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Clinical Research Article

Comparison of modified thoracoabdominal nerve block through perichondral approach and subcostal transversus abdominis plane block for pain management in laparoscopic cholecystectomy: a randomized-controlled trial

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ABSTRACT

Background: The modified thoracoabdominal nerve block through the perichondral approach (M-TAPA) is a novel regional analgesic technique that can provide analgesia for both the lateral and anterior abdominal walls. This study aimed to compare the analgesic effect of M-TAPA with that of the subcostal transversus abdominis plane block (TAPB) in patients undergoing laparoscopic cholecystectomy (LC).
Methods: Sixty patients scheduled to undergo elective LC were randomly assigned to receive either M-TAPA or subcostal TAPB during anesthesia induction. The primary outcome was the maximum pain intensity during movement within the first 12 hours postoperatively, measured using an 11-point numeric rating scale (NRS). Secondary outcomes included changes in NRS scores during rest, coughing, and movement, which were assessed at 1, 2, 4, 6, and 12 hours postoperatively and immediately before discharge. Additionally, postoperative nausea and vomiting, and patient satisfaction were recorded as secondary outcomes.
Results: Data from 56 patients were analyzed, and no significant difference was observed in the primary outcome between the two groups (M-TAPA: 5.5 [interquartile range (IQR): 5–7] *vs*. subcostal TAPB: 5 [IQR: 4–7], median difference: 0, 95% confidence interval: –1 to 1, P = 0.580). Furthermore, no significant differences in secondary outcomes were observed between the two groups.
Conclusions: No significant difference was observed in the analgesic effect between the two techniques. Consequently, further research is necessary to compare the efficacy of M-TAPA with other well-established regional analgesic techniques.

Keywords: Acute Pain; Cholecystectomy, Laparoscopic; Laparoscopy; Nerve Block; Pain, Postoperative; Patient Satisfaction; Postoperative Complications; Ultrasonography.

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INTRODUCTION

Despite the introduction of a minimally invasive approach, cholecystectomy can cause significant acute postoperative pain owing to multifactorial factors [1]. According to one prospective study, approximately half of the patients who underwent laparoscopic cholecystectomy (LC) experienced moderate or severe immediate postoperative pain [2]. Acute postoperative pain is the most common cause of patient discomfort during the period after LC [3] and is the most common cause of readmission after discharge [4]. It may also be associated with the development of chronic postsurgical pain [5]. Therefore, pain control is an important component of perioperative care in patients who undergo LC.

Ultrasound-guided regional analgesia is a useful option for multimodal analgesia during LC. Among various regional analgesic techniques, the subcostal transversus abdominis plane block (TAPB) is a regional analgesic technique that can provide analgesia of the supraumbilical abdomen and, unlike the erector spinae plane (ESP) and quadratus lumborum (QL) blocks, it has the advantage that it can be performed in a supine position. In a recently published meta-analysis, subcostal TAPB showed the greatest reduction in pain score at 12 hours postoperatively compared with other regional analgesic techniques [6]. However, pain from the incision site for the right lateral port in the LC may not be covered because the subcostal TAPB cannot block the lateral cutaneous branches of the thoracoabdominal nerves [7]. To compensate for the above shortcomings of TAPB, Tulgar et al. [8] introduced a new regional analgesic technique called the thoracoabdominal nerve block through the perichondral approach (TAPA) in 2019. This is a method of injecting local anesthetics between the lower aspect of the 9–10th costal cartilages and the transversus abdominis muscle passing directly below it and the external oblique muscle passing above the cartilage to obtain abdominal wall analgesia, including the area of the lateral cutaneous branches. Subsequently, Tulgar et al. [9] introduced modified TAPA (M-TAPA), which administers local anesthetics only between the costal cartilage and the transversus abdominis muscle. Additionally, they recently demonstrated the spread of drugs in TAPA and M-TAPA in a cadaver study [10]. Furthermore, a recent study conducted in patients undergoing LC showed that M-TAPA provided better analgesia and higher patient satisfaction than local infiltration [11].

However, evidence on the effectiveness of M-TAPA remains limited. To the best of the authors' knowledge, no research has reported a comparison of its analgesic effects with subcostal TAPB—which is a well-known analgesic technique. Therefore, the aim of this study was to investigate the effect of M-TAPA on postoperative pain and patient satisfaction compared to subcostal TAPB in patients undergoing LC.

MATERIALS AND METHODS

This prospective single center randomized controlled study was approved by the Institutional Review Board of Seoul National University Hospital (Approval No. H-2111-040-1270) and registered at clinicaltrials.gov (No. NCT05207306, registered on March 22, 2022) before enrollment.

The study included all patients aged 18–70 years who were scheduled for elective LC, with the following exclusion criteria: 1) American Society of Anesthesiologists (ASA) physical classification III or higher; 2) chronic pain or continuous use of analgesics, antidepressants, or anticonvulsants for ≥ 3 months; 3) allergy to any of the anesthetic or analgesic medications used in the protocol, including ropivacaine, acetaminophen, ketorolac, nefopam, nalbuphine, or tramadol; 4) single-port LC; 5) abdominal wall infection; 6) psychological conditions that may interfere with outcome interpretation; and 7) inability to comprehend the study protocol or provide informed consent. Written informed consent was obtained from all patients.

1. Patient randomization and blinding

After enrollment, patients were randomized to either the M-TAPA or subcostal TAPB group using block randomization with mixed block sizes (two or four) and a 1:1 allocation ratio. An investigator not involved in the study used R software (version 3.5.1; R Foundation for Statistical Computing) to perform randomization. The results were sealed in an envelope and delivered to the researchers (H.Y.C. and H-.J.L.) who performed ultrasound-guided nerve blocks on the day of surgery. To ensure that the patients remained blinded to their group assignment, ultrasound-guided nerve blocks were performed during the induction of general anesthesia, and adhesive foam dressings were attached to both block needle insertion sites during the study period to prevent unblinding of both patients and evaluators.

2. Anesthesia and surgical protocol

All patients received 200 mL of a carbohydrate drink (Nucare NONPO: Daesang Corp.) 2 hours before surgery and entered the operating room without premedication. Standard monitoring—including electrocardiography, non-invasive blood pressure measurements, and peripheral oxygen saturation measurements—was initiated. Endotracheal intubation was performed after anesthesia induction using propofol (1–2 mg/kg), rocuronium (0.6–1.2 mg/kg), and target-controlled infusion of remifentanil using Minto's conceptual model. Before surgical incision, either M-TAPA or subcostal TAPB was performed by anesthesiologists with patients in the supine position. In the M-TAPA group, the anesthesiologist used ultrasound guidance (Affiniti 50; Philips) with a linear 4.0–12.0-MHz transducer to find the 10th costal cartilage, inserted a 21-gauge 100-mm needle (Echoplex plus; Vygon) in a cephalad direction using an in-plane technique, and injected 15 mL of 0.375% ropivacaine bilaterally into the plane between the transversus abdominis muscle and the lower aspect of the costal cartilage (**Fig. 1A**). In the subcostal TAPB group, the anesthesiologist used ultrasound guidance to insert a 21-gauge 100-mm needle from the bilateral ends of the rectus abdominis muscles using an in-plane technique and injected 15 mL of 0.375% ropivacaine bilaterally into the plane between the transversus abdominis and rectus abdominis muscles (**Fig. 1B**) [12]. Anesthesia was maintained using sevoflurane (0.8–1 minimum alveolar concentration) and target-controlled infusion of remifentanil to maintain blood pressure within 20% of the baseline. Intravenous infusion of acetaminophen (1 g) and ketorolac (30 mg) was initiated when the gallbladder was dissected from the liver bed. Dexamethasone was administered intravenously as an antiemetic during anesthesia induction, and ramosetron was administered along with acetaminophen.

The surgery was performed using a trocar through a three-hole incision (umbilicus, right upper abdomen, and epigastric area), and pneumoperitoneum was maintained at 12 mmHg. In cases of severe adhesions or bleeding during surgery, an additional trocar was used or open-converted, according to the surgeon's judgment. Patients with unplanned open conversion were subsequently excluded from the analysis.

3. Postoperative pain management

Patients in the post-anesthesia care unit (PACU) with a numeric rating scale (NRS) pain score of ≥ 5 points were administered 50 μg of intravenous fentanyl as a rescue analgesic. After transfer to the ward, all patients were administered 40 mg nefopam mixed with 500 mL normal saline for 8 hours. If the patient's NRS pain score was ≥ 4 points, 10 mg of intravenous nalbuphine was used as a rescue analgesic. Following oral intake, typically 6 hours after surgery, a combination tablet of tramadol (37.5 mg) and acetaminophen (325 mg) was administered as a

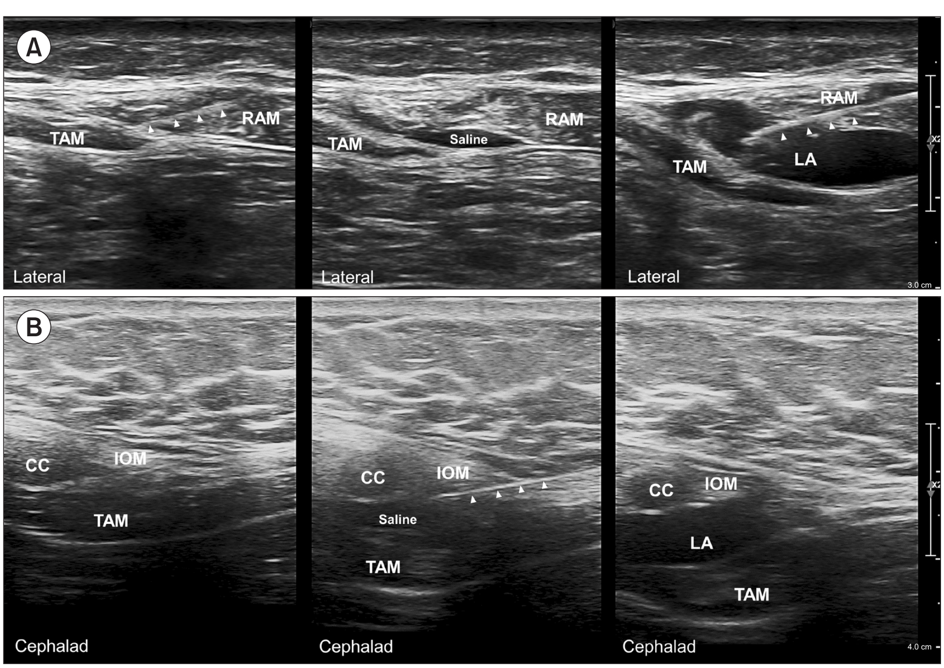

Fig. 1. Ultrasound images of subcostal transversus abdominis plane block (A) and modified thoracoabdominal nerve block through perichondral approach (B). The arrow represents the needle. CC: costal cartilage, LA: local anesthetics, RAM: rectus abdominal muscle, TAM: transversus abdominis muscle, IOM: internal oblique muscle.

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rescue analgesic. In cases of moderate-to-severe postoperative nausea and vomiting (PONV), rescue antiemetics were administered either upon request or as per protocol. Patients in the PACU received 10 mg of intravenous metoclopramide, whereas those in the ward were administered 0.3 mg of intravenous ramosetron.

4. Data collection and outcome measures

Demographic and intraoperative data, including age, sex, body mass index, ASA physical status, number of skin incisions for port placement, total port diameter, duration of surgery (min), duration of anesthesia (min), and intraoperative remifentanil consumption (μg), were recorded. A research nurse who was blinded to the patients' group allocation visited the patients at 1, 2, 4, 6, and 12 hours postoperatively and immediately before discharge. The primary outcome was the maximum pain intensity during movement within the first 12 hours postoperatively, which was measured using an 11-point NRS score (0: no pain/10: worst pain). Secondary outcomes included changes in postoperative pain scores at rest and during coughing and movement (measured at 1, 2, 4, 6, and 12 hours postoperatively and immediately before discharge), and the occurrence rate of PONV at 1, 2, 4, 6, and 12 hours postoperatively and immediately before discharge. Patient satisfaction with pain control was evaluated using a 7-point Likert scale (1 = strongly dissatisfied and 7 = strongly satisfied) immediately before discharge. Additionally, the total dose of rescue analgesics converted to an equivalent intravenous fentanyl dose was investigated, based on previous studies [13,14]. The conversion factors for equivalent dose conversion to morphine for nalbuphine and tramadol are 1 and 0.1, respectively, and the conversion factor for equivalent dose conversion of morphine to fentanyl is 10. Therefore, 10 mg of intravenous nalbuphine was calculated as 100 μg of intravenous fentanyl, while 37.5 mg of oral tramadol was calculated as 12.5 μg of intravenous fentanyl. The authors also retrospectively investigated analgesic prescriptions from the outpatient clinic 2 weeks after discharge. Surgeons who were unaware of the patients' group assignments routinely prescribed oral ibuprofen to patients who reported moderate or severe pain.

5. Statistical analysis

For sample size calculation, data of 378 patients who underwent LC at Seoul National University Hospital in 2021 were used. The maximum NRS score of these patients was 7 ± 1.6 points during the first 12 hours postoperatively, as reported by the acute pain service team. Thus, assuming that subcostal TAPB reduced the NRS score by 30% within 12 hours after surgery and the minimal clinically important difference of the NRS score was 1.7 (maximum NRS scores were Subcostal TAPB 5 ± 2, TAPA 3.3 ± 2) [15], the effect size, calculated using G*Power Version 3.1.9.7 (University of Dusseldorf), was 0.85. To achieve a power of 80% and type 1 error of 0.05, the number of patients required per group was 24. Considering a dropout rate of 20%, the planned recruitment total was 60 patients.

The Shapiro–Wilk test was used to determine the normal distribution of continuous variables. Continuous variables that followed a normal distribution were reported as means ± standard deviations and compared using a two-sample Student's *t*-test. In cases where the distribution was not normal, the median (interquartile range [IQR]) values were reported, and the two independent groups were compared using the Mann–Whitney *U*-test. The chi-square or Fisher's exact test was used to describe categorical data as frequencies or percentages and to compare the two groups based on their expected counts. The generalized estimating equation (GEE) with an autoregressive correlation structure, which is more flexible than repeated-measured analysis of variance, was used to investigate the nonparametric longitudinal variables [16,17]. The variables under investigation included differences in postoperative pain scores, the occurrence of PONV, and the cumulative fentanyl equivalent dose for rescue analgesic between the two groups. These variables were measured at specific time points: 1, 2, 4, 6, and 12 hours postoperatively and immediately before discharge. If the GEE analysis revealed a significant interaction between group and time, subsequently, a post hoc pairwise multiple comparison was conducted using least squares mean with the Bonferroni correction to calculate the adjusted mean difference in pain intensity between the two groups at each time point. Statistical analysis and randomization were performed using R software, version 3.6.1 (R Foundation for Statistical Computing). All hypothesis tests were two-sided, and statistical significance was set at $P < 0.05$.

RESULTS

From April 2022 to February 2023, 75 patients were assessed for eligibility, and 60 patients were randomly allocated to either the M-TAPA or subcostal TAPB group (**Fig. 2**). One patient in the M-TAPA group and two in

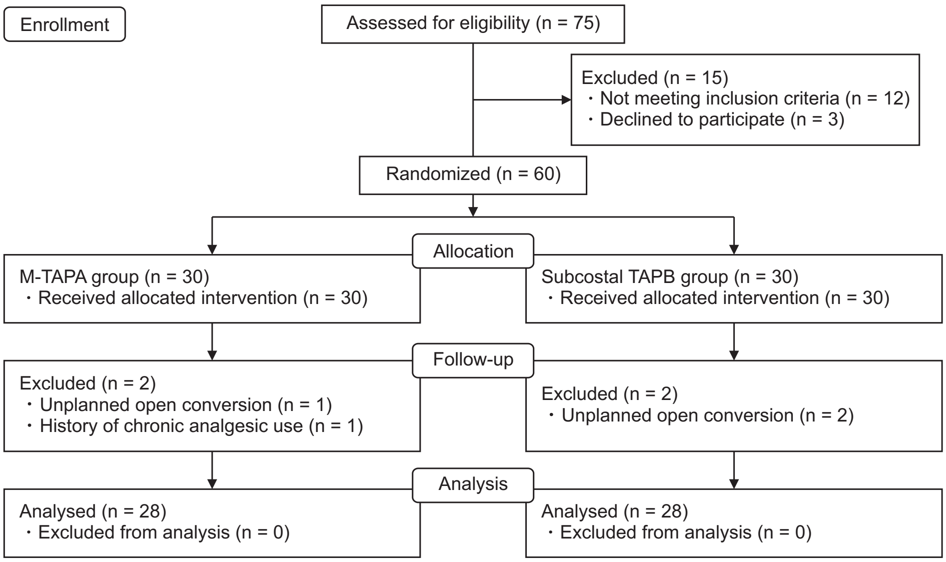

Fig. 2. CONSORT diagram of the study. M-TAPA: modified thoracoabdominal nerve block through the perichondral approach, TAPB: transversus abdominis plane block.

Table 1. Baseline characteristics of the study participants

Characteristics	M-TAPA (n = 28)	Subcostal TAPB (n = 28)	*P* value
Demographic data			
Age (yr)	60.2 ± 10.8	58.4 ± 12.3	0.558
Female	11 (39.3)	15 (53.6)	0.421
Body mass index (kg/m^2)	23.6 ± 3.7	24.2 ± 3.8	0.504
Background medical status			
ASA physical status I/II	12/16 (42.9/57.1)	6/22 (21.4/78.6)	0.153
Operation and anesthesia related			
Skin incision 3/4 holes	27/1 (96.4/3.6)	24/4 (85.7/14.3)	0.349
Total port diameter	22.0 (22.0–24.5)	22.0 (22.0–22.0)	0.623
Duration of surgery (min)	35 (30–46)	30.0 (25–45)	0.523
Duration of anesthesia (min)	55 (50–67)	52.5 (45–65)	0.414
Intraoperative remifentanil use (μg)	232 (199–282)	223 (151–334)	0.999

The values are presented as means ± standard deviations, medians (interquartile ranges), or numbers (%).
ASA: American Society of Anesthesiologists, M-TAPA: modified thoracoabdominal nerve block through perichondral approach, TAPB: transversus abdominis plane block.

the subcostal TAPB group were excluded because of unplanned conversion to open surgery. One patient in the M-TAPA group was excluded after group assignment because of chronic analgesic use for ankylosing spondylitis was discovered. Therefore, the data from 56 patients were included in the final analysis. The baseline characteristics of the two groups were not significantly different, as indicated in **Table 1**.

No significant difference was observed in maximum pain intensity during movement within 12 hours after surgery between the two groups (M-TAPA: 5.5 [IQR: 5–7] *vs*. subcostal TAPB: 5 [IQR: 4–7], median difference: 0, 95% confidence interval [CI]: –1 to 1, P = 0.580) (**Fig. 3**).

Figs. 4–6 show the comparisons of pain intensities at rest, during coughing, and during movement between the two groups. Both pain intensities at rest and during coughing showed significant group-time interactions in the GEE analysis (P = 0.017, P = 0.004, respectively). However, the subsequent post hoc analysis only showed a significant difference in pain intensity during coughing at 4 hours postoperatively (M-TAPA: 4.00 [0.32] *vs*. subcostal TAPB: 2.82 [0.28], mean difference: 1.14, corrected 95% CI: 0.02–2.27, P = 0.007). Finally, during the study period, GEE analysis revealed significant effects of time (P < 0.001) on pain intensity during movement but no significant effect of group (P = 0.639) or group-time interaction (P = 0.064).

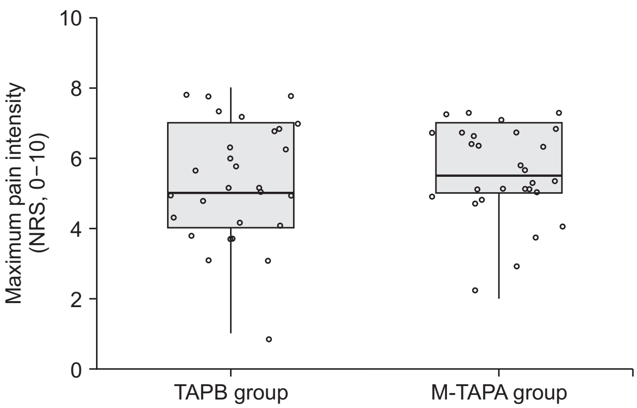

Fig. 3. Comparison of maximum pain intensity during movement within the first 12 hours postoperatively between the two groups. The box plot represents the median and interquartile range of the NRS in the M-TAPA and subcostal TAPB groups during the study period. The upper whisker represents the maximum value, whereas the lower whisker represents the minimum value, excluding outliers. The scatter plot, indicated by round symbols, displays individual data points. M-TAPA: modified thoracoabdominal nerve block through the perichondral approach, NRS: numeric rating scale, TAPB: transverse abdominis plane block.

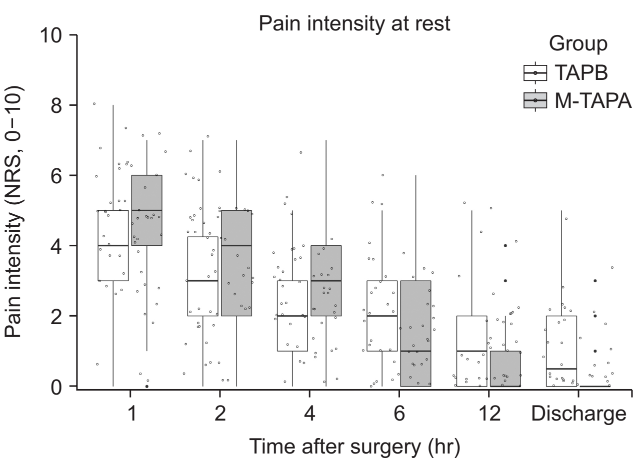

Fig. 4. Comparisons of pain intensity at rest between the two groups. The box plot represents median and interquartile range of the NRS in the M-TAPA and subcostal TAPB groups during the study period. The upper whisker represents the maximum value, whereas the lower whisker represents the minimum value, excluding outliers. The scatter plot, indicated by round symbols, displays individual data points. M-TAPA: modified thoracoabdominal nerve block through the perichondral approach, NRS: numeric rating scale, TAPB: transverse abdominis plane block.

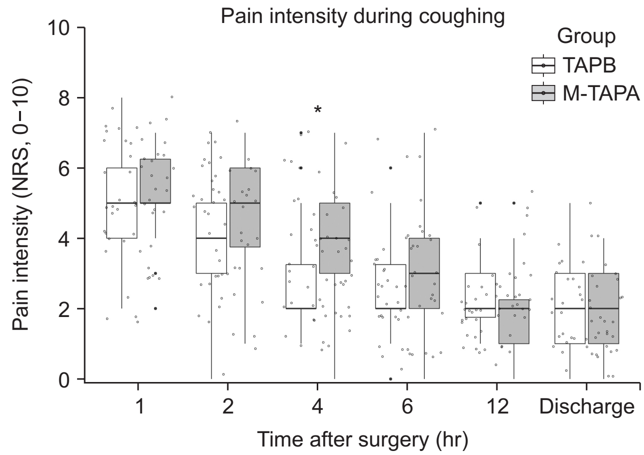

Fig. 5. Comparisons of pain intensity during coughing between the two groups. The box plot represents the median and interquartile range of the NRS in the M-TAPA and subcostal TAPB groups during the study period. The upper whisker represents the maximum value, whereas the lower whisker represents the minimum value, excluding outliers. The scatter plot, indicated by round symbols, displays individual data points. The asterisk represents a significant difference between the two groups in the *post-hoc* analysis. M-TAPA: modified thoracoabdominal nerve block through the perichondral approach, NRS: numeric rating scale, TAPB: transverse abdominis plane block.

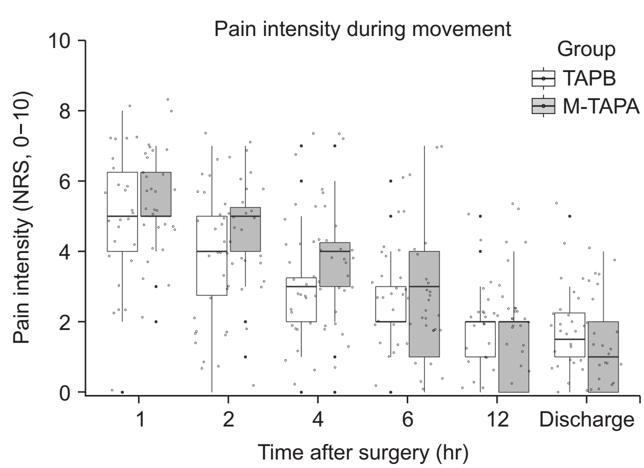

Fig. 6. Comparisons of pain intensity during movement between the two groups. The box plot represents the median and interquartile range of the NRS in the M-TAPA and subcostal TAPB groups during the study period. The upper whisker represents the maximum value, whereas the lower whisker represents the minimum value, excluding outliers. The scatter plot, indicated by round symbols, displays individual data points. M-TAPA: modified thoracoabdominal nerve block through the perichondral approach, NRS: numeric rating scale, TAPB: transverse abdominis plane block.

Table 2. Detailed information of postoperative nausea or vomiting and cumulative fentanyl equivalent dose between the M-TAPA and subcostal TAPB groups

Other postoperative outcomes	M-TAPA (n = 28)	Subcostal TAPB (n = 28)
Overall postoperative nausea or vomiting during postoperative hospital stay	13 (46.4)	12 (42.9)
1 h postoperatively	9 (32.1)	7 (25.0)
2 h postoperatively	5 (17.9)	5 (17.9)
4 h postoperatively	1 (3.6)	3 (10.7)
6 h postoperatively	3 (10.7)	2 (7.1)
12 h postoperatively	3 (10.7)	1 (3.6)
At discharge	2 (7.1)	1 (3.6)
Rescue fentanyl equivalent dose during postoperative hospital stay (μg)	50 (0–50)	50 (0–50)
Rescue analgesic use during postoperative hospital stay	18 (64.3)	15 (53.6)
Intravenous fentanyl 50 μg	14 (50.0)	13 (46.4)
Intravenous nalbuphine 10 mg	2 (7.1)	4 (14.3)
Oral tramadol/acetaminophen tablet	3 (10.7)	2 (7.1)

The values are presented as medians (interquartile ranges) or numbers (%).
M-TAPA: modified thoracoabdominal nerve block through perichondral approach, TAPB: transversus abdominis plane block.

Table 3. Comparison of patient satisfaction with pain control between the M-TAPA and subcostal TAPB groups

Patient satisfaction	M-TAPA (n = 28)	Subcostal TAPB (n = 28)	*P* value
Patient satisfaction with pain control			0.195
Very satisfied	7 (25.0)	9 (32.1)	
Satisfied	13 (46.4)	7 (25.0)	
Slightly satisfied	8 (28.6)	8 (28.6)	
Neutral	0 (0.0)	3 (10.7)	
Slightly dissatisfied	0 (0.0)	1 (3.6)	
Dissatisfied	0 (0.0)	0 (0.0)	
Very dissatisfied	0 (0.0)	0 (0.0)	

The values are presented as numbers (%).
M-TAPA: modified thoracoabdominal nerve block through perichondral approach, TAPB: transversus abdominis plane block.

GEE analysis indicated significant effects of time (P = 0.012) on the occurrence of PONV but no significant effect of group (P = 0.842) and group-time interaction (P = 0.531). It also indicated significant effects of time (P < 0.001) on the cumulative fentanyl equivalent dose for rescue analgesia but no significant effect of group (P = 0.560) and group-time interaction (P = 0.410). Detailed information regarding the occurrence of PONV and rescue analgesic use is presented in **Table 2**. There was no significant group difference in satisfaction with pain control (**Table 3**). All patients were discharged on the morning of postoperative day 1. One patient in each group complained of moderate to severe pain and was prescribed analgesics during the outpatient visit at 2 weeks after discharge.

DISCUSSION

The aim of this study was to compare the analgesic effects of M-TAPA and subcostal TAPB in patients who underwent LC. The results showed that both techniques were useful in providing satisfactory analgesia compared to patients who did not receive regional analgesia at the authors' institution. However, no significant difference in the analgesic effect of the two techniques was observed, which was unexpected and contradicted the initial hypothesis.

One possible explanation for this finding is that the increase in pain intensity due to the right lateral port incision may not have been significant because most patients underwent LC *via* the three-port technique, where the right lateral port measured only 5 mm. This finding is consistent with that of previous studies reporting that the port size is significantly associated with postoperative pain intensity [18]. The authors' institution routinely uses the three-port technique to minimize postoperative pain, and recent meta-analyses have reported better analgesic outcomes using this technique [19]. Another possible explanation for these results is that, as subcostal TAPB covers a part of the lateral abdominal wall, it may provide pain relief for incisions made through the right lateral port [20]. Moreover, as the authors' institution ensures that the right lateral port is located close to the lateral margin of the rectus abdominis muscle, the advantage of M-TAPA in blocking the lateral abdominal wall may not have provided an additive analgesic effect compared with subcostal TAPB. Additionally, the M-TAPA method may not have been able to effectively address incisional pain in the lateral abdominal wall. A recent pilot study reported that M-TAPA did not provide sufficient coverage of this area [21].

Despite these unexpected results, this study showed that both the M-TAPA and subcostal TAPB might be effective analgesic techniques for LC, which is consistent with observations of previous studies investigating the analgesic effect of subcostal TAPB in the same surgery [22]. As outlined in the Methods section, patients undergoing LC at the authors' institution without regional analgesia had an average maximum NRS score of 7 points within 12 hours postoperatively, indicating severe postoperative pain. Moreover, a previous study at the authors' institution revealed that patients who underwent three-port LC experienced better pain-related outcomes than those who underwent single-incision robotic cholecystectomy or LC; however, the average pain intensity on postoperative day 1 was moderate [23]. Conversely, the results of this study may suggest that both analgesic techniques would be effective in providing satisfactory analgesia.

Among several abdominal interfascial plane blocks, subcostal TAPB and M-TAPA were selected, as they required less time to perform compared to other blocks, such as ESP and QL blocks, which need to be implemented in the lateral decubitus position. Although regional analgesia is an effective method for postoperative pain control, the time required for its implementation can be a major obstacle to its clinical adoption [24,25]. This time constraint may be particularly challenging for institutions like that of the authors, where the preoperative procedure room has not yet been activated. Moreover, interfascial plane blocks closer to epidural space, such as ESP and QL blocks, will likely have a visceral analgesic effect due to epidural spread. However, their visceral analgesic effect is still controversial [26,27], and several meta-analyses have reported a comparable analgesic effect between subcostal TAPB and other interfascial plane blocks [28–30]. Further, a recent meta-analysis reported that subcostal TAPB was associated with the greatest reduction in pain intensity at 12 hours postoperatively and PONV among various regional analgesic techniques [6]. Hence, these two techniques, that can be performed in the supine position while inducing anesthesia, were selected. Neither technique prolonged the anesthesia time, except for the operation time, and showed a satisfactory analgesic effect.

This study has some limitations. First, the findings may have limited generalizability as they were obtained from a single institution. Second, although this investigation focused on postoperative pain intensity and opioid-related side effects, which are important factors affecting the overall quality of recovery, they may not be sufficient to fully assess the multidimensional quality of recovery. Additionally, because of the authors' institutional practice, patients undergoing LC were discharged on the morning of the 1st postoperative day, less than 24 hours after surgery, which prevented us from investigating patient-reported outcomes beyond patient satisfaction, such as the Quality of Recovery-15 questionnaire. Third, differences in experience may have impacted the effectiveness of the two methods. The authors had considerable experience with subcostal TAPB; however, they did not have as much experience with M-TAPAs. Additionally, there was one correspondence that reported technical difficulties with M-TAPA [31]. Fourth, administration of rescue analgesics might have influenced the primary outcome, maximum pain intensity. Therefore, the authors aimed to provide detailed information on this issue, and they found no significant difference in the rescue fentanyl equivalent dose between the two groups. Finally, as this study was designed based on the hypothesis that there would be a significant difference between the two techniques, the non-significant results do not demonstrate that the effects of the two techniques are equal or that the effect of one technique is non-inferior to the other.

In conclusion, although M-TAPA was expected to provide a better analgesic effect than subcostal TAPB by covering the incisional pain caused by the right lateral port, this study showed no significant difference in the analgesic effect between the two techniques. This study indicated the need for further studies comparing the effectiveness of M-TAPA with other regional analgesic techniques.

DATA AVAILABILITY

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request and with permission of the Institutional Review Board of Seoul National University Hospital.

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CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

AUTHOR CONTRIBUTIONS

Hye-Yeon Cho: Writing the initial draft. In Eob Hwang: Data/evidence collection. Mirang Lee: Data/evidence collection. Wooil Kown: Critical review, commentary or revision. Won Ho Kim: Critical review, commentary or revision. Ho-Jin Lee: Supervision.

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