Cite as: Li XF, Zhao L, Ji YN. Comparison of analgesic effects between ultrasound-guided thoracic paravertebral block and intercostal nerve block in patients with multiple rib fractures [J]. Chin J Clin Res, 2024, 37(4):514-518.

DOI: 10.13429/j.cnki.cjcr.2024.04.006

Comparison of analgesic effects between ultrasound-guided thoracic paravertebral block and intercostal nerve block in patients with multiple rib fractures

LI Xiaofang*, ZHAO Li, JI Yanan

**Department of Anesthesiology, The Fifth Affiliated Hospital of Xinjiang Medical University, Urumqi, Xinjiang 830011, China*

Abstract: Objective To compare the analgesic effects and safety of ultrasound thoracic paravertebral block (TPVB) and intercostal nerve block (INB) in patients with unilateral multiple rib fractures. **Methods** Patients with unilateral multiple rib fractures treated by surgery at The Fifth Affiliated Hospital of Xinjiang Medical University from January 2022 to June 2023 were selected. A total of 82 patients who met the inclusion and exclusion criteria were included, and divided into the TPVB group (20 mL of ropivacaine 0.33% for TPVB after general anesthesia) and INB group (5mL of ropivacaine 0.33% for INB after general anesthesia) by random number table method, with 41 patients in each group. The visual analog score (VAS) was used to assess patient's pain, and the time and dosage of analgesics were recorded. The pulmonary and non-pulmonary complications within 72 hours after operation were observed. **Results** Kaplan-Meier curves showed that there was a statistically significant difference in first use time of analgesics between the two groups (χ^2=6.125, P=0.013). The proportion of patients with analgesia demand in the TPVB group was significantly lower than that in the INB group within 24 hours after operation (19.51% *vs* 36.59% , χ^2=4.895, P=0.027) and 48 hours after operation（41.46%*vs* 63.41%, $\chi2$=3.961, P=0.047), and the total dose of analgesics used in the TPVB group 25-48 hours after operation was significantly lower than that in the INB group [(13.78±9.48) mg *vs* (26.20±12.31)mg, t=3.527, P＜0.01]. VAS scores at rest and during coughing at all time points after surgery significantly decreased in both groups（P<0.01）. At 6 and 18 hours postoperatively, the VAS score at rest in the TPVB group was lower than that in the INB group, and at 1, 6, and 18 hours postoperatively, the VAS score when coughing in the TPVB group was lower than that in the INB group, with statistically significant differences(P<0.05). There was no statistically significant difference in the incidence of pulmonary and non-pulmonary complications between the two groups (P＞0.05). **Conclusion** Ultrasound-guided TPVB can effectively alleviate pain and reduce opioid consumption in patients with unilateral multiple rib fractures compared with INB.

Keywords: Multiple rib fracture; Analgesia; Thoracic paravertebral block; Intercostal nerve block; Ultrasonic guidance

The most common cause of rib fractures is blunt chest trauma, with an incidence up to 12% of all trauma patients [1]. Rib fractures and their associated morbidity, disability and mortality constitute a significant healthcare burden [2-3]. It's estimated that one-third of traumatic rib fracture patients experienced a mortality rate as high as 65% due to secondary pulmonary complications [4-6]. Patients with single rib fractures have a low complication rate, which can be managed with oral analgesics [7-9]. In the case of multiple rib fractures, pain is usually more severe and often alters respiratory dynamics. Severe pain during respiration results in shallow breathing and ineffective cough, making inadequate clearance of airway secretions and sputum retention, which can lead to complications [10-11]. Thus, adequate analgesia is essential for the prevention of complications such as atelectasis and pneumonia. In recent years, regional anesthesia techniques have played an increasingly important role due to their ability to reduce postoperative pain and related postoperative complications. Regional anesthesia used for treating rib fractures include thoracic paravertebral nerve block (TPVB) [12] and intercostal nerve block (INB), and there is still controversy about which of these two anesthesia techniques is more effective in terms of analgesia and safety [13]. The aim of this study was to compare the analgesic effect and safety of TPVB and ICB in patients with multiple rib fractures.

1 Materials and methods

1.1 General data

This study was approved by the Ethics Committee of the hospital (approval number:XYDWFYLSH-2023-113). Patients with unilateral multiple rib fractures who admitted to The Fifth Affiliated Hospital of Xinjiang Medical University from January 2022 to June 2023 were selected.

Inclusion criteria:

(1) patients with unilateral multiple rib fractures;
(2) patients with preoperative visual analogue score (VAS) score ≥7;
(3) patients' informed consent.

Exclusion criteria:

(1) patients with bilateral rib fractures, sternal fractures, or severe trauma outside the chest wall;
(2) patients with pre-existing severe vertebral deformities, local infections at the site of injection, and coagulation disorders;
(3) patients known to be allergic to local anesthetics used in the study;
(4) patients admitted to the ICU after the operation;
(5) Patients unable to communicate effectively.

After applying the inclusion and exclusion criteria, a total of 82 patients were included, with a mean age of (36.24 ± 9.68) years, 55 males and 27 females. The most common cause of fracture among the included patients was traffic accidents, accounting for 70.73% (58/82) of the patients, followed by fall from height (14.63%), direct blow (10.98%) and others (3.66%). The patients were divided into TPVB and INB groups using random number table method, with 41 patients in each group.

There was no statistically significant difference between the two groups in terms of age, gender, body mass index (BMI), number of rib fractures, fracture site and cause of fracture (P>0.05). **[Table 1]**

Tab.1 Comparison of general characteristics between TPVB group and INB group

Indicators	TPVB group (n=41)	INB group (n=41)	t/χ^2 value	P value
Age (years, $\bar{x}\pm s$)	36.39±10.07	36.06±9.41	0.136	0.892
Gender [Male, case (%)]	26（63.41）	29（70.73）	0.497	0.481
BMI（kg/m^2, $\bar{x}\pm s$）	25.24±2.01	24.56±1.32	1.811	0.074
Number of rib fractures（$\bar{x}\pm s$）	4.85±1.06	4.56±0.95	1.315	0.192
Fracture site [case (%)]				
Left side	24（58.54）	26（63.41）	0.205	0.651
Right side	17（41.46）	15（36.59）		
Cause of fracture [case (%)]				
Traffic accidents	28（68.29）	30（73.17）		
Fall from height	7（17.07）	5（12.20）	0.847	0.838
Direct blow	4（9.76）	5（12.20）		
Others	2（4.88）	1（2.40）		

1.2 Anaesthesia protocol

TBVP group: The patient was placed in the lateral position after general anesthesia, and TPVB was performed at the level of the vertebrae between above and below the fractured ribs or two segments below the highest fractured ribs. An ultrasound probe (Fujifilm Sonosite, USA) was used to identify the spinous process, transverse process, pleura, transverse costal ligament, and the paravertebral space at the level of the target vertebrae. After infiltrating the skin and subcutaneous tissues with 2-3 mL of 2% lidocaine, the puncture needle was punctured into the paravertebral space under ultrasound guidance, and after suctioning without regurgitation, 20 mL of 0.33% ropivacaine was injected.

INB group: The patient was placed in the lateral position after general anesthesia, and the procedure was performed in the intercostal space between above and below the fractured rib. An ultrasound probe (Fujifilm Sonosite, USA) was used to visualize the ribs, intercostal muscles and pleura. After infiltrating the skin and subcutaneous tissues with 2-3 mL of 2% lidocaine, a puncture needle was targeted to the lower edge of the rib under ultrasound guidance, and after aspiration without regurgitation, 5 mL of 0.33% ropivacaine was injected into the intercostal space.

1.3 Observing indicators

(1) The VAS was used to assess pain of patients (range 0-10, with larger scores indicating more severe pain) as baseline, 1, 6, 18, and 36 hours postoperatively, including at rest and when coughing.
(2) If the patient's VAS score was >3 at rest or if the patient requested it, analgesia was given, and the time and dose of opioids were recorded, and the opioid dosage was calculated using converted morphine equivalents.
(3) Pulmonary-related complications such as pulmonary atelectasis, pulmonary infection, pneumothorax, and other non-pulmonary-related complications such as nausea and vomiting, cardiac arrhythmia, drowsiness, and hemorrhage at the puncture site, were observed in the patient within 72 hours after the operation.
These observational indicators were assessed and data were collected by a physician unaware of the blockade technique performed.

1.4 Statistical methods

Data processing was performed using SPSS 26.0. Measurement data were expressed as $\bar{x} \pm s$, and *t*-test was used for comparison between groups. Count data were expressed as cases and percentages, and chi-square test was used for comparison between groups. Time to first analgesic medication was described by Kaplan-Meier survival analysis, and the mean time to first analgesic medication was compared between the two groups using log-rank test. VAS pain scores at baseline, 1, 6, 18, and 36 hours were compared using repeated measures analysis of variance and LSD-*t* test. $P<0.05$ was considered statistically significant difference.

2 Results

2.1 Time and dosage of postoperative analgesics in the two groups

Comparison of the analgesic effects of the two blocking regimens according to the time of the patient's first postoperative application of analgesics. Kaplan-Meier curve analysis showed a statistically significant difference between the two groups in the time of first use of analgesics ($\chi^2 = 6.125$, $P = 0.013$). **[Figure 1]** The proportion of patients requiring postoperative analgesia was significantly lower in the TPVB group than in the INB group for both 24 and 48 hours ($P < 0.05$). The total dose of analgesics used in the TPVB group was significantly lower than that used in the INB group from 25 to 48 hour ($P < 0.01$), whereas the difference in the total dose of analgesics used in the two groups was not statistically significant from 0 to 24 hour ($P >0.05$). **[Table 2]**

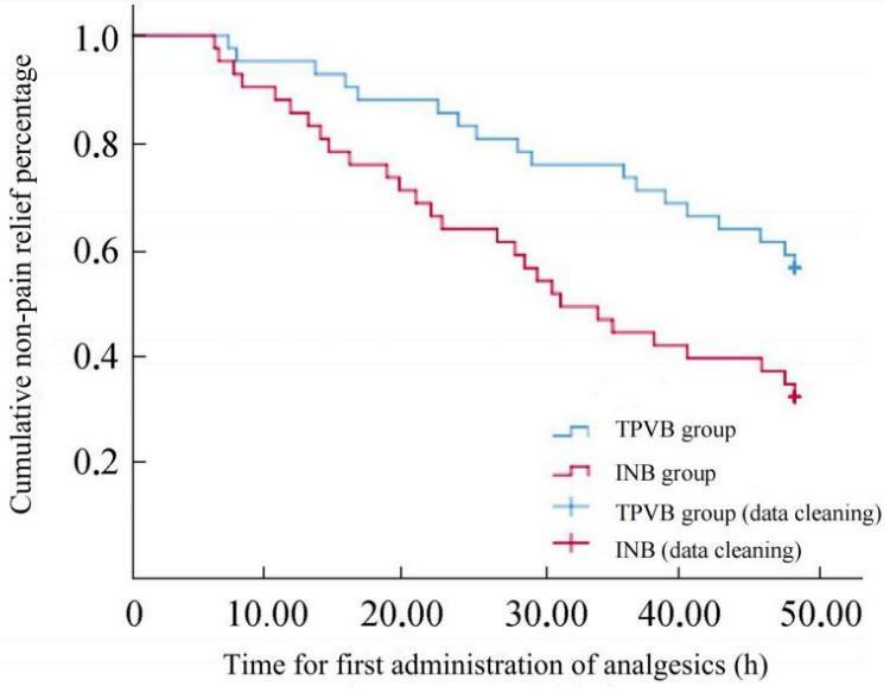

Fig.1 Kaplan-Meier curve of time for the first administration of analgesics

Tab. 2 Comparison of the proportion and dosage of analgesics between two groups of patients 24 to 48 hours after operation （n=41）

Group	Analgesia within 24 h [case(%)]	Total dosage of analgesics in 0-24 h (mg，$\bar{x}\pm s$)	Analgesia within 48 h [case (%)]	Total dosage of analgesics in 25-48 h (mg，$\bar{x}\pm s$)
TPVB group	7（19.51）	26.24±15.83	17（41.46）	13.78±9.48
INB group	16（36.59）	30.73±16.84	26（63.41）	26.20±12.31
χ^2/t value	4.895	0.598	3.961	3.527
***P* value**	0.027	0.556	0.047	0.001

2.2 VAS scores at rest and when coughing

(1) At rest: there was no statistically significant difference in baseline VAS scores at rest between the two groups (P >0.05), and the VAS scores at rest decreased significantly at all time points after drug administration (P<0.01). The VAS scores at rest in the TPVB group were lower than those in the INB group at 6 h and 18 h postoperatively (P<0.05), whereas the difference between the two groups at 1 h and 36 h postoperatively were not statistically significant (P >0.05). **[Table 3]**

(2) When coughing: there was no statistically significant difference in baseline VAS scores at coughing between the two groups (P>0.05), and the VAS scores at coughing decreased significantly at all time points after drug administration (P<0.01). The VAS scores at coughing in the TPVB group were lower than those in the INB group at 1, 6, and 18 h postoperatively (P<0.05), whereas the difference between the two groups at 36 hour postoperatively was not statistically significant (P>0.05). **[Table 4]**

Tab. 3 Comparison of VAS scores at rest between TPVB group and INB group（n=41，$\bar{x}\pm s$）

Group	Baseline	1 h postoperatively	6 h postoperatively	18 h postoperatively	36 h postoperatively
TPVB group	8.15±1.33	0.71±0.75[a]	2.39±0.83[a]	2.24±0.77[a]	1.17±0.44[b]
INB group	8.32±1.31	1.05±0.95[a]	3.24±1.34[ab]	2.78±1.01[ab]	1.32±0.52[b]
F / P_{group} value			5.312/0.024		
F/ P_{time} value			10.351/<0.001		
F / $P_{interaction}$ value			12.776/<0.001		

Note: Compared with baseline, [a]P<0.05; compared with TPVB group at the same time point, [b]P<0.05.

Tab. 4 Comparison of VAS scores when coughing between TPVB group and INB group（n=41，$\bar{x}\pm s$）

Group	Baseline	1 h postoperatively	6 h postoperatively	18 h postoperatively	36 h postoperatively
TPVB group	9.12±0.68	1.63±0.58[a]	3.07±0.72[a]	2.37±0.54[a]	1.51±0.51[a]
INB group	9.22±0.76	1.98±0.72[ab]	3.59±0.63[ab]	2.85±0.65[ab]	1.68±0.61[a]
F / P_{group} value			23.075/<0.001		
F/ P_{time} value			33.551/<0.001		
F / $P_{interaction}$ value			25.418/<0.001		

Note: Compared with baseline, [a]P<0.05; compared with TPVB group at the same time point, [b]P<0.05.

2.3 Incidence of pulmonary complications in the two groups

Four cases of pulmonary atelectasis and one case of pulmonary infection occurred in the TPVB group; five cases of pulmonary atelectasis, three cases of pulmonary infection, and one case of pneumothorax occurred in the INB group. There was no statistically significant difference in the incidence of pulmonary complications between the two groups (12.20% *vs* 19.51%, χ^2=0.599, P=0.439).

2.4 Incidence of other complications in the two groups

Four cases of nausea and vomiting, one case of cardiac arrhythmia, one case of drowsiness and one case of hemorrhage at the puncture site were observed in the

TPVB group, and six cases of malignant vomiting, one case of cardiac arrhythmia and one case of drowsiness were observed in the patients in the INB group. There was no statistically significant difference in the total incidence of other complications between the two groups (17.07% *vs* 19.51%, χ^2=0.061, *P*=0.812).

3 Discussion

Pain in traumatic multiple rib fractures is usually severe and difficult to control, leading to altered respiratory dynamics and potential limitations in mobility [10]. Appropriate analgesia can prevent serious complications such as pulmonary atelectasis and pneumonia. In young patients with one or two rib fractures, nonsteroidal anti-inflammatory drugs (NSAIDs) are usually sufficient. However, for elderly patients, those with multiple rib fractures, severe pain, or impaired lung function, regional anesthesia techniques are the preferred choice for relieving rib fracture pain [9].

This study observed the efficacy of TPVB and INB by assessing the time to first use of analgesics and total analgesic consumption at 0-24 h and 25-48 h post-block. The results showed that when local anesthetics were injected into the paravertebral spaces, the analgesic effect was better than that when local anesthetics were injected into the intercostal spaces, and the proportions of patients requiring postoperative analgesia were significantly lower in the TPVB group than that in the INB group for both 24 h and 48 h. The proportion of patients requiring postoperative analgesic was significantly lower in the TPVB group than in the INB group in both 24 h and 48 h. The total dosage of pulmonary used in the TPVB group was significantly lower than that of patients in the INB group in the 25-48 h period. Moreover, both TPVB and INB were effective in decreasing the pain scores of the patients with multiple rib fractures, with the VAS scores lower than that of the INB group in the TPVB group than the INB group at rest in the 6 h and 18 h periods after the operation, and also lower than the INB group during the coughing period in the 1 h, 6 h and 18 h after the operation. Therefore, for the choice of analgesia for unilateral multiple rib fractures, TPVB may be more recommended compared to INB.

There are fewer studies comparing the analgesic effect and safety of TPVB and INB in patients with unilateral multiple rib fractures, and most of the studies mainly focus on the application of the two in thoracoscopy and do not obtain uniform results. Some studies found that TPVB had a better analgesic effect [12,14], while others indicated a comparable effect between TPVB and INB [13]. Wang *et al.* [15] concluded that VAS scores and opioid dosage were lower in TPVB patients than in INB patients during the 25-48 h postoperatively. One study confirmed that ultrasound-guided TPVB was superior to INB by comparing postoperative morphine dosage, and VAS scores at rest and when coughing [16]. Although the population selected for this study was different from the above studies, the final results were consistent.

In addition, this study also observed the incidence of pulmonary and non-pulmonary complications in the two groups within 72 hours. The results showed that there were four cases of pulmonary atelectasis and one case of pulmonary infection in the TPVB group, and five cases of pulmonary atelectasis, three cases of pulmonary infection and one case of pneumothorax in the INB group; there were four cases of nausea and vomiting, one case of arrhythmia, one case of drowsiness and one case of hematoma at the puncture site in the TPVB group, six cases of nausea and vomiting, one case of arrhythmia and one case of drowsiness in the INB group; the difference between the incidence of pulmonary and non-pulmonary complications between the two groups was not statistically significant. In the INB group, the incidence of pulmonary and non-pulmonary complications was 1 case of arrhythmia and 1 case of drowsiness. The difference between the incidence of pulmonary and non-pulmonary complications of the two groups was not statistically significant. The above results were similar to the studies of Guo *et al.* [14] and Wang *et al.* [17]. However, Zhang *et al.* [18] concluded that there was a reduction in opioid dosage and a lower rate of postoperative complications after TPVB compared to INB.

This study has some limitations. Firstly, the analgesic effect of intravenous opioids was not compared with that of INB. Secondly, the operations were performed after the patients were under general anesthesia in order to reduce the patients' intraoperative discomfort, so the level of block and the time of block onset were not measured. Finally, follow-up was not prolonged, and efficacy was not evaluated regarding length of hospital stay, intensive care unit stay, and long-term complications.

In conclusion, compared with INB, ultrasound-guided TPVB can effectively reduce pain, prolong the duration of analgesia, and reduce opioid consumption in patients with unilateral multiple rib fractures.

Conflict of Interest: None

References

[1] Tignanelli CJ, Rix A, Napolitano LM, et al. Association between adherence to evidence-based practices for treatment of patients with traumatic rib fractures and mortality rates among US trauma centers[J]. JAMA Netw Open, 2020, 3(3): e201316.

[2] Bugaev N, Breeze JL, Alhazmi M, et al. Magnitude of rib fracture displacement predicts opioid requirements[J]. J Trauma Acute Care Surg, 2016, 81(4): 699-704.

[3] Kumar R, Sharma A, Bansal R, et al. Re: is erector spinae plane block useful in preventing the transition from acute to chronic pain after multiple rib fractures?[J]. Turk J Anaesthesiol Reanim, 2020, 48(2): 169.
[4] Gongola A, Bradshaw JC, Jin J, et al. Retrospective study on rib fractures: smoking and alcohol matter for mortality and complications[J]. Trauma Surg Acute Care Open, 2021, 6(1): e000732.
[5] Lynch N, Salottolo K, Foster K, et al. Comparative effectiveness analysis of two regional analgesia techniques for the pain management of isolated multiple rib fractures[J]. J Pain Res, 2019, 12: 1701-1708.
[6] Duong W, Grigorian A, Nahmias J, et al. An increasing trend in geriatric trauma patients undergoing surgical stabilization of rib fractures[J]. Eur J Trauma Emerg Surg, 2022, 48(1): 205-210.
[7] Beks RB, Reetz D, de Jong MB, et al. Rib fixation versus non-operative treatment for flail chest and multiple rib fractures after blunt thoracic trauma: a multicenter cohort study[J]. Eur J Trauma Emerg Surg, 2019, 45(4): 655-663.
[8] Dogrul BN, Kiliccalan I, Asci ES, et al. Blunt trauma related chest wall and pulmonary injuries: an overview[J]. Chin J Traumatol, 2020, 23(3): 125-138.
[9] Kim M, Moore JE. Chest trauma: current recommendations for rib fractures, pneumothorax, and other injuries[J]. Curr Anesthesiol Rep, 2020, 10(1): 61-68.
[10] Kim J, Lee HJ, Lee YJ, et al. Ultrasound-guided thoracic paravertebral block as a sympathetic blockade for upper extremity neuropathic pain: a prospective pilot study[J]. J Pain Res, 2020, 13: 3395-3403.
[11] Deng G, Gofeld M, Reid JN, et al. A retrospective cohort study of healthcare utilization associated with paravertebral blocks for chronic pain management in Ontario[J]. Can J Pain, 2021, 5(1): 130-138.
[12] Liu XL,Jiang P,Wang YT.Effects of serratus anterior plane block and thoracic paravertebral block on postoperative analgesia and stress response in breast cancer patients[J]. Chin J Clin Res, 2022,35(12):1689-1692，1698. **[In Chinese]**
[13] Li JS, An J, Song HW, et al. Anesthesia and postoperative analgesic effects of general anesthesia combined with thoracic paravertebral block in patients undergoing thoracoscopic radical resection of lung cancer[J]. Oncol Prog, 2021, 19(10): 1019-1022.**[In Chinese]**
[14] Guo YH, (A/'e/'ei) LD, Li KB, et al. Effects of ultrasound-guided intercostal nerve block and multiple injections of thoracic paravertebral block on postoperative analgesia in elderly patients undergoing thoracoscopic surgery[J]. Chin J Gerontol, 2022, 42(22): 5498-5501.**[In Chinese]**
[15] Wang C. Prospective randomized controlled study of ultrasound-guided paravertebral nerve block and intercostal nerve block in pain control after video-assisted thoracoscopic surgery[J]. Biomed Eng Clin Med, 2020, 24(2): 144-147. **[In Chinese]**
[16] Chen N, Qiao Q, Chen RM, et al. The effect of ultrasound-guided intercostal nerve block, single-injection erector spinae plane block and multiple-injection paravertebral block on postoperative analgesia in thoracoscopic surgery: a randomized, double-blinded, clinical trial[J]. J Clin Anesth, 2020, 59: 106-111.
[17] Wang FF, Wang Z, Xu ZY. Comparison of ultrasound-guided thoracic paravertebral nerve block and intercostal nerve block[J]. J Nantong Univ Med Sci, 2022, 42(3): 244-247.**[In Chinese]**
[18] Zhang R, Huo F, Tian L, et al. Comparison of analgesic effect of ultrasound-guided paravertebral block and intercostal nerve block after thoracoscopic pulmonary surgery[J]. J Clin Anesthesiol, 2020, 36(9): 886-889. **[In Chinese]**

Submission received: 2023-09-10 / **Revised**:2023-11-24

·论　著·

超声引导下胸椎旁神经阻滞与肋间神经阻滞在多发肋骨骨折患者中的镇痛效果对比

李晓芳[1]，　赵莉[2]，　纪亚男[1]

1. 新疆医科大学第五附属医院麻醉科，新疆 乌鲁木齐 830011；2. 哈密市中心医院麻醉科，新疆 哈密 839000

摘要：目的　对比在多发性肋骨骨折患者中采用超声引导下胸椎旁神经阻滞（TPVB）和肋间神经阻滞（INB）的镇痛效果和安全性。**方法**　选择 2022 年 1 月至 2023 年 6 月在新疆医科大学第五附属医院就诊的单侧肋骨骨折行切开复位内固定术治疗的患者。共纳入满足纳入和排除标准的 82 例患者，采用随机数字表将患者分为 TPVB 组（全麻后给予0.33%罗哌卡因 20 mL 行 TPVB）和 INB 组（全麻后给予 0.33%罗哌卡因 5 mL 行 INB），每组 41 例。使用视觉模拟评分（VAS）评估患者疼痛，记录镇痛药物用药时间及剂量。观察患者术后 72 h 肺部及非肺部并发症情况。**结果**　Kaplan-Meier 曲线显示，两组患者首次使用镇痛药的时间比较差异有统计学意义（$\chi^2=6.125$，$P=0.013$）。术后 24 h 和 48 h 内 TPVB 组有镇痛需求患者比例均显著低于 INB 组患者（19.51% *vs* 36.59%，$\chi^2=4.895$，$P=0.027$；41.46% *vs* 63.41%，$\chi^2=3.961$，$P=0.047$），TPVB 组患者 25～48 h 使用镇痛药物总剂量显著低于 INB 组患者［（13.78±9.48）mg *vs*（26.20±12.31）mg，$t=3.527$，$P<0.01$］。两组术后所有时间点静息时和咳嗽时的 VAS 评分均显著下降（$P<0.01$），且 TPVB 组术后 6、18 h 静息时 VAS 评分低于 INB 组，术后 1、6、18 h 咳嗽时 VAS 评分低于 INB 组，差异有统计学意义（$P<0.05$）。两组患者肺部及非肺部并发症发生率比较差异均无统计学意义（$P>0.05$）。**结论**　相较于 INB，超声引导下的 TPVB 可有效缓解单侧多发性肋骨骨折患者的疼痛并减少阿片类药物消耗。

关键词：多发肋骨骨折；镇痛；胸椎旁神经阻滞；肋间神经阻滞；超声引导；肺部并发症

中图分类号：R614.4　**文献标识码：**A　**文章编号：**1674-8182（2024）04-0514-05

Comparison of analgesic effects between ultrasound-guided thoracic paravertebral block and intercostal nerve block in patients with multiple rib fractures

LI Xiaofang*, ZHAO Li, JI Yanan

* *Department of Anesthesiology, The Fifth Affiliated Hospital of Xinjiang Medical University, Urumqi, Xinjiang 830011, China*

Abstract: Objective　To compare the analgesic effects and safety of ultransound-guided thoracic paravertebral block (TPVB) and intercostal nerve block (INB) in patients with unilateral multiple rib fractures. **Methods**　Patients with unilateral multiple rib fractures treated by surgery at the Fifth Affiliated Hospital of Xinjiang Medical University from January 2022 to June 2023 were selected. A total of 82 patients who met the inclusion and exclusion criteria were included, and divided into TPVB group (20 mL of ropivacaine 0.33% for TPVB after general anesthesia) and INB group (5 mL of ropivacaine 0.33% for INB after general anesthesia) by random number table method, with 41 patients in each group. The visual analog score (VAS) was used to assess patient's pain, and the time and dosage of analgesics were recorded. The pulmonary and non-pulmonary complications within 72 hours after operation were observed. **Results**　Kaplan-Meier curves showed that there was a statistically significant difference in first use time of analgesics between the two groups ($\chi^2=6.125$, $P=0.013$). The proportion of patients with analgesia demand in the TPVB group was significantly lower than that in the INB group within 24 hours after operation (19.51% *vs* 36.59%, $\chi^2=4.895$, $P=0.027$) and 48 hours after operation (41.46% *vs* 63.41%, $\chi^2=3.961$, $P=0.047$), and the total dose of analgesics used

DOI：10.13429/j.cnki.cjcr.2024.04.006

出版日期：2024-04-20

QR code for English version

in the TPVB group 25-48 hours after operation was significantly lower than that in the INB group [(13.78±9.48) mg *vs* (26.20±12.31) mg, t = 3.527, P<0.01]. VAS scores at rest and during coughing at all time points after surgery significantly decreased in both groups (P<0.01). At 6 and 18 hours postoperatively, the VAS score at rest in the TPVB group was lower than that in the INB group, and at 1, 6, and 18 hours postoperatively, the VAS score when coughing in the TPVB group was lower than that in the INB group, with statistically significant differences (P<0.05). There was no statistically significant difference in the incidence of pulmonary and non-pulmonary complications between the two groups (P>0.05). **Conclusion** Ultrasound-guided TPVB can effectively alleviate pain and reduce opioid consumption in patients with unilateral multiple rib fractures compared with INB.

Keywords: Multiple rib fracture; Analgesia; Thoracic paravertebral block; Intercostal nerve block; Ultrasonic guidance; Pulmonary complication

肋骨骨折最常见的原因是胸部钝挫伤,在所有创伤患者中发生率高达 12%[1]。肋骨骨折本身及其相关的并发症、残疾和死亡构成了重大的医疗保健负担[2-3]。据估计,三分之一的创伤性肋骨骨折患者出现继发性肺部并发症的相关死亡率高达 65%[4-6]。单发肋骨骨折的患者并发症发生率较低,口服非甾体抗炎药即可止痛[7-9]。多发性肋骨骨折,疼痛通常更严重,并经常改变呼吸动力学,呼吸过程中疼痛加剧会导致浅呼吸和无效咳嗽,从而导致气道分泌物清除不足和痰液滞留,可引发并发症[10-11],因而充分的镇痛对于预防肺不张和肺炎等并发症至关重要。近年来,区域麻醉技术因能减少术后疼痛及相关并发症而发挥越来越重要的作用。用于治疗肋骨骨折的区域麻醉技术包括胸椎旁神经阻滞(thoracic paravertebral block, TPVB)[12]和肋间神经阻滞(intercostal nerve block, INB)等,而这两种麻醉技术哪一种镇痛效果及安全性更好仍然存在争议[13]。本研究旨在对比 TPVB 与 INB 在多发性肋骨骨折患者中的镇痛效果和安全性。现报道如下。

1　资料与方法

1.1　一般资料　选择 2022 年 1 月至 2023 年 6 月在新疆医科大学第五附属医院就诊的单侧多发肋骨骨折行切开复位内固定术治疗的患者。纳入标准:(1) 单侧多发肋骨骨折患者;(2) 术前视觉模拟评分(VAS)评分≥7;(3) 患者知情同意。排除标准:(1) 双侧肋骨骨折、胸骨骨折或胸壁外有严重创伤的患者;(2) 既往存在脊柱畸形,注射部位局部感染、凝血功能障碍等;(3) 已知对研究中使用的局部麻醉药过敏者;(4) 术后进入 ICU 者;(5) 不能有效沟通者。在满足纳入和排除标准后,共纳入 82 例患者,年龄(36.24±9.68)岁,男性 55 例,女性 27 例;82 例中最主要的骨折原因是交通事故,为 58 例(70.73%),其次是高空坠落 12 例(14.63%)、直接击打 9 例(10.98%)和其他 3 例(3.66%)。采用随机数字表将患者分为 TPVB 组和 INB 组,各 41 例。两组患者的基线资料差异均无统计学意义(P>0.05)。见表 1。本研究经医院伦理委员会审批(审批号:XYDWFYLSH-2023-113)。

表 1　TPVB 组和 INB 组患者一般特征对比

Tab. 1　Comparison of general characteristics between TPVB group and INB group

项目	TPVB 组(n=41)	INB 组(n=41)	t/χ^2 值	P 值
年龄(岁, $\bar{x}\pm s$)	36.39±10.07	36.06±9.41	0.136	0.892
性别[男, 例(%)]	26(63.41)	29(70.73)	0.497	0.481
BMI(kg/m^2, $\bar{x}\pm s$)	25.24±2.01	24.56±1.32	1.811	0.074
肋骨骨折数($\bar{x}\pm s$)	4.85±1.06	4.56±0.95	1.315	0.192
骨折部位[例(%)]				
左侧	24(58.54)	26(63.41)	0.205	0.651
右侧	17(41.46)	15(36.59)		
骨折原因[例(%)]				
交通事故	28(68.29)	30(73.17)		
高空坠落	7(17.07)	5(12.20)		
直接击打	4(9.76)	5(12.20)	0.847	0.838
其他	2(4.88)	1(2.40)		

1.2　麻醉方案　TPVB 组:全麻后患者被置于侧卧位,在骨折肋骨上方和下方之间的脊椎水平或最高骨折肋骨下方 2 段进行 TPVB。超声探头(美国富士索诺声)用于识别棘突、横突、胸膜、肋横突韧带和目标椎体水平的椎旁间隙。用 2~3 mL 2%利多卡因渗透皮肤和皮下组织后,在超声引导下将穿刺针穿刺进入椎旁间隙,抽吸无回血后,注射 0.33%罗哌卡因 20 mL。INB 组:全麻后患者被置于侧卧位,在骨折肋骨上方和下方之间肋间隙进行 INB。超声探头(美国富士索诺声)用于观察肋骨、肋间肌和胸膜。用 2~3 mL 2%利多卡因渗透皮肤和皮下组织后,在超声引导下将穿刺针穿刺靶向肋骨下边缘,抽吸无回血后,将0.33%罗哌卡因 5 mL 注射到肋间隙中。

1.3　观察指标　(1) 使用 VAS 评估患者疼痛(范围 0 ~ 10 分,分数越大表示疼痛越重),由患者根据自身疼痛体验客观记录疼痛评分,疼痛评估时间点为基线、术后 1、6、18、36 h,包括静息时和咳嗽时。(2) 如

果患者静息时 VAS 评分>3 或患者有需求，则给予镇痛处理，并记录阿片类药物的使用时间及剂量，采用转换吗啡当量计算阿片类药物用量。（3）观察患者术后 72 h 内肺不张、肺部感染、气胸等肺部相关并发症，观察患者术后 72 h 内恶心呕吐、心律失常、嗜睡、穿刺部位血肿等其他非肺部相关并发症。以上观察指标均由一位对所执行的阻滞技术不知情的医生对患者进行评估并收集数据。

1.4　*统计学方法*　使用 SPSS26.0 软件进行数据处理。计量资料以 $\bar{x}\pm s$ 表示，组间比较采用成组 t 检验；计数资料以例和百分比表示，组间比较采用 χ^2 检验；通过 Kaplan-Meier 生存分析描述两组首次镇痛药物的使用时间，并采用 log-rank 检验进行比较。基线、1、6、18 和 36 h 的 VAS 疼痛评分比较采用重复测量方差分析及两两比较的 LSD-t 检验。P<0.05 为差异具有统计学意义。

2　结　果

2.1　*两组患者术后使用镇痛药的时间和用量*　根据患者术后首次应用镇痛药物的时间对比两种阻滞方案的镇痛效果，Kaplan-Meier 曲线分析显示两组患者首次使用镇痛药的时间比较差异有统计学意义（χ^2 = 6.125，P=0.013）。见图 1。24 h 和 48 h 内 TPVB 组有术后镇痛需求患者比例均显著低于 INB 组患者（P<0.05），TPVB 组患者 25~48 h 使用镇痛药物总剂量显著低于 INB 组患者（P<0.01），而两组患者 0~24 h 使用镇痛药物总剂量差异无统计学意义（P>0.05）。见表 2。

2.2　*静息时和咳嗽时 VAS 评分*　（1）静息时：两组静息时基线 VAS 疼痛评分差异无统计学意义（P>0.05），术后所有时间点静息时 VAS 评分均显著下降（P<0.01）；术后 6、18 h TPVB 组静息时 VAS 评分低于 INB 组（P<0.05），而术后 1、36 h 时两组间差异无统计学意义（P>0.05）。见表 3。（2）咳嗽时：两组患者咳嗽时基线 VAS 评分差异无统计学意义（P>0.05），术后所有时间点咳嗽时 VAS 评分均显著下降（P<0.01）；术后 1、6、18 h TPVB 组咳嗽时 VAS 评分低于 INB 组（P<0.05），而术后 36 h 两组间差异无统计学意义（P>0.05）。见表 4。

2.3　*两组患者肺部并发症发生率*　TPVB 组出现肺不张 4 例、肺部感染 1 例；INB 组患者出现肺不张 5 例、肺部感染 3 例、气胸 1 例。两组患者肺部并发症发生率比较差异无统计学意义（12.20% *vs* 19.51%，χ^2 = 0.599，P=0.439）。

2.4　*两组患者其他并发症发生率*　TPVB 组出现恶性呕吐 4 例、心律失常 1 例、嗜睡 1 例和穿刺部位血肿 1 例；INB 组患者出现恶心呕吐 6 例、心律失常 1 例和嗜睡 1 例。两组患者其他并发症总发生率比较差异无统计学意义（17.07% *vs* 19.51%，χ^2 = 0.061，P=0.812）。

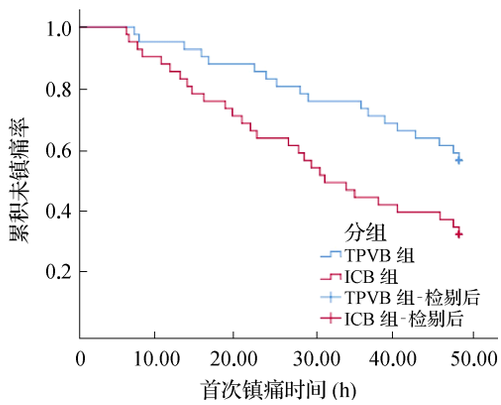

图 1　首次使用镇痛药时间的 Kaplan-Meier 曲线

Fig. 1　Kaplan-Meier curve of time for the first administration of analgesics

表 2　两组患者术后使用镇痛药的比例和用量比较　（n=41）

Tab. 2　Comparison of the proportion and dosage of analgesics between two groups of patients after operation　（n=41）

组别	24 h 内有镇痛［例(%)］	0~24 h 镇痛药物总剂量(mg, $\bar{x}\pm s$)	48 h 内有镇痛［例(%)］	25~48 h 镇痛药物总剂量(mg, $\bar{x}\pm s$)
TPVB 组	7(19.51)	26.24±15.83	17(41.46)	13.78±9.48
INB 组	16(36.59)	30.73±16.84	26(63.41)	26.20±12.31
χ^2/t 值	4.895	0.598	3.961	3.527
P 值	0.027	0.556	0.047	0.001

表 3　TPVB 组与 INB 组静息时的 VAS 评分比较　（n=41，$\bar{x}\pm s$）

Tab. 3　Comparison of VAS scores at rest between TPVB group and INB group　（n=41，$\bar{x}\pm s$）

组别	基线	术后 1 h	术后 6 h	术后 18 h	术后 36 h
TPVB 组	8.15±1.33	0.71±0.75[a]	2.39±0.83[a]	2.24±0.77[a]	1.17±0.44[a]
INB 组	8.32±1.31	1.05±0.95[a]	3.24±1.34[ab]	2.78±1.01[ab]	1.32±0.52[a]
$F_{组间}/P_{组间}$			5.312/0.024		
$F_{时间}/P_{时间}$			10.351/<0.001		
$F_{交互}/P_{交互}$			12.776/<0.001		

注：与本组基线比较，[a]P<0.05；与 TPVB 组比较，[b]P<0.05。

表 4　TPVB 组与 INB 组咳嗽时的 VAS 评分比较　（n=41，$\bar{x}\pm s$）

Tab. 4　Comparison of VAS scores during cough between TPVB group and INB group　（n=41，$\bar{x}\pm s$）

组别	基线	术后 1 h	术后 6 h	术后 18 h	术后 36 h
TPVB 组	9.12±0.68	1.63±0.58[a]	3.07±0.72[a]	2.37±0.54[a]	1.51±0.51[a]
INB 组	9.22±0.76	1.98±0.72[ab]	3.59±0.63[ab]	2.85±0.65[ab]	1.68±0.61[a]
$F_{组间}/P_{组间}$			23.075/<0.001		
$F_{时间}/P_{时间}$			33.551/<0.001		
$F_{交互}/P_{交互}$			25.418/<0.001		

注：与本组基线比较，[a]P<0.05；与 TPVB 组比较，[b]P<0.05。

3　讨　论

外伤性多发肋骨骨折的疼痛通常很严重，难以控

制,可能影响呼吸动力学,甚至限制运动能力[10]。适当的镇痛可以预防肺不张和肺炎等严重并发症发生。对于一根或两根肋骨骨折的年轻患者,非甾体类抗炎药通常是足够的。而对于老年患者、多发肋骨骨折、剧烈疼痛或肺功能受损的患者,区域麻醉技术是缓解肋骨骨折疼痛的首选[9]。

本研究通过阻滞后第一次使用镇痛药物时间和 0~24 h、25~48 h 镇痛药物总消耗量来观察 TPVB 和 INB 的疗效,结果表明,当将局麻药注射到椎旁间隙时,其镇痛效果比将局麻药注射到肋间时的镇痛效果好,24 h 和 48 h 内 TPVB 组有术后镇痛需求患者比例均显著低于 INB 组患者,25~48 h 使用镇痛药物总剂量显著低于 INB 组患者;此外,TPVB 和 INB 均能有效降低多发肋骨骨折患者疼痛评分,在术后 6、18 h TPVB 组静息时 VAS 评分低于 INB 组,且在术后 1、6、18 h 咳嗽时 VAS 评分也低于 INB 组。因此,对单侧多发肋骨骨折镇痛的选择,相较于 INB,可能 TPVB 更值得推荐。目前关于 TPVB 和 INB 在单侧多发性肋骨骨折患者中的镇痛效果和安全性比较的研究较少,多数研究主要集中于二者在胸腔镜方面的应用,且未获得统一的结果,有的研究指出 TPVB 镇痛效果更好[12,14],也有研究认为两者镇痛效果相当[13]。王辰[15]研究认为,在术后 25~48 h,TPVB 患者 VAS 评分和阿片类药物用量均低于 INB 患者。一项研究对比术后吗啡用量、静息时和咳嗽时 VAS 评分,证实超声引导下 TPVB 效果优于 INB[16]。虽然本研究与以上研究选择的人群不同,但最终结果一致。

另外,本研究还观察了 72 h 内两组患者并发症发生率,结果显示 TPVB 组出现肺不张 4 例、肺部感染 1 例,INB 组患者出现肺不张 5 例、肺部感染 3 例、气胸 1 例;TPVB 组出现恶心呕吐 4 例、心律失常 1 例、嗜睡 1 例和穿刺部位血肿 1 例,INB 组患者出现恶心呕吐 6 例、心律失常 1 例和嗜睡 1 例,两组患者肺部及非肺部并发症发生率比较差异无统计学意义,上述结果与郭延洪等[14]和王锋锋等[17]的研究类似。然而,张冉等[18]研究认为,与 INB 比较,TPVB 术后并发症发生率降低。

本研究的局限性:首先,未和静脉注射阿片类药物镇痛效果进行对比;其次,为了减少患者术中不适,操作均在患者全麻后进行,故阻滞水平及阻滞起效时间未测量;最后,未增加随访时间,未从住院和重症监护住院时间及远期并发症方面评价疗效。

综上所述,相较于 INB,超声引导下的 TPVB 可有效缓解单侧多发性肋骨骨折患者的疼痛,具有较长的镇痛持续时间,可以减少阿片类药物消耗。

利益冲突　无

参考文献

[1] Tignanelli CJ, Rix A, Napolitano LM, et al. Association between adherence to evidence-based practices for treatment of patients with traumatic rib fractures and mortality rates among US trauma centers [J]. JAMA Netw Open, 2020, 3(3): e201316.

[2] Bugaev N, Breeze JL, Alhazmi M, et al. Magnitude of rib fracture displacement predicts opioid requirements[J]. J Trauma Acute Care Surg, 2016, 81(4): 699-704.

[3] Kumar R, Sharma A, Bansal R, et al. Re: is erector spinae plane block useful in preventing the transition from acute to chronic pain after multiple rib fractures? [J]. Turk J Anaesthesiol Reanim, 2020, 48(2): 169.

[4] Gongola A, Bradshaw JC, Jin J, et al. Retrospective study on rib fractures: smoking and alcohol matter for mortality and complications [J]. Trauma Surg Acute Care Open, 2021, 6(1): e000732.

[5] Lynch N, Salottolo K, Foster K, et al. Comparative effectiveness analysis of two regional analgesia techniques for the pain management of isolated multiple rib fractures [J]. J Pain Res, 2019, 12: 1701-1708.

[6] Duong W, Grigorian A, Nahmias J, et al. An increasing trend in geriatric trauma patients undergoing surgical stabilization of rib fractures[J]. Eur J Trauma Emerg Surg, 2022, 48(1): 205-210.

[7] Beks RB, Reetz D, de Jong MB, et al. Rib fixation versus non-operative treatment for flail chest and multiple rib fractures after blunt thoracic trauma: a multicenter cohort study [J]. Eur J Trauma Emerg Surg, 2019, 45(4): 655-663.

[8] Dogrul BN, Kiliccalan I, Asci ES, et al. Blunt trauma related chest wall and pulmonary injuries: an overview[J]. Chin J Traumatol, 2020, 23(3): 125-138.

[9] Kim M, Moore JE. Chest trauma: current recommendations for rib fractures, pneumothorax, and other injuries[J]. Curr Anesthesiol Rep, 2020, 10(1): 61-68.

[10] Kim J, Lee HJ, Lee YJ, et al. Ultrasound-guided thoracic paravertebral block as a sympathetic blockade for upper extremity neuropathic pain: a prospective pilot study[J]. J Pain Res, 2020, 13: 3395-3403.

[11] Deng G, Gofeld M, Reid JN, et al. A retrospective cohort study of healthcare utilization associated with paravertebral blocks for chronic pain management in Ontario [J]. Can J Pain, 2021, 5(1): 130-138.

[12] 刘熙,江鹏,王燕婷.前锯肌平面阻滞与胸椎旁神经阻滞对乳腺癌术后镇痛和应激反应的影响[J].中国临床研究,2022,35(12):1689-1692,1698.
Liu XL, Jiang P, Wang YT. Effects of serratus anterior plane block and thoracic paravertebral block on postoperative analgesia and stress response in breast cancer patients[J]. Chin J Clin Res, 2022, 35(12): 1689-1692,1698.

[13] 李军仕,安静,宋红伟,等.全身麻醉复合胸椎旁神经阻滞对胸腔

镜肺癌根治术患者的麻醉效果和术后镇痛效果[J].癌症进展,2021,19(10):1019-1022.
Li JS, An J, Song HW, et al. Anesthesia and postoperative analgesic effects of general anesthesia combined with thoracic paravertebral block in patients undergoing thoracoscopic radical resection of lung cancer[J]. Oncol Prog, 2021, 19(10): 1019-1022.

[14] 郭延洪,阿良德,李孔兵,等.超声引导肋间神经阻滞与多次注射胸椎旁阻滞对老年胸腔镜手术患者术后镇痛效果的影响[J].中国老年学杂志,2022,42(22):5498-5501.
Guo YH, E LD, Li KB, et al. Effects of ultrasound-guided intercostal nerve block and multiple injections of thoracic paravertebral block on postoperative analgesia in elderly patients undergoing thoracoscopic surgery[J]. Chin J Gerontol, 2022, 42(22): 5498-5501.

[15] 王辰.超声引导椎旁神经阻滞与肋间神经阻滞在电视胸腔镜手术术后疼痛控制中前瞻性随机对照研究[J].生物医学工程与临床,2020,24(2):144-147.
Wang C. Prospective randomized controlled study of ultrasound-guided paravertebral nerve block and intercostal nerve block in pain control after video-assisted thoracoscopic surgery[J]. Biomed Eng Clin Med, 2020, 24(2): 144-147.

[16] Chen N, Qiao Q, Chen RM, et al. The effect of ultrasound-guided intercostal nerve block, single-injection erector spinae plane block and multiple-injection paravertebral block on postoperative analgesia in thoracoscopic surgery: a randomized, double-blinded, clinical trial[J]. J Clin Anesth, 2020, 59: 106-111.

[17] 王锋锋,王展,徐志云.超声引导下胸椎旁神经阻滞和肋间神经阻滞的应用比较[J].南通大学学报(医学版),2022,42(3):244-247.
Wang FF, Wang Z, Xu ZY. Comparison of ultrasound-guided thoracic paravertebral nerve block and intercostal nerve block[J]. J Nantong Univ Med Sci, 2022, 42(3): 244-247.

[18] 张冉,霍飞,田龙,等.超声引导下椎旁神经阻滞与肋间神经阻滞用于胸腔镜肺部术后镇痛效果的比较[J].临床麻醉学杂志,2020,36(9):886-889.
Zhang R, Huo F, Tian L, et al. Comparison of analgesic effect of ultrasound-guided paravertebral block and intercostal nerve block after thoracoscopic pulmonary surgery[J]. J Clin Anesthesiol, 2020, 36(9): 886-889.

收稿日期:2023-09-10　**修回日期**:2023-11-24　**编辑**:王娜娜

(上接第 509 页)

[28] Liu F, Kong FL, Zhong L, et al. Preoperative esketamine alleviates postoperative pain after endoscopic plasma adenotonsillectomy in children[J]. Clin Med Res, 2023, 21(2): 79-86.

[29] Kim KS, Kwak HJ, Min SK, et al. The effect of ketamine on tracheal intubating conditions without neuromuscular blockade during sevoflurane induction in children[J]. J Anesth, 2011, 25(2): 195-199.

[30] Luo J, Yin KQ, Zhao DH, et al. Effect of intravenous induction with different doses of Esketamine combined with propofol and sufentanil on intraocular pressure among pediatric strabismus surgery: a randomized clinical trial[J]. BMC Anesthesiol, 2023, 23(1): 275.

[31] Patel D, Talbot C, Luo WS, et al. The use of esketamine sedation in the emergency department for manipulation of paediatric forearm fractures: a 5 year study[J]. Injury, 2021, 52(6): 1321-1330.

[32] van de Bunt JA, Veldhoen ES, Nievelstein RAJ, et al. Effects of esketamine sedation compared to morphine analgesia on hydrostatic reduction of intussusception: a case-cohort comparison study[J]. Paediatr Anaesth, 2017, 27(11): 1091-1097.

[33] Chen Y, Ru FX, Ye QP, et al. Effect of S-ketamine administered at the end of anesthesia on emergence delirium in preschool children undergoing tonsillectomy and/or adenoidectomy[J]. Front Pharmacol, 2023, 14: 1044558.

[34] Andolfatto G, Willman E, Joo D, et al. Intranasal ketamine for analgesia in the emergency department: a prospective observational series[J]. Acad Emerg Med, 2013, 20(10): 1050-1054.

[35] Yeaman F, Oakley E, Meek R, et al. Sub-dissociative dose intranasal ketamine for limb injury pain in children in the emergency department: a pilot study[J]. Emerg Med Australas, 2013, 25(2): 161-167.

[36] Nemeth M, Jacobsen N, Bantel C, et al. Intranasal analgesia and sedation in pediatric emergency care-a prospective observational study on the implementation of an institutional protocol in a tertiary children's hospital[J]. Pediatr Emerg Care, 2019, 35(2): 89-95.

[37] Qian Q, Liu HX, Li YQ. Effect of esketamine nasal drops on pain in children after tonsillectomy using low temperature plasma ablation[J]. Front Pediatr, 2023, 11: 1110632.

[38] Xu Y, Chen Q, Li P, et al. Safety and efficacy of esketamine for postoperative analgesia in pediatric patients with hypospadias[J]. Front Surg, 2023, 10: 1131137.

[39] Marhofer P, Krenn CG, Plöchl W, et al. S(+)-ketamine for caudal block in paediatric anaesthesia[J]. Br J Anaesth, 2000, 84(3): 341-345.

[40] De Negri P, Ivani G, Visconti C, et al. How to prolong postoperative analgesia after caudal anaesthesia with ropivacaine in children: S-ketamine versus clonidine[J]. Paediatr Anaesth, 2001, 11(6): 679-683.

[41] Hager H, Marhofer P, Sitzwohl C, et al. Caudal clonidine prolongs analgesia from caudal S(+)-ketamine in children[J]. Anesth Analg, 2002, 94(5): 1169-1172.

收稿日期:2024-01-29　**修回日期**: 2024-02-27　**编辑**:王海琴