

## Original Article

# B-ultrasound-guided thoracic paravertebral block for postoperative analgesia in patients undergoing thoracic surgery

Fang Lu, Yanqing Zhang, Xinyu Chen, Mei Liao, Lin Yin

*Department of Anesthesiology, Yichun People's Hospital, Yichun 336000, Jiangxi, China*

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**Abstract:** Objective: To investigate the effects of B-ultrasound-guided thoracic paravertebral block for postoperative analgesia in patients undergoing thoracic surgery. Methods: 120 patients undergoing thoracic surgery in our hospital from June 2017-December 2019 were retrospectively analyzed and divided into two groups based on the anesthesia they received. The patients in group A (n=58) were given epidural blocks and the patients in group B (n=62) were given B-ultrasound-guided thoracic paravertebral blocks, and we measured the perioperative arterial pressure (MAP), heart rates (HR), cortisol (Cor), serum norepinephrine (NE), visual analog scale for pain (VAS), and adverse reactions in the two groups of patients. Results: The HR at T1, T2, and T3 in group B was higher than it was in group A ( $P < 0.05$ ). The MAP was lower at T1, T2, and T3 in group B than it was in group A ( $P < 0.05$ ). The serum Cor levels at T1, T2, and T3 were lower in group B than they were in group A ( $P < 0.05$ ). The serum NE levels at T1, T2, and T3 were lower in group B than they were in group A ( $P < 0.05$ ). At rest and when coughing, the patients' VAS scores in group B were lower than they were in group A at 6, 12, 24, and 48 hours after the surgery ( $P < 0.05$ ). The incidence of respiratory depression was 3.23%, and the incidence of nausea and vomiting was 3.23% in group B, which was lower than the incidences in group A ( $P < 0.05$ ). Conclusion: B-ultrasound-guided thoracic paravertebral block showed preferable analgesic effects on postoperative analgesia in patients undergoing thoracic surgery by being conducive to stable hemodynamics, having a reduced perioperative stress response, and causing fewer adverse reactions.

**Keywords:** B-ultrasound, thoracic paravertebral block, epidural block, thoracic, surgery, analgesia

## Introduction

As is common in surgical procedures, thoracotomy is invasive and easily causes pain [1], and coupled with the perioperative stress response, hemodynamic fluctuations as well as the use of opioid drugs leads to nausea, vomiting and other complications [2, 3].

Studies have shown that the incidence of chronic pain after thoracotomy is about 50%, which significantly affects the patients' physical and mental health [4, 5]. The commonly-used epidural analgesia in clinical practice has relative and absolute contraindications, let alone a higher risk of intraspinal complications, so it is necessary to use an effective and safe method of anesthesia during the perioperative

period [6, 7]. Thoracic paravertebral block refers to the injection of local anesthetic drugs in the thoracic paravertebral space to block the sympathetic nerves adjacent to the applied site and ultimately to exert analgesic effects [8]. At present, thoracic paravertebral block has been widely used at home and abroad. Scholars believe that thoracic paravertebral block is not quite different from epidural block and that it supports stable hemodynamics, a reduced stress response and complications as well, but some disagree with this [9, 10].

In view of this, in this study, epidural block and B-ultrasound-guided thoracic paravertebral block were respectively performed during thoracotomy to compare the analgesic effects of the two analgesia methods, so as to provide

evidence for an effective and safe anesthetic method in patients undergoing thoracic surgery.

### Materials and methods

#### Materials

120 patients undergoing thoracic surgery in our hospital from June 2017-December 2019 were retrospectively analyzed and divided into two groups based on the anesthesia each received. The patients in group A (n=58) were given epidural blocks, and those in group B (n=62) were given B-ultrasound-guided thoracic paravertebral blocks. (1) Inclusion criteria: patients who were classified as ASA I-II and patients who showed indications for thoracotomy and who could tolerate surgery and anesthesia could be enrolled. This study was approved by the Ethics Committee of Yichun People's Hospital. All the patients signed an informed consent. (2) Exclusion criteria: patients who suffered from morbid obesity, patients who had skin infections at the puncture site, patients who had abnormal preoperative coagulation, patients who had diseases related to the central nervous system or severe cardiovascular disease or severe hypertension, and patients who withdrew halfway were excluded.

#### Methods

15 min before the anesthesia, the two groups of patients were intramuscularly injected with 0.02 mg/kg penethylidine hydrochloride (Chengdu Riset Pharmaceutical Co., Ltd., SFDA: H20051948, Specification: 1 ml:1 mg) followed by a rapid opening of the venous channel after admission to closely monitor the electrocardiogram, blood pressure, heart rate, and saturation.

In group A, an epidural block was performed for the patients, who were in a lateral position. The intervertebral space was confirmed. The puncture site was routinely disinfected. First, a pichu was made 1 cm beside the thoracic spinous process at the puncture site, and then the thoracic epidural puncture was carried out. Reaching the epidural space, the catheter was placed cephalad at a depth of 3 cm and properly fixed. Each patient was injected with 5 ml of 1% lidocaine (Shanghai Xudong Haipu Pharmaceutical Co., Ltd., SFDA: H31022163, Spe-

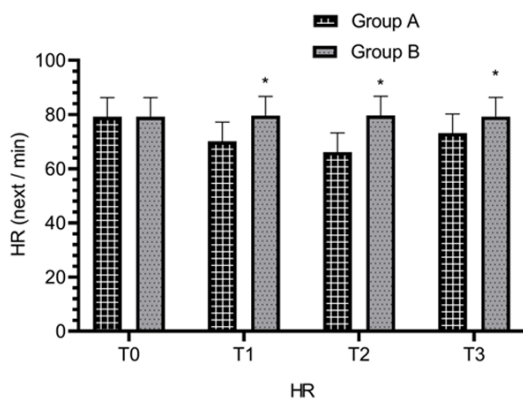
cification: 2 ml:4 mg). 5 minutes later, they were each injected with 5 ml of 0.375% ropivacaine (Guangdong Jiabo Pharmaceutical Co., Ltd., SFDA: H20173194, Specification: 20 ml:200 mg). Just before the sternal closure, each was given a load of 5 ml of 0.375% ropivacaine again to control the level of anesthesia below T4.

In group B, a B-ultrasound-guided thoracic paravertebral block was applied to the patients in lateral position. The surgical side was on the upper side, with the back arched and the head bowed. 2.5 cm beside the surgical side, the T4-7 spinous process was the location for the puncture guided by B-ultrasound. As the epidural puncture using the sagittal plane slightly in the cranial direction reached the transverse process, the needle was withdrawn to the upper skin to adjust the direction. Once the tip was crossed from the transverse process, the insertion continued to a depth of 1 cm. The disappearance of the resistance indicated to the insertion had entered the paravertebral space. If at pumpback no gas, fluid, or blood was found, 3-5 ml sufentanil (Yichang Humanwell Pharmaceutical Co., Ltd., SFDA: H42022076, specification: 2 ml:0.1 mg) mixed with 0.375% ropivacaine hydrochloride was injected.

In groups A and B, the general anesthesia induction was 30 minutes after the anesthesia. The patients were intravenously injected with 2-4 mg midazolam (Jiangsu Nhwa Pharmaceutical Co., Ltd., SFDA: H10980025, specification: 2 ml:10 mg\*5), 0.3-0.4 µg/kg sufentanil, 0.3 mg/kg etomidate (Jiangsu Nhwa Pharmaceutical Co., Ltd., SFDA: H32022992, specification: 10 mL:20 mg), 0.15-0.20 mg/kg cisatracurium (Jiangsu Hengrui Medicine Co., Ltd., SFDA: H20174008, specification: 20 mg), followed by endotracheal intubation. The maintenance of the anesthesia was achieved using 0.10-0.25 µg/(kg.h) remifentanil (Langfang Branch of China National Pharmaceutical Industry Co., Ltd., SFDA: H20123421, specification: 2 mg 5 vials), 1-3 mg/(kg.h) (Xi'an Libang Pharmaceutical Co., Ltd., SFDA: H2001-0368, dosage form: 10 ml:100 mg), together with an intermittent bolus of vecuronium bromide (North China Pharmaceutical Co., Ltd., SFDA: H20103495, specification: 50 mg/5 ml), so as to effectively maintain muscle relaxation. During the operation, intermittent posi-

**Table 1.** The general data of the patients in both groups [n (%)]/( $\bar{x} \pm s$ )

| Items                |                   | Group A<br>(n=58) | Group B<br>(n=62) | $t/X^2$ | $P$   |
|----------------------|-------------------|-------------------|-------------------|---------|-------|
| Sex (cases)          | M                 | 32 (55.17)        | 36 (58.06)        | 0.051   | 0.821 |
|                      | F                 | 26 (44.83)        | 26 (41.94)        |         |       |
| Age (yrs)            |                   | 59.68±3.28        | 59.72±3.15        | 0.048   | 0.962 |
| Body mass (kg)       |                   | 58.63±2.18        | 58.92±2.12        | 0.522   | 0.603 |
| Disease type (cases) |                   |                   |                   |         |       |
|                      | Mediastinal tumor | 10 (17.24)        | 14 (22.58)        | 0.125   | 0.968 |
|                      | Esophagus cancer  | 30 (51.72)        | 32 (51.61)        |         |       |
|                      | Lung cancer       | 18 (31.03)        | 16 (25.81)        |         |       |
| ASA grade            |                   |                   |                   |         |       |
|                      | I                 | 32 (55.17)        | 36 (58.06)        | 0.051   | 0.821 |
|                      | II                | 26 (44.83)        | 26 (41.94)        |         |       |

**Figure 1.** Comparison of the HR in both groups. The HR at T0 in group A was not notably different from the HR in group B,  $P > 0.05$ . The HR at T1, T2, and T3 in group B was higher than the HR in group A,  $P < 0.05$ . \* indicates  $P < 0.05$  compared with group A.

tive pressure ventilation was applied. The recovery of spontaneous respiration indicated the time for extubation after the operation.

#### Outcome measures

(1) Hemodynamics: The MAP and HR changes were recorded at T0 (before the anesthesia), T1 (5 min after intubation), T2 (30 min after the surgery began), and T3 (at the end of the surgery), respectively. (2) Stress response: 3 ml of fasting venous blood was collected in the morning at T0, and at T1, T2, and T3, respectively and centrifuged at 3000 r/min for 10 min. The supernate was for the enzyme-linked immunosorbent assay for the serum Cor and NE levels. (3) Analgesia [11]: The VAS (visual analog scale

for pain) scores at rest and when coughing at 6, 12, 24, and 48 hours after surgery were recorded. The total scores ranged from 0-10. 0 indicated anodynia and 10 indicated severe pain. (4) The incidence of adverse reactions was also recorded.

#### Statistics

SPSS 22.0 was used for the data analysis. The measurement data were expressed as the mean  $\pm$  standard deviation. The data following a normal distribution were subject to t tests; otherwise, Mann-Whitney U tests were performed. The enumeration

data were expressed as [n (%)]. The comparisons among groups were subject to  $\chi^2$  tests.  $P < 0.05$  indicated statistical significance.

#### Results

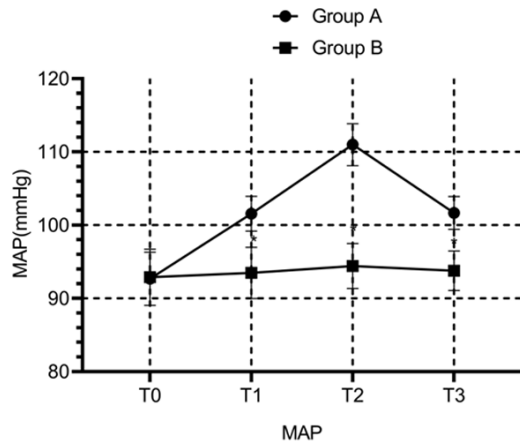
##### Comparison of the general data in both groups

There was no significant differences between group A and group B in terms of gender, age, or body mass ( $P > 0.05$ ), disease types (including mediastinal tumor, esophageal cancer, lung cancer, and others) ( $P > 0.05$ ) or the constituent ratio of ASA grade (I and II) ( $P > 0.05$ ) (Table 1).

##### Comparison of the hemodynamic indicators in both groups

Compared with the value at T0, the HR at T1, T2, and T3 decreased in group A with significant differences ( $P < 0.05$ ), but the HR at T1, T2 and T3 in group B showed no significant differences ( $P > 0.05$ ). For the HR at T0, little difference was found between the two groups ( $P > 0.05$ ), but the HR of group B at T1, T2, and T3 were higher than those of group A, showing a significant difference ( $P < 0.05$ ) (Figure 1).

Compared with the MAP at T0, the MAP at T1, T2, and T3 was increased in group A, with significant differences ( $P < 0.05$ ). The same was not true in group B ( $P > 0.05$ ). For the MAP at T0, little difference was found between the two groups ( $P > 0.05$ ) unlike the values recorded at T1, T2, and T3 ( $P < 0.05$ ) (Figure 2).



**Figure 2.** Comparison of the MAP in both groups. The MAP at T0 in group A was not significantly different from the MAP in group B,  $P > 0.05$ . The MAP at T1, T2, and T3 in group B was lower than the MAP in group A,  $P < 0.05$ . \* indicates  $P < 0.05$  compared with group A.

#### *Comparison of the perioperative stress responses in both groups*

The Serum COR at T1, T2, and T3 in group A increased compared with T0, with significant differences ( $P < 0.05$ ). Compared with the value at T0, the serum COR at T1, T2, and T3 in group B increased with a significant difference ( $P < 0.05$ ). In group A and group B, the serum COR values at T0 were not significantly different from each other ( $P > 0.05$ ). The serum CORs at T1, T2, and T3 in both groups were increased continuously with significant differences ( $P < 0.05$ ), of which the values in group B were lower than the values in group A ( $P < 0.05$ ) (Table 2).

The serum NE at T1, T2, and T3 in group A increased compared with T0, with significant differences ( $P < 0.05$ ). The same was true in group B ( $P > 0.05$ ). Between group A and group B, the serum NE levels at T0 were not significantly different from each other ( $P > 0.05$ ). The serum NEs at T1, T2, and T3 in both groups were increased continuously with significant differences ( $P < 0.05$ ), of which those in group B were lower than those in group A ( $P < 0.05$ ) (Table 3).

#### *Comparison of the analgesic effects in both groups*

At rest, the VAS scores at 6 h, 12 h, 24 h, and 48 h after the operation in group B were lower

than the scores in group A, with significant differences ( $P < 0.05$ ) (Figure 3). When coughing, the VAS scores at 6 h, 12 h, 24 h, and 48 h after the operations in Group B were lower than the scores in Group A, with significant differences ( $P < 0.05$ ) (Figure 4).

#### *Comparison of the adverse reactions in both groups*

The incidences of vertigo, drowsiness ( $P > 0.05$ ), respiratory depression ( $P < 0.05$ ), and nausea and vomiting ( $P < 0.05$ ) were 10.34%, 6.70%, 20.69%, and 20.69% in group A and 6.45%, 3.23%, 3.23%, and 3.23% in group B, respectively (Table 4).

#### **Discussion**

Postoperative pain in patients undergoing thoracic surgery generally requires perfect analgesic measures [12]. Epidural blocks are now usually used in clinical practice for pain relief. However, it is difficult to perform a puncture in the thoracic spinal canal because it often causes intraoperative and postoperative hypotension [13, 14]. In recent years, with the improvement of ultrasound technology, nerve stimulators and levels, local nerve-blocking technology has also been widely used in thoracic surgery, and it not only offers an ideal analgesic effect but reduced adverse reactions, especially for thoracic paravertebral blocks with a high application rate [15, 16].

In the classic thoracic paravertebral block, blind exploration positions the paravertebral space by the presence of resistance, resulting in lower accuracy and easily damaged pleura, nerves, and blood vessels [17, 18]. Ultrasound in thoracic paravertebral block is remarkably improves the success of thoracic paravertebral blocks [19]. Ultrasound images clearly showing the thoracic transverse process, parietal pleura, and thoracic paravertebral space facilitate the accurate localization of the thoracic paravertebral space and display the entire insertion process directly, preventing a wrong insertion, pleural damage, and pneumothorax [20, 21]. At the same time, pressing the pleura during the injection helps estimate the puncture location, avoiding any injuries to blood vessels [22]. In this study, the HR at T1, T2, and T3 in group B were higher, while the MAP was lower, than the corresponding values in group A ( $P < 0.05$ ), sug-

**Table 2.** The perioperative serum Cor in both groups ( $\bar{x} \pm s$ , ng/ml)

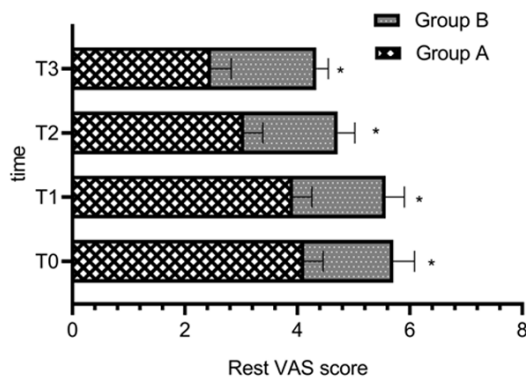
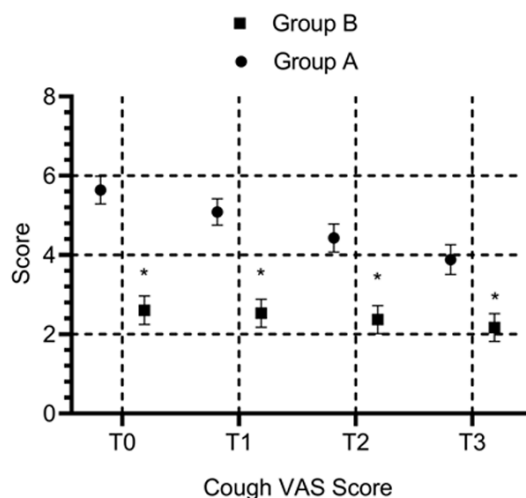
| Groups         | T0          | T1                         | T2                         | T3                         |
|----------------|-------------|----------------------------|----------------------------|----------------------------|
| Group A (n=58) | 132.56±8.52 | 172.12±8.75 <sup>#</sup>   | 196.68±9.16 <sup>#</sup>   | 219.98±9.68 <sup>#</sup>   |
| Group B (n=62) | 132.58±8.49 | 152.16±8.66 <sup>#,*</sup> | 178.96±8.96 <sup>#,*</sup> | 188.15±9.06 <sup>#,*</sup> |
| t              | 0.009       | 8.874                      | 7.567                      | 13.127                     |
| P              | 0.993       | 0.000                      | 0.000                      | 0.000                      |

Note: <sup>#</sup>indicates  $P < 0.05$  compared with T0. \*indicates  $P < 0.05$  compared with group A.

**Table 3.** The perioperative serum NE in both groups ( $\bar{x} \pm s$ , ng/ml)

| Groups         | T0           | T1                          | T2                          | T3                          |
|----------------|--------------|-----------------------------|-----------------------------|-----------------------------|
| Group A (n=58) | 252.12±12.56 | 378.96±13.28 <sup>#</sup>   | 395.63±13.98 <sup>#</sup>   | 422.58±13.99 <sup>#</sup>   |
| Group B (n=62) | 252.19±12.52 | 312.52±12.28 <sup>#,*</sup> | 346.52±12.08 <sup>#,*</sup> | 368.96±12.28 <sup>#,*</sup> |
| t              | 0.022        | 20.135                      | 14.587                      | 15.804                      |
| P              | 0.983        | 0.000                       | 0.000                       | 0.000                       |

Note: <sup>#</sup>indicates  $P < 0.05$  compared with T0. \*indicates  $P < 0.05$  compared with group A.

**Figure 3.** Comparison of the VAS scores at rest after the surgery in both groups. At rest, the VAS scores at 6 h, 12 h, 24 h, and 48 h after surgery in group B were smaller than those in group A,  $P < 0.05$ . \* indicates  $P < 0.05$  compared with group A.**Figure 4.** Comparison of the VAS scores when coughing after the surgery in both groups. The coughing VAS scores at 6 h, 12 h, 24 h, and 48 h after the surgery in group B were smaller than they were in group A as well,  $P < 0.05$ . \* indicates  $P < 0.05$  compared with group A.

gesting that B ultrasound-guided thoracic paravertebral block maintains better hemodynamics compared with epidural block. This could be related to the unilateral thoracic sympathetic block caused by the thoracic paravertebral block. In addition, epidural block enjoys a wider plane, and both sides of the body produce a sympathetic block at the same time to arouse stronger sympathetic suppression, so the epidural block has a greater impact on perioperative hemodynamics [23].

Stress response refers to the process in which the anterior pituitary-adrenal cortex secretion increases, the sympathetic nerve excitability increases, and neuroendocrine activity occurs when the body is subjected to various noxious stimuli such as strenuous exercise, bleeding, and pain, which in turn promotes changes in various functions and the body's metabolism [24]. In general, moderate body stress responses are normal, but when noxious stimuli continue too long or the degree is strong, severe stress responses occur, seriously impairing body functions [25, 26]. Thoracotomy is invasive, coupled with psychological, anesthetic, and other factors, and it will trigger a serious stress response, and the serum Cor and NE lev-

**Table 4.** The adverse reactions in the two groups [n (%)]

| Groups   | Case | Dizziness | Drowsiness | Respiratory depression | Nausea and vomiting |
|----------|------|-----------|------------|------------------------|---------------------|
| Group A  | 58   | 6 (10.34) | 4 (6.70)   | 12 (20.69)             | 12 (20.69)          |
| Group B  | 62   | 4 (6.45)  | 2 (3.23)   | 2 (3.23)*              | 2 (3.23)*           |
| $\chi^2$ |      | 0.297     | 0.425      | 4.434                  | 4.434               |
| <i>P</i> |      | 0.586     | 0.514      | 0.035                  | 0.035               |

Note: \*indicates  $P < 0.05$  compared with group A.

els will also increase. In this study, compared with T0, the serum Cor and NE levels were increased at each time point in both groups, but they were lower in group B than in group A ( $P < 0.05$ ), suggesting that the stress response in group B was milder than it was in group A, which may be because B-ultrasound-guided thoracic paravertebral block injection can produce multiple sympathetic nerves and ipsilateral body block, thus effectively inhibiting the stress response. Postoperative pain is a common complication after thoracotomy, and it produces a noxious stimulation in the body, and then causes alertness in patients. As a result, patients develop a series of defense reactions, affecting the effect of the postoperative rehabilitation [27]. In this study, at rest and when coughing, the VAS scores at 6 h, 12 h, 24 h, and 48 h after the operation in group B were lower than those in group A, and the incidence rates of respiratory depression and nausea and vomiting were lower than they were in group A ( $P < 0.05$ ), suggesting that compared with epidural block, B-ultrasound-guided thoracic paravertebral block has a better analgesic effect and helps to reduce the incidence rate of adverse reactions. This could be explained by the fact that the unilateral somatomotor and sensory block caused by B-ultrasound-guided thoracic paravertebral block promotes the use of local anesthetics with a higher volume than epidural block, so it generates a more ideal analgesic effect. Second, in this study, we used a combination of local anesthetics and opioids in B-ultrasound-guided thoracic paravertebral block, which can give full play to the drug synergy and block the pain sensation simultaneously in the ascending conduction pathway at the spinal cord level, and then obtain the ideal analgesic effect.

In summary, B ultrasound-guided thoracic paravertebral block in thoracotomy has an ideal analgesic effect, which is conducive to maintaining stable perioperative hemodynamics,

reducing perioperative stress responses, and lowering the incidence of adverse reactions.

However, the small sample size included in this study may lead to bias in the results. Studies with larger sample sizes and longer periods of time are warranted.

#### Disclosure of conflict of interest

None.

**Address correspondence to:** Lin Yin, Department of Anesthesiology, Yichun People's Hospital, No. 1061, Jinxiu Avenue, Yiyang New District, Yichun 336000, Jiangxi, China. Tel: +86-15083853242; E-mail: ecn-01e@163.com

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