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CLINICAL TRIAL REPORT

Effects of Transverse Abdominis Plane (TAP) Block on the MAC_{BAR} of Sevoflurane in Gynecologic Patients with Laparoscopic Pneumoperitoneal Stimulation: An Up-Down Sequential Allocation Study

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Purpose: This study aimed to observe the effect of bilateral transverse abdominis plane (TAP) block on the MAC_{BAR} of sevoflurane in gynecological patients with laparoscopic pneumoperitoneal stimulation.

Patients and Methods: Fifty patients who underwent laparoscopic surgery were randomly assigned to either the control group (n= 25) or the TAP block group (n= 25). Patients in the TAP block group were subjected to a bilateral transversal abdominal muscle plane block with 0.33% ropivacaine (20 mL on each side) guided by ultrasound. The control group received an equal volume of normal saline. The MAC_{BAR} of sevoflurane in each group was determined using a sequential allocation technique.

Results: The MAC_{BAR} of sevoflurane in the TAP block group was significantly lower than that in the control group (4.20% [95% confidence interval {CI}, 4.02%–4.38%] vs 5.03% [95% CI, 4.89%–5.18%]).

Conclusion: Bilateral TAP block can reduce the MAC_{BAR} of sevoflurane in gynecological patients with pneumoperitoneum stimulation.

Trial Registration Number: ChiCTR2100046517. The trial is publicly available and registered at www.chictr.org.cn on May 18, 2021.

Keywords: Transverse abdominis plane block, Adrenergic response, Minimum alveolar concentration, Pneumoperitoneum stimulation, Sevoflurane

Introduction

Laparoscopic surgery is a minimally invasive surgery that is widely used in gynecological patients and has the advantages of less damage and faster recovery, and its proportion in the field of gynecology has increased significantly.[1] The establishment of pneumoperitoneum by injecting carbon dioxide (CO_2) into the abdominal cavity is usually performed in laparoscopic surgery, which can cause a strong stress response resulting in large hemodynamic fluctuations.[2] During CO_2 pneumoperitoneum, the effect of CO_2 activation of the sympathetic adrenergic system seems to dominate.[3] However, the changes in the sympathetic stress response caused by laparoscopic surgical stimulation are the result of the simultaneous action of excision stimulation and carbon dioxide pneumoperitoneum stimulation. General anesthesia alone has difficulty inhibiting this stress response; too much depth of anesthesia can also lead to hemodynamic instability.[4] General anesthesia combined with epidural or nerve block anesthesia may be effectively relieved.[3,5,6]

The minimum alveolar concentration (MAC) of inhaled anesthetic for blocking adrenergic response (BAR) in 50% of patients is defined as the MAC_{BAR} of inhalation anesthetic.[7] Many pharmacological factors such as non-steroidal anti-

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inflammatory drugs,[8] analgesics,[9] anesthetics,[10] and physiological factors such as hypercapnia were associated with changes in MAC_{BAR} of inhaled anesthetics.[11] However, few studies have focused on the influence of nerve blocking factors on the MAC_{BAR}.

Transverse abdominis plane(TAP)block can block the abdominal wall afferent nerve by injecting local anesthetic into the neural plane between the internal oblique and transverse abdominal muscles and provides directive analgesia between the costal margin and the inguinal ligament.[12] Several studies have shown that TAP block can reduce the visual analog scale (VAS) pain score and analgesic needs of abdominal surgery, in addition to having the advantages of good patient compliance and overall comfort.[13,14] Moreover, it does not have complications of intraspinal anesthesia such as hypotension, bradycardia, urinary retention, postoperative headache, and motor block.[15,16] Multiple studies have shown that TAP block is beneficial for pain management in laparoscopic surgery,[17,18] but there are conflicting data that TAP block does not increase any analgesic effect in gynecological laparoscopic surgery.[19] Therefore, the application of TAP block in gynecological laparoscopic surgery remains controversial.

Whether the TAP block affects MAC_{BAR} of sevoflurane during laparoscopic surgery is unknown. We hypothesized that bilateral TAP block can effectively reduce MAC_{BAR} of sevoflurane in gynecological patients undergoing laparoscopic surgery with pneumoperitoneal stimulation. Observing the effect of bilateral TAP block on sevoflurane MAC_{BAR} may help anesthesiologists carefully titrate sevoflurane concentration and analgesic dose during combined TAP block anesthesia.

Methods

Study Design and Ethics

This single-center, randomized clinical controlled trial was approved by the Ethics Committee of the Affiliated Hospital of North Sichuan Medical University (approval number: 2021ER080-1, on July 8, 2021) and was registered at https://www.chictr.org.cn (ChiCTR2100046517, principal investigator: P.P.J., date of registration: May 18, 2021) before patient enrollment. This study was conducted in accordance with the Declaration of Helsinki and applicable CONSORT guidelines. Written informed consent was obtained from all participants and an approved protocol was followed throughout the study period.

Participants

Fifty women aged 18–65 years with an American Society of Anesthesiologists (ASA) Physical Status of I or II were selected for elective gynecological laparoscopic surgery in our hospital. The exclusion criteria were history of cardiac, pulmonary, liver, or renal disease; history of hypertension, diabetes, or stroke; drug or alcohol abuse; preoperative acid-base electrolyte imbalance; coagulation dysfunction; current use of any vasoactive medications; recent use of any medications known to affect MAC or sympathetic adrenergic response; pregnant women; body mass index (BMI)< 18 or >30 kg m^{-2}; contraindication for inhalation anesthesia or local anesthetics; and inability to comply with the protocol for any reason.

Randomization

Patients were randomly allocated (1:1) into two groups (TAP block group and control group) using Statistical Product Service Solutions (SPSS, IBM) 23.0 software. The TAP block group received a bilateral transverse abdominis plane block (injection of 0.33% ropivacaine 20 mL on each side) 30 min before anesthesia guided by ultrasound. An equal volume of normal saline was administered in the transverse abdominal muscle plane to the control group. The TAP block technique in both groups was performed by a specialized anesthesiologist who administered the medication according to a sterile envelope prepared by a nurse who prepared two 20 mL syringes containing 0.33% ropivacaine or saline in a sterile envelope according to the group number.

Anesthesia Process

All patients fasted for 8 hours, did not drink for 4 hours before surgery, and did not receive premedication. Electrocardiography (ECG), pulse oxygen saturation (SPO_2), and left invasive radial arterial pressure (IAP) were

routinely monitored using a multifunction monitor (Mindray Medical International Limited, BeeVisionN15). Oxygen was delivered at a rate of 2 L min^{-1} through the nasal prongs. The nurse opened the venous channel on one side of the patient's upper limb and injected lactate Ringer's solution at a rate of 15–20 mL kg^{-1} h^{-1}. Remifentanil was injected simultaneously to reach a plasma target-controlled concentration of 2 ng mL^{-1}.

The patient was placed in the supine position with an ultrasound high-frequency line probe placed at the midaxillary line, iliac crest, or costal margins. The operator gently slid the ultrasonic probe back and forth to the proximal or distal end of the patient. When the abdominal wall muscle structure on the ultrasonic display was clear, a 22-gauge, 8-cm short-beveled needle was inserted from the middle to the lateral using an in-plane technique until the needle tip was demonstrated in the plane between the transverse abdominis and the internal oblique muscle. When the negative pressure test showed no blood, 1–2 mL of local anesthetic was slowly injected to confirm the position of the needle tip, and then 20 mL of 0.33% ropivacaine or normal saline was injected with an intermittent negative aspiration test. The contralateral TAP block was performed in the same manner. Remifentanil injection was discontinued after completion of the transversal plane block, and the patients were transferred to the operating room 30 minutes later. The skin cold sensation test[20] on the bilateral abdominal walls was performed 20 min after the block was completed by a specified anesthesiologist using an ice cube placed in a disposable plastic glove. Compared to patient's cold sensation at the neck skin, if the cold sensation on two sides of the abdominal wall was reduced or absent, the TAP block was considered to be effective. The boundaries of sensory changes in the abdominal skin were marked on the skin. If the cold sensation persisted in the patient's bilateral abdominal wall, the TAP block was considered a failure and was excluded from the study. The TAP-blocking process and labeling results are shown in Figure 1.

The bispectral index (BIS), ECG, SPO_2 and IAP were routinely monitored in the operating room before induction. General anesthesia was induced by intravenous injection of propofol 2–3 mg kg^{-1} and remifentanil 1–2 μg kg^{-1}. Cisatracurium besilate 0.15 mg kg^{-1} was injected to facilitate insertion of the tracheal tube. Mechanical ventilation

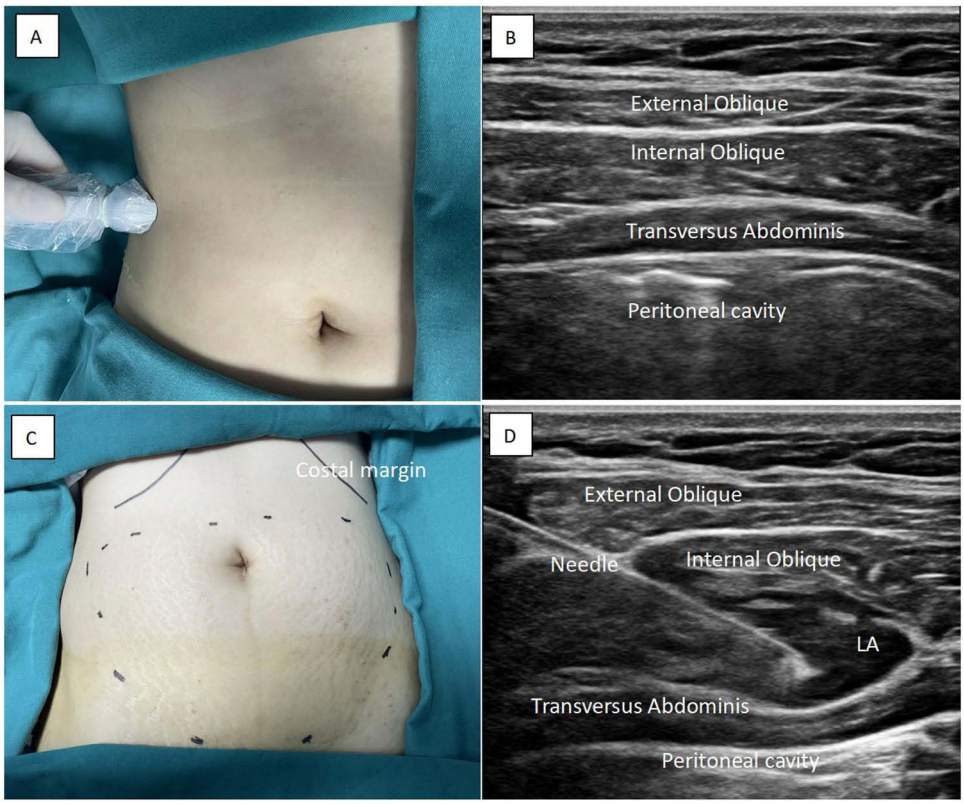

Figure 1 The TAP-blocking process and labeling results. (**A**) Ultrasound-guided TAP block. (**B**) The abdominal muscle structure was shown on ultrasound. (**C**) Area of hypoesthesia measured 20 min after TAP block. (**D**) TAP blocks the process of LA injection.
Abbreviations: TAP, transverse abdominis plane; LA, local anesthetic.

was controlled using 85% oxygen at a flow rate of 2 L min^{-1}. A preset concentration of sevoflurane was inhaled to maintain anesthesia, and end-expiratory carbon dioxide partial pressure ($P_{ET}CO_2$) was maintained within the normal range (35–45 mmHg) by regulating respiratory parameters. $P_{ET}CO_2$ and end-tidal sevoflurane concentrations (C_{ET}Sevo) were measured using the above-mentioned multifunctional monitor. Carbon dioxide pneumoperitoneum was established at a pressure of 13 mmHg after reaching the preset target sevoflurane concentration and maintaining stability for 15 min. The establishment of CO_2 pneumoperitoneum requires four laparoscopic ports (one for a periumbilical balloon trocar of 10 mm, two accessory ports of 5 mm inserted into the right and left lower quadrants, and one accessory port of 10 mm in the right or left lower quadrant as the main operating hole). The patient's heart rate (HR) and mean arterial pressure (MAP) were recorded 1 and 3 minutes before and after the creation of CO_2 pneumoperitoneum. When MAC_{BAR} measurement was completed, the depth of anesthesia was maintained by pumping remifentanil (4–6μg kg^{-1} h^{-1}) and inhaled sevoflurane (1–3%). The infusion of remifentanil was stopped and sufentanil 0.2μg kg^{-1} was intravenously injected at the end of surgery. When the patient's consciousness and spontaneous breathing had recovered, the tracheal tube was removed and the patient was sent to the anesthesia recovery room for further observation.

The visual analogue scale (VAS) pain score was determined by an appointed anesthesia nurse based on the standard from 0 (no pain at all) to 10 (worst imaginable pain) at 30 min, 2 h, 4h, 6 h, 12 h, 24 h and 48h after the operation. In the anesthesia recovery room, 0.1 mg kg^{-1} of oxycodone was administered intravenously when the VAS score was ≥4. Postoperative nausea and vomiting (PONV) were assessed at two post-operative intervals: 0–2h and 2–24h, and the incidence of nausea and vomiting and the use of emergency antiemetic (4mg ondansetron per dose) were recorded. After the patient was admitted to the ward, tramadol was administered orally at 100 mg day^{-1} for postoperative analgesia and demerol 50 mg for remedial analgesia was administered intravenously if severe pain persisted. Postoperative analgesic drug requirements and local anesthetic toxicity (nerve block, tongue numbness, convulsion, apnea, arrhythmia, and other symptoms) were recorded. Patients were followed up after surgery for complications, such as abdominal wall hematoma, intestinal perforation, and intraoperative awareness.

Determination of MAC_{BAR}

The MAC_{BAR} of sevoflurane was determined using the Dixon up-and-down sequential allocation technique.[21] The mean values of HR or MAP at 1 and 3 min before pneumoperitoneum establishment were taken as the baseline values. The mean values of HR or MAP at 1 and 3 min after pneumoperitoneum pressure stabilization were taken as the change in values. A sympathetic adrenergic positive response was defined as an increase in HR or MAP greater than or equal to 20% of its baseline value after pneumoperitoneum establishment. In contrast, if the increase in HR or MAP was less than 20% of the baseline value, the sympathetic adrenergic response was defined as negative. A designated observer, who was blinded to the study design, completed the judgment of sympathetic adrenergic positive or negative responses. The first patient's predetermined C_{ET}Sevo in the control group (4.8%) and TAP block group (4.4%) was obtained by a pilot test. If the response after pneumoperitoneum stimulation was positive (negative), the C_{ET}Sevo score in the next patient increased (decreased) by 0.2%. Patients with HR <50 bpm or MAP <50 mmHg who required treatment with vasoactive drugs such as atropine or ephedrine during the study period were excluded from the study, and C_{ET}Sevo was repeated in the next patient to continue the sequential test. Positive responses to negative responses or negative responses to positive responses were used as intersection points for successive patients. The determination was continued until six intersection points from positive to negative and negative to positive occurred in each group,[22] and the intervention ceased when the target sample size was reached.

Outcomes

The primary objective of this study was to evaluate the effect of TAP block on the MAC_{BAR} of sevoflurane during pneumoperitoneum stimulation. The MAC_{BAR} value for sevoflurane was obtained using the sequential allocation technique described above. The mean C_{ET}Sevo in 12 patients with 6 intersection points was the MAC_{BAR} value of sevoflurane in each group.

The secondary observation indexes of this study included HR, MAP, and BIS before and after pneumoperitoneum establishment; VAS pain score at 30 min, 2 h, 4 h, 6 h, 12 h, 24 h and 48h after surgery; intraoperative analgesic drug dosage; analgesic demand within 48 h after surgery; PONV and the use of antiemetics and related complications.

Sample Size Calculation

Using PASS 2021 software to calculate the sample size based on the pre-experimental results, we assumed that the MAC_{BAR} of sevoflurane in the control and TAP block groups was 4.8% and 4.4%, respectively. The standard deviation was set to 0.5%. Thus, to achieve a power of 80% and a type I error of 0.05 to detect a difference of 0.4% with a possible dropout rate of 20%, 25 patients per group were required.

Statistical Analysis

SPSS software (version 23.0) was used for statistical analysis. The statistical data of HR, MAP, and BIS were derived from 12 patients, with six intersections of positive responses to negative responses in each group. Differences (delta values) in HR, MAP, and BIS before and after pneumoperitoneum stimulation were calculated. Data are expressed as mean ± SD for numerical variables and as numbers for categorical variables.

The MAC_{BAR} of sevoflurane; age; BMI; operative time; consumption of sufentanil, remifentanil, oxycodone, and dolantin; and HR, MAP, BIS, and VAS pain scores were compared between the two groups using an independent sample *T* test. Probit regression was used to estimate MAC_{BAR} with 95% confidence interval (CI). ASA classification, type of surgery, PONV and the use of antiemetics were compared between the two groups using the chi-squared test. $p < 0.05$ was considered statistically significant based on a two-tailed probability.

Results

A consort diagram of this study is shown in Figure 2. In the anticipant 50 patients, 2 patients in the control group did not receive the allocated intervention owing to the six intersection points were obtained, and 2 patients in the TAP block group did not receive the further intervention owing to the TAP block failed. In the control and TAP block groups, 3 cases and 2 cases with MAP <50 mmHg or HR<50 bpm were excluded from the test. Finally, to obtain six intersections, 20 and 21 cases were used for the control and TAP block groups, respectively (Figure 3).

The demographic and clinical characteristics of patients are shown in Table 1. The intraoperative doses of remifentanil, oxycodone, and dolantin in the TAP block group were significantly lower than those in the control group ($p < 0.05$).

MAC_{BAR} of sevoflurane is shown in Table 2. The MAC_{BAR} of sevoflurane at six consecutive intersections from positive to negative in both groups was (5.03%[95% CI, 4.89% ~ 5.18%] vs 4.20%[95% CI, 4.02%~4.38%]; difference, 0.83% [95% CI, 0.62% to 1.05%], $p < 0.001$), the MAC_{BAR} of sevoflurane at six consecutive intersections from negative to positive was (4.90%[95% CI, 4.77%~5.03%] vs 4.10%[95% CI, 3.97% ~ 4.23%]; difference, 0.82% [95% CI, 0.63% to 0.97%], $p < 0.001$); similar MAC_{BAR} of sevoflurane results was obtained by using probit regression in the control group and TAP group (4.91%[95% CI, 4.61%~5.07%] vs 4.14%[95% CI, 3.79%~4.37%], $p < 0.001$).

Comparisons of the HR, MAP, and BIS between the control and TAP block groups are shown in Table 3. The HR before and after pneumoperitoneum in the TAP block group was significantly lower than that in the control group ($p < 0.05$). MAP before and after pneumoperitoneum, delta values of HR and MAP, and BIS were not significantly different between the two groups ($p > 0.05$).

A comparison of the postoperative VAS pain scores between the two groups is shown in Figure 4. The postoperative VAS scores between the two groups showed significant differences at 30 min and 2 h after surgery ($p < 0.001$), but no significant differences were found at 4, 6, 12, 24, and 48 h after surgery ($p > 0.05$).

PONV and the use of antiemetics are shown in Table 4. The incidence of PONV and the use rate of antiemetic drugs at 0–2 hours and 2–24 hours after surgery showed no statistical difference between the control group and TAP block group ($p > 0.05$).

Abdominal wall hematoma and local anesthetic intoxication were not found in any patient, and no intraoperative awareness was found during postoperative follow-up.

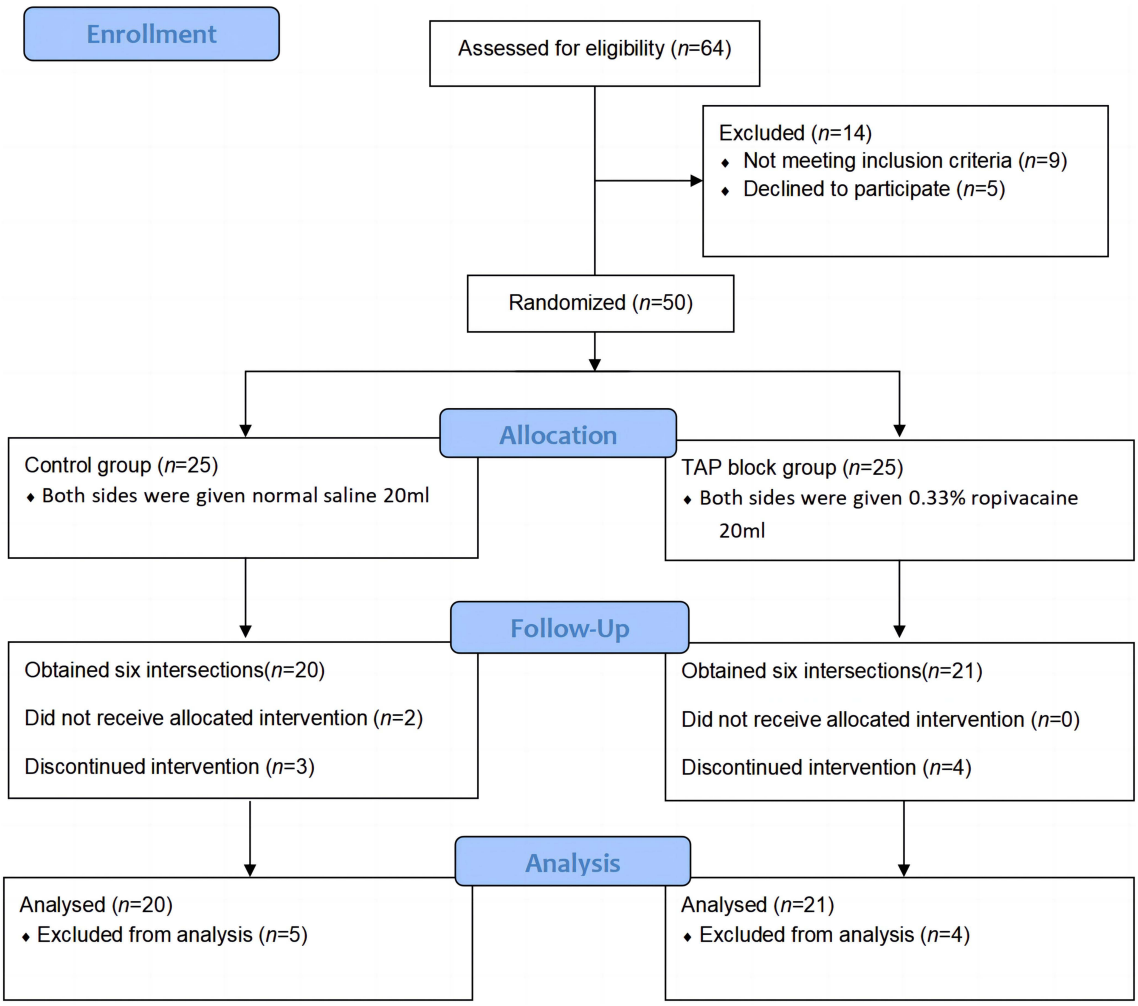

Figure 2 Consort diagram for the trail. In this study, 50 patients were randomly allocated into 2 groups with 25 patients in each group. To obtain six intersection points in each group, 20 and 21 patients in the control group and TAP group were needed respectively. Finally, remaining 2 patients did not undergo the experimental intervention because a sufficient number of intersections were obtained.

Discussion

The establishment of CO_2 pneumoperitoneum by laparoscopic surgery can cause a stress response in patients, produce a large amount of endogenous substances such as catecholamine hormones that participate in perioperative myocardial ischemia,[3] and lead to a series of adverse effects such as organ function suppression, immune function decline, and metabolic enhancement.[6,23] This study showed that bilateral TAP block significantly reduced the MAC_{BAR} of sevoflurane in gynecological patients with laparoscopic pneumoperitoneal stimulation. This indicates that sevoflurane combined with bilateral TAP block can effectively inhibit the sympathetic stress response, mainly because the TAP block can effectively block neuromuscular excitatory transmission in the abdominal wall and lead to the suspension of surgical noxious stimulation in the central nervous system.[24] TAP block causes the abdominal skin and peritoneal parietal sensory nerve to be blocked at T_6-L_1 level and provides effective pain control.[15] *Carney* et al[25] even reported that TAP block not only blocked distal sensory efference, but also might affect the more proximal paravertebral space. Therefore, in this study, bilateral TAP block before surgery not only reduced the stimulation of skin incision, but also reduced the stimulation of CO_2 pneumoperitoneum to the parietal peritoneum, which would greatly reduce the sympathetic stress response caused by laparoscopic pneumoperitoneum stimulation, thus reducing the MAC_{BAR} of sevoflurane.

In this study, MAC_{BAR} of sevoflurane was determined using a sequential up-down method. In contrast to previous studies,[21,26,27] the average end-expiratory concentration of sevoflurane was the MAC_{BAR} value not only for 12 patients

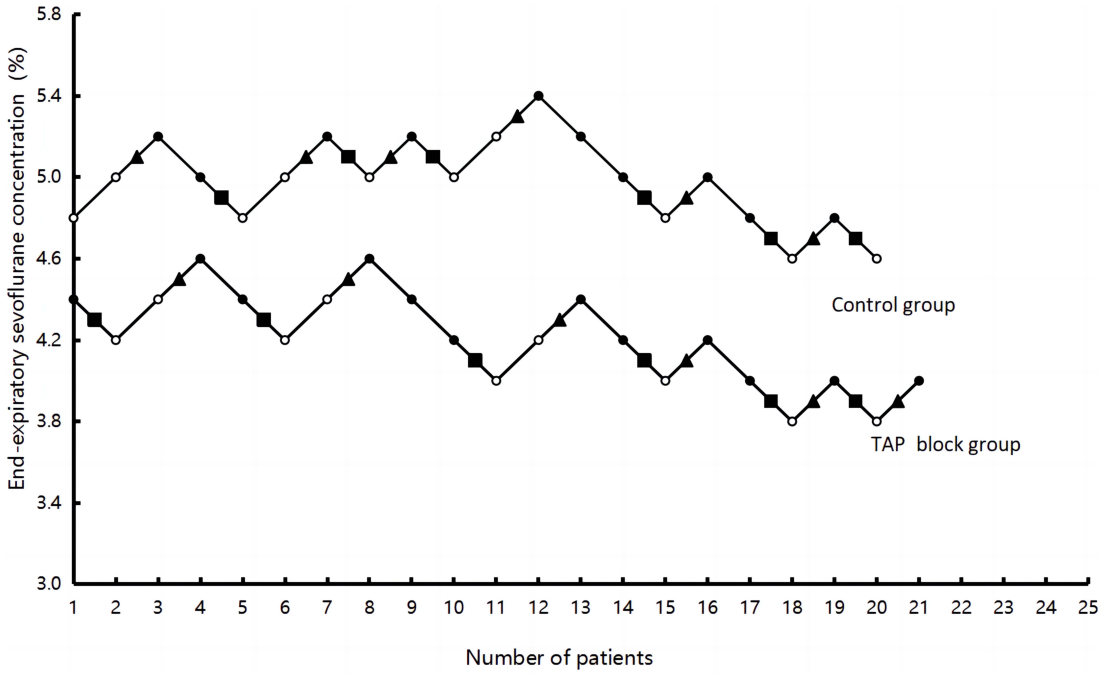

Figure 3 The measurement of sevoflurane MAC_{BAR} in the two groups. The positive reaction was represented by ○,while the negative reaction was represented by ●. The intersections from positive to negative reactions are represented by ▲, and the intersections from negative to positive reactions are represented by ■.To get six crossovers, 20 and 21 patients were needed in the control group and TAP block group, respectively.
Abbreviation: TAP, transverse abdominis plane.

with six consecutive intersections from positive to negative, but also for 12 patients with six consecutive intersections from negative to positive. Both results are similar to those obtained by the probit regression used in this study (Table 2). This demonstrates the accuracy of our research and practicability of our method.

Table 1 The Demographic and Clinical Characteristics of Patients in Two Groups

	Control group (*n*=20)	TAP block group (*n*=21)	*p*
Age; years	35.6±8.7	39.0±9.9	0.287
BMI; kg m^{-2}	21.5±2.00	21.9±2.14	0.522
ASA physical status, *n*			
I	11	12	640
II	6	9	
Procedures, *n*			0.694
Oophorectomy	6	8	
Hysteromyoma excision	3	5	
TLH	6	4	
TLH with BSO	2	4	
Operative time, min	124±53	131±47	0.650
Analgesic drug consumption			
Sufentanil, *μg*	11±3	12±4	0.347
Remifentanil, *μg*	559±152	452±140	0.031
Oxycodone, *mg*	4.6±0.9	3.1±0.7	0.023
Dolantin, *mg*	54.4±3.8	27.4±3.4	0.032

Notes: Values are presented as mean±*SD* or *n*. $p < 0.05$ was considered statistically significant.
Abbreviations: TAP, Transversus abdominis plane; ASA, American Society of Anesthesiologists; BMI, Body mass index; BSO, Bilateral salpingo-oophorectomy; TLH, Total laparoscopic hysterectomy.

Table 2 The MAC_{BAR} of Sevoflurane Were Compared Between the Two Groups by Means of Independent Sample and Probit Regression

Group	Empirical mean MAC_{BAR}(95% CI)%		Probit regression MAC_{BAR}(95% CI)%
	Positive to negative	Negative to positive	
Control group	5.03 (4.89~5.18)	4.90 (4.77~5.03)	4.91 (4.61~5.07)
TAP block group	4.20 (4.02~4.38)	4.10 (3.97~4.23)	4.14 (3.79~4.37)
p	<0.001	<0.001	<0.001

Notes: Values are presented as means (95% CI). $p < 0.05$ was considered statistically significant.
Abbreviation: TAP, transverse abdominis plane; CI, confidence interval.

Table 3 Comparison of the HR, MAP, BIS Between Two Groups

	Control group (n=20)	TAP block group (n=21)	*p*
MAP, mmHg			
Pre-anesthesia	88±10	91±7	0.322
Pre-pneumoperitoneum	63±5	63±8	0.929
Post-pneumoperitoneum	78±12	75±11	0.543
Delta	15±9	13±9	0.475
HR, bpm			
Pre-anesthesia	74±14	75±11	0.879
Pre-pneumoperitoneum	86±16	70±5	0.006
Post-pneumoperitoneum	90±22	74±9	0.034
Delta	4±17	4±9	0.977
BIS			
Pre-anesthesia	93±12	92±10	0.889
Pre-pneumoperitoneum	45±9	46±10	0.876
Post-pneumoperitoneum	47±8	48±11	0.901
Delta	2±1	2±2	0.899

Notes: The pre-anesthesia value was before anesthesia; The pre-pneumoperitoneum value was the average value measured 3 and 1 min before CO_2 pneumoperitoneum; The post-pneumoperitoneum value was the average value measured 3 and 1 min after CO_2 pneumoperitoneum; The value of delta represents the difference between before and after pneumoperitoneum stimulation. Values are presented as mean±SD. $P < 0.05$ was considered statistically significant.
Abbreviation: MAP, bispectral index; HR, bispectral index; TAP, transverse abdominis plane; BIS, bispectral index.

In this study, we found that preoperative bilateral TAP block reduced the MAC_{BAR} of sevoflurane by approximately 16% (Table 2). However, in our earlier studies, we discovered that a plasma target-controlled remifentanil concentration of 1 ng mL^{-1} could reduce the MAC_{BAR} of sevoflurane during pneumoperitoneum stimulation by 48% and 36% in adults[21] and children,[27] respectively. Therefore, we assumed that intravenous opioids are more effective in depressing the stress response than bilateral TAP block by pneumoperitoneum stimulation, possibly because CO_2 activates the central nervous system to induce sympathetic adrenaline activation, and the TAP block lacks visceral analgesia,[3,25] but it needs further study to confirm this.

In this study, no statistically significant differences were found in the changes in BIS, HR, and MAP between the two groups before and after pneumoperitoneum stimulation (Table 3). This might imply that when the adrenergic response was inhibited in half of patients, the hemodynamic changes and the depth of anesthesia measured by BIS were not related to whether the abdominal wall was blocked by local anesthesia. The reason for a faster heart rate in the control group than that in the TAP block group before and after pneumoperitoneum establishment may be related to the use of a high concentration of sevoflurane as described by *Goo's* study.[28]

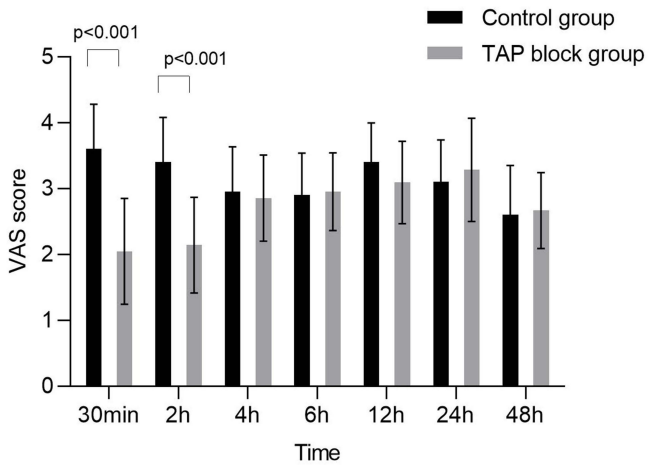

Figure 4 Comparison of VAS scores between the two groups. There were significant differences in VAS scores between the two groups within 2 hours after surgery (p <0.001), but no differences at 4, 6, 12, 24 and 48 hours after surgery (p > 0.05).
Abbreviations: VAS, visual analogue scale; TAP, transverse abdominis plane.

The MAC_{BAR} of the TAP block group was significantly lower than that of the control group, indicating that the TAP block before surgery required a lower C_{ET}Sevo to achieve a similar MAC_{BAR} effect with CO_2 pneumoperitoneum stimulation compared to the control group (Table 2). We found that the consumption of intraoperative and postoperative analgesic drug in the TAP block group was significantly lower than that in the control group (Table 1), demonstrating that bilateral TAP block before surgery can effectively reduce the use of perioperative analgesic drug dosage and consumption of sevoflurane, thereby reducing the incidence of postoperative hyperalgesia,[29] delayed awakening, and other related complications,[30] which is consistent with the findings of.[31] However, the results of this study found that there was no difference in PONV and the use of antiemetic drugs between the control group and the TAP block group. Therefore, the influence of TAP block on PONV in gynecological laparoscopic surgery needs to be further studied in additional cases.

By observing the effect of preoperative TAP block on the postoperative VAS pain score, we found that the VAS pain score in the TAP block group was significantly lower than that in the control group within 2 h after surgery (Figure 4). However, there were no significant differences in the VAS pain scores between the two groups at 4, 6, 12, 24, and 48 h after surgery, which may be related to the timely use of oxycodone and demerol for remedial analgesia, and the dose of ropivacaine for TAP block was small. Azawi's[32] article noted that the half-life of ropivacaine is approximately two hours and that postoperative TAP-block administration may be the optimal choice if prolonged analgesia is required. In addition, it has been confirmed that increasing the concentration of local anesthetics can also prolong the block time.[33]

Table 4 Postoperative Nausea and Vomiting outcomes

	Control group (n=20)	TAP block group (n=21)	p
Early time (0–2 h)			
Nausea	7 (35%)	5 (24%)	0.431
Vomiting	4 (20%)	3 (14%)	0.943
Antiemetic	4 (20%)	3 (14%)	0.943
Late time (2–24 h)			
Nausea	10 (50%)	7 (33%)	0.279
Vomiting	5 (25%)	4 (19%)	0.934
Antiemetic	6 (30%)	4 (19%)	0.651

Notes: Values are numbers (proportion). p <0.05 was considered statistically significant.
Abbreviation: TAP, transverse abdominis plane.

In this study, the ultrasound-guided TAP block had the imaging advantages of real-time needle trajectory and local anesthetic diffusion. It can effectively avoid abdominal wall hematoma, intestinal perforation, and local anesthetic intoxication.

This study has several limitations. First, changes in plasma catecholamine concentrations and inflammatory cytokines in the two groups were not monitored simultaneously; however, our previous studies have shown that catecholamine hormone changes in the body are consistent when half of the adrenergic response is suppressed during laparoscopic surgical stimulation. Second, since we measured MAC_{BAR} of sevoflurane using the up-and-down sequential allocation method and the properties of abdominal wall skin anesthesia in the TAP group, double blindness was not used in this study. Third, the HR and MAP data only analyzed 12 patients with six intersections of positive to negative responses in each group; other patient data were not analyzed.

Conclusion

Bilateral TAP block guided by preoperative ultrasound can significantly reduce the MAC_{BAR} of sevoflurane and the need for intraoperative and postoperative analgesics during laparoscopic surgical stimulation in gynecological patients.

Data Sharing Statement

All data generated or analyzed during this study have been included in the published article. Further inquiries regarding the datasets can be directed to the corresponding author upon reasonable request.

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Disclosure

The authors have no competing interests in this work.

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