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Efficacy of transversus abdominis plane block for gastric surgery: a meta-analysis

Hao Zhang[1], Hong Pan[1] and Xiaodong Chen[1*]

Abstract

Background Multimodal analgesia is an important component of Enhanced Recovery After Surgery (ERAS). Transversus abdominis plane (TAP) block helps achieve this pain management in various types of surgeries. To evaluate the efficacy of TAP block versus non-TAP approaches for postoperative pain management and recovery after gastric surgery.

Methods A systematic literature search across four databases (Cochrane, Embase, Web of Science, PubMed) until February 2024 identified relevant randomized controlled trials (RCTs) evaluating TAP block in gastric surgery. Two independent reviewers screened studies, extracted data, and assessed analyses. Primary outcome: postoperative pain scores. Secondary outcomes: postoperative opioid consumption, hospital stay, time to ambulation, and time to flatus.

Results Twelve RCTs involving 841 participants were included. Compared to non-TAP, the TAP group demonstrated significantly lower visual analog scale (VAS) pain scores at 1, 3, 6, 12, 24, and 48 h postoperatively (WMD range: -0.62 to -0.97). Time to first ambulation (SMD − 0.46; 95% CI: -0.92, 0.00) and first flatus (WMD − 5.17; 95% CI: -8.58, -1.77) were shorter in the TAP group. Postoperative opioid consumption was reduced with TAP (WMD − 1.89; 95% CI: -2.41, -1.37), with no difference in hospital stay between groups.

Conclusion TAP block effectively relieves pain after gastric surgery, decreases postoperative morphine requirements, and modestly shortens bed rest duration while promoting intestinal function recovery. However, it does not significantly affect the overall hospital length of stay.

Keywords Transversus abdominis plane (TAP) block, Gastric surgery, Postoperative pain scores, Opioid consumption, Ambulation

Introduction

Gastric resection, a surgical technique, is widely utilized for gastric tumors (e.g., gastric cancer, gastrointestinal stromal tumors), severe gastric ulcers, pyloric obstruction of various etiologies, and severe obesity. Gastric cancer, the fifth most common cancer worldwide [1], is the primary indication for gastric resection. Concurrently, with rising global obesity rates, particularly morbid obesity [2], an increasing number of patients opt for bariatric surgeries like sleeve gastrectomy and gastric bypass. With the enhanced recovery after surgery (ERAS) concept, healthcare professionals focus on multimodal postoperative pain management strategies [3], including epidural anesthesia, transversus abdominis plane block, and local infiltration anesthesia, to alleviate postoperative pain following gastric surgery. These methods have demonstrated significant efficacy, accelerating postoperative

*Correspondence:
Xiaodong Chen
236165437@qq.com
[1]Department of general surgery, Chongqing Western Hospital, Jiulongpo District Chongqing, Chongqing 400050, China

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recovery and reducing postoperative complication incidence.

TAP is a regional anesthesia technique introduced by Rafi in 2001 [4]. Involving local anesthetic injection into the fascial plane between transversus abdominis and internal oblique muscles, it blocks abdominal wall nerve conduction, reducing postoperative pain, opioid consumption, hospital stay, and improving patient satisfaction. Initially performed under ultrasound guidance, TAP blocks can now utilize direct laparoscopic visualization [5]. Widely used in various abdominal surgeries [6, 7, 8, 9] like laparoscopic hysterectomy, cholecystectomy, inguinal hernia repair, and colorectal resection, demonstrating good analgesic effects. However, their efficacy in gastric surgeries, including gastric cancer and bariatric procedures, lacks sufficient evidence.

In recent years, the Enhanced Recovery After Surgery (ERAS) approach has gained recognition, with studies highlighting its efficacy in optimizing postoperative recovery, minimizing hospitalization, lowering medical costs, and enhancing patient satisfaction and quality of life [10, 11, 12, 13]. Postoperative pain control, early mobilization, and rapid intestinal recovery are key principles of ERAS [3], aligning well with the benefits of TAP block. While meta-analyses have assessed TAP block efficacy in laparoscopic sleeve gastrectomy [14], its role in traditional open gastric surgeries remains inadequately analyzed, leaving its overall effectiveness across all gastric procedures uncertain. This study evaluates TAP block efficacy in both laparoscopic and open gastric surgeries through meta-analysis, providing comprehensive evidence for clinical practice.

Methods

Literature search

Two researchers searched Cochrane, Embase, Web of Science, and PubMed databases using keywords related to TAP block (Abdominal wall block, Abdominal wall injection, Abdominal wall analgesia, Abdominal wall anesthesia, Transversus Abdominal wall block, Transversus abdominis plane block, Transversalis abdominis block, Transverse abdominal plane block, TAP block) combined with OR operator, and keywords related to gastric surgery (Stomach, Stomachs, Gastrectomy, Gastrectomies, Gastrointestinal Surgery, Gastric) combined with OR operator. These two sets were then combined using AND operator. No filters applied for publication date, age, gender, article type, or language. The final literature search was performed on February 3, 2024. Study protocol registered in PROSPERO (CRD42024534141).

All retrieved articles imported into Endnote21 software, duplicates removed, remaining articles screened. Only randomized controlled trials (RCTs) included. No restrictions on TAP block injection method, type or dose of injected drugs. Studies involving non-gastric surgeries excluded, as were studies with placebo injection in control group receiving TAP block.

Data extraction

Two researchers evaluated text, tables, or images from original articles, extracting study design, publication year, patient characteristics, TAP injection type (ultrasound-guided or laparoscopic-guided), surgery type, control method, Visual Analog Scale (VAS) scores (at rest or during movement), time points for pain score measurements, hospital stay duration, postoperative morphine consumption, time to first flatus, and time to first ambulation. Means and standard deviations of outcomes extracted. When not reported, approximated from medians, interquartile ranges, group mean differences, and standard errors. Discrepancies in evidence selection and data extraction resolved through discussion.

Quality assessment

Two researchers independently assessed included studies' quality, compared results, resolved differences through discussion. This study employed the Cochrane risk-of-bias tool to evaluate the quality of included randomized controlled trials [15], assessing random sequence generation, allocation concealment, blinding, outcome assessor blinding, incomplete outcome data, selective reporting, and other biases. Egger's test assessed publication bias. Sensitivity analysis conducted for heterogeneous results.

Statistical analysis

The primary outcome was VAS score, with some studies providing scores at rest and during movement. Observation time points: postoperative 1, 3, 6, 12, 24, and 48 h. Secondary outcomes: total hospital stay (hours), postoperative morphine consumption (mg), time to first flatus (hours), and time to first ambulation (hours). Weighted mean difference (WMD) primarily used as statistical measure for continuous variables. Due to large intergroup differences, standardized mean difference (SMD) used for postoperative morphine consumption and time to first ambulation. High heterogeneity identified when I-squared > 50%. Subgroup analyses conducted based on TAP block method, surgical method, and control method. Analyses performed using Stata 15 and Review Manager 5.4.

Results

Literature search process and results

Two researchers retrieved 663 references from Cochrane (210), Embase (131), PubMed (50), and Web of Science (272). After title and abstract screening, 161 duplicates and 466 irrelevant studies excluded, leaving 35 references for full-text review. Subsequently, 23 references further excluded due to incomplete data, resulting in 12 references meeting inclusion criteria (Fig. 1).

Basic characteristics of included studies

Twelve randomized controlled trials, recruiting 841 patients undergoing various gastric surgeries between 2012 and 2022, were included. The mean age across groups was 32–62 years. Ultrasound-guided TAP was used in eight studies, and laparoscopic-guided TAP in four. Nine studies involved laparoscopic surgeries (laparoscopic sleeve gastrectomy and gastric bypass), and three traditional open gastrectomy. Eight control groups received no special treatment; four administered treatments like morphine analgesia and local incision infiltration anesthesia (Table 1).

Risk of Bias assessment

Two researchers analyzed and assessed various biases, including random sequence generation, allocation concealment, blinding of outcome assessment, incomplete outcome data, and selective reporting. Most studies performed well in random sequence generation and allocation concealment. However, some had a higher risk of bias in blinding of outcome assessment and incomplete outcome data, potentially affecting the objectivity and completeness of results (Figure S1).

Meta-analysis result

Postoperative pain

Eight studies, involving 505 patients, reported postoperative pain data [16, 17, 18, 19, 20, 21, 22, 23], three provided both resting and activity-related pain scores. Compared to the control group, patients receiving TAP

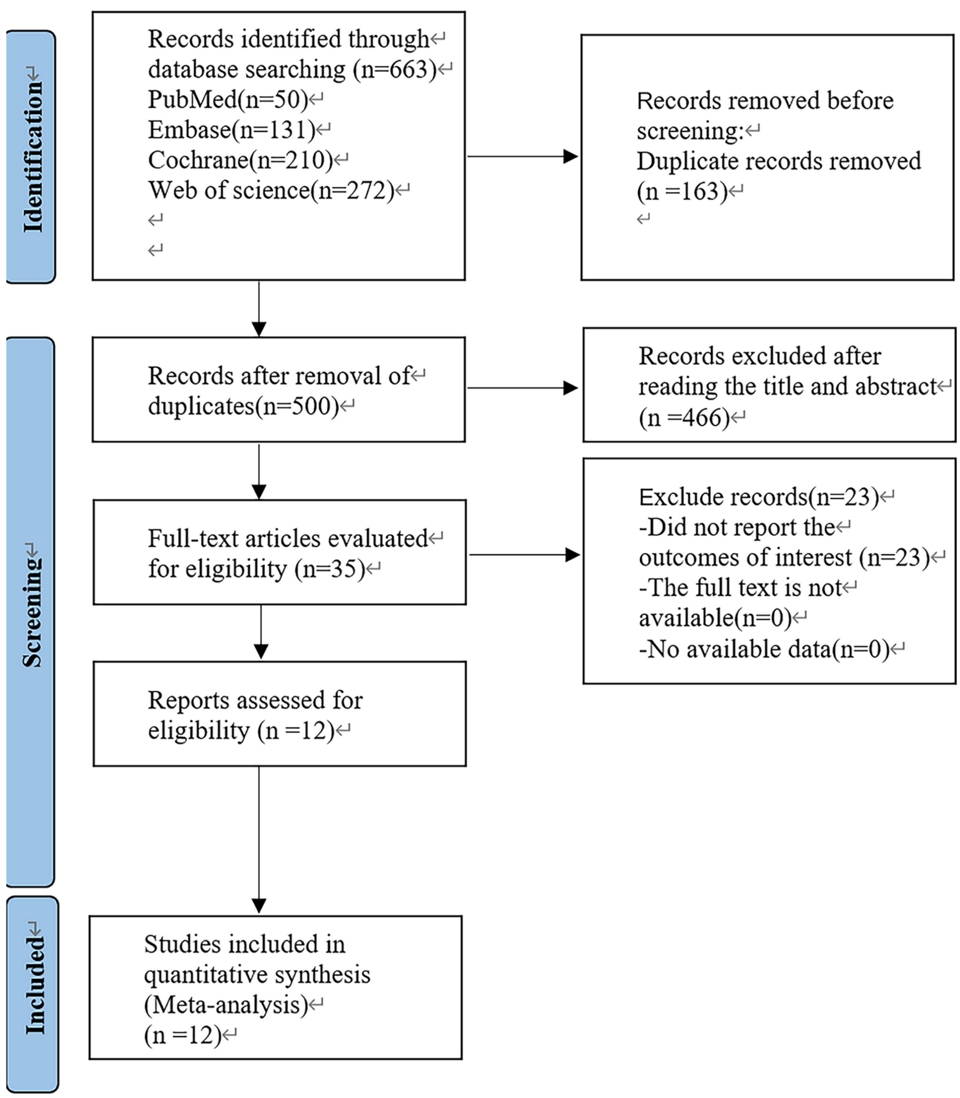

Fig. 1 Literature Search Flowchart

Table 1 Basic characteristics of included studies

Study	Year	Country	Sample size		Gender(Male/Female)	Mean age		Intervention		Injection method	Surgical method	Outcome
			EG	CG		EG	CG	EG	CG			
A. Aboseif	2023	Egypt	20	20	8/32	41	40	TAP	Placebo	Ultrasound-guided	LGB; LSG	NRS; F1;F4;F5;F6;F7;F8;F9
A. M. Said	2017	USA	45	45	31/59	32	33	TAP	Morphine	Laparoscopically assisted	LSG	NRS; F9;F10;F12;F14
B.M.Abdelhamid	2020	Egypt	22	22	25/19	36	36	TAP	Opioid	Ultrasound-guided	LSG	VAS; F18;F19;F20;F21
E. Albrecht	2013	USA	27	30	11/46	45	39	TAP	Placebo	Ultrasound-guided	LGB	NRS; F22;F23;F24
G. Okut	2022	Turkey	30	30	28/32	35	32	TAP	Placebo	Laparoscopically assisted	LSG	VAS; F27;F28
J. Ruiz-Tovar	2018	Spain	70	70	60/80	42	42	TAP	PSI	Laparoscopically assisted	RYGB	VAS; F28;F29;F30
K. A. Wong	2020	USA	75	71	22/124	42	40	TAP	Placebo	Laparoscopically assisted	LSG; RYGB	F0;F12;F24;F26;F32
R. Liu	2019	China	30	31	44/17	59	60	TAP	Placebo	Ultrasound-guided	Open radical gastrectomy	VAS; F38;F33;F34;F9;F12;F39
R. M. Hussien	2023	Egypt	15	15	15/15	41	41	TAP	NSAIDS	Ultrasound-guided	LSG	VAS; F33;F19
T. Mittal	2018	India	30	30	N/A	N/A	N/A	TAP	Placebo	Ultrasound-guided	LSG	VAS; F12;F17;F10
W. Zhan	2020	China	30	30	30/30	58	60	TAP	Placebo	Ultrasound-guided	Open radical gastrectomy	VAS; F33
Y. Wu	2013	China	27	26	37/16	60	62	TAP	Placebo	Ultrasound-guided	Open radical gastrectomy	VAS; F9;F12

EG: Experimental Group; CG: Control Group; TAP: Transversus Abdominis Plane; NRS: Numerical rating scale; VAS: Visual analogue scale; LGB: Laparoscopic gastric bypass; LSG: Laparoscopic sleeve gastrectomy; RYGB: Roux-en-Y Gastric Bypass; PSI: Port-site infiltration; F0: Pain score; F1: OR Time; F2: Blood Loss; F3: Pain Scores at three hours postoperatively; F4: FVC (L) after operation; F5: FEV1 (L) after operation; F6: FEV1/FVC (%) after operation; F7: PaO2 (mmHg) after operation; F8: PaO2/FiO2 after operation; F9: Morphine consumption (mg); F10: No. of requested doses of rescue analgesia; F12: Time to first ambulation, flatus (h); F14: Time to first oral intake (h); F17: Patient Satisfaction Score; F18: Paracetamol consumption (g); F19: Pethidine consumption (mg); F20: First request of rescue analgesia (h); F21: Total fentanyl requirement (μg); F22: Cumulative postoperative opioid consumption; F23: The time to first analgesic request; F24: Length of stay in hospital; F25: Mean arterial pressure (MAP); F26: PCA pump measurements; F27: Time to first flatus and defecation; F28: Length of hospital stay; F29: Morphine rescues (%); F30: Hospital discharge during the first 48 h after surgery (%); F31: Prophylaxis of nauseas and vomiting appeared (%); F32: Nonopioid pain medication usage; F33: Changes in SBP (mmHg), DBP (mmHg) and HR (beats/min) before and after skin incision; F34: The dose of sufentanil (μg), nicardipine (mg) and esmolol (mg) supplemented intraoperatively; F35: PACU morphine analgesia (mg); F36: Intraoperative rescue fentanyl; F37: The dose of propofol (mg), remifentanil (μg) supplemented intraoperatively; F38: Neuroendocrine mediators and cytokines at different time points of 48 h after operation; F39: PACU stay (min); F40: Extubation time; F41: Postoperative rescue fentanyl; F42: Tramadol consumption during the first day after surgery; F43: Prophylaxis of nauseas and vomiting appeared score; F44: Quality of Recovery Questionnaire 40; F45: Sedation scores; F46: The dose of sufentanil (μg), remifentanil (mg), Propofol (g), Oxymetazoline (μg), supplemented intraoperatively block had lower VAS scores at rest and during activity at 1 h (WMD, -0.78; 95% CI: -1.38, -0.18; $P = 0.011$), 3 h (WMD, -0.97; 95% CI: -1.20, -0.74; $P < 0.001$), 6 h (WMD, -0.97; 95% CI: -1.27, -0.66; $P < 0.001$), 12 h (WMD, -0.96; 95% CI: -1.37, -0.55; $P < 0.001$), 24 h (WMD, -0.76; 95% CI: -1.05, -0.48; $P < 0.001$), and 48 h (WMD, -0.62; 95% CI: -1.13, -0.12; $P = 0.016$) postoperatively. TAP block effectively reduces postoperative pain in gastric surgery patients within 48 h. Except for the 3 h postoperative data, heterogeneity was observed at other time points; a sensitivity analysis was conducted (Fig. 2).

Morphine consumption

Four studies, involving 244 patients, reported data on postoperative morphine consumption [18, 22, 24, 25]. Patients receiving TAP block had reduced postoperative morphine consumption compared to the control group (WMD, -1.89; 95% CI: -2.41, -1.37) (Fig. 3).

Total length of hospital stay

Four studies, including 394 patients, reported data on the total length of hospital stay [20, 21, 26, 27]. No significant difference was found in total hospital stay between

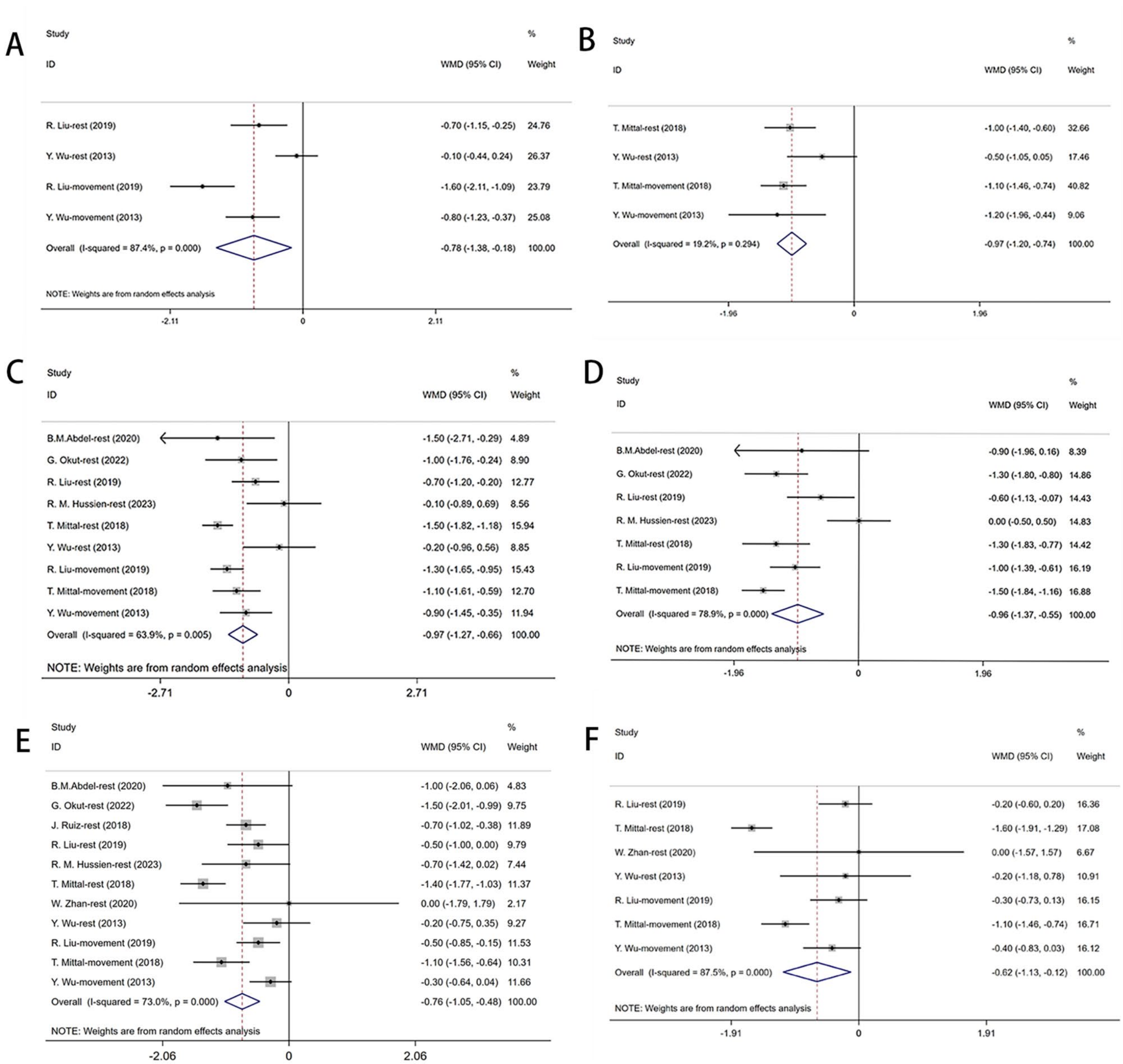

Fig. 2 (**A**) Forest plot of VAS scores 1 h postoperatively; (**B**) Forest plot of VAS scores 3 h postoperatively; (**C**) Forest plot of VAS scores 6 h postoperatively; (**D**) Forest plot of VAS scores 12 h postoperatively; (**E**) Forest plot of VAS scores 24 h postoperatively; (**F**) Forest plot of VAS scores 48 h postoperatively

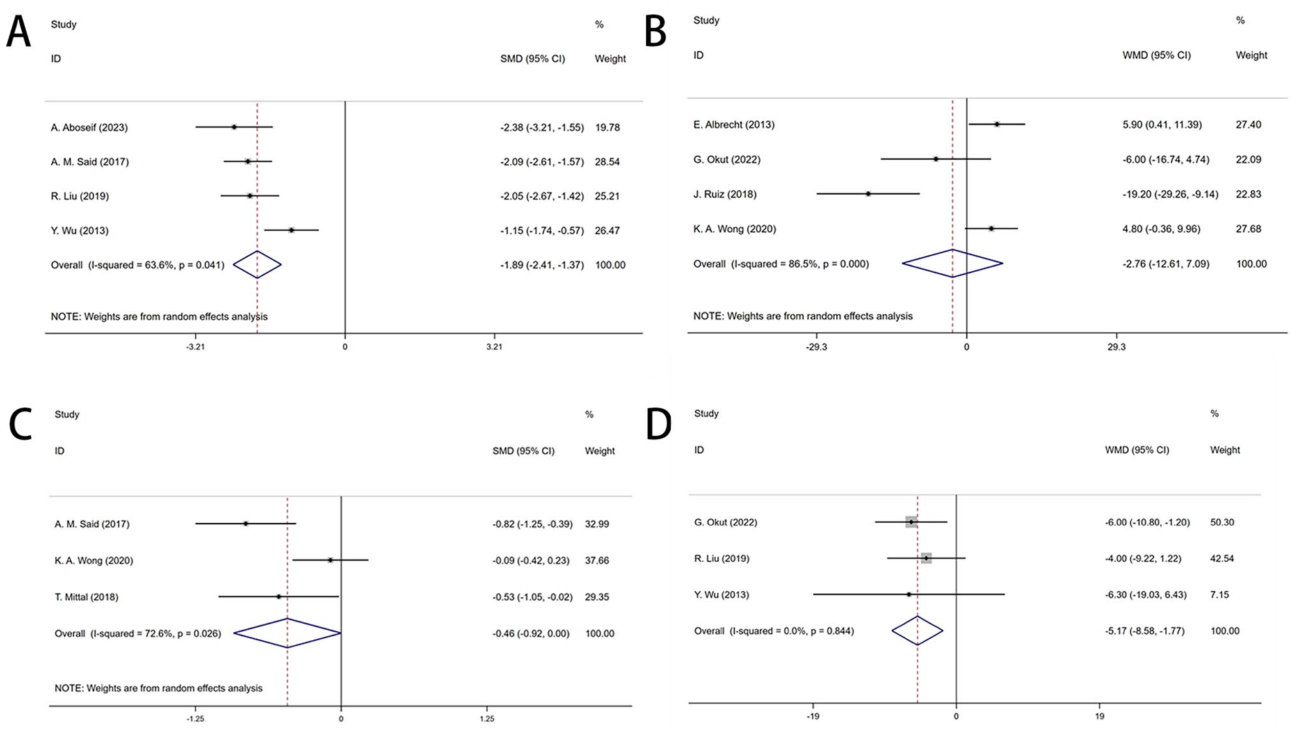

Fig. 3 (**A**) Forest plot of Morphine consumption; (**B**) Forest plot of Length of hospital stay; (**C**) Forest plot of Time to first ambulation; (**D**) Forest plot of Time to first flatus

patients receiving TAP block and the control group (WMD, -2.76; 95% CI: -12.61, 7.09) (Fig. 3).

Time to first ambulation

Three studies, enrolling 296 patients, reported data on time to first ambulation postoperatively [19, 25, 27]. Patients receiving TAP block had a shorter time to first ambulation compared to the control group (SMD, -0.46; 95% CI: -0.92, 0.00) (Fig. 3).

Time to first flatus

Three studies, involving 174 patients, reported data on time to first postoperative flatus [18, 20, 22]. Patients receiving TAP block had a shorter time to first postoperative flatus compared to the control group (WMD, -5.17; 95% CI: -8.58, -1.77) (Fig. 3).

Subgroup analysis

Subgroup analyses were conducted by two researchers based on surgical methods (laparoscopic or traditional open surgery), TAP block techniques (laparoscopic-guided or ultrasound-guided), and control group treatment (with or without other analgesic measures). Table 2 shows detailed results. Results indicated that, regardless of surgical approach (laparoscopic or open) or TAP injection technique (ultrasound-guided or laparoscopy-guided), the TAP block group demonstrated lower VAS scores within 48 h postoperatively compared to the control group. However, in the active placebo group, no significant differences were observed in VAS scores at 12 and 24 h postoperatively between patients receiving TAP block and those receiving opioid treatment. Similarly, no significant differences were found in VAS scores at 6, 12, and 24 h postoperatively between patients receiving TAP block and those treated with Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) (Table 2).

Sensitivity analysis and publication bias assessment

Due to the observed heterogeneity among studies in most meta-analyses, further sensitivity analyses were conducted using the leave-one-out method. After excluding individual studies, the overall WMD and 95% CI remained similar, indicating relatively robust conclusions. Egger's test was conducted to assess publication bias. The results suggested no evidence of publication bias in other analyses, except for the pooled results of 1-hour postoperative pain scores (Figure S2-S19).

Discussion

Transversus abdominis plane (TAP) block has evolved from an emerging regional anesthesia technique into an integral component of postoperative pain management for abdominal surgeries over the past two decades. The technique involves injecting local anesthetics into the

Table 2 Subgroup analysis data

Outcome	group	Subgroup	No of study	Heterogeneity		SMD/WMD(95%CI)	*P*
				I^2(%)	*P*		
Pain Scores at 3 h postoperatively	Type of operation	LSG	2	0	0.715	-1.06 (-1.32, -0.79)	0.000
		Open radical gastrectomy	2	53.4	0.143	-0.74 (-1.18, -0.30)	0.001
Pain Scores at 6 h postoperatively	Type of operation	LSG	5	65	0.022	-1.07 (-1.54, -0.59)	0.000
		Open radical gastrectomy	4	64.6	0.037	-0.85 (-1.28, -0.41)	0.000
	Injection method	Ultrasound guided	8	68.3	0.002	-0.96 (-1.29, -0.62)	0.000
		Laparoscopically	1	N/A	N/A	-1.00 (-1.76, -0.24)	0.010
	Control group	Active placebo(Opioid)	1	N/A	N/A	-1.50 (-2.71, -0.29)	0.015
		Active placebo(NSAIDS)	1	N/A	N/A	-0.10 (-0.89, 0.69)	0.803
		Placebo	7	60.6	0.018	-1.03 (-1.33, -0.74)	0.000
Pain Scores at 12 h postoperatively	Type of operation	LSG	5	84.1	0.000	-1.02 (-1.60, -0.43)	0.001
		Open radical gastrectomy	2	28.7	0.236	-0.84 (-1.22, -0.46)	0.000
	Injection method	Ultrasound guided	6	81.6	0.000	-0.90 (-1.37, -0.42)	0.000
		Laparoscopically	1	78.9	0.000	-1.30 (-1.80, -0.80)	0.000
	Control group	Active placebo(Opioid)	1	N/A	N/A	-0.90 (-1.96, 0.16)	0.095
		Active placebo(NSAIDS)	1	N/A	N/A	0.00 (-0.50, 0.50)	1.000
		Placebo	5	56.6	0.056	-1.16 (-1.47, -0.86)	0.000
Pain Scores at 24 h postoperatively	Type of operation	LSG	5	10.0	0.349	-1.25 (-1.49, -1.00)	0.000
		Open radical gastrectomy	5	0	0.834	-0.38 (-0.58, -0.18)	0.000
		RYGB	1	N/A	N/A	-0.70 (-1.02, -0.38)	0.000
	Injection method	Ultrasound guided	9	71.4	0.000	-0.68 (-1.01, -0.35)	0.000
		Laparoscopically	2	85.4	0.009	-1.08 (-1.86, -0.29)	0.007
	Control group	Active placebo(Opioid)	1	N/A	N/A	-1.00 (-2.06, 0.06)	0.064
		Active placebo(NSAIDS)	1	N/A	N/A	-0.70 (-1.42, 0.02)	0.056
		Active placebo(PSI)	1	N/A	N/A	-0.70 (-1.02, -0.38)	0.000
		Placebo	8	80.9	0.000	-0.76 (-1.14, -0.37)	0.000
Pain Scores at 48 h postoperatively	Type of operation	LSG	2	76.8	0.038	-1.36 (-1.85, -0.87)	0.000
		Open radical gastrectomy	5	0	0.962	-0.28 (-0.52, -0.05)	0.017
Length of stay in hospital	Injection method	Ultrasound guided	1	N/A	N/A	5.90 (0.41, 11.39)	0.035
		Laparoscopically	3	89.0	0.000	-6.35 (-21.20, 8.50)	0.402
	Control group	Active placebo(PSI)	1	N/A	N/A	-19.20 (-29.26, -9.14)	0.000
		Placebo	3	48.5	0.143	3.29 (-2.01, 8.59)	0.224
Morphine consumption (SMD)	Type of operation	LSG	1	N/A	N/A	-2.09 (-2.61, -1.57)	0.000
		Open radical gastrectomy	2	76.0	0.041	-1.59 (-2.47, -0.72)	0.000
		LSG; LGB	1	N/A	N/A	-2.38 (-3.21, -1.55)	0.000
	Injection method	Ultrasound guided	3	71.8	0.029	-1.82 (-2.55, -1.09)	0.000
		Laparoscopically	1	N/A	N/A	-2.09 (-2.61, -1.57)	0.000
	Control group	Active placebo(Opioid)	1	N/A	N/A	-2.09 (-2.61, -1.57)	0.000
		Placebo	3	71.8	0.029	-1.82 (-2.55, -1.09)	0.000
Time to first ambulation (SMD)	Injection method	Ultrasound guided	1	N/A	N/A	-0.53 (-1.05, -0.02)	0.042
		Laparoscopically	2	85.5	0.009	-0.44 (-1.15,0.27)	0.224
	Control group	Active placebo(Opioid)	1	N/A	N/A	-0.82 (-1.25, -0.39)	0.000
		Placebo	2	50.5	0.155	-0.27 (-0.69, 0.16)	0.218
Time to first flatus	Type of operation	LSG	1	N/A	N/A	-6.00 (-10.80, -1.20)	0.014
		Open radical gastrectomy	2	0.0	0.743	-4.33 (-9.16, 0.50)	0.079
	Injection method	Ultrasound guided	2	0.0	0.743	-4.33 (-9.16, 0.50)	0.079
		Laparoscopically	1	N/A	N/A	-6.00 (-10.80, -1.20)	0.014

SMD: Standardized Mean Difference; WMD: Weighted Mean Difference; LSG: Laparoscopic sleeve gastrectomy; RYGB: Roux-en-Y Gastric Bypass; LGB: Laparoscopic gastric bypass; PSI: Port-site infiltration; NSAIDS: Non-Steroidal Anti-Inflammatory Drugs

fascial plane between the internal oblique and transversus abdominis muscles, effectively blocking the anterior abdominal wall's nerve supply. This prevents pain signals from being transmitted through the anterior abdominal wall's sensory nerves, avoiding peripheral and central sensitization and reducing abdominal surgery-related pain [28]. TAP block's practical clinical efficacy has been tested in various surgeries worldwide. Several meta-analyses have evaluated TAP block's effects on colorectal, biliary, gynecological, and bariatric surgeries [14, 29, 30, 31, 32], however, meta-analyses regarding its efficacy in all gastric surgeries are still lacking. This study's results showed lower VAS scores in the experimental group compared to the control group at 1, 3, 6, 12, 24, and 48 h postoperatively ($P < 0.05$). TAP block can effectively reduce postoperative pain within 48 h after gastric surgery, similar to Hytham K. S. Hamid's findings [14]. Although TAP block significantly reduced postoperative VAS scores, the included studies did not clarify their clinical relevance. Research [33] indicates that the minimal clinically important difference (MCID) for VAS scores in acute postoperative pain assessment is 0.99. In this study, the mean VAS score differences between the TAP and control groups at 1 h, 3 h, 6 h, 12 h, 24 h, and 48 h postoperatively were 0.78, 0.97, 0.97, 0.96, 0.76, and 0.62, respectively. Although statistically significant, these differences were below the MCID threshold, suggesting limited clinical relevance. Subgroup analysis revealed more pronounced analgesic effects of TAP block in laparoscopic surgery (mean VAS score differences exceeding 0.99). In contrast, in traditional open surgery, the VAS score differences, though statistically significant, did not reach the clinically significant threshold. This may result from smaller incisions in laparoscopic procedures, enabling more precise TAP block coverage, whereas larger incisions in open surgeries span multiple nerve areas, potentially leading to inadequate coverage. Subgroup analysis revealed that in control subgroups without analgesia, TAP block produced VAS score differences surpassing the MCID at 6 and 12 h, demonstrating clinical significance. However, in control subgroups receiving opioid or NSAIDs treatment, no significant differences in VAS scores were observed at 12 and 24 h postoperatively compared to TAP block, potentially diminishing the overall effect size. TAP block significantly reduces postoperative pain within 48 h in laparoscopic gastric surgery; however, in open gastric surgery, it reduces VAS scores and alleviates some pain, but without clinical significance.

The TAP block group had significantly lower total postoperative morphine consumption than the control group, consistent with the VAS score results. Reduced postoperative pain naturally leads to decreased morphine consumption, which can decrease the incidence of postoperative adverse reactions such as nausea, vomiting, and gastrointestinal paralysis, promoting postoperative recovery [34]. Heterogeneity among the studies may be due to different methods of calculating morphine consumption. For example, Alfred M. Said [25] reported total morphine consumption within 24 h postoperatively, while Yiquan Wu [22] reported it within 72 h. Some studies did not clearly specify the time frame for morphine calculation, potentially contributing to heterogeneity. We selected standardized mean difference (SMD) instead of weighted mean difference (WMD) for our analysis to standardize the results and enhance the validity of cross-study comparisons.

The total length of hospital stay did not significantly differ between the TAP block and control groups, possibly due to varying discharge criteria across study centers. However, the TAP block group had significantly shorter times to first ambulation and postoperative flatus compared to the control group, indicating that TAP block can facilitate early postoperative mobilization and reduce postoperative complications, as prolonged bed rest is a high-risk factor [35]. The time to first postoperative flatus showed minimal heterogeneity among studies, yielding relatively reliable results. However, heterogeneity was observed for the time to first ambulation, possibly due to varying postoperative management strategies at medical centers, with some encouraging early ambulation and others being more conservative. Different surgical techniques used in the studies could also contribute to this heterogeneity; patients undergoing laparoscopic surgery may ambulate earlier than those undergoing traditional open surgery.

This study has several limitations. First, the small number of included publications, some of which exhibited publication bias. Second, there is methodological heterogeneity across studies, including variations in TAP block techniques, with some using ultrasound-guided and others laparoscopy-guided methods, which could affect efficacy. Furthermore, the types and dosages of local anesthetics varied, potentially influencing outcomes. Third, the control groups were inconsistent-some had no analgesic interventions, while others used active placebos such as opioids, NSAIDs, or wound infiltration, which may affect the evaluation of TAP block efficacy. Finally, the studies involved diverse patient populations with varying age, gender, and pain perception thresholds, complicating the assessment of effectiveness.

We addressed heterogeneity through subgroup analyses based on surgical approach, TAP technique, and control group interventions. These analyses demonstrated that, irrespective of the approach (laparoscopic or open surgery) or TAP technique (ultrasound-guided or laparoscopy-guided), the TAP blockade group exhibited lower VAS scores within 48 h postoperatively, confirming its analgesic efficacy. Surprisingly, in active placebo groups, patients receiving TAP block exhibited no significant difference in VAS scores at 12 and 24 h postoperatively compared to those treated with opioids or NSAIDs. This may stem from non-standardized analgesic dosages across control groups in various studies. For example, in R. M. Hussien et al.'s study [17], control patients received supplementary NSAIDs doses at

1 and 8 h postoperatively, coinciding with the ongoing metabolism of local anesthetics, potentially diminishing the analgesic effects of TAP block and masking its efficacy. These findings suggest that, in some instances, TAP block may not outperform opioids or NSAIDs. Given the limited number of studies in certain subgroups, caution is warranted in interpreting these results. Along with subgroup analyses, sensitivity analyses using the leave-one-out method showed no significant changes in pooled effect sizes or 95% confidence intervals, regardless of the excluded study. This suggests that our findings were not significantly influenced by any single study and exhibit good stability. Certain results exhibited high statistical heterogeneity (I^2 > 50%), implying that TAP block efficacy may depend on various factors rather than being consistently effective across all gastric surgery patients. Large-scale, well-designed randomized controlled trials are needed to validate our findings and directly compare TAP block with conventional analgesics such as opioids and NSAIDs, addressing the observed heterogeneity.

Conclusion

TAP block effectively manages pain following gastric surgery, particularly laparoscopic procedures, reduces postoperative morphine use, and shortens recumbency periods while promoting intestinal function recovery. Although TAP block improves postoperative recovery and patient satisfaction, it does not significantly reduce overall hospitalization duration. Heterogeneity exists among the included studies due to differences in TAP block techniques, control group interventions, and surgical methods, limiting the generalizability of these findings. These factors should be considered and applied to real-world clinical settings before implementation.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12871-025-03097-9.

Supplementary Material 1

Acknowledgements
Not applicable.

Author contributions
All authors contributed to the study conception and design. Hao Zhang: Conceptualization, Methodology, Software, Writing- Original draft, Data curation, Visualization were performed; Hong Pan: Investigation, Writing - Original Draft, Writing - Reviewing and Editing were performed; Xiaodong Chen: Conceptualization, Supervision, Project administration were performed. All authors read and approved the final manuscript.

Funding
The study did not receive any specific funding from funding agencies in the public, commercial or non-profit sectors.

Data availability
The data used to support the findings of this study are included within the article.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Conflict of interest
The authors declare that there are no conflicts of interest.

Received: 13 November 2024 / Accepted: 23 April 2025
Published online: 02 May 2025

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