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Application of ultrasound-guided anterior quadratus lumborum block at the lateral supra-arcuate ligament in bariatric surgery

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Abstract: Objective To compare the analgesic effect of ultrasound-guided anterior quadratus lumborum block at the lateral supra-arcuate ligament (QLB-LSAL) and transversus abdominis plane block (TAPB) in laparoscopic sleeve gastrectomy (LSG). **Methods** From January 2023 to January 2024, 90 cases underwent LSG in Suqian First People's Hospital were randomly divided into two groups: QLB-LSAL group and TAPB group, 45 cases in each group. Bilateral nerve block was performed before induction of general anesthesia, and 0.375% ropivacaine 20 mL was injected into each side of both groups. Both groups of patients received the same general anesthesia and postoperative patient-controlled intravenous analgesia (PCIA) regimen. The number of block dermatomes after block, mean arterial pressure (MAP), heart rate (HR), and visual analogue scale (VAS) score were measured in different time. The intraoperative consumption of sufentanil and remifentanil, the interval time from the end of operation to the first pressing of the analgesia pump, the consumption of analgesics within 48 h after operation, the requirement for rescue analgesia, and the incidence of adverse reactions were recorded. **Results** The MAP and HR at 1 min and 5 min after skin incision, the intraoperative consumption of remifentanil, the VAS score at 2,6,12,24 h after operation, the consumption of analgesics within 48 h after operation, and the incidence of nausea and vomiting in QLB-LSAL group were significantly lower than those in TAPB group (P<0.05). The number of block dermatomes at 5 min, 10 min, 6 h, 24 h after blocking, and the interval time from the end of operation to the first pressing of the analgesia pump in QLB-LSAL group were significantly higher than those in TAPB group (P<0.05). There was no significant difference in the intraoperative consumption of sufentanil, the requirement for rescue analgesia, and the incidence of respiratory depression between the two groups (P>0.05). **Conclusion** Ultrasound-guided QLB-LSAL combined with general anesthesia can reduce skin incision reaction, reduce the consumption of intraoperative opioids, stabilize hemodynamics, and provide effective postoperative analgesia in laparoscopic gastrectomy.

Keywords: Ultrasound-guided; Arcuate ligament; Quadratus lumborum block; Transversus abdominis plane block; Laparoscopic sleeve gastrectomy; Ropivacaine

With the progress of society and changes in lifestyle, the proportion of obese and overweight residents in China has rapidly increased, with approximately 46% of adults and 16% of children being obese or overweight [1]. Pathological obesity (BMI ≥ 40 kg/m^2 or BMI ≥ 35 kg/m^2 combined with other obesity related diseases) has become a global public health issue [2]. Bariatric surgery can effectively achieve and maintain weight reduction, and decrease complications associated with obesity [3]. Obese patients may have heightened pain perception, and inadequate postoperative pain management can lead to increased use of opioid analgesics, delayed mobilization, higher incidence of postoperative complications, all of which contribute to prolonged hospital stays, increased healthcare costs, and reduced quality of life [4-5]. The lateral supra-arcuate ligament anterior quadratus lumborum block (QLB-LSAL), introduced in 2020, involves injecting a local anesthetic below the 12th rib, anterior to the origin of the quadratus lumborum, and above the lateral supra-arcuate ligament. The anesthetic spreads upwards through the thoracoabdominal fascia to the lower thoracic vertebrae, blocking the T_4 to L_1 plane. This method is considered safe, has a quick onset, a broad block range, and precise anesthetic effects [6], making it a viable option for supplemental anesthesia and postoperative pain management in thoracic and abdominal surgeries. This study aims to evaluate the analgesic effect of the ultrasound-guided QLB-LSAL in laparoscopic sleeve gastrectomy (LSG) and compare it with the transversus abdominis plane block (TAPB), providing a more optimized reference for clinical selection.

1 Materials and methods

1.1 General information

This study was approved by the hospital's ethics committee (2023-SL-0103), and informed consent was obtained from the patients or their families. A total of 90 patients undergoing elective LSG under general anesthesia at Suqian First People's Hospital from January 2023 to January 2024 were selected. The patients were randomly divided into the QLB-LSAL group and the TAPB group, with 45 patients in each group.

Inclusion criteria: no restriction on gender, aged 18–45 years, BMI 30–40 kg/m², ASA II–III. **Exclusion criteria:** blood disorders or coagulation dysfunction, infection at the puncture site, allergy to local anesthetics or analgesics, psychiatric or neurological disorders, unwillingness to cooperate with the study or follow-up, conversion to open surgery or significant bleeding during the operation, transfer to the ICU after surgery.

In the QLB-LSAL group, 1 patient refused follow-up and 2 were transferred to the ICU postoperatively. In the TAPB group, 1 patient converted to open surgery. Consequently, 42 patients in the QLB-LSAL group and 44 patients in the TAPB group were included in the study.

1.2 Research methods

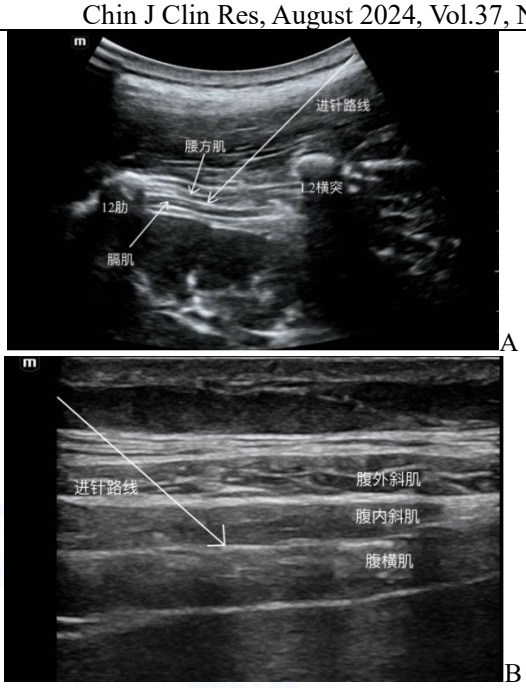
The patients in QLB-LSAL group received QLB-LSAL combined with general anesthesia, while the patients in TAPB group received TAPB combined with general anesthesia.

For the QLB-LSAL group: patients were placed in the prone position, and a convex array probe of the Mylab Alpha ultrasound device (Esaote, Italy) was used to scan the quadratus lumborum muscle longitudinally 5–6 cm lateral to the midline of the spine. The probe was moved parallel to the spine until the transverse processes of L_1 and L_2 appeared, positioning the 12th rib and the transverse processes of L_1 and L_2 in the center of the image. The sliding of the diaphragm or pleura beneath the deep surface of the quadratus lumborum was then observed with respiration. The probe was tilted slowly towards the midline of the spine, making the ultrasound beam perpendicular to the reflected pleura and diaphragm. The target area for the anterior block at the lateral supra-arcuate ligament of the quadratus lumborum was identified. A needle was inserted in-plane along the long axis, and after confirming no blood, air, or cerebrospinal fluid on aspiration, 20 mL of 0.375% ropivacaine (ropivacaine hydrochloride injection, 10 mL:75 mg) was injected (**Figure 1A**). The same procedure was used on the other side.

For the TAPB group: patients were placed in the supine position, and a high-frequency linear probe was used to scan along the rib edge to the midaxillary line, identifying the external oblique, internal oblique, and transversus abdominis muscles. The plane between the transversus abdominis and internal oblique muscles was the target for the block. The needle was inserted from the medial side of the probe, and once the needle tip passed through the internal oblique muscle to the transversus abdominis plane, 20 mL of 0.375% ropivacaine was injected (**Figure 1B**). The same procedure was used on the other side.

1.3 Anesthesia methods

All patients fasted for 8 hours and were prohibited from drinking for 2 hours before surgery. Upon entering the operating room, oxygen was administered via nasal cannula at 2–3 L/min, and blood pressure (BP), pulse oximetry (SpO_2), and electrocardiogram (ECG) were monitored. An arterial line was placed for continuous invasive arterial pressure monitoring under local anesthesia. Subsequently, nerve block procedures were performed according to random assignment. The doses of general anesthetics for both groups were based on standardized lean body weight (normalized lean weight, NLW), where NLW = total weight × √(22/BMI) [7].



Note: A, QLB-LSAL; B, TAPB。

Fig.1 Different nerve block methods

For anesthesia induction, intravenous administration of etomidate 0.3 mg/kg, rocuronium 0.9 mg/kg, and sufentanil 0.5–1 μg/kg was given, followed by tracheal intubation with a visual laryngoscope 3 minutes later and mechanical ventilation. Intraoperative maintenance of anesthesia included inhalation of 1% sevoflurane, propofol 4–10 $mg \cdot kg^{-1} \cdot h^{-1}$, remifentanil 0.1–1.0 $\mu g \cdot kg^{-1} \cdot min^{-1}$, and intermittent boluses of rocuronium 0.10–0.15 mg/kg to maintain neuromuscular blockade. BIS was maintained at 40–60, and blood pressure was kept within 20% of the baseline. Ondansetron 8 mg and dexamethasone 10 mg were administered to prevent nausea and vomiting. Oxygen concentration was maintained at 50%–60%, I:E ratio at 1:2, tidal volume (VT) at 6–8 ml/kg, respiratory rate (RR) at 10–14 breaths/min, and $P_{ET}CO_2$ at 30–40 mmHg. After skin closure, manual lung re-expansion was performed, and neostigmine 2–4 mg/kg was injected to reverse muscle relaxation. The endotracheal tube was removed after the patient regained consciousness and spontaneous breathing, and the patient was sent to the recovery room for observation. Postoperatively, all patients used patient-controlled intravenous analgesia (PCIA). The analgesia pump was prepared with oxycodone 20 mg, flurbiprofen 200 mg, diluted with saline to 100 mL, with no background infusion, a single dose of 5 mL, a lockout interval of 5 minutes, and a loading dose of 20 mL/h. Patients could press the PCA pump when they felt

intolerable pain. If PCA was ineffective and VAS score ≥4, additional flurbiprofen 100 mg or oxycodone 3–5 mg was administered for rescue analgesia.

1.4 Observation indicators

(1) The sensory block levels were recorded at 5 min, 10 min, 6 h, 24 h, and 48 h after the block (using the ice cube method to determine the sensory block level).

(2) The mean arterial pressure (MAP) and heart rate (HR) of both groups were recorded after entering the room, before skin incision, and at 1 min and 5 min after skin incision.

(3) The amounts of sufentanil and remifentanil used during surgery were recorded.

(4) Postoperative VAS scores were recorded at 2, 6, 12, 24, and 48 hours.

(5) The interval from the end of surgery to the first PCA pump press, the amount of analgesic drugs used within 48 hours after surgery, the need for rescue analgesia, and the occurrence of adverse reactions such as nausea and vomiting, respiratory depression, infection, local anesthetic toxicity, and puncture injury were also recorded.

1.5 Statistical methods

Based on data from pilot studies and existing literature, the sample size was estimated using PASS statistical software. A two-sided test with α=0.05, power (1-β) =0.9, allowable error of 1.48, and standard deviation of 1.99 indicated a minimum sample size of 38 patients per group. Considering the loss to follow-up, this study included 42 patients per group.

Statistical analysis was performed using SPSS version 26.0. For continuous data, the Kolmogorov-Smirnov test was conducted. Normally distributed data was expressed as $\bar{x}\pm s$, and independent samples *t*-test was used for group comparisons, repeated measures analysis of variance was used for the comparison at different time points. Non-normally distributed data was presented as *M* (P_{25}, P_{75}), the Mann-Whitney *U* test was used. Count data was expressed as case (%) and analyzed using the chi-square test. $P< 0.05$ was considered statistically significant.

2 Results

2.1 General data

There was no statistically significant difference in age, height, weight, gender, BMI, ASA classification, or operative time between the two groups ($P > 0.05$). **See Table 1.**

2.2 Blockade levels

The blockade levels at 5 min, 10 min, 6 h, and 24 h post-blockade were higher in the QLB-LSAL group compared to the TAPB group ($P < 0.05$). There was no significant difference in blockade levels at 48 h post-blockade between the two groups ($P > 0.05$). **See Table 2.**

2.3 Intraoperative MAP and HR

There was no significant difference in MAP and HR values between groups upon entry to the operating room and before skin incision ($P > 0.05$). However, MAP and HR values at 1 min and 5 min after skin incision were lower in the QLB-LSAL group compared to the TAPB group ($P < 0.05$). **See Table 3.**

2.4 Postoperative VAS scores

There was no significant difference in VAS scores at 48 h postoperatively between the two groups ($P > 0.05$). VAS scores at 2 h, 6 h, 12 h, and 24 h postoperatively were significantly lower in the QLB-LSAL group compared to the TAPB group ($P < 0.05$). **See Table 4.**

Tab.1 Comparison of general data between two groups ($\bar{x}\pm s$)

Indicator	QLB-LSA group (*n*=42)	TAPB group (*n*=44)	t/χ^2 value	*P* value
Age(year,$\bar{x}\pm s$)	30.38±6.61	29.75±7.56	0.411	0.682
Height(cm,$\bar{x}\pm s$)	165.48±6.79	164.18±5.88	0.946	0.347
Weight (kg,$\bar{x}\pm s$)	95.33±9.49	92.8±8.05	1.340	0.184
Gender[case(%)]			0.568	0.451
Male	6（14.3%）	9（20.5%）		
Female	36（85.7%）	35（79.5%）		
BMI(kg/m^2,$\bar{x}\pm s$)	34.99±2.6	34.57±2.15	0.818	0.415
ASA[case(%)]			0.636	0.425
II	31（73.8%）	29（65.9%）		
III	11（26.2%）	15（34.1%）		
Operative time (min, $\bar{x}\pm s$)	108.24±7.38	105.82±9.64	1.302	0.196

Tab.2 Comparison of the number of block dermatomes between two groups [pcs, *M*（*P*25, *P*75)]

Group	5 min	10 min	6 h	24 h	48 h
QLB-LSA group	3 (2,3)	6 (6,7)	7 (7,8)	5 (4,5)	0 (0,0)
TAPB group	1 (0,1)	4 (3,4)	3 (2,3)	0 (0,0)	0 (0,0)
Z value	8.068	8.221	8.237	8.559	0.024
P value	<0.001	<0.001	<0.001	<0.001	0.981

2.5 Intraoperative opioid use, postoperative analgesia, and adverse reactions

There was no significant difference in intraoperative sufentanil use, rescue analgesia rate, or incidence of respiratory depression between the two groups ($P > 0.05$). However, intraoperative remifentanil use and postoperative 48 h hydrocodone and flurbiprofen ester use, as well as the incidence of nausea and vomiting, were lower in the QLB-LSAL group compared to the TAPB group ($P < 0.05$). The time from the end of surgery to the first press of the pain pump was longer in the QLB-LSAL group compared to the TAPB group ($P < 0.05$). Both groups did not experience infections, local anesthetic toxicity, or puncture injuries. **See Table 5.**

Tab.3 Comparison of MAP and HR between two groups ($\bar{x}$±s)

Group	MAP (mmHg)				HR			
	Entry to the operating room	before skin incision	1 min after skin incision	5 min after skin incision	Entry to the operating room	before skin incision	1 min after skin incision	5 min after skin incision
QLB-LSA group(*n*=42)	102.95±10.44	83.29±10.89	85.07±8.24[a]	89.10±9.51[a]	74.57±7.55	63.52±6.15	68.26±10.45[a]	72.48±8.86[a]
TAPB group (*n*=44)	99.86±12.03	80.86±11.95	89.16±7.64	95.39±7.80	77.57±8.58	64.00±9.56	72.64±9.17	76.57±8.25

Note: Compared with the TAPB group, [a]*P*<0.05.

Tab.4 Comparison of VAS scores between the two groups (point, $\bar{x}$±s)

Group	2 h	6 h	12 h	24 h	48 h
QLB-LSA group（*n*=42）	2.12±0.74[a]	2.33±0.53[a]	2.36±0.98[a]	2.02±0.90[a]	0.93±0.68
TAPB group（*n*=44）	3.82±0.76	4.09±1.14	4.52±0.70	3.66±0.96	1.16±0.57
***F/P*组间 value**	*F*=308.240, *P*<0.001				
***F/P*时间 value**	*F*=121.73, *P*<0.001				
***F/P*交互 value**	*F*=18.242, *P*<0.001				

Note: Compared with the TAPB group, [a]*P*<0.05.

Tab.5 Comparison of intraoperative opioid dosage, postoperative analgesia and adverse reactions between the two groups

Indicator	QLB-LSA group（*n*=42）	TAPB group（*n*=44）	t/χ^2 value	*P* value
Sufentanil consumption（ug, $\bar{x}$±s）	54.05±5.44	51.93±4.73	1.928	0.057
Remifentanil consumption （mg, $\bar{x}$±s）	1.97±0.35	2.12±0.34	2.002	0.048
Hydrocodone consumption（mg, $\bar{x}$±s）	13.43±4.06	15.25±4.35	2.007	0.048
Flurbiprofen ester consumption（mg）	131.90±39.28	151.36±40.15	2.271	0.026
Time from the end of surgery to the first press of the pain pump（h, $\bar{x}$±s）	10.48±4.19	6.32±3.09	5.260	<0.001
Rescue analgesia [case（%）]	6（14.3%）	8（18.2%）	0.239	0.625
Nausea and vomiting [case（%）]	9（21.4%）	19（43.2%）	4.631	0.031
Respiratory depression [case（%）]	2（4.8%）	2（4.5%）	0.221	0.642

3 Discussion

LSG is a minimally invasive surgery, but the accumulation of abdominal fat in obese patients leads to a higher incidence of postoperative pain [8]. Early postoperative incisional pain and ineffective cough increase the risk of complications such as atelectasis and respiratory distress [9]. Obese patients are more susceptible to pain-related complications and the effects of opioid analgesics [10]. Therefore, selecting effective postoperative analgesia methods is crucial for promoting their rapid recovery. With the advancement of enhanced recovery after surgery (ERAS), multimodal analgesia based on regional nerve blockade has received increasing attention in clinical practice. This study demonstrated that QLB-LSAL could provide effective perioperative analgesia for LSG patients. Compared to TAPB, QLB-LSAL reduced intraoperative and postoperative opioid use, significantly prolonged the time from surgery to the first press of the pain pump, and markedly reduced the incidence of postoperative nausea and vomiting, thereby facilitating rapid recovery in LSG patients.

In recent years, TAPB has been widely used in abdominal surgery [11-12]. Numerous studies have shown its efficacy in cesarean section, colorectal cancer surgery, and other procedures [13-14]. TAPB involves injecting local anesthetic drugs into the fascial plane between the internal oblique and transversus abdominis muscles to block the cutaneous branches of the intercostal nerves [15]. It primarily provides analgesia at the incision site but does not relieve visceral pain. In this study, VAS scores at 2 h, 6 h, 12 h, and 24 h postoperatively were significantly lower in the QLB-LSAL group compared to the TAPB group. QLB-LSAL, as a novel approach to quadratus lumborum block, represents the latest advancement in postoperative abdominal pain management [16-17]. Traditional approaches to QLB primarily involve spreading local anesthetics through the posterior aspect of the iliopsoas

muscle below the diaphragm, which blocks the lower thoracic vertebral side [18]. Using contrast agents in QLB injections, the study observed that the contrast agent spread from the posterior aspect of the internal and external oblique tendons to the side of the thoracic vertebrae [19]. From an anatomical perspective, QLB-LSAL injects local anesthetic drugs above the tendons of the oblique tendons, spreads through the intrathoracic fascia to the paraspinal fascia gap, and blocks spinal nerve roots and sympathetic trunks, providing both somatic and visceral pain relief.

This study demonstrated that compared to TAPB, QLB-LSAL provided more extensive blockade and more effective analgesia. The study found that QLB-LSAL achieved blockade at 5 min after surgery, with sensory levels decreasing by 2-3 blockade planes. Shi [16] and others found that after unilateral injection of 0.5% ropivacaine, patients felt at T_7 to L_1 within 5 min, and this study reached a longer blockade plane with a lower concentration of 0.375% ropivacaine in this study. The results showed that MAP and HR values at 1 min and 5 min after skin incision and intraoperative remifentanil use were significantly lower in the QLB-LSAL group compared to TAPB, suggesting that QLB-LSAL can reduce stress responses after skin incision and reduce intraoperative remifentanil usage, providing effective intraoperative analgesia for LSG patients. Compared to TAPB, the time from the end of surgery to the first press of the pain pump was significantly longer, and analgesic drug use within 48 hours was significantly reduced in the QLB-LSAL group. The duration of postoperative analgesia for TAPB blockade in abdominal surgery is only 8-12 hours, whereas studies have shown that QLB maintenance can last 24-48 hours [19]. This indicates that QLB-LSAL is superior to TAPB for postoperative analgesia in LSG.

Postoperative nausea and vomiting were the most common complications after LSG, and the incidence in the QLB-LSAL group was significantly lower than that in the TAPB group. This may be related to QLB-LSAL producing effects similar to paravertebral blockade, effectively relieving both somatic and visceral pain and reducing the amount of opioids used intraoperative and postoperatively, which is clinically significant.

Limitations of this study: (1) In order to meet clinical treatment needs, a pure general anesthesia group was not set up to demonstrate the effectiveness of the two nerve blockade methods; (2) In this study, 0.375% ropivacaine was used for QLB-LSAL, and it was not compared with the application of ropivacaine at different concentrations. Whether QLB-LSAL at different concentrations of ropivacaine has advantages in analgesia for LSG still requires further study.

In summary, QLB-LSAL, as a novel approach to nerve blockade, is a safe, rapid-onset, broad-spectrum, and effective anesthesia method that can provide good analgesic effects for patients undergoing LSG, reduce the complications, and promote rapid recovery in patients.

The authors report no conflict of interest

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·论　著·

超声引导下外侧弓状韧带上腰方肌前侧阻滞在减重手术中的应用

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摘要：目的　比较超声引导下外侧弓状韧带上腰方肌前侧阻滞（QLB-LSAL）和腹横肌平面阻滞（TAPB）用于腹腔镜袖状胃切除术（LSG）术中及术后的镇痛效果。**方法**　选择宿迁市第一人民医院 2023 年 1 月至 2024 年 1 月择期行 LSG 的患者 90 例，采用随机数字表法分为 QLB-LSAL 组和 TAPB 组，各 45 例。两组均于全身麻醉诱导前在超声引导下行双侧神经阻滞，均每侧单次注入 0.375%罗哌卡因 20 mL。两组患者全身麻醉方法相同，术毕患者均行静脉自控镇痛（PCIA）。记录两组阻滞后不同时间的阻滞平面节段、平均动脉压（MAP）、心率（HR）、视觉模拟评分法（VAS）评分，记录术中舒芬太尼和瑞芬太尼用量、手术结束至第一次按压镇痛泵的间隔时间及术后 48 h 内镇痛药物用量、补救镇痛情况及不良反应发生情况。**结果**　QLB-LSAL 组切皮后 1、5 min MAP 和 HR，术中瑞芬太尼用量，术后 2、6、12、24 h VAS 评分，及术后 48 h 内镇痛药物用量和恶心呕吐发生率均显著低于 TAPB 组（$P<0.05$）。QLB-LSAL 组阻滞后 5 min 、10 min 、6 h 、24 h 的阻滞平面节段，手术结束至第一次按压镇痛泵的间隔时间多于 TAPB 组（$P<0.05$）。两组术中舒芬太尼用量、补救镇痛率以及呼吸抑制发生率比较差异无统计学意义（$P>0.05$）。**结论**　超声引导下 QLB-LSAL 联合全身麻醉可使 LSG 术中血流动力学更加平稳，减少术中阿片类药物用量，并提供有效的术后镇痛。

关键词：超声引导；弓状韧带；腰方肌阻滞；腹横肌平面阻滞；腹腔镜袖状胃切除术；罗哌卡因

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Application of ultrasound-guided anterior quadratus lumborum block at the lateral supra-arcuate ligament in bariatric surgery

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Abstract: Objective　To compare the analgesic effect of ultrasound-guided anterior quadratus lumborum block at the lateral supra-arcuate ligament (QLB-LSAL) and transversus abdominis plane block (TAPB) in laparoscopic sleeve gastrectomy (LSG). **Methods**　From January 2023 to January 2024, 90 patients underwent LSG in Suqian First People's Hospital were randomly divided into two groups: QLB-LSAL group and TAPB group, 45 cases in each group. Bilateral nerve block was performed before induction of general anesthesia, and 0.375% ropivacaine 20 mL was injected into each side of both groups. Both groups of patients received the same general anesthesia and postoperative patient-controlled intravenous analgesia (PCIA) regimen. The number of block dermatomes after block, mean arterial pressure (MAP), heart rate (HR), visual analogue scale (VAS) score were measured in different time. The intraoperative consumption of sufentanil and remifentanil, the interval time from the end of operation to the first pressing of the analgesia pump, the consumption of analgesics within 48 h after operation, the requirement for rescue analgesia, and the incidence of adverse reactions were recorded. **Results**　The MAP and HR at 1 min and 5 min after skin incision, the

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intraoperative consumption of remifentanil, the VAS score at 2, 6, 12, 24 h after operation, the consumption of analgesics within 48 h after operation, and the incidence of nausea and vomiting in QLB-LSAL group were significantly lower than those in TAPB group (P<0.05). The number of block dermatomes at 5 min, 10 min, 6 h, 24 h after block, and the interval time from the end of operation to the first pressing of the analgesia pump in QLB-LSAL group were significantly higher than those in TAPB group (P<0.05). There was no significant difference in the intraoperative consumption of sufentanil, the requirement for rescue analgesia, and the incidence of respiratory depression between the two groups (P>0.05). **Conclusion** Ultrasound-guided QLB-LSAL combined with general anesthesia can stabilize hemodynamics, reduce the consumption of intraoperative opioids, and provide effective postoperative analgesia in patients received LSG.

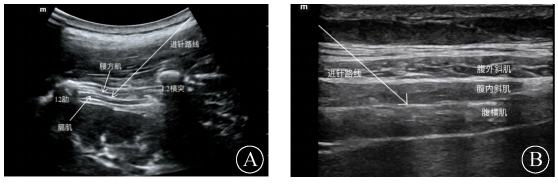
Keywords: Ultrasound-guided; Arcuate ligament; Quadratus lumborum block; Transversus abdominis plane block; Laparoscopic sleeve gastrectomy; Ropivacaine

随着社会的进步和生活方式的转变，中国居民中肥胖和超重的比例迅速增加，大约有 46%的成年人和 16%的儿童属于肥胖或超重[1]。病态肥胖（BMI≥40 kg/m^{2}或 BMI≥35 kg/m^2 合并其他肥胖相关疾病）已经转变为一个全球性的公共健康问题[2]。减重手术可以有效实现和维持体重减轻，降低与肥胖相关的并发症[3]。肥胖患者可能对疼痛有更强的感知，若术后疼痛管理不当，可能会导致阿片类镇痛药物的使用量增加，术后的下床活动时间推迟，术后并发症的发生率，这些因素都会导致住院时间延长，医疗费用增加，以及生活质量的降低[4-5]。外侧弓状韧带上腰方肌前侧阻滞（anterior quadratus lumborum block at the lateral supra-arcuate ligament，QLB-LSAL）是 2020 年提出的创新入路，将局麻药液注射在 12 肋下方、腰方肌起始部的前方、外侧弓状韧带上方，药液通过胸内筋膜往上扩散到低位胸椎旁，达到阻滞 T_4 到 L_1 平面的效果，是一种安全性高、起效快、阻滞范围广和麻醉效果确切的阻滞方法[6]，可以作为胸、腹部手术的辅助麻醉和术后镇痛的一种选择。本研究旨在评价超声引导下 QLB-LSAL 用于腹腔镜下袖状胃切除术（laparoscopic sleeve gastrectomy，LSG）的镇痛效果，并与腹横肌平面阻滞（transversus abdominis plane block，TAPB）作比较，为临床选择提供更优化的参考。

1　资料与方法

1.1　一般资料　本研究已获医院伦理委员会批准（2023-SL-0103），患者或家属均签署知情同意书。选取 2023 年 1 月至 2024 年 1 月于宿迁市第一人民医院择期全麻下行 LSG 的患者 90 例，采用随机数字表法分为 QLB-LSAL 组和 TAPB 组，各 45 例。纳入标准：性别不限，年龄 18～45 周岁，BMI 30～40 kg/m^2，ASA Ⅱ～Ⅲ级。排除标准：存在血液疾病或凝血功能障碍，穿刺部位感染，对局麻药物、镇痛药物过敏，存在精神或神经系统疾病。剔除标准：不愿意配合研究者，术中改行开腹手术或出现大出血者，术毕转入 ICU 者。其中 QLB-LSAL 组 1 例拒绝访视，2 例术后转入 ICU，TAPB 组 1 例改行开腹手术，予以剔除。最终 QLB-LSAL 组 42 例、TAPB 组 44 例纳入研究。

1.2　*研究方法*　QLB-LSAL 组采用 QLB-LSAL 联合全身麻醉，TAPB 组采用 TAPB 联合全身麻醉。（1）QLB-LSAL 组：患者取俯卧位，采用 Mylab Alpha 型超声仪（Esaote 公司，意大利）将凸阵探头垂直旁开脊柱中线 5～6 cm 长轴扫查腰方肌，腰方肌头侧附着点定位 T_{12} 肋骨，将探头向脊柱方向平行移动，可以看到 L_1、L_2 横突出现，将 T_{12}肋与 L_1、L_2 横突置于图像中央，随即观察到腰方肌深面随呼吸移动的膈肌或者胸膜的滑动，此时将超声探头尾端缓慢向脊柱中线方向倾斜，使超声波束垂直于折返的胸膜和膈肌，此时超声图像上可见腰方肌-膈肌对合区，即为 QLB-LSAL 的靶向区域。采用长轴平面内穿刺进针，当针尖穿过腰方肌达到腰方肌和膈肌之间的筋膜层，回抽无血液、空气或脑脊液后注入 0.375%罗哌卡因（盐酸罗哌卡因注射液，10 mL∶75 mg，浙江琅制药股份有限公司，批号：EE2252）20 mL（图 1A），可以观察到局麻药在腰方肌与膈肌之间扩散，另一侧采用相同的方法阻滞。（2）TAPB 组：患者取平卧位，将高频线性探头沿一侧肋缘下向腋中线扫查，辨别腹外斜肌、腹内斜肌、腹横肌。腹横肌与腹内斜肌之间的间隙即为阻滞平面，从探头内侧进针，针尖穿过腹内斜肌即为腹横肌平面，回抽无血液、空气后注入 0.375%罗哌卡因 20 mL（图 1B），另一侧采用相同的方法阻滞。



注：A 为 QLB-LSAL；B 为 TAPB。

图 1　不同神经阻滞方法图

Fig. 1　Different nerve block methods

1.3　麻醉方法　所有患者术前禁食 8 h，禁饮 2 h。入室后鼻导管吸氧，氧流量 2~3 L/min，监测血压、脉搏氧饱和度（SpO_2）、心电图（ECG），局麻下行桡动脉穿刺置管连续监测有创动脉压，随后根据随机分组进行神经阻滞操作。两组患者全麻药物剂量按照标准瘦体重（normalized lean weight，NLW），NLW = 总体重×$\sqrt{(22/BMI)}$[7]。麻醉诱导：依次静脉注射依托咪酯 0.3 mg/kg、罗库溴铵 0.9 mg/kg、舒芬太尼 0.5~1.0 μg/kg，3 min 后在可视喉镜下气管插管，行机械通气。术中静-吸复合麻醉维持：吸入 1%七氟醚，丙泊酚 4~10 mg/（kg·h）、瑞芬太尼 0.1~1.0 μg/（kg·min）以及间断追加罗库溴铵 0.10~0.15 mg/kg维持肌松，并维持 BIS 在 40~60，血压维持在基础值的 20%以内。术中给予昂丹司琼 8 mg、地塞米松 10 mg 预防恶心呕吐，吸入氧浓度 50%~60%，吸呼比（I∶E）= 1∶2，潮气量（VT）6~8 mL/kg，呼吸频率（RR）10~14 次/min，$P_{ET}CO_2$ 维持在 30~40 mmHg。在手术皮肤缝合结束后，进行手动肺部复张，并注射舒更葡糖钠 2~4 mg/kg 拮抗肌松。待患者清醒、自主呼吸恢复时拔出气管导管后送恢复室观察。术毕所有患者均采用自控静脉镇痛（patient-controlled intravenous analgesia，PCIA），镇痛泵药物配制：羟考酮 20 mg、氟比洛芬酯 200 mg 加生理盐水稀释至 100 mL，无背景输注剂量，单次按压剂量 5 mL，锁定时间 5 min，负荷剂量 20 mL/h。患者感到疼痛无法忍受时即可按压自控镇痛泵，若按压镇痛泵无效后，VAS 评分≥4 分，可以给予一次性的氟比洛芬酯 100 mg 或羟考酮 3~5 mg 以进行补救性镇痛。

1.4　观察指标　记录阻滞后 5 min、10 min、6 h、24 h、48 h 的阻滞平面节段（冰块法测定阻滞平面）。记录两组患者入室后、切皮前、切皮后 1 min 和 5 min 的平均动脉压（MAP）和心率（HR），术中舒芬太尼和瑞芬太尼用量。记录两组术后 2、6、12、24、48 h VAS 评分。记录手术结束至第一次按压镇痛泵的间隔时间、术后 48 h 内镇痛药物用量、补救镇痛情况，及恶心呕吐、呼吸抑制、感染、局部麻醉药中毒和穿刺损伤等不良反应发生情况。

1.5　统计学方法　运用 PASS 2023 软件估算样本量，根据预试验与既往文献的数据进行估算。检验水准 $\alpha=0.05$，检验效能 $1-\beta=0.9$，容许误差 δ 为 1.48，标准差 σ 为 1.99，采用双侧检验确定每组患者最小样本量为 38 例。考虑到失访，本研究中每组纳入 45 例。

采用 SPSS 26.0 软件分析数据。计量资料进行 Kolmogorov-Smirnov 正态性检验，服从正态分布以 $\bar{x}\pm s$ 表示，两组间比较采用两独立样本 t 检验，不同时间点比较采用重复测量资料的方差分析；不服从正态分布以 $M(P_{25}, P_{75})$ 表示，两组间比较采用两独立 Mann-Whitney U 检验；计数资料以例（%）表示，采用 χ^2 检验。均为双侧检验，$P<0.05$ 为差异有统计学意义。

2　结　果

2.1　一般资料　两组患者年龄、身高、体重、性别、BMI、ASA 分级及手术时间比较，差异无统计学意义（$P>0.05$）。见表 1。

2.2　阻滞平面节段　QLB-LSAL 组阻滞后 5 min、10 min、6 h、24 h 的阻滞平面节段多于 TAPB 组（$P<0.05$）。两组阻滞后 48 h 的阻滞平面节段比较，差异无统计学意义（$P>0.05$）。见表 2。

2.3　术中 MAP 和 HR　两组入室后、切皮前 MAP 和 HR 比较差异无统计学意义（$P>0.05$），QLB-LSAL 组切皮后 1 min 和 5 min 的 MAP 和 HR 低于 TAPB 组（$P<0.05$）。见表 3。

2.4　术后 VAS 评分　两组术后 48 h VAS 评分比较，差异无统计学意义（$P>0.05$），QLB-LSAL 组术后 2、6、12、24 h VAS 评分低于 TAPB 组（$P<0.05$）。见表 4。

表 1　两组患者一般资料比较

Tab. 1　Comparison of general data between two groups

项目	QLB-LSAL 组（$n=42$）	TAPB 组（$n=44$）	t/χ^2 值	P 值
年龄（岁，$\bar{x}\pm s$）	30.38±6.61	29.75±7.56	0.411	0.682
身高（cm，$\bar{x}\pm s$）	165.48±6.79	164.18±5.88	0.946	0.347
体重（kg，$\bar{x}\pm s$）	95.33±9.49	92.8±8.05	1.340	0.184
性别[例（%）]				
男	6（14.3）	9（20.5）	0.568	0.451
女	36（85.7）	35（79.5）		
BMI（kg/m^2，$\bar{x}\pm s$）	34.99±2.6	34.57±2.15	0.818	0.415
ASA[例（%）]				
Ⅱ级	31（73.8）	29（65.9）	0.636	0.425
Ⅲ级	11（26.2）	15（34.1）		
手术时间（min，$\bar{x}\pm s$）	108.24±7.38	105.82±9.64	1.302	0.196

表 2　两组患者阻滞后不同时点阻滞平面节段数的比较　[个，$M(P_{25}, P_{75})$]

Tab. 2　Comparison of the number of block dermatomes between two groups　[pcs，$M(P_{25}, P_{75})$]

组别	5 min	10 min	6 h	24 h	48 h
QLB-LSAL 组（$n=42$）	3（2,3）	6（6,7）	7（7,8）	5（4,5）	0（0,0）
TAPB 组（$n=44$）	1（0,1）	4（3,4）	3（2,3）	0（0,0）	0（0,0）
Z 值	8.068	8.221	8.237	8.559	0.024
P 值	<0.001	<0.001	<0.001	<0.001	0.981

2.5　术中阿片类药物用量、术后镇痛情况及不良反应　两组术中舒芬太尼用量、补救镇痛率、呼吸抑制发生率比较差异无统计学意义（$P>0.05$）。QLB-LSAL 组术中瑞芬太尼用量、术后 48 h 羟考酮和氟比洛芬酯用量、恶心呕吐发生率低于 TAPB 组（$P<0.05$）。QLB-LSAL 组手术结束至第一次按压镇痛泵的间隔时间长于 TAPB（$P<0.05$）。两组均未出现感染、局麻药中毒、穿刺损伤等不良反应。见表 5。

表 3　两组患者 MAP 和 HR 比较　（$\bar{x}\pm s$）

Tab. 3　Comparison of MAP and HR between two groups　（$\bar{x}\pm s$）

组别	MAP（mmHg）				HR（次/min）			
	入室后	切皮前	切皮后 1 min	切皮后 5 min	入室后	切皮前	切皮后 1 min	切皮后 5 min
QLB-LSAL 组（$n=42$）	102.95±10.44	83.29±10.89	85.07±8.24[a]	89.10±9.51[a]	74.57±7.55	63.52±6.15	68.26±10.45[a]	72.48±8.86[a]
TAPB 组（$n=44$）	99.86±12.03	80.86±11.95	89.16±7.64	95.39±7.80	77.57±8.58	64.00±9.56	72.64±9.17	76.57±8.25

注：与 TAPB 组比较，[a]$P<0.05$。

表 4　两组患者术后不同时点 VAS 评分比较　（分，$\bar{x}\pm s$）

Tab. 4　Comparison of VAS scores between the two groups　（point，$\bar{x}\pm s$）

组别	2 h	6 h	12 h	24 h	48 h
QLB-LSAL 组（$n=42$）	2.12±0.74[a]	2.33±0.53[a]	2.36±0.98[a]	2.02±0.90[a]	0.93±0.68
TAPB 组（$n=44$）	3.82±0.76	4.09±1.14	4.52±0.70	3.66±0.96	1.16±0.57
$F/P_{组间}$ 值	308.240/<0.001				
$F/P_{时间}$ 值	121.730/<0.001				
$F/P_{交互}$ 值	18.242/<0.001				

注：与 TAPB 组比较，[a]$P<0.05$。

表 5　两组患者术中阿片类药物用量、术后镇痛情况及不良反应比较

Tab. 5　Comparison of intraoperative opioid dosage, postoperative analgesia and adverse reactions between the two groups

项目	QLB-LSAL 组（$n=42$）	TAPB 组（$n=44$）	t/χ^2 值	P 值
舒芬太尼用量（μg，$\bar{x}\pm s$）	54.05±5.44	51.93±4.73	1.928	0.057
瑞芬太尼用量（mg，$\bar{x}\pm s$）	1.97±0.35	2.12±0.34	2.002	0.048
羟考酮用量（mg，$\bar{x}\pm s$）	13.43±4.06	15.25±4.35	2.007	0.048
氟比洛芬酯用量（mg，$\bar{x}\pm s$）	131.90±39.28	151.36±40.15	2.271	0.026
术毕至第一次按压镇痛泵时间（h，$\bar{x}\pm s$）	10.48±4.19	6.32±3.09	5.260	<0.001
补救镇痛[例（%）]	6（14.3）	8（18.2）	0.239	0.625
恶心呕吐[例（%）]	9（21.4）	19（43.2）	4.631	0.031
呼吸抑制[例（%）]	2（4.8）	2（4.5）	0.221	0.642

3　讨　论

LSG 是一种微创手术，但因肥胖患者腹部脂肪积聚，腹壁切口较深，导致术后疼痛发生率高[8]。腹腔镜术后早期切口痛和患者咳痰无力，也增加了患者术后出现肺不张和呼吸窘迫等并发症的风险[9]。肥胖患者更容易受到疼痛相关并发症和阿片类药物的影响[10]，选择良好的术后镇痛方法是促进其快速康复的重要环节。随着加速康复外科的发展，以区域神经阻滞为基础的多模式镇痛方法受到广泛关注。本研究结果显示，QLB-LSAL 可以为 LSG 手术患者提供良好的围术期镇痛。与 TAPB 比较，QLB-LSAL 可以减少术中及术后阿片类药物的用量，延长手术结束至第一次按压镇痛泵时间，降低术后恶心呕吐发生率，从而促进 LSG 患者术后快速康复。

近年来，TAPB 在腹部手术中广泛应用[11-12]，大量文献报道表明其在剖宫产、结直肠癌等手术中取得了良好的镇痛效果[13-14]。TAPB 是将局部麻醉药物注入腹内斜肌和腹横肌之间的筋膜层，以阻断肋间神经的皮支[15]，仅在术后切口处起到镇痛效果，不能缓解内脏疼痛。本研究中 QLB-LSAL 组术后 2、6、12、24 h VAS 评分低于 TAPB 组。QLB-LSAL 作为一种新入路腰方肌阻滞，是目前最新的腹部术后镇痛方式[16-17]。传统入路的腰方肌阻滞（QLB）主要作用机制是局麻药通过膈肌下缘的内外侧弓状韧带后方扩散至低位胸椎旁，进而产生阻滞作用[18]。有研究通过 QLB 中注射造影剂，观察到造影剂从内外侧弓状韧带的后方向胸椎旁分布[19]。从解剖学角度来看，QLB-LSAL 将局麻药物注射到弓状韧带以上水平，通过胸内筋膜向椎旁筋膜下间隙扩散，阻滞了脊神经根及交感神经干，不仅能提供躯体镇痛，也能有效地抑制内脏痛。

本研究结果显示，与 TAPB 相比，QLB-LSAL 阻滞范围更广，能提供更加完善的镇痛效果。本研究结果中 QLB-LSAL 阻滞 5 min 后温度觉减退出现 2～3 个阻滞平面。Shi 等[16]研究发现，单侧注射 0.5% 罗哌卡因 20 mL 5 min 后患者感觉平面可达 T_7 到 L_1。本研究达到相同阻滞平面时间偏长，推测可能与本研究中使用较低浓度的罗哌卡因（0.375%）有关。本研究结果显示，QLB-LSAL 组切皮后 1 min、5 min MAP 和 HR，术中瑞芬太尼用量低于 TAPB，提示 QLB-LSAL 可以减轻患者切皮后的应激反应，降低术中瑞芬太尼用量，为 LSG 患者提供有效的术中镇痛。与 TAPB 相比，QLB-LSAL 组在手术结束至第一次按压镇痛泵时间延长，48 h 内镇痛药物用量减少。TAPB 阻滞用于腹部手术的术后镇痛时间为 8～12 h，而有研究表明，QLB 维持时间可达 24～48 h[19]。说明 QLB-LSAL 用

于 LSG 的术后镇痛效果优于 TAPB。

术后恶心呕吐是 LSG 术后最常见的并发症，QLB-LSAL 组恶心呕吐发生率明显低于 TAPB，可能与 QLB-LSAL 产生了类似椎旁阻滞作用，有效的缓解了患者躯体和内脏痛以及减少了术中及术后阿片类药物的用量有关，具有临床意义。

本研究局限性有以下几点：(1) 为了临床治疗需要，未设置单纯全麻组以证明两种神经阻滞方式的有效性；(2) 本研究中采用 0.375%罗哌卡因用于 QLB-LSAL，未与不同浓度罗哌卡因的应用进行比较，不同浓度罗哌卡因下的 QLB-LSAL 在 LSG 中的镇痛效果是否更具优势，仍需进一步研究。

综上所述，QLB-LSAL 作为一种新型入路的神经阻滞，是一种安全，起效迅速，阻滞范围广，麻醉效果确切的阻滞方法，可以为 LSG 患者提供良好的镇痛效果，减少并发症发生率，从而促进患者快速康复。

利益冲突　无

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