Journal of Pain Research

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

Single- versus Multiple-Injection Intertransverse Process Block for VATS: A Randomized Trial on Dermatomal Sensory Blockade

Kittitorn Supphapipat, Artid Samerchua, Prangmalee Leurcharusmee, Panuwat Lapisatepun, Tanyong Pipanmekaporn, Nichagoon Konkarn, Kullaphun Prapussarakul, Thidarut Jinadech, Mullika Wanvoharn

Department of Anesthesiology, Faculty of Medicine, Chiang Mai University, Chiang Mai, 50200, Thailand

Correspondence: Artid Samerchua, Maharaj Nakorn Chiang Mai Hospital, Department of Anesthesiology, Faculty of Medicine, Chiang Mai University, Chiang Mai, 50200, Thailand, Tel +66826944496, Email artidsamerchua@gmail.com

Purpose: While the intertransverse process (ITP) block can enhance chest wall analgesia, the optimal injection technique remains unclear. This study compared the efficacy of single versus multiple injections of the ITP block, hypothesizing that multiple injections would provide superior sensory blockade.

Patients and Methods: Forty patients undergoing video-assisted thoracic surgery were randomized to receive single or multiple ultrasound-guided ITP block injections with 30 mL of 0.25% bupivacaine and 1% lidocaine with epinephrine (5 μg/mL). The single-injection group received 30 mL at the T4–5 level, while the multiple-injection group received 10 mL/injection at the T3–4, T4–5, and T5–6 levels. The primary outcome was dermatomal sensory changes on the anterolateral chest wall. Secondary outcomes included block performance time, complications, and postoperative analgesia.

Results: The median (interquartile range [IQR]) dermatomal sensory levels were 2 (2–4) for single-injection and 3 (1.5–3.5) for multiple-injection (median difference: 0, 95% confidence interval [CI]: −1 to 1, $p = 0.91$). The single-injection group had a shorter median (IQR) block performance time than the multiple-injection group [7 (5.2–8.4) min versus 9.1 (7.8–11.2) min; median difference: −1.9 min; 95% CI: −4 to −0.1 min; $p = 0.01$]. Intraoperative hypotension occurred in 63.2% of the single-injection group and 65% of the multiple-injection group ($p = 0.91$). There was no statistically significant difference in postoperative pain intensity between groups.

Conclusion: Single- and multiple-injection ITP blocks showed no significant difference in sensory changes or analgesic effect. The shorter performance time of the single-injection technique suggests it may be a more practical option. However, larger, higher powered studies are required to confirm equivalence and establish definitive recommendations.

Keywords: thoracic surgery, nerve block, anesthesia and analgesia, pain management, enhanced recovery

Introduction

The ultrasound-guided intertransverse process (ITP) block is a paraspinal regional anesthetic technique used for chest wall analgesia.[1] Clinical studies have demonstrated that the ITP block provides analgesic efficacy comparable to that of the paravertebral block (PVB), particularly in procedures such as video-assisted thoracoscopic surgery (VATS) and breast cancer surgery.[2,3]

The ITP block has emerged as a safer alternative to the PVB, reducing risks such as neuraxial and posterior intercostal artery injury, pneumothorax, inadvertent epidural LA spread, and technical difficulties.[4] It may also resolve the inconsistent anterior LA spread observed in association with the erector spinae plane (ESP) block.[5,6] However, details concerning the optimal injection technique for the ITP block remain uncertain.

There is evidence to indicate that the ITP block can be performed using either single or multiple injections, with the LA volume divided into aliquots for the latter approach. The clinical and anatomical effects of these techniques, however,

Received: 9 June 2025
Accepted: 8 September 2025
Published: 15 September 2025

remain controversial.[7,8] Single injections have shown variable LA spread, ranging from 1–2 to 6 vertebral levels, and sensory effects have been inconsistent across the anterior and posterior hemithorax.[5,9–11] Conversely, multiple injections have been associated with more reliable LA spread, covering up to 7 vertebral levels and consistently reaching the paravertebral space, potentially improving block efficacy.[12]

Although direct evidence comparing single- and multiple-injection ITP block is limited, findings from the PVB and ESP block suggest that multi-level injections may provide more reliable block distribution, broader sensory coverage, and enhanced analgesic effect.[10,13–15] Based on this rationale behind current knowledge, we conducted a prospective randomized trial to compare the efficacy of ultrasound-guided single- versus multiple-injection ITP blocks. We hypothesized that multiple injections would result in a greater number of dermatomes exhibiting sensory changes on the anterolateral chest wall in patients undergoing VATS. Secondary outcomes included block performance time, intraoperative hemodynamic effects, and postoperative analgesia.

Materials and Methods

Study Population

This single-center randomized controlled trial was approved by the Research Ethics Committee of the Faculty of Medicine, Chiang Mai University (Approval number: ANE-2566-0137) on 20 June 2023, and registered at ClinicalTrials.gov (Registration number: NCT06210958) on 22 December 2023. The first patient was enrolled in January 2024. This research was conducted in accordance with the Declaration of Helsinki and followed the Consolidated Standards of Reporting Trials (CONSORT) guidelines. All participants were fully informed of the study objectives, procedures, potential risks, and benefits and written informed consents was obtained prior to enrollment.

Patients aged 20 to 70 years, scheduled for VATS for pulmonary resection, and classified as American Society of Anesthesiologists (ASA) physical status I to III were included. Exclusion criteria included weight <40 kg, morbid obesity (Body Mass Index >40 kg/m^2), ineligible for regional anesthesia (eg, drug allergy, local/systemic infection, and coagulopathy), hepatic or renal failure, chronic pain, and pregnancy.

Randomization and Blinding

After providing consent for the study, participants were randomly assigned to receive either ultrasound-guided single (single-injection) or multiple injections (multiple-injection) of the ITP block. Randomization was achieved using a computer-generated sequence in a 1:1 ratio with a block size of four. Group assignments were concealed in opaque envelopes and opened immediately before the block by a nurse who was not involved in the trial. All blocks were administered by a regional anesthesiologist (AS or PrL), who were not blinded to group allocation. The outcome assessor, attending anesthesiologist, surgeon, and nurse were all blinded to the group assignment.

Block Technique

After inducing general anesthesia (GA) and intubation, the regional anesthesiologist and team took over patient care. The ITP block was performed in the lateral position, surgical side up. The patient's skin was disinfected with 2% chlorhexidine in 70% isopropyl alcohol. All steps were conducted under aseptic conditions. For the single-injection group, a linear ultrasound transducer (L11–3, SONIMAGE® HS1, Konica Minolta, Japan) was positioned over the T4 transverse process in the sagittal plane and then moved caudally to visualize the T4–5 transverse processes. The caudal end of the probe was then adjusted slightly laterally and obliquely to optimize visualization of the retro-superior costotransverse ligament (SCTL) space, the SCTL, the paravertebral space, and the underlying pleura.

A 22-gauge, 80-mm block needle (B. Braun Medical AG, Melsungen, Germany) was advanced in-plane from lateral to medial direction, targeting the needle tip just above the SCTL. Correct needle placement was confirmed by sonographic visualization of anterior pleural displacement after a test bolus injection of 1–2 mL of 0.9% normal saline.[9,10] Once confirmed, 30 mL of LA, consisting of 0.25% bupivacaine (2.5 mg/mL) mixed with 1% lidocaine and adrenaline (1:400,000), was gradually administered (Figure 1). For the multiple-injection group, 10 mL of LA was administered at each of the T3–4, T4–5, and T5–6 levels, with separate injections performed at each site.

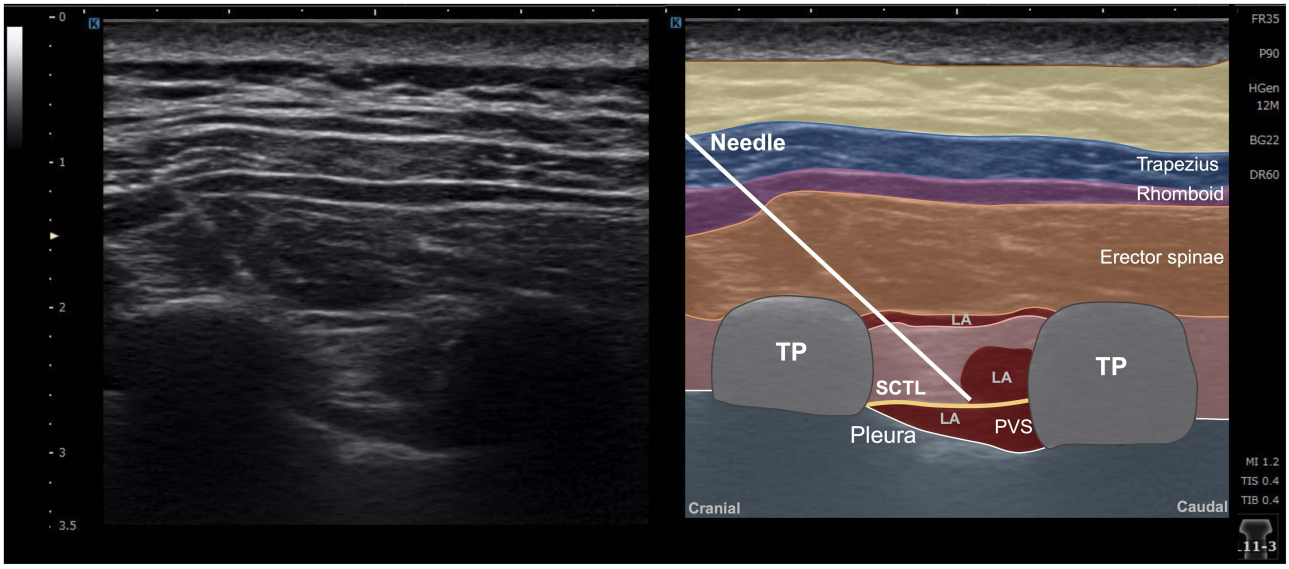

Figure 1 Ultrasound images of the intertransverse process block at the T4–5 level. The injection point is located just above the superior costotransverse ligament. The distribution of local anesthetic is observed in the retro-SCTL space, the erector spinae plane, and the paravertebral space.
Abbreviations: TP, transverse process; SCTL, superior costotransverse ligament; PVS, paravertebral space; LA, local anesthetic.

Intraoperative and Postoperative Cares

All patients underwent standardized GA for VATS using a left-sided double-lumen endobronchial tube for lung isolation, managed by an attending anesthesiologist. GA was maintained with sevoflurane (minimum alveolar concentration: 1.1–1.3), oxygen, and cisatracurium under standard monitoring. Intraoperative fluid management consisted of crystalloids at a rate of 1–2 mL/kg/h. Inadequate analgesia, defined as a >20% increase in heart rate or systolic blood pressure from baseline, was managed with fentanyl boluses (0.5 mcg/kg) titrated to the hemodynamic response. Hypotension, defined as a decrease in systolic blood pressure of more than 20% or below 90 mmHg, was managed using intravenous boluses of ephedrine or phenylephrine, as appropriate. Episodes of bradycardia, defined as a heart rate below 50 beats per minute, were treated with intravenous atropine (0.6 mg). Intraoperative medications included intravenous acetaminophen (1000 mg), dexamethasone (10 mg), parecoxib (40 mg), and ondansetron (0.1 mg/kg).

Thoracoscopy was performed in the lateral position using two ports: one port at the 6^{th}, 7^{th} or 8^{th} intercostal space (ICS) in the anterior or mid-axillary line for camera insertion, as indicated by the surgical procedure, and one port at the 4^{th} ICS in the anterior axillary line for surgical instruments. After the completion of the surgical procedure, a chest tube was placed at the camera port site.

Post-surgery, patients were extubated following the reversal of the neuromuscular blockade and were transferred to the post-anesthetic care unit (PACU) in accordance with standard protocols. Pain scores were assessed using a numeric rating scale (NRS, 0–10). Patients with NRS scores ≥4 were given intravenous morphine (0.05 mg/kg) every 15 min as needed until the NRS score was <4. Postoperative pain management included acetaminophen (500 mg every 6 h), Codigesic® (acetaminophen 300 mg and codeine phosphate 15 mg every 8 h), and gabapentin (300 mg every 24 h).

Outcomes

The primary outcome was the number of dermatomes with sensory changes on the anterolateral chest wall. Sensory assessment was conducted by a blinded assessor using a cold touch (ice pack) test to evaluate deficits or altered sensitivity at dermatomes T2–T10. The assessment began at the mid-clavicular line on the block side, progressing laterally to the posterior axillary line on the chest wall and the apex of the axilla, approximately one hour after the arrival of the patient at the PACU. The contralateral side was also evaluated for exploratory purposes.

Secondary outcomes included: (1) the performance of the ITP block, with block performance time (defined as the time from probe placement to the completion of LA injection), and block-related complications (such as bleeding,

hematoma, pneumothorax, and LA systemic toxicity) recorded by a non-blinded operator; (2) intraoperative outcomes, including fentanyl consumption and intraoperative hypotension, documented by the attending anesthesiologist; and (3) postoperative outcomes, which included pain scores and morphine consumption recorded at 1, 2, 6, 12, and 24 h by a nurse blinded to group allocation. Analgesia-related adverse events, including nausea, vomiting, sedation, and hypotension, were also recorded.

Sample Size Calculation

This study primarily aimed to evaluate sensory coverage of dermatomes following single- and multiple-injection ITP blocks. Based on existing data, the approximate standard deviation (SD) of the number of affected dermatomes for both techniques was 1.4.[16] A clinically significant difference (delta) in anesthetized thoracic dermatomes was defined as 1.5 segments.[17] With a two-sided test (alpha = 0.05, power = 80%), the estimated sample size was 16 patients per group. Allowing for a 20% attrition rate, 20 patients per group were enrolled, totaling 40.

Statistical Analyses

Statistical analyses were conducted using STATA version 16 (StataCorp, 2019). The Shapiro–Wilk test was used to assess the normality of data distribution. Continuous variables are expressed as mean (standard deviation [SD]) and 95% confidence interval [CI] or median (interquartile range [IQR]), while categorical variables are reported as numbers and percentages. Fisher's exact test was used for comparisons of categorical variables, while Student's *t*-test and Mann–Whitney *U*-test were applied to compare continuous variables with normal and non-normal distributions, respectively. The Hodges-Lehmann method was used to estimate the median difference and its 95% CI. Postoperative NRS scores were analyzed using two-way repeated measures ANOVA. Statistical analyses were conducted on an intention-to-treat basis, and p values < 0.05 were considered statistically significant.

Results

Baseline Characteristics

During the trial, 45 patients were assessed for eligibility. Five were excluded: 3 due to coagulopathy and 2 due to renal failure. Forty patients were then randomized into either the single-injection group (20) or the multiple-injection group (20). All received their assigned treatment, but one patient in the single-injection group discontinued participation due to a necessary conversion to open thoracotomy. Therefore, 39 patients were analyzed for outcomes (Figure 2). Patient characteristics and surgical procedures were similar between groups, as shown in Table 1.

Primary Outcome

Sensory blockade distribution was similar between groups at most thoracic dermatomes, with the highest proportion at T4 and T5 (Table 2). The median (IQR) [range] dermatomal sensory levels were 2 (2–4) [0–5] for single-injection and 3 (1.5–3.5) [0–6] for multiple-injection (median difference = 0, 95% CI: −1 to 1, $p = 0.91$). Sensory blockade did not extend to dermatomes T9 or T10 in either group, while T2 and T8 were only blocked in the multiple-injection group. No dermatomes were affected in 10.5% (single-injection) and 20% (multiple-injection) ($p = 0.41$). No bilateral sensory blocks occurred. The median (IQR) sensory evaluation time was 265 (185–300) min for single-injection and 267.5 (200–292.5) min for multiple-injection ($p = 0.97$).

Secondary Outcomes

The single-injection group had a shorter median (IQR) block performance time than the multiple-injection group [7 (5.2–8.4) min versus 9.1 (7.8–11.2) min; median difference: −1.9 min; 95% CI: −4 to −0.1 min; $p = 0.01$]. No block-related complications were observed in either group. Intraoperative hypotension occurred in 63.2% of the single-injection group and 65% of the triple-injection group ($p = 0.91$), despite no significant blood loss in either group.

Intraoperative fentanyl consumption was comparable between groups (Table 3). Median (IQR) NRS pain scores over 24 h did not differ significantly, with similar values across all time points (Figure 3). Likewise, the number of patients

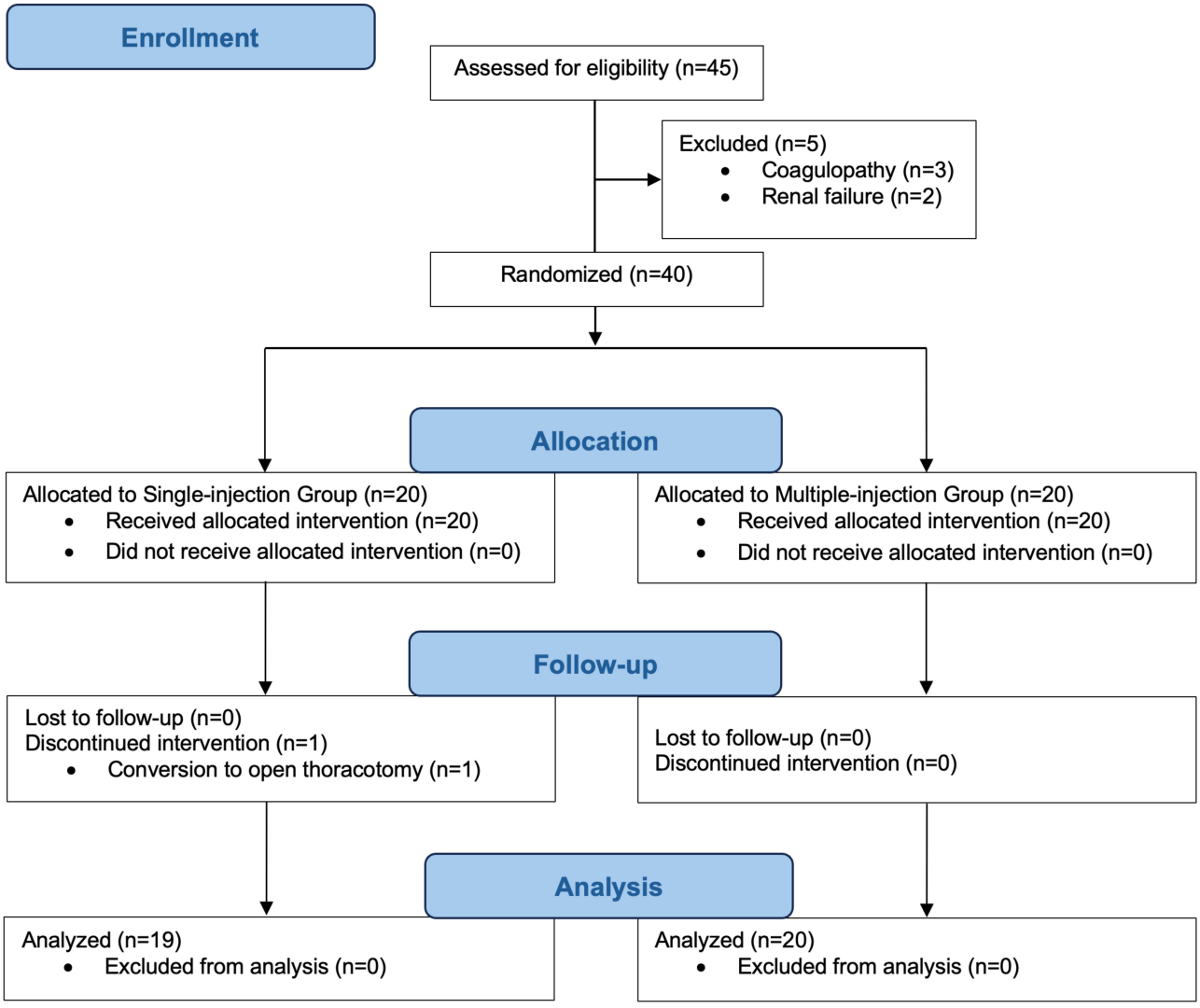

Figure 2 Flow diagram.

experiencing moderate-to-severe pain over 24 h was comparable between groups (Table 3). Time to first morphine use and cumulative morphine consumption over 24 h were also comparable. No nausea, vomiting, or postoperative hypotension occurred within the first 24 h.

Table 1 Patient Characteristics

	Single-Injection Group (n=19)	Multiple-Injection Group (n=20)	*p* value
Preoperative data			
Age (y)	63 (55–69)	63 (57–68.5)	0.73[a]
Sex *M/F*	7/19	8/12	0.84[b]
BMI (kg/m^2)	24 (3.5)	23.8 (4.6)	0.84[c]
ASA I/II/III	0/16/3	2/13/5	0.25[b]

(*Continued*)

https://doi.org/10.2147/JPR.S545731

Table 1 (Continued).

	Single-Injection Group (n=19)	Multiple-Injection Group (n=20)	*p* value
Surgery			0.89[b]
Wedge Resection	5 (26.3%)	4 (20%)	
Segmentectomy	2 (10.5%)	2 (10%)	
Lobectomy	12 (63.2%)	14 (70%)	
Duration of surgery (min)	145 (105–180)	122.5 (97.5–122.5)	0.60[a]
Duration of anesthesia (min)	200 (140–240)	202.5 (150–237.5)	0.97[a]

Notes: Data presented as count, frequency (%), median (IQR), or mean (SD). [a]Mann–Whitney *U*-test. [b]Fisher's exact test. [c]Student's *t*-test.
Abbreviations: ASA, American Society of Anesthesiologists Classification; BMI, Body mass index.

Table 2 Sensory Block Distribution of the Anterolateral Chest Wall

	Single-Injection (n=19)		Multiple-Injection (n=20)		*p* value
	Number of Patients	Percentage (95% CI)	Number of Patients	Percentage (95% CI)	
T2	0	0	1	5% (0.1% to 24.9%)	0.32[a]
T3	7	36.8% (16.3% to 61.6%)	5	25% (8.7% to 49.1%)	0.42[a]
T4	14	73.7% (48.8% to 90.9%)	14	70% (45.7% to 88.1%)	0.80[a]
T5	15	79% (54.4% to 93.9%)	16	80% (56.3% to 94.3%)	0.94[a]
T6	10	52.6% (28.9% to 75.6%)	10	50% (27.2% to 72.8%)	0.87[a]
T7	4	21.1% (6.1% to 45.6%)	2	10% (1.2% to 31.7%)	0.34[a]
T8	0	0	2	10% (1.2% to 31.7%)	0.16[a]

Notes: Data presented as count and percentage (95% CI). [a]Fisher's exact test.

Table 3 Secondary Outcomes

	Single-Injection (n=19)	Multiple-Injection (n=20)	Median Difference[a] (95% CI)	*p* value
Fentanyl consumption (mcg/kg)	1.3 (1–1.6)	1.5 (1.2–2)	−0.2 (−0.6 to 0.2)[a]	0.24[c]
Postoperative pain (NRS) max 0–10				0.83[d]
0 – 1 h	5 (3–8)	5.5 (3–8)	0 (−2 to 2)[a]	0.90[c]
1 – 2 h	4 (2–5)	4 (2.5–5.5)	0 (−1 to 1)[a]	0.80[c]
2 – 6 h	3 (0–5)	3 (1.5–5)	0 (−1 to 2)[a]	0.78[c]
6 – 12 h	3 (1–5)	2 (0–3)	1 (0 to 3)[a]	0.08[c]
12 – 24 h	2 (0–3)	2.5 (0–3)	0 (−1 to 1)[a]	0.53[c]
Patients with moderate-to-severe pain (NRS≥4)				
0 – 1 h	14 (73.7)	13 (65)	1.2 (0.6 to 2.7)[b]	0.41[e]
1 – 2 h	12 (63.2)	11 (55)	1.2 (0.6 to 2.4)[b]	0.42[e]
2 – 6 h	9 (47.4)	8 (40)	1.2 (0.6 to 2.2)[b]	0.64[e]
6 – 12 h	6 (31.6)	3 (15)	1.5 (0.8 to 2.9)[b]	0.12[e]
12 – 24 h	2 (10.5)	3 (15)	0.8 (0.3 to 2.5)[b]	0.53[e]
Time to first morphine use (min)	30 (30–30)	30 (30–30)	0 (0 to 0)[a]	0.78[c]
24-hour morphine consumption (mg)	9 (3–15)	7.8 (5.5–9)	1 (−3 to 6)[a]	0.62[c]

Notes: Data presented as median (IQR) or frequency (%). [a]Median difference calculated as the single-injection median minus multiple-injection median, using the Hodges-Lehmann estimator. [b]Relative risk for single vs multiple injection. [c]Mann–Whitney *U*-test. [d]Two-way repeated ANOVA. [e]Fisher's exact test.
Abbreviations: NRS, Numeric Rating Scale; PACU, Post Anesthesia Care Unit.

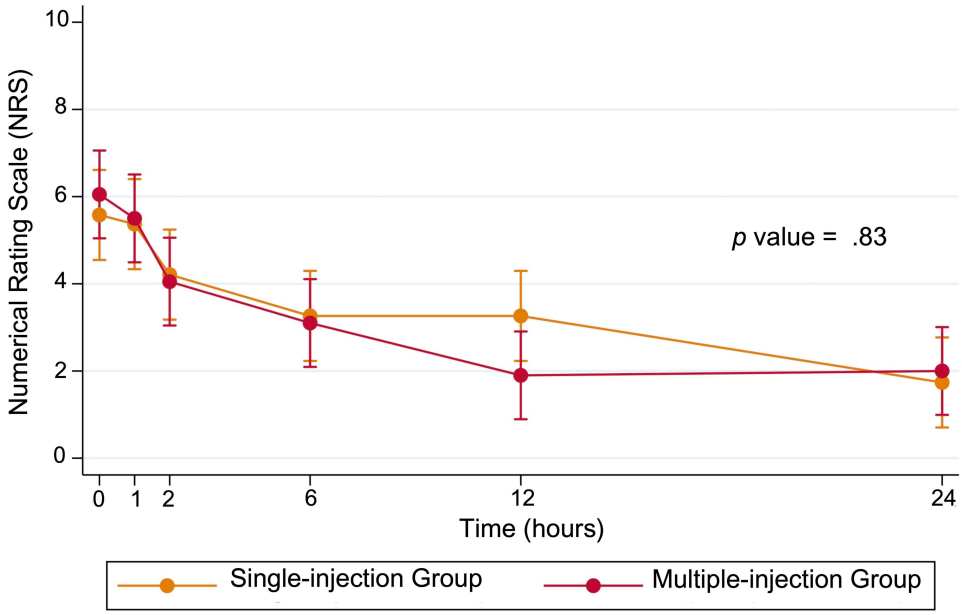

Figure 3 24-hour postoperative pain score.

Discussion

This study investigated the effect of the number of injections on cutaneous sensory changes following an ultrasound-guided ITP block. Our findings indicate that a single injection of the ITP block did not show a significant difference in dermatomal coverage of the anterolateral chest wall compared to the multiple-injection technique. Intraoperative and postoperative analgesia outcomes were also similar between groups. The shorter block performance time associated with the single-injection technique may make it a more practical and feasible option.

To date, studies evaluating the efficacy of the ITP block in sensory blockade remain limited. Nielsen et al[10] reported a mean dermatomal involvement of 4.4 with a single injection and 3.6 with multiple injections using a total of 21 mL of 0.75% ropivacaine, with a mean difference of 0.8 dermatomes at 35 min post-block. Similar to those findings, our study found minimal differences in dermatomal coverage between single- and multiple-injection groups. However, the smaller number of blocked dermatomes observed (2 in the single-injection group and 3 in the multiple-injection group), may be explained by the longer assessment time, approximately 4 h post-block in our study. This finding is in alignment with those of Pangthipampai et al[9] who reported a reduction in blocked anterior thoracic dermatomes from 3.5 at 1 h to 0.5 at 4 h post-ITP block. The differences in dermatomal coverage over time may be attributed to the dynamic spread and dissipation of LA. This highlights the impact of assessment timing on dermatomal coverage and the transient nature of sensory blockade with the ITP block.

The innervation of the hemithorax is complex. The posterior chest wall is innervated by the dorsal rami, while the anterolateral chest and axillary regions are primarily supplied by the anterior and lateral cutaneous branches of the thoracic intercostal nerves. These intercostal nerves are extensions of the ventral rami from the corresponding spinal nerve roots.[18] The ITP block involves the injection of LA into the tissue between two adjacent transverse processes, posterior to the SCTL, within the retro-SCTL space.[1,19] This space contains the posterior rami of the spinal nerves, making the ITP block effective for the anesthetization of the posterior chest wall.[9] However, for the block to affect the ventral rami and/or intercostal nerves, the LA must disperse from posterior to anterior, spreading into the paravertebral space via the costotransverse foramen, medially into the intervertebral foramen, or laterally into the intercostal space.[6,20]

Achieving consistent LA spread across the costotransverse foramen to the anteromedial targets of the vertebral body is challenging due to the small size and high resistance of the structure.[9,20] This difficulty is frequently observed during the ITP block, with simultaneous distension of the retro-SCTL space, visible leakage of LA into the erector spinae plane, and anterior pleural displacement.[5,20] Anatomical and MRI studies have demonstrated consistent LA spread within or

https://doi.org/10.2147/JPR.S545731

between segments into the paravertebral space, intercostal space, neural foramina, epidural space, and costotransverse space following the ITP block.[5,9,20] However, the sensory blockade effect remains limited, variable, and short-lived across the anterior and lateral chest wall, as also observed in our study.[9,10,21] This limitation may be attributed to the inability of an adequate LA mass to consistently reach the intended neural structures.[5,9,20] Our results suggest that, even with a large volume of LA delivered via a single injection or separate aliquots during multiple injections, the pattern and pathway of LA extension may be similar, contributing to the observed sensory blockade characteristics in both groups.

Both injection techniques of the ITP block in our study failed to reliably cover the T3-T8 dermatomes of the anterolateral hemithorax, which are essential for adequate anesthetization of the instrument and chest tube port incisions in VATS.[22] This aligns with an observational study reporting 55% and 75% cutaneous sensory block coverage following single and multiple injections, respectively.[10] Furthermore, the limited sensory extension was insufficient to fully anesthetize the parietal pleura, resulting in poor chest tube-related pain control.[23] This was reflected in the substantial number of patients in our study who reported moderate to severe pain in the immediate postoperative period. Additionally, the rapid block regression observed with the short duration of analgesia following the ITB block in our study could not be overlooked. Future studies should explore strategies to prolong its analgesic effect, such as catheter-based techniques or the use of perineural adjuvants. Although some clinical evidence suggests that the ITP block demonstrates noninferior efficacy compared to the PVB in patients undergoing VATS,[2,24] our findings do not support its use as the primary analgesic technique for VATS. More clinically effective techniques, such as the PVB or, alternatively, the ESP block, as recommended by the Procedure-Specific Postoperative Pain Management (PROSPECT) guidelines, should be considered.[25]

In our study, intraoperative fentanyl requirements were low in both groups, possibly indicating a true analgesic effect of the block, or a reduced need for fentanyl due to the high incidence of intraoperative hypotension with both injection techniques. However, the potential to distinguish between these effects remains challenging. The intraoperative hypotension associated with the ITP block may result from epidural LA extension or sympathetic trunk blockade.[9,10,20] However, intraoperative hypotension is multifactorial, with contributing factors including anesthetic agents, patient positioning, hypovolemia, and surgical manipulation around the mediastinum. Previous studies in volunteers without GA have reported a mean arterial pressure reduction of 2–4 mmHg following an ITP block.[10] Under GA for VATS, this hypotensive effect may be more pronounced, as observed in our study.

No statistically significant advantage of multiple injections over a single injection for the ITP block were found in this study and the post hoc power for the primary outcomes of dermatomal coverage and pain score was low (5–10%; Table 4). Given this limited power and the small effect size, these results should be interpreted with caution. The absence of significant differences may be attributable to random variability or insufficient power to detect small but potentially meaningful effects, rather than true equivalence. While the single-injection technique was associated with a shorter performance time and may offer practical advantage in clinical practice, its modest sensory coverage and the underpowered nature of our study limit the strength of our conclusions. However, the outcomes do warrant larger, adequately powered randomized trials are needed to confirm these findings.

A significant limitation of this study is the single-timepoint assessment of sensory blockade, which limits our ability to evaluate the onset, peak effect, and temporal progression of the ITP block. Evidence from ITP and related fascial plane blocks suggests that peak dermatomal coverage typically occurs around 1 h post-block, followed by gradual regression,

Table 4 Post Hoc Power Analysis

Parameters	Power	Sample Size Needed (Each Group)	Effect Size (Cohen's d)
The number of affected dermatomes	0.05	4036	0.05
Intraoperative fentanyl consumption	0.68	156	0.32
Pain score 24 h after surgery	0.06	11,445	0.05
Time to first use of morphine	0.05	5656	−0.05
24-h morphine consumption	0.10	371	0.21

Notes: Calculations were based on assuming an alpha of 0.05, 80% power, a normal distribution, unknown but equal variances, and a two-sided test.

with the reported duration of sensory blockade ranging from 6 to 10 h.[9,26,27] Assessment of sensory changes closer to this peak would have provided a more accurate representation of maximal block efficacy. However, due to logistical constrains and workflow demands in our operating theater, earlier standardized assessments were not feasible. As a result, the 4-h post-block assessment in our study most likely reflects a regressive phase rather than the peak effect. Future studies should incorporate early and serial sensory assessment to more accurately characterize the onset, peak coverage, and duration of the ITP block.

Additionally, our ITP block technique utilized a specific ultrasound approach, needle direction, and LA volume, which may limit the generalizability of our findings to other techniques.[19,28] Further research is needed to confirm these findings across different injection techniques and anatomical variations.

Conclusion

This trial demonstrates that single-injection ITP blocks are as effective as multiple injections for anterolateral chest wall sensory blockade, with reduced procedure time. However, the limited coverage and rapid regression of both techniques question their role as primary analgesia for VATS. Future studies should refine ITP techniques or prioritize alternatives (eg, PVB per PROSPECT guidelines) while addressing power and temporal assessment gaps.

Data Sharing Statement

The datasets from this study are available from the corresponding author upon reasonable request.

Ethics Statement

This study was approved by the Research Ethics Committee of the Faculty of Medicine, Chiang Mai University (Approval number ANE-2566-0137, dated 20 June 2023).

Acknowledgments

The authors wish to thank the ward nurses of the Department of Surgery at Maharaj Nakorn Chiang Mai Hospital for their valuable assistance. The authors also thank the Research Administration Section, Faculty of Medicine, Chiang Mai University for their assistance, and the use of ChatGPT 4.0 for language correction during the preparation of the manuscript. This study received no funding. The authors declare no conflicts of interest.

Disclosure

The authors declare no competing interests in this work.

References

1. El-Boghdadly K, Wolmarans M, Stengel AD, et al. Standardizing nomenclature in regional anesthesia: an ASRA-ESRA Delphi consensus study of abdominal wall, paraspinal, and chest wall blocks. *Reg Anesth Pain Med*. 2021;46(7):571–580. doi:10.1136/rapm-2020-102451
2. Chen X, Yang J, Xia M, Wu H, Wang S, Zhang W. Single-injection midpoint transverse process-to- pleura block versus thoracic paravertebral block for postoperative analgesia after uniportal video-assisted thoracoscopic surgery: a randomized controlled trial. *J Cardiothorac Vasc Anesth*. 2022;36 (8 Pt A):2432–2438. doi:10.1053/j.jvca.2021.12.036
3. Zhang H, Qu Z, Miao Y, et al. Comparison between ultrasound-guided multi-injection intertransverse process and thoracic paravertebral blocks for major breast cancer surgery: a randomized non-inferiority trial. *Reg Anesth Pain Med*. 2023;48(4):161–166. doi:10.1136/rapm-2022-104003
4. Nair S, Gallagher H, Conlon N. Paravertebral blocks and novel alternatives. *BJA Educ*. 2020;20(5):158–165. doi:10.1016/j.bjae.2020.01.006
5. Varela V, Ruiz C, Montecinos S, Prats-Galino A, Sala-Blanch X. Spread of local anesthetic injected in the paravertebral space, intertransverse processes space, and erector spinae plane: a cadaveric model. *Reg Anesth Pain Med*. 2024;49(3):228–232. doi:10.1136/rapm-2023-104342
6. Cho TH, Kim SH, Kwon HJ, Kim KW, Yang HM. Anatomy of the thoracic paravertebral space: 3D micro-CT findings and their clinical implications for nerve blockade. *Reg Anesth Pain Med*. 2021;46(8):699–703. doi:10.1136/rapm-2021-102588
7. Yu X, Liu C. Intertransverse process block: a narrative review. *J Clin Anesth*. 2025;104:111857. doi:10.1016/j.jclinane.2025.111857
8. Kim SH. Anatomical classification and clinical application of thoracic paraspinal blocks. *Korean J Anesthesiol*. 2022;75(4):295–306. doi:10.4097/kja.22138
9. Pangthipampai P, Siriwanarangsun P, Pakpirom J, Sivakumar RK, Karmakar MK. Intertransverse process block (ITPB) at the retro-superior costotransverse ligament (retro-SCTL) space: evaluation of local anesthetic spread using MRI and sensory blockade in healthy volunteers. *J Clin Anesth*. 2025;101:111718. doi:10.1016/j.jclinane.2024.111718
10. Nielsen MV, Tanggaard K, Bojesen S, et al. Efficacy of the intertransverse process block: single or multiple injection? A randomized, non-inferiority, blinded, cross-over trial in healthy volunteers. *Reg Anesth Pain Med*. 2024;49(10):708–715. doi:10.1136/rapm-2023-104972

11. Chen Q, Yang H, Zhao D, Tang X, Liu H. Anesthetic spread of ultrasound-guided paraspinal blocks in video-assisted thoracoscopic surgery: a three-dimensional reconstruction image study. *Pain Physician*. 2023;26(4):E383–E387. doi:10.36076/ppj.2023.26.E383
12. Nielsen MV, Moriggl B, Hoermann R, Nielsen TD, Bendtsen TF, Borglum J. Are single-injection erector spinae plane block and multiple-injection costotransverse block equivalent to thoracic paravertebral block? *Acta Anaesthesiol Scand*. 2019;63(9):1231–1238. doi:10.1111/aas.13424
13. Naja ZM, El-Rajab M, Al-Tannir MA, et al. Thoracic paravertebral block: influence of the number of injections. *Reg Anesth Pain Med*. 2006;31(3):196–201. doi:10.1016/j.rapm.2005.12.004
14. Yu S, Gao G, Ma R, Lu L, Zhao Y, Yang Z. Bilateral erector spinae plane block by multiple injection for pain control in pseudomyxoma peritonei surgery: a single-blind randomized controlled trial. *BMC Anesthesiol*. 2024;24(1):370. doi:10.1186/s12871-024-02749-6
15. Zengin EN, Zengin M, Yigit H, Sazak H, Sekerci S, Alagoz A. Comparison of the effects of one-level and bi-level pre-incisional erector spinae plane block on postoperative acute pain in video-assisted thoracoscopic surgery; a prospective, randomized, double-blind trial. *BMC Anesthesiol*. 2023;23(1):270. doi:10.1186/s12871-023-02232-8
16. de la Fuente Birkebaek A, Tanggaard K, Bojesen S, et al. The intertransverse process block single- or multiple-injection? A study protocol. *Acta Anaesthesiol Scand*. 2023;67(7):987–992. doi:10.1111/aas.14248
17. Uppal V, Sondekoppam RV, Sodhi P, Johnston D, Ganapathy S. Single-injection versus multiple-injection technique of ultrasound-guided paravertebral blocks: a randomized controlled study comparing dermatomal spread. *Reg Anesth Pain Med*. 2017;42(5):575–581. doi:10.1097/AAP.0000000000000631
18. Chin KJ, Versyck B, Pawa A. Ultrasound-guided fascial plane blocks of the chest wall: a state-of-the-art review. *Anaesthesia*. 2021;76 Suppl 1(S1):110–126. doi:10.1111/anae.15276
19. Karmakar MK, Sivakumar RK, Sheah K, Pangthipampai P, Lonnqvist PA. The retro superior costotransverse ligament space as a new target for ultrasound-guided intertransverse process block: a report of 2 cases. *A a Pract*. 2022;16(7):e01610. doi:10.1213/XAA.0000000000001610
20. Cho TH, Kwon HJ, Cho J, Kim SH, Yang HM, Yang H-M. The pathway of injectate spread during thoracic intertransverse process (ITP) block: micro-computed tomography findings and anatomical evaluations. *J Clin Anesth*. 2022;77:110646. doi:10.1016/j.jclinane.2022.110646
21. Nielsen MV, Tanggaard K, Hansen LB, Hansen CK, Vazin M, Borglum J. Insignificant influence of the intertransverse process block for major breast cancer surgery: a randomized, blinded, placebo-controlled, clinical trial. *Reg Anesth Pain Med*. 2024;49(1):10–16. doi:10.1136/rapm-2023-104479
22. Sertcakacilar G, Tire Y, Kelava M, et al. Regional anesthesia for thoracic surgery: a narrative review of indications and clinical considerations. *J Thorac Dis*. 2022;14(12):5012–5028. doi:10.21037/jtd-22-599
23. Ukeh I, Fang A, Patel S, Opoku K, Nezami N. Percutaneous chest tube for pleural effusion and pneumothorax. *Semin Intervent Radiol*. 2022;39(3):234–247. doi:10.1055/s-0042-1751295
24. Swathi KB, Kamal M, Kumar M, Kumar R, Chhabra S, Bhatia P. Comparison of analgesic efficacy of the conventional approach and mid-transverse process to pleura approach of the paravertebral block in video-assisted thoracoscopy surgeries: a randomised controlled trial. *Indian J Anaesth*. 2021;65(7):512–518. doi:10.4103/ija.IJA_64_21
25. 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. *Anaesthesia*. 2022;77(3):311–325. doi:10.1111/anae.15609
26. Zhang J, He Y, Wang S, et al. The erector spinae plane block causes only cutaneous sensory loss on ipsilateral posterior thorax: a prospective observational volunteer study. *BMC Anesthesiol*. 2020;20(1):88. doi:10.1186/s12871-020-01002-0
27. Shibata Y, Kampitak W, Tansatit T. The novel costotransverse foramen block technique: distribution characteristics of injectate compared with erector spinae plane block. *Pain Physician*. 2020;23(3):E305–E314.
28. Kim JY, Lee UY, Kim DH, et al. Anatomical assessments of injectate spread stratified by the volume of the intertransverse process block at the T2 level. *Reg Anesth Pain Med*. 2024;49(12):867–870. doi:10.1136/rapm-2023-104998