İstanbul Med J 2026; 27(1): 44-9
DOI: 10.4274/imj.galenos.2026.68638

Which is The Best Timing for Ultrasound-Guided Transversus Abdominis Plane Block During Laparoscopic Cholecystectomy: Preoperative or Postoperative?

Vildan Kölükçü[1], Ahmet Tuğrul Şahin[1], Mehtap Gürler Balta[1], Ali Genç[1], Bülent Koca[2]

[1]Tokat Gaziosmanpaşa University Faculty of Medicine, Department of Anesthesiology and Reanimation, Tokat, Türkiye
[2]Tokat Gaziosmanpaşa University Faculty of Medicine, Department of General Surgery, Tokat, Türkiye

ABSTRACT

Introduction: In biliary operations, laparoscopic techniques have largely replaced traditional methods; cholecystectomy is among the most common. Despite being minimally invasive, this procedure still poses a notable challenge in managing postoperative pain. This study aims to examine the impact of administering the transversus abdominis plane (TAP) block either before or after surgery on pain levels and hemodynamic responses in patients undergoing laparoscopic cholecystectomy.

Methods: A total of 75 cases were retrospectively reviewed, all of whom had undergone a laparoscopic cholecystectomy and received a bilateral TAP block under ultrasound guidance. Participants were divided into two cohorts: the TAP block was administered to Group 1 before surgery and to Group 2 after surgery. Evaluated variables included demographic data, numerical pain scales, hemodynamic indicators, patient-controlled analgesia (PCA) device utilization, opioid requirements, and postoperative symptoms.

Results: Group 1 consisted of 35 patients. American Society of Anesthesiologists grading, body mass index, surgery length, and demographic characteristics such as age and sex were statistically similar in both patient groups. Intraoperative hemodynamic parameters were also similar ($p>0.05$). The amount of remifentanil administered during surgery was considerably greater in those assigned to Group 2 ($p=0.001$). Pain intensity assessed at 0 and 1 hours after surgery was markedly lower in Group 1 than in Group 2 ($p<0.05$). No statistically significant difference in PCA usage was found between the groups ($p>0.05$). Nevertheless, patients in Group 2 required considerably more opioid analgesics in addition to PCA at postoperative hours 0 and 1 ($p=0.036$ and $p=0.040$, respectively). Furthermore, nausea occurred more frequently in Group 2 at the second postoperative hour ($p=0.040$).

Conclusion: This study demonstrates that preoperative TAP block administration during laparoscopic cholecystectomy reduces intraoperative opioid requirements, lowers early postoperative pain scores, and decreases the need for additional postoperative opioid analgesia compared with postoperative TAP block administration.

Keywords: Transversus abdominis plane block, laparoscopic cholecystectomy, postoperative analgesia

Introduction

Because it is less invasive and offers quicker recovery than open procedures, laparoscopic cholecystectomy is now the most widely adopted method in biliary surgery (1). Persistent postoperative pain represents a substantial barrier to optimal early recovery, and when poorly addressed, it can lead to long-term complications, including chronic pain syndromes and prolonged hospitalization (2). The current standard of care for postoperative pain management is multimodal analgesia, which includes non-steroidal anti-inflammatory drugs (NSAIDs), opioids, and regional nerve blocks (3). Although opioids are potent analgesics, their use is limited by adverse effects, including itching, respiratory depression, nausea, and vomiting (4). Likewise, NSAIDs are linked to significant complications such as cardiac issues, kidney impairment, and gastrointestinal problems (5). In this context, regional nerve blocks provide multiple benefits, such as reducing dependence on systemic analgesics and decreasing complications associated with their use. Additionally, these blocks contribute to maintaining hemodynamic stability, promoting early mobilization and discharge, enhancing patient satisfaction, and reducing overall hospital costs (6).

In 2001, Rafi (7) described the transversus abdominis plane (TAP) block as a method of regional anesthesiain which local anesthetic is delivered into the fascial space between the internal oblique and transversus abdominis muscles. The injection is guided by identifying the anatomical landmark referred to as the triangle of Petit. This approach primarily targets the

Address for Correspondence: Asst. Prof., Vildan Kölükçü, MD, Tokat Gaziosmanpaşa University Faculty of Medicine, Department of Anesthesiology and Reanimation, Tokat, Türkiye
E-mail: vildankolukcu@gmail.com **ORCID ID:** orcid.org/0000-0002-3914-3899

Cite this article as: Kölükçü V, Şahin AT, Gürler Balta M, Genç A, Koca B. Which is the best timing for ultrasound-guided transversus abdominis plane block during laparoscopic cholecystectomy: preoperative or postoperative? İstanbul Med J. 2026; 27(1): 44-9

Received: 24.09.2025
Accepted: 07.01.2026
Publication Date: 02.02.2026

anterior branches of thoracic nerves T7-T12 and the first lumbar nerve (8). As ultrasound (US)-guided techniques have become more common in clinical practice, the TAP block has proven effective in minimizing opioid requirements during and after surgeries such as laparotomy, appendectomy, cesarean delivery, and laparoscopic cholecystectomy (9). The duration of pain relief provided by the TAP block can last up to 24 hours and varies depending on the type of anesthetic agent administered (10). Although it can be applied at different points in the perioperative period, existing research offers limited insight into the optimal timing for its administration.

This study explores how the timing of US-guided TAP block administration at different perioperative stages influences intraoperative hemodynamic stability, opioid requirements, postoperative pain levels, and total analgesic consumption in patients undergoing laparoscopic cholecystectomy.

Methods

Compliance with Ethical Standards

The study was approved by the Ethics Committee of Tokat Gaziosmanpaşa University (approval number: 25-MOBAEK-001, date: 07.01.2025).

Study Design

The study retrospectively examined individuals who underwent laparoscopic cholecystectomy between January 1 and December 30, 2024, and who received bilateral TAP blocks under US guidance for postoperative pain control, in addition to receiving patient-controlled analgesia (PCA). Data were retrieved from the institutional hospital database. Only patients aged 18-75 years and classified as American Society of Anesthesiologists (ASA) class I-III were included in the study.

Patients were grouped according to when the TAP block was applied.

In Group 1, the bilateral TAP block was administered following endotracheal intubation but before the surgical procedure began.

In Group 2, the bilateral TAP block was administered immediately after the surgical procedure and just prior to extubation.

Additional regional anesthetic techniques, including spinal or epidural anesthesia, were not employed in any patient.

The primary endpoint of the study was the assessment of pain levels during the first 24 hours after surgery. Pain assessment was performed using the numeric rating scale (NRS) (11). In cases where the NRS score was 5 or higher, an NSAID was administered as the first-line additional analgesic. If pain persisted, a rescue analgesic consisting of 50 mg of intravenous tramadol was administered. All patients who received rescue analgesia were recorded. Pain management after abdominal surgery is routinely performed in this manner at our institution.

Secondary outcomes included intraoperative hemodynamic parameters, intraoperative opioid consumption, postoperative hemodynamic data within 24 hours, PCA usage metrics, additional opioid requirements, and postoperative nausea and vomiting.

Researchers analyzed and contrasted the primary and secondary outcomes observed in each group.

TAP Block Technique and Pain Management

In this study, all patients received bilateral TAP blocks under US-guidance via a lateral approach. The procedures were performed by experienced anesthesiologists. According to our institutional protocol, TAP blocks were administered using 0.25% bupivacaine (Buvasin 0.5%, Vem İlaç, Türkiye), with 20 mL injected on each side, for a total of 40 mL of local anesthetic per patient. All patients included in the study underwent the standard procedure used in our routine clinical practice. Each patient received intravenous paracetamol (1 g) and dexketoprofen (50 mg) before extubation. Following extubation, a standardized PCA device was connected to each patient. After extubation, all patients received postoperative analgesia via a PCA pump prepared according to the standard procedure of our clinic. The content of the PCA bag consisted of 300 mg (6 mL) of tramadol diluted with normal saline to a total volume of 150 mL (2 mg/mL tramadol). According to the PCA protocol, patients could receive a 20-mg bolus of tramadol upon request without a continuous background infusion. The daily dose was capped at 400 mg, and the lockout interval was set at 20 minutes. Both pain intensity scores and PCA usage statistics were recorded using the institution's standardized pain monitoring form.

Exclusion Criteria

Participants were excluded if they had missing data, used the PCA device improperly, had known opioid dependence or tolerance, had the laparoscopic procedure converted to an open procedure, had a history of abdominal surgery, underwent emergency procedures, required intraoperative blood transfusion or inotropic agents, or had preexisting hepatic or renal dysfunction.

Statistical Analysis

The statistical analyses were performed using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA). The normality of continuous data was assessed through the Shapiro-Wilk test. Data conforming to a normal distribution were presented as mean ± standard deviation, while non-normally distributed variables were described using medians with their corresponding minimum and maximum values. Categorical variables were summarized as frequencies and percentages.

Depending on the distribution characteristics, different statistical tests were employed for group comparisons. Variables with a normal distribution were analyzed using the independent t-test, whereas variables that did not follow a normal distribution were analyzed using the Mann-Whitney U test. For categorical comparisons, either Fisher's exact test or Pearson's chi-square test was applied as appropriate.

Results

The study population comprised 75 individuals, 35 of whom were assigned to Group 1. No statistically significant differences were observed between the groups with respect to ASA status, body mass index, duration of surgery, patient age, and gender distribution ($p>0.05$) (Table 1). No

substantial variation in intraoperative heart rate or in mean arterial pressure was observed between the two groups (p>0.05) (Graphic 1). Regarding intraoperative remifentanil consumption, the mean values were 86.11±153 mcg in Group 1 and 446.7±632 mcg in Group 2, indicating significantly higher consumption in Group 2 (p=0.001).

Statistical analysis revealed a clear disparity in postoperative pain levels across the study cohorts. At rest, Group 2 reported considerably pain levels than Group 1 at both the immediate (0-hour) and 1-hour time points following surgery (p<0.001 and p=0.005, respectively; Table 2). A similar pattern was observed during coughing, where Group 2 again reported higher pain scores at the same time intervals (p<0.001 and p=0.006, respectively; Table 3). No statistically significant differences were identified between the groups at subsequent time points, either at rest or during coughing (p>0.05).

Analysis of PCA-device data revealed comparable results across groups in terms of analgesic request frequency, bolus administrations, and total analgesic use during the first 24 hours (p>0.05; Table 4).

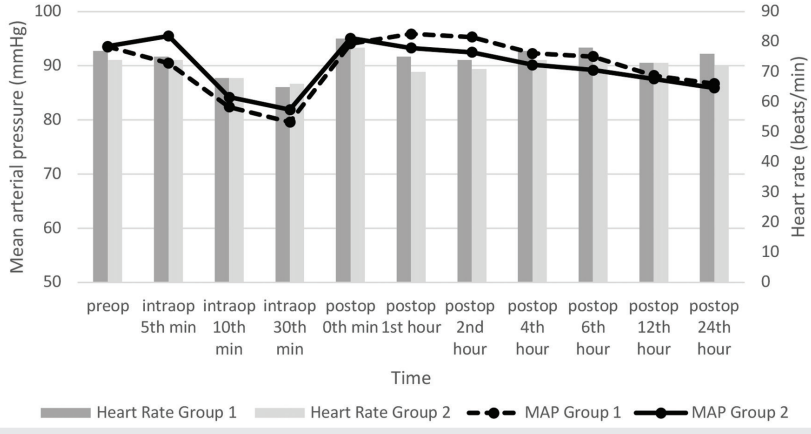
However, analysis of additional opioid administration beyond PCA revealed that patients in Group 2 had significantly higher opioid requirements at 0 and 1 hours postoperatively (p=0.036 and p=0.040, respectively; Table 5).

Assessment of nausea and vomiting following surgery indicated a higher incidence of nausea in Group 2 at the second hour (p=0.040; Table 6). Despite this, no significant difference between groups was observed in the frequency of postoperative vomiting (p>0.05).

Table 1. Demographic characteristics and duration of surgery

	Group 1	Group 2	p
Age (years)	50.9±16.1	45.2±15.4	0.126[a]
Sex (male/female)	21 (60%)/14 (40%)	16 (40%)/24 (60%)	0.084[b]
BMI (kg/m^2)	27.27±2.86	26.93±2.49	0.562[a]
ASA 1	6 (17%)	5 (12.5%)	0.510[b]
2	20 (57%)	28 (70%)	
3	9 (26%)	7 (17.5%)	
Duration of surgery (minimum)	79.9±16.4	75.1±18.3	0.235[a]

Data are presented as mean ± standard deviation or number of patients (%). [a]Independent samples t-test; [b]Pearson chi-square test
BMI: Body mass index, ASA: American Society of Anesthesiologists



Graphic 1. Intergroup comparison of mean arterial pressure and heart rate

Table 2. Intergroup comparison of numeric rating scales at rest

	Group 1	Group 2	p[a]
0th hour	3.00 (0–7)	4.00 (0–10)	**<0.001***
1st hour	3.00 (0–7)	4.00 (1–9)	**0.005***
2nd hour	3.00 (0–7)	3.00 (0–9)	0.532
4th hour	2.00 (0–7)	2.00 (0–6)	0.790
6th hour	1.00 (0–5)	2.00 (0–5)	0.278
12th hour	1.00 (0–5)	1.00 (0–5)	0.409
24th hour	0.00 (0–4)	1.00 (0–5)	0.061

*Significant difference at <0.05 level according to Mann-Whitney U test, Data are presented as median (min-max), [a]Mann-Whitney U test

Table 3. Intergroup comparison of numeric rating scales at cough

	Group 1	Group 2	p[a]
0th hour	4.00 (0–8)	5.00 (0–10)	**<0.001***
1st hour	4.00 (0–8)	5.00 (1–9)	**0.006***
2nd hour	4.00 (0–8)	4.00 (0–9)	0.444
4th hour	3.00 (0–8)	3.00 (0–7)	0.897
6th hour	2.00 (0–6)	2.00 (0–6)	0.527
12th hour	2.00 (0–7)	2.00 (0–6)	0.427
24th hour	2.00 (0–5)	2.00 (0–6)	0.172

*Significant difference at <0.05 level according to Mann-Whitney U test, Data are presented as median (min-max), [a]Mann-Whitney U test

Table 4. Comparison of patient-controlled analgesia usage data between groups

	Group 1	Group 2	p[a]
Number of demands	18.34±10.99	19.75±10.52	0.573
Number of boluses	10.83±5.08	11.55±3.96	0.493
Requested dose (mg)	361.14±211.76	395.0±210.43	0.490
Delivered dose (mg)	213.71±101.83	228.5±81.88	0.488

All values expressed as mean ± standard deviation, [a]Independent samples t-test

Table 5. Comparison of the number of patients receiving additional intravenous rescue opioids

	Group 1 (n=35)	Group 2 (n=40)	p
0 hour	3 (8.6%)	11 (27.5%)	**0.036**[a]
1st hour	2 (5.7%)	9 (22.5%)	**0.040**[a]
2nd hour	1 (2.9%)	2 (5.0%)	0.637[a]
2–4 hours	1 (2.9%)	1 (2.5%)	0.924[a]
4–8 hours	0	1 (2.5%)	0.346[a]
8–16 hours	1 (2.9%)	0	0.467[b]
16–24 hours	1 (2.9%)	1 (2.5%)	0.924[a]

[a]Pearson chi-square test, [b]Fisher's exact test

Table 6. Comparison of the number of patients experiencing postoperative nausea between groups

	Group 1 (n=35)	Group 2 (n=40)	p
0th hour	3 (8.6%)	8 (20.0%)	0.163[a]
1st hour	2 (5.7%)	5 (12.5%)	0.438[b]
2nd hour	2 (5.7%)	9 (22.5%)	**0.040**[a]
4th hour	1 (2.9%)	2 (5.0%)	0.637[a]
6th hour	2 (5.7%)	2 (5.0%)	0.891[a]
12th hour	4 (11.4%)	3 (7.5%)	0.699[b]
24th hour	1 (2.9%)	0	0.467[b]

[a]Pearson chi-square test, [b]Fisher's exact test

Discussion

Our findings suggest that administering a bilateral TAP block under US guidance at different time points notably affects early postoperative outcomes after laparoscopic cholecystectomy. Individuals who received a TAP block before surgery reported lower pain levels at 0 and 1 hour after the operation, compared with those who received the block postoperatively. Moreover, patients in the preoperative TAP block group required significantly less remifentanil during surgery. In addition, the use of intravenous rescue opioids was markedly reduced in this group.

TAP block is an essential component of multimodal analgesic strategies for laparoscopic abdominal surgery. Previous research has shown that it is superior to control groups, providing better pain relief and reducing the need for postoperative analgesics after abdominal surgery. By reducing opioid consumption, the TAP block helps mitigate undesirable side effects associated with opioids (12). Although TAP blocks are commonly employed in abdominal surgeries, the ideal timing for their application remains a subject of debate among researchers. Depending on institutional practice and surgical planning, the block may be administered at various time points. Previous literature indicates that TAP block administration is feasible at various stages, including before induction of general anesthesia, immediately before the skin incision while under general anesthesia, or immediately after the surgical procedure while the patient remains under general anesthesia (13). Other studies have also explored the effectiveness of TAP block when applied at different time intervals during spinal anesthesia (14). This investigation categorized patients into two cohorts: one received the TAP block after endotracheal intubation and before surgery began; the other received it after the operation, prior to extubation.

Delivering analgesia in advance of surgical trauma, referred to as preemptive analgesia, may help diminish postoperative pain severity by limiting central nervous system sensitization and decreasing pain signal transmission from peripheral sites. Nonetheless, the existing literature offers differing perspectives on the optimal timing for TAP block application. In a meta-analysis by Dost et al. (15), studies of TAP block in laparoscopic cholecystectomy were reviewed; studies in which the block was administered postoperatively showed more favorable outcomes. In contrast, De Oliveira et al. (9) reported in their meta-analysis that application of a preoperative TAP block led to lower early postoperative pain levels and reduced opioid use in laparoscopic abdominal procedures. Despite such evidence, few studies have directly examined how the timing of TAP block affects outcomes within the same patient cohort. For example, Rahimzadeh et al. (16) conducted a comparative analysis of TAP block timings in laparoscopic cholecystectomy and reported that postoperative pain levels and opioid consumption did not vary meaningfully across TAP block timings. On the other hand, Dirican et al. (17) reported that performing the TAP block postoperatively alleviated early postoperative pain in women who underwent total abdominal hysterectomy. Although another study comparing TAP block timings showed no significant difference in early postoperative pain, it noted that patients who underwent the procedure before the surgical incision experienced less pain after the second postoperative hour (18). Another study involving inguinal hernia surgery also demonstrated superior early pain control in the pre-incisional TAP block group (19). Consistent with previous research, the current analysis revealed a clear reduction in early postoperative pain among individuals who underwent a preoperative TAP block. Differences in results reported across studies may be attributed to variations in local anesthetic type and dosage. For example, Rahimzadeh et al. (16) used a different local anesthetic from that used in our study, while Amr and Amin (18) administered a higher dose; these differences may explain the differing outcomes. Although Dirican et al. (17) used a similar dosage, we believe that variations in surgical duration might have influenced the results. Bhanushree et al. (20) observed that delivering the TAP block before surgery yielded more favorable outcomes than administering it afterward, particularly in abdominal procedures lasting under 180 minutes. Consistent with Shim et al. (19), the surgical duration in our study was relatively short compared with other reports.

Preoperative administration of peripheral nerve blocks is believed to reduce intraoperative opioid requirements by inducing central desensitization (21). In our study, an infusion of remifentanil was employed as part of the anesthetic regimen to counteract stress-induced

hemodynamic responses. Shim et al. (19) reported that remifentanil use during surgery was markedly reduced in patients who received the TAP block prior to incision. Our findings are consistent and show decreased intraoperative remifentanil requirements in the same group. Earlier studies have indicated a correlation between elevated intraoperative remifentanil administration and a heightened requirement for additional postoperative pain relief (22). This phenomenon has been attributed to remifentanil-induced postoperative hyperalgesia. In our study, the higher remifentanil consumption observed in Group 2 may explain the increased requirement for rescue analgesia during the immediate postoperative period. Additionally, as the TAP block contributes to reduced total opioid consumption during laparoscopic cholecystectomy, it may indirectly affect the frequency of postoperative nausea and vomiting. The increased nausea observed during the early postoperative phase in patients who received the TAP block after the surgical incision might be linked to their greater reliance on supplemental opioid analgesics.

Study Limitations

Our study has several limitations. The study was conducted retrospectively, and because the TAP blocks were administered under general anesthesia, the exact level of sensory blockade could not be assessed. Additionally, the study lacked a control group, and the evaluation was limited to the first postoperative day. On the other hand, factors influencing the anesthesia team's preferences for the timing of block administration could not be determined.

Conclusion

Our findings suggest that administering the TAP block before the incision phase in laparoscopic cholecystectomy contributes to reduced intraoperative opioid use, improved early pain control, and reduced need for rescue opioid analgesics compared with its application after the surgical incision. We believe that identifying the optimal timing for its administration and validating it through prospective, randomized studies would make a meaningful contribution to the literature.

Ethics

Ethics Committee Approval: The study was approved by the Ethics Committee of Tokat Gaziosmanpaşa University (approval number: 25-MOBAEK-001, date: 07.01.2025).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions: Surgical and Medical Practices - V.K., A.T.Ş., M.G.B., A.G., B.K.; Concept - V.K., A.T.Ş., M.G.B.; Design - V.K., M.G.B., A.G., B.K.; Data Collection or Processing - V.K., A.T.Ş., M.G.B., A.G., B.K.; Analysis or Interpretation - V.K., A.T.Ş.; Literature Search - V.K., A.G.; Writing - V.K., A.T.Ş., M.G.B., A.G., B.K.

References

1. Alsharari AF, Abuadas FH, Alnassrallah YS, Salihu D. Transversus abdominis plane block as a strategy for effective pain management in patients with pain during laparoscopic cholecystectomy: a systematic review. J Clin Med. 2022; 11: 6896.
2. Kalu R, Boateng P, Carrier L, Garzon J, Tang A, Reickert C, et al. Effect of preoperative versus postoperative use of transversus abdominis plane block with plain 0.25% bupivacaine on postoperative opioid use: a retrospective study. BMC Anesthesiol. 2021; 21: 114.
3. Peng K, Ji FH, Liu HY, Wu SR. Ultrasound-guided transversus abdominis plane block for analgesia in laparoscopic cholecystectomy: a systematic review and meta-analysis. Med Princ Pract. 2016; 25: 237-46.
4. Benyamin R, Trescot AM, Datta S, Buenaventura R, Adlaka R, Sehgal N, et al. Opioid complications and side effects. Pain Physician. 2008; 11: S105-20.
5. Harirforoosh S, Asghar W, Jamali F. Adverse effects of nonsteroidal antiinflammatory drugs: an update of gastrointestinal, cardiovascular and renal complications. J Pharm Pharm Sci. 2013; 16: 821-47.
6. Cardwell TW, Zabala V, Mineo J, Ochner CN. The effects of perioperative peripheral nerve blocks on peri- and postoperative opioid use and pain management. Am Surg. 2022; 88: 2842-50.
7. Rafi AN. Abdominal field block: a new approach via the lumbar triangle. Anaesthesia. 2001; 56: 1024-6.
8. Tsai HC, Yoshida T, Chuang TY, Yang SF, Chang CC, Yao HY, et al. Transversus abdominis plane block: an updated review of anatomy and techniques. Biomed Res Int. 2017; 2017: 8284363.
9. De Oliveira GS Jr, Castro-Alves LJ, Nader A, Kendall MC, McCarthy RJ. Transversus abdominis plane block to ameliorate postoperative pain outcomes after laparoscopic surgery: a meta-analysis of randomized controlled trials. Anesth Analg. 2014; 118: 454-63.
10. Grape S, Kirkham KR, Akiki L, Albrecht E. Transversus abdominis plane block versus local anesthetic wound infiltration for optimal analgesia after laparoscopic cholecystectomy: a systematic review and meta-analysis with trial sequential analysis. J Clin Anesth. 2021; 75: 110450.
11. Nugent SM, Lovejoy TI, Shull S, Dobscha SK, Morasco BJ. Associations of pain numeric rating scale scores collected during usual care with research administered patient reported pain outcomes. Pain Med. 2021; 22: 2235-41.
12. Ergin A, Aydin MT, Çiyiltepe H, Karip AB, Fersahoğlu MM, Özcabi Y, et al. Effectiveness of local anesthetic application methods in postoperative pain control in laparoscopic cholecystectomies; a randomised controlled trial. Int J Surg. 2021; 95: 106134.
13. Escudero-Fung M, Lehman EB, Karamchandani K. Timing of transversus abdominis plane block and postoperative pain management. Local Reg Anesth. 2020; 13: 185-93.
14. Ambooken E, Chirayath JJ, Raghavan P. A comparison of preincisional and postincisional ultrasound guided transversus abdominis plane block. J Anaesthesiol Clin Pharmacol. 2021; 37: 406-10.
15. Dost B, De Cassai A, Balzani E, Geraldini F, Tulgar S, Ahiskalioglu A, et al. Analgesic benefits of pre-operative versus postoperative transversus abdominis plane block for laparoscopic cholecystectomy: a frequentist network meta-analysis of randomized controlled trials. BMC Anesthesiol. 2023; 23: 408.
16. Rahimzadeh P, Faiz SHR, Latifi-Naibin K, Alimian M. A Comparison of effect of preemptive versus postoperative use of ultrasound-guided bilateral transversus abdominis plane (TAP) block on pain relief after laparoscopic cholecystectomy. Sci Rep. 2022; 12: 623.
17. Dirican B, Erdogan M, Ucar M, Uzgul U, Gulhas N, Kayhan G, et al. Comparison of preoperative and postoperative approaches to ultrasound-guided transversus abdominis plane block for postoperative analgesia in total abdominal hysterectomy. Biomedical Research-India. 2017; 28: 1738-42.

18. Amr YM, Amin SM. Comparative study between effect of pre- versus post-incisional transversus abdominis plane block on acute and chronic post-abdominal hysterectomy pain. Anesth Essays Res. 2011; 5: 77-82.

19. Shim JW, Ko J, Lee CS, Lee DS, Park J, Lee HM, et al. Better timing of ultrasound-guided transversus abdominis plane block for early recovery after open inguinal herniorrhaphy: a prospective randomised controlled study. Asian J Surg. 2021; 44: 254-61.

20. Bhanushree G, Krishnamurthy P, Dileep PK, Rohit S. Comparative study of pre-operative ultrasound guided transversus abdominis plane block versus post-operative ultrasound guided transversus abdominis plane block on perioperative hemodynamic status and post operative analgesic requirement in patients undergoing laparoscopic abdominal surgeries. European Journal of Molecular & Clinical Medicine 2022; 9: 2781-9.

21. Xuan C, Yan W, Wang D, Li C, Ma H, Mueller A, et al. Efficacy of preemptive analgesia treatments for the management of postoperative pain: a network meta-analysis. Br J Anaesth. 2022; 129: 946-58.

22. Komatsu R, Turan AM, Orhan-Sungur M, McGuire J, Radke OC, Apfel CC. Remifentanil for general anaesthesia: a systematic review. Anaesthesia. 2007; 62: 1266-80.