

Efficacy and Safety of Bupivacaine Liposome Intercostal Nerve Block for Postoperative Analgesia After Single-port Thoracoscopic Surgery

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Abstract

Objective: To explore the efficacy and safety of bupivacaine liposome (LB) intercostal nerve block (INB) for postoperative analgesia in adult thoracoscopic surgery.

Methods: A total of 110 patients who were admitted to our hospital from January 2025 to May 2025 and were scheduled to undergo single-port thoracoscopic surgery were selected as the research subjects. According to the random number table method, they were divided into the observation group (266mg LB 20mL + sodium chloride injection 10mL, INB) and the control group (0.5% bupivacaine 30 mL, INB), with 55 cases in each group. All patients were treated with single-port thoracoscopic surgery under general anesthesia. The Visual Analogue Scale (VAS) was used to observe the differences in postoperative analgesic effects between the two groups, and to compare the additional analgesia conditions, adverse reactions, and satisfaction of the two groups. **Results:** Compared with the control group, the VAS scores of the active state in the observation group were significantly lower at 12, 24, and 48 hours after the operation, and the VAS scores of the resting state at 4, 12, 24, and 48 hours after the operation were significantly lower. Compared with the control group, the rate of additional analgesia within 24 hours after surgery and the number of compressions of patient-controlled intravenous analgesia (PCIA) in the observation group were significantly lower, the incidence of nausea and vomiting and the total incidence were significantly lower, and the satisfaction rate of analgesia in patients was significantly higher. **Conclusion:** LB combined with INB in adult thoracoscopic surgery can exert a relatively long-lasting postoperative analgesic effect, reduce the rate of additional analgesia and the number of PCIA compressions, have fewer adverse reactions, and the overall satisfaction of patients is high.

Keywords

Bupivacaine; liposomes; Intercostal nerve block; Single-port thoracoscopic surgery; Analgesia Safety

1. Introduction

Single-port thoracoscopic surgery is a minimally invasive surgery that is widely used in clinical practice at present. It has the advantages of small incision, less intraoperative blood loss, and quick postoperative recovery [1]. However, postoperative incision pain is still an important influencing factor affecting the recovery quality of patients [2]. Effective perioperative analgesia can help alleviate postoperative pain, reduce surgical complications, and promote the faster recovery of patients [3]. The intercostal nerve is the nerve responsible for transmitting pain signals. Previous studies [4] have shown that during single-port thoracoscopic surgery, the intercostal nerve may be pulled or compressed, and postoperative factors such as breathing, coughing, and drainage tubes may stimulate, thereby leading to the occurrence of postoperative pain. Intercostal nerve block (INB) is a classic analgesic method. By injecting local

anesthetic drugs around the intercostal nerve, it blocks the conduction of the nerve, thereby reducing the pain in the corresponding area. It is often used to meet the postoperative analgesic needs of cardiothoracic surgery [5]. Bupivacaine liposome (LB) is an extended-release agent of bupivacaine, which can effectively prolong the analgesic time and reduce the usage of opioids [6]. It was approved for marketing by the National Medical Products Administration of China in 2022 [7]. At present, there is still a lack of literature reports in China on the use of LB combined with INB for postoperative analgesia after single-port thoracoscopy. This study aims to observe the effect and safety of LB combined with INB on postoperative analgesia after single-port thoracoscopic surgery, and to provide new ideas for postoperative analgesia.

2. Data and Methods

Research subject: This study is a prospective randomized controlled study. Patients who were admitted to our hospital from January 2025 to May 2025 and were scheduled to undergo single-port thoracoscopic surgery were selected as the research subjects. The inclusion criteria were: (1) Age >18 years old; (2) American Society of Anesthesiologists (ASA) Grade I or II; (3) Elective single-port thoracoscopic surgery under general anesthesia; (4) Agree to participate in this research. Exclusion criteria: (1) Allergy to local anesthetics used in the research institute; (2) Combined with hemorrhagic diseases; (3) There is a history of chronic pain or intercostal pain before the operation; (4) Those with a combined history of opioid abuse and cognitive impairment; (5) The number of closed thoracic drainage tubes placed is more than two.

INB is all performed by senior physicians with rich experience in block therapy. Both groups were performed before the thoracic cavity was closed at the end of thoracoscopic surgery. Under the direct vision of the thoracoscope, intercostal nerve block was performed between the 4th and 6th costal Spaces on the surgical side of the patients. The pre-prepared nerve block drug solution was injected. The operator touched the intercostal space with the patient's hand. One hand was separated from the skin, and the other hand was held in a pen-holding position to hold the injection needle, which was inserted into the intercostal muscles about 1 to 2 cm. The drug was injected without blood return. Nerve block solution in the control group: 30mL of 0.5% bupivacaine. Observation group nerve block drug solution: 20 mL of 266 mg LB + 10 mL of sodium chloride injection, totaling 30 mL. Postoperative additional analgesic measures: If the patient's visual Analogue Scale (VAS) score is greater than 5 points in the active state and greater than 3 points in the resting state after the operation, or if the patient actively requests additional analgesic drugs, 5 mg of dezocine should be injected intramuscularly.

Clinical data: Collect and compare the general data and surgical data of the two groups, including age, gender, ASA grade, operation time, etc. **Primary endpoint of observation:** Compare the analgesic effects of the two groups. The VAS was used to evaluate the degree of pain in the active (or coughing) state and the resting state of the patients at 4, 12, 24, and 48 hours after the operation, ranging from 0 to 10 points. The higher the score, the more severe the pain [8]. **Additional analgesia:** The additional analgesia rate and the number of PCIA compressions within 24 hours after surgery were compared between the two groups. **Safety:** The incidences of adverse analgesic reactions such as respiratory depression, nausea, and vomiting, as well as the satisfaction rate of analgesia, were compared between the two groups.

This study conducted a statistical analysis using SPSS 27.0 software. Measurement data were described by mean \pm standard deviation as the central tendency and dispersion degree of the data. Comparisons were conducted using t-tests or repeated measures analysis of variance. Count data use cases (%) describe the distribution, and the chi-square test is used for comparison. When $P < 0.05$, it is considered that there are significant differences in the results.

3. Results

There were no significant differences in general data and surgical data between the two groups ($P > 0.05$), as shown in Table 1.

Table 1. Basic data of two groups of patients

Clinical data	Control group	Observation group	t/χ^2 value	P	
Age	51.4 \pm 7.49	52.34 \pm 8.01	0.187	> 0.05	
Gender	Male	29	30	0.311	> 0.05
	Female	26	25		

Table 1. Continued

Clinical data	Control group	Observation group	t/ χ^2 value	P
BMI	21.44±1.84	22.39±1.94	0.432	> 0.05
Operation time /min	56.25±21.61	57.25±23.61	0.682	> 0.05
Intraoperative blood loss /mL	48.64±13.78	50.14±14.88	0.325	> 0.05
Propofol /mg	443.61±61.75	427.88±60.74	0.542	> 0.05
Sufentanil / μ g	32.54±8.32	31.23±8.24	0.428	> 0.05

There were significant differences in the VAS scores of the active state and the resting state between the two groups at different time points and between groups ($P<0.05$), while there was no significant difference in the interaction effect between time points and groups ($P>0.05$). Compared with the control group, the VAS scores of the active state in the observation group at 12 h, 24 h and 48 h after surgery were significantly lower ($P<0.05$), and the VAS scores of the resting state at 4 h, 12 h, 24 h and 48 h after surgery were significantly lower ($P<0.05$), as shown in Table 2.

Table 2. Comparison of VAS scores of the two groups of active states

Group	4 hours after the operation	12 hours after the operation	24 hours after the operation	48 hours after the operation
Activity status	2.69±0.89	3.10±0.36 b	3.28±0.46 b	2.66±0.37 ac
Observation group				
Control group	2.31±1.43h	2.36±0.98 bd	2.11±0.78 bd	1.79±0.64 bcd
Quiescent condition				
Observation group	1.21±0.18	1.25±0.24 b	1.00±0.11b	0.88±0.13 bc
Control group	0.75±0.21h	0.66±0.18 bd	0.53±0.13 bd	0.42±0.17 bcd

Notes: Compared with 4 hours after the operation, a: $P>0.05$ and b: $P<0.05$; Compared with 12 hours after the operation, c: $P<0.05$; Compared with the control group, d: $P<0.05$.

In the control group and the observation group, 2 cases (3%) and 12 cases (20%) of patients received additional analgesia within 24 hours after the operation, respectively. The number of PCIA compressions was (1.02±0.26) times and (3.19±0.74) times, respectively ($P<0.05$), and there were significant differences between the groups ($P<0.01$). In the observation group, there were 6 cases of nausea and vomiting, 2 cases of urinary retention, and a total of 8 cases of adverse reactions. In the control group, there were 15 cases of nausea and vomiting, 3 cases of urinary retention, and a total of 18 cases of adverse reactions. The incidence of nausea and vomiting and the total incidence in the observation group were significantly lower than those in the control group ($P<0.05$). In the observation group, 45 cases were satisfied with analgesia, 10 cases were basically satisfied, 0 cases were dissatisfied, and the total satisfaction rate was 100.0%. In the control group, 33 cases were satisfied with analgesia, 17 cases were basically satisfied, and 5 cases were dissatisfied. The total satisfaction rate was 93.33%. Compared with the control group, the total satisfaction rate of the observation group was significantly higher ($P<0.05$).

4. Discussion

In recent years, with the in-depth application of the ERAS concept in clinical practice, clinicians have been paying increasing attention to the postoperative analgesic effect and comfort of patients undergoing thoracoscopic surgery. Due to factors such as intraoperative traction and postoperative thoracic catheter drainage in single-port thoracoscopic surgery, intercostal nerve damage may occur, aggravating the postoperative pain of patients. Moreover, postoperative actions involving the chest, such as coughing and deep breathing of patients will further aggravate their pain [9]. In the past, PCIA was mostly used for postoperative analgesia in clinical practice, but it was prone to increase the dosage of opioid drugs. With the proposal of multimodal analgesia regimens, more and more studies [10, 11] have pointed out that INB can effectively alleviate postoperative pain and improve the comfort of patients by blocking the pain signals transmitted by intercostal nerves. In the results of this study, the average VAS scores of all patients at rest and

during activity after the operation were all below 4 points, suggesting that INB has a good analgesic effect. Since the duration of bupivacaine regional block is 8 to 10 hours, its pharmacokinetic time is significantly shorter than that of LB and cannot meet the needs of postoperative pain control [12]. LB is a long-acting preparation of bupivacaine. Compared with bupivacaine, its analgesic time is longer, up to 72 hours [13], which can meet the postoperative analgesic needs of patients undergoing thoracoscopic surgery. When LB enters the body, bupivacaine is gradually released as liposomes rupture. Because the rupture time of different liposomes may vary, Therefore, the action time of bupivacaine in the body can be prolonged to achieve a long-acting and sustained-release effect [14]. The results of this study show that the NRS scores of the activity status at 12 hours after surgery in both groups showed a significant upward trend compared with those at 4 hours after surgery, and the NRS scores of the activity status at 48 hours after surgery compared with those at 12 hours after surgery showed a significant downward trend. Moreover, compared with the control group, the NRS scores of the activity status and resting status at 12 hours, 24 hours, and 48 hours after surgery in the observation group were significantly lower. Similar to the results reported by LEASIA et al. [15], it suggests that LB combined with INB can provide long-term and good analgesic effects for patients undergoing thoracoscopic surgery after the operation. Furthermore, the results of this study show that compared with the control group, the rate of additional analgesia within 24 hours after surgery and the number of PCIA compressions in the observation group were significantly lower. This further confirms from the side that the postoperative analgesic effect of LB is good and the analgesic time is longer. In this study, the maximum recommended dose for adult local infiltration analgesia, as recommended in the LB drug instructions, was 20 mL: 266 mg, but the doses of LB and bupivacaine were different. To further reduce the bias of the research results, LB was diluted with sodium chloride injection and then injected, which could better diffuse in INB and also reduce the influence of the drug dose on the research results. By comparing the results of adverse reactions and analgesic satisfaction between the two groups, the total incidence of nausea, vomiting, and adverse reactions in the observation group was lower than that in the control group, and the total satisfaction rate was higher. It is speculated that the reason might be that the analgesic duration of LB was longer than that of bupivacaine, and the number of PCIA compressions was reduced, thereby reducing the dosage of opioid drugs after surgery. Studies have pointed out [16] that opioid drugs contained in PCIA can increase the incidence of postoperative nausea and vomiting.

In conclusion, the combination of LB and INB in single-port thoracoscopic surgery can exert a relatively long-lasting postoperative analgesic effect, reducing the rate of additional analgesia and the number of PCIA compressions. The adverse reactions are relatively small, the overall satisfaction of patients is high, and it has certain clinical application value. This study still has certain deficiencies. It is a single-center study, the pain assessment indicators are relatively single, and there is no specific classification discussion on the types of single-port thoracoscopic surgery, etc. Subsequently, the sample size will be further expanded to deeply explore the application value of LB combined with INB.

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