中国临床研究
Chin J Clin Res, January 2024, Vol.37, No.1
Cite as: Huang YB, Wang MF, He T, et al. Effects of nerve block in different areas on opiate dosage and stress response in patients undergoing thoracoscopic radical resection of lung cancer[J]. Chin J Clin Res, 2024, 37(1): 61-65.
DOI: 10.13429/j.cnki.cjcr.2024.01.013

Effects of nerve block in different areas on opiate dosage and stress response in patients undergoing thoracoscopic radical resection of lung cancer

HUANG Yibo, WANG Meifang, HE Teng, PU Jianfeng
Department of Anesthesiology, Changshu Second People's Hospital,
Suzhou, Jiangsu 215500, China
Corresponding author: WANG Meifang, E-mail: 2003wmf@163.com

Abstract: Objective To explore the effects of ultrasound-guided serratus anterior plane block (SAPB) and thoracic paravertebral block (TPVB) on opiate dosage and stress response in patients undergoing thoracoscopic radical resection of lung cancer. **Methods** A total of 130 patients undergoing elective thoracoscopic radical resection of lung cancer in Changshu Second People's Hospital between June 2019 and January 2022 were enrolled. According to the random number table method, they were divided into SAPB group (65 cases, ultrasound-guided SAPB before anesthesia induction) and TPVB group (65 cases, ultrasound-guided TPVB before anesthesia induction). After surgery, all underwent patient-controlled intravenous analgesia with analgesia pumps. The timepoints including preoperative, thoracic closure, and postoperative 2, 6, and 24 hours were set as T_1, T_2, T_3, T_4, and T_5, respectively, and the intraoperative blood loss and fluid supplement, operation time, intraoperative dosages of sufentanil and propofol, and postoperative cumulative dosages of sufentanil at T_3, T_4 and T_5 in the two groups were recorded. At T_3, T_4 and T_5, pain changes were evaluated by Prince-Henry pain scores. The levels of prostaglandins E_2 (PGE_2), norepinephrine (NE) and cortisol (Cor) were detected by enzyme-linked immunosorbent assay. The partial pressure of arterial oxygen was detected by a blood gas analyzer, and oxygenation index (OI) was calculated. The occurrence of postoperative adverse events (PAEs) in the two groups was recorded. **Results** From T_3 to T_5, levels of PGE_2, NE, and Cor in SAPB group were significantly lower than those in TPVB group (P<0.05). OI at T_2 to T_4 was significantly lower than that at T_1, while OI at T_5 was significantly higher than that at T_2, T_3 ,and T_4 in both groups (P<0.05). From T_2 to T_4, OI in SAPB group was significantly higher than that in TPVB group (P<0.05). Compared with TPVB group, the cumulative consumption of sufentanil in SAPB group slightly decreased from T_3 to T_5, but the differences were not statistically significant (P>0.05). The incidences of nausea and vomiting (6.15% *vs* 18.46%, χ^2=4.561, P=0.033), atelectasis (3.08% *vs* 12.31%, χ^2=3.900, P=0.048) and hypotension (7.69% *vs* 20.00%, χ^2=4.127, P=0.042) in SAPB group were lower than those in TPVB group. **Conclusion** Compared with TPVB, ultrasound-guided SAPB can relieve stress response, promote the recovery of pulmonary oxygenation and reduce PAEs in patients undergoing thoracoscopic radical resection of lung cancer, but whether it can significantly reduce the dosage of opiates needs to be further explored.

Keywords: Ultrasound guidance; Serratus anterior plane block; Thoracic paravertebral block; Thoracoscopic radical resection of lung cancer; Opiate; Stress response
Fund program: Changzhou Scientic Research Program (cswsq201903)

Patients undergoing thoracoscopic radical resection of lung cancer suffer from hypoxemia, pulmonary atelectasis and decreased pulmonary oxygenation due to intraoperative chest wall incision and damage to chest wall nerves and muscle tissues caused by instruments. In severe cases, patients even develop chronic post-thoracotomy pain syndrome, which impacts their quality of life seriously [1-3]. Currently, thoracic paravertebral block (TPVB) and serratus anterior plane block (SAPB) are primarily used to perform a regional block in clinical thoracoscopic radical resection of lung cancer in order to improve the patients' postoperative pain [4]. Research revealed that TPVB has operational risks such as puncture site hematoma and pneumothorax, whereas SAPB can achieve analgesia through the intercostal nerve blocks of T2 to T9 cutaneous branches. Compared with TPVB, SAPB has a more comprehensive effect on nerve blocks for antero-lateral chest walls [5-6]. Previous clinical studies have reported the use of SAPB for multimodal analgesia in the perioperative period of thoracoscopic surgery [7]. However, comparative studies of the clinical effects of analgesia in SAPB compared to those in TPVB are rare. This study explores the effects of SAPB and TPVB on dosage of opioid and stress response in patients undergoing radical resection for lung cancer, aiming to provide a reference for pain management.

1 Data and methods

1.1 General data

A total of 130 patients undergoing elective thoracoscopic radical resection of lung cancer in Changshu Second People's Hospital were enrolled between June 2019 and January 2022. The inclusion and exclusion criteria for the study were as follows.

Inclusion criteria: aged from 40 to 70 years old; body mass index (BMI) 18-30 kg/m^2; pathologically confirmed which met diagnostic criteria for lung cancer [8]; undergoing selective operation of thoracoscopic surgery; American Society of Anaesthesiologists (ASA) Physical status classification was I-II [9]; no infection at the puncture point; and the patients and their family members were informed consent.

Exclusion criteria: had a previous history of thoracic surgery; comorbid immune-related diseases; comorbid coagulation disorders; preoperative radiotherapy or chemotherapy treatment; allergy to opioids or local anaesthesia drugs; comorbid peripheral neurological diseases; had a previous history of chronic pain.

According to the random number table method, the patients were divided into SAPB group (65 cases, ultrasound-guided SAPB before anesthesia induction) and TPVB group (65 cases, ultrasound-guided TPVB before anesthesia induction). Thirty-six males and 29 females in the SAPB group were aged 40-70 (54.63±5.71) years old, with a BMI of (23.44±2.56) kg/m^2, and there were 19 cases of ASA class I and 46 cases of ASA class II. Thirty-five males and 30 females in the TPVB group were aged 40-70 (54.72±5.89) years old, with a BMI of (23.58 ± 2.32) kg/m^2, and there were 21 cases of ASA class I and 44 cases of ASA class II. The difference in baseline data between the two groups was not statistically significant (P>0.05). This study was approved by the Ethics Committee in Changshu Second People's Hospital (Ethics review number: No. 2021-0127).

1.2 Anesthesia methods

Patients routinely fasted for 8 hours and dehydrated for 2 hours before surgery. Systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), heart rate (HR), electrocardiogram (ECG), oxygen saturation (S_PO_2) behavior by pulse oximetry, and electroencephalographic bispectral index (BIS) were monitored. Prior to the anesthesia induction, ultrasound-guided SAPB was performed in the SAPB group using 30 mL 0.25% ropivacaine, and ultrasound-guided TPVB was performed in the TPVB group using 30 mL 0.25% ropivacaine. After nerve blocks, all patients were given dexmedetomidine hydrochloride 0.5 μg/kg for sedation, with a pumping rate of 1 μg/(kg·h). After nasal inhalation of pure oxygen for 3-5 min, 0.4-0.5 μg/kg sufentanil and 1.5-2 mg/kg propofol were administered intravenously. Once the patient lost consciousness, 0.2-0.3 mg/kg cisatracurium was injected intravenously. The disposable face mask was discontinued after the relaxation of the skeletal muscles, and the double-lumen endobronchial tubes were used for mechanical ventilation. The tidal volume was 6-8 mL/kg, the frequency was 12-14 times/min, the inspiratory to expiratory ratios (I:E) was 1:2, and the inspired oxygen concentration was 50%. Intraoperative one-lung ventilation was performed during the operation, the tidal volume was 4-6 mL/kg, the inspired oxygen concentration was 100%, and the value of end-tidal carbon dioxide partial pressure ($P_{ET}CO_2$) was maintained at 35-45 mmHg through adjusted respiratory rate. After adjusting the patient to the surgical position, sufentanil was given intravenously at 0.1-0.2 μg/kg prior to skin incision. During the operation, 4-8 mg/(kg·h) propofol and 1.5%-2% sevoflurane were administered intravenously to maintain the BIS value at 45-60. Cis atracurium [0.1 mg/(kg·h)] was pumped intravenously, and 0.15-0.2 μg/kg of sufentanil was added every 1 hour of the operation. The change in intraoperative blood pressure was maintained at the basal blood pressure ±20%. At the end of the surgery, patients in both SAPB and TPVB groups were given patient-controlled intravenous analgesia (PCIA) pumps. The analgesic pump formula: sufentanil 100 μg, tolansetron 4 mg, haloperidol 2.4 mg with saline to 100 mL. Analgesic pump set loading volume of 5 mL, the background dose of 2 mL/h, the self-control of the additional dose of 0.5 mL, the locking time of 15 min. If the PCIA pump drug was close to the end of the infusion in postoperative follow-up, the same concentration of drugs should be supplied into the pump.

1.3 Observation indicators

1.3.1 Surgical indicator, intraoperative anaesthesia dosage and opioid dosage

The surgical indicators such as the volume of blood loss and fluid supplement, operation time and intraoperative anesthesia dosage of sufentanil and propofol in the two groups were compared. The timepoints including preoperative period, thoracic closure, and postoperative 2, 6, and 24 hours were set as T_1, T_2, T_3, T_4, and T_5, respectively. The use of sufentanil in T_3, T_4 and T_5 was compared between the two groups.

1.3.2 Pain condition

The Prince-Henry pain score [10] was used to evaluate the pain changes in the two groups at T_3, T_4 and T_5, respectively. The Prince-Henry pain score is a 5-point scale ranging from 0 to 4, with higher scores indicating more intense pain.

1.3.3 Indicators of stress response

Three mL of venous blood was drawn from patients of the two groups at T_1, T_2, T_3, T_4 and T_5, respectively. Levels of prostaglandin E2 (PGE2), norepinephrine (NE), and cortisol (Cor) in the serum were detected by using the enzyme immunoassay method (Shanghai Wanlang Bio-technology Co., Ltd.).

1.3.4 Pulmonary oxygenation function

Radial artery blood was drawn from the two groups at T_1, T_2, T_3, T_4 and T_5, respectively. Blood gas analysis was performed using an ABL90 FLEX PLUS blood gas analyzer provided by Radiometer Medical Devices Inc. Arterial partial pressure of blood oxygen was recorded and oxygenation index (OI) was calculated. Postoperative hypoxemia was judged by the following criteria [11-12]: OI<300 mmHg at any postoperative time point or a 40% reduction in OI compared with the preoperative period.

1.3.5 Postoperative adverse events

Adverse events like postoperative nausea and vomiting, pulmonary atelectasis, hypoxemia and hypotension were recorded in both groups.

1.4 Statistical methods

Data were analyzed by SPSS 23.0 statistical software. Continuous data were expressed through $\bar{x} \pm s$, and the difference between two groups was analyzed by independent sample *t*-test. The comparison of indicators between and within groups at different time points was analyzed by repeated-measures ANOVA; Discrete data were expressed by cases (%), and the difference between groups was analyzed by Chi-square test or Yates's correction for continuity. $P<0.05$ was considered as the difference was statistically significant.

2 Results

2.1 Comparison of stress response indexes in the two groups at different time points

Compared with T_1, the levels of PGE_2, NE and Cor in the two groups at T_2 showed an increased tendency, and the levels of NE and Cor in the SAPB group were significantly lower than those in the TPVB group, with a statistically significant difference ($P<0.05$). Compared with T_2, the levels of PGE_2, NE and Cor in the two groups at T_3, T_4, and T_5 decreased, in which the levels of PGE_2, NE and Cor were significantly lower in the SAPB group than in the TPVB group, and the difference was statistically significant ($P<0.05$) **[Table 1]**.

Tab. 1 Comparison of pain stress indexes between two groups at different time points (n=65，$\bar{x} \pm s$)

Groups	Time point	PGE_2（μg/L）	NE（ng/L）	Cor（ng/L）
SAPB	T_1	1.30±0.19	298.74±30.58	209.69±19.56
	T_2	2.56±0.24[a]	361.25±32.68[a]	312.65±22.37[a]
	T_3	1.79±0.30[a]	304.75±31.92[a]	283.12±20.45[a]
	T_4	1.93±0.35[a]	273.86±28.41[a]	267.95±19.26[a]
	T_5	2.14±0.27[a]	232.13±26.45[a]	249.51±16.82[a]
TPVB	T_1	1.31±0.22	301.46±31.72	209.04±21.43
	T_2	2.65±0.23[a]	381.33±34.29[ab]	353.17±23.16[ab]
	T_3	1.98±0.26[ab]	330.12±32.47[ab]	314.79±21.65[ab]
	T_4	2.54±0.38[ab]	294.61±32.05[ab]	285.96±20.23[ab]
	T_5	2.89±0.34[ab]	253.42±31.43[ab]	268.34±19.55[ab]
F/P_{group} value		21.564/<0.001	43.125/<0.001	74.135/<0.001
F/P_{time} value		79.058/<0.001	85.490/<0.001	89.123/<0.001
$F/P_{group*time}$ value		98.451/<0.001	115.642/<0.001	102.495/<0.001

Note: Compared with the same group before treatment，[a]$P<0.05$; compared same time point of SAPB group，[b]$P<0.05$.

2.2 Comparison of OI in the two groups at different time points

At T_1 to T_5, the values of OI in the SAPB group were 440.17±24.59, 397.82±15.94, 391.24±18.65, 382.47±17.23 and 425.64±23.01, respectively. In the TPVB group, the values of OI was 441.05±25.62, 386.17±19.02, 370.94±18.42, 361.29±18.55, and 395.62±21.45 at five time points. In both groups, the OI at T_2-T_4 was significantly lower than that at T_1 ($P<0.05$), while the OI at T_5 was significantly higher than that at T_2, T_3, and T_4 ($P<0.05$). OI at T_2-T_4 in SAPB group was significantly higher than that in the TPVB group ($P<0.05$).

2.3 Comparison of surgery-related indexes and intraoperative anaesthetic dosage between the two groups

The differences between the two groups in intraoperative blood loss and fluid supplement, operation time and propofol dosage were not statistically significant ($P>0.05$) **[Table 2]**.

2.4 Comparison of opioid dosage between the two groups

The cumulative consumption of sufentanil consumed in the SAPB group was lower than that in the TPVB group at T_3, T_4 and T_5, but the difference was not statistically significant (P>0.05) **[Table 3].**

2.5 Comparison of Prince-Henry scores between the two groups at different postoperative time points

The Prince-Henry scores of both groups at T_4 and T_5 were significantly lower compared with that at T_3 (P < 0.05). The difference in Prince-Henry scores between the two groups at all time points was not statistically significant (P > 0.05) **[Table 4]**.

2.6 Comparison of the incidence of adverse events between the two groups

The incidence of nausea and vomiting, pulmonary atelectasis and hypotension in the SAPB group was significantly lower than that in the TPVB group (P <0.05), and the incidence of hypoxemia was lower but the difference was not statistically significant compared with that in the TPVB group (P>0.05) **[Table 5]**.

Tab.2 Comparison of operation-related indexes and intraoperative anesthetic dosages between two groups (n=65, $\bar{x}\pm s$)

Groups	Intraoperative blood loss (mL)	Intraoperative fluid supplement (mL)	Operation time (min)	Propofol dosage (mg)
SAPB	102.46±19.47	675.93±89.44	115.53±16.45	342.75±59.82
TPVB	104.61±18.49	671.53±86.92	112.19±16.04	355.73±60.64
T value	0.645	0.284	1.172	1.228
P value	0.519	0.776	0.243	0.221

Tab.3 Comparison of cumulative dosages of sufentanil between two groups (μg, $\bar{x}\pm s$)

Groups	Cases	T_3	T_4	T_5
SAPB	65	6.59±0.91	13.78±2.78	64.71±7.74
TPVB	65	6.74±1.06	14.33±3.61	65.47±8.86
t value		0.866	0.973	0.521
P value		0.388	0.332	0.603

Tab.4 Comparison of Prince-Henry scores between two groups at different time points ($\bar{x}\pm s$)

Groups	Cases	T_3	T_4	T_5
SAPB	65	3.52±0.20	2.85±0.19[a]	1.74±0.28[a]
TPVB	65	3.60±0.25	2.91±0.17[a]	1.66±0.23[a]
F/P_{group} value			2.126/0.147	
F/P_{time} value			129.164/＜0.001	
$F/P_{group*time}$ value			521.739/<0.001	

*Compared with T_3 in the same group, [a]P＜0.05.

Tab. 5 Incidence of adverse events in two groups [n=65, case(%)]

Groups	Nausea and vomiting	Pulmonary atelectasis	Hypoxaemia	Hypotension
SAPB	4（6.15）	2（3.08）	1（1.54）	5（7.69）
TPVB	12（18.46）	8（12.31）	7（10.77）	13（20.00）
χ^2 value	4.561	3.900	3.330	4.127
P value	0.033	0.048	0.068	0.042

3 Discussion

In recent years, with the wide application of surgical concepts about modern medicine accelerated rehabilitation in thoracoscopic surgery, postoperative pain management in thoracoscopic patients has become a key direction in the research field of surgery [13-14]. At present, TPVB, SAPB and other regional block analgesic modalities are used in clinical practice as effective methods of analgesia in thoracoscopic surgery. TPVB blocks unilateral spinal nerves and sympathetic nerve chain, which has a better effect of blocking on unilateral somatic movement, sensory, and sympathetic nerves. However, due to the deep location of the TPVB in some patients, the anatomical structure is relatively complex, and TPVB has high requirements for operators, which results in a higher failure rate of blocking [15-16]. SAPB, as a novel regional block technique in the fascial plane blocks, has prominent bony landmarks. Local anesthetic infiltrates the dorsal nerve and the long thoracic nerve, which can achieve analgesia of the anterolateral chest wall and a higher success rate of blocking [17].

This study revealed no significant difference between the two groups in intraoperative blood loss and fluid supplement, operative time, or intraoperative propofol dosage. There was an increased tendency for the cumulative amount of sufentanil consumed in the SAPB group to be lower than that of the TPVB group at T_3, T_4 and T_5, but the difference was not statistically significant. In this study, the Prince-Henry score was used to assess the degree of pain response, and the results showed that the Prince-Henry score of both groups decreased significantly with the prolongation of time. However, there was no significant difference between the two groups, suggesting that effects of ultrasound-guided analgesic SAPB and TPVB were similar. TPVB can block the thoracic surface nerves and the sympathetic nerves at the same time, and it has better analgesic effects in viscera. In contrast, SAPB only blocks the surface nerves and has a semi-paravertebral analgesic effect. In this study, the analgesic effects of SAPB and TPVB were similar, which may be because ultrasound-guided SAPB can achieve sound anterolateral analgesia of the chest wall [18]. However, the blockade of pleural and visceral pain is still incomplete, so the pain is not evident in the resting state but can be severe when patients take a deep breath or cough. In addition, TPVB blocks both incisional and visceral pain, because the operation is complex, its blocked goal is in the deeper part. The diffusion of the local anesthetic drugs may be challenging, thus affecting its success rate.

This study showed that at T_2, the levels of PGE_2, NE, and Cor in both groups showed an increasing trend compared with T_1, and the levels of NE and Cor in the SAPB group were lower than those in the PVB group. PGE2, NE and Cor in both groups showed a gradual decreasing trend from T_3 to T_5. The levels of PGE2, NE and Cor in the SAPB group were significantly lower than those of the TPVB group at all time points, suggesting that SAPB could improve the stress response, and inhibit cardiovascular response. Stress response in patients undergoing thoracoscopic radical lung cancer surgery is detrimental to intraoperative hemodynamic stability, as evidenced by a significant increase in the levels of stress-response indexes, such as PGE_2, NE and Cor, prior to anesthesia induction and during the operation. SAPB can block the neural conduction of injurious impulses, attenuating the stress response [19]. In this study, OI at T_2 to T_4 was significantly lower than that at T_1 in both groups, and OI at T_5 was significantly higher than that at T_2, T_3, and T_4, and OI at T_2 to T_4 in the SAPB group was significantly higher than that in the TPVB group. The above results indicate that compared with TPVB, SAPB showed the lowest decrease in OI at T_1-T_4 and the most significant degree of elevation at T_5, consistent with Fang Liang et al [20]. It suggests that ultrasound-guided SAPB can accelerate the recovery speed of postoperative pulmonary oxygenation function in patients who underwent thoracoscopic radical lung cancer surgery. In this study, the incidence of adverse events such as nausea and vomiting, pulmonary atelectasis, hypoxemia and hypotension in the SAPB group was significantly lower than that in the TPVB group, which further confirmed the safety of ultrasound-guided SAPB, and indicated that SAPB could reduce the stress response and improve safety.

In conclusion, ultrasound-guided SAPB can effectively relieve postoperative pain in patients undergoing thoracoscopic radical lung cancer surgery, promote the recovery of pulmonary oxygenation function and reduce the incidence of postoperative adverse events, which is of great significance for rapid recovery. Whether SAPB can reduce the cumulative sufentanil dosage requires further discussion in enlarging sample sizes.

Conflict of Interest None

References

[1] Hung WT, Cheng YJ, Chen JS. Nonintubated thoracoscopic surgery for early-stage non-small cell lung cancer[J]. Gen Thorac Cardiovasc Surg, 2020, 68(7): 733-739.

[2] Feray S, Lubach J, Joshi GP, et al. PROSPECT guidelines for video-assisted thoracoscopic surgery: a systematic review and procedure-specific postoperative pain management recommendations[J]. Anaesthesia, 2022, 77(3): 311-325.

[3] Lei YS, Liu HY, Xia F, et al. Effects of esketamine on acute and chronic pain after thoracoscopy pulmonary surgery under general anesthesia: a multicenter-prospective, randomized, double-blind, and controlled trial[J]. Front Med (Lausanne), 2021,8(8):693-695.

[4] Landoni G, Lomivorotov VV, Neto CN, et al. Volatile anesthetics versus total intravenous anesthesia for cardiac surgery[J]. N Engl J Med, 2019, 380(13): 1214-1225.

[5] Gürkan Y, Aksu C, Kuş A, et al. Erector spinae plane block and thoracic paravertebral block for breast surgery compared to IV-morphine: a randomized controlled trial[J]. J Clin Anesth, 2020,5(9):84-88.

[6] Chen JQ, Yang XL, Gu H, et al. The role of Serratus anterior plane block during in video-assisted thoracoscopic surgery[J]. Pain Ther, 2021, 10(2): 1051-1066.

[7] Liu X, Song T, Xu HY, et al. The serratus anterior plane block for analgesia after thoracic surgery: a meta-analysis of randomized controlled trails[J]. Medicine (Baltimore), 2020,99(21): e20286.

[8] China Lung Cancer Prevention and Treatment Alliance.Chinese expert consensus on screening and management of lung cancer[J]. Int J Respir, 2019, 39(21): 1604-1615. **[In Chinese]**

[9] Apfelbaum JL, Hagberg CA, Connis RT, et al. 2022 American society of anesthesiologists practice guidelines for management of the difficult airway[J]. Anesthesiology, 2022, 136(1): 31-81.

[10] Zhang Y, Fang ZJ, Shan T, et al. Effect of ultrasound-guided erector spinae plane block on pulmonary function after thoracoscopic lobectomy[J]. J Clin Anesthesiol, 2020, 36(1): 17-20. **[In Chinese]**

[11] Feng M, Luo B, Wang XD ,et al. Relationship between neutrophil to lymphocyte ratio and hypoxemia in patients with acute exacerbation of chronic obstructive pulmonary disease[J].Chin J Clin Res, 2022,35(9):1292-1295. **[In Chinese]**
[12] Tong YW, Zhou WT, Wang T,et al.Effect of veno-venous extracorporeal membrane oxygenation support on prognosis of patients with refractory hypoxemia after cardiopulmonary bypass cardiac surgery[J].J Clin Pract Diagn Ther, 2023,37(11):1111-1117. **[In Chinese]**
[13] Yap A, Lopez-Olivo MA, Dubowitz J, et al. Anesthetic technique and cancer outcomes: a meta-analysis of total intravenous versus volatile anesthesia[J]. Can J Anaesth, 2019, 66(5): 546-561.
[14] Sun K, Liu DY, Chen JE, et al. Moderate-severe postoperative pain in patients undergoing video-assisted thoracoscopic surgery: a retrospective study[J]. Sci Rep, 2020, 10: 795.
[15] El Shora HA, El Beleehy AA, Abdelwahab AA, et al. Bilateral paravertebral block versus thoracic epidural analgesia for pain control post-cardiac surgery: a randomized controlled trial[J]. Thorac Cardiovasc Surg, 2020,68(5):410-416.
[16] Patel SJ, Augoustides JGT. Serratus anterior plane block—a promising technique for regional anesthesia in minimally invasive cardiac surgery[J]. J Cardiothorac Vasc Anesth, 2020, 34(11): 2983-2985.
[17] Vig S, Bhan S, Ahuja D, et al. Serratus anterior plane block for post-thoracotomy analgesia: a novel technique for the surgeon and anaesthetist[J]. Indian J Surg Oncol, 2019, 10(3): 535-539.
[18] Mao G, Qiu L. Perioperative analgesic effect of serratus anterior plane block versus erector spinae plane block in patients undergoing thoracoscopic lobectomy[J].Chin J Clin Res, 2022,35(10):1366-1370,1375. **[In Chinese]**
[19] De Cassai A, Boscolo A, Zarantonello F, et al. Serratus anterior plane block for video-assisted thoracoscopic surgery: a meta-analysis of randomised controlled trials[J]. Eur J Anaesthesiol, 2021, 38(2): 106-114.
[20] Fang L, Zhang HL, Bao XH, et al. Ultrasound-guided serratus anterior plane block combined with erector spinae plane block for intra- and post-operative analgesia after video-assisted thoracoscopic lobectomy[J]. J Third Mil Med Univ, 2020, 42(8): 841-847. **[In Chinese]**

Submission received: 2023-06-14/**Revised:**2023-08-16

·论　著·

不同区域神经阻滞对胸腔镜肺癌根治术患者阿片类药物用量和应激反应的影响

黄益波，　王梅芳，　贺腾，　濮健峰
常熟市第二人民医院麻醉科，江苏 苏州 215500

摘要：目的　探讨胸腔镜肺癌根治术患者进行超声引导下前锯肌平面阻滞(SAPB)与胸椎旁神经阻滞(TPVB)对阿片类药物用量和应激反应的影响。**方法**　选取 2019 年 6 月至 2022 年 1 月于常熟市第二人民医院择期接受胸腔镜肺癌根治术的患者 130 例,根据随机数字表法分为 SAPB 组 65 例和 TPVB 组 65 例。麻醉诱导前,SAPB 组进行超声引导下 SAPB,TPVB 组进行超声引导下 TPVB,术后均连接镇痛泵给予静脉自控镇痛。将术前、关闭胸腔时、术后 2 h、6 h 和 24 h 等时间点分别设为 T_1、T_2、T_3、T_4 和 T_5,记录两组术中出血量、术中补液量、手术时间、术中舒芬太尼及丙泊酚用量和术后 T_3、T_4 和 T_5 舒芬太尼累积使用量;分别于 T_3、T_4 和 T_5 采用 Prince-Henry 评分评估两组疼痛变化,酶联免疫法检测前列腺素 E_2(PGE_2)、去甲肾上腺素(NE)和皮质醇(Cor)水平,血气分析仪检测动脉血氧分压,计算氧合指数(OI);记录两组术后不良事件发生情况。**结果**　T_3~T_5 时间点,SAPB 组 PGE_2、NE 和 Cor 水平显著低于 TPVB 组($P<0.05$)。两组 T_2~T_4 时的 OI 较 T_1 时明显降低,T_5 时的 OI 较 T_2、T_3、T_4 时明显升高,且 SAPB 组 T_2~T_4 时的 OI 显著高于 TPVB 组($P<0.05$)。SAPB 组在 T_3~T_5 累积消耗的舒芬太尼用量稍低于 TPVB 组,但差异无统计学意义($P>0.05$)。SAPB 组恶心呕吐(6.15% *vs* 18.46%, $\chi^2=4.561$, $P=0.033$)、肺不张(3.08% *vs* 12.31%, $\chi^2=3.900$, $P=0.048$)和低血压(7.69% *vs* 20.00%, $\chi^2=4.127$, $P=0.042$)发生率均低于 TPVB 组。**结论**　在超声引导下,与 TPVB 比较, SAPB 可缓解胸腔镜肺癌根治术患者应激反应,促进肺氧合功能恢复,减少术后不良事件。但能否显著降低阿片类药物用量,有待进一步探讨。

关键词： 超声引导；前锯肌平面阻滞；胸椎旁神经阻滞；胸腔镜肺癌根治术；阿片类药物；应激反应
中图分类号： R614.4　**文献标识码：** A　**文章编号：** 1674-8182(2024)01-0061-05

Effects of nerve block in different areas on opiate dosage and stress response in patients undergoing thoracoscopic radical resection of lung cancer

HUANG Yibo, WANG Meifang, HE Teng, PU Jianfeng
Department of Anesthesiology, Changshu Second People's Hospital, Suzhou, Jiangsu 215500, China
Corresponding author: WANG Meifang, E-mail: 2003wmf@163.com

Abstract: Objective　To explore the effects of ultrasound-guided serratus anterior plane block (SAPB) and thoracic paravertebral block (TPVB) on opiate dosage and stress response in patients undergoing thoracoscopic radical resection of lung cancer. **Methods**　A total of 130 patients undergoing elective thoracoscopic radical resection of lung cancer in Changshu Second People's Hospital between June 2019 and January 2022 were enrolled. According to the random number table method, they were divided into SAPB group (65 cases, ultrasound-guided SAPB before anesthesia induction) and TPVB group (65 cases, ultrasound-guided TPVB before anesthesia induction). After surgery, all underwent patient-controlled intravenous analgesia with analgesia pumps. The timepoints including preoperative, thoracic closure, and postoperative 2, 6, and 24 hours were set as T_1, T_2, T_3, T_4 and T_5, respectively, and the intraoperative blood loss and fluid supplement, operation time, intraoperative dosages of sufentanil and propofol, and postoperative cumulative dosages of sufentanil at T_3, T_4 and T_5 in the two groups were recorded. At T_3, T_4 and T_5, pain changes were evaluated

DOI: 10. 13429/j. cnki. cjcr. 2024. 01. 013
基金项目： 常熟市科研计划项目 (cswsq201903)
通信作者： 王梅芳，E-mail: 2003wmf@163.com
出版日期： 2024-01-20

QR code for English version

by Prince-Henry scores. The levels of prostaglandins E_2 (PGE_2), norepinephrine (NE) and cortisol (Cor) were detected by enzyme-linked immunosorbent assay. The partial pressure of arterial oxygen was detected by a blood gas analyzer, and oxygenation index (OI) was calculated. The occurrence of postoperative adverse events (PAEs) in the two groups was recorded. **Results** From T_3 to T_5, levels of PGE_2, NE, and Cor in SAPB group were significantly lower than those in TPVB group ($P<0.05$). OI at T_2 to T_4 was significantly lower than that at T_1, while OI at T_5 was significantly higher than that at T_2, T_3, and T_4 in both groups ($P<0.05$). From T_2 to T_4, OI in SAPB group was significantly higher than that in TPVB group ($P<0.05$). Compared with TPVB group, the cumulative consumption of sufentanil in SAPB group slightly decreased from T_3 to T_5, but the differences were not statistically significant ($P>0.05$). The incidences of nausea and vomiting (6.15% *vs* 18.46%, $\chi^2=4.561$, $P=0.033$), atelectasis (3.08% *vs* 12.31%, $\chi^2=3.900$, $P=0.048$) and hypotension (7.69% *vs* 20.00%, $\chi^2=4.127$, $P=0.042$) in SAPB group were lower than those in TPVB group. **Conclusion** Compared with TPVB, ultrasound-guided SAPB can relieve stress response, promote the recovery of pulmonary oxygenation and reduce PAEs in patients undergoing thoracoscopic radical resection of lung cancer, but whether it can significantly reduce the dosage of opiates needs to be further explored.

Keywords: Ultrasound guidance; Serratus anterior plane block; Thoracic paravertebral block; Thoracoscopic radical resection of lung cancer; Opiate; Stress response

Fund program: Changzhou Scientific Research Program (csnsq 201903)

胸腔镜肺癌根治术患者常因术中胸壁切口及器械对胸壁神经、肌肉组织造成的损伤导致低氧血症、肺不张和肺氧合功能下降，严重者甚至发展为慢性疼痛综合征，对其生活质量造成严重影响[1-3]。目前临床胸腔镜肺癌根治术多采用胸椎旁神经阻滞(thoracic paravertebral block, TPVB)和前锯肌平面阻滞(serratus anterior plane block, SAPB)等方法进行区域阻滞，以有效改善患者术后疼痛[4]。研究发现，TPVB 存在穿刺导致血肿和气胸等操作风险，而 SAPB 可通过阻滞肋间神经的 $T_2 \sim T_9$ 皮支达到镇痛效果，与 TPVB 相比，对前外侧胸壁神经阻滞效果更加完全[5-6]。既往可见报道 SAPB 用于胸腔镜手术围术期多模式镇痛的临床研究[7]，但少见其与 TPVB 在镇痛中的临床效果对比研究。本研究主要探讨 SAPB 与 TPVB 对胸腔镜肺癌根治术患者阿片类药物用量和应激反应的影响，旨在为胸腔镜肺癌根治术患者疼痛管理提供参考。

1　资料与方法

1.1　*一般资料*　选取 2019 年 6 月至 2022 年 1 月于常熟市第二人民医院择期接受胸腔镜肺癌根治术的患者 130 例。纳入标准：年龄 40~70 岁；身体质量指数(BMI) 18~30 kg/m^2；经病理确诊符合肺癌诊断标准[8]；择期接受胸腔镜手术；美国麻醉医师学会(ASA)分级 Ⅰ ~ Ⅱ 级[9]；穿刺点无感染；患者及家属了解并知情同意。排除标准：既往有胸外科手术史；合并免疫相关疾病；合并凝血功能障碍；术前接受放化疗治疗；对阿片类药物或局麻药物过敏；合并周围神经系统疾病；既往有慢性疼痛史。按照随机数字表法将患者分为 SAPB 组 65 例和 TPVB 组 65 例。SAPB 组男 36 例，女 29 例；年龄 40~70(54.63±5.71)岁；BMI(23.44±2.56) kg/m^2；ASA 分级Ⅰ级 19 例，Ⅱ级 46 例。TPVB 组男 35 例，女 30 例；年龄 40~70(54.72±5.89)岁；BMI(23.58±2.32) kg/m^2；ASA 分级 Ⅰ 级 21 例，Ⅱ 级 44 例。两组基线资料差异无统计学意义($P>0.05$)。本研究经常熟市第二人民医院伦理委员会批准通过(伦审号：2021-0127 号)。

1.2　*麻醉方法*　患者术前 8 h 常规禁食，术前 2 h 常规禁水，监测收缩压(SBP)、舒张压(DBP)、平均动脉压(MAP)、心率(HR)、心电图(ECG)、指脉氧饱和度(S_PO_2)和脑电双频谱指数(BIS)值。麻醉诱导前，SAPB 组使用 0.25%罗哌卡因 30 mL 进行超声引导下 SAPB，TPVB 组使用 0.25%罗哌卡因 30 mL 进行超声引导下 TPVB。神经阻滞完成后，所有患者均给予盐酸右美托咪定 0.5 μg/kg 镇静处理，泵注速度 1 μg/(kg · h)。面罩吸入纯氧 3~5 min 后，静脉予舒芬太尼 0.4~0.5 μg/kg，丙泊酚 1.5~2 mg/kg，观察患者意识消失后静脉注射顺式阿曲库铵 0.2~0.3 mg/kg，待骨骼肌松弛后停止麻醉面罩，行双腔支气管插管机械通气。设置潮气量 6~8 mL/kg，频率 12~14 次/min，吸呼比 1∶2，吸入氧浓度 50%。术中行单肺通气，设置潮气量 4~6 mL/kg，吸入氧浓度 100%，调整呼吸频率使呼气末二氧化碳分压($PetCO_2$)维持在 35~45 mmHg。翻身摆好手术体位，切皮前静脉给予舒芬太尼 0.1~0.2 μg/kg。术中静脉泵注丙泊酚 4~8 mg/(kg · h)，吸入七氟烷 1.5%~2%，使 BIS 值维持在

45~60。静脉泵注顺式阿曲库铵 0.1 mg/(kg·h),手术时间每过 1 h 追加舒芬太尼 0.15~0.2 μg/kg,术中血压变化维持在基础血压±20%。手术结束后,SAPB 组、TPVB 组均给予患者静脉自控镇痛(PCIA)泵。镇痛泵配方:舒芬太尼 100 μg,托烷司琼 4 mg,氟哌利多 2.4 mg 加生理盐水至 100 mL,镇痛泵设定负荷量 5 mL,背景剂量 2 mL/h,自控追加剂量 0.5 mL,锁定时间 15 min。术后随访如 PCIA 泵药物接近输注完毕,则向泵中补充相同浓度药物。

1.3　观察指标

1.3.1　手术指标、术中麻醉药用量和阿片类药物用量　比较两组患者术中出血量、术中补液量、手术时间等手术指标和术中舒芬太尼、丙泊酚等麻醉药用量情况。将术前、关闭胸腔时和术后 2、6、24 h 分别设为 T_1、T_2、T_3、T_4 和 T_5,比较两组在 T_3、T_4 和 T_5 时间点舒芬太尼使用情况。

1.3.2　疼痛情况　分别于 T_3、T_4 和 T_5,采用 Prince-Henry 评分[10]评估两组疼痛变化。Prince-Henry 评分为 0~4 分 5 个等级,评分越高表示疼痛越强烈。

1.3.3　应激反应指标　分别于 T_1、T_2、T_3、T_4 和 T_5,抽取两组患者静脉血 3 mL,采用酶联免疫法(试剂盒购自上海瓦兰生物科技)检测血清前列腺素 E_2(PGE_2)、去甲肾上腺素(NE)和皮质醇(Cor)水平。

1.3.4　肺氧合功能　分别于 T_1、T_2、T_3、T_4 和 T_5,抽取两组患者桡动脉血,采用雷度米特医疗设备公司提供的 ABL90FLEX 型血气、血氧、电解质和代谢物分析仪进行血气分析,记录动脉血氧分压,计算氧合指数(OI)。术后低氧血症判断标准[11-12]:术后任意时间点的 OI<300 mmHg 或 OI 较术前减少 40%。

1.3.5　术后不良事件　记录两组患者术后恶心呕吐、肺不张、低氧血症和低血压等不良事件发生情况。

1.4　统计学方法　数据分析用 SPSS 23.0 软件。计量资料用 $\bar{x}\pm s$ 表示,两组间差异分析采用独立样本 t 检验;不同时间点组间和组内指标比较用重复测量方差分析,两两比较用 LSD-t 检验;计数资料用例(%)表示,组间差异分析用 χ^2 检验或校正 χ^2 检验。$P<0.05$为差异有统计学意义。

2　结　果

2.1　两组不同时间点应激反应指标水平比较　与 T_1 时比较,T_2 时两组 PGE_2、NE 和 Cor 水平呈现升高趋势,两组间比较,SAPB 组 NE 和 Cor 水平显著低于 TPVB 组,差异有统计学意义($P<0.05$);与 T_2 时比较,T_3、T_4、T_5 两组 PGE_2、NE 和 Cor 水平降低,其中 SAPB 组 PGE_2、NE 和 Cor 水平显著低于 TPVB 组,差异有统计学意义($P<0.05$)。见表 1。

2.2　两组不同时间点 OI 比较　T_1~T_5 时,SAPB 组的 OI 分别为(440.17±24.59)、(397.82±15.94)、(391.24±18.65)、(382.47±17.23)和(425.64±23.01),TPVB 组的 OI 分别为(441.05±25.62)、(386.17±19.02)、(370.94±18.42)、(361.29±18.55)和(395.62±21.45);两组 T_2~T_4 时的 OI 较 T_1 时明显降低($P<0.05$),T_5 时的 OI 较 T_2、T_3、T_4 时明显升高($P<0.05$),且 SAPB 组 T_2~T_4 时的 OI 显著高于 TPVB 组($P<0.05$)。

2.3　两组手术相关指标和术中丙泊酚用量比较　两组术中出血量、术中补液量、手术时间和丙泊酚用量差异无统计学意义($P>0.05$)。见表 2。

表 1　两组不同时间点应激指标水平比较　($n=65$, $\bar{x}\pm s$)

Tab. 1　Comparison of stress indexes between two groups at different time points　($n=65$, $\bar{x}\pm s$)

组别	时间	PGE_2(μg/L)	NE(ng/L)	Cor(ng/L)
SAPB 组	T_1	1.30±0.19	298.74±30.58	209.69±19.56
	T_2	2.56±0.24^a	361.25±32.68^a	312.65±22.37^a
	T_3	1.79±0.30^{ac}	304.75±31.92^{ac}	283.12±20.45^{ac}
	T_4	1.93±0.35^{ac}	273.86±28.41^{ac}	267.95±19.26^{ac}
	T_5	2.14±0.27^{ac}	232.13±26.45^{ac}	249.51±16.82^{ac}
TPVB 组	T_1	1.31±0.22	301.46±31.72	209.04±21.43
	T_2	2.65±0.23^a	381.33±34.29^{ab}	353.17±23.16^{ab}
	T_3	1.98±0.26^{abc}	330.12±32.47^{abc}	314.79±21.65^{abc}
	T_4	2.54±0.38^{abc}	294.61±32.05^{abc}	285.96±20.23^{abc}
	T_5	2.89±0.34^{abc}	253.42±31.43^{abc}	268.34±19.55^{abc}
$F_{组间}/P_{组间}$值		21.564/<0.001	43.125/<0.001	74.135/<0.001
$F_{时间}/P_{时间}$值		79.058/<0.001	85.490/<0.001	89.123/<0.001
$F_{交互}/P_{交互}$值		98.451/<0.001	115.642/<0.001	102.495/<0.001

注:与同组 T_1 比较,$^aP<0.05$;与 SAPB 组同时点比较,$^bP<0.05$;与同组 T_2 比较,$^cP<0.05$。

表 2　两组手术相关指标和术中丙泊酚用量比较　($n=65$, $\bar{x}\pm s$)

Tab. 2　Comparison of operation-related indexes and intraoperative propofol dosages between two groups　($n=65$, $\bar{x}\pm s$)

组别	术中出血量(mL)	术中补液量(mL)	手术时间(min)	丙泊酚(mg)
SAPB 组	102.46±19.47	675.93±89.44	115.53±16.45	342.75±59.82
TPVB 组	104.61±18.49	671.53±86.92	112.19±16.04	355.73±60.64
t 值	0.645	0.284	1.172	1.228
P 值	0.519	0.776	0.243	0.221

2.4　两组阿片类药物用量比较　SAPB 组在 T_3、T_4 和 T_5 时间点累积消耗的舒芬太尼用量稍低于 TPVB 组,但差异无统计学意义($P>0.05$)。见表 3。

2.5　两组术后不同时间点 Prince-Henry 评分比较　与 T_3 时比较,两组在 T_4 和 T_5 的 Prince-Henry 评分均明显降低($P<0.05$);各时点两组间 Prince-Henry 评分差异无统计学意义($P>0.05$)。见表 4。

2.6　两组不良事件发生率比较　SAPB 组恶心呕吐、

肺不张和低血压发生率均显著低于 TPVB 组($P<0.05$),低氧血症发生率虽低,但较 TPVB 组差异无统计学意义($P>0.05$)。见表 5。

表 3 两组舒芬太尼累积用量比较 (μg, $\bar{x}\pm s$)
Tab. 3 Comparison of cumulative dosages of sufentanil between two groups (μg, $\bar{x}\pm s$)

组别	例数	T_3	T_4	T_5
SAPB 组	65	6.59±0.91	13.78±2.78	64.71±7.74
TPVB 组	65	6.74±1.06	14.33±3.61	65.47±8.86
t 值		0.866	0.973	0.521
P 值		0.388	0.332	0.603

表 4 两组不同时间点 Prince-Henry 评分比较 (分, $\bar{x}\pm s$)
Tab. 4 Comparison of Prince-Henry scores between two groups at different time points (point, $\bar{x}\pm s$)

组别	例数	T_3	T_4	T_5
SAPB 组	65	3.52±0.20	2.85±0.19^a	1.74±0.28^a
TPVB 组	65	3.60±0.25	2.91±0.17^a	1.66±0.23^a
$F_{组间}/P_{组间}$值			2.126/0.147	
$F_{时间}/P_{时间}$值			129.164/<0.001	
$F_{交互}/P_{交互}$值			521.739/<0.001	

注:与同组 T_3 比较,$^aP<0.05$。

表 5 两组术后不良事件发生率 [$n=65$, 例(%)]
Tab. 5 Incidence of postoperatiue adverse events in two groups [$n=65$, case(%)]

组别	恶心呕吐	肺不张	低氧血症	低血压
SAPB 组	4(6.15)	2(3.08)	1(1.54)	5(7.69)
TPVB 组	12(18.46)	8(12.31)	7(10.77)	13(20.00)
χ^2 值	4.561	3.900	3.330	4.127
P 值	0.033	0.048	0.068	0.042

3 讨 论

近年来随着现代医学加速康复外科理念在胸腔镜手术中的广泛应用,胸腔镜患者术后疼痛管理成为外科领域研究的重点方向[13-14]。目前临床多采用 TPVB 和 SAPB 等区域阻滞镇痛方式作为胸腔镜手术镇痛的有效方法,其中 TPVB 阻滞单侧脊神经和交感神经链,对单侧躯体运动、感觉和交感神经具有较好的阻滞作用,但部分患者因 TPVB 阻滞位置较深,解剖结构相对复杂,对操作医师要求较高,导致仍存在较高的阻滞失败率[15-16]。SAPB 作为筋膜平面新型区域阻滞技术,具有明显的骨性标志,局麻药浸润背神经及胸长神经,可达到前外侧胸壁镇痛,阻滞成功率更高[17]。

本研究结果显示,两组术中出血量、术中补液量、手术时间和术中丙泊酚用量无差异,SAPB 组在 T_3、T_4 和 T_5 时累积消耗的舒芬太尼用量较 TPVB 组有降低趋势,但差异无统计学意义。本研究采用 Prince-Henry 评分评估两组疼痛反应程度,结果显示两组随着时间的延长 Prince-Henry 评分均明显降低,但两组间差异无统计学意义,提示超声引导下 SAPB 和 TPVB 镇痛效果类似。TPVB 可同时对胸部体表神经及交感神经进行阻滞,具有较好的内脏镇痛效果,SAPB 只对体表神经进行阻滞,具有半椎旁镇痛的效果。本研究中 SAPB 和 TPVB 镇痛效果类似,分析其原因可能在于超声引导下 SAPB 可以取得较好的胸壁前外侧镇痛效果[18],但对于胸膜及内脏疼痛的阻滞尚不完善,故而在静息状态下疼痛不明显而在深呼吸或者咳嗽时患者仍能感觉疼痛;而 TPVB 虽然对切口痛及内脏痛都有阻滞效果,但由于其阻滞靶点所在部位较深,操作存在一定难度,局麻药物的扩散可能并不理想,从而影响其成功率。

本研究结果显示,T_2 时,两组 PGE_2、NE 和 Cor 水平较 T_1 呈现升高趋势,且 SAPB 组 NE 和 Cor 水平低于 PVB 组,$T_3\sim T_5$ 时,两组 PGE_2、NE 和 Cor 水平均呈下降趋势,其中 SAPB 组在各时点均显著低于 TPVB 组,说明 SAPB 可改善应激反应、抑制心血管反应。胸腔镜肺癌根治术患者应激反应不利于术中血流动力学稳定,表现为机体 PGE_2、NE 和 Cor 等应激反应指标水平在麻醉诱导前和术中明显升高。SAPB 可对伤害性冲动的神经传导产生阻滞作用,减轻应激反应[19]。本研究中,两组 $T_2\sim T_4$ 时的 OI 较 T_1 时明显降低,T_5 时的 OI 较 T_2、T_3、T_4 时明显升高,且 SAPB 组 $T_2\sim T_4$ 时的 OI 显著高于 TPVB 组。以上结果说明与 TPVB 比较,SAPB 在 $T_1\sim T_4$ 时的 OI 下降幅度最低,且在 T_5 时的升高程度最大,与方亮等[20]的研究结果基本一致,提示超声引导下 SAPB 可加速接受胸腔镜肺癌根治术患者术后肺氧合功能的恢复。本研究中,SAPB 组恶心呕吐、肺不张和低血压等不良事件发生率均显著低于 TPVB 组,进一步证实超声引导下 SAPB 的安全性,说明 SAPB 可降低应激反应,安全性好。

综上所述,超声引导下 SAPB 可有效降低胸腔镜肺癌根治术患者的应激反应,促进肺氧合功能恢复,减少术后不良事件发生率,对快速康复具有重要意义。SAPB 究竟能否降低阿片类药物舒芬太尼的累积用量,尚待进一步扩大样本量继续探讨。

利益冲突 无

参考文献

[1] Hung WT, Cheng YJ, Chen JS. Nonintubated thoracoscopic surgery for early-stage non-small cell lung cancer [J]. Gen Thorac

Cardiovasc Surg, 2020, 68(7): 733-739.

[2] Feray S, Lubach J, Joshi GP, et al. PROSPECT guidelines for video-assisted thoracoscopic surgery: a systematic review and procedure-specific postoperative pain management recommendations[J]. Anaesthesia, 2022, 77(3): 311-325.

[3] Lei YS, Liu HY, Xia F, et al. Effects of esketamine on acute and chronic pain after thoracoscopy pulmonary surgery under general anesthesia: a multicenter-prospective, randomized, double-blind, and controlled trial[J]. Front Med (Lausanne), 2021,8(8):693-695.

[4] Landoni G, Lomivorotov VV, Neto CN, et al. Volatile anesthetics versus total intravenous anesthesia for cardiac surgery[J]. N Engl J Med, 2019, 380(13): 1214-1225.

[5] Gürkan Y, Aksu C, Kuş A, et al. Erector spinae plane block and thoracic paravertebral block for breast surgery compared to Ⅳ-morphine: a randomized controlled trial[J]. J Clin Anesth, 2020,5(9):84-88.

[6] Chen JQ, Yang XL, Gu H, et al. The role of Serratus anterior plane block during in video-assisted thoracoscopic surgery[J]. Pain Ther, 2021, 10(2): 1051-1066.

[7] Liu X, Song T, Xu HY, et al. The serratus anterior plane block for analgesia after thoracic surgery: a meta-analysis of randomized controlled trails[J]. Medicine (Baltimore), 2020,99(21): e20286.

[8] 中国肺癌防治联盟,中华医学会呼吸病学分会肺癌学组,中国医师协会呼吸医师分会肺癌工作委员会.肺癌筛查与管理中国专家共识[J].国际呼吸杂志,2019,39(21):1604-1615.
China Lung Cancer Prevention and Treatment Alliance. Chinese expert consensus on screening and management of lung cancer[J]. Int J Respir, 2019, 39(21): 1604-1615.

[9] Apfelbaum JL, Hagberg CA, Connis RT, et al. 2022 American society of anesthesiologists practice guidelines for management of the difficult airway[J]. Anesthesiology, 2022, 136(1): 31-81.

[10] 张媛,方兆晶,单涛,等.超声引导下竖脊肌平面阻滞对胸腔镜肺叶切除术患者术后肺功能的影响[J].临床麻醉学杂志,2020,36(1):17-20.
Zhang Y, Fang ZJ, Shan T, et al. Effect of ultrasound-guided erector spinae plane block on pulmonary function after thoracoscopic lobectomy[J]. J Clin Anesthesiol, 2020, 36(1): 17-20.

[11] 冯梅,罗兵,王学东,等.急性加重期慢性阻塞性肺疾病患者中性粒细胞/淋巴细胞比值与低氧血症的关系[J].中国临床研究,2022,35(9):1292-1295.
Feng M, Luo B, Wang XD, et al. Relationship between neutrophil to lymphocyte ratio and hypoxemia in patients with acute exacerbation of chronic obstructive pulmonary disease[J]. Chin J Clin Res, 2022, 35(9): 1292-1295.

[12] 通耀威,周旺涛,王睿,等.静脉—静脉体外膜肺氧合在体外循环手术后难治性低氧血症治疗中的应用价值[J].中华实用诊断与治疗杂志,2023,37(11):1111-1117.
Tong YW, Zhou WT, Wang T, et al. Effect of veno-venous extracorporeal membrane oxygenation support on prognosis of patients with refractory hypoxemia after cardiopulmonary bypass cardiac surgery[J]. J Clin Pract Diagn Ther, 2023, 37(11): 1111-1117.

[13] Yap A, Lopez-Olivo MA, Dubowitz J, et al. Anesthetic technique and cancer outcomes: a meta-analysis of total intravenous versus volatile anesthesia[J]. Can J Anaesth, 2019, 66(5): 546-561.

[14] Sun K, Liu DY, Chen JE, et al. Moderate-severe postoperative pain in patients undergoing video-assisted thoracoscopic surgery: a retrospective study[J]. Sci Rep, 2020, 10: 795.

[15] El Shora HA, El Beleehy AA, Abdelwahab AA, et al. Bilateral paravertebral block versus thoracic epidural analgesia for pain control post-cardiac surgery: a randomized controlled trial[J]. Thorac Cardiovasc Surg, 2020, 68(5): 410-416.

[16] Patel SJ, Augoustides JGT. *Serratus* anterior plane block—a promising technique for regional anesthesia in minimally invasive cardiac surgery[J]. J Cardiothorac Vasc Anesth, 2020, 34(11): 2983-2985.

[17] Vig S, Bhan S, Ahuja D, et al. Serratus anterior plane block for post-thoracotomy analgesia: a novel technique for the surgeon and anaesthetist[J]. Indian J Surg Oncol, 2019, 10(3): 535-539.

[18] 毛菇,仇澜.前锯肌平面阻滞和竖脊肌平面阻滞在胸腔镜下肺叶切除术患者围术期镇痛效果[J].中国临床研究,2022,35(10):1366-1370,1375.
Mao G, Qiu L. Perioperative analgesic effect of serratus anterior plane block versus erector spinae plane block in patients undergoing thoracoscopic lobectomy[J]. Chin J Clin Res, 2022, 35(10): 1366-1370, 1375.

[19] De Cassai A, Boscolo A, Zarantonello F, et al. Serratus anterior plane block for video-assisted thoracoscopic surgery: a meta-analysis of randomised controlled trials[J]. Eur J Anaesthesiol, 2021, 38(2): 106-114.

[20] 方亮,张皓琳,包晓航,等.超声引导下前锯肌平面阻滞联合竖脊肌平面阻滞在 VAST 肺叶切除术术中及术后镇痛的应用[J].第三军医大学学报,2020,42(8):841-847.
Fang L, Zhang HL, Bao XH, et al. Ultrasound-guided serratus anterior plane block combined with erector spinae plane block for intra- and post-operative analgesia after video-assisted thoracoscopic lobectomy[J]. J Third Mil Med Univ, 2020, 42(8): 841-847.

收稿日期:2023-06-14　**修回日期**:2023-08-16　**编辑**:王海琴