The effects of different analgesic methods on chronic pain in patients undergoing video-assisted thoracoscopic surgery

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Abstract

Introduction: *Thoracic epidural block, paravertebral block, and intercostal nerve block have been confirmed to alleviate acute pain after video-assisted thoracoscopic surgery (VATS). In contrast, little is known about the effects of these methods on chronic post-surgical pain (CPSP).*

Aim: *To investigate the effects of epidural block, paravertebral block, and intercostal nerve block on postoperative chronic pain in patients undergoing VATS.*

Material and methods: *A total of 240 patients undergoing VATS were randomly divided into 4 groups: an epidural group, paravertebral group, intercostal group, and a control group. All patients were interviewed after 1, 3, 6, and 12 months to investigate the incidence and severity of CPSP.*

Results: *The epidural group had lower incidence of chronic pain within 6 months and it was less severe within 3 months compared with the control group. The incidence and intensity of chronic pain within 3 months were lower in the intercostal group than in the control group. The incidence and intensity of pain within 1 month of surgery were lower in the paravertebral group than in the control group. Of the 122 patients who developed pain after 1 month, 93 (76.2%) reported chronic pain after 12 months, and only 9 (11.7%) had chronic pain after 12 months despite reporting no pain at 1 month.*

Conclusions: *The prevalence of CPSP after VATS is high. Epidural block, paravertebral block, and intercostal nerve block can all reduce the incidence and severity of CPSP, with epidural block showing the best effect. In addition to acute pain, 1-month postoperative pain also exerts a warning effect on CPSP.*

Key words: *chronic pain, video-assisted thoracoscopic surgery, chronic post-surgical pain, paravertebral nerve block, intercostal nerve block, thoracic epidural block.*

Introduction

Postoperative pain is one of the most common complaints from patients after thoracic surgery. It is attributed to many factors, including intercostal nerve injury, pulmonary parenchymal injury, chest tube placement, and systemic inflammatory response [1]. Poor pain management may lead to chronic post-surgical pain (CPSP), which can severely impair physical function and quality of life. Compared with patients undergoing thoracotomy, those undergoing video-assisted thoracoscopic surgery (VATS) are expected to have less perioperative pain. However, their acute pain remains at a high incidence and is likely to develop into chronic pain [2–4]. Previous studies have reported varying incidences of acute pain ranging from 59% to 90% and chronic pain ranging from 14% to 80% [2, 4, 5]. In addition, 20–30% of patients with CPSP are associated with a neuropathic component, which can result in more

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severe pain and a wider pain range [6]. However, the relationship between neuropathic pain (NP) and CPSP is less clear.

At present, common analgesic methods in clinics such as paravertebral nerve block (TPVB), thoracic epidural block (TEB), and intercostal nerve block (INB) have been confirmed to alleviate acute pain after VATS [7–10]. In contrast, little is known about the effects of these methods on neuropathic pain and long-term chronic pain, especially the incidence and severity of chronic pain in different periods. So, we hypothesize that TEB, TPVB, and INB not only offer effective acute pain relief but also reduce the incidence of CPSP to improve the long-term outcomes of patients.

Aim

This study was conducted to confirm the effect of the 3 most common analgesia methods – TEB, TPVB, and INB – on postoperative chronic pain relief in patients undergoing VATS and the characteristics of CPSP at different periods, to improve the long-term outcomes of patients.

Material and methods

Patient selection and allocation

The study was approved by the Ethics Committee of Medical Science Research of the First Hospital of China Medical University (Approval: 2021-40-2) and registered prior to patient enrolment in the Chinese Clinical Trial Registry at www.chictr.org.cn (ChiCTR2100046730). In total 240 patients aged 18–65 years with an American Society of Anesthesiologists (ASA) physical status of II scheduled for VATS were enrolled in our study. All participants signed a document of informed consent. Patients was excluded as follows: opioids abuse, previous history of thoracic surgery, severe cardiovascular, hepatic, and renal disorders, previous chronic pain, emergent open thoracotomy, emergent transferring to an intensive care unit (ICU) within 3 days (failure to assess postoperative acute pain), and reoperation within 1 year. Once enrolled, patients were randomly allocated into the following 4 groups: epidural puncture and catheterization (epidural group), a single multi-point TPVB (paravertebral group), INB (intercostal group), and no regional block (control group). Patient-controlled epidural analgesia (PCEA) was used in the epidural group, while patient-controlled intravenous analgesia (PCIA) was used in the other 3 groups.

Intraoperative management

Patients were monitored using a multi-functional monitor electrocardiogram, including heart rate, invasive blood pressure, pulse oximetry, and bispectral index monitoring (BIS) [11]. A flurbiprofen axetil injection (50 mg) was given intravenously before anaesthesia for pre-emptive analgesia [6]. Propofol (4 µg/ml plasma target-controlled infusion), sufentanil (0.4 µg/kg), and cis-atracurium (0.2 mg/kg) were administered during anaesthesia induction. All patients received double-lumen tracheal intubation. Anaesthesia was maintained with 1% propofol (30 ml/h), sevoflurane (0.5–2%) combined with remifentanil (0.1–0.2 µg/kg/min), to maintain a bispectral index of 40–60. Tropisetron (5 mg) was injected before completing the surgery.

The epidural group received thoracic epidural block by an experienced anaesthesiologist, with a 5-cm catheter inserted at the level of T6–T7 in the left lateral position before the induction of general anaesthesia [12].

The paravertebral group received a 2-space TPVB under ultrasound guidance in the lateral position by the same experienced anaesthesiologist after induction. The probe was placed at the T4–T5 and T6–T7 vertebrae. The position of the probe was adjusted until a superior view was seen of the adjacent costotransverse and spinous process, corresponding paravertebral space, and pleura. After negative aspiration, 10 ml ropivacaine (0.5%) was administered in each of both paravertebral spaces [13]. The lowered pleura due to fluid pressure was seen to be the symbol of success.

The intercostal group received INB with 1% ropivacaine in 3 intercostal spaces (3 ml per target spot) at levels T4–T7. This was done by a surgeon under the direct vision of a thoracoscope before chest closure. Visualizing slight distention of the pleura could be seen as a successful block [14].

The control group was performed without any regional block.

After the surgery, the effect of sensory block was tested with alcohol cotton swabs for the epidural, paravertebral, and intercostal groups. PCEA was connected with the catheter in the epidural group, and the pump was programmed as follows: 300 ml volume including 60 ml ropivacaine and 5 ml pa-

tient-controlled bolus, 30 min lockout period, and 4 ml background infusion. The paravertebral, intercostal, and control groups were connected with PCIA after surgery. The PCIA was achieved with a 100 ml mixture containing 40 mg oxycodone with 1 ml background infusion per hour and 4 ml patient-controlled bolus. All analgesic pumps were removed for all patients 72 h after surgery.

The visual analogue scale (VAS) was scored as follows: 0–10 points, 0 (no pain); 1–3 points, mild pain; 4–6 points, moderate pain; and 7–10 points, severe pain [15]. If patients reported a visual analogue score (VAS score) for acute postoperative pain ≥ 3, the pump could be pressed for an additional bolus. All pumps were maintained until the fourth postoperative night.

All patients were interviewed by telephone at 1, 3, 6, and 12 months after the surgery to investigate the occurrence and severity of chronic pain. For patients who suffered chronic pain, detail symptoms of pain including triggering stimuli, intermittent or rest pain, range of pain, and numbness were recorded. The ID pain score was finished according to the patient's description of pain to evaluate the neuropathic component.

Observation and recording indicators

The primary outcome was the incidence and severity of chronic pain at 1 (M1), 3 (M2), 6 (M3), and 12 (M4) months after surgery. The secondary outcomes included VAS scores at rest and cough at 24 h (P1), 48 h (P2), and 72 h (P3) after surgery. All data were recorded by an investigator who was blind to the group allocation.

Statistical analysis

Sample size calculations were performed using an online power sample size calculator based on our previous pilot study. It shows different acute pain VAS scores for patients in the epidural group, paravertebral, and intercostal groups (2.0 ±1.41, 3.0 ±1.63, and 2.5 ±2.07, respectively) compared with the control group (3.62 ±2.19) at 24 h after the surgery. A total of 168 patients (42 per group) were needed at a power of 85% and a two-sided type I error of 0.05. Considering countervail potential dropouts and those lost to follow-up, finally we recruited 60 patients in each group for a total of 240 patients. All data were processed using SPSS version 23.0 (SPSS Inc., Chicago, IL, USA) and GraphPad Prism version 8.0 (GraphPad Software, Inc., La Jolla, CA, USA). Data were assessed for normality using the Kolmogorov-Smirnov test. Quantitative variables were presented as mean ± SD/median ± interquartile spacing, and categorical data were reported as numbers (percentages). The χ^2 or Fisher's exact test, one-way ANOVA, or Mann-Whitney *U* test were used for comparisons among the 4 groups. Differences were considered statistically significant at $p < 0.05$.

Results

A total of 240 patients were enrolled in the study, of whom 41 were excluded: 2 for VATS conversion to thoracotomy, 4 for accidentally transferred to the Intensive Care unit within 3 days, 3 for block failure, 14 for reporation within 1 year, and 18 because they were lost to follow-up. Eventually, a total of 199 patients completed the project: 50 from the epidural group, 50 from the paravertebral group, 50 from the intercostal group, and 49 from the control group, as shown in Figure 1. The demographic data, including age, gender, baseline systolic pressure (SBP), baseline diastolic pressure (DBP), heart rate (HR), height, body mass, and ASA grade, are summarized in Table I (all $p > 0.05$).

The median acute pain VAS scores at rest and cough within 3 days after surgery were minimum in the epidural group and maximum in the control group ($p < 0.05$). The epidural, paravertebral, and intercostal groups showed lower rest and cough VAS scores at P1 and P2 compared with the control group. The epidural group presented a lower rest and cough VAS score at P1 compared with the paravertebral and intercostal groups. There were no significant differences at P3 in the rest VAS among the 4 groups. The epidural group showed a lower cough VAS score at P3 compared with the control group. Additionally, the epidural group had a lower incidence of chronic pain within 6 months and it was less severe within 3 months compared with the control group. The incidence and intensity of chronic pain within 3 months were lower in the intercostal group than in the control group. The incidence and intensity of pain within 1 month of surgery were lower in the paravertebral group than in the control group ($p < 0.05$) There was no significant difference in the incidence of neuropathic characteristics among the 4 groups (Table II).

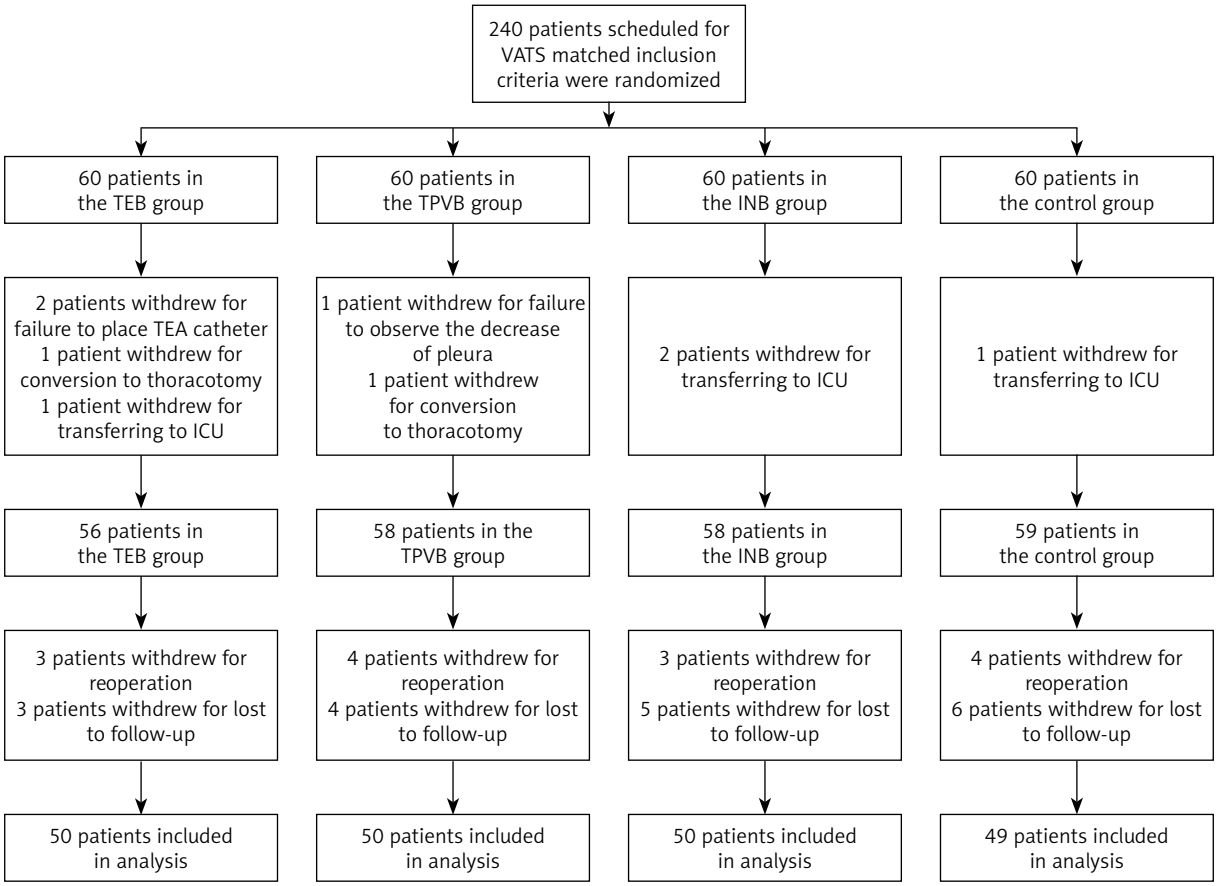

Figure 1. Flowchart of the study

TEB – thoracic epidural block, TPVB – paravertebral nerve block, INB – intercostal block nerve block, ICU – intensive care unit.

Table I. Demographic and surgical data of the 4 groups

Variables	Epidural group (n = 50)	Paravertebral group (n = 50)	Intercostal group (n = 50)	Control group (n = 49)	P-value
Gender (%):					0.458
Male	22 (44.0%)	29 (58.0%)	25 (50.0%)	28 (51.7%)	
Female	28 (56.0%)	21 (42.0%)	25 (50.0%)	21 (42.9%)	
Aged [years]	54.62 (8.11)	52.44 (9.22)	54.98 (10.94)	51.82 (11.37)	0.301
Height [cm]	164.76 (6.59)	167.34 (7.80)	166.84 (9.41)	167.10 (6.96)	0.326
Body mass [kg]	65.44 (8.01)	69.33 (18.60)	67.24 (12.86)	69.43 (13.07)	0.368
ASA status	II (100%)	II (100%)	II (100%)	II (100%)	1.00
SBP [mm Hg]	149.88 (19.13)	150.58 (17.58)	147.98 (20.03)	146.27 (16.53)	0.645
DBP [mm Hg]	76.6 (12.06)	77.56 (11.64)	78.72 (12.63)	78.69 (11.92)	0.782
Heart rate	71.26 (12.10)	73.58 (11.84)	72.24 (10.15)	70.45 (10.31)	0.537

Data represent mean (SD); $p < 0.05$ is considered as a statistically significant difference. ASA – American Society of Anesthesiologists, SBP – systolic blood pressure, DBP – diastolic blood pressure.

Statistical analyses were performed on the symptoms, inducement, and nature of chronic pain according to the description of patients. The main symptoms of chronic pain included occasional pain (29.6%), scar numbness (22.2%), and rest pain (21%), occurring mainly without any triggering stim-

Table II. The VAS scores at resting and coughing at different times, the incidence of CPSP, the NRS scores of CPSP at different times, and the incidence of NP of the 4 groups

Variable	Epidural group	Paravertebral group	Intercostal group	Control group	*P*-value
VAS score at rest:					
24 h	1.0 (0.0–3.0)*	2.0 (2.0–3.0)*#	2.0 (2.0–3.0)*#	3.0 (3.0–5.0)#	< 0.001
48 h	1.0 (0.0–2.25)*	1.0 (1.0–3.0)*	1.0 (1.0–2.0)*	2.0 (1.0–3.5)	< 0.001
72 h	0.0 (0.0–2.0)	0.0 (0.0–3.0)	0.0 (0.0–2.25)	1.0 (1.0–1.0)	0.062
VAS Score at coughing:					
24 h	2.0 (1.0–4.0)*	4.0 (3.0–4.0)*#	3.0 (3.0–5.25)*#	5.0 (3.0–6.0)#	< 0.001
48 h	2.0 (0.75–4.0)*	2.0 (1.0–3.0)*	2.0 (1.0–2.0)*	3.0 (2.0–4.0)	< 0.001
72 h	1.0 (0.0–2.0)*	1.0 (1.0–2.0)	1.0 (0.0–3.0)	2.0 (1.0–3.0)	0.008
The incidence of CPSP:					
1 month	48% (*n* = 24)*	58% (*n* = 29)*	56% (*n* = 28)*	84% (*n* = 41)	0.002
3 months	50% (*n* = 25)*	56% (*n* = 28)	46% (n–23)*	78% (*n* = 38)	0.008
6 months	46% (*n* = 23)*	56% (*n* = 28)	44% (*n* = 22)	69% (*n* = 34)	0.045
12 months	46% (*n* = 23)	52% (*n* = 26)	48% (*n* = 24)	59% (*n* = 29)	0.571
NRS score:					
1 month	0.0 (0.0–4.0)*	2.0 (0.0–4.0)*	2.0 (0.0–3.0)*	3.0 (3.0–5.0)	0.001
3 months	0.5 (0.0–3.0)*	2.0 (0.0–4.0)	0.0 (0.0–3.0)*	3.0 (1.5–4.0)	0.002
6 months	0.0 (0.0–3.0)	2.0 (0.0–4.0)	0.0 (0.0–3.0)	2.0 (0.0–4.0)	0.079
12 months	0.0 (0.0–3.0)	1.0 (0.0–3.3)	0.0 (0.0–3.0)	2.0 (0.0–3.0)	0.557
The incidence of NP	18.0% (*n* = 9)	20% (*n* = 10)	16% (*n* = 8)	22% (*n* = 11)	0.866

*Data presented as median (first and third quartiles)/N(%). P < 0.05 is considered as a statistically significant difference. *Indicates a significant difference from group I. #Indicates a significant difference from group A. VAS – visual analogue scale, CPSP – chronic post-surgical pain, NP – neuropathic pain, NRS – numerical rating scale.*

uli (33%), moving heavy objects (12%), or pressing on a painful location (11.6%). The nature of pain was mainly described as dull pain (30%) and whiny pain (20%) (Table III).

Of the 98 patients with acute pain within 24 h of surgery, 60 (61.2%) reported chronic pain at 12 months, and 42 (41.6%) had chronic pain despite reporting acute pain with VAS ≤ 3 at 24 h after surgery ($p = 0.004$). Of the 122 patients who developed pain at 1 month postoperatively, 93 (76.2%) reported chronic pain at 12 months, and only 9 (11.7%) had chronic pain after 12 months despite reporting no pain at 1 month ($p < 0.001$). Of the 38 patients with NP, 37 (97.4%) reported chronic pain at 12 months after surgery, and 65 (40.4%) had chronic pain after 12 months despite reporting no NP ($p < 0.001$). There was no significant difference between pain intensity at 1 month and chronic pain incidence after 12 months ($p = 0.499$) (Table IV). The severity of pain at 1, 3, 6, and 12 months after surgery is shown in Table V. Among patients with moderate and severe pain at 1 month after VATS, 47.1% showed NP. In contrast, 10.6% of patients who suffered mild pain showed NP (Table VI). The relationship between severity of pain at 1 month and NP is shown in Table VI.

Discussion

The incidence and severity of postoperative pain after thoracic surgery is reportedly higher than that after other surgeries. Although thoracoscopy uses small surgical incisions, it cannot avoid intercostal nerve damage, indwelling thoracic drainage tube, and inflammatory response. The incidence of postoperative pain after VATS remains high, with Takenaka *et al.* [2] reporting the highest incidence of acute pain, i.e. up to 90% [2, 3]. In this study, 98 (50%) patients suffered from moderate and severe acute pain (VAS score over 3). Many studies have reported that acute postoperative pain not only in-

Table III. The characteristics of chronic pain

Variable	Incidence (number)
Various symptoms:	
Occasionally pain inside the chest cavity	29.6% (*n* = 59)
Scar numbness	22.2% (*n* = 44)
Rest pain	21% (*n* = 41)
Back pain	8% (*n* = 16)
Shoulder pain	3.5% (*n* = 7)
Incision pain	9% (*n* = 18)
Incision surroundings numbness	6% (*n* = 12)
Trigger factors:	
Without any triggering stimulus	33% (*n* = 66)
Pressing the painful area	11.6% (*n* = 23)
Coughing	4% (*n* = 8)
Moving heavy objects	12% (*n* = 24)
Cold or rainy weather	4% (*n* = 8)
Bad emotion	5% (*n* = 10)
Pain properties:	
Dull pain	30% (*n* = 60)
Twinge	4% (*n* = 16)
Severe pain	9.5% (*n* = 19)
Squeezing	11% (*n* = 22)
Whiny pain	20% (*n* = 40)

Data expressed as frequency (%) and number (n).

fluences the recovery of lung function but is also a strong predictor of development of chronic pain [16, 17]. Poor management of early postoperative pain may lead to a high incidence of CPSP, which severely impairs physical function and quality of life [18]. The CPSP incidence after VATS, which is highly variable, is reported as 11–35% by Wei *et al*. [1], 40–60% by Takenaka *et al*. [2], 14–83% by Peng *et al*. [19], 4–47% by Chaudhary *et al*. [20], and 25–75% by Wildgaard *et al*. [5]. In this study, 110 (55.2%) patients suffered from CPSP (NRS scores exceed 0 at 3 months after VATS). Various analgesic methods have been confirmed to alleviate acute postoperative pain [21, 22]. In addition, TEB is regarded as the gold standard for postoperative analgesia, and TPVB is the most representative region block technique. Intrathoracic INB is a frequently used technique due to its safety, convenience, and accuracy [10, 14, 23]. These 3 methods are the most common techniques for acute pain relief after VATS, and their effects have been confirmed by numerous studies. However, few studies have reported the effects of regional block on the development of chronic pain. In fact, regional anaesthesia causes afferent nerve blockade to mediate immune protection and alleviate acute pain [24]. Moreover, it can reduce the central sensitization caused by acute pain and prevent the occurrence of CPSP [18]. In this study, 3 regional nerve block methods combined with PCA were shown to improve acute postoperative pain. Further comparison shows the significant superiority of TEB combined with PCEA, which is consistent with the results of Meierhenrich *et al*. [14] and Li *et al*. [12]. In addition, we confirmed that TEB, TPVB, and INB reduced the incidence and intensity of chronic pain; TEB combined with PCEA reduced the incidence of chronic pain at 6 months after VATS, INB combined with PCIA reduced the incidence and severity within 3 months, and TPVB showed a reduction effect within 1 month.

We found that moderate and severe chronic pain (NRS score > 3) appeared to be common also in patients after VATS. In this study, 54.1%, 49.1%, 43%, and 35.3% of patients suffered moderate and severe pain after 1, 3, 6, and 12 months. Such a distribution is dissimilar to that reported in an earlier study, in which 89% of patients with chronic pain were considered as having mild pain [12]. In fact, 20–30% of patients with CPSP are associated with a neuropathic component caused by surgery-induced intercostal nerve damage, which can result in more severe pain and a wider pain range [6]. Peng *et al*. [19] indicated that the incidence of CPSP after VATS with NP was 32.5%, which is in accordance with the 31.5% incidence reported by Fiorelli *et al*. [25]. In this study, we found that 26.6% of patients with CPSP (19.1% of all patients) showed a neuropathic characteristic with the ID-Pain method [26]. There was no evidence in our study to support the conclusion that different analgesic methods have an impact on the occurrence of NP. Interestingly, of the 38 patients with neuropathological pain, 37 patients still suffered 1-year postoperative pain. Moreover, among the patients with moderate and severe pain at 1 month after VATS, 47.1% showed NP. In contrast, 10.6% of patients who suffered mild pain showed NP. Therefore, we inferred that moderate and severe pain at 1 month after VATS has a warning impact on the prevalence of NP, with less possibility of recovering once NP is established, which has not been report-

Table IV. Relationship between acute pain at coughing within 24 h, 1-month postoperative pain, severity of 1-month postoperative pain, NP and 12-month postoperative pain

Variable	Pain at 12 months	No pain at 12 months	*P*-value
VAS score at coughing within 24 h post-operation > 3	61.2% (*n* = 60)	38.8% (*n* = 38)	0.004
VAS score at coughing within 24 h post-operation ≤ 3	41.6% (*n* = 42)	58.4% (*n* = 59)	
NRS score of pain at 1 month post-operation > 0	76.2% (*n* = 93)	23.8% (*n* = 29)	< 0.001
NRS score of pain at 1 month post-operation = 0	11.7% (*n* = 9)	88.3% (*n* = 68)	
Severity of pain at 1 month (*n* = 122):			0.499
Mild (1–3) (*n* = 56)	71.4% (*n* = 40)	28.6% (*n* = 16)	
Moderate (4–6) (*n* = 54)	79.6% (*n* = 43)	20.4% (*n* = 11)	
Severe (7–10) (*n* = 12)	83.3% (*n* = 10)	16.7% (*n* = 2)	
Patients with NP	97.4% (*n* = 37)	2.6% (*n* = 1)	< 0.001
Patients without NP	40.4% (*n* = 65)	59.6% (*n* = 96)	

Data are expressed as frequency (%) and numbers (n). P < 0.05 is considered as a statistically significant difference. VAS – visual analogue scale, NP – neuropathic pain, NRS – numerical rating scale.

Table V. The severity of CPSP at 1, 3, 6, and 12 months

Variable	Mild (NRS1–3)	Moderate (NRS4–6)	Severe (NRS7–10)
Pain at 1 month (*n* = 122)	46.0% (*n* = 56)	44.2% (*n* = 54)	9.8% (*n* = 12)
Pain at 3 months (*n* = 114)	50.9% (*n* = 58)	47.4% (*n* = 54)	1.8% (*n* = 2)
Pain at 6 months (*n* = 107)	57.0% (*n* = 61)	42.1% (*n* = 45)	0.9% (*n* = 1)
Pain at 12 months (*n* = 102)	64.7% (*n* = 66)	35.3% (*n* = 36)	0.0% (*n* = 0)

Data are expressed as frequency (%) and number (n). P < 0.05 is considered as a statistically significant difference. NRS – numerical rating scale.

Table VI. The relationship between severity of pain at 1 month and NP

Severity of pain at 1 month (*n* = 122)	No NP	NP	*P*-value
Mild (1–3) (*n* = 56)	89.3% (*n* = 50)	10.7% (*n* = 6)	< 0.001
Moderate (4–6) (*n* = 54)	53.7% (*n* = 29)	46.3% (*n* = 25)	
Severe (7–10) (*n* = 12)	8.3% (*n* = 1)	91.7% (*n* = 11)	

Data are expressed as frequency (%) and number (n). P < 0.05 is considered as a statistically significant difference. NP – neuropathic pain.

ed in previous studies. The results of our statistical analysis have significant value. However, given that the number of patients diagnosed with NP is small, randomized controlled trials with larger sample sizes are needed.

Postoperative pain is associated with somatic, inflammatory, and neuropathic pain [27]. Central sensitization caused by acute pain leads to spontaneous firing of nociceptors, which is thought to underlie CPSP [18]. Studies have confirmed that the intensity of acute pain is a strong predictor of the development of chronic pain [1, 16, 19]. Our study also showed that patients with acute pain (cough VAS at 24 h > 3) were more likely to suffer from chronic pain. The incidences of moderate and severe acute pain were significantly higher in patients who developed CPSP than in patients who did not. Moreover, we found a significantly high incidence of pain at 1 month postoperatively in patients who developed CPSP. After screening 122 patients with 1-month postoperative pain, we found that 90.2% (*n* = 110) of them developed chronic pain after 3 months, 82.0% (*n* = 100) still suffered from chronic pain after 6 months, and 76.2% (*n* = 93) had poor pain relief after 1 year. In a further screening of 102 patients with pain after 12 months, we found that 40 of them had mild pain in 1 month, and 53 patients suffered moderate and severe pain in 1 month. Therefore, we

inferred that the 1-month postoperative pain could also be a signal for CPSP.

There are some limitations of this study. Firstly, it is not double-blind research. Secondly, although the pain score is a routine assessment method, it relies mainly on the subjective feelings of patients. Thirdly, the sample size is not large enough to strongly support the conclusions.

Conclusions

The prevalence of CPSP after VATS is high. TEB, TPVB, or INB combined with PCA can reduce the incidence and severity of CPSP, with TEB showing the best effect. In addition to acute pain, 1-month postoperative pain also exerts a warning effect on CPSP and deserves more attention.

Conflict of interest

The authors declare no conflict of interest.

References

1. Wei S, Zhang G, Ma J, et al. Randomized controlled trial of an alternative drainage strategy vs routine chest tube insertion for postoperative pain after thoracoscopic wedge resection. BMC Anesthesiol 2022; 22: 27.
2. Takenaka S, Saeki A, Sukenaga N, et al. Acute and chronic neuropathic pain profiles after video-assisted thoracic surgery: a prospective study. Medicine 2020; 99: e19629.
3. Wang H, Li S, Liang N, et al. Postoperative pain experiences in Chinese adult patients after thoracotomy and video-assisted thoracic surgery. J Clin Nursing 2017; 26: 2744-54.
4. Bayman EO, Parekh KR, Keech J, et al. Preoperative patient expectations of postoperative pain are associated with moderate to severe acute pain after VATS. Pain Medicine 2019; 20: 543-54.
5. Wildgaard K, Ravn J, Kehlet H. Chronic post-thoracotomy pain: a critical review of pathogenic mechanisms and strategies for prevention. Eur J Cardiothor Surg 2009; 36: 170-80.
6. Warfield DJ Jr, Barre S, Adhikary SD. Current understanding of the fascial plane blocks for analgesia of the chest wall: techniques and indications update for 2020. Curr Opin Anaesthesiol 2020; 33: 692-7.
7. Moon S, Lee J, Kim H, et al. Comparison of the intraoperative analgesic efficacy between ultrasound-guided deep and superficial serratus anterior plane block during video-assisted thoracoscopic lobectomy: a prospective randomized clinical trial. Medicine 2020; 99: e23214.
8. Moorthy A, Eochagain AN, Dempsey E, Buggy D. Ultrasound-guided erector spinae plane catheter versus video-assisted paravertebral catheter placement in minimally invasive thoracic surgery: comparing continuous infusion analgesic techniques on early quality of recovery, respiratory function and chronic persistent surgical pain: study protocol for a double-blinded randomised controlled trial. Trials 2021; 22: 965.
9. Wang L, Wang Y, Zhang X, et al. Serratus anterior plane block or thoracic paravertebral block for postoperative pain treatment after uniportal video-assisted thoracoscopic surgery: a retrospective propensity-matched study. J Pain Res 2019; 12: 2231-8.
10. Guerra-Londono CE, Privorotskiy A, Cozowicz C, et al. Assessment of intercostal nerve block analgesia for thoracic surgery: a systematic review and meta-analysis. JAMA Network Open 2021; 4: e2133394.
11. Zhang Y, Fu Z, Fang T, et al. A comparison of the analgesic efficacy of serratus anterior plane block vs. paravertebral nerve block for video-assisted thoracic surgery: a randomized controlled trial. Videosurgery Miniinv 2022; 17: 134-42.
12. Li XL, Zhang J, Wan L, Wang J. Efficacy of single-shot thoracic paravertebral block combined with intravenous analgesia versus continuous thoracic epidural analgesia for chronic pain after thoracotomy. Pain Physician 2021; 24: E753-9.
13. Mao Y, Zuo Y, Mei B, et al. Efficacy of perineural dexamethasone with ropivacaine in thoracic paravertebral block for postoperative analgesia in elective thoracotomy: a randomized, double-blind, placebo-controlled trial. J Pain Res 2018; 11: 1811-9.
14. Meierhenrich R, Hock D, Kühn S, et al. Analgesia and pulmonary function after lung surgery: is a single intercostal nerve block plus patient-controlled intravenous morphine as effective as patient-controlled epidural anaesthesia? A randomized non-inferiority clinical trial. Br J Anaesthesia 2011; 106: 580-9.
15. Arends S, Böhmer AB, Poels M, et al. Post-thoracotomy pain syndrome: seldom severe, often neuropathic, treated unspecific, and insufficient. Pain Rep 2020; 5: e810.
16. Gotoda Y, Kambara N, Sakai T, et al The morbidity, time course and predictive factors for persistent post-thoracotomy pain. Eur J Pain 2001; 5: 89-96.
17. Wang S, Li Y, Fei M, et al. Clinical analysis of the effects of different anesthesia and analgesia methods on chronic postsurgical pain in patients with uniportal video-assisted lung surgery. J Cardiothor Vasc Anesth 2020; 34: 987-91.
18. De Kock M. Expanding our horizons: transition of acute postoperative pain to persistent pain and establishment of chronic postsurgical pain services. Anesthesiology 2009; 111: 461-3.
19. Peng Z, Li H, Zhang C, et al. A retrospective study of chronic post-surgical pain following thoracic surgery: prevalence, risk factors, incidence of neuropathic component, and impact on qualify of life. PLoS One 2014; 9: e90014.
20. Chaudhary O, Baribeau Y, Urits I, et al. Use of erector spinae plane block in thoracic surgery leads to rapid recovery from anesthesia. Ann Thor Surg 2020; 110: 1153-9.
21. Xiong C, Han C, Zhao D, et al. Postoperative analgesic effects of paravertebral block versus erector spinae plane block for thoracic and breast surgery: a meta-analysis. PLoS One 2021; 16: e0256611.
22. Komatsu T, Kino A, Inoue M, et al. Paravertebral block for video-assisted thoracoscopic surgery: analgesic effectiveness and role in fast-track surgery. Int J Surg 2014; 12: 936-9.
23. Xin L, Hou N, Zhang Z, Feng Y. The effect of preoperative ultrasound-guided erector spinae plane block on chronic post-

surgical pain after breast cancer surgery: a propensity score-matched cohort study. Pain Therapy 2022; 11: 93-106.
24. Novak-Jankovič V, Markovič-Božič J. Regional anaesthesia in thoracic and abdominal surgery. Acta Clin Croatica 2019; 58 (Suppl 1): 96-100.
25. Fiorelli S, Cioffi L, Menna C, et al. Chronic pain after lung resection: risk factors, neuropathic pain, and quality of life. J Pain Symptom Manag 2020; 60: 326-35.
26. Li J, Feng Y, Han J, et al. Linguistic adaptation, validation and comparison of 3 routinely used neuropathic pain questionnaires. Pain Phys 2012; 15: 179-86.
27. Mongardon N, Pinton-Gonnet C, Szekely B, et al. Assessment of chronic pain after thoracotomy: a 1-year prevalence study. Clin J Pain 2011; 27: 677-81.

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