Disease and Diagnosis

Dis Diagn. 2023; 12(4):168-173

doi 10.34172/ddj.2023.502

Original Article

Effect of Ultrasound-Guided Transversus Abdominal Plane Block on Postoperative Pain After Laparotomy Abdominal Surgery

Ali Akbar Nasiri[1*], Sara Akhavan Salamat[1], Shahryar Sane[1]

[1]Department of Anesthesiology, Faculty of Medicine, University of Medical Sciences, Urmia, Iran

***Correspondence to**
Ali Akbar Nasiri,
Email: nasiriali7@gmail.com

Abstract

Background: Transversus abdominis plane (TAP) block is used to manage pain in patients undergoing laparotomy abdominal surgery. This study aimed to investigate the effect of ultrasound-guided TAP block on postoperative pain and complications in patients undergoing laparotomy abdominal surgery.

Materials and Methods: In this randomized double-blinded prospective clinical trial, 64 patients undergoing laparotomy surgery were selected based on inclusion and exclusion criteria and were randomly divided into two groups with 32 patients in each group. General anesthesia was induced in all patients. At the end of the surgery, a TAP block was performed under ultrasound guidance in the intervention group, and the control group received no intervention. The severity of pain was assessed 2, 6, 12, 18, and 24 hours after surgery using visual analogue scale (VAS) criteria. Patients who scored their pain more than 4 on the VAS for pain relief received 25 mg of intravenous (IV) pethidine. Furthermore, potential complications, including nausea, vomiting, and dizziness were assessed and recorded in both groups.

Results: Mean pain severity 2, 4, 6, 12, 18, and 18 hours after surgery was significantly lower in the TAP-block group than in the control group ($P=0.001$). The mean dose of pethidine received in TAP block patients was 28.90 ± 19.16 and 60.93 ± 14.11 in the control group, which showed a significant difference ($P=0.001$). Moreover, the mean time to the first dose of pethidine in patients in the TAP block group and the control group was 15.36 ± 3.56 and 8.43 ± 4.28 hours after surgery ($P=0.001$). In addition, the incidence of nausea and vomiting was lower in the TAP group than in the control group.

Conclusion: Ultrasound-guided TAP block can control post-laparotomy pain and reduce opioid use during hospitalization.

Keywords: Ropivacaine, Laparotomy, Transversus abdominis plane block, Anesthesia, Pain

Received: March 12, 2023, **Accepted:** May 10, 2023, **ePublished:** September 30, 2023

Introduction

A laparotomy is a surgical technique in which the abdominal wall is cut to reach the abdominal cavity (1). Postoperative pain is severe pain that emerges with a surgical incision and ends with wound healing (2). Appropriate postoperative analgesia may improve surgical results, control the stress response after surgery, and reduce postoperative morbidity (3). Unsurprisingly, pain and the length of the recovery period are the two main issues following laparotomy abdominal surgery.

Achieving proper pain control can improve patient comfort, hasten healing and return to normal life, reduce hospital stays, lessen complications such as pulmonary thromboembolism, and even save medical expenses (4). In various abdominal and gynecological surgical procedures, the transversus abdominis plane (TAP) block was proposed as an essential component of the analgesic method to control postoperative pain (5). When using the TAP technique, local anesthetics are injected into a plane between the internal oblique and TA muscles. These muscles contain the thoracolumbar nerves that come from the spinal roots of T6 to L1 and supply the skin, muscles, parietal peritoneum, and anterolateral abdominal wall with sensation (6). The ultrasound-guided application is typically recommended over the blind approach in considering the risk of complications during the procedure (7). The precision and efficiency of administering local anesthetics into the TAP were improved by performing an ultrasound-guided block (8).

While studies have been conducted to evaluate TAP block in different surgeries (9, 10), to our knowledge, limited study has assessed its benefit in laparotomy abdominal surgeries. Therefore we designed the present study to evaluate the effects of ultrasound-guided TAP

block for postoperative pain and complications in patients who underwent laparotomy abdominal surgery. We hypothesize that better postoperative pain control with TAP block reduces the sympathoadrenal, endocrine, and cytokine responses and their markers such as white blood cell, blood sugar, tumor necrosis factor-α, Interleukin-1, and serum cortisol level. It has been shown that following surgery, the main secreted cytokines are Interleukin-1, Interleukin-6, and tumor necrosis factor-α (11).

Materials and Methods

After the Research Ethics Committee approval of Urmia University of Medical Sciences and written informed consent, 64 American Society of Anesthesiologists Physical Status I/II patients of either gender, aged 18–60 years, scheduled to undergo laparotomy abdominal surgery were enrolled in this randomized double-blinded prospective clinical trial. Using computer-coded sealed envelopes, patients were randomly assigned to one of two groups (control or TAP group) based on eligibility criteria. The inclusion criteria were the patients undergoing elective laparotomy under general anesthesia who had no placed epidural catheter, received no analgesics at least 24 hours pre-operation, and had no history of local anesthetic hypersensitivity. Moreover, the exclusion criteria were the patients with an age range of younger than 18 or older than 60, pregnancy, diabetes, opioid drug addiction, history of previous abdominal surgery, emergency surgery, mental illness, chronic pain disorders, inherited or acquired coagulopathy, and injection site infection.

In the present study, the pain assessor nurses were blinded to the patient's assignment. The allocation was blinded for all patients, surgeons, anesthesiologists, and follow-up observers until the end of the study. The anonymity of allocation was ensured by enclosing assignments in sealed, opaque, and sequentially numbered envelopes opened by a nurse only according to a procedure proposed by Zhao et al (12). During the trial period, the nurse prepared 0.5% ropivacaine or saline (40 mL) for each patient under the allocation and did not take part in any other associated process.

Alprazolam 0.25 mg was administered orally to all patients the night before and the morning of surgery. Each patient was fitted with all available monitors in the operating room, including an electrocardiogram, pulse oximetry, and a non-invasive blood pressure machine. A Ringers' lactate drip was also started. Fentanyl 2 g/kg intravenous (IV), propofol 2-3 mg/kg IV, and vecuronium 0.1 mg/kg IV were used to induce general anesthesia. Following sufficient muscle relaxation, a pro-seal laryngeal mask airway of the proper size was applied. Positive pressure ventilation and a mixture of 50% oxygen, 50% nitrous oxide, and 1-2% sevoflurane were used to keep the patient under anesthesia while maintaining an end-tidal carbon dioxide concentration of 30–40 mm Hg.

To reach the peritoneal cavity, a big incision is made in the lower abdomen during a laparotomy, often referred to as a celiotomy. Then, an ultrasound-guided TAP block was performed on Group A immediately after the end of surgery (the case group). The TA and internal oblique muscles were scanned and examined while the ultrasound probe was positioned longitudinally on the midaxillary line at the umbilicus to execute the TAP block. The 22-gauge 90 mm disposable spinal needle was put in the plane, and 20 mL of ropivacaine 0.25% was injected on both sides after the needle tip was pushed into the fascia between the TA and internal oblique muscles. One anesthetist specialized in that field handled everything but was not in charge of gathering the data. The TAP block was performed with saline (the same volume) for Group B (the control group).

The patient's hemodynamic parameters, including heart rate, systolic blood pressure (BP), diastolic BP, and mean BP were monitored during the procedure at intervals of five minutes. If hemodynamic parameters increased by 15% from baseline, an additional 1 ug/kg IV dose of fentanyl was given, and the total amount of fentanyl used during surgery was noted. After the procedure was finished, the neuromuscular blockade was reversed, the inhalation anesthetics were stopped, and the patient was extubated.

Following surgery, the patients were sent to the recovery area where a nurse who was unaware of the patients' group assignment evaluated their level of discomfort. The visual analogue scale (VAS) was used to measure and record the patients' pain intensity at 2, 4, 6, 12, 18, and 24 hours following surgery. Patients who scored their pain more than 4 on the VAS for pain relief received 25 mg of IV pethidine. Additionally, each patient's nursing reports contained a record of the pethidine doses that were administered. For matching and confounding factor elimination, no analgesic other than pethidine (i.e., oral and rectal analgesics) was given to the patients. The period between the conclusion of the procedure and the first dose of pethidine was regarded as the analgesic duration. Additionally, the probable side effects in both groups such as nausea, vomiting, and dizziness were evaluated and noted.

Sample Size

A sample size of 64 patients was determined according to a study by Suseela et al (12) using the mean difference formula for two groups with a power of 80%, a significance level/alpha of 0.05, and d (the minimum difference between the groups under study that would be of biological relevance) of 0.27 as follows:

Statistical Analysis

All data were analyzed using SPSS software (version 20).

Data were checked for normality before the statistical analyses. Continuous variables were presented as mean ± standard deviation or median (1Q, 3Q), and categorical variables were presented as absolute numbers and percentages. The Kolmogorov-Smirnov test was used to assess the normal distribution of data. Then, the chi-square test (Fischer's exact test), independent *t* test (Mann-Whitney U), and repeated measures ANOVA were used to compare data between groups. Furthermore, *P* values less than 0.05 were considered statistically significant.

Results

Of 64 patients in the study, 31 were men (48.4%) and 33 were women (51.6%). The mean age of the patient was 41.92 ± 10.63 (23-60 years). The demographic data of the patients are presented in Table 1.

Table 2 presents the mean pain severity at 2, 4, 6, 12, 18, and 24 postoperative hours in both groups based on the VAS scores. The postoperative mean VAS pain score in the control group was higher than that in the intervention group, with statistically significant differences at all time intervals ($P < 0.001$). Moreover, most patients in the intervention group did not suffer pain during 24 hours postoperatively, while most patients in the control group experienced pain during 24 hours postoperatively (Table 2). According to the obtained findings, the pain severity was significantly lower in the patients undergoing TAP block compared to the control group.

All the patients in the control group received pethidine within 24 hours post-surgery, while only 25 patients (78.1%) in the TAP block group needed pethidine for pain management, and seven patients (21.9%) did not need it. Therefore, the need for pethidine was significantly lower in the TAP block group compared to the control group ($P = 0.001$).

According to Table 3, the mean dose of pethidine received in TAP block patients was 28.90 ± 19.16 and 60.93 ± 14.11 in the control group, which showed a significant difference between the groups ($P = 0.001$). Furthermore, the mean time of the first dose of pethidine in patients in the TAP block group and the control group was 15.36 ± 3.56 and 8.43 ± 4.28 hours after surgery ($P = 0.001$), respectively.

Moreover, the development of complications in both groups, including dizziness, nausea, and vomiting are presented in Table 4. The incidence of nausea and vomiting was lower in the TAP group than in the control group, and dizziness did not appear in the TAP group.

Table 1. Demographic Characteristics of Patients

Variable		TAP Block Group	Control Group	*P* Value
Gender	Male	17 (51.3%)	14 (43.8%)	0.3*
	Female	15 (46.9%)	18 (56.2%)	
Age (y)		41.62 ± 9.99 (25-58)	42.21 ± 11.38 (23-60)	0.8**

Note. TAP: Transversus abdominis plane; * Chi-square test; ** Independent sample t-test.

Table 2. The Pain Severity by Group Based on the VAS

VAS	TAP Block Group	Control Group	*P* Value*
Hour 2	0.56 ± 0.55	2.37 ± 0.97	0.001
Hour 4	1.09 ± 0.68	3.03 ± 0.82	0.001
Hour 6	2.15 ± 1.16	4.03 ± 0.69	0.001
Hour 12	2.9 ± 1.44	5.06 ± 0.71	0.001
Hour 18	3.78 ± 1.75	5.15 ± 0.67	0.001
Hour 24	4.03 ± 1.73	5.59 ± 0.71	0.001

Note. VAS: Visual analogue scale; TAP: Transversus abdominis plane; *Independent sample t-test.

Discussion

Poor postoperative pain management is one of the most frequent problems in hospitalized patients, resulting in decreased mobility and satisfaction (13). According to the usefulness of the TAP block in postoperative pain management, efforts have been made to improve its effectiveness in recent years (14). However, we selected postoperative TAP over preoperative TAP due to its benefits such as avoiding local anesthetic distribution within the muscle layers induced by the prolonged head-down position and delaying local anesthetic metabolization (15). Some researchers concluded that the analgesic effect of TAP block performed postoperatively was before the emergence from anesthesia (16-18).

According to the obtained results, the pain severity assessed using the VAS at 2, 4, 6, 12, 18, and 24 postoperative hours was significantly lower in the patients undergoing TAP block compared to the control group. These findings are compatible with those of Mulder et al (19) and Brogi et al (20) who found significantly lower pain within the first postoperative 24 hours in the patients undergoing TAP block. In contrast, Venkatraman et al reported no significant difference in pain severity assessed 2 and 24 postoperative hours in the patients undergoing TAP block and the placebo group, while the pain severity at 4, 6, and 12 post-surgery hours was lower in the TAP block group (21). In addition, Fakor et al (22) and Sharma et al (23) investigated the effect of TAP block

Table 3. The Mean Dose of Received Pethidine, the Number of Doses, and the Time of the First Dose of Pethidine in Both Groups

Variable	TAP Block Group	Control Group	*P* Value*
Dose of pethidine (mg)	28.90 ± 19.16	60.93 ± 14.11	0.001
Number of pethidine doses (n)	1.15 ± 0.76	2.43 ± 0.56	0.001
Time of the first dose of pethidine (the hour after surgery)	15.36 ± 3.56	8.43 ± 4.28	0.001

Note. TAP: Transversus abdominis plane; * Independent sample t-test.

Table 4. The Development of Complications, Including Nausea, Vomiting, and Dizziness in Both Groups

Complication	TAP Block Group	Control Group	*P* Value *
Nausea	6 (18.8%)	10 (31.3%)	0.19
Vomiting	3 (9.4%)	6 (18.8%)	0.23
Dizziness		2 (6.3%)	0.24

Note. TAP: Transversus abdominis plane; * Fisher exact test.

on postoperative analgesia, reporting similar results that were compatible with our results. Recent studies have reported a significant pain reduction assessed using the VAS in the patients undergoing TAP block compared to those receiving a placebo or morphine (24-26). However, the maximum duration of effectiveness is only 24 hours, which restricts the use of the related technology (21).

In this study, the need for pethidine administration was significantly lower in the TAP block group compared to the control group. This result agrees with the study by Breazu et al (27) which showed that 1% pethidine is much more effective in controlling pain than 0.25% bupivacaine in the postanaesthesia care unit. In contrast, Baeriswyl et al reported that patients undergoing TAP block receive less IV morphine than patients who do not receive TAP block during the first six postoperative hours. After this time, the TAP block had no lasting impact on the decline in opiate use (28). Moreover, Brogi et al (20) and Mulder et al (19) found similar results compatible with ours, showing that TAP block could significantly reduce postoperative opioid administration. Additionally, Venkatraman et al confirmed our results regarding the effect of TAP block on the received opioid dose (21). Meanwhile, other clinicians such as Fibla et al discovered that blocking time does not impact postoperative pain levels (29).

The duration of postoperative analgesia was longer in the TAP group compared to the control group in the study by Sharma et al, which is similar to our study. However, their reported analgesia duration (8.5 hours) was significantly shorter than those reported by comparable studies and the present study (23). Additionally, prior research showed that TAP block has analgesic effects up to 48 hours after surgery (30).

In the present study, the low prevalence of block-related problems suggests that using the right local anesthetic dose for TAP block could be a safe way to lessen postoperative discomfort. Our study reported a higher prevalence of dizziness, nausea, and vomiting in the control group than in the TAP group. This result is in contrast to previous findings (31), which showed that both groups experienced high postoperative nausea and vomiting (31% and 69% in the block and control groups, respectively). The study by Baeriswyl et al reported no difference in the incidence of postoperative problems (e.g., nausea, vomiting, and pruritus) between the TAP block and spinal anesthetic groups (28). Mulder et al found contrasting outcomes, reporting that the TAP block group had a lower rate of nausea and a higher oral meal tolerance than the control group (19).

One of the limitations of this study was performing the TAP block at the end of the procedure, which made its effect on the consumption of narcotics and anesthetic drugs unclear. Another drawback was that the pain assessment was limited to 24 hours. In addition, the small sample size and single-center study were other limitations. For further studies, it is suggested to perform TAP immediately before the surgery with many patients and at multiple centers.

Conclusion

This study demonstrated the remarkable effects of TAP block on patients' postoperative pain scores and complications compared to routine general anesthesia. It provides better quality analgesia of longer duration in the postoperative period. Accordingly, TAP block could be considered an integral part of the multimodal analgesic strategy as well as an inexpensive, simple, and easily performed procedure.

Acknowledgments

The authors would like to express their gratitude to the clinical research development unit of Imam Khomeini Hospital, Urmia University of Medical Sciences, for English editing.

Authors' Contribution

Conceptualization: Aliakbar Nasiri.
Data curation: Aliakbar Nasiri.
Formal analysis:Shahrayr Sane.
Funding acquisition: Aliakbar Nasiri.
Investigation: Aliakbar NAsiri.
Methodology: Sara Akhavan Salamat**.**
Project administration: Aliakbar Nasiri.
Resources: Sara Akhavan Salamat.
Supervision: Aliakbar Nasiri.
Validation: Shahryar Sane.
Visualization: Shahryar Sane.
Writing–original draft: Aliakbar Nasiri.
Writing–review & editing: Sara Akhvan Salamat.

Competing Interests

The authors report there are no competing interests to declare.

Ethical Approval

Research involving human subjects complied with all relevant national regulations, institutional policies and is in accordance with the tenets of the Helsinki Declaration (as amended in 2013), and has been approved by the Ethics Committee of Urmia University of Medical Sciences with code: IR.UMSU.REC.1398.349.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

1. Rajaretnam N, Okoye E, Burns B. Laparotomy. In: StatPearls. Treasure Island, FL: StatPearls Publishing; 2022. Available from: https://www.ncbi.nlm.nih.gov/books/NBK525961/. Updated September 19, 2022.
2. Pogatzki-Zahn EM, Segelcke D, Schug SA. Postoperative pain-from mechanisms to treatment. Pain Rep. 2017;2(2):e588.

doi: 10.1097/pr9.0000000000000588.
3. Sinha S, Palta S, Saroa R, Prasad A. Comparison of ultrasound-guided transversus abdominis plane block with bupivacaine and ropivacaine as adjuncts for postoperative analgesia in laparoscopic cholecystectomies. Indian J Anaesth. 2016;60(4):264-9. doi: 10.4103/0019-5049.179464.
4. Garimella V, Cellini C. Postoperative pain control. Clin Colon Rectal Surg. 2013;26(3):191-6. doi: 10.1055/s-0033-1351138.
5. Zhao Y, Zhang HY, Yuan ZY, Han Y, Chen YR, Liu QL, et al. Analgesic efficacy of postoperative bilateral, ultrasound-guided, posterior transversus abdominis plane block for laparoscopic colorectal cancer surgery: a randomized, prospective, controlled study. BMC Anesthesiol. 2021;21(1):107. doi: 10.1186/s12871-021-01317-6 .
6. Seervi SN, Singariya G, Kamal M, Kumari K, Siddeshwara A, Ujwal S. Effect of addition of buprenorphine or dexamethasone to levobupivacaine on postoperative analgesia in ultrasound guided transversus abdominis plane block in patients undergoing unilateral inguinal hernia repair: a prospective randomized double blind controlled trial. Korean J Anesthesiol. 2019;72(3):245-52. doi: 10.4097/kja.d.18.00182.
7. Li Z, Chen L. Comparison of ultrasound-guided modified Seldinger technique versus blind puncture for peripherally inserted central catheter: a meta-analysis of randomized controlled trials. Crit Care. 2015;19(1):64. doi: 10.1186/s13054-015-0742-y.
8. Salama ER. Post-operative bilateral continuous ultrasound-guided transversus abdominis plane block versus continuous local anaesthetic wound infusion in patients undergoing abdominoplasty. Indian J Anaesth. 2018;62(6):449-54. doi: 10.4103/ija.IJA_221_18.
9. Földi M, Soós A, Hegyi P, Kiss S, Szakács Z, Solymár M, et al. Transversus abdominis plane block appears to be effective and safe as a part of multimodal analgesia in bariatric surgery: a meta-analysis and systematic review of randomized controlled trials. Obes Surg. 2021;31(2):531-43. doi: 10.1007/s11695-020-04973-8.
10. Zhou H, Ma X, Pan J, Shuai H, Liu S, Luo X, et al. Effects of transversus abdominis plane blocks after hysterectomy: a meta-analysis of randomized controlled trials. J Pain Res. 2018;11:2477-89. doi: 10.2147/jpr.s172828.
11. Özçınar B, Aksakal N, Yanar F, Ağcaoğlu O, Peker KD, Türkoğlu Ü, et al. Increased interleukin 1 and tumor necrosis factor alpha levels after thyroid surgery. Ulus Cerrahi Derg. 2014;30(2):80-4. doi: 10.5152/ucd.2014.2484.
12. Suseela I, Anandan K, Aravind A, Kaniyil S. Comparison of ultrasound-guided bilateral subcostal transversus abdominis plane block and port-site infiltration with bupivacaine in laparoscopic cholecystectomy. Indian J Anaesth. 2018;62(7):497-501. doi: 10.4103/ija.IJA_55_18.
13. Berger JS, Gonzalez A, Hopkins A, Alshaeri T, Jeon D, Wang S, et al. Dose-response of intrathecal morphine when administered with intravenous ketorolac for post-cesarean analgesia: a two-center, prospective, randomized, blinded trial. Int J Obstet Anesth. 2016;28:3-11. doi: 10.1016/j.ijoa.2016.08.003.
14. Imani F, Rahimzadeh P, Faiz HR, Abdullahzadeh-Baghaei A. An evaluation of the adding magnesium sulfate to ropivacaine on ultrasound-guided transverse abdominis plane block after abdominal hysterectomy. Anesth Pain Med. 2018;8(4):e74124. doi: 10.5812/aapm.74124.
15. 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(1):623. doi: 10.1038/s41598-021-04552-6.
16. Park JM, Lee J. Effect of transversus abdominis plane block on the quality of recovery in laparoscopic nephrectomy: a prospective double-blinded randomized controlled clinical trial. Medicine (Baltimore). 2022;101(41):e31168. doi: 10.1097/md.0000000000031168.
17. Soltani Mohammadi S, Dabir A, Shoeibi G. Efficacy of transversus abdominis plane block for acute postoperative pain relief in kidney recipients: a double-blinded clinical trial. Pain Med. 2014;15(3):460-4. doi: 10.1111/pme.12311.
18. Liu R, Qin H, Wang M, Li K, Zhao G. Transversus abdominis plane block with general anesthesia blunts the perioperative stress response in patients undergoing radical gastrectomy. BMC Anesthesiol. 2019;19(1):205. doi: 10.1186/s12871-019-0861-0.
19. Mulder L, Ramirez E, Poirier J, Torquati A, Omotosho PA. Transversus abdominis plane (TAP) block significantly improves opioid use and length of stay in bariatric surgery patients. Surg Obes Relat Dis. 2018;14(11):S40. doi: 10.1016/j.soard.2018.09.064 .
20. Brogi E, Kazan R, Cyr S, Giunta F, Hemmerling TM. Transversus abdominal plane block for postoperative analgesia: a systematic review and meta-analysis of randomized-controlled trials. Can J Anaesth. 2016;63(10):1184-96. doi: 10.1007/s12630-016-0679-x .
21. Venkatraman R, Abhinaya RJ, Sakthivel A, Sivarajan G. Efficacy of ultrasound-guided transversus abdominis plane block for postoperative analgesia in patients undergoing inguinal hernia repair. Local Reg Anesth. 2016;9:7-12. doi: 10.2147/lra.s93673 .
22. Fakor F, Farzi F, Abdollahzadeh M, Golrizan F, Kazemnejad E. The effect of transversus abdominis plane (TAP) block with bupivacaine 25% on post cesarean pain. J Guilan Univ Med Sci. 2014;23(91):53-60. [Persian].
23. Sharma S, Mehta N, Khan A. Transversus abdominis plane (TAP) block as a modality for postoperative analgesia in abdominal surgeries. J Evol Med Dent Sci. 2017;6(43):3385-9 .
24. Kahsay DT, Elsholz W, Bahta HZ. Transversus abdominis plane block after caesarean section in an area with limited resources. South African J Anaesth Analg. 2017;23(4):90-5. doi: 10.1080/22201181.2017.1349361.
25. Baeriswyl M, Kirkham KR, Kern C, Albrecht E. The analgesic efficacy of ultrasound-guided transversus abdominis plane block in adult patients: a meta-analysis. Anesth Analg. 2015;121(6):1640-54. doi: 10.1213/ane.0000000000000967.
26. Serifsoy TE, Tulgar S, Selvi O, Senturk O, Ilter E, Peker BH, et al. Evaluation of ultrasound-guided transversalis fascia plane block for postoperative analgesia in cesarean section: a prospective, randomized, controlled clinical trial. J Clin Anesth. 2020;59:56-60. doi: 10.1016/j.jclinane.2019.06.025.
27. Breazu CM, Ciobanu L, Bartos A, Bodea R, Mircea PA, Ionescu D. Pethidine efficacy in achieving the ultrasound-guided oblique subcostal transversus abdominis plane block in laparoscopic cholecystectomy: a prospective study. Bosn J Basic Med Sci. 2017;17(1):67-73. doi: 10.17305/bjbms.2016.1647.
28. Baeriswyl M, Zeiter F, Piubellini D, Kirkham KR, Albrecht E. The analgesic efficacy of transverse abdominis plane block versus epidural analgesia: a systematic review with meta-analysis. Medicine (Baltimore). 2018;97(26):e11261. doi: 10.1097/md.0000000000011261.
29. Fibla JJ, Molins L, Mier JM, Sierra A, Vidal G. A prospective study of analgesic quality after a thoracotomy: paravertebral block with ropivacaine before and after rib spreading. Eur

J Cardiothorac Surg. 2009;36(5):901-5. doi: 10.1016/j.ejcts.2009.05.041.
30. Tupper-Carey DA, Fathil SM, Tan YK, Kan YM, Cheong CY, Siddiqui FJ, et al. A randomised controlled trial investigating the analgesic efficacy of transversus abdominis plane block for adult laparoscopic appendicectomy. Singapore Med J. 2017;58(8):481-7. doi: 10.11622/smedj.2016068.
31. McDonnell JG, O'Donnell B, Curley G, Heffernan A, Power C, Laffey JG. The analgesic efficacy of transversus abdominis plane block after abdominal surgery: a prospective randomized controlled trial. Anesth Analg. 2007;104(1):193-7. doi: 10.1213/01.ane.0000250223.49963.0f.