

Research Article

A Comparison of Analgesic Effect between Preoperative and Postoperative Transversus Abdominis Plane (TAP) Blocks for Different Durations of Laparoscopic Gynecological Surgery

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Aim. This study aims to compare the postoperative analgesia between preoperative and postoperative ultrasound-guided transversus abdominis plane (TAP) blocks for different durations of laparoscopic gynecological surgery. **Methods.** A total of 120 patients, ASA I-III, 18–65 years of age, were divided randomly into 2 groups: preoperative TAP group (pre-TAP group) and postoperative TAP group (post-TAP group). Patients in the pre-TAP group ($n = 60$) and post-TAP group ($n = 60$) received bilateral TAP blocks of 0.375% ropivacaine, 40 mL, preoperatively and postoperatively, respectively. Duration of surgery, postoperative pain score, consumption of analgesics, and postoperative nausea and vomiting (PONV) during the first 24 h postoperatively were recorded. **Results.** For all the patients in the two groups, similar analgesia was obtained with no statistical difference. The same results were found in duration of surgery < 180 min. Meanwhile, patients undergoing surgery > 180 min in the post-TAP group obtained lower postoperative pain score, lower analgesics consumption, and higher satisfaction score than those in the pre-TAP group. **Conclusion.** Postoperative TAP block could offer better postoperative analgesia than preoperative TAP block for patients undergoing surgery > 180 min. No difference was found in analgesia effect between preoperative TAP block and postoperative TAP block for patients undergoing surgery < 180 min.

1. Introduction

There are several methods to offer postoperative analgesia for abdominal surgery, oral analgesics, patient-controlled intravenous analgesia (PCIA), patient-controlled epidural analgesia (PCEA), and regional nerve block [1–3].

PCEA plays a direct role in the near operative region and possesses a more immediate analgesic mechanism; thus, it could offer fast, clear, and accurate analgesic effect and reduce the use of opioids. PCEA seems to be an ideal method for postoperative pain control; it could be demonstrated to have a good postoperative analgesic effect in many common operations such as abdominal and gynecological surgeries [3, 4]. PCIA acts on the whole body through intravenous analgesics with relatively longer and more rapid analgesic effect with the PCA device. It has the advantages of simple operation and a wide range of drug uses, including the

narcotic analgesics and nonsteroidal anti-inflammatory drugs. PCIA is applicable to pain, postoperative pain, wound pain, after-burn pain, and inflammatory pain [5, 6].

However, the side effects of PCEA and PCIA are also notable [4, 7]. PCEA might cause low blood pressure, pruritus, paresthesia, nausea, and vomiting, and PCIA could cause itching and respiratory depression due to the inevitable use of opioids [4, 7, 8]. At the same time, with the development of laparoscopic minimally invasive surgery, the surgical incision is reduced, and the postoperative pain is not as strong as open surgery [2, 9–11].

In view of the shortcomings of PCEA and PCIA, nerve block has the advantages of less trauma, less impact on systemic circulation, no inhibition of the respiratory center, and relief of nausea and vomiting [2, 9, 12, 13]. Transversus abdominis plane (TAP) block is a regional technique for analgesia of the anterolateral abdominal wall [14] and may

offer good analgesia on abdominal surgery, especially gynecologic surgery [15–18]. TAP block seems to be an interesting alternative in patients with, for example, severe obesity, where epidural or spinal anesthesia/analgesia is technically difficult and/or poses a risk [19–21].

Previous studies showed that it was inconsistent to determine the optimal time on TAP for patients undergoing surgeries. Some investigators recommended that TAP be performed before surgery [17, 20, 22], some preferred postoperative performance [15, 16, 23, 24], and others found that there was no difference between the two time points.

Till now, there have been no report to show the analgesic effect of TAP on patients undergoing surgeries of different duration. We aimed to compare analgesia between preoperative and postoperative TAP blocks for different duration of laparoscopic gynecological surgery.

2. Materials and Methods

This prospective, randomized, single-blind clinical trial was approved by the ethics committee of the Second Hospital of Dalian Medical University and clinical trials registration number is ChiCTR1900027881.

2.1. Patient Population. We assumed that the difference in consumption of postoperative analgesics between groups was 20%; thus, at least 58 patients should be recruited in each group. For convenience, we planned to recruit 60 patients in each group.

The inclusion criteria were planned as follows:

- (1) ASA I-III
- (2) 18–65 years of age
- (3) Patients scheduled for laparoscopic gynecological surgery under general anesthesia in the Second Hospital of Dalian Medical University

The exclusion criteria were planned as follows:

- (1) Patients with history of chronic pain therapy during the past half year
- (2) Addiction (including opioids and benzodiazepines)
- (3) Allergy to prescription medications
- (4) Psychological disorders
- (5) Pregnancy
- (6) Any contraindication to TAP block
- (7) Refusal of consent

2.2. Procedure. After signing the written consent, all the patients were allocated into 2 groups randomly, pre-TAP group and post-TAP group. Heart rate (HR), blood pressure (BP), saturation of oxygen (SpO₂), and bispectral index (BIS) were monitored and data collected every 5 minutes. All the patients received standard general anesthesia. Induction of general anesthesia was induced using 0.03 mg/kg Midazolam (Jiangsu Nhwa Pharmaceutical Co., Ltd., Xuzhou, China), 0.3 μg/kg Sufentanil (Yichang Humanwell Pharmaceutical

Co., Ltd., Yichang, China), 0.3 mg/kg Etomidate (Jiangsu Nhwa Pharmaceutical Co., Ltd., Xuzhou, China), and 0.3 mg/kg Cisatracurium (Jiangsu Hengrui Medicine Co., Ltd., Jiangsu, China). Following intubation, maintenance of general anesthesia was total intravenous anesthesia including propofol (4–12 mg/kg/h), remifentanyl, and dexmedetomidine. The dosage was determined by the anesthesiologist according to keeping BIS at the scope 50 ± 5, systolic blood pressure (SBP) was controlled within 20% of the base value, and the mean arterial blood pressure (MBP) was not lower than 65 mmHg. Cisatracurium was added at 0.05 mg/kg according to the requirements of surgeons. Crystals and colloidal liquid solutions are used for volume displacement, and all aspects of anesthesia management are performed by the anesthesiologist in accordance with current clinical practice. The tidal volume was set at 6–8 ml/kg, respiratory rate was set at 12 breaths/min, and end-expiratory partial pressure of carbon dioxide (CO₂) was maintained at 35–45 mmHg. Dizocine (10 mg) and Ramosetron 0.3 mg were given intravenously 30 minutes before the end of surgery. If HR was lower than 45 bpm or higher than 120 bpm, we intravenously injected atropine 0.5–1 mg and esmolol 0.5 mg/kg, respectively; if BP was lower than 80% of basic value or SBP was higher than 160 mmHg, we administered norepinephrine 8–12 ug/min and nicardipine 2–10 ug/kg/min, respectively.

After induction of anesthesia, patients in the pre-TAP group received USG bilateral TAP block with 0.375% ropivacaine (Beijing Taide Pharmaceutical Co., Ltd., Beijing, China), 20 mL each side, before incision and patients in the post-TAP group were given same medications after the end of surgery and before extubation. After extubation, patients were transferred to postanesthesia care unit (PACU). When patients reached the criteria of leaving PACU, they could be transferred to ward. At ward, patients would be asked for the pain score, which was visual analogue scale (VAS) at 0, 2, 6, 12, and 24 h postoperatively. Flurbiprofen axetil (Jiangsu Hengrui Medicine Co., Ltd., Jiangsu, China), 50 mg intravenously, used as postoperative analgesic should be given if VAS was more than or equal 4.

2.3. Outcome Measures. Vital signs including HR, RR, BP, SpO₂, and BIS value were recorded every five minutes from entrance to operating room to leaving the PACU. Consumption of opioids during surgery, consumption of postoperative analgesics, times of rescue, which means times of postoperative analgesics demanding, duration of surgery, pain score at 0, 2, 6, 12, and 24 h postoperatively, mean duration of first analgesic demanding after surgery, postoperative nausea and vomiting (PONV), and satisfaction scores of patients and surgeons were also recorded.

VAS of 0 indicated no pain. VAS of 10 meant an ultimate pain. The VAS of patients was measured by a researcher who did not know this study. Degree of PONV was measured with a categorical scoring system (none = 0; mild = 1; moderate = 2; severe = 3). Satisfaction score ranges from 0 to 10, and 0 means totally unsatisfactory, while 10 means totally satisfactory. Duration of surgery was regrouped to three

subgroups: subgroup S, in which duration of surgery was <90 mins; subgroup M, in which duration of surgery was 90–180 mins; and subgroup L, in which duration of surgery was >180 mins. Only the patients were blinded to the group assignment.

2.4. Statistical Analysis. GraphPad Prism version 5 (GraphPad Software, Inc.) was used for data analysis. Demographic data was analyzed by chi-square test and *t*-test. Haemodynamic data, pain score and consumption of analgesics and opioids, were analyzed by repeated-measures analysis of variance and post hoc pairwise comparison for different stages of anesthesia. $P < 0.05$ was considered to have a statistically significant difference.

3. Results

3.1. Subject Characteristics. We totally recruited 132 patients. 3 patients were deleted because they refused to cooperate postoperatively, 7 patients were excluded because they were changed from laparoscopic surgeries to open ones during the surgeries, and 2 patients were deleted because of being diagnosed as retroperitoneal tumor during surgeries and they received abdominal surgery instead of gynecological surgery. Thus, finally we recruited 60 patients in each group.

There was no significant difference in gender, height, weight, ASA status, and duration of surgery between the two groups (Table 1). There was also no significant difference in cases, height, weight, and ASA status among the three subgroups (Table 2).

3.2. Clinical Results. No difference was found in vital signs between pre-TAP group and post-TAP group; and no severe accident happened.

There was no significant difference in postoperative pain score between pre-TAP group and post-TAP group (Figure 1).

In subgroup L, VAS in the pre-TAP group was higher than that in the post-TAP group at 0, 2, and 6 hours postoperatively (2.0 ± 1.3 versus 0.5 ± 0.7 , 2.5 ± 1.3 versus 1.0 ± 0.8 , and 3.1 ± 1.5 versus 1.6 ± 1.3 , respectively) with significant difference, $P < 0.01$ (Figure 2). No statistical difference in postoperative pain score was found in subgroup S and subgroup M between the pre-TAP group and post-TAP group.

Data in Table 3 show that, for all the patients recruited, there was no difference in duration of first rescue, times of rescue, and satisfaction scores of patients and surgeons between the pre-TAP group and post-TAP group. Consumption of opioids (remifentanyl) in the pre-TAP group was significantly lower than that in the post-TAP group (269.7 ± 86.4 versus 324.6 ± 136.4 , $P = 0.03$). Degree of PONV in the pre-TAP group was lower than that in the post-TAP group (0.5 ± 0.8 versus 0.8 ± 0.9 , $P = 0.03$).

In the three subgroups, consumption of opioids and degree of PONV in the pre-TAP group were lower than those in the post-TAP group with statistical difference. For

TABLE 1: Demographic data.

	Pre-TAP ($n = 60$)	Post-TAP ($n = 60$)	<i>P</i>
Age (Y)	44.6 ± 11.3	46.4 ± 10.4	0.93
ASA I	51	52	0.98
ASA II	9	8	0.98
BMI (kg/m^2)	24.5 ± 3.6	24.5 ± 3.6	0.87
Duration (min)	133.4 ± 68.2	132.5 ± 71.6	0.74

ASA: American Society of Anesthesiologists.

subgroup S and subgroup M, no statistical difference was found in duration of first rescue, times of rescue, and satisfaction scores of patients and surgeons between pre-TAP and post-TAP groups. Meanwhile, in subgroup L, duration of first rescue in the pre-TAP group was lower than that in the post-TAP group (3.4 ± 2.8 h versus 11.0 ± 1.8 h, $P = 0.01$). Times of rescue in the pre-TAP group was 1.0 ± 0.5 , which was significantly lower than that in the post-TAP group (0.5 ± 0.5) with $P = 0.03$. Patients in the pre-TAP group gave higher satisfaction score compared to their counterparts in the post-TAP group (7.4 ± 0.9 versus 8.8 ± 1.0), and the difference was significant ($P = 0.04$) (see Table 4).

4. Discussion

This was the first study to compare postoperative analgesia effect between pre-TAP and post-TAP blocks for different duration of surgeries.

Previous studies showed that it was inconsistent to determine the optimal time on TAP for patients undergoing surgeries. Some investigators recommended that TAP be performed before surgery [17, 20, 22]. Mansouri et al. found that bilateral intrapleural block performed before cardiac surgery could get better analgesia than postoperative manipulation due to preemptive analgesia [25]. Niraj et al. obtained same results in patients undergoing open appendectomy [26]. Some researchers concluded that the analgesic effect of TAP block performed postoperatively was prior to emergence from anesthesia [15, 16, 23, 24]. McDonnell et al. found that the sensory block produced by lidocaine 0.5% receded over 4 to 6 hours, which was supported by magnetic resonance imaging studies that showed a gradual reduction in contrast in the transversus abdominis plane over time. French et al. reported that general anesthesia with postoperative supplementary bilateral ultrasound-guided TAP blocks was chosen to reduce the requirements for postoperative opioids and the risk of postoperative respiratory depression [27, 28]. Meanwhile other clinicians like Fibla et al. found that blocking time did not seem to affect postoperative pain scores [29].

In our study, for all the patients in pre-TAP and post-TAP groups, no difference was found in postoperative pain score, which was similar to the results of previous studies [29, 30]. In subgroups, no difference was found in subgroup S and subgroup M between pre-TAP and post-TAP group. Meanwhile, in subgroup L, postoperative scores in pre-TAP groups were significantly lower than those in post-TAP group at 0, 2, and 6 hours postoperatively, and the duration

TABLE 2: Demographic data of subgroups.

	Group S: <90 min			Group M: 90–180 min			Group L: >180 min		
	Pre-TAP	Post-TAP	<i>P</i>	Pre-TAP	Post-TAP	<i>P</i>	Pre-TAP	Post-TAP	<i>P</i>
Case	22	21	1	19	20	1	19	19	1
Age (Y)	45.9 ± 11.4	45.6 ± 10.7	0.92	39.8 ± 11.5	49.6 ± 9.3	0.33	47.2 ± 10.2	44.2 ± 10.4	0.88
ASA I	18	18	1	16	17	0.95	17	17	1
ASA II	4	3	0.95	3	3	1	2	2	1
BMI (kg/m ²)	25.0 ± 3.8	23.6 ± 2.6	0.19	24.5 ± 3.9	25.4 ± 4.7	0.38	24.0 ± 3.1	24.6 ± 3.0	0.78
Duration (min)	54 ± 19	56 ± 18	0.55	126 ± 23	122 ± 25	0.66	221 ± 31	226 ± 40	0.13

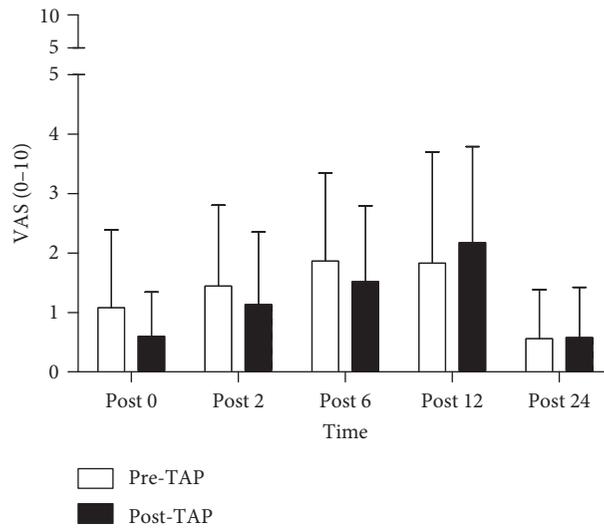


FIGURE 1: Postoperative pain scores of the pre-TAP group and post-TAP group. No significant difference was found.

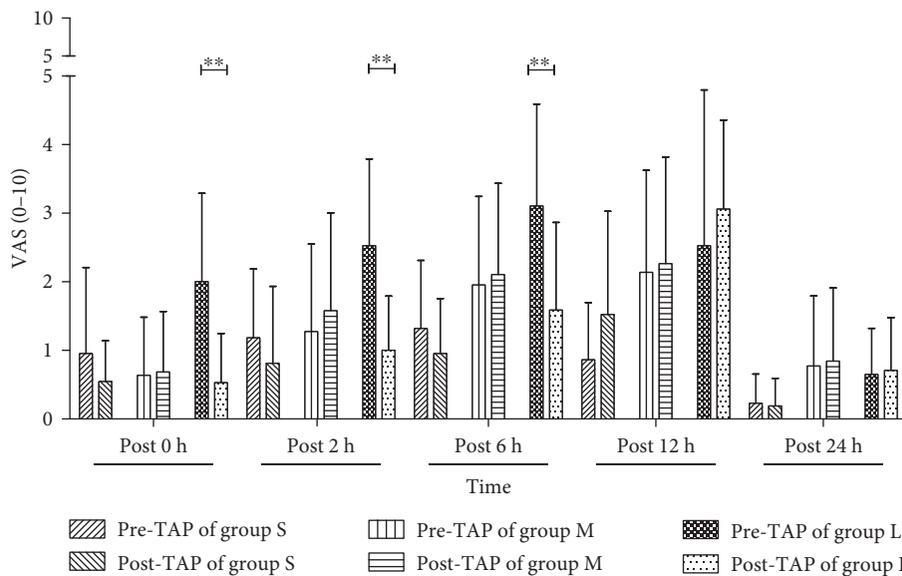


FIGURE 2: Postoperative pain score in subgroups. In group L, VAS in the pre-TAP group was higher than that in the post-TAP group at 0, 2, and 6 hours postoperatively. ***P* < 0.01.

of first rescue was 4.4 hours postoperatively in pre-TAP group and 8.0 hours postoperatively in post-TAP group. The above results indicate that the analgesic effect of bilateral

TAP of 0.375% ropivacaine began to fade at about 4 hours after manipulation and began to disappear at about 8 hours after manipulation. This block duration in our study also

TABLE 3: Clinical data of all the patients.

	Pre-TAP	Post-TAP	<i>P</i>
Duration of first rescue (h)	5.1 ± 5.5	7.2 ± 4.8	0.56
Times of rescue	0.5 ± 0.6	0.5 ± 0.6	0.90
Degree of PONV	0.5 ± 0.8	0.8 ± 0.9	0.03*
Remifentanyl (ug/kg.min)	269.7 ± 86.4	324.6 ± 136.4	0.03*
Satisfaction score of patients	8.5 ± 1	7.8 ± 0.8	0.78
Satisfaction score of surgeons	9.1 ± 0.8	8.9 ± 0.9	0.88

**P* < 0.05.

TABLE 4: Clinical data of subgroups.

	Subgroup S: <90 min			Subgroup M: 90–180 min			Subgroup L: >180 min		
	Pre-TAP	Post-TAP	<i>P</i>	Pre-TAP	Post-TAP	<i>P</i>	Pre-TAP	Post-TAP	<i>P</i>
Duration of first rescue (h)	6.5 ± 7.6	5.3 ± 5.3	0.23	5.2 ± 4.7	5.8 ± 4.2	0.57	4.4 ± 2.8	8.0 ± 1.8	0.01*
Times of rescue	0.4 ± 0.5	0.3 ± 0.5	0.33	0.5 ± 0.5	0.7 ± 0.7	0.32	1.0 ± 0.5	0.5 ± 0.5	0.03*
Degree of PONV	0.4 ± 0.8	0.6 ± 0.9	0.04*	0.5 ± 0.9	0.7 ± 0.7	0.04*	0.6 ± 0.8	1.3 ± 1.0	0.02*
Remifentanyl (ug/kg.min)	189.0 ± 28.8	239.0 ± 36.9	0.04*	279 ± 66.5	313.8 ± 163.2	0.04*	338.9 ± 95.5	404.3 ± 116.8	0.02*
Satisfaction score of patients	9.1 ± 0.8	9.0 ± 0.9	0.87	8.9 ± 1.2	8.8 ± 1.0	0.78	7.4 ± 0.9	8.8 ± 1.0	0.04*
Satisfaction score of surgeons	8.8 ± 1.0	8.8 ± 0.9	0.76	8.9 ± 0.8	8.9 ± 0.9	0.82	8.6 ± 1.0	8.8 ± 0.9	0.23

**P* < 0.05.

explains why no difference was found in subgroup S and subgroup M between pre-TAP and post-TAP groups. The durations of surgery in subgroup S and subgroup M were <2 hours, which indicates that the analgesic effect of bilateral TAP of 0.375% ropivacaine had not begun to fade yet. But this block duration was shorter than that in Stoving et al.'s study, approximately 10 hours with large variation [31]. Although the concentration was the same in these two studies, difference of block duration might be due to the different pharmaceutical factory. From the above results, we might conclude that it was necessary to decide the time of TAP block according to the duration of surgery.

In our study, the consumption of opioids and dosage of remifentanyl in pre-TAP group were significantly lower than those in post-TAP group (269.7 ± 86.4 versus 324.6 ± 136.4 ug/kg.min, *P* = 0.03). The same results happened in all the subgroups. In subgroup S, subgroup M, and subgroup L, patients in pre-TAP group consumed less remifentanyl compared to their counterparts in post-TAP group with statistical difference. This result showed that pre-TAP block could offer better analgesia than postoperative manipulation due to preemptive analgesia, which leads to the lower intraoperative consumption of opioids. This result was also consistent with studies from Mansouri [25] and Niraj et al. [26]. However, in subgroup L, patients in pre-TAP group consumed less postoperative analgesics compared to their counterparts in post-TAP group. This difference might be due to the fact that the block duration of bilateral TAP of 0.375% ropivacaine was 4–8 hours after manipulation. The lower pain score and lower consumption of rescue could be the reason why in subgroup L patients in post-TAP group got higher satisfaction score compared to their counterparts in post-TAP group.

The degree of PONV in pre-TAP group was lower than that in post-TAP group, and the same results happened in all the subgroups. This might be due to the lower consumption

of opioids in pre-TAP group. This result was consistent with Shin et al.'s study [30].

5. Conclusion

It was necessary to decide the time of TAP block according to the duration of surgery. For patients undergoing laparoscopic gynecological surgery, preoperative TAP block was recommended for duration of surgery <180 min for lower consumption of intraoperative opioids, while postoperative TAP block was better than preoperative manipulation for duration of surgery >180 min, which might obtain lower postoperative pain score, less postoperative analgesics, and higher satisfaction score. Further research is warranted to investigate whether the TAP block technique can be improved by optimizing dose and technique-related factors.

Data Availability

All the underlying data supporting the results of this study can be found in IRB of the Second Hospital of Dalian Medical University.

Disclosure

Meiyu Wei and Ming Liu are the co-first authors.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

Authors' Contributions

Meiyu Wei and Ming Liu contributed equally to this work.

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References

- [1] S. Hashiguchi, "PCEA and IVPCA for acute postoperative pain management," *Masui*, vol. 59, no. Suppl, pp. S49–S53, 2010.
- [2] P. Lirk, J. Thiry, M.-P. Bonnet, G. P. Joshi, and F. Bonnet, "Pain management after laparoscopic hysterectomy: systematic review of literature and PROSPECT recommendations," *Regional Anesthesia & Pain Medicine*, vol. 44, no. 4, pp. 425–436, 2019.
- [3] M. B. Rodríguez-Campoó, A. Curto, M. González, and C. Aldecoa, "Patient intermittent epidural boluses (PIEB) plus very low continuous epidural infusion (CEI) versus patient-controlled epidural analgesia (PCEA) plus continuous epidural infusion (CEI) in primiparous labour: a randomized trial," *Journal of Clinical Monitoring and Computing*, vol. 33, no. 5, pp. 879–885, 2019.
- [4] P. Tian, X. Fu, Z. J. Li, and X. L. Ma, "Comparison of patient-controlled epidural analgesia and patient-controlled intravenous analgesia after spinal fusion surgery: a meta-analysis of randomized controlled trials," *BMC Musculoskelet Disord*, vol. 16, p. 388, 2015.
- [5] L. Han, Y. Su, H. Xiong et al., "Oxycodone versus sufentanil in adult patient-controlled intravenous analgesia after abdominal surgery," *Medicine*, vol. 97, no. 31, p. e11552, 2018.
- [6] S. Guo, G. Duan, J. Wang, X. Chi, L. Zhang, and X. Zhang, "Comparison of sufentanil-tramadol PCIA between laparoscopic cholecystectomy and gynecological laparoscopy," *Zhonghua Wai Ke Za Zhi*, vol. 53, no. 2, pp. 150–154, 2015.
- [7] S. Baranovic, B. Maldini, M. Milosevic, R. Golubic, and T. Nikolic, "Peripheral regional analgesia with femoral catheter versus intravenous patient controlled analgesia after total knee arthroplasty: a prospective randomized study," *Collegium Antropologicum*, vol. 35, no. 4, pp. 1209–1214, 2011.
- [8] S. H. Kim, Y.-S. Shin, Y. J. Oh, J. R. Lee, S. C. Chung, and Y. S. Choi, "Risk assessment of postoperative nausea and vomiting in the intravenous patient-controlled analgesia environment: predictive values of the Apfel's simplified risk score for identification of high-risk patients," *Yonsei Medical Journal*, vol. 54, no. 5, pp. 1273–1281, 2013.
- [9] M. Zhou, L. Wang, C. Wu et al., "Efficacy and safety of different doses of dezocine for preemptive analgesia in gynecological laparoscopic surgeries: a prospective, double blind and randomized controlled clinical trial," *International Journal of Surgery*, vol. 37, no. Suppl 1, pp. 539–545, 2017.
- [10] E. M. Sandberg, A. R. H. Twijnstra, S. R. C. Driessen, and F. W. Jansen, "Total laparoscopic hysterectomy versus vaginal hysterectomy: a systematic review and meta-analysis," *Journal of Minimally Invasive Gynecology*, vol. 24, no. 2, pp. 206–217, 2017.
- [11] J. Joo, H. K. Moon, and Y. E. Moon, "Identification of predictors for acute postoperative pain after gynecological laparoscopy (STROBE-compliant article). *Medicine (Baltimore)*," vol. 98, no. 42, p. e17621, 2019.
- [12] X. Wang, W. Liu, Z. Xu et al., "Effect of dexmedetomidine alone for intravenous patient-controlled analgesia after gynecological laparoscopic surgery," *Medicine (Baltimore)*, vol. 95, no. 19, p. e3639, 2016.
- [13] E. J. Ahn, G. J. Choi, H. Kang, C. W. Baek, Y. H. Jung, and Y. C. Woo, "Comparison of ramosetron with palonosetron for prevention of postoperative nausea and vomiting in patients receiving opioid-based intravenous patient-controlled analgesia after gynecological laparoscopy," *BioMed Research International*, vol. 2017, Article ID 9341738, , 2017.
- [14] H. C. Tsai, T. Yoshida, T. Y. Chuang et al., "Transversus abdominis plane block: an updated review of anatomy and techniques," *Biomed Res Int*, vol. 2017, Article ID 8284363, 2017.
- [15] J. Y. Yap, M. Bhat, W. McMullen, and K. Ragupathy, "Novel use of laparoscopic-guided TAP block in total laparoscopic hysterectomy," *Journal of Obstetrics and Gynaecology*, vol. 38, no. 5, p. 736, 2018.
- [16] F. W. Abdallah, S. H. Halpern, and C. B. Margarido, "Transversus abdominis plane block for postoperative analgesia after Caesarean delivery performed under spinal anaesthesia? a systematic review and meta-analysis," *British Journal of Anaesthesia*, vol. 109, no. 5, pp. 679–687, 2012.
- [17] K. K. Khan and R. I. Khan, "Analgesic effect of bilateral subcostal tap block After laparoscopic cholecystectomy," *Journal of Ayub Medical College, Abbottabad*, vol. 30, no. 1, pp. 12–15, 2018.
- [18] M. Shahait and D. I. Lee, "Application of TAP block in laparoscopic urological surgery: current status and future directions," *Current Urology Reports*, vol. 20, no. 5, p. 20, 2019.
- [19] J. Ruiz-Tovar, E. Albrecht, A. Macfarlane, and F. Coluzzi, "The TAP block in obese patients: pros and cons," *Minerva Anestesiologica*, vol. 85, no. 9, pp. 1024–1031, 2019.
- [20] J. Jakobsson, L. Wickerts, S. Forsberg, and G. Ledin, "Transversus abdominal plane (TAP) block for postoperative pain management: a review," *F1000Research*, vol. 4, 2015.
- [21] B. Pirrera, V. Alagna, A. Lucchi et al., "Transversus abdominis plane (TAP) block versus thoracic epidural analgesia (TEA) in laparoscopic colon surgery in the ERAS program," *Surgical Endoscopy*, vol. 32, no. 1, pp. 376–382, 2018.
- [22] A. Özdilek, Ç. A. Beyoğlu, Ç. Demirdağ et al., "Perioperative analgesic effects of preemptive ultrasound-guided subcostal transversus abdominis plane block for percutaneous nephrolithotomy: a prospective, randomized trial," *Journal of Endourology*, vol. 34, no. 4, pp. 434–440, 2020.
- [23] A. Kupiec, J. Zwierzchowski, J. Kowal-Janicka et al., "The analgesic efficiency of transversus abdominis plane (TAP) block after caesarean delivery," *Ginekologia Polska*, vol. 89, no. 8, pp. 421–424, 2018.
- [24] N. Ma, J. K. Duncan, A. J. Scarfe, S. Schuhmann, and A. L. Cameron, "Clinical safety and effectiveness of transversus abdominis plane (TAP) block in post-operative analgesia: a systematic review and meta-analysis," *Journal of Anesthesia*, vol. 31, no. 3, pp. 432–452, 2017.
- [25] M. Mansouri, K. Bageri, E. Noormohammadi, M. Mirmohammadsadegi, A. Mirdehgan, and A. G. Ahangaran, "Randomized controlled trial of bilateral intrapleural block in cardiac surgery," *Asian Cardiovascular and Thoracic Annals*, vol. 19, no. 2, pp. 133–138, 2011.
- [26] G. Niraj, A. Searle, and M. Mathews, "Analgesic efficacy of ultrasound-guided transversus abdominis plane block in patients undergoing open appendectomy," *British Journal of Anaesthesia*, vol. 4, pp. 601–605, 2011.
- [27] J. G. McDonnell, B. D. O'Donnell, T. Farrell et al., "Transversus abdominis plane block," *Regional Anesthesia and Pain Medicine*, vol. 32, no. 5, pp. 399–404, 2007.
- [28] J. L. H. French, J. McCullough, P. Bachra, and N. M. Bedforth, "Transversus abdominis plane block for analgesia after

- caesarean section in a patient with an intracranial lesion,” *International Journal of Obstetric Anesthesia*, vol. 18, no. 1, pp. 52–54, 2009.
- [29] J. J. Fibla, L. Molins, J. M. Mier, A. Sierra, and G. Vidal, “A prospective study of analgesic quality after a thoracotomy: paravertebral block with ropivacaine before and after rib spreading,” *European Journal of Cardio-Thoracic Surgery*, vol. 36, no. 5, pp. 901–905, 2009.
- [30] H.-J. Shin, S. T. Kim, K. H. Yim, H. S. Lee, J. H. Sim, and Y. D. Shin, “Preemptive analgesic efficacy of ultrasound-guided transversus abdominis plane block in patients undergoing gynecologic surgery via a transverse lower abdominal skin incision,” *Korean Journal of Anesthesiology*, vol. 61, no. 5, pp. 413–418, 2011.
- [31] K. Stoving, C. Rothe, C. V. Rosenstock, E. K. Aasvang, L. H. Lundstrom, and K. H. Lange, “Cutaneous sensory block Area, muscle-relaxing effect, and block duration of the transversus abdominis plane block: a randomized, blinded, and placebo-controlled study in healthy volunteers,” *Regional Anesthesia and Pain Medicine*, vol. 40, no. 4, pp. 355–362, 2015.