relieving postoperative pain during a cesarean section. However, there are many variants, the choice of which is partly determined by the availability of the agents, individual preferences, and economic accessibility [10].

Despite advances in controlling postoperative pain, the quality of analgesia and satisfaction of women is not always at a high level in some cases because of individual intolerance, and side effects of analgesics or methods [6].

Effective pain relief during and after a cesarean section is essential for the activation of a woman's postoperative recovery. Also, it may affect the mother's ability to care for the baby in the postpartum period and promote early effective breastfeeding [11]. Since the full control of pain during and after a cesarean section usually requires the use of adjuvants, it is important to analyze the actual practice of their use with an assessment of the volume of drug load and the total cost of anesthesia and pain relief.

Thus, the authors from Taiwan (Huang et al.) did not find a statistical difference in the frequency of prescriptions of adjuvants (Ketamine, Propofol, Fentanyl, and Meperidine) for pain management during surgery, nor differences between spinal and epidural anesthesia [12]. In our study, the need for adjuvants (Trimeperidine) was higher for spinal anesthesia compared with that for epidural anesthesia.

In the last quarter of a century, it is believed that spinal anesthesia for a cesarean section is the most effective and economically viable method of regional anesthesia compared with an epidural one [2,3,7].

However, the authors do not reject epidural anesthesia as it may be preferable for certain conditions, such as hypertension caused by pregnancy, or heart failure, when slower development of anesthesia is desired, or in cases where prolonged anesthesia may be required.

The cost-effectiveness of anesthesia and analgesia for a cesarean section is generally not well understood. If we estimate the average cost, then epidural anesthesia is more expensive than spinal anesthesia [2, 13]. This was confirmed by the results of our research.

The NICE guidelines (after the English The National Institute for Clinical Excellence) [14], ASA/SOAP (from the USA the Society for Obstetric Anesthesia and Perinatology) [15], and the clinical recommendations of the Russian Federation [16, 17] recommend regional methods of anesthesia (for example, spinal, epidural, and combined spinal-epidural anesthesia). These methods are recommended because they are safer and lead to a reduction in the number of cases of emergency cesarean sections. Also, general (anesthesia) and spinal anesthesia are recommended [14–17].

In the clinical recommendations of the Russian Federation [16, 17], spinal anesthesia is suggested as the method of choice, and general anesthesia (narco-sis) is used for contraindications and refusal of women. For postoperative pain relief, NICE recommends using opioid analgesics and non-steroidal anti-inflammatory drugs as an adjunct. ASA/SOAP recommends an only neuro-axial injection of opioids, not an intermittent injection of parenteral opioids. The Russian Federation recommends acetaminophen (Paracetamol) at a dose of 1000 mg in combination with non-steroidal anti-inflammatory drugs (such as Lornoxicam, Ketoprofen, Dexalgin, Meloxicam, and Nimesulide) [14–17]. The use of Ketoprofen, in practice, corresponds to clinical recommendations, but not after surgery. In these cases, acetaminophen is recommended as the agent of choice.

The results of our study could contribute to the revision and strengthening of domestic clinical recommendations.

Conclusions

1. During a cesarean section, the use of spinal anesthesia, in addition to local anesthetics, Trimeperidine was prescribed more often than during epidural anesthesia.

2. In the postoperative period, Ketoprofen (intramuscularly) and Trimeperidine were used with the same frequency for spinal and epidural anesthesia. In contrast, local anesthetics were more often used for epidural anesthesia (0.2% Ropivacaine solution) through a preserved catheter.

3. Additional research is needed to confirm the differences in the need for opioid analgesics in different methods of regional anesthesia.

4. The cost of drug therapy during and on the first day after surgery was the highest with epidural anesthesia.

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