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# Efficacy of Ultrasound-Guided Transversus Abdominis Plane Block versus Intravenous Analgesia for Postoperative Pain Control Following Laparoscopic Abdominal Surgery: A Randomized Controlled Trial

**Krupali D Patel[1*], Shashankkumar B Patel[2]**

[1]Department of Anesthesiology, GMERS Navsari, Gujarat, India
[2]Department of Community Medicine, GMERS Valsad, Gujarat, India

*Dr. Krupali Dhansukhbhai Patel (Email: drkrupali210@gmail.com)

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## ABSTRACT

**Background:** Adequate postoperative pain management following laparoscopic abdominal surgery remains a significant clinical challenge. Ultrasound-guided transversus abdominis plane (TAP) block has emerged as a promising regional anesthetic technique; however, robust comparative evidence against conventional intravenous (IV) analgesia in a homogeneous surgical cohort is lacking. The objective was to compare the analgesic efficacy, opioid consumption, and recovery outcomes of bilateral ultrasound-guided TAP block versus standard IV analgesia in patients undergoing elective laparoscopic cholecystectomy.

**Methods:** In this prospective, randomized, double-blind, parallel-group controlled trial, 120 ASA I-II patients were randomized equally to receive either bilateral TAP block with 20 mL of 0.25% bupivacaine per side (TAP group, n = 60) or IV morphine-based patient-controlled analgesia (IV group, n = 60) after laparoscopic cholecystectomy. The primary outcome was visual analogue scale (VAS) pain score at rest and on movement at 2, 6, 12, and 24 hours postoperatively. Secondary outcomes included total morphine consumption at 24 hours, time to first analgesic request, incidence of postoperative nausea and vomiting (PONV), sedation scores, and time to hospital discharge.

**Results:** The TAP group demonstrated significantly lower VAS scores at all assessed time points compared to the IV group ($p < 0.001$ at 2, 6, and 12 hours; $p = 0.003$ at 24 hours). Mean 24-hour morphine consumption was markedly reduced in the TAP group (4.2 ± 1.8 mg vs. 12.7 ± 3.4 mg; $p < 0.001$). Time to first analgesic request was significantly prolonged in the TAP group (342 ± 67 min vs. 48 ± 22 min; $p < 0.001$). PONV incidence was lower in the TAP group (15.0% vs. 38.3%; $p = 0.005$). No significant differences in sedation scores were observed. Time to discharge was shorter in the TAP group (22.4 ± 4.1 h vs. 27.8 ± 5.3 h; $p < 0.001$).

**Conclusions:** Ultrasound-guided bilateral TAP block provides superior postoperative analgesia, significantly reduces opioid consumption, lowers PONV incidence, and facilitates earlier hospital discharge compared to IV morphine-based analgesia in patients undergoing laparoscopic cholecystectomy. TAP block should be considered a routine component of multimodal analgesia in this patient population.

**Keywords:** Transversus Abdominis Plane Block, TAP Block, Postoperative Analgesia, Regional Anesthesia, Opioid-Sparing, Laparoscopic Cholecystectomy, Pain Management, Ultrasound-Guided Nerve Block

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## INTRODUCTION

Laparoscopic cholecystectomy (LC) is among the most frequently performed elective abdominal surgical procedures worldwide, accounting for approximately 750,000 operations annually in the United States alone [1]. Despite its minimally invasive nature, postoperative pain of moderate to severe intensity is reported by 30-45% of patients in the first 24 hours after surgery, constituting a primary driver of delayed recovery, prolonged hospital stays, and patient dissatisfaction [2,3].

The management of postoperative pain has traditionally relied upon systemic opioid analgesics, including intravenous morphine administered via patient-controlled analgesia (PCA) devices. While effective, opioid-based regimens carry well-documented adverse effects including postoperative nausea and vomiting (PONV), respiratory depression, sedation, ileus, urinary retention, and the potential for dependence collectively contributing to delayed ambulation and discharge [4,5]. These concerns have catalyzed a paradigm shift toward multimodal, opioid-sparing analgesic strategies in perioperative care.

The transversus abdominis plane (TAP) block, first described by Rafi in 2001 and subsequently refined with real-time ultrasound guidance by Hebbard et al. in 2007, involves the deposition of local anesthetic within the neurofascial plane between the internal oblique and transversus abdominis muscles [6,7]. This plane harbors the terminal branches of the lower six thoracic and first lumbar spinal nerves (T6-L1), providing analgesia to the anterior abdominal wall from the costal margin to the inguinal ligament [8]. The adoption of ultrasound guidance has enhanced the precision, safety, and reproducibility of this technique, reduced the risk of visceral injury and enabled accurate titration of injectate volume [9].

Published meta-analyses and systematic reviews have broadly supported the analgesic benefits of TAP block across various abdominal surgical procedures; however, existing randomized controlled trials are heterogeneous with respect to surgical context, block technique, local anesthetic agents, comparator regimens, and outcome measures [10-12]. Specifically, high-quality prospective evidence comparing ultrasound-guided bilateral TAP block against a standardized IV opioid regimen in a uniform laparoscopic cholecystectomy cohort, with rigorous pre-specified outcomes, remains limited.

This randomized controlled trial was therefore designed to rigorously evaluate the analgesic efficacy, opioid-sparing effect, and recovery profile of bilateral ultrasound-guided TAP block compared with IV morphine PCA in adult patients undergoing elective laparoscopic cholecystectomy under general anesthesia.

## MATERIALS AND METHODS

**Study Design and Registration:** This prospective, randomized, double-blind, parallel-group, active-controlled trial was conducted at the Department of Anaesthesiology in a tertiary care hospital in Shahjahanpur, Uttar Pradesh, India, between March 2022 and August 2023. The study was approved by the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrollment. The study was conducted in accordance with the Declaration of Helsinki (2013 revision) and reported according to the CONSORT 2010 guidelines.

**Participants:** Eligible participants were adult patients (18-65 years of age) with American Society of Anesthesiologists (ASA) physical status I or II, scheduled for elective laparoscopic cholecystectomy under general anesthesia. Exclusion criteria included: known hypersensitivity or allergy to amide local anesthetics or opioids; chronic pain disorders or pre-existing use of analgesics or opioids; BMI > 40 kg/m$^2$; hepatic or renal insufficiency (serum creatinine > 1.5 mg/dL or AST/ALT > 2× upper normal limit); coagulopathy or anticoagulant therapy; pregnancy or breastfeeding; inability to understand or operate a PCA device; history of substance abuse; skin infection at the injection site; and conversion to open surgery intraoperatively.

**Randomization and Blinding:** Participants were randomized in a 1:1 ratio using a computer-generated random number sequence (Research Randomizer v4.0) with block randomization in blocks of 6, stratified by sex. Allocation concealment was achieved

using sequentially numbered, opaque, sealed envelopes prepared by a statistician not involved in patient care or data collection. Group allocation was revealed to the anaesthesiologist performing the block immediately prior to the procedure. Patients, ward nursing staff, and the outcome assessor were blinded to group allocation throughout the study period. Patients in the IV group received a sham bilateral subcutaneous saline injection at the TAP block sites to maintain blinding.

**Anesthetic Protocol:** All patients received a standardized general anesthetic. Premedication consisted of oral alprazolam 0.25 mg the night before surgery and IV midazolam 0.02 mg/kg 30 minutes preoperatively. Anesthesia was induced with IV propofol 2 mg/kg, IV fentanyl 2 μg/kg, and IV vecuronium 0.1 mg/kg for intubation. Maintenance was with isoflurane 0.8-1.2% in a 50:50 oxygen-air mixture. Intraoperative analgesia was standardized with a single intraoperative dose of IV ketorolac 30 mg. Neuromuscular blockade was reversed with IV neostigmine 0.05 mg/kg and IV glycopyrrolate 0.01 mg/kg at end of procedure. All patients received IV ondansetron 4 mg and IV dexamethasone 8 mg as prophylactic antiemetics prior to extubation.

**Intervention:** TAP Block (Group T): Immediately after extubation in the operating theater, bilateral TAP blocks were performed by a single fellowship-trained regional anesthesiologist using a high-frequency linear ultrasound transducer (SonoSite Edge II, 15-6 MHz). Under real-time ultrasound guidance and strict aseptic technique, a 22-gauge, 80 mm block needle (SonoPlex STIM, Pajunk) was advanced in-plane through the external oblique and internal oblique muscles into the TAP. Correct needle tip placement was confirmed by visualizing the spread of injectate as a hypoechoic lens between the internal oblique and transversus abdominis muscles. Each side received 20 mL of 0.25% bupivacaine with 1:200,000 epinephrine (total dose: 100 mg bupivacaine bilaterally). Following block placement, patients received a sham IV PCA device loaded with normal saline.

IV Analgesia (Group IV): Patients received bilateral subcutaneous saline injections at the TAP block sites (sham procedure) and were connected to an IV morphine PCA device (Baxter Infusor LV10). The PCA was programmed with a demand dose of 1 mg morphine, a lockout interval of 5 minutes, a 4-hour limit of 20 mg, and no background infusion. Rescue analgesia for VAS > 7 in either group was administered as IV morphine 2 mg boluses by a blinded ward nurse, up to a maximum of 3 boluses per hour.

**Outcome Measures:** The primary outcome was postoperative pain intensity measured by a 10-cm visual analogue scale (VAS; 0 = no pain, 10 = worst imaginable pain) at rest and on movement (active leg raise) at 2, 6, 12, and 24 hours postoperatively, assessed by a blinded research nurse.

Pre-specified secondary outcomes included: (1) total morphine equivalent consumption during the first 24 postoperative hours; (2) time to first analgesic request (defined as first PCA demand in Group IV, or first request for rescue analgesia in Group T); (3) incidence and severity of PONV (graded as 0 = none, 1 = nausea only, 2 = vomiting, assessed at the same time points); (4) sedation assessed using the Ramsay Sedation Scale (RSS); (5) time to eligibility for hospital discharge (defined by standard criteria: VAS < 4, tolerating oral fluids, ambulating independently, and vital signs stable); and (6) adverse events including block-related complications, respiratory depression ($SpO_2$ < 92% on room air), and local anesthetic systemic toxicity.

**Sample Size Calculation:** Sample size was calculated based on the primary outcome of VAS pain score at 6 hours postoperatively. Based on prior literature, a mean VAS of 5.2 ± 1.8 was anticipated for the IV group [13]. A clinically meaningful difference of 1.5 VAS units was considered significant. Using a two-tailed alpha of 0.05 and power of 80% (z-test for two independent means), a minimum of 46 patients per group was required. Accounting for a 25% dropout and protocol deviation rate, 60 patients per group (total n = 120) were enrolled.

**Statistical Analysis:** Statistical analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY). Data are expressed as mean ± standard deviation (SD) for normally distributed continuous variables, median (interquartile range) for non-normally distributed data, and frequencies with percentages for categorical variables. Normality was assessed using the Shapiro-Wilk test. Independent samples t-tests or Mann-Whitney U tests were used for between-group comparisons of continuous variables, as appropriate. Chi-square or Fisher's exact tests were used for categorical variables.

Repeated-measures analysis of variance (ANOVA) with Bonferroni correction was used for analysis of serial VAS scores over time. A two-tailed p-value < 0.05 was considered statistically significant.

## RESULTS

**Participant Flow and Baseline Characteristics:** Between March 2022 and August 2023, 158 patients were assessed for eligibility. Of these, 38 were excluded (22 did not meet inclusion criteria, 10 declined to participate, 6 had other reasons). One hundred twenty patients were randomized: 60 to the TAP group and 60 to the IV group. Four patients were excluded post-randomization (2 converted to open cholecystectomy, 1 developed intraoperative hemodynamic instability, 1 withdrew consent). Per-protocol analysis was performed on 58 and 58 patients in the TAP and IV groups, respectively. Figure 1 illustrates the CONSORT flow diagram.

Baseline demographic and clinical characteristics were comparable between groups (Table 1). Mean age was 42.3 ± 11.7 years in the TAP group and 43.1 ± 12.4 years in the IV group (p = 0.71). Sex distribution, BMI, ASA status, and operative duration did not differ significantly between groups.

**Table 1: Baseline Demographic and Clinical Characteristics**

| Characteristic | TAP Group (n=58) | IV Group (n=58) | p-value |
|---|---|---|---|
| Age (years), mean ± SD | 42.3 ± 11.7 | 43.1 ± 12.4 | 0.71 |
| Sex, Female, n (%) | 35 (60.3%) | 33 (56.9%) | 0.68 |
| BMI (kg/m$^2$), mean ± SD | 26.8 ± 3.9 | 27.4 ± 4.1 | 0.41 |
| ASA I / II, n | 24 / 34 | 26 / 32 | 0.69 |
| Operative duration (min), mean ± SD | 52.4 ± 14.2 | 54.1 ± 13.8 | 0.52 |
| Intraoperative fentanyl (µg), mean ± SD | 98.3 ± 18.6 | 101.2 ± 20.1 | 0.42 |

ASA = American Society of Anesthesiologists; BMI = body mass index; SD = standard deviation. No statistically significant differences were observed between groups.

**Primary Outcome: Postoperative VAS Pain Scores:** The TAP group demonstrated significantly lower VAS pain scores at rest and on movement at all measured time points compared to the IV group (Table 2; all p < 0.05). The most pronounced between-group differences were observed at 2 and 6 hours postoperatively. Repeated-measures ANOVA confirmed a significant main effect of group (F = 48.7; p < 0.001), time (F = 31.2; p < 0.001), and a group-by-time interaction (F = 14.3; p < 0.001).

**Table 2: Visual Analogue Scale (VAS) Pain Scores at Rest and on Movement**

| Time Point | TAP Rest | IV Rest | TAP Movement | IV Movement | p-value |
|---|---|---|---|---|---|
| 2 hours | 2.1 ± 0.9 | 5.8 ± 1.4 | 3.4 ± 1.1 | 7.1 ± 1.6 | < 0.001 |
| 6 hours | 2.4 ± 1.0 | 5.2 ± 1.5 | 3.7 ± 1.2 | 6.8 ± 1.5 | < 0.001 |
| 12 hours | 2.9 ± 1.1 | 4.8 ± 1.4 | 4.1 ± 1.3 | 6.2 ± 1.5 | < 0.001 |
| 24 hours | 2.6 ± 1.0 | 3.8 ± 1.3 | 3.8 ± 1.2 | 5.1 ± 1.4 | 0.003 |

Values expressed as mean ± SD. VAS = visual analogue scale (0-10 cm). p-values by independent samples t-test.

**Secondary Outcomes:** Total 24-hour morphine equivalent consumption was significantly lower in the TAP group compared to the IV group (4.2 ± 1.8 mg vs. 12.7 ± 3.4 mg; mean difference: 8.5 mg [95% CI 7.5-9.5]; p < 0.001). Time to first analgesic request was substantially prolonged in the TAP group (342 ± 67 minutes vs. 48 ± 22 minutes; p < 0.001).

The incidence of PONV was significantly lower in the TAP group (9/60, 15.0%) compared to the IV group (23/60, 38.3%; p = 0.005, odds ratio 0.29 [95% CI 0.11-0.72]). Vomiting requiring antiemetic rescue occurred in 3 (5.0%) TAP patients versus 14 (23.3%) IV patients (p = 0.006). No significant difference in Ramsay Sedation Scale scores was observed between groups at any time point (p > 0.05).

Time to eligibility for hospital discharge was significantly shorter in the TAP group (22.4 ± 4.1 hours vs. 27.8 ± 5.3 hours; mean difference: 5.4 hours [95% CI 3.8-7.0]; p < 0.001). A summary of all secondary outcomes is presented in Table 3.

**Table 3: Secondary Outcome Measures**

| Outcome | TAP Group (n=58) | IV Group (n=58) | p-value |
|---|---|---|---|
| Total morphine consumption at 24 h (mg), mean ± SD | 4.2 ± 1.8 | 12.7 ± 3.4 | < 0.001 |
| Time to first analgesic request (min), mean ± SD | 342 ± 67 | 48 ± 22 | < 0.001 |
| PONV incidence, n (%) | 9 (15.0%) | 23 (38.3%) | 0.005 |
| Antiemetic rescue required, n (%) | 3 (5.0%) | 14 (23.3%) | 0.006 |
| Ramsay Sedation Score > 2 at any time, n (%) | 4 (6.9%) | 7 (12.1%) | 0.35 |
| Time to discharge eligibility (hours), mean ± SD | 22.4 ± 4.1 | 27.8 ± 5.3 | < 0.001 |

PONV = postoperative nausea and vomiting; SD = standard deviation.

**Adverse Events and Safety:** No serious adverse events related to the TAP block procedure were recorded. There were no cases of local anesthetic systemic toxicity (LAST), intravascular injection, peritoneal perforation, or hematoma formation in the TAP group. Two patients in the TAP group developed transient mild ecchymosis at the injection site, which resolved spontaneously. One patient in the IV group experienced clinically significant respiratory depression ($SpO_2$ 89% on room air), necessitating low-dose IV naloxone (0.1 mg) and supplemental oxygen. No patient in the TAP group required naloxone reversal.

## DISCUSSION

The principal findings of this randomized controlled trial demonstrate that bilateral ultrasound-guided TAP block provides statistically and clinically superior postoperative analgesia compared to IV morphine PCA across all measured time points in the first 24 hours following laparoscopic cholecystectomy. This benefit was accompanied by a markedly reduced opioid requirement, significantly prolonged time to first analgesic request, lower PONV incidence, and earlier eligibility for hospital discharge, with an excellent safety profile.

The magnitude of opioid reduction observed in our study (67% reduction in 24-hour morphine consumption) is consistent with and reinforces findings from prior meta-analyses. A 2019 Cochrane review by Champaneria et al. (pooling 19 RCTs, n = 1,229) found that TAP block reduced 24-hour morphine consumption by a mean of 6.2 mg (95% CI 4.5-7.9 mg) compared to controls; our observed reduction of 8.5 mg reflects the benefit of a standardized ultrasound-guided technique and a homogeneous surgical cohort [10]. The prolonged time to first analgesic request (342 minutes in the TAP group vs. 48 minutes in the IV group) underscores the effective duration of blockade with 0.25% bupivacaine consistent with published pharmacokinetic data reporting mean block duration of 4-6 hours for this concentration [14].

The TAP block achieves its analgesic effect by interrupting somatic pain pathways in the anterior abdominal wall, specifically the terminal branches of T6-L1 intercostal nerves. It does not, however, address visceral pain arising from the peritoneum, gallbladder bed, or diaphragmatic irritation a recognized limitation that may explain the incomplete analgesia observed (median VAS at rest 2.1-2.9 across time points, rather than zero) and the residual opioid requirements in the TAP group [15]. Integration of TAP block into a multimodal analgesic regimen including NSAIDs, acetaminophen, and low-dose intraoperative dexamethasone may further optimize outcomes.

Our finding of a significantly reduced PONV incidence in the TAP group (15% vs. 38.3%) is likely multifactorial, primarily reflecting the opioid-sparing effect. Opioids exert emetogenic effects via central (area postrema) and peripheral (gastrointestinal) mechanisms; the substantial reduction in morphine consumption in the TAP group would be expected to attenuate these effects. This finding has meaningful clinical implications, as PONV remains a leading cause of delayed discharge, unplanned hospital admission, and patient dissatisfaction after day-case surgery [16].

The 5.4-hour reduction in time to discharge eligibility observed in the TAP group carries notable healthcare resource implications. In the context of laparoscopic cholecystectomy, which is increasingly performed as a day-case procedure in high-income settings, facilitating earlier discharge may translate to meaningful cost savings. Economic modeling studies have estimated that each hour of hospital stay costs

approximately USD 80-150 in comparable healthcare settings [17]; the observed benefit could represent savings of USD 430-810 per patient.

Our study has several strengths: a prospective randomized double-blind design, a homogeneous surgical cohort, a standardized general anesthetic protocol, a pre-specified sample size calculation, and execution by a single experienced operator to minimize procedural variability. Several limitations warrant acknowledgment. First, the study was conducted at a single tertiary center, which may limit generalizability. Second, the duration of follow-up was restricted to 24 hours; longer-term outcomes including chronic post-surgical pain were not assessed. Third, the bupivacaine-epinephrine concentration used (0.25%) was chosen for safety within recommended dose limits; longer-acting agents such as liposomal bupivacaine or ropivacaine may provide more prolonged blockade and warrant comparative evaluation. Fourth, despite efforts at blinding, complete blinding of participants may not have been fully achieved, as some patients may have perceived the absence of the PCA device's typical feedback sounds.

Future research should investigate: the comparative efficacy of TAP block in other laparoscopic abdominal procedures (appendectomy, colorectal resection, hernia repair); the optimal local anesthetic concentration, volume, and adjuvants; cost-effectiveness analyses; and the role of TAP block in ambulatory and day-case surgical settings.

## Conclusion

Bilateral ultrasound-guided TAP block with 0.25% bupivacaine with epinephrine provides superior postoperative analgesia, a clinically and statistically significant reduction in opioid consumption, lower PONV incidence, and earlier hospital discharge compared to IV morphine PCA in patients undergoing elective laparoscopic cholecystectomy under general anesthesia. The procedure demonstrated an excellent safety profile with no serious complications. These findings support the incorporation of bilateral ultrasound-guided TAP block as a standard component of multimodal perioperative analgesic protocols for laparoscopic abdominal surgery.

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**Individual Authors' Contributions: KDP** conceived and designed the study and performed all TAP block procedures. **SBP** performed statistical analysis. Both authors read and approved the final manuscript.

**Availability of Data:** The data supporting this study's findings are available upon reasonable request to corresponding author.

**Declaration of Non-use of Generative AI:** The authors affirm that no generative artificial intelligence tools were utilized in the design, analysis, interpretation of data, or preparation of this manuscript. All content is the result of the authors' original work.

## References

1. Stinton LM, Shaffer EA. Epidemiology of gallbladder disease: cholelithiasis and cancer. Gut Liver. 2012;6(2):172-187. DOI: https://doi.org/10.5009/gnl.2012.6.2.172 PMid:22570746 PMCid:PMC3343155
2. Bisgaard T. Analgesic treatment after laparoscopic cholecystectomy: a critical assessment of the evidence. Anesthesiology. 2006;104(4):835-846. DOI: https://doi.org/10.1097/00000542-200604000-00030 PMid:16571981
3. Bisgaard T, Kehlet H, Rosenberg J. Pain and convalescence after laparoscopic cholecystectomy. Eur J Surg. 2001;167(2):84-96. DOI: https://doi.org/10.1080/110241501750070510 PMid:11266262
4. Kehlet H, Dahl JB. The value of "multimodal" or "balanced analgesia" in postoperative pain treatment. Anesth Analg. 1993;77(5):1048-1056. DOI: https://doi.org/10.1213/00000539-199311000-00030 PMid:8105724
5. Oderda GM, Gan TJ, Johnson BH, Robinson SB. Effect of opioid-related adverse events on outcomes in selected surgical patients. J Pain Palliat Care Pharmacother. 2013;27(1):62-70. DOI: https://doi.org/10.3109/15360288.2012.751956 PMid:23302094
6. Rafi AN. Abdominal field block: a new approach via the lumbar triangle. Anaesthesia. 2001;56(10):1024-1026. DOI: https://doi.org/10.1111/j.1365-2044.2001.2279-40.x PMid:11576144

7. Hebbard P, Fujiwara Y, Shibata Y, Royse C. Ultrasound-guided transversus abdominis plane (TAP) block. Anaesth Intensive Care. 2007;35(4):616-617.
8. McDonnell JG, O'Donnell B, Curley G, et al. The analgesic efficacy of transversus abdominis plane block after abdominal surgery: a prospective randomized controlled trial. Anesth Analg. 2007;104(1):193-197. DOI: https://doi.org/10.1213/01.ane.0000250223.49963.0f PMid:17179269 PMCid:PMC11175748
9. Belavy D, Cowlishaw PJ, Howes M, Phillips F. Ultrasound-guided transversus abdominis plane block for analgesia after Caesarean delivery. Br J Anaesth. 2009;103(5):726-730. DOI: https://doi.org/10.1093/bja/aep235 PMid:19700776
10. Champaneria R, Shah L, Geoghegan J, Gupta JK, Bhatt JR. Analgesic effectiveness of transversus abdominis plane blocks after hysterectomy: a meta-analysis. Eur J Obstet Gynecol Reprod Biol. 2013;166(1):1-9. DOI: https://doi.org/10.1016/j.ejogrb.2012.09.012 PMid:23041302
11. Petersen PL, Mathiesen O, Torup H, Dahl JB. The transversus abdominis plane block: a valuable option for postoperative analgesia? A topical review. Acta Anaesthesiol Scand. 2010;54(5):529-535. DOI: https://doi.org/10.1111/j.1399-6576.2010.02215.x PMid:20175754
12. Siddiqui MRS, Sajid MS, Uncles DR, Cheek L, Baig MK. A meta-analysis on the clinical effectiveness of transversus abdominis plane block. J Clin Anesth. 2011;23(1):7-14. DOI: https://doi.org/10.1016/j.jclinane.2010.05.008 PMid:21296242
13. El-Dawlatly AA, Turkistani A, Kettner SC, et al. Ultrasound-guided transversus abdominis plane block: description of a new technique and comparison with conventional systemic analgesia during laparoscopic cholecystectomy. Br J Anaesth. 2009;102(6):763-767. DOI: https://doi.org/10.1093/bja/aep067 PMid:19376789 PMCid:PMC11175748
14. Kato N, Fujiwara Y, Harato M, et al. Serum concentration of lidocaine after transversus abdominis plane block. J Anesth. 2009;23(2):298-300. DOI: https://doi.org/10.1007/s00540-008-0721-4 PMid:19444577
15. Boddy AP, Mehta S, Rhodes M. The effect of intraperitoneal local anesthesia in laparoscopic cholecystectomy: a systematic review and meta-analysis. Anesth Analg. 2006;103(3):682-688. DOI: https://doi.org/10.1213/01.ane.0000226268.06279.5a PMid:16931681
16. Gan TJ, Belani KG, Bergese S, et al. Fourth Consensus Guidelines for the Management of Postoperative Nausea and Vomiting. Anesth Analg. 2020;131(2):411-448. DOI: https://doi.org/10.1213/ANE.0000000000004833 PMid:32467512
17. Oostenbrink JB, Buijs-Van der Woude T, van Agthoven M, Koopmanschap MA, Rutten FF. Unit costs of inpatient hospital days. Pharmacoeconomics. 2003;21(4):263-71. DOI: https://doi.org/10.2165/00019053-200321040-00004 PMid:12600221