Saudi Journal of Biological Sciences 26 (2019) 1991–1994

Contents lists available at ScienceDirect

Saudi Journal of Biological Sciences

journal homepage: www.sciencedirect.com

Original article

The efficacy of ropivacaine and bupivacaine in the caesarean section and the effect on the vital signs and the hemodynamics of the lying-in women

Huaizhao Wang [a], Qinghua Gao [a], Ruixue Xu [a], Wei Dong [b], Yanan Zhang [a], Jinxin Fan [c,*]

[a] Department of Anesthesiology, Qingdao Huangdao District Central Hospital, Qingdao 266400, China
[b] Department of Anesthesiology, The First Affiliated Hospital of Shantou University Medical College, Shantou 515041, China
[c] Department of Anesthesiology, Qingdao Municipal Hospital, Qingdao 266011, China

ARTICLE INFO

Article history:
Received 9 July 2019
Revised 25 July 2019
Accepted 31 July 2019
Available online 1 August 2019

Keywords:
Ropivacaine
Bupivacaine
Caesarean section
Combined spinal and epidural analgesia
Vital signs
Hemodynamics

ABSTRACT

Objective: To investigate the efficacy of ropivacaine and bupivacaine in caesarean section and vital signs and the hemodynamics of the lying-in women.
Methods: A total of 480 lying-in women who were admitted to this hospital for treatment between December 2017 and June 2018 were enrolled into this study as the subjects, which were divided into the experiment group and the control group, with 240 subjects in each group. In the experiment group, subjects received the local anesthesia by infusion of 1.5 mL ropivacaine (0.75%), while those in the control group also took the local anesthesia by infusion of 1.5 mL bupivacaine (0.75%). Thereafter, we observed the differences in the anesthetic efficiency, vital signs and hemodynamics of the lying-in women between two groups.
Results: The excellent and good rates of the anesthesia in two groups were 92.1% and 87.9%, showing no obvious difference; in the experiment group, the average arterial pressures and systolic pressures at 5 min and 10 min after combined spinal and epidural analgesia (CSEA) were all elevated when comparing to the control group (all $P < 0.05$); in the experiment group, the onset time was obviously extended, while duration of sensory and motor block and the duration of motor block were all shorter than those in the control group (all $P < 0.05$). During anesthesia, the incidence rate of the adverse reactions in the control group was 2.50%, significantly higher than 0.83% in the experiment group ($P < 0.05$).
Conclusion: Despite that ropivacaine and bupivacaine are efficient in anesthesia in the CSEA in the caesarean section, ropivacaine is more recommended for little influence on the hemodynamics, shorter duration of sensory block and motor block and low incidence rate of adverse reactions, which are conducive to the recovery and also safe to the patients.

1. Introduction

Combined spinal and epidural analgesia (CSEA) is a common anesthetic method in caesarean section, which integrates the spinal anesthesia into the epidural anesthesia. Thus, CSEA has the advantages of the subarachnoid anesthesia and epidural anesthesia, like rapid onset, precise analgesic efficacy and a low dose for the local anesthesia (David et al., 2000; Gizzo et al., 2014). During the CSEA, the analgesic effect varies in different analgesics (Dweik et al., 2014). Traditional anesthetics for local anesthesia include lidocaine, procaine and tetracaine, and currently, more drugs are developed for the CSEA, including bupivacaine, *L*-bupivacaine and ropivacaine, etc. Ropivacaine is a novel long-acting amides local anesthetics, and had been approved by Federal Drug Administration (FDA, USA) for local anesthesia. It can block the transduction of nervous excitation by inhibiting the activity of sodium channel of the nerve cells, and is characterized by the separated sensory and motor, rapid onset, few adverse reactions and good dispersivity (DeKock et al., 2001; Matsota et al., 2009; Unlugenc et al., 2009). The study is designed to compare the

* Corresponding author.
E-mail address: xnh2019@126.com (J. Fan).
Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

https://doi.org/10.1016/j.sjbs.2019.07.014
1319-562X/

efficacy of bupivacaine and ropivacaine in CSEA, and observed the effects of them on the vital signs and hemodynamics of the lying-in women in caesarean section, so as to clarify the anesthetic effects of them in CSEA and provide reference for clinical application.

2. Subjects and methods

2.1. Subjects

A total of 480 lying-in women who volunteered to take caesarean section under CSEA between December 2017 and July 2018 were enrolled into this study as subjects. All subjects had the indications of caesarean section according to the *Obstetrics and Gynecology*. Thereafter, they were randomized into the experiment group (n = 240) and control group (n = 240). Comparison of the general data of subjects between two groups showed no remarkable difference ($P > 0.05$; Table 1), indicating that the data were comparable. Inclusion criteria: (a) gestational weeks of subjects >36 weeks; (b) subjects in ASA I or II. Exclusion criteria: (a) patients with the contraindications of intrathecal block; (b) patients with the history of allergy to ropivacaine or bupivacaine; (c) patients with the pregnancy complications, like preeclampsia or placenta previa. This study gained the approval from the Ethics Committee of the hospital.

2.2. Methods

Before caesarean section, food and water were all withdrawn from the subjects, and after being delivered into the operation room, they were monitored for the electrocardiogram, transcutaneous oxygen saturation, blood pressure and heart rate. In L2/3 intervertebral disc space, CSEA needle was used for puncture, and till the needle was inserted in the epidural space, a 25G lumbar spinal needle was inserted into the subarachnoid space Dweik et al., 2014. Following the effusion of cerebrospinal fluid (CSF), 1.5 mL ropivacaine (0.75%) was slowly infused into the subjects of the experiment group, while 1.5 mL bupivacaine (0.75%) into the subjects of the control group. After infusion, the tube was inserted into the epidural space and fixed, and then the subjects were required to keep in supine position. Fluid resuscitation was also performed by infusion of 7 mL kg^{-1} h^{-1} Ringer lactate solution during the surgery, and after surgery, epidural analgesia was carried out for patients.

2.3. Observation indexes

During the surgery, following clinical indicators of the patients were monitored: heart rate, average arterial pressure, systolic blood pressure, anesthetic efficacy, anesthetic satisfaction and incidence rate of the adverse reactions, like nausea, vomiting, decrease in blood pressure or headache (Dweik et al., 2014). Heart rate and blood pressure were monitored as follows: After the subjects were delivered into the operation room and calmed down, heart rate, average arterial pressure and systolic pressure were monitored respectively at 5 min prior to the anesthesia, 5 min and 10 min after anesthesia, and 2 min after operation. Level of anesthesia: Levels of anesthesia were monitored every 5 min after anesthesia, and the highest level of block, emergence time and duration of the highest block level.

Anesthesia was evaluated as follows: Poor, subjects with acute pains, strong discomfort, arrhythmia that needed to be corrected by general anesthesia, or tension of the abdominal muscle; good, subjects with mild discomfort that required the medication, or with the variation of heart rate over 20.0%; excellent, subjects with promising analgesic effect, no discomfort, variation of heart rate within 20.0%, and normal clinical indicators (DeKock et al., 2001).

2.4. Statistical analysis

SPSS 17.0 software was applied for the data analysis. Measurement data in normal distribution were shown in ($\bar{x} \pm s$), and compared by the t test. Enumeration data were presented by the percentage (%) and compared by chi-square test. $P < 0.05$ suggested that the difference had statistical significance.

3. Results

3.1. Comparison of the anesthetic effect of patients between two groups

Excellent and good cases in anesthesia in the observation group and the control group took up 92.1% and 87.9%, respectively, with no obvious difference ($P > 0.05$; Table 2).

3.2. Comparison of the hemodynamic indicators of the subjects between two groups

At 5 and 10 min after anesthesia, the heart rate of the subjects in two groups were higher than those before anesthesia ($t = 2.125$ or 2.024, $P < 0.05$), but at the same time point, difference in the heart rate between two groups showed no statistical significance ($t = 0.025$ or 0.047, $P > 0.05$). On the contrary, the average arterial pressure and SBP in two groups were decreased significantly after anesthesia when comparing with the levels before anesthesia ($t = 2.212$, 0.026, 2.413 or 2.213, $P < 0.05$), ant at 5 and 10 min after anesthesia, the average arterial pressure and SBP in the experiment group were elevated at the same time points, and the differences from the levels of the control group had statistical significance ($t = 2.143$, 3. 012, 2.151 or 2.354, $P < 0.05$; Table 3).

Table 1
Comparison of general data of the subjects between two groups ($\bar{x} \pm s$).

Group	n	Age (years)	Height (cm)	Weight (kg)	BMI (kg/m^2)	Heart rate (beat/min)	SBP (mmHg)	DBP (mmHg)
Observation group	240	29.3 ± 3.4	160.6 ± 16.3	65.4 ± 4.9	25.4 ± 4.8	78.5 ± 8.5	120.4 ± 13.6	72.8 ± 17.3
Control group	240	30.6 ± 2.9	162.9 ± 14.3	62.2 ± 5.7	21.8 ± 7.2	76.6 ± 10.1	124.1 ± 11.9	75.7 ± 13.9
t		0.846	0.655	0.749	0.902	0.529	0.342	0.988
P		0.411	0.587	0.52	0.213	0.644	0.854	0.155

Table 2
Comparison of the anesthetic effect of patients between two groups.

Group	Excellent	Good	Poor	Excellent and good rate
Experiment group	19(7.9)	29(12.1)	192(80.0)	221(92.1)
Control group	29(12.1)	29(12.1)	182(75.8)	211(87.9)

Table 3
Comparison of the hemodynamic indicators of the subjects ($\bar{x} \pm s$).

Group	n	Time point	Heart rate (beat/min)	Average arterial pressure (mmHg)	SBP (mmHg)
Observation group	240	Before anesthesia	78.7 ± 8.9	92.9 ± 6.6	120.4 ± 13.4
		At 5 min after anesthesia	86.9 ± 4.7	89.2 ± 5.4	110.4 ± 9.3
		At 10 min after anesthesia	84.2 ± 3.5	86.9 ± 5.9	106.9 ± 10.6
		At 2 min after surgery	82.9 ± 4.9	88.3 ± 7.5	119.9 ± 5.8
Control group	240	Before anesthesia	78.6 ± 8.7	92.9 ± 9.9	124.1 ± 11.2
		At 5 min after anesthesia	83.2 ± 4.5	83.9 ± 6.1	104.7 ± 7.9
		At 10 min after anesthesia	82.3 ± 4.9	78.5 ± 3.6	100.5 ± 4.4
		At 2 min after surgery	73.9 ± 4.2	89.9 ± 6.5	121.6 ± 6.8

Table 4
Comparison of the anesthesia levels of subjects between two groups [$\bar{x} \pm s$, n(%)].

Group	Sensory block		Motor block	
	Onset time (s)	Duration (min)	Onset time (s)	Duration (min)
Observation group	69.7 ± 7.1	113.5 ± 7.2	161.2 ± 17.3	162.2 ± 20.1
Control group	55.3 ± 9.2	132.7 ± 6.2	154.5 ± 16.7	211.3 ± 19.7
t/χ^2	2.222	2.009	0.527	2.462
P	0.024	0.042	0.643	0.013

3.3. Comparison of the anesthesia level of subjects between two groups

In the experiment group, the onset time of sensory block of the subjects was longer than that in the control group, while the duration of the sensory block and motor block was significantly shorter with no evident difference (all $P < 0.05$; Table 4).

3.4. Comparison of the adverse reactions of patients between two groups

In the control group, there were 2 patients with headache, 1 patient with decrease in blood pressure, 2 with nausea and vomiting and 1 with chest distress. In the experiment group, 1 patient had nausea and vomiting and 1 had decrease in blood pressure. In the control group, the incidence rate of adverse reaction was 2.50%, significantly higher than 0.83% in the experiment group, with significant differences ($P < 0.05$).

4. Discussion

Caesarean section is usually preferred for the difficulty in the natural labor due to some reasons. Selection of anesthesia in caesarean section should take various factors into consideration, including the surgical indications, the urgency of surgery, requirement of the pregnant woman as well as the judgement of the anesthetists. As is known to all, epidural block is a classical anesthetic method, while general anesthesia is only adopted for the contraindication of epidural block or local infiltrative anesthesia, including maternal bleeding, disturbance of blood coagulation, factors threatening the fetal survival or the denial to take local anesthesia by pregnant woman. CSEA converges the advantages of the epidural anesthesia and lumbar anesthesia that has been applied widely with a low dose, rapid onset and promising analgesic effect (Eid et al., 2011). Thus, CSEA is preferred in caesarean section that can effectively mitigate the pains and shorten the delivery time (Buyse et al., 2007).

In caesarean section, anesthetics may affect the pregnant woman and fetus (Gupta et al., 2013). Ropivacaine, as a *L*-amide anesthetics in the chemical structure similar to bupivacaine. However, bupivacaine has a potent cardiotoxicity that may bring about the discomfort for some pregnant women, while ropivacaine has the advantage of separated sensory and motor block, with less toxicity to cardiovascular system and central nervous system (Leo et al., 2009; Jain et al., 2012; Roofthooft and Van, 2008). Besides, ropivacaine stabilizes the hemodynamics with little effect on the heart rate and blood pressure and a long time of motor block (Gupta et al., 2013). Relevant studies have shown that ropivacaine has a lower lipid solubility than bupivacaine (Kuusniemi et al., 2000), which suggests that ropivacaine generates less toxic effect on the cardiovascular system and heart; in addition, ropivacaine is more efficient in blocking the sensor and motor that is inferior to the lidocaine but superior to the bupivacaine (Choi et al., 2006). The study has shown that ropivacaine (0.5%) is applicable in the CSEA of caesarean section, with a lower incidence rate of shivering than bupivacaine in an equivalent dose (Cappelleri et al., 2005), while either a low or high dose results in the discomfort for lying-in women (Dyer and Joubert, 2004). Foreign literature also reports that the dose of ropivacaine in the lumbar anesthesia for caesarean section is between 15 and 20 mg, but due to the features of Asians, this dose may not be suitable to the condition of Chinese (Akerman et al., 2012). Thus, it is urgent to search for the most suitable anesthetic dose and protocol for Chinese.

The results of this study indicated that ropivacaine and bupivacaine gained promising anesthetic effects in CSEA of caesarean section: The excellent and good rate of anesthetic effect of the experiment group was 92.1%, while the rate in the control group was 87.9%. At 5 min and 10 min after infusion of ropivacaine or bupivacaine for CSEA, the average arterial pressure and SBP in two groups were decreased magnificently, and the indicators in the experiment group were higher than those in the control group at the same time point, but the heart rate remained similar to the control group. Thus, ropivacaine interferes less on the hemodynamics. In the experiment group, the onset time of sensory block was significantly longer than that in the control group, while the durations of the sensory block and motor block were shorter. Hence, ropivacaine satisfies more for caesarean section, with a higher satisfaction and more rapid recovery in motor. The incidence rate of adverse reaction in the experiment group was 0.83%, significantly lower than 2.50% in the control group, suggesting that ropivacaine is safe in clinical application.

5. Conclusion

In conclusion, despite that ropivacaine and bupivacaine are efficient in anesthesia in the CSEA in the caesarean section, ropivacaine is more recommended for little influence on the

hemodynamics, shorter duration of sensory block and motor block and low incidence rate of adverse reactions, which are conducive to the recovery and also safe to the patients.

Declaration of Competing Interest

The authors declared that there is no conflict of interest.

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