Tropical Journal of Pharmaceutical Research July 2024; 23 (7): 1207-1213
ISSN: 1596-5996 (print); 1596-9827 (electronic)

Available online at http://www.tjpr.org
http://dx.doi.org/10.4314/tjpr.v23i7.20

Original Research Article

Effect of ropivacaine concentrations in combined spinal-epidural anesthesia on efficacy and sedation levels in lower abdominal obesity patients

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Sent for review: 6 August 2023 *Revised accepted: 29 June 2024*

Abstract

Purpose: *To investigate the effect of varying ropivacaine concentrations in combined spinal-epidural anesthesia (CSEA) on anesthetic efficacy and sedation in patients with lower abdominal obesity.*
Methods: *110 patients with lower abdominal obesity who received CSEA in Traditional Chinese Medicine Hospital, Lin 'an District, Hangzhou, China from January 2020 to December 2022 were retrospectively enrolled. Patients were divided into a low-concentration group (LC group, n = 49) which received 0.3 % ropivacaine, and a high-concentration group (HC group, n = 61) which received 0.5 % ropivacaine. Changes in visual analogue scale (VAS) scores and Ramsay sedation scale (RSS) scores in both groups were analyzed at 1, 2, 4 and 6 h after surgery.*
Results: *The LC group showed significantly higher static and dynamic VAS scores than HC group at 1, 2, 4 and 6 h after surgery. Furthermore, HC group demonstrated significantly shorter ($p < 0.05$) onset times for sensory and motor blocks, longer sensory and motor recovery times, and lower mean arterial pressure (MAP) level 10 min after administration compared to the LC group. However, MAP levels 30 min after administration were similar to baseline levels in both groups ($p > 0.05$).*
Conclusion: *High-concentration ropivacaine in CSEA offers superior post-operative analgesia, and improves patient satisfaction without increasing adverse reactions in patients with lower abdominal obesity. Further studies using larger sample size and longer duration of investigation are required to strengthen the validity of these results.*

Keywords: *Spinal-epidural anesthesia, Anesthetic effect, Sedation score, lower abdominal obesity*

Tropical Journal of Pharmaceutical Research is indexed by Science Citation Index (SciSearch), Scopus, Web of Science, Chemical Abstracts, Embase, Index Copernicus, EBSCO, African Index Medicus, JournalSeek, Journal Citation Reports/Science Edition, Directory of Open Access Journals (DOAJ), African Journal Online, Bioline International, Open-J-Gate and Pharmacy Abstracts

INTRODUCTION

As global living standards have risen, obesity has escalated into a worldwide epidemic, affecting over 600 million individuals [1]. Among those with obesity, individuals with abdominal obesity often exhibit hypertrophy in the lower abdomen, primarily due to accumulation of visceral and subcutaneous fat in the abdominal region [2]. In women, this condition negatively impacts reproductive ability and complicated cesarean sections [3]. Reportedly, women with lower abdominal hypertrophy are more like to undergo cesarean sections compared to their normal-weight counterparts [4]. Pain management remains a critical challenge for most surgical

patients, often referred to as the "fifth vital sign" [5]. Combined spinal-epidural anesthesia (CSEA) has become a preferred method for surgeries involving the lower limb and abdomen, praised for its rapid onset, efficacy, low failure rate, and minimal local anesthetic requirement [6]. However, the specific effect of CSEA in patients with lower abdominal obesity and the optimal choice of clinical anesthetic drugs remain topics of debate. Conventional spinal anesthetics may lead to adverse reactions including hypotension, vomiting, nausea, as well as dyspnea, especially in patients with lower abdominal obesity [7].

Ropivacaine is a modern, long-acting amide local anesthetic favored for its ability to differentiate between sensory and motor nerve blocks [8]. Previous studies has demonstrated varying anesthetic and analgesic effects of different ropivacaine concentrations in epidural labor analgesia [9]. However, a standard concentration for CSEA has not been established. Therefore, this study investigated the anesthetic effect of varying ropivacaine concentrations in CSEA on patients with lower abdominal obesity to promote clinical analgesia practices.

METHODS

Patient data

Medical records of 110 patients with lower abdominal obesity who received CSEA in Traditional Chinese Medicine Hospital, Hangzhou City, China from January 2020 to December 2022 were enrolled. Participants were divided into a low-concentration group (LC group, n = 49), receiving 0.3 % ropivacaine, and a high-concentration group (HC group, n = 61), receiving 0.5 % ropivacaine.

Ethical matters

This study was approved by the Medical Ethics Committee of the hospital (approval no. llazyyIIK2023061201) and conducted following the provisions in the Declaration of Helsinki [10].

Inclusion criteria

Patients with full-term singleton pregnancies undergoing cesarean section met the diagnostic criteria for abdominal obesity before pregnancy [2], received CSEA, were aged between 21 - 35 years old, and had detailed clinical data.

Exclusion criteria

Patients who suffered surgical contraindications had contraindications for CSEA, had a history of analgesic-induced pain, were allergic or intolerant to the drugs adopted in this study, patients had liver or renal insufficiency, or prolonged use of analgesic drugs.

Anesthesia administration

Patients were required to fast and abstain from drinking. Oxygen was provided and continuous ECG, respiration, blood pressure, pulse, and oxygen saturation monitoring were conducted. Sodium Lactate Ringer's Injection (Sichuan Kelun Pharmaceutical Co., Ltd, China, State Food and Drug Administration (SFDA) approval no. H20055488) was administered via the venous channel. Patients were positioned laterally for skin preparation and puncture. A 25 G spinal needle was inserted through an epidural needle into the arachnoid membrane, and 15 mg of 1 % ropivacaine hydrochloride injection (Jiabo Pharmaceutical Co. Ltd, Guangdong, China, SFDA approval no. H20113381, 10 mL, 75 mg) was diluted with cerebrospinal fluid to 0.3 % ropivacaine for the LC group or 0.5 % ropivacaine for the HC group, with 2.5 mL injected into the subarachnoid space. Epidural catheter was set up for continuous administration. The anesthetic plane was assessed after the procedure, and lidocaine was added through the epidural catheter as needed to maintain systolic blood pressure ≥ 100 mmHg.

Evaluation of parameters/indices

Visual analogue scale

The visual analogue scale (VAS) was utilized for assessing pain levels 1, 2, 4, and 6 h after surgery which ranges from 0 to 10, where 10 represents the highest level of pain [11]. Both static and dynamic VAS scores were compared during these time intervals. Sensory and motor block onset as well as recovery times were analysed.

Ramsay sedation scale

Ramsay sedation scale (RSS) was used to evaluate sedation levels in both groups before surgery, at its initiation, 30 min after surgery and after completion. The RSS ranges from 1 to 6 where 1 represents a patient showing signs of anxiety, restlessness, or irritability, 2 represents a cooperative, oriented, and calm patient, 3 represents when a patient responds only to commands, 4 represents if the patient promptly responds to eyebrow tapping or loud auditory stimuli, 5 represents slow response, and 6 represents no response [12].

Mean arterial pressure (MAP) and heart rate (HR)

Baseline and post-administration (10 and 30 min) mean arterial pressure (MAP) and heart rate (HR) were recorded.

Adverse reactions

Adverse reactions (hypotension, dyspnea, nausea, vomiting, shivering as well as bradycardia) and patients' anesthesia satisfaction (highly satisfied, satisfied and dissatisfied) were evaluated.

Statistical analysis

Data were analyzed using Statistical Packages for Social Sciences (SPSS 22, IBM, Armonk, NY, USA) software and visualized with GraphPad Prism 8 (GraphPad Software, San Diego, CA, USA). Count data were presented as rates, and analyzed using the chi-square test. Measurement data were presented as mean ± standard deviation (SD) and analyzed using t-test. $P < 0.05$ was considered statistically significant.

RESULTS

Baseline characteristics

There was no significant difference in baseline characteristics between the two groups of patients ($p > 0.05$; Table 1).

Pain scores

The LC group exhibited significantly higher static and dynamic VAS scores 1, 2, 4 and 6 h after surgery compared to HC group ($p < 0.05$) (Figure 1).

Table 1: Baseline characteristics

Characteristic	Status	LC group (n = 49)	HC group (n = 61)	χ^2	*P*-value
Age					
	≥30	20	27	0.132	0.717
	<30	29	34		
Gestational age (week)					
	≥38	32	38	0.107	0.744
	<38	17	23		
Height (cm)					
	≥160	35	42	0.086	0.769
	<160	14	19		
Drinking history					
	Yes	10	13	0.013	0.908
	No	39	48		
Smoking history					
	Yes	8	9	0.051	0.821
	No	41	52		
Place of residence					
	Rural area	31	40	0.063	0.801
	Urban area	18	21		

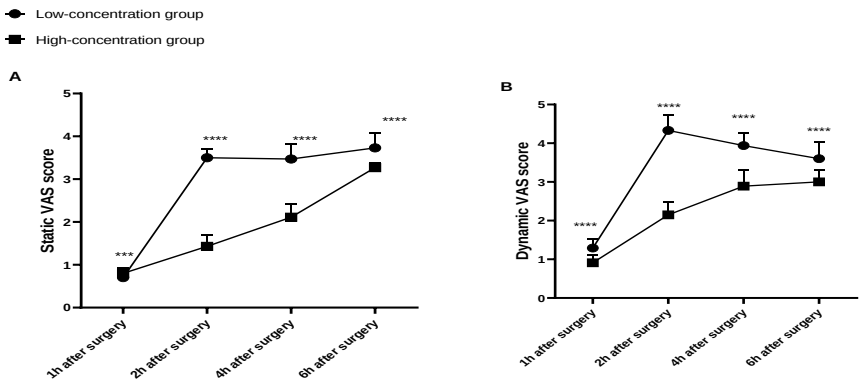

Figure 1: Post-operative VAS scores between the two groups. (A) Static VAS score was significantly higher in low-concentration group 1, 2, 4 and 6 h after surgery. (B) Dynamic VAS score was significantly higher in low-concentration group. ***$P < 0.001$, ****$p < 0.0001$ vs. high-concentration group

Onset and recovery of block

The HC group experienced significantly reduced time of onset and extended time of recovery compared to LC group ($p < 0.05$) (Figure 2).

Hemodynamic indices

The HC group exhibited significantly lower MAP levels compared to LC group 10 min after administration ($p < 0.05$), while at baseline and 30 min after administration, MAP levels in both groups were identical ($p > 0.05$). Additionally, there was no significant difference in HR at baseline, 10 min and 30 min after administration ($p > 0.05$) (Figure 3).

Ramsay sedation scale

Before surgery, RSS scores of both groups were non-significant ($p > 0.05$). However, the HC group reported significantly higher RSS scores at the commencement of surgery, 30 min after surgery, and after surgery compared to the LC group ($p < 0.05$) (Figure 4).

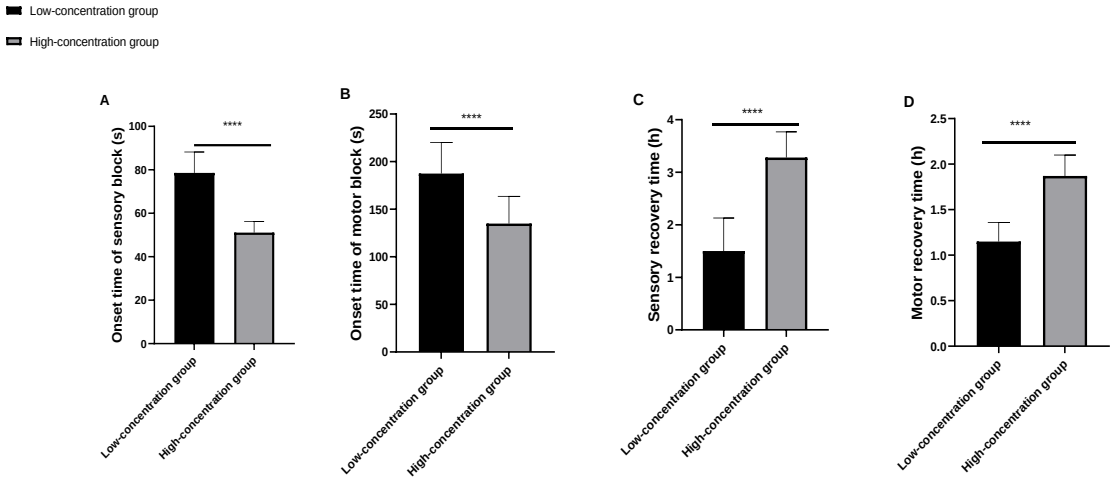

Figure 2: Onset and recovery of blocks between the two groups. (A, B) The high-concentration group experienced significantly shorter time of onset of sensory and motor blocks than the low-concentration group. (C, D) The high-concentration group experienced significantly longer sensory and motor recovery times than the low-concentration group. ****$P < 0.0001$ compared to low-concentration group

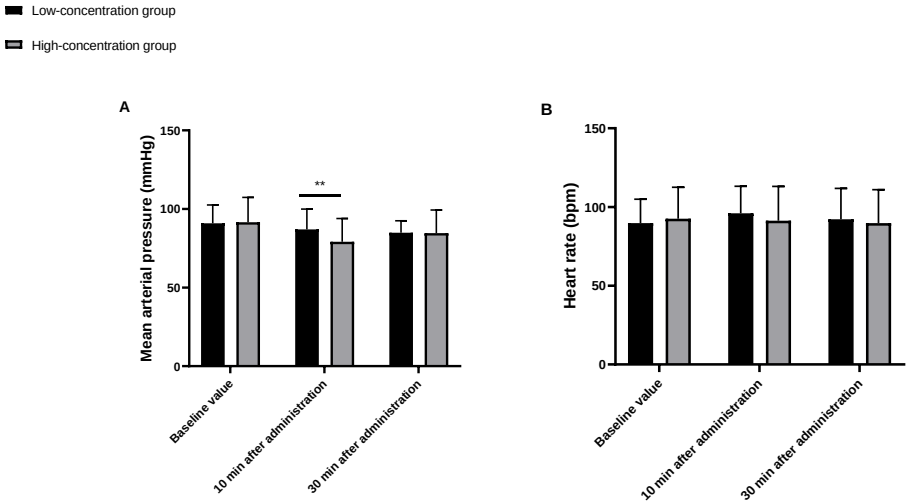

Figure 3: Hemodynamics between the two groups. (A) The high-concentration group exhibited significantly lower MAP levels compared to low-concentration group at 10 min after administration, while MAP levels in the two groups were not significantly different at baseline and 30 min after administration. (B) The HR at baseline, 10 and 30 min after administration were identical in both groups. **$P < 0.01$ vs. low-concentration group

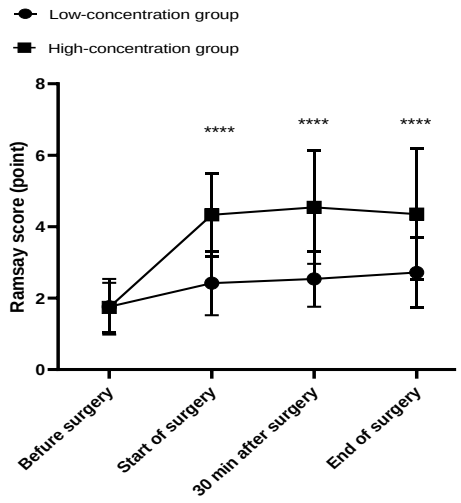

Figure 4: Ramsay sedation scale between the two groups. ****P < 0.0001 vs. low-concentration group

Adverse reactions

Incidence of adverse reactions did not differ significantly between HC and LC groups (p > 0.05; Table 2).

Anesthesia satisfaction level

The HC group demonstrated a significantly higher satisfaction level compared to LC group (p < 0.05; Table 3).

DISCUSSION

With the rising living standards and dietary changes, the prevalence of abdominal obesity has surged [1,13]. Individuals with abdominal obesity, particularly those with enlarged lower abdomens are at an increased risk of dystocia compared to normal-weight counterparts [3,14]. Cesarean section, as a strategy for managing dystocia and high-risk pregnancies, significantly reduces mortality rates for both high-risk pregnant women and perinatal infants, thereby ensuring maternal and infant health [15].

Combined spinal-epidural anesthesia (CSEA) known for its rapid onset and effective anesthesia, has become the preferred anesthesia technique for cesarean sections, gradually supplanting epidural anesthesia due to its superior benefits [16]. Ropivacaine, a long-acting amide local anesthetic and a pure levorotatory isomer, exhibits varying blocking effects on nerve fibers at different concentrations [17]. However, the optimal concentration of ropivacaine used in CSEA remains unclear. Pathak *et al* [18] demonstrated that higher concentrations of ropivacaine provide improved motor block and analgesic effects compared to lower concentrations. This study aimed to investigate the anesthetic and sedative effects of 0.3 and 0.5 % ropivacaine in CSEA on patients with lower abdominal obesity.

Wang *et al* [19] reported that higher concentrations of ropivacaine resulted in significantly lower VAS scores after surgery, which is in tandem with the findings of this current study. The HC group exhibited significantly lower static and dynamic VAS scores at 1, 2, 4, and 6 h after surgery compared to LC group, indicating superior analgesic efficacy of 0.5 % ropivacaine in CSEA. In addition, the HC group experienced shorter time of onset for sensory and motor blocks and prolonged sensory and motor recovery periods, suggesting enhanced anesthetic effects at higher ropivacaine concentrations. Ye *et al* [17] revealed that 0.5 % ropivacaine provided better sedation compared to 0.4 % ropivacaine, corroborating the findings of this study. Also, the HC group showed higher RSS scores, indicating improved sedation. The above finding suggests a better sedative effect in HC group compared to LC group.

Table 2: Incidence of adverse reactions between the two groups (n(%))

Group	Nausea and vomiting	Hypotension	Dyspnea	Shivering	Bradycardia	Total incidence of adverse reaction
LC (n = 49)	7(14.3)	5(10.2)	4(8.2)	4(8.2)	2(4.0)	22(44.9)
HC (n = 61)	8(13.1)	7(11.4)	4(6.6)	4(6.6)	1(1.6)	24(39.3)

Table 3: Anesthesia satisfaction level between the two groups (n(%))

Group	Very satisfied	Satisfied	Dissatisfied	Satisfaction rate (%)
LC (n = 49)	37(75.6)	7(14.2)	5(10.2)	89.7
HC (n = 61)	56(91.8)	4(6.6)	1(1.6)	98.3

Furthermore, there was a significant difference in MAP 10 min after injection with 0.5 % ropivacaine exerting a lesser impact on patient hemodynamics. Additionally, there was no significant inter-group difference in adverse reactions, but a higher level of anesthesia satisfaction was reported in HC group. These outcomes suggest that high-concentration ropivacaine is safe and effective without increasing adverse reactions, potentially enhancing patient anesthesia outcomes. This is consistent with the findings of Chen *et al* [20] who reported a similar effect of 0.1 and 0.068 % ropivacaine on serum inflammatory markers and body temperature in parturients undergoing epidural labor analgesia.

Limitations of this study

The study has some limitations such as small sample size and the lack of long-term prognosis evaluation.

CONCLUSION

High-concentration (0.5 %) ropivacaine in CSEA for patients with lower abdominal obesity provides superior postoperative analgesia, improves sedation effect, stable hemodynamics, and greater patient satisfaction without increasing adverse reactions. Future studies should address the challenges of small sample size and short-term evaluation to strengthen the validity of these results.

DECLARATIONS

Acknowledgements

None.

Funding

None provided.

Ethical approval

This study was approved by the Medical Ethics Committee of the hospital (approval no. llazyyIIK2023061201).

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of Interest

No conflict of interest associated with this work.

Contribution of Authors

We declare that this work was done by the authors named in this article and all liabilities pertaining to claims relating to the content of this article will be borne by the authors. Yangling Zhu conceived and designed the study, and drafted the manuscript. Yangling Zhu and Xiaoshu Zheng collected, analyzed and interpreted the experimental data. Both authors revised the manuscript for important intellectual content. Both authors read and approved the final draft of the manuscript for publication.

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