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A randomized comparison of low dose ropivacaine programmed intermittent epidural bolus with continuous epidural infusion for labour analgesia

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Abstract

Background: Two methods of local anaesthetic administration into the epidural space in natural delivery pain management are compared in the article. Methods compared are programmed intermittent epidural bolus (PIEB) and continuous epidural infusion (CEI). Patient-controlled epidural analgesia was provided simultaneously in all cases.

Methods: 84 primipara with average age 30.7 (27.5-34) years, and gestational age 39.1 (38.5-40) weeks planned to natural delivery were examined. PIEB and patient controlled epidural analgesia was used in the first group. Patient controlled epidural analgesia and continuous epidural infusion (CEI) of local anaesthetic was used in the second group. Ropivacaine hydrochloride 0.08% without any adjuvants was utilized as local anaesthetic. Pain assessment was conducted using VAS while motor block was assessed using the Bromage scale.

Results: Labor progression dynamics and condition of newborns were equally independent to the method of analgesia. However, analgesic endpoint was better and more long-lasting while using PIEB with patient controlled epidural analgesia. Moreover, a lesser amount of local anaesthetic was consumed. In the group with programmed bolus, the total volume of local anaesthetic was 59.9 (45-66) ml in comparison with 69.5 (44-92) ml in the continuous infusion group ($p = 0.033$). The time to first bolus requested by the puerpera was significantly longer in the programmed bolus group – 89.2 (57-108) min compared to 43.2 (35-65) minutes in the continuous infusion group ($p = 0.021$).

Conclusion: Administration of low-concentrated ropivacaine solution 0.08% with no opioids using PIEB provides better and more prolonged analgesia with less local anaesthetic consumption and without any additional maternal and newborn side effects in comparison with continuous infusion.

Keywords: delivery, patient controlled epidural analgesia, programmed intermittent epidural bolus, continuous infusion, Bromage scale

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Introduction

Delivery is considered to be one of the most painful experiences of woman, which she has throughout her life. In the last two decades safe and effective labour pain management has become to be expected by women in the majority of developed countries. Epidural analgesia (EA) is an effective method of pain management in labour. It is considered the reference standard for pain relief and is preferable to other methods of pain relief such as the use of systemic opioids, nitrous oxide and not pharmacological methods [1-5].

Epidural analgesia techniques are being constantly improved in order to improve the analgesic effect and

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to reduce motor block in natural delivery. A technique for epidural analgesia plays an important role in adequate labour pain relief. Currently, patient-controlled epidural analgesia (PCEA) is commonly used in obstetrics. For the first time it was used by Gambling D. R. 1988 [6] for pain relief in the first stage of labour. PCEA technique allows the patient herself to initiate the activation of the bolus for analgesia. Compared to continuous epidural infusion of local anaesthetic, the use of PCEA reduces the local anaesthetic consumption without reducing the effectiveness of analgesia and increases patient satisfaction, allowing the woman to actively participate in the active pushing phase of labour [7-10]. In addition, PCEA reduces the episodes of breakthrough pain that occurs suddenly as a result of the increasing of tolerance to the drug, which requires additional intervention [11].

In the last decade, PIEB – programmed intermittent epidural bolus method has been introduced to clinical practice. The method is based on the programmed intermittent injection of local anaesthetic into the epidural space in contrast to a continuous infusion (CEI), where the anaesthetic is injected continuously at a certain speed. Wong C.A. was one of the first who described this technique in 2006. Local anaesthetic is distributed and spread in the epidural space more homogeneously and widely as a result of drug administration by programmed intermittent boluses under higher pressure in comparison with the CEI. This leads to a better analgesic effect and the reduction of local anaesthetic consumption together with motor block risk [5, 9, 12, 13].

The amount and concentration of local anaesthetic (LA) play an important role in adequate labour pain management [5, 14]. Recently local anaesthetics in low concentration are commonly utilized. 6 randomized clinical trials were found in PubMed, dedicated to programmed intermittent epidural bolus in clinical practice of labour pain relief and there is only one publication where 0.15% Ropivacaine solution with sufentanil is used as a local anaesthetic [15]. Use of low concentration, local anaesthetics leads to a lower risk of motor block development, which does not affect the delivery process and foetal condition. Combination of local anaesthetics and opioids is used to reduce LA concentration. However, the use of opioids has adverse effects; most common is itching, more rarely – nausea and vomiting [16, 17]. Sometimes the avoiding opioid analgesic use as a part of the epidural analgesia solution is needed in order to reduce the side effects risk.

The aim of the study is to compare the technique of programmed intermittent administration of low concentrated ropivacaine without opioids with continuous infusion during epidural analgesia with the purpose of natural delivery pain relief.

Methods

The study was approved by the local Ethics Committee No 3/6 23.03.2017. Eighty-four primipara planned to natural delivery and full-term pregnancy were recruited and examined in the Perinatal Center of Saint-Petersburg State Paediatric Medical University from January to June 2018. All patients were provided with epidural analgesia as desired for labour pain relief. Puncture and catheterization of epidural space were performed at the level of L_3-L_4/L_4-L_5 after signing the patient informed consent for participation in clinical study and if there was no contraindications. 5 minutes after the administration of lidocaine hydrochloride 2% 3 ml test-dose, in order to induce analgesia ropivacaine solution 0.08% 10 ml was administrated. In case of insufficient analgesia level (VAS score > 40 mm) an additional 10 ml of 0.08% ropivacaine solution was administrated. Patients were excluded from the study in cases where the painful condition persisted after repeated administration of local anaesthetic.

Randomized distribution of patients into two groups depending on the EA method was conducted later. 0.08% ropivacaine hydrochloride solution was utilized as a local anaesthetic in both groups.

The following regimen was used in the PIEB group (n = 44): programmed intermittent epidural boluses of LA 8.0 ml each 30 min with patient controlled epidural analgesia, LA bolus 8.0 ml, lockout interval 30 min. In the control CEI group (n = 40) patient-controlled epidural analgesia was conducted (8.0 ml LA lockout-interval 30 minutes) with continuous background infusion of ropivacaine hydrochloride 0.08% with an infusion rate of 8.0 ml/h. Infusion pump "Mini Rhythmic Evolution" (Micrel Medical Devices SA, Athens, Greece) was used for epidural analgesia.

Exclusion criteria from the study were the presence of severe somatic disease, mental disorders, purulent-septic diseases, allergy to local anaesthetics, and systemic coagulopathy or treatment with anticoagulants.

Assessments of pain level were performed with the 100-mm visual analogue scale (VAS) at the peak of contractions before analgesia induction, after analgesia, at the active phase of labour (with cervical dilatation 5 cm) and at the peak of childbirth pangs. Development of motor block was diagnosed by Bromage scale every hour throughout the time of anaesthesia. Information about the side effects such as pruritus, nausea and vomiting were collected for all parturients.

Statistical processing was performed using the software packages STATISTICA v. 7.0 (STAT*CON*, Witzenhausen, Germany) with nonparametric tests (the Wilcoxon test), because part of the array data did not

conform to the normal distribution law. The initial results of the study are presented as the median and interquartile range (25 and 75 percentiles). Critical significance level was established as $p < 0.05$.

Results

Two women in each group underwent caesarean delivery due to suspected fetal hypoxia, representing 4.8% in the PIEB group and 5.3% in the control CEI group which was not statistically significant ($p > 0.05$) and were excluded from the statistical analysis. Finally, 42 patients were in the PIEB group and 38 patients in the CEI group.

General characteristics of examined patients are presented in Table 1. No significant differences in age and anthropometric indices of the pregnant women in the studied groups were found. The age of the patients in the first group was 30.8 (27-34) years, in the second group – 31.2 (28-34). Body weight of women in the first group was 72.3 (67-77.5) kg, in the second group – 75.6 (68.5-81) kg. Gestational period was 38-40 weeks in both groups. No statistically significant differences between the groups were found.

Table 1. General characteristics of examined patients

Indices	PIEB (n = 42)	CEI (n = 38)	Confidence level
Age, years	30.8 (27-34)	31.2 (28-34)	0.417
Height, cm	167.1 (164.5-170)	165.8 (161.5-170)	0.310
Weight, kg	72.3 (67-77.5)	75.6 (68.5-81)	0.871
Gestational age, weeks	39.1 (38-40)	39.2 (38-40)	0,571

As shown in Table 2, examination of blood pressure (BP) and heart rate (HR) indices during natural delivery pain management, indices of BP and HR prior to anaesthesia did not differ between the groups. In the first group BP was 120.8/72.5 mm of mercury, HR – 78.9 beats per minute, in the second group BP – 120.9/73.6 mm of mercury, HR was 79.9 beats per minute. A slight decrease in BP and HR occurred after the pain relief onset in comparison with the baseline data, which was not statistically significant. Systolic BP after anaesthesia decreased by 4% compared to baseline, diastolic BP decreased by 5%, HR decreased by 10%. A slight decrease in BP and HR is associated with use of low concentrated local anaesthetic, whose hemodynamic effects are minimal.

In the active phase of labour (with cervical dilatation 5 cm) and active pushing phase, the BP and HR parameters did not differ depending on the EA technique used ($p < 0.05$). In PIEB group BP was within 114.5/69.6 and 118.9/74 millimetre of mercury, HR 78.7 and 80.3 beats per minute respectively. In CEI group BP was 114.2/69.4 and 119.9/74.1 millimetre of mercury, HR – 77.9 and 81.4 respectively.

Table 2. Indices of blood pressure (BP) and heart rate (HR) during labour pain relief

Indices	PIEB (n = 42)	CEI (n = 38)	Confidence level
Initial systolic BP	120.8 (115-125)	120.9 (112.5-129)	1.0
Initial diastolic BP	72.5 (69-77)	73.6 (67-80)	0.511
Initial heart rate	78.9 (72.5-84.5)	79.9 (74-87)	0.522
Systolic BP after analgesia	116.1 (112-120)	115.8 (110-121.5)	0.749
Diastolic BP after analgesia	68.7 (66-72)	70.6 (65.5-73.5)	0.176
HR after analgesia	78.4 (73-83.5)	77.7 (72-81)	0.868
Systolic BP (5 cm cervical dilatation)	114.5 (110-117.5)	114.2 (110-120)	1.0
Diastolic BP (5 cm cervical dilatation)	69.6 (67-72)	69.4 (64.5-71)	0.391
HR (5 cm cervical dilatation)	78.7 (75-82)	77.9 (73.5-81)	0.871
Systolic BP (active pushing phase)	118.9 (113.5-124)	119.9 (117-125)	0.868
Diastolic BP (active pushing phase)	74 (70-78)	74.1 (70-78.5)	1.0
HR (active pushing phase)	80.3 (78-84)	81.4 (78-84.5)	0.144

Pain syndrome assessment with VAS and motor block assessment with Bromage scale during the labour are shown in Table 3. Assessment of pain level using VAS and assessment of motor block using Bromage scale in different study stages (Table 3), at baseline all women were diagnosed with pain syndrome, accompanied by high VAS pain score more than 80 mm, which was used as a reason for labour pain management. Adequate pain relief was achieved after the analgesia induction which was characterized by significantly lower VAS score in comparison with baseline scores. At the active labour phase (cervical dilatation 5 cm) and the active pushing phase lower VAS scores were observed in the PIEB group 18.8 and 24.5 mm respectively in comparison with the control CEI group, where the VAS score was 24.3 and 37.3 mm respectively ($p < 0.05$).

While studying EA effects on motor function, no motor block development was observed in both groups during the whole period of analgesia. The Bromage score in all groups was 0 during the labour; all women were not limited in mobility, they got up, walked and were active. No itching, nausea and vomiting were recognised in patients in both groups.

Table 3. Assessment of pain level using VAS and assessment of motor block using the Bromage scale in different study stages

Indices	PIEB (n = 42)	CEI (n = 38)	Confidence level
VAS before analgesia	80.3 (70-90)	81.2 (70-90)	0.689
VAS after analgesia	16.5[a] (10-20)	17.8[a] (10-25)	1.0
VAS (5 cm cervical dilatation)	18.8[a,b] (15-25)	24.3[a,b] (20-30)	0.0344
VAS (active pushing phase)	24.5[a,b] (20-35)	37.3[a,b] (20-50)	0.0265
Bromage scale (all stages)	0	0	1.0
Pruritus	0	0	1.0
Nausea and vomiting	0	0	1.0

[a] – differences are statistically significant in comparison with the first stage of research
[b] – the difference are significant between groups I and II

Effects of different EA techniques on cervical dilatation and labour dynamics are shown in Table 4. Epidural analgesia in natural delivery was initiated in the presence of regular contractions, cervical dilatation 3-4 cm. There was no significant difference in cervical dilatation between the groups at the moment of EA induction ($p > 0.05$). Moreover, no significant difference in labour dynamics was observed according to the EA technique used. Time from the induction of EA to the childbirth was 4.1 hours in the first group and 4.0 hours in the second group; the difference was not statistically significant.

Table 4. Duration of delivery with epidural analgesia and local anaesthetic consumption

Indices	PIEB (n = 42)	CEI (n = 38)	Confidence level
Cervical dilatation (cm) before epidural analgesia	3.4 (3-4)	3.3 (3-4)	0.689
Total duration of labour (hours)	8.3 (7-10)	8.1 (6.5-10)	0.863
Time from EA induction to childbirth (hours)	4.1 (3-5)	4.0 (3-5)	0.486
Total volume of LA	59.9 (45-66)	69.5 (44-92)	0.033
Time to desired bolus (min)	89.2 (57-108)	43.2 (35-65)	0.021
Number of additional boluses	1.5 (1-2)	2.1 (2-3)	0.038

As shown in Table 4, the lowest consumption of local anaesthetic was recorded when conducting PIEB in combination with PCEA – 59.9 ml, that was statistically significantly less in comparison with CEI of local anaesthetic in combination with PCEA, where the consumption was 69.5 ml ($p = 0.033$).

Time to the additional requested bolus was twice longer in the PIEB group – 89.2 min in comparison with 43.2 min in CEI group, which was statistically significant ($p = 0.021$). In addition, in the PIEB group, the number of additional boluses administered was 1.5 times less in comparison with the control group, where women requested additional administration 2.1 times, which was also statistically significant ($p = 0.038$).

Newborns Apgar scores according to method of epidural analgesia in labour are shown in Table 5. One minute after the birth, newborns had an Apgar score of 7.9 points in the studied groups, in the fifth minute Apgar score was 8.9-9 points, no statistically significant differences between the groups were observed ($p > 0.05$).

Table 5. Apgar score

Indices	PIEB (n = 42)	CEI (n = 38)	Confidence level
1 min Apgar score	7.9 (8-8)	7.9 (8-8)	0,683
5 min Apgar score	8.9 (9-9)	9 (9-9)	1.0

Discussion

At the present time the epidural analgesia technique is being modified as it represents a major method of labour analgesia, meeting the requirements of perfect labour pain management. It was done in order to reduce negative effects of epidural analgesia on the puerperal condition, physiology of childbirth, foetus and newborn.

Even in 1988, Gambling et al. considered patient controlled epidural analgesia to be a preferred method of local anaesthetic administration to the epidural space. They also claimed that PCEA reduces severe pain requiring additional local anaesthetic and reduces the local anaesthetic consumption without compromising the effectiveness of anaesthesia [6]. Some authors showed that continuous epidural analgesia provides the achievement of a well-marked analgesic effect for the 1st and 2nd stages of labour while maintaining the motor activity of mother in labour. Moreover, that does not affect myometrial contractile activity, mechanism of labour and does not negatively affect the foetus [5].

Advent of programmed intermittent epidural bolus technique is the next stage of neuraxial labour analgesia. Previous studies showed that the use of the method's intermittent epidural bolus administration led to the decrease of the number of breakthrough pain episodes, the increase of maternal satisfaction with anaesthesia provided, most likely because of the better homogeneous distribution of local anaesthetic in the epidural space [7-10]. In our study we also obtained similar results, characterized by a decrease of additional

boluses number, associated with the pain syndrome in the auto-bolus LA administration group.

It can be assumed that the decrease of motor block risk when using the PIEB technique not only leads to better maternal satisfaction with pain relief, but also reduces the frequency of artificial delivery [7, 8, 12, 18-20]. No motor block developed in any group of our examined patients with no difference of EA technique. Moreover, there was no difference in EA technique effects on cervical dilatation and labour process. Whereas George et al. study showed a reduction of labour duration, particularly the second stage when using PIEB compared to CEI [21].

It is possible that the absence of effects on the motor block is because we used a low concentration and a small dose of local anaesthetic. In addition, through the use of low concentration of local anaesthetic in small doses, our study did not show significant reduction in BP and HR during the whole time of anaesthesia. On the other hand, despite the use of low concentration of LA in small doses and without the addition of opioids, pronounced analgesic effect was achieved. Analgesic effect was significantly better in the programmed intermittent epidural bolus group. The ropivacaine concentration in our study is almost twice lower than in the study by Nunes et al.; however, the results of analgesia are not worse [15].

Sia et al. compared PCEA with programmed boluses against PCEA with continuous background infusion. They concluded that programmed boluses' use led to the reduction of local anaesthetic consumption and the decrease in the additional self-administrated boluses number in comparison with continuous infusion [22]. The results of our study are similar, showing a significantly lower LA consumption and less frequency of additional self-administrated boluses when using PIEB in comparison with CEI.

The use of programmed intermittent boluses provides better and more prolonged analgesia with less local anaesthetic consumption in comparison with continuous infusion, which is confirmed by other authors [23].

Our study, as well as previous studies did not show any difference in the effects of different EA techniques on the newborn condition, in particular the Apgar score, which did not differ between the groups at 1 and 5 minutes after birth [7, 8, 10, 18-20, 22-24].

Conclusions

Administration of low-concentrated ropivacaine solution 0.08% without opioids using programmed intermittent epidural bolus and PCEA provides better and more prolonged analgesia with less local anaesthetic consumption in comparison with continuous infusion and PCEA technique. In addition, no motor block, no pruritus and nausea, no additional effects on labour dynamics or maternal haemodynamic state, and no effects on foetal and newborns condition were evidenced.

Conflict of interest

Nothing to declare

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