



Analgesic Efficacy of Transverse Abdominis Plane Block and Quadratus Lumborum Block in Laparoscopic Sleeve Gastrectomy: A Randomized Double-Blinded Clinical Trial

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ABSTRACT

Introduction: The analgesic effect and safety of transversus abdominis plane block (TAPB) is still controversial in various abdominal procedures. Quadratus lumborum block (QLB) has been considered to provide a widespread and long-lasting analgesic effect in gynecological

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surgeries. However, the analgesic effects of these two techniques in patients with extreme obesity undergoing laparoscopic sleeve gastrectomy (LSG) are still unknown.

Methods: A total of 225 patients with obesity were randomly assigned to group TAPB ($n = 76$, 30 ml 0.33% ropivacaine with dexmedetomidine $1 \mu\text{g kg}^{-1}$), group QLB ($n = 76$, 30 ml 0.33% ropivacaine with dexmedetomidine $1 \mu\text{g kg}^{-1}$), or general anesthesia alone (GA, $n = 73$, 30 ml 0.9% saline). During the 48-h postoperative period, patients received continuous intravenous patient-controlled analgesia (PCA) containing sufentanil $2 \mu\text{g kg}^{-1}$, dexmedetomidine $2 \mu\text{g kg}^{-1}$, and granisetron 3 mg. The scores of visual analogue scale (VAS) in surgical incision and viscera, considering as the primary outcomes, were continuously recorded at postoperative 0, 0.5, 1, 2, 6, 12, 24, 48 h and discharge.

Results: Comparing with patients in the GA group, VAS scores of incision and viscera were consistently reduced during the initial 6–12 h after LSG in TAPB and QLB groups, and they received less propofol and remifentanyl ($P < 0.001$) as well. In the QLB group, patients had longer duration for the first rescue analgesia, and fewer requirements of the rescue analgesia within 24 h than the GA group ($P < 0.05$). In addition, there were fewer PCA requirements in QLB group than GA and TAPB groups ($P < 0.05$).

Conclusions: Ultrasound-guided transversus abdominis plane block and quadratus lumborum block could provide comparable analgesic effects for a laparoscopic sleeve gastrectomy in obese patients.

Trial Registration: Chinese Clinical Trial Registry; ChiCTR1800019236.

Keywords: Laparoscopic sleeve gastrectomy; Obesity; Postoperative pain; Quadratus lumbar nerve block; Transversus abdominis plane block

Key Summary Points

Why carry out this study?

Obese surgical patients require more opioid medication in the postoperative period, while the complications limited the usage of opioids.

Transversus abdominis plane block (TAPB) and quadratus lumbar nerve block (QLB) could provide effective postoperative analgesia.

We hypothesized that in laparoscopic sleeve gastrectomy, both TAPB and QLB were superior to general anesthesia for postoperative anaesthesia, and both were comparable.

What was learned from the study?

The adjunct of TAPB or QLB with the general anesthesia could significantly relieve postoperative pain for laparoscopic sleeve gastrectomy in obese patients.

TAPB and QLB yielded comparable reduction in the consumption of general anaesthetics and analgesics for bariatric surgery.

It is safe and efficient to apply perioperative administration of dexmedetomidine in this population.

INTRODUCTION

Obesity is becoming the primary cause of preventable death and highly associated with all-cause mortality [1, 2]. With the increase of severe obesity, the population of bariatric surgery is also increasing [3]. Approximately 86% of postoperative patients complain about moderate-to-severe or even extreme post-surgical pain [4]. Almost 25% of patients who received pain medications experienced adverse effects [5]. Obese surgical patients require more opioid medication in the postoperative period [6], because they may have greater perception of pain and persisting long-term severe pain [7]. However, in this population undergoing bariatric surgery, the higher incidence of obstructive sleep apnea (55–70%) limited the usage of opioids. Therefore, active and effective pain control is of priority to the perioperative management for obese patients. Adequate analgesia could effectively reduce the risk of postoperative pulmonary infection, and further improve postoperative rehabilitation [8].

Regional nerve block technology has been widely used for its superior pain relief and rare complications compared with patient-controlled intravenous or epidural analgesia [4]. Because of the comparable analgesic efficacy to epidural analgesia [9], ultrasound-guided transversus abdominis plane block (TAPB) has been used in multimodal analgesia management. TAPB under costal margin is acknowledged in the settings of upper abdominal surgery, such as gastrectomy [10], cholecystectomy [11], and liver transplantation [12]. Comparing with general anesthesia alone, adjunct with TAPB in laparoscopic sleeve gastrectomy (LSG) or laparoscopic gastric bypass surgery had significantly reduced postoperative pain score, analgesic dosage, and increased satisfaction [13, 14]. However, TAPB promoted a similar incidence rate of postoperative hypotension to epidural analgesia after abdominal surgery [9]. Since the limited spread of local anesthetics, TAPB produces more significant somatic analgesia than visceral analgesia [15]. It is also noted that there was no additional analgesic benefit for local anesthetic

infiltration to the trocar insertion site and systemic analgesia in laparoscopic gastric bypass surgery [16]. Therefore, the efficacy of TAPB needs to be further confirmed as the addition to multimodal analgesia in this population.

Although there were variable QLBs (lateral, posterior, and anterior) [17], ultrasound-guided quadratus lumborum block (QLB) is believed to be effective against both somatic and visceral pain via a local anesthetic effect in the paravertebral space for its anatomical advantages [18]. QLB provides a widespread, long-lasting, and more effective postoperative analgesia in laparoscopic obstetrics in renal surgery [19], hip surgery [20], gynecology operations [21], and unilateral inguinal hernia repair or orchiopexy [22]. In addition, posteromedial QLB reduces morphine consumption and improves analgesia with higher overall satisfaction scores following laparoscopic colorectal surgery [23]. However, few studies have evaluated the efficacy of QLB in obese patients for bariatric surgery. Therefore, in the present randomized controlled trial, we aimed to compare the postoperative anesthetic effect of these analgesia approaches and the side effects among obese patients who underwent LSG.

METHODS

Patients

The study was carried out at “The second affiliated hospital of Anhui Medical University” in Hefei City, Anhui Province, China. Informed consent was obtained from all individual participants included in the study. A total of 234 patients aged 18 to 65 years were included in the study from 02/11/2018 to 21/8/2020. Inclusion criteria were American Society of Anesthesiologists (ASA) physical status I–II, BMI > 40 kg m⁻², or > 35 kg m⁻² with co-existing diseases. Exclusion criteria were lack of patient consent, obesity due to endocrine disorder, allergic diathesis for drugs used in the study, serious illness (heart, lung, kidney, or liver), coagulation dysfunction, pre-existing psychological disorder, analgesic or psychotropic medications. Patients with chronic

pain were also excluded. Patients were randomly allocated into three groups of a general anesthesia (GA) group, a transversus abdominis plane block (TAPB) group, and a quadratus lumborum block (QLB) group with a computer-generated randomization sequence (<http://www.randomization.com>).

Ethics

Ethical approval for this study (PJ-YX2018-026) was provided by the Ethics Committee of second affiliated hospital of Anhui Medical University, Hefei City, Anhui Province, China (Chairperson Prof. Wenbing Yao) on October 18, 2018. Then the trial was registered in the Chinese Clinical Trial Registry (ChiCTR1800019236). The study was in accordance with the Declaration of Helsinki and its later amendments.

Blinding

Allocation was concealed in opaque sealed envelopes. Before block, the assignment envelope was opened by the primary investigator. The experienced anesthesiologist who performed TAPB or QLB was blinded to the drug and placebo. To ensure that patients were also blinded to their treatment group, no discussion about the research occurred in the operating room. Surgeons and all patients were also unaware of the assigned treatment. The postoperative follow-up assessments were performed by blinded staff.

Analgesic Technique

Ultrasound-guided bilateral TAPB or QLB was performed before general anesthesia to ensure the success of the block. For TAPB, patients in the supine position, by using an in-plane approach, a convex array probe (Sonosite Micromaxx, Bothell, WA, USA) with a frequency of 2–5 MHz was placed in the clavicle midline, a 22-G 100-mm needle, was inserted between the internal oblique and the transversus abdominis muscle. After careful negative aspiration, 30 ml of 0.33% ropivacaine

(including dexmedetomidine $1 \mu\text{g kg}^{-1}$) was injected in the fascial plane and was observed to spread between the two layers on either side.

For QLB, patients were requested to cooperate in a semi-supine position by rotating the surgical table and placing a sterilized towel on the same side of the patient's hip. The 2–5 MHz convex array ultrasound probe was placed in the posterior axillary line between the rib margin and the iliac crest. A 22-G, 150-mm needle passed through the quadratus lumborum muscle, and the needle tip was located between the quadratus lumborum muscle and psoas major muscle. An oval spread of the same local anesthetic in the plane confirmed the presence of the needle in the correct plane [24].

Patients in the GA group were injected with normal saline either in the fascial plane between the internal oblique and the transverses abdominis muscle or in the plane between the quadratus psoas muscle and psoas major muscle. The analgesic technique was described in detail for the patients. All block procedures were performed by an experienced anesthesiologist who was familiar with ultrasound-guided block applications. The same volume (30 ml) of injectate was used in all groups. A successful block was confirmed by using acupuncture before the induction of general anesthesia.

General Anesthesia

All patients received standard general anesthesia techniques with endotracheal intubation and muscle paralysis. Before general anesthesia induction, a bolus infusion of dexmedetomidine $2 \mu\text{g kg}^{-1} \text{h}^{-1}$ was performed for 15 min. General anesthesia was induced with midazolam 0.025 mg kg^{-1} , propofol 1.5 mg kg^{-1} , cisatracurium 0.2 mg kg^{-1} , and remifentanyl $2 \mu\text{g kg}^{-1}$. Sevoflurane concentration was titrated to maintain the bispectral index between 40 and 60. Intraoperative analgesia was assured by remifentanyl infusion $5\text{--}15 \mu\text{g kg}^{-1} \text{h}^{-1}$. Muscle relaxation was confirmed by infusing cisatracurium $0.1\text{--}0.2 \text{ mg kg}^{-1} \text{h}^{-1}$. Dexmedetomidine was continuously infused during the entire surgery at $0.4 \mu\text{g kg}^{-1} \text{h}^{-1}$. The dosages of

all intravenous anesthetics were calculated by ideal body weight. To maintain mean arterial pressure (MAP) or heart rate (HR) within a range of 20% more or less than the baseline, ephedrine, atropine, or phenylephrine were used during the surgery. To alleviate visceral pain, parecoxib 40 mg and nalbuphine 10 mg were used before surgery initiation. All surgical procedures of LSG were performed by the same surgeon team. Thirty minutes before the end of the surgery, 3 mg granisetron, as prophylaxis against postoperative nausea and vomiting (PONV) was administered.

Outcomes

Postoperative pain scores were considered as the primary outcomes of analgesia efficacy. Visual analog scale (VAS) in the surgical wound (VASi) and viscera (VASv) were used during the postoperative period. At the time of preoperative visit, patients were familiarized with a 10-cm VAS device for pain (0 = no pain at all, 10 = worst imaginable pain). The presence and severity of pain were enquired when they entered the postanesthesia care unit (PACU), 1 h and 2 h after surgery in PACU, 6 h, 12 h, 24 h, and 48 h following LSG in ward, respectively.

Secondary outcome measures included additional analgesia, early recovery indicator, and the side effects. Additional analgesia included the duration of the first rescue analgesia treatment, the number of patients that required rescue analgesia, and the total number of effective patient-controlled analgesia (PCA) requests during the 48-h postoperative period. In case the VAS scores exceeded 4/10 in any group at any time, the patients received rescue analgesia with nalbuphine 10 mg IV in PACU, or diclofenac sodium and lidocaine 75 mg IM in ward. Systemic postoperative analgesia in the form of patient-controlled intravenous analgesia (PCIA) was immediately made available for 48 h. A PCA electronic device contained sufentanil $2 \mu\text{g kg}^{-1}$, dexmedetomidine $2 \mu\text{g kg}^{-1}$, and granisetron 3 mg. An initial bolus of 2 ml was programmed to deliver followed by 0.8 ml

bolus (lockout interval = 15 min; infusion rate = 2 ml h⁻¹).

Early recovery indicator included the time to ambulation and first flatus, the length of post-operative hospital stay, and the side effects (such as nausea and vomiting, itching, respiratory depression, bradycardia, hypotension) during the follow-up period. The perioperative hemodynamic variables (MAP, HR, blood glucose, lactic acid) were also recorded at different time points, including T0 (before anesthesia), T1 (anesthesia intubation), T2 (pneumoperitoneum complete), T3 (gastrectomy), T4 (extubation), T5 (PACU entering), and T6 (PACU 1 h). Perioperative hypotension was defined as MAP decrease of more than 20% of baseline lasting at least 2 min.

Statistical Analysis

Based on our preliminary trials, we assumed that the mean VAS of pain immediately after surgery will be 3.0 (standard deviation, SD = 2.6) in GA group, 1.8 (SD = 1.3) in TAPB group, 1.3 (SD = 0.8) in QLB group. To provide 90% power at a two-sided significance level of 5%, we recruited 78 patients in each group with 20% dropout rate.

Descriptive data were presented as mean and SD or percentages as appropriate. The assumption of data normality was confirmed through a Shapiro–Wilk test. Analysis of variance (ANOVA), Kruskal–Wallis *H* tests, Chi-square tests, or Fisher's exact tests as appropriate, were used to compare the baseline characteristics between the three groups. The outcomes, including the changes of VASi and VASv scores and hemodynamic monitoring parameters over time between the three groups, were evaluated by a linear mixed model followed by pairwise comparisons with Bonferroni correction. For other outcomes, including details of anesthesia, additional analgesia, and other early postoperative outcomes, were compared in the three groups with Kruskal–Wallis *H* tests, Chi-square tests, or Fisher's exact tests, followed by Bonferroni post hoc tests. All outcomes were obtained from all patients. The analyses were conducted in SPSS version 23.0 (IBM Corp,

Chicago, IL, USA). A *P* value less than 0.05 was considered as statistically significant.

RESULTS

Three hundred and twenty-one patients with obesity underwent LSG at the second affiliated hospital of Anhui Medical University between November 2, 2018 and August 21, 2020 were initially assessed; 87 patients did not meet the inclusion criteria, one patient in the GA group experienced anaphylactic reaction during the surgery, two patients' postsurgical information were inadvertently missed, six patients were lost to follow-up, thus were excluded, and 225 patients were finally included to the study (Fig. 1). Clinical and surgical characteristics of LSG patients in three groups were comparable (Table 1).

Primary Outcomes

VASv and VASi scores of all patients were described continuously (Supplementary Table 1). The majority of patients experienced mild pain in surgical incision and viscera (Fig. 2). The mixed model showed that VASv scores over time were significantly different in the three groups ($P_{\text{time*group}} = 0.002$). Patients in the TAPB and QLB groups have significantly lower pain scores in viscera than GA from 0 until 12 h after LSG. There was no difference between the TAPB and QLB groups in pain scores at any time point (Fig. 2). Similar results were observed in the VAS scores of surgical wounds, while there was no interaction between the groups and time on the VASi scores ($P_{\text{time*group}} = 0.127$). Considering time from 0 to 12 h after LSG, these three groups had different VASi scores ($P < 0.001$), with patients in the TAPB and QLB groups having lower scores than GA ($P < 0.05$ after Bonferroni correction).

Secondary Outcomes

Patients in the TAPB group received significantly less intraoperative propofol -112.7 mg (95% CI -160.8 to -64.7 mg) and remifentanyl

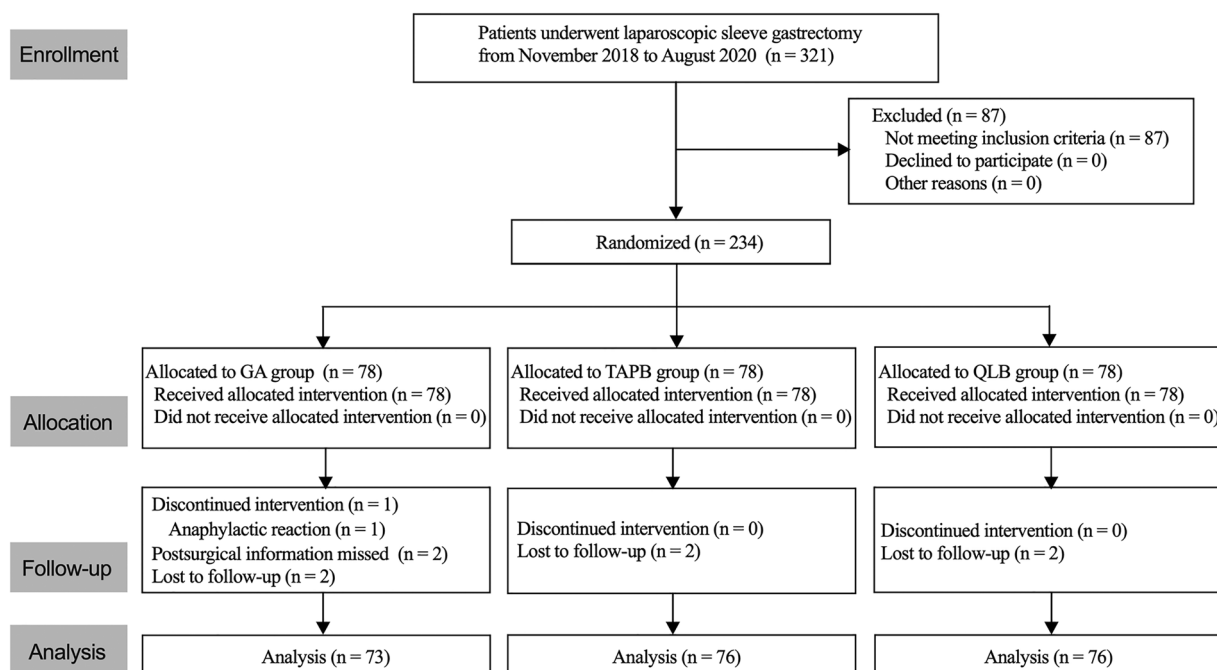


Fig. 1 CONSORT flow diagram. *GA* general anesthesia, *TAPB* transversus abdominis plane block, *QLB* quadratus lumborum block

–513.0 µg (95% CI –684.9 to –341.1 µg) than the GA group. In the QLB group, the differences were –86.85 (95% CI –134.9 to –38.81 mg) in propofol, and –468.9 µg (95% CI –640.8 to –297.0 µg) in remifentanyl comparing with the GA group. Otherwise, there was no difference in anesthetics consumption between TAPB and QLB groups (Table 1).

Comparing with the GA group, there was a longer duration of the first rescue analgesia requirement, fewer patients requiring postoperative analgesia in 24 h, and less accumulated PCA requests in the QLB group (all $P < 0.05$). At the same time, patients in the QLB group required less effective PCA than those in the TAPB group ($P < 0.05$) (Table 2).

There was no difference in early recovery outcomes, including the time to first drink, ambulate, and first flatus in three groups (Table 2). The incidence of total complications within postoperative 6 months was 8.9%. There was potential clinical importance, but no statistical difference in the incidence of postoperative hypotension and PONV in patients

without or with blocks. The percentages of readmission within postoperative 6 months because of the postoperative complications in each group were similar ($P = 0.476$, Table 2).

There were no significant differences in HR and MAP in all three groups before anesthesia (T0). After general anesthesia without or with blocks, massive reductions in HR and MAP were observed in all patients (Supplementary Table 2). To stabilize MAP or HR, vasoactive drug consumption was not significantly different among the three groups. There were similar incidences of hypotension during and after LSG in three groups. Although more patients experienced severe hypotension in the TAPB group, particularly at T5 and T6, the difference did not reach significance (Fig. 3).

DISCUSSION

This randomized controlled double-blinded clinical trial indicated that the addition of TAPB and QLB significantly relieved postoperative

Table 1 Clinical and surgical characteristics of laparoscopic sleeve gastrectomy patients

	GA (n = 73)	TAPB (n = 76)	QLB (n = 76)	P ^a
Age (years)	32.4 ± 7.3	30.4 ± 7.5	32.7 ± 6.9	0.050
Sex (male/female)	19/54	20/56	17/59	0.823
BMI (kg/m ²)	42.2 ± 6.1	43.3 ± 7.5	41.8 ± 5.2	0.633
Hypertension	28 (38.4)	26 (34.2)	25 (32.9)	0.769
Hyperglycemia	23 (31.5)	24 (31.6)	23 (30.3)	0.981
Hyperlipidemia	64 (87.7)	70 (92.1)	68 (89.5)	0.668
OSAHS	70 (95.9)	73 (96.1)	75 (98.7)	0.542
Arthritis	13 (17.8)	10 (13.2)	12 (15.8)	0.735
Surgery duration (minutes)	89.0 ± 20.2	85.2 ± 26.3	90.6 ± 18.5	0.065
Postoperative hospital stay (days)	3.5 ± 0.7	3.8 ± 1.5	3.5 ± 0.8	0.428
Details of anaesthesia				
Intraoperative propofol consumption (mg)	425.9 ± 145.1	313.2 ± 118.7*	339.1 ± 106.7*	< 0.001
Intraoperative remifentanyl consumption (µg)	1613.8 ± 564.7	1100.8 ± 396.7*	1144.9 ± 348.6*	< 0.001
Intraoperative vasoactive drugs	23 (31.5)	20 (26.3)	23 (30.38)	0.766

Data are given as means with standard deviations (SD) or percentage (%)

OSAHS obstructive sleep apnea hypopnea syndrome

*P < 0.05 vs GA group

^aKruskal–Wallis H tests, Chi-square tests, or Fisher's exact tests were used to compare continuous and categorical variations as appropriate

visceral and incisional pain, accompanied by reduced anesthetics consumption without affecting hemodynamics during LSG. The superiority of QLB over TAPB was presented by the decreases in postoperative rescue analgesia. Fewer patients complained of moderate pain without or with blocks (VAS ≥ 4). A similar incidence of complications to general anesthesia suggested the comparable side effects of these two blocks in this population. Neither TAPB nor QLB promoted PONV, postoperative hypotension, or postoperative recovery outcomes.

The extent of analgesia provided by TAPB depends on the site of injection and the spread pattern of local anesthetics. Currently, there are three types of ultrasound-guided approaches in use, including an anterior oblique-subcostal approach, a mid-axillary approach, and a posterior approach. TAPB appears optimal in the

course of open appendectomy (posterior or lateral approach), a Cesarean delivery (posterior or lateral approach), and an open colorectal section (subcostal or lateral approach) [25]. Only the mid-axillary and posterior TAPB present a remarkable posterior spread of local anesthetics around the quadratus lumborum to the paravertebral space. By using these two approaches, the block area could reach T12-L2 or even T5-L1 vertebral levels [26]. The majority of local anesthetics spread forward in TAPB under the costal margin. Therefore, anterior TAPB provides efficient somatic analgesia for upper abdominal surgery, including open liver resection [27], laparoscopic and open surgery, or bariatric surgery in the obese population [28, 29]. In a retrospective cohort study of 509 consecutive patients at a single large tertiary care center, the addition of TAPB to the laparoscopic bariatric surgery was associated

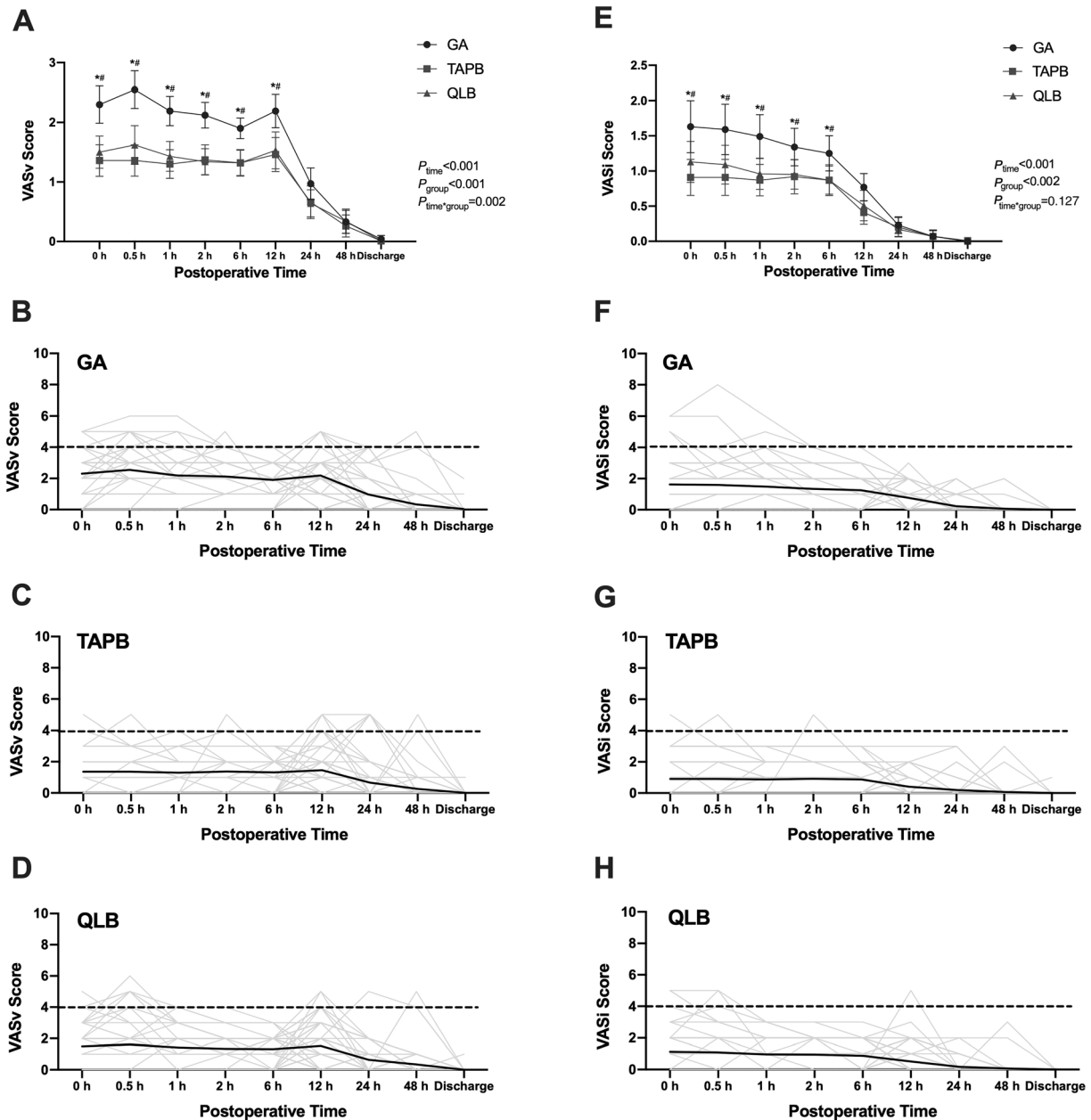


Fig. 2 Pain scores in viscera and incision over time in obese patients after laparoscopic sleeve gastrectomy. Data are given as mean \pm SD; *GA* general anaesthesia, *TAPB* transversus abdominis plane block, *QLB* quadratus

lumborum block, *VAS* visual analog scale from 0 to 10 cm. * $P < 0.05$, TAPB vs. GA at the same time point. # $P < 0.05$, QLB vs. GA at the same time point

with decreases in total opioid use, antiemetic treatments, and length of stay [30]. A single-shot TAPB or continuous TAPB provided similar analgesia in somatic pain and less analgesia in visceral pain after laparoscopic cholecystectomy

[31]. That's why we chose bilateral TAPB under costal margin in obese patients with LSG. Comparing with general anesthesia alone, it was reported that the addition of TAPB successfully reduced the postoperative pain score

Table 2 Secondary outcomes of laparoscopic sleeve gastrectomy patients

	GA (n = 73)	TAPB (n = 76)	QLB (n = 76)	P ^a
Additional analgesia				
Duration of first requiring rescue analgesia treatment (minutes)	45.3 ± 32.6	68 ± 63.8	119 ± 36.8*	0.009
Patients requiring rescue analgesia treatment within 24 h	23 (31.5)	20 (26.3)	9 (11.8)*	0.012
Effective PCA requests number	3.7 ± 5.3	2.3 ± 3.1	1.6 ± 4.1* [#]	< 0.001
Early recovery outcomes				
First drink (h)	31.8 ± 11.2	30.6 ± 14.2	33.5 ± 15.1	0.513
First ambulate (h)	33.9 ± 12.4	34.5 ± 13.3	31.3 ± 12.5	0.238
First flatus (h)	37.3 ± 15.5	38.4 ± 15.5	36.2 ± 15.8	0.469
Postoperative hypotension	13 (17.8)	22 (28.9)	20 (26.3)	0.304
PONV in hospital	26 (35.6)	24 (31.6)	22 (28.9)	0.918
Antiemetic medication	5 (6.8)	5 (6.6)	6 (7.9)	0.946
Complications within POM 6	6 (8.2)	9 (11.8)	5 (6.6)	0.508
Anastomotic leakage	1	1	–	
Postoperative wound infection	1	1	–	
Acute renal insufficiency	–	1	–	
PONV	5	6	5	
Rehospitalization within POM 6	7 (9.6)	9 (11.8)	6 (7.9)	0.713
Rehospitalization caused by complications	4 (7.7)	2 (3.8)	2 (3.1)	0.476

Data are given as means with standard deviations (SD) or percentage (%)

PONV postoperative nausea and vomiting, POM postoperative month

* $P < 0.05$ vs GA group, [#] $P < 0.05$ vs TAPB group

^aKruskal–Wallis H tests, Chi-square tests, or Fisher's exact tests were used to compare continuous and categorical variations as appropriate

and analgesic requirement, and also increased patients' satisfaction with rapid recovery (early postoperative discharge, early ambulation, and early recovery of intestinal activity) following LSG. Moreover, the analgesic effect lasted 48 h after TAPB. However, the VAS score within postoperative 6 h (5.20 ± 1.01) showed that the patient still suffered from moderate and severe pain. When combined with modified systematic multimodal analgesia, we found that TAPB successfully suppressed both incisional pain and

visceral pain, and the majority of patients complained of mild pain ($VAS \leq 2$) during the early postoperative period.

Despite the multiple types of QLB, only trans-muscular QLB has been considered to consistently spread to lumbar nerve roots and within the psoas major and QL muscles under magnetic resonance imaging. The observed block area is L1 to T4 in cadavers and volunteers [17, 32]. The distribution of QLB injectate has been further confirmed in abdominal surgery

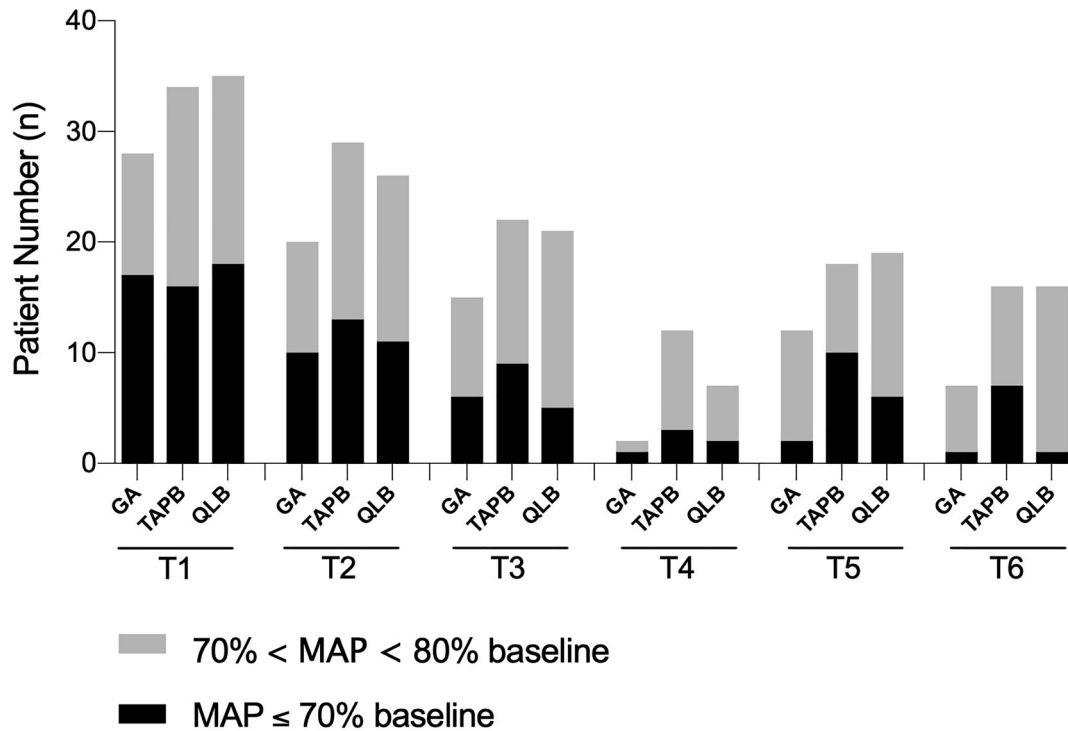


Fig. 3 Number of postoperative hypotensive patients after laparoscopic sleeve gastrectomy. Data are given as percentage (%). *GA* general anesthesia, *TAPB* transversus abdominis plane block, *QLB* quadratus lumborum block. T0

(baseline, before anesthesia), T1 (anesthesia intubation), T2 (pneumoperitoneum complete), T3 (gastrectomy), T4 (extubation), T5 (PACU entering), T6 (PACU 1 h)

patients by using three-dimensional computed tomography (3D-CT) images. Transverse oblique paramedian QLB consistently spreads in the anterior aspect of the QL muscle with occasional spread to the lumbar and thoracic paravertebral areas [33], where QLB suppresses nerve transmission against both somatic and visceral pain. It explains that QLB is theoretically regarded to perform better analgesia than TAPB, especially in visceral pain. However, the application of QLB was limited in upper abdominal surgery, and there were still insufficient data to draw definitive conclusions of QLB compared to TAPB in Cesarean delivery [34, 35]. To shorten the time to perform QLB, we modified the block without flipping obese patients based on the previous report [24]. We found that preoperative bilateral QLB application significantly reduced postoperative pain caused by LSG in obese patients. Few patients with QLB required additional PCA requests within 48 h. This may suggest the superiority of QLB over

TAPB. Although few patients required rescue analgesia with a longer duration after QLB than TAPB, the differences did not reach significance. The failure to differentiate the effect of TAPB and QLB could be attributed to the modified general anesthesia protocol in our study.

As a selective α_2 -adrenergic receptor agonist, dexmedetomidine elicits sedative, anti-anxiety, and analgesic effects. It is fascinating that dexmedetomidine can retain spontaneous breathing with a reliable sedative effect. In our study, dexmedetomidine was administered in the entire perioperative period. During dexmedetomidine ($2 \mu\text{g kg}^{-1} \text{h}^{-1}$) infusion before general anesthesia, gradual sedation was reached without obvious breath suppression, and the stable hemodynamics during LSG further supported the relatively high safety of dexmedetomidine adjunct in obese patients. It is evidenced that perioperative administration could provide potent analgesia and associated impact, including reducing the intensity of

postoperative pain, the use of opioids, and the incidence of PONV without prolonging the recovery time [36]. Similar effects have been also observed in bariatric surgery in obese patients [37]. This could uncover the lower PONV observed in our study after dexmedetomidine ($2 \mu\text{g kg}^{-1}$) was supplemented in PCIA. Alternatively, in gynecological laparoscopy or renal transplantation, TAPB combined with dexmedetomidine ($1 \mu\text{g kg}^{-1}$) provided a more effective analgesic effect, improved recovery from anesthesia, and reduced post-operative pain (less morphine consumption, lower VAS score) [38, 39]. Furthermore, dexmedetomidine ($0.8 \mu\text{g kg}^{-1}$) could reduce the 50% effective concentration of ropivacaine. It partially contributed to the significantly lower VAS values after TAPB and QLB at postoperative 12 h in our study. Meanwhile, none of the patients reported prolonged respiratory symptoms after LSG, although 96.9% of the patients complained of OSA before surgery. This partially explains why even without TAPB or QLB, the VAS scores of visceral pain and incisional pain of patients in the general anesthesia group were both lower than those reported.

The perioperative inflammatory response has been considered a major potential mechanism underlying perioperative pain. In our study, all patients received dexmedetomidine, nalbuphine, and a nonsteroidal anti-inflammatory agent (parecoxib sodium) with potent anti-inflammatory properties. Perioperative dexmedetomidine infusion in obese patients undergoing bariatric surgery ideally controlled postoperative pain and PNOV, with a stable hemodynamic profile, and without any reported major adverse events [37]. In particular, nalbuphine is a semi-synthetic kappa-receptor agonist and μ -receptor antagonist, with a ceiling effect when increasing dosage. For managing moderate and severe pain, its analgesic potency is similar to morphine, but the side effects are less. Comparing with opioids, there might be a lower risk for opioid-induced side effects (nausea, vomiting) and severe adverse events (respiratory depression). It is usually used as an acute analgesia rescue composition, even in children [40]. Because of this multiple analgesia with or without peripheral nerve block, VAS

values either in viscera or incision were lower than other studies, even lower than TAPB in a single-blind, controlled study of LSG [13]. However, rapid recovery was not achieved after TAPB or QLB, including early postoperative discharge, early ambulation, and early recovery of intestinal activity.

This study has some limitations. First, to avoid the disturbance of needle inching on the BIS record during dexmedetomidine infusion, the block areas of TAPB or QLB were not determined in detail before general anesthesia. Second, due to the supervision of psychotropic anesthetics, the medications used for rescue analgesia in the PACU and the wards are not completely consistent. Third, because of the equipped program to the PCA pump, the effective PCIA requests could not be recorded in each postoperative hour.

CONCLUSIONS

Given the technically demanding and time-consuming placement, and the considerable risk of adverse effects, we suggest that TAPB and QLB provide comparable analgesia for the perioperative management in laparoscopic sleeve gastrectomy. QLB may be superior regarding postoperative rescue analgesia when compared to TAPB. Multimodal systemic analgesia strategy including regional nerve block could be a critical part of perioperative management for this population.

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Author Contributions. Qi Xue helped with conceptualization, data curation, formal analysis, writing - review & editing. Zhaoxia Chu contributed to conceptualization, investigation, writing - original draft. Junjun Zhu helped with investigation, writing - original draft. Xiaoyan Zhang helped with investigation. Hong Chen helped with investigation, writing - review & editing. Wu Liu helped with investigation, writing - review & editing. Benli Jia helped with investigation, writing - review & editing. Ye Zhang helped with conceptualization, writing review & editing, supervision. Yong Wang helped with writing - review & editing, supervision. Chunxia Huang helped with conceptualization, methodology, formal analysis, project administration, writing - review & editing, supervision, funding acquisition. Xianwen Hu helped with conceptualization, methodology, project administration, writing - review & editing, supervision.

Disclosures. Qi Xue, Zhaoxia Chu, Junjun Zhu, Xiaoyan Zhang, Hong Chen, Wu Liu, Benli Jia, Ye Zhang, Yong Wang, Chunxia Huang, Xianwen Hu declare that they have no conflicts of interest.

Compliance with Ethics Guidelines. Ethical approval for this study (PJ-YX2018-026) was provided by the Ethics Committee of second hospital of Anhui Medical University, Hefei City, Anhui Province, China (Chairperson Prof. Wenbing Yao) on October 18, 2018. The trial was registered in the Chinese Clinical Trial Registry (ChiCTR1800019236). The study was

in accordance with the Declaration of Helsinki and its later amendments. Informed consent was obtained from all individual participants included in the study.

Data Availability. The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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