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Intertransverse process block versus subcostal transversus abdominis plane block in patients undergoing laparoscopic radical gastrectomy: a prospective randomized controlled trial

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Abstract

Background Laparoscopic radical gastrectomy has been reported to be associated with substantial trauma and pain. This study compared the impact of ultrasound-(US)-guided, bilateral, double-injection intertransverse process block (ITPB) on postoperative analgesia with subcostal transversus abdominis plane block (TAPB) in patients who were undergoing laparoscopic radical gastrectomy.

Methods Sixty-two patients who were undergoing laparoscopic radical gastrectomy surgery under general anesthesia were included. These patients were randomized to either the ITPB group or the TAPB group. Patients in the ITPB group received a double-shot US-guided bilateral ITPB at the thoracic level T6/7 and T9/10 level using ropivacaine (0.3%, 15 mL). Patients in the TAPB group received bilateral subcostal TAPB one injection per side using ropivacaine (0.3%, 30 mL). All patients used a BIS-guided combined intravenous and inhalation anesthesia. The primary outcome was defined as postoperative morphine-equivalent consumption during the first 24 h.

Results The study recruited 62 patients (31 in each group) for the analysis. A comparatively less postoperative opioid consumption was observed in the ITPB group compared with the subcostal TAPB group within the first 24 h postoperatively (mean [standard deviation-(SD)] morphine-equivalent dose): 27.8 (5.7) mg *vs* 31.2 (4.4) mg, $P<0.001$. The ITPB group showed lower intraoperative opioid use, and statistical significantly lower scores at rest and coughing at 6, 24 h postoperatively. The time to first requiring rescue analgesia was longer in the ITPB group than the subcostal TAPB group (median [IQR]): 8.0 [8.0] *vs* 6.0 [6.0] h, $P=0.009$. The patients in the ITPB group exhibited earlier independent movement, lower incidence of postoperative complications and higher levels of satisfaction ($P=0.021$).

Conclusion This study showed that the double-shot bilateral ITPB could reduce opioids consumption and achieve longer and better pain relief. Additionally, it promoted early postoperative activity and improved patient satisfaction.

Trial registration ChiCTR2300072986. Registered 29 June 2023.

Keywords Ultrasound-guided, Intertransverse process block, Transversus abdominis plane block, Laparoscopic radical gastrectomy, Postoperative pain

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Introduction

Laparoscopic techniques have been commonly used in surgical procedures involving radical gastrectomy in recent years. The surgical treatment for gastric cancer can cause substantial body trauma and is associated with complex regional innervation. Patients have been reported to suffer from the incision pain as well as visceral pain post-surgery [1]. Poor analgesia is supposed to cause a severe stress reaction, in turn adversely affecting postoperative recovery [2].

Opioids remain the primary method of analgesia [3]. Recently, researchers have been trying to identify alternative analgesic methods, because the use of opioids can cause variable adverse effects [4]. Some studies have identified regional block techniques as commonly used techniques in multimodal analgesia [5]. The regional blocks are relatively safer and expected to be more successful in pain management during and after laparoscopic radical gastrectomy.

Ultrasound-guided subcostal transversus abdominis plane block (TAPB) has been widely used in abdominal surgery [6]. This technique blocks the anterior branches of T6-L1 spinal nerve roots, which alleviates pain during abdominal procedures [7]. Intertransverse process block (ITPB) has been recently identified as a modification of the paravertebral block for postoperative analgesia. The injection point is between the posterior border of the transverse process and the pleura. ITPB has been shown to provide effective analgesia for thoracoscopic surgeries, lumbar decompression and large breast cancer operations [8–10].

However, there is a lack of clarity regarding the analgesic efficacy of ITPB. A study showed that the ITPB did not significantly affect the outcome of major breast cancer surgery [11]. There has been no study comparing the roles of double-shot bilateral ITPB and TAPB in major abdominal surgery, particularly both during and after laparoscopic radical gastrectomy, which could act as an effective analgesia for visceral pain management in abdominal surgery. This study aimed to compare the analgesic efficiency of ITPB and subcostal TAPB in patients undergoing laparoscopic radical gastrectomy.

Materials and methods

Study design

This study was a single-center, prospective randomized controlled trial. The study was conducted in alignment with Declaration of Helsinki and reported according to CONSORT guideline. This study was approved by the Ethics Committee of Yancheng First People's Hospital (approval number 2023-k-089). All patients provided signed informed consent forms. The trial registration number was as follows: ChiCTR2300072986 (date of registration: 29/06/2023).

Patient recruitment

The inclusion criteria for this study were as follows: (1) diagnosed with gastric cancer and scheduled for elective radical gastrectomy; (2) aged 18–80 years old; (3) weighed 50–80 kg with a body mass index (BMI) of 18–28 kg/m^2; (4) American Society of Anesthesiology class (ASA) I、II、III. The exclusion criteria were as follows: (1) contraindications to deep nerve block, including, but not limited to, anesthetic drug allergy, coagulopathy (INR > 1.5 and/or platelet count < 70/mL), infection at the injection site; (2) chronic opioid dependence or chronic pain for more than 3 months; (3) patients with mental illness or those who could not cooperate with the completion of the rating scale; (4) pregnant and lactating women; (5) nerve block procedure is impossible due to anatomical difficulties on ultrasound scans or nerve block failure.

Randomization and blinding

Patients were randomly assigned in a 1:1 ratio into two groups using random numbers determined via SPSS 25.0 (IBM, Chicago, IL, USA). The group assignment was concealed in sequentially numbered opaque envelopes. Before the administration of the nerve block, the allocation envelope was uncovered by the primary investigator. In this study, nerve block procedures were performed by an experienced anesthesiologist. Both the anesthesiologist who did anesthesia management and the researcher who followed-up after the operation were blinded. All patients were informed of their group allocation at the time of discharge.

Pain reporting and management

On the day prior to surgery, all subjects underwent training to assess pain levels using a visual analogue score (VAS) ranging from 0 to 10 (0 = no pain to 10 = worst pain imaginable). Mild pain was defined as VAS of 1–3. The researchers also explained how/why the surgery caused pain, how to use the patient-controlled analgesia (PCA) pump, the common/possible adverse reactions to the use of analgesics, and the treatment involved.

Presurgical and surgical procedures

Thirty minutes before surgery, all patients included in this study were taken to the pre-anesthesia room and did not receive preoperative medication. The following monitoring procedures were done once the patient was in the

room: percutaneous oxygen saturation (SpO_2), non-invasive blood pressure monitoring and electrocardiogram. All patients received supplemental oxygen via a nasal cannula (2 L/min). After peripheral venous access was achieved, lidocaine (local anesthesia, LA) was administered for radial artery puncture catheterization, followed by monitoring of the invasive arterial blood pressure. Patients in both groups received an intravenous injection of 1 mg midazolam for sedation and 50 ug fentanyl for analgesia before nerve block.

The patients in the ITPB group were placed in right lateral decubitus. After routine disinfection and draping, the transducer was placed approximately 3–4 cm lateral to the midline in the sagittal position. The ribs were counted in a cephaladto-caudad direction to determine the level of vertebrae. A high-frequency matrix ultrasound probe (Anaesus ME7, Mindray Bio-Medical Electronics, Shenzhen, China) was placed medially in a sagittal orientation to identify the anatomical transition from the ribs to transverse processes. After administration 1–2 mL of 1% lidocaine, the needle's trajectory was maintained in a caudad-to-cephalad direction [12]. Once the needle tip was just posterior to the superior costotransverse ligament (SCTL), without piercing it, the exact location of the needle tip was confirmed based on the visualization of the spread of 1.0–2.0 mL of saline in the compartment posterior to the SCTL and anterior to the erector spinae fascia plane. Even if some SCLT anatomy was not evident in the US, the direction of the puncture from head to tail could reduce the likelihood of SCLT puncture (Fig. 1A). Once the correct placement of the needle tip was confirmed, 15 mL of 0.3% ropivacaine was injected at the T6/7 and T9/10 levels. The same procedure was done on the opposite side(total 60 mL).

In the TAPB group, after placing the patients in a supine position, a linear high-frequency US transducer probe (Sonosite Micromaxx, Bothell, WA, USA) was placed perpendicular to the abdominal wall. When needle tip just reached the transversus abdominis plane (between the internal oblique and the transverses abdominal muscle), approximately 2 mL of normal saline was injected to facilitate muscle separation. After repeated aspiration, 30 mL of ropivacaine (0.3%) was injected. The local anesthetic formed a spindle-shaped hypoechoic ultrasound image (Fig. 1B). The same procedure was done on the opposite side (total 60 mL).

After administering the block, the patients were observed for 10 min; Cold stimulation was used to assess the skin of abdominal wall for sensory loss. In the absence of an apparent block plane, the procedure was considered to be a failure. We excluded patients who were considered to have failed the block.

Laparoscopic radical gastrectomy

The same gastrointestinal surgery team performed laparoscopic radical gastrectomy on all subjects in the supine 'split-leg' position. Five trocar ports were placed according to the location of gastric area. Pneumoperitoneal CO_2 pressure was maintained at 13.5–15 mmHg. At the end of surgery, the tumour specimen was extracted through a low mid-line incision 4–6 cm long, and two drains were placed at the trocar sites under the costal arches.

Anesthesia methods and postoperative analgesia

All subjects received standardized general anesthesia via endotracheal intubation by anesthesiologists who were blinded to group allocation. The drugs used for induction included fentanyl (1 μg/kg), propofol (1.5–2.5 mg/kg), and rocuronium (1 mg/kg). Anesthesia was maintained with remifentanil (0–0.3 μg/kg/min) and sevoflurane (1%-1.5% in oxygen) to maintain a bispectral index value of 40–60. Fluids were supplemented to expand blood volumes. The heart rate and mean arterial pressure (MAP) were kept within 20% of preoperative value using remifentanil and ephedrine individually. Rocuronium was given intermittently as required. The patients were given Parecoxib sodium 40 mg, palonosetron 75 μg, and fentanly 50 μg approximately 30 min prior to the end of the surgery. Sugammadex (3 mg/kg) was used to reverse the residual muscle relaxation. The patients were transferred to the post-anesthesia care unit (PACU) after extubation.

All patients received an intravenous patient-controlled analgesia (PCA) pump (butorphanol tartrate 12 mg, palonosetron 0.15 mg and dexmedetomidine 100 μg in sodium chloride 0.9%, 100 mL at 1 mL/h, bolus = 1 mL, lockout interval = 15 min) postoperatively. The patients were supposed to press the pump when a VAS pain score ≥ 4 was experienced or per the patient's requirement. The dose of butorphanol per day was 8 mg. In case the patient's VAS pain score was > 6 or rescue analgesia was required, dezocine (5 mg) prescribed until the VAS score < 3 was achieved. Patients were administered supplemental oxygen, and they underwent intensive monitoring to prevent hypoxemia when PCA pumps were used postoperatively. When patients had adverse reactions such as hypotension, we used ephedrine (in the operating room) or dopamine (in the ward) to deal with it. When the patient had severe postoperative nausea and vomiting, the PCA was stopped infusing and the patient received an intravenous bolus of 0.3 mg of ramosetron for antiemetic therapy.

Data collection

The primary outcome of this study was to determine the amount of opioids consumed within 24 h post-surgery,

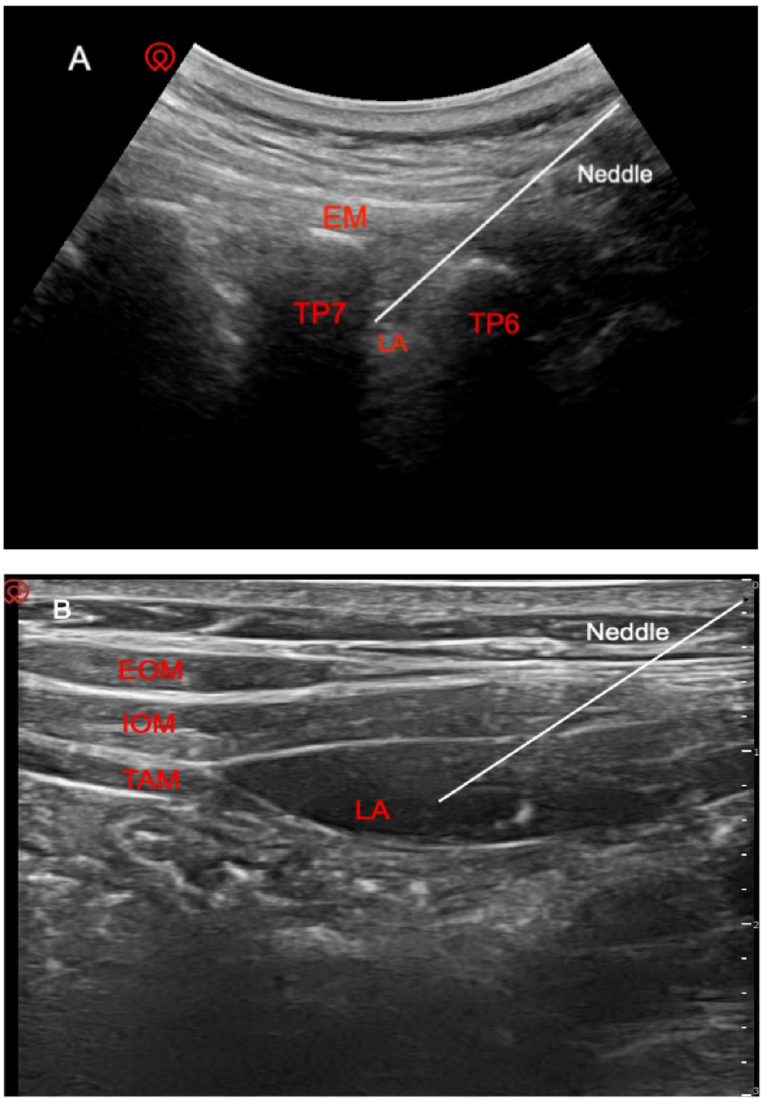

Fig. 1 Ultrasound images of two groups. **A** Ultrasound image of the intertransverse process block: T6/7 transverse process; EM: erector spinae muscle; TP: transverse process; LA: local anesthetic. **B** A spindle-shaped hypoechoic ultrasound image of LA was shown in the transversus abdominis plane. TAM: transversus abdominis muscle; EOM: external oblique muscle; IOM: internal oblique muscle; LA: local anesthetic

measured in morphine equivalents from the time of extubation.

The secondary outcomes included the morphine-equivalent consumption during surgery and within the second 24 h after surgery, the total number of PCA pump comperssions within 48 h postoperatively, the time of first rescue analgesia and the dose of rescue analgesic drug (dezocine) within 48 h after sugery, the VAS during rest and cough at 0 (normal verbal communication could be performed by patients), 2, 6, 24, and 48 h after the operation, time to independent movement (the time from intervention to be able to be independently mobile e.g., using the bathroom), the total incidence of perioperative tachycardia and hypertension (defined as an increase in heart rate and MAP by at least 20% of the baseline value), complications, associated with the block, the total incidence of nausea, vomiting, dizziness as reported by the patient in a yes/no questionnaire and patient satisfaction.

Statistical methods

All statistical analyses were done using SPSS 25.0. software. The normalized data distribution was confirmed via the Shapiro–Wilk test. The independent-sample t-test was done for normalized data distribution, and the Mann–Whitney U test was used for variables with

non-normalized data distribution. Normally and non-normally distributed data were expressed as mean (standard deviation [SD]) and median [inter-quartile range (IQR)] respectively. Repeated-measures analysis of variance and independent samples t-test were used to compare the VAS scores between the two groups. The differences for opioid consumption, time to independent movement, and the PCA requests number were analyzed using Student's t-test followed by 2-tailed Dunnett test. The median difference (95% confidence intervals [CI]) in time to first requiring rescue analgesia between the two groups was calculated using the Independent-Samples Hodges-Lehman Median Difference. Postoperative complications and patient's satisfaction were presented as frequency (%) and were analyzed by the Chi-square test. Bonferroni correction was used for multiple comparisons. A P-value < 0.05 was indicated statistically significant differences in data.

The sample size was calculated using the G*Power 3.1.9 software. In the preliminary trials, 20 patients (10 patients in each group) showed that the average morphine-equivalent consumption was 26.5 (6.3) mg in the ITPB group and 32.1 (5.2) mg in the TAPB group at 24 h postoperatively. A minimal sample of 28 patients in each group was calculated for a type I error (0.05) and type II error (0.1), translating to 90% power for detecting the difference. A total of 62 patients (31 patients in each group) were selected for analyses, with a 10% dropout rate.

Results

In this study, 68 patients were assessed for eligibility, between June 2023 and February 2024, of which 6 were excluded since they did not fulfill the inclusion criteria, and remaining 62 patients were included and were available for the final analysis (Fig. 2). None of the subjects were lost to follow-up.

Demographic data and surgical data were observed to be comparable between the two groups (Table 1).

The results showed somewhat lesser total opioid consumption in the ITPB group than that in the TAPB group within the first 24 h postoperatively (mean (SD) morphine-equivalent dose): 27.8 (5.7) mg *vs* 31.2 (4.4) mg, $P = 0.010$. Lower levels of intraoperative opioid use (mean (SD), 18.9 (5.6) vs 31.3 (11.3) mg, $P < 0.001$) and remifentanil (0.2 (0.3) vs 0.8 (0.3) mg, $P < 0.001$, Table 2) was observed in the ITPB group.

Furthermore, patients in the ITPB group exhibited a longer time to need for first rescue analgesia than that in the subcostal TAPB group (median [IQR]: 8.0 [8.0] *vs* 6.0 [6.0] h, $P = 0.009$, 95% CI: 0.62–12.77 h), along with a lower rescue consumption of dezocine at 48 h postoperatively (1.0 [2.0] vs 2.4 [2.9] mg, $P = 0.024$).

Lower VAS values were also somewhat observed in the ITPB group at 2 h postoperatively, than in the subcostal TAPB group (mean (SD), 1.9 (0.8) vs 3.2 (1.0), $P < 0.001$, Table 3). Similar results were obtained in pain scores at rest or during coughing at 6 h and 24 h, postoperatively (Fig. 3). On the contrary, both groups exhibited similar VAS pain scores at 0 and 48 h postoperatively.

Significant differences in time to independent movement (25.8 (4.9) vs 30.35 (9.5) h, $P = 0.022$) and patient satisfaction were observed between two groups. Similar incidences of perioperative complications, tachycardia, and hypertension were observed between the two groups (Table 4).

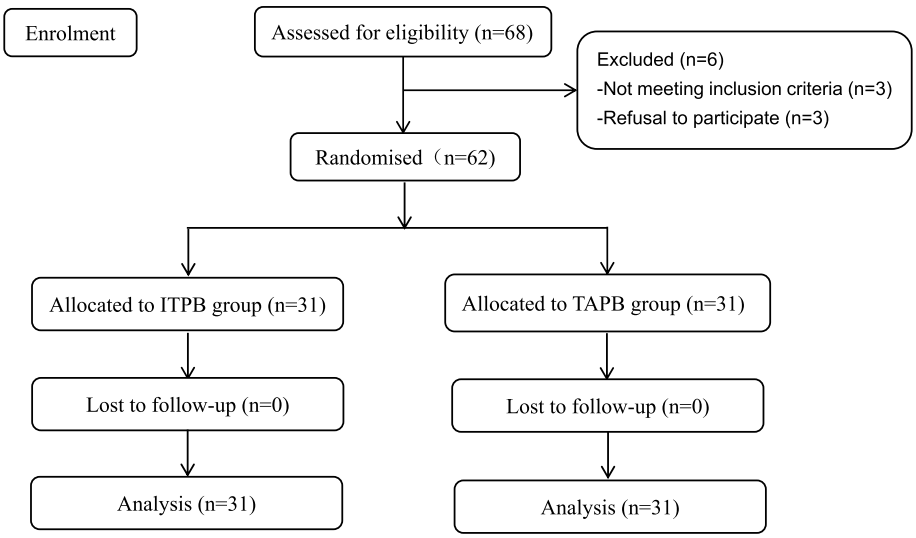

Fig. 2 Flow diagram of subject enrolment and analysis. ITPB, intertransverse process plane block. TAPB, transversus abdominis plane block

Table 1 Comparison of baseline characteristics, surgery and anesthesia duration between the two groups

Characteristic	ITPB group ($n=31$)	TAPB group ($n=31$)	*P*
Age (years)	65.7 (8.4)	65.6 (5.9)	0.958
Male sex	24 (77.4%)	19 (61.3%)	0.168
Weight (kg)	66.5 (12.5)	67.2 (7.1)	0.768
Body mass index ($kg{\cdot}m^{-2}$)	23.5 (4.0)	24.6 (2.7)	0.250
ASA-PS			0.596
II	19 (61.3%)	21 (66.7%)	
III	12 (38.7%)	10 (32.3%)	
Hypertension	7 (22.6%)	8 (25.8%)	0.767
Diabetes	3 (9.7%)	5 (16.1%)	0.449
Cerebral infarction	3 (9.7%)	2 (6.5%)	0.641
Duration of surgery (min)	225.0 (9.1)	221.1 (15.2)	0.240
Duration of anesthesia (min)	253.1 (27.1)	244.8 (18.2)	0.131

Values are n, n (%) or mean (standard deviation), unless otherwise noted

ASA American Society of Anesthesiologists, *ITPB* Intertransverse process block, *TAPB* Transversus abdominis plane block

Table 2 Intraoperative and postoperative opioids consumption

	ITPB group ($n=31$)	TAPB group ($n=31$)	*P*
Total opioids consumption, first 24 h (mg)	27.8 (5.7)	31.2 (4.4)	0.010
Total opioids consumption, secound 24 h (mg)	17.5 (8.5)	21.6 (8.7)	0.065
Intraoperative opioids consumption (mg)	18.9 (5.6)	31.3 (11.3)	< 0.001
Intraoperative remifentanil consumption (mg)	0.2 (0.3)	0.8 (0.3)	< 0.001

Values are presented as mean (standard deviation)

Table 3 Comparison of VAS scores at rest and coughing at each observational point in the two groups of patients ($n=31$ each)

	Group ITPB		Group TAPB	
	Resting	Coughing	Resting	Coughing
Postoperative 0 h	2.0 (0.8)	3.3 (1.0)	2.3 (0.8)	3.4 (1.0)
Postoperative 2 h	1.9 (0,8)*	3.2 (1.0)	2.7 (0.9)	3.5 (1.2)
Postoperative 6 h	1.7 (0.7)*	2.7 (0.6)	2.4 (0.5)*	3.7 (0.8)
Postoperative 24 h	1.2 (0.7)*	2.4 (0.8)	2.3 (0.6)*	3.4 (0.7)
Postoperative 48 h	1.1 (0.5)	2.1 (0.7)	1.3 (0.6)	2.7 (0.8)

Comparison of VAS pain scores at rest and during coughing between ITPB and TAPB. This measurement was repeated at 0, 2, 6, 24, 48 h postoperatively. ITPB, intertransverse process block; TAPB, transversus abdominis plane block. VAS, visual analogue score; Values were expressed as mean (standard deviation).
*$P<0.05$ vs group T

Discussion

The results of this study demonstrated that ITPB showed some a reduction in intraoperative opioid requirements to maintain hemodynamic stability, prolonged the time to first need for rescue analgesia, and reduced perioperative opioid usage. Statistically, the time to first ambulation (defined as the time from intervention to be able to be independently mobile) was shorter in the ITPB group, which had the potential to benefit the postoperative recovery of patients.

The postoperative pain associated with laparoscopic radical gastrectomy is primarily or adjuvant due to the spinal nerve afferent-mediated somatic pain of the abdominal wall incision, sympathetic afferents-mediated visceral pain, and inflammatory factors released by local injured tissue [13]. Thoracic epidural analgesia (TEA) is the current standard for pain management in abdominal surgery [14]; however, it might elevate the risk of epidural hematoma, postoperative hypotension, and urinary retention, in turn delaying acclerated recovery [15, 16].

Recent years have seen the development of multimodal analgesia using nerve blocks as the primary mode of perioperative analgesia, which has been shown to effectively provide analgesia to promote early perioperative recovery [17, 18]. Some studies have proposed an US-guided technique called "subcostal" TAPB for producing reliable analgesia for supraumbilical abdominal surgery [13], and minimizing the perioperative stress response [19]. However, TAPB provides only somatic (i.e., abdominal wall) analgesia and not visceral analgesia. Thus, they might offer reduced efficacy compared with the paraaxonal block (paraneuraxial block) or TEA [20].

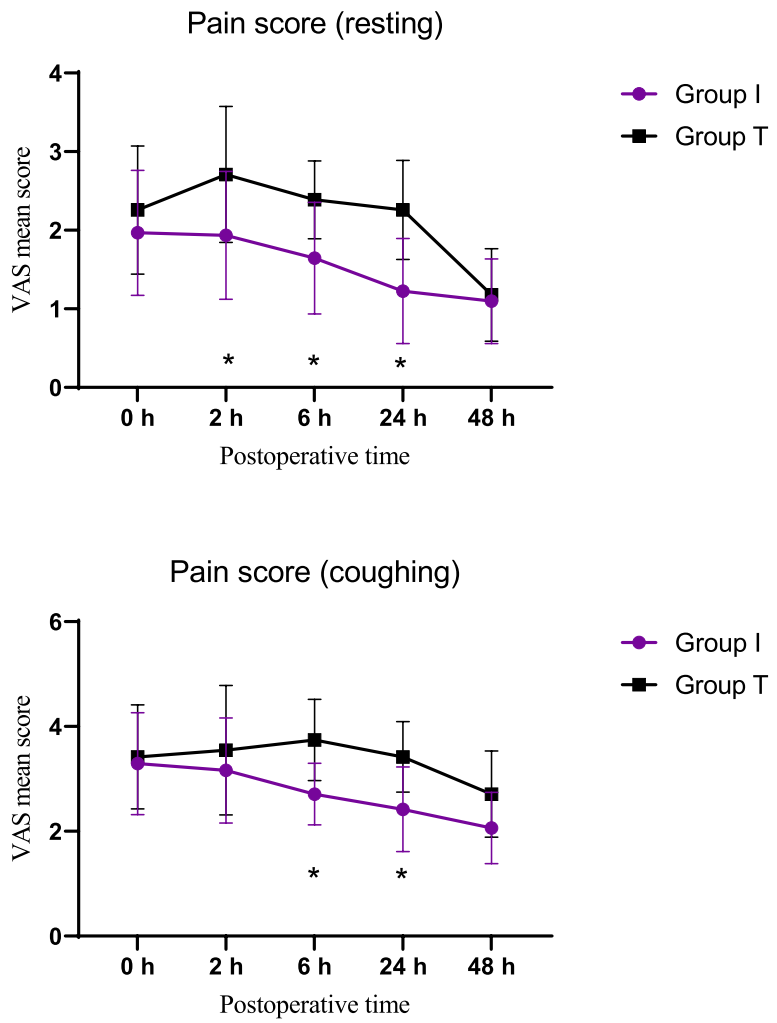

Fig. 3 Comparison of VAS pain scores at rest and during coughing between ITPB and TAPB. This measurement was repeated at 0, 2, 6, 24, 48 h postoperatively. ITPB, intertransverse process block; TAPB, transversus abdominis plane block. VAS, visual analogue score; Values were expressed as mean (standard deviation). *$P < 0.05$ vs group T

ITPB is considered a "paravertebral by proxy" block [21]. Costache et al. were the first to inject 2% methylene blue between the posterior border of the transverse process and the pleura in the cadaver. The results confirmed the penetration of methylene blue into the paravertebral space as well as the adjacent vertebral bodies [22]. Another study by Tae-Hyeon Cho et al. showed that LA in ITPB could be expanded anteriorly via the transverse costal foramen of the medial suture of the transverse ligament of the costotransvertebral process ligament by acting on the spinal nerve roots in the paravertebral space. It could also inhibit the sympathetic nerves, inducing both somatic and visceral analgesia [12]. Based on these observations, it was hypothesizd that ITPB had a theoretically better analgesic effect than TAPB, especially in visceral pain. Also, LA could extend 1–2 vertebral levels via the transverse intercostal space between the transverse process and the ribs [23]. Thus, two segments, i.e., T6/7 and T9/10 were selected in the ITPB group, assuming that the block range could cover the entire surgical operation area, providing a wide analgesic range for large-scale traction and internal organ movement during surgery.

An insignificant difference was observed in pain scores at rest and coughing immediately post-extubation. There was a possibility that since all patients received a combination of fentanyl 50 mcg and parecoxib sodium 30 min before the end of the surgery, the duration of drug action was covered till extubation. In this study, the nerve block was administered after latent sedation and analgesia before anesthesia induction, which was aligned with preemptive analgesia [24]. It effectively prevented the injury impulse transmission that was caused by surgery to the center and reduced the intraoperative opioid dosage to alleviate hyperalgesia attributed to the rapid

Table 4 Comparison of other secondary outcomes between the groups

	ITPB group ($n=31$)	TAPB group ($n=31$)	*P*
Perioperative tachycardia	4 (12.9%)	7 (23.6%)	0.319
Perioperative hypertension	5 (16.1%)	9 (29.0%)	0.224
Additional analgesia			
Time to first requiring rescue analgesia (h)	8.0 [8.0]	6.0 [6.0]	0.009
Rescue analgesic (dezocine) consumption (mg)	1.0 [2.0]	2.4 [2.9]	0.024
Effective PCA requests number within 48 h	1.2 (1.1)	1.8 (1.3)	0.064
Time to independent movement (h)	25.8 (4.9)	30.3 (9.5)	0.022
Postoperative complications			
Dizzness	1 (3.2%)	3 (9.7%)	0.605
Nausea or vomiting	4 (12.9%)	8 (25.8%)	0.199
Patient's satisfaction			0.021
Highly satisfied	18 (58%)	9 (29%)	
Satisfied	13 (42%)	22 (71%)	
Dissatisfied	0 (0%)	0 (0%)	
Incidence of complications (hematoma, infection, pneumothorax)	0 (0%)	0 (0%)	1.000

Values are presented as mean (standard deviation) or median [inter-quartile range (IQR)]. Dizziness, nausea or vomiting presented as n (%)

PCA Patient-controlled analgesia. *ITPB* Intertransverse process block, *TAPB* Transversus abdominis plane block

metabolism of remifentanil post-surgery. A reduction in the risk of developing opioid-induced hyperalgesia (OIH) could improve patient safety [25].

One of the leading causes of perioperative pain is believed to be the inflammatory response that occurs during surgery [26]. Here, the afferent center of injurious stimulus was reduced in all patients via the administration of butorphanol and a non-steroidal anti-inflammatory drug (parecoxib sodium) [27]. The mechanism of action of erector spinae plane block has been proposed to involve the analgesic and anti-inflammatory effects of systemic absorbed local anesthetics [28]. There was a reasonable doubt as to whether ITPB possessed similar anti-inflammatory effects.

Current investigations on the diffusion path of ITPB have been limited to cadaveric studies. However, living patients might have variable compartmental and tissue pressures [23], and any variations in tissue integrity and spatial dimensions due to respiratory movements might impact the extent of injection diffusion. These cadaveric studies provide guidance regarding the clinical application of nerve blocks. Based on experimental data, ITPB is simple to perform and can easily recognize anatomical landmarks. This technique possesses a lower risk of accidental trauma to local vessels, pleura, and nerves [10]. It evades the potential risks related to the paravertebral blocks or epidural blocks. These observations are consistent with our results, which show that no block-related complications were observed in the ITPB group.

With a lower perioperative opioid use in the ITPB group, a reduction in postoperative nausea and vomiting was expected. However, an insignificant difference was observed in the postoperative complications between the two groups (12.9% *vs* 25.8%, $P=0.199$). This could be attributed to the fact that the sample sizes in this study were calculated using the primary outcome measures, which lacked statistical power. The lower incidence of nausea and vomiting in this study than that of 31.7% in the previous study could be attributed to the aggressive use of antiemetics during surgery [29].

This study had several limitations. First, the sensory dermatome coverage of patients and the onset time of the block were not evaluated to avoid bias; thus, there is a possibility that both groups may include patients with incomplete analgesia. However, all patients received individualized analgesia with the appropriate multimodal analgesia regimen. Second, the time to administer the block was not measured; thus, this study did not exhibit data on the advantages of ITPB over TAPB regarding the simplicity of postoperative analgesia during surgery. Third, the local anesthetic we chose for this study was 60 mL of 0.3% ropivacaine. Although the total dose was smaller than in the previous study [30], we did not know whether it was the optimal dose or concentration in patients undergoing gastric cancer surgery. In future research, we hope to measure the plasma concentrations of ropivacaine for preciseness. Additionally, this study was a single-centered study, and the follow-up was done only up to 48 h post-surgery; thus, the effect of analgesia

on the length of stay was not determined. Future studies might be done using a larger sample size and a longer follow-up period to determine the effect of analgesia on postoperative recovery quality.

Conclusions

US-guided ITPB appears to offer benefit by decreasing some aspects of postoperative pain and to some extent opioid usage and improve patient satisfaction with postoperative analgesic effectiveness compared with TAPB. Therefore, we recommend that ITPB should be included in the multimodal perioperative analgesia protocol for patients undergoing laparoscopic radical gastrectomy. Further studies are required to explore the detailed mechanism of action of ITPB and to determine the optimal volume and concentration of local anesthetics.

Abbreviations

ASA	American society of anesthesiologists
PACU	Post-anesthesia care unit
PCA	Patient-controlled analgesia
ITPB	Intertransverse process block
TAPB	Transversus abdominis plane block
LA	Local anesthetic
TEA	Thoracic epidural analgesia
SCTL	Superior costotransverse ligament
VAS	Visual analogue score
MAP	Mean arterial pressure
OIH	Opioid-induced hyperalgesia
US	Ultrasound

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Authors' contributions

QC and HD designed of the studies. YZ and FW performed the experiments and collected data. QC and XZ analyzed the data and drafted the manuscript. HD and BQ acted as supervisors for this study. All authors contributed to the article and approved the submitted version.

Funding

Not applicable.

Data availability

Due to concealment involving participants, privately anonymous datasets will be sent to by reasonable request corresponding author.

Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Committee of Yancheng First People's Hospital (2023-k-089, 17/06/2023). All patients provided signed informed consent forms. The trial registration number was as follows: ChiCTR2300072986, date of registration: 29/06/2023.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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