SPINAL ANESTHESIA WITH ROPIVACAINE FOR LOWER LIMB SURGERY

Dang Chi Binh[1], Vo Van Hien[2]*

Abstract

Objectives: To evaluate the anesthetic effect and impacts on respiration, circulation, and some undesirable consequences of spinal anesthesia with ropivacaine in patients who are scheduled for lower limb surgery. ***Methods:*** A clinical interventional study, a randomized group with comparative analysis on 70 patients who were indicated for lower limb surgery at the Department of Surgery - Anesthesia and Resuscitation, Military Hospital 121, Military Region 9 (Can Tho province) from November 2022 to June 2023, randomly divided into 2 groups: Group R (35 patients treated with ropivacaine) and group B (35 patients treated with bupivacaine). Evaluate and compare the criteria of anesthetic effects, intraoperative movement inhibition, and postoperative pain relief. Record the effects of some criteria on circulation, respiration, and unwanted effects related to the anesthetic method. ***Results:*** All patients in both groups achieved a good level of anesthesia. In lower limb surgery, the effective pain relief time following spinal anesthesia with ropivacaine was 145.09 ± 7.03 minutes, and the movement inhibition duration was 97.60 ± 7.10 minutes. The effects of ropivacaine on circulation and respiration were minimal, and its side effects, such as bradycardia (5.71%), hypotension (2.86%), and shivering (2.86%), were mild, temporary, and readily managed. ***Conclusion:*** Ropivacaine provided effective and safe spinal anesthesia for lower limb surgery, and short-term mobility, and provided pain relief postoperatively. It caused some modest, temporary side effects that were easily managed, but it had little influence on breathing and circulation.

Keywords: Spinal anesthesia; Ropivacaine; Bupivacaine; Lower limb surgery.

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[1]Military Hospital 121, Military Region 9

[2]Vietnam Military Medical University

[*]Corresponding author: Vo Van Hien (vanhien103@gmail.com)

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INTRODUCTION

Spinal anesthesia is often applied for abdominal and lower abdominal surgeries, urology, obstetrics and gynecology, and orthopedic surgeries. The advantage of the spinal anesthetic approach is that it has a high success rate, does not require difficult techniques or equipment, and ensures effective anesthesia and analgesia. Furthermore, spinal anesthesia reduces the duration and expense of postoperative care, allowing for early mobilization postoperatively.

Numerous local anesthetics, such as ropivacaine, levobupivacaine, and bupivacaine, are recommended for spinal anesthesia. Since 1996, ropivacaine, an amide anesthetic, has been utilized in medical clinics. Although it shares characteristics with bupivacaine, the drug causes less bradycardia and hypotension [1]. Due to its limited fat solubility, it also permits an earlier movement recovery period than bupivacaine [2].

There has not been much research in Vietnam to date on spinal anesthesia for low-limb surgery using just ropivacaine. Thus, the purpose of our study was: *To assess the effects of anesthesia, perioperative movement inhibition, and postoperative analgesia duration, as well as the effects of spinal anesthesia with ropivacaine on respiration, circulation, and side effects in patients undergoing lower limb surgery.*

MATERIALS AND METHODS

1. Subjects

70 patients indicated lower limb surgery under spinal anesthesia at the Department of Surgery - Anesthesia and Resuscitation, Military Hospital 121, Military Region 9 (Can Tho province) from November 2022 to June 2023.

* *Inclusion criteria:* Patients age ≥ 18; with American Society of Anesthesiologists (ASA) classification I-II; heights ranging from 160 - 170cm; consent to surgery and study; have no contraindications to spinal anesthesia using ropivacaine or bupivacaine.

* *Exclusion criteria:* Patients with known contraindications to spinal anesthesia; unable to communicate; resting heart rate < 60 bpm; known allergy to amide local anesthetic; pregnancy; history of substance abuse.

2. Methods

* *Research design:* A clinical interventional study, randomized group with comparative analysis. Patients were randomly drawn into one of the two groups of 35:

- Group R (n = 35): Received 10mg of intrathecal ropivacaine.

- Group B (n = 35): Received 10mg of intrathecal bupivacaine.

* *Research process:* Preoperative assessments of each patient's condition were conducted through an examination and testing. Additionally, the anesthetic technique used was explained to the patients.

On arrival in the operating room, an intravenous cannula of appropriate size was placed. 500mL of normal saline was administered. Standard monitors were placed, and baseline readings of heart rate, blood pressure (BP), and oxygen saturation were recorded. Supplemental oxygen was administered in every case.

Under complete aseptic precautions, spinal anesthesia was administered using a 27-gauge spinal needle in the L2-L3 interspace in the sitting position. Patients in group R received a 10-milligram dose of ropivacaine for spinal anesthesia, while patients in group B received a 10-milligram dosage of 0.5% hyperbaric bupivacaine for the same purpose.

* *Data collection:* Patients' general characteristics, such as age (years), height (cm), weight (kg), gender, surgical duration, and type of surgery. Pinprick sensation was assessed using a 20-gauge hypodermic needle. During the tracking of sensory level, the time taken for loss of pinprick sensation at T10 (onset of analgesia) and analgesia duration (from the time spinal anesthesia was given until the patient felt pain at the surgical sites) were recorded. The duration of postoperative pain relief is measured from the completion of surgery until the patient experiences discomfort at the surgical wound (VAS $\geq$ 4) and needs to take their first dose of painkiller. The quality of anesthesia was assessed by the Abouleizh Ezzat scale with three levels: Good, medium, and poor. Motor block was evaluated by the modified Bromage scale (0 = able to raise a leg, 1 = able to flex the knee, 2 = able to flex the ankle, and 3 = no movement). Patients were also observed and noted for side effects such as nausea, vomiting, shivering, bradycardia, hypotension, and respiratory depression.

Time points to collect data: Preoperative time (H_0), perioperative every 5 minutes for the first 30 minutes

corresponding to the values: H_5, H_{10}, H_{15}, H_{20}, H_{25}, H_{30}; then every 10 minutes for the remaining duration until the surgery is finished, according to the values: H_{40}, H_{50}, H_{60},... H_e.

* *Statistical calculation*: The Statistical Package for the Social Sciences 22.0 (SPSS 20.0) software was used for statistical calculation. Data were expressed as either mean ± standard deviation or numbers and percentages. A p-value less than 0.05 is believed to be statistically significant.

3. Ethics

This study received approval from the Medical Research Ethics Committee of Military Hospital 103, Vietnam Military Medical University, according to Decision No. 145/CNChT-HĐĐĐ, dated November 25, 2022. All patients' data was secure throughout the study to protect their anonymity. All patients gave their family members written and informed consent to enter the study. The authors declared no conflicts of interest.

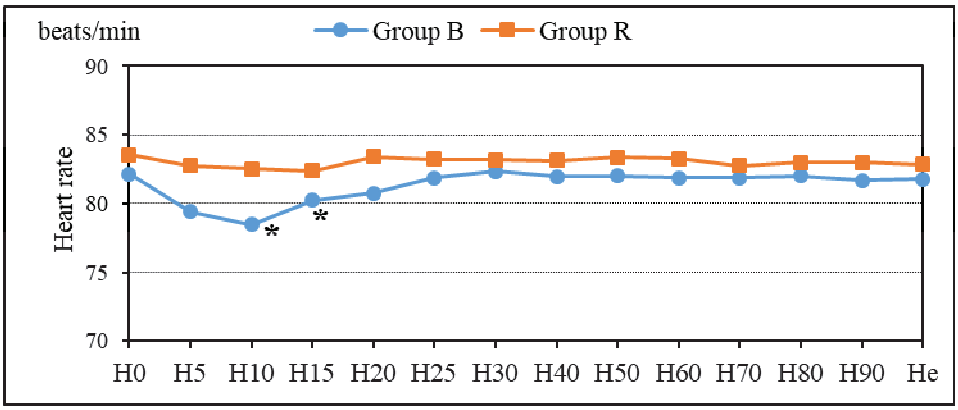
RESULTS

Table 1. Patients' general characteristics.

Criteria		Group R (n = 35)	Group B (n = 35)	p
Age (year)		39.11 ± 15.57	39.29 ± 13.34	> 0.05
Height (cm)		165.20 ± 3.11	165.54 ± 3.35	> 0.05
Weight (kg)		62.29 ± 8.72	63.91 ± 8.62	> 0.05
Gender (%)	Male	77.14	77.14	> 0.05
	Female	22.86	22.86	
Surgical location (%)	Thigh	25.71	11.43	> 0.05
	Knee	34.29	51.43	
	Lower legs and feet	40.0	37.14	
Duration of surgery (minutes)		54.86 ± 20.0	59.77 ± 19.03	> 0.05

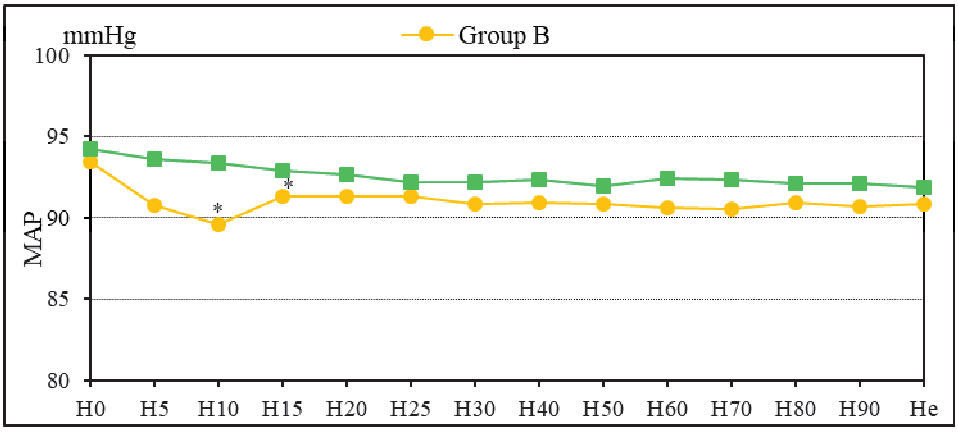
Table 2. Sensory and motor block.

Criteria		Group R (n = 35)	Group B (n = 35)	p
Onset time (minutes)		7.62 ± 0.72	4.90 ± 1.10	< 0.05
Duration time (minutes)		145.09 ± 7.03	178.03 ± 13.02	< 0.05
Duration of postoperative pain relief (minutes)		79.51 ± 22.02	107.89 ± 23.46	< 0.05
Sensory block level at the 10th minute after administering spinal anesthesia (n, %)	T_6	14 (40.0)	20 (57.1)	> 0.05
	T_8	21 (60.0)	15 (42.9)	
Proportion of patients who achieve motor block level at minute 20th after administering spinal anesthesia (n, %)	M_2	26 (74.3)	0	< 0.05
	M_3	9 (25.7)	35 (100)	
Proportion of patients who achieve the quality of good anesthesia (n, %)		35 (100)	35 (100)	> 0.05
Duration of motor block (minutes)		97.60 ± 7.10	158 ± 14.79	< 0.05



(: Statistically different compared with H_0 time-point, $p < 0.05$).*

Figure 1. Heart rate changes during surgery (beats/minute).



(: Statistically different compared with H_0 time-point, $p < 0.05$).*

Figure 2. Changes in mean arterial blood pressure during surgical procedures (mmHg).

After spinal anesthesia, the patients' mean respiratory rate and mean saturation of peripheral oxygen (SpO_2) in both groups were not statistically different ($p > 0.05$). No patient had respiratory depression (respiratory rate < 10 breaths/minute or $SpO_2 < 90\%$).

Table 3. Unwanted effects.

Unwanted effects	Group R (n = 35) n (%)	Group B (n = 35) n (%)	p
Bradycardia	2 (5.71)	8 (22.86)	< 0.05
Hypotension	1(2.86)	6 (17.14)	< 0.05
Shivering	1 (2.86)	3 (8.57)	> 0.05

In addition, we did not encounter any cases of other unwanted effects such as itching, headaches, back pain, nausea or vomiting.

DISCUSSION

The results of our study showed that the onset time for T10-level pain block in group R was 7.62 ± 0.72 minutes, enough pain inhibition to perform lower limb surgery. The onset time of the ropivacaine spinal group in our study was slower than the study by Dar FA et al. (4.90 ± 1.10 minutes [3]) and Boztug N et al. (3.60 ± 1.84 minutes [4]). After 20 minutes, group R patients at the T6 level and the T8

level had achieved pain inhibition in 40% and 60% of cases, respectively. According to Jagtap S et al., the T6 level was the maximum level of pain inhibition that could be attained [5]. The ropivacaine group's maximum level of pain inhibition, according to Kulkarni KR et al. (2014), was primarily T6 [6]. Pain inhibition levels ranged from T8 to T6 in both research groups. This block level ensures sufficient anesthesia for surgery while also having a low risk of affecting respiration and circulation.

The results of our study showed that 100% of patients achieved a good level of anesthesia; no patient had to use additional painkillers or needed to change anesthesia methods. Our research results are consistent with those of Nguyen Anh Tuan (2015) [7] and Jagtap S et al. (2014) [5]. Group R's anesthetic duration time lasted 145.09 ± 7.03 minutes, which was sufficient for lower limb surgery because the average surgical time falls between 60 and 70 minutes. Dar FA et al. (2015) stated that the effective analgesia duration for the patients treated with ropivacaine was 160 ± 12.9 minutes [3], while Nguyen Anh Tuan's (2015) effective pain relief duration for group R is 145.14 ± 5.96 minutes [7]. Boztug N et al. (2005) found that the effective analgesia duration of ropivacaine 10mg was 110.70 ± 31.22 minutes [4]. Huynh Huu Hieu and Phan Ton Anh Vu (2017) showed that the sensory inhibition duration of ropivacaine at the dose of 10mg combined with 25mcg fentanyl was 166.8 ± 12.1 minutes [8].

After 20 minutes of spinal anesthesia, group B had 35 patients (100%) with motor inhibition at the M3 level ($p < 0.05$), while group R had 9 patients (25.7%) with motor inhibition at the M3 level and 26 patients (74.3%) with motor inhibition at the M2 level. According to Gautier PhE et al. (1999), patients in the group treated with spinal anesthesia with 10mg ropivacaine had a motor block level at the M1 level of 3%, a motor block level at the M2 level of 20%, and a motor block level at the M1 level of 20%; M3 level was 77% [9]. Nguyen Anh Tuan (2015), when comparing the effects of spinal anesthesia with a mixture of ropivacaine-fentanyl (group RF) and bupivacaine-fentanyl (group BF) for lower limb surgery, realized that Group BF had 65.78% motor inhibition at the M3 level, and Group RF had 13.15% motor inhibition at the M3 level ($p < 0.05$) [7]. Huynh Huu Hieu and Phan Ton Anh Vu (2017) evaluated the effectiveness of ropivacaine in spinal anesthesia in patients undergoing arthroscopic knee surgery with motor

inhibition levels M1, M2, and M3 of 1.5%, 18.5%, and 80%, respectively [8].

Based on the research findings, it is evident that even with a lower level of motor inhibition than that of 10mg bupivacaine 0.5%, the dosage of 10mg ropivacaine 0.5% still provides adequate muscle softening for lower limb surgery. Group R's motor inhibition period (97.60 ± 7.10 minutes) was significantly shorter than group B's (158 ± 14.79 minutes) ($p < 0.05$). As per the findings of Dar FA et al. (2015), the bupivacaine group exhibited a longer motor inhibition period of 174 minutes compared to the ropivacaine group's motor inhibition period of 126 minutes [3]. According to research by Luck JF et al. (2008), the motor recovery time for the ropivacaine group was 90 minutes, while it was 180 minutes for the bupivacaine group ($p < 0.0001$) [10]. The motor inhibition time of Huynh Huu Hieu and Phan Ton Anh Vu's research (2017) was 88.7 ± 13 minutes [8]. We found that ropivacaine has a shorter motor inhibition period than bupivacaine, which will help patients feel better more quickly and leave the recovery room sooner. It will also lessen the chance of thrombosis following surgical embolization, particularly in patients who are at high risk of thrombosis, and increase patient satisfaction.

Because of the strongest paravertebral sympathetic nerve blockade, heart rate and arterial blood pressure in our study frequently dropped after spinal anesthesia and decreased most from the fifth to the tenth minute (*Figure 1, 2*). In order to identify and treat hypotension early on, it is therefore essential to supplement fluids and keep a closer eye on the patient during this time. The study also discovered that ropivacaine-induced spinal anesthesia had minimal effects on breathing. There were no instances of respiratory failure (respiratory rate < 10 cycles per minute, or SpO_2 < 95%) in either group before or after surgery.

The study resulted in bradycardia, hypotension, and shivering as unfavorable effects (*Table 3*). There were bradycardia patients (beats per minute < 60) in both groups; group R had 2 patients (5.71%) and group B had 8 patients (22.86%) who required medication treatment. Nguyen Anh Tuan (2015) reported that 2 patients (5.88%) had bradycardia in group B, and there was 1 patient in group R (2.94%) [7]. According to research by Dar FA et al. (2015), 5% of patients with bradycardia had bupivacaine, while 9% had ropivacaine [3]. In our study, there were 1 patient (2.86%) in group R and 6 patients (17.14%) in group B who had hypotension. Nevertheless, following

ephedrine treatment and rehydration, the arterial blood pressure in each of these cases recovered to normal levels; no cases of severe hypotension necessitating intensive resuscitation were observed.

Group R had 2.86% of patients who shivered, whereas group B had 3 patients (8.57%) with shivering ($p > 0.05$). According to research by Jagtap S et al. (2014), there was one patient (3.3%) who experienced shivering in the RF group and none in the BF group [5]. Shivering rates were observed to be 16% in the bupivacaine group and 10% in the ropivacaine group by Dar FA et al. (2015) [3]. Chatterjee S et al. (2014) found that the rate of patients with tremors in the ropivacaine group was 22% [11]. Shivering is an unwanted effect after spinal anesthesia, and its mechanism is currently unknown. In our study, tremors only manifested during surgery. The shivering symptoms rapidly subsided and went away after we treated them with warmed fluid infusions and a gradual intravenous injection of 30 - 50mg of diluted dolargan.

We did not experience any other unfavorable side effects during the study, including headaches, nausea, vomiting, back pain, itching, or headaches 24 hours postoperatively.

CONCLUSION

Using 10mg of 0.5% isobaric ropivacaine for spinal anesthesia at the L2-L3 position is a good way to guarantee anesthesia for lower limb surgery. This anesthetic method also inhibits movement in the short term, improves analgesic effects postoperatively, has minimal effects on respiratory and circulation, and has a few mild, temporary side effects that are easily treated.

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