Randomized Trial

Bilateral Ultrasound-Guided Erector Spinae Plane Block Versus Transversus Abdominis Plane Block on Postoperative Analgesia after Total Abdominal Hysterectomy

Alshaimaa Abdel Fattah Kamel, MD[1], Olfat Abdelmoniem Ibrahem Amin, MD[1], and Mohamed Abdel Moniem Ibrahem, MD[2]

From: [1]Department of Anaesthesia and Surgical Intensive Care, Faculty of Medicine, Zagazig University, Alsharkia, Egypt; [2]Department of Obstetrics and Gynecology, Faculty of Medicine, Zagazig University, Alsharkia, Egypt

Address Correspondence:
Alshaimaa Abdel Fattah Kamel, MD
Department of Anaesthesia and Surgical Intensive Care
Faculty of Medicinem Zagazig University
Alsharkia, Egypt
E-mail: AlshaimaaKamel8o@yahoo.com

Disclaimer: There was no external funding in the preparation of this manuscript.

Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript.

Manuscript received: 11-21-2019
Revised manuscript received: 01-16-2020
Accepted for publication: 01-22-2020

Free full manuscript: www.painphysicianjournal.com

Background: Transversus abdominis plane (TAP) blocks provide postoperative pain relief after various abdominal surgeries. Recently, erector spinae plane (ESP) block has obtained vast attention due to its simplicity and usage in truncal procedures.

Objectives: This study aims to compare the ultrasound-guided bilateral ESP block versus bilateral TAP block on postoperative analgesia after open total abdominal hysterectomy.

Study Design: A prospective, double-blinded, randomized, controlled, clinical trial.

Setting: Zagazig University Hospitals.

Methods: After ending of surgical procedure and before reversing of the muscle relaxant, 48 women were randomly allocated into 2 equal groups: erector spinae (ES) group received bilateral ultrasound-guided ESP block with 20 mL of bupivacaine 0.375% plus 5 ug/mL adrenaline (1:200000) in each side at the level of T9, and transversus abdominis (TA) group received bilateral ultrasound-guided TAP block with the same volume of bupivacaine plus adrenaline.

Results: Visual Analog Scale scores at 30 minutes, 2, 4, 6, 8, 12, 16, 20, and 24 hours were statistically significantly lower in the ES group compared with the TA group. The time for requirement of first morphine was highly statistically significantly prolonged in the ES group (14.81 ± 3.52 hours) compared with the TA group (10.58 ± 2.35 hours). The total amount of morphine consumption in 24 hours postoperatively was statistically significantly decreased in the ES group; $P = 0.01$. Incidence of postoperative nausea and vomiting was higher but statistically insignificant in the TA group than the ES group. There were statistically significant numbers of unsatisfied patients (4) in the TA group compared with the ES group (no patient).

Limitations: Sensorial evaluation of patients was not performed because both blocks had been done under general anesthesia but did not affect outcome. Therefore we recommend further studies comparing between both blocks.

Conclusions: Bilateral ultrasound-guided ESP block provides more potent and longer postoperative analgesia with less morphine consumption than TAP block after open total abdominal hysterectomy.

Key words: Abdominal hysterectomy, transversus abdominis plane block, erector spinae plane block, postoperative analgesia

Pain Physician 2020: 23:375-382

Hysterectomy represents the second most common obstetric surgery after cesarean section. Total abdominal hysterectomy is usually accompanied with moderate to severe postoperative pain; moreover, untreated postoperative abdominal hysterectomy pain leads to delay in the recovery after surgery, longer hospital stay, chronic pain, increase in the chance of venous thrombosis, and patient dissatisfaction (1,2).

Administration of opioid for treatment of acute pain after total abdominal hysterectomy are associated with many side effects, such as sedation, pruritus, nausea, and vomiting, hence regional analgesia techniques are an integral part of opioid-sparing analgesia after total abdominal hysterectomy (3).

The first introduction of transversus abdominis plane (TAP) block was in 2001. TAP block is a regional injection of local anesthetic between the transversus abdominis and internal oblique muscle planes. TAP block affects the sensory nerves of the anterolateral abdominal wall (T6-L1) that innervate the abdomen. TAP block is an easy technique, and decreases postoperative pain and opioid consumption (4).

Erector spinae plane (ESP) block is a novel interfascial plane block used in postoperative pain and chronic neuropathic pain relief of the thoracoabdominal region. However, its first use was for treatment of chronic pain, but recently it has been used as a postoperative regional analgesia technique in different surgeries from the shoulder to hip regions (5-7).

To the best of our knowledge, until now there has not been a published study regarding the comparison between the ultrasound-guided bilateral ESP block versus bilateral TAP block. Therefore the aims of this study were to compare between the ultrasound-guided bilateral ESP block versus bilateral TAP block on postoperative analgesia after open total abdominal hysterectomy. Our primary aims were to compare postoperative pain intensity using Visual Analog Scale (VAS) score, the total amount of morphine consumption in the first 24 hours after the operation, and the time for first call rescue analgesia. Our secondary aims were to compare patient satisfaction and recognize the adverse effects.

Methods

This study was approved by the University's institutional review board (IRB #5423-12-6-2019), and written informed consent was obtained from all patients participating in this trial. The trial was registered prior to patient enrollment at clinical trial.gov (NCT03965156, date of registration: June 13, 2019).

A CONSORT (Consolidated Standards of Reporting Trials) flow diagram depicting the passage of patients through the trial has been provided in Fig. 1. Fifty-four women scheduled to undergo open total abdominal hysterectomy were evaluated for inclusion criteria in this study. Six patients were excluded as they discharged before completing the follow-up of the study.

This prospective double-blind randomized controlled clinical trial was conducted from June to October 2019 on 48 women aged between 40 and 60 years, with body mass index (BMI) 25 to 35kg/m², belong to American Society of Anesthesiologist (ASA) I, II physical status, and scheduled for elective open total abdominal hysterectomy under general anesthesia.

Patients with local infection at site of puncture, altered mental status, and history of allergy to study drugs (bupivacaine or morphine), chronic pain, severe hepatic or kidney impairment, and hematologic disorders, including coagulation abnormality or on anticoagulants were excluded from this study.

Our primary aims were to compare postoperative pain intensity using VAS score, the total amount of morphine consumption in the first 24 hours after the operation, and the time for first call rescue analgesia. Our secondary aims were to compare patient satisfaction and recognize the adverse effects.

One day before surgery, all patients were informed about the VAS score (8). The VAS score is a 10-cm line labeled with "worst pain imaginable" on the right border, and "no pain" on the left border. The patient was instructed to make a mark along the line to represent the intensity of pain currently being experienced. Also, all the patients were undergoing routine preoperative evaluation.

In the preparatory room, all patients were monitored with electrocardiography, noninvasive blood pressure monitoring and pulse oximeter, end tidal CO_2, and an intravenous (IV) line was established to administer IV fluid. Basal vital data of the patient were recorded (respiratory rate, oxygen saturation, heart rate, and blood pressure).

Induction of anesthesia was done by fentanyl 1 ug/kg and propofol 2 mg/kg, then the endotracheal tube placement was facilitated with 0.5 mg/kg IV atracurium. Anesthesia was maintained by 1.2% isoflurane in 100% O_2, atracurium 0.1 mg/kg/h, and fentanyl 0.5 ug/kg/h.

After ending of surgical procedure and before reversing the muscle relaxant, patients were randomly

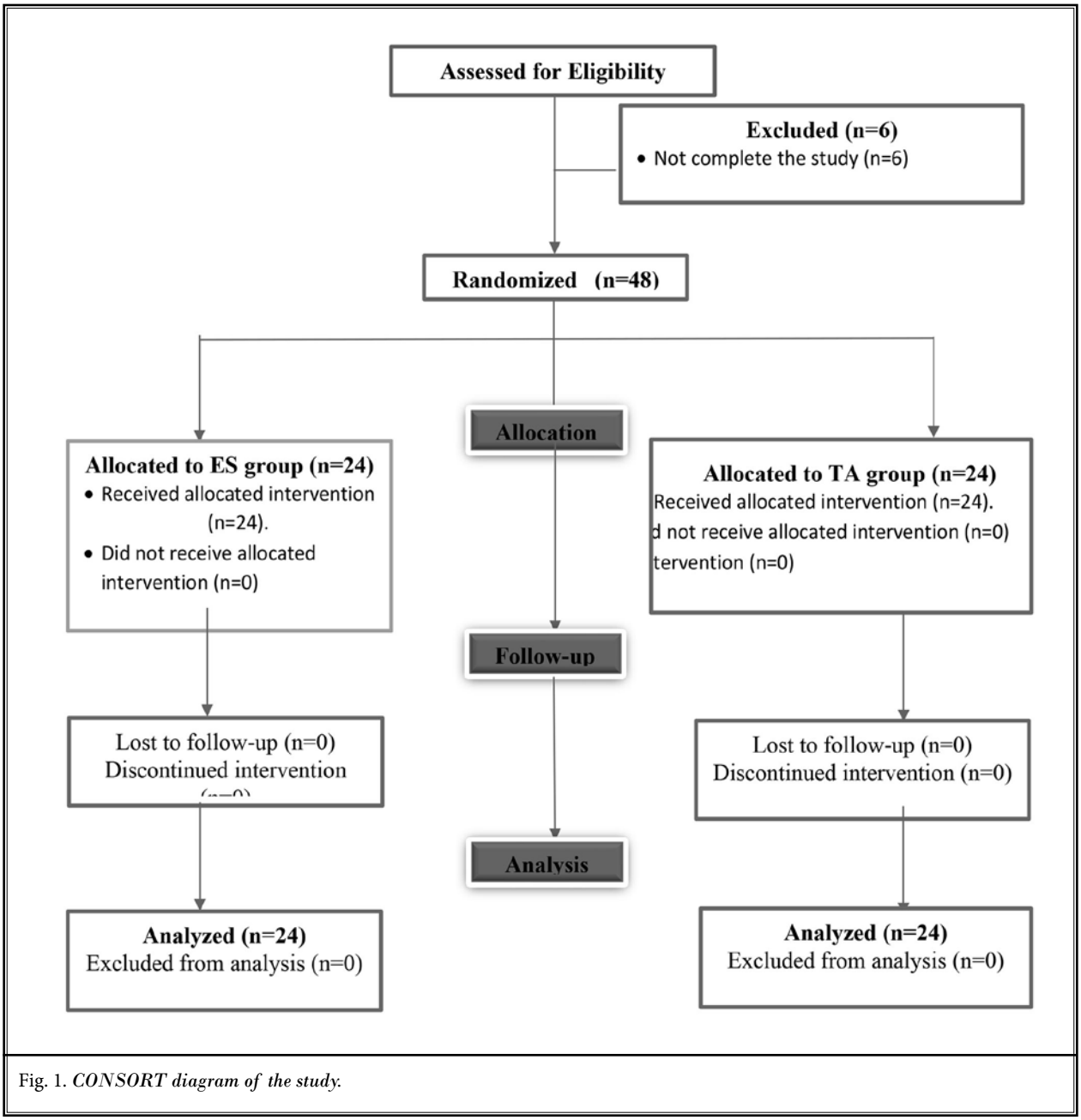

Fig. 1. *CONSORT diagram of the study.*

divided by a computer-generated table into 2 equal groups: erector spinae (ES) group (n = 24) received bilateral ultrasound-guided ESP block, with each block 20 mL of bupivacaine 0.375% plus 5 ug/mL adrenaline (1:200000) at the level of T9; and transversus abdominis (TA) group (n = 24) received bilateral ultrasound-guided TAP block with the same volume of bupivacaine plus adrenaline.

Block Technique

Ultrasound-guided ESP block (Fig. 2). In the lateral decubitus, after skin sterilization, ESP block was performed at the level of T9. Counting down from the spine of the seventh cervical vertebrae, and the spine of the 9 thoracic vertebrae (T9). A linear high-frequency (3–5 MHz) ultrasound transducer (SonoSite M-Turbo; FUJIFILM Sonosite, Inc., Bothell, WA) was placed sagit-

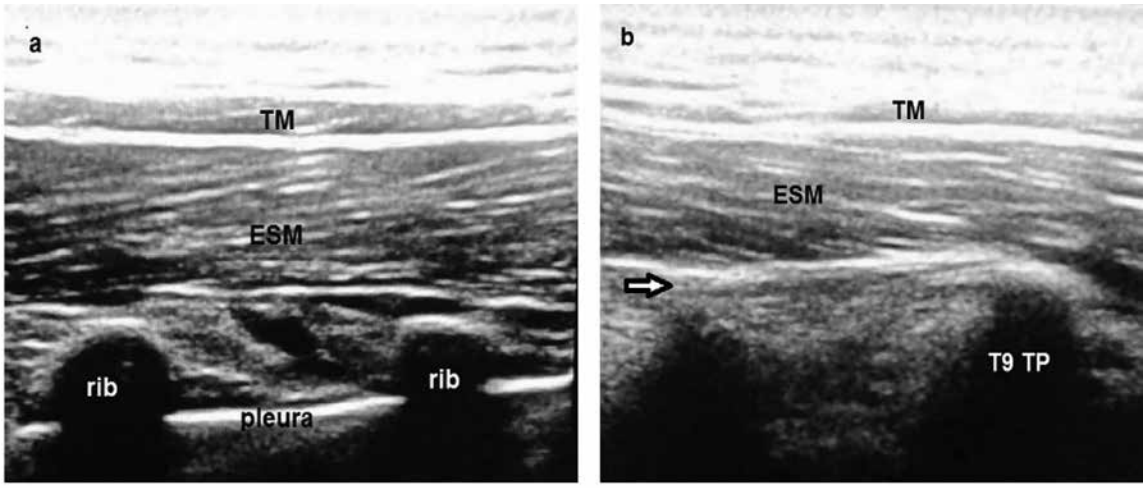

Fig. 2. *(A) Parasagittal ultrasound view of the proximal ribs, which are recognizable by their rounded appearance and the clearly visible hyperechoic pleura between them. (B) Parasagittal ultrasound view at the T9 level in a slightly more medial plane prior to ESP block showing trapezius muscle (TM) and erector spinae muscle (ESM) superficial to TP recognized by the more squared-off appearance and absence of visible pleura. The arrow shows the target site of the block.*

tal 3 cm lateral to T9 spinous process. A hyperechoic shadow of the transverse process (TP) and erector spinae was defined. A 22-gauge short bevel needle (Spinocan; B. Braun Melsungen AG, Melsungen, Germany) was inserted in cranial to caudal direction toward TP in plane to the ultrasound transducer until the needle touched the TP crossing all the muscles. The location of the needle tip was confirmed by visible normal saline solution separating erector spinae muscle off the bony shadow of the TP on ultrasound imaging (9). When the appropriate needle tip was confirmed, 20 mL of bupivacaine 0.375% plus 5 ug/mL adrenaline (1:200000) was injected. The procedure was repeated following the same steps on the other side of the back. Sonographic confirmation of the local anesthetic spread was seen as an anechoic shadow in the paravertebral spaces from T7 to T12.

Ultrasound-guided TAP block (Fig. 3). In supine position and after skin sterilization, the linear high-frequency transducer (6–13 MHz) was placed in the transverse plane to the lateral abdominal wall in the mid-axillary line, between the lower costal margin and iliac crest. The 3 abdominal wall muscles (external oblique, internal oblique, and transversus abdominis) were visualized. The needle was inserted in-plane and advanced anterior to posterior under continual visualization until the tip between the internal oblique and the transversus abdominis muscle was shown (10). After negative aspiration, 20 mL of bupivacaine 0.375% plus 5 ug/mL adrenaline (1:200000) was injected. The success of the injection was confirmed by separation of the internal oblique and transversus abdominis with a distinct pocket of local anesthetic in-between. The procedure was repeated following the same steps on the other side.

After ending of the block, the inhalational anesthetic was turned off and the muscle relaxant was reversed by giving neostigmine 0.05 mg/kg plus atropine 0.01 mg/kg. The patient was extubated and transferred to the recovery room. In the recovery room, the outcome assessor (the anesthesiologist not sharing in the study) assessed the primary and secondary outcomes.

The primary outcomes measured were (1) pain intensity using VAS score at 30 minutes, 2, 4, 6, 8, 12, 16, 20, and 24 hours postoperative, then IV increments of 3 mg morphine (rescue analgesic) had been given if VAS > 3. After administration of rescue analgesic, patients were shifted to a postoperative analgesic regimen of pethidine 1 mg/kg IV every 4 hours maximum daily dose 300 mg; (2) the time for requirement of first morphine dose (hours); and (3) the total amount of morphine consumption during the first 24 hours of postoperative period.

Secondary outcomes measured were (1) overall patient satisfaction at the end of 24 hours postop-

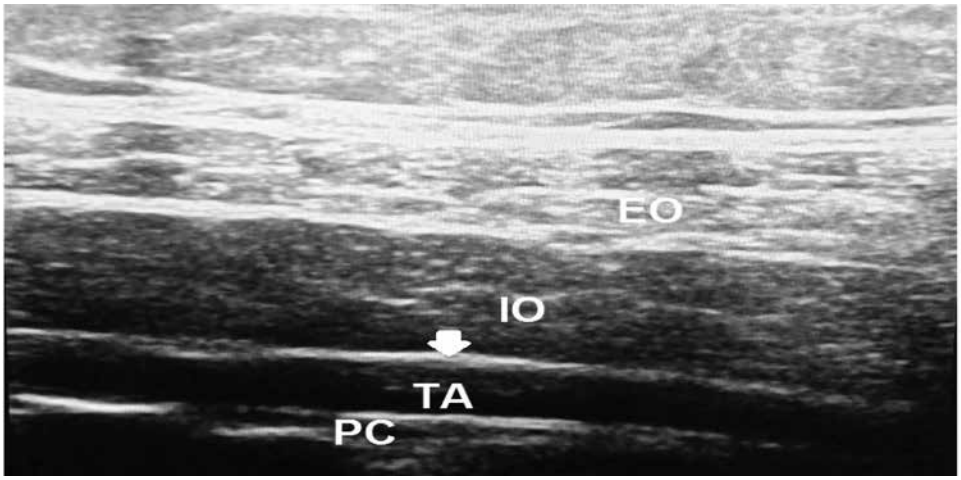

Fig. 3. *Sonoanatomy of the structures of the abdominal wall. EO, external oblique; IO, internal oblique; TA, transversus abdominis; PC, peritoneal cavity. The arrow shows the TAP target for block.*

eratively: all patients were asked to rate the overall degree of satisfaction of analgesia using a 1 to 3 verbal scale (1 = unsatisfactory analgesia, 2 = satisfactory analgesia, and 3 = excellent analgesia) (11); (2) morphine-related side effects: incidence of nausea and vomiting, respiratory depression (respiratory rate < 8 breaths/min), bradycardia (heart rate decreases by > 20% of basal reading), pruritus and urine retention; (3) bupivacaine-related side effects: lightheadedness, circumoral numbness, tongue paresthesia, drowsiness, irritability, muscle twitches, convulsions, bradycardia, hypotension (mean arterial blood pressure decreases by > 20% of basal reading), hypoventilation and cardiac arrest; and (4) any sign of adverse effects of the block techniques (local site infection, hematoma formation, bowel perforation, and pneumothorax). All suspected associated side effects were recorded and managed early.

The sample size. Assuming that mean ± standard deviation of pain scores in ESP block were 4.7 ± 3.7 versus 2.5 ± 1 in TAP block (12,13); therefore the total sample size was 48 cases (24 in each group) using OPENEPI (Open Source Epidemiologic Statistics for Public Health version 3.01) with 95% confidence interval and power of test was 80%.

Statistical Analysis

Data were analyzed with SPSS version 17.0 (SPSS Inc., Chicago, IL). Quantitative data were expressed as mean ± standard deviation and analyzed by an independent sample t-test. Qualitative data were expressed as number and percentage and were analyzed by the chi-square test; *P* value was considered significant if < 0.05, and highly significant if < 0.001.

Results

The 2 groups were comparable regarding age, BMI, ASA physical status, and the duration of surgery. There was no statistically significant difference between the 2 groups with regard to these parameters (Table 1).

Comparison of VAS scores are shown in Fig. 4. VAS scores were statistically significantly lower in the ES group compared with the TA group, with highly statistically significantly lower scores at 30 minutes, 2, 12, 16, 20, and 24 hours; $P < 0.0001$.

The time for requirement of first morphine dose

Table 1. *Patient chracteristics and duration of surgery*

	Group ES (n = 24)	Group TA (n = 24)	Test	*P*
Age (yrs)	53.7 ± 6.5	56.4 ± 5.9	T = 1.5	0.13 (NS)
BMI (kg/m^2)	23.13 ± 4.24	24.1 ± 3.84	T = 0.83	0.41 (NS)
ASA (N) I II	 16 8	 17 7	$\chi^2 = 0.09$	0.75 (NS)
Duration of surgery (min)	118.36 ± 38.21	109.32 ± 34.82	T = 0.85	0.39 (NS)

Data are expressed as mean ± standard deviation, or number. P < 0.05 was significant.
χ^2, chi-square test; NS, nonsignificant.

was highly statistically significantly prolonged in the ES group (14.81 ± 3.52 hours) compared with the TA group (10.58 ± 2.35 hours); $P < 0.0001$. In regard total amount of morphine consumption in 24 hours, the results showed that there was a statistically significant decrease in the ES group; $P = 0.01$ (Table 2).

The total number of patients who developed nausea and vomiting were more in the TA group but did not reach a statistically significant difference compared with the ES group; $P > 0.05$ (Table 2). No other opioid- or bupivacaine-related side effects or any complication related to both block techniques were noted.

There was a statistically significant number of unsatisfied patients (4) in the TA group compared with the ES group (no patient) $P = 0.03$, whereas there were statistically insignificant satisfaction and excellent satisfaction levels between the 2 groups; $P > 0.05$ (Table 3).

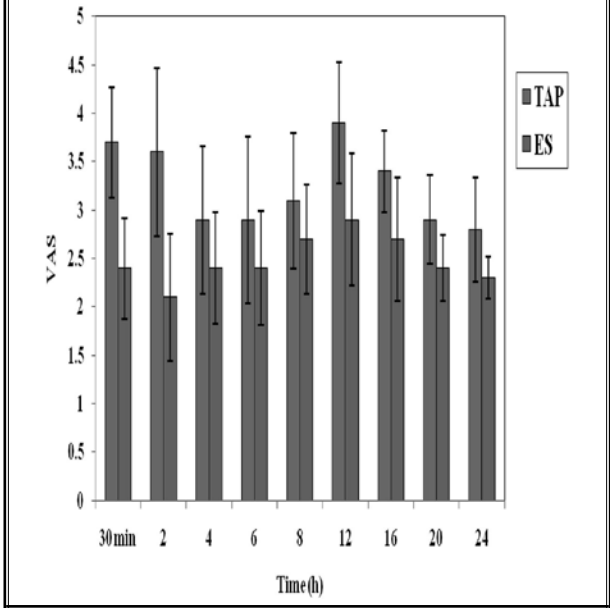

Fig. 4. *Trend of changes of postoperative visual analog pain score in both groups. Mean ± Standard deviation*

Discussion

Although ultrasound TAP block is an easy technique, decreases postoperative pain, and opioid consumption, it lacks visceral pain relief and limits the spread of local anesthetics (14). The ultrasound-guided ESP block is considered an alternative method that provides effective postoperative analgesia for breast and thoracic surgery when performed at the T4-5 and T7 level for abdominal surgery. ESP block improves the somatic and visceral pain by affecting the ventral ramus and rami communicates that contain sympathetic nerve fibers when local anesthetic spreads through the paravertebral space (5,15,16).

Our results have shown that ultrasound-guided bilateral single-shot ESP block performed at the end of the total abdominal hysterectomy significantly lowered VAS scores at postoperative measured times and was highly statistically significant at 30 minutes, 2, 12, 16, 20, and 24 hours when compared with TAP block. Altiparmak et al (17) found that the Numeric Rating Scale scores were statistically significantly lowered in the ESP group at postoperative 15, 30, and 60 minutes, and 12 and 24 hours compared with oblique subcostal TAP after laparoscopic cholecystectomy.

Tulgar et al (18) and Hamed et al (9) found that the postoperative VAS pain score was significantly higher in the control group for the first 12 hours postoperative and comparable to ESP block after total abdominal hysterectomy.

ESP block is a periparavertebral block that influences the somatic and visceral pain fibers (19). Goda et al (20) concluded that VAS scores were statistically significantly lowered in the ultrasound-guided paravertebral block (PVB) group in immediate postoperative, 2, 6, and 24 hours compared with the TAP block. Also, Dai et al (13) concluded that TAP block did not exhibit

Table 2. *Comparison of quality of analgesia between both groups.*

	Group ES (n = 24)	Group TA (n = 24)	Test	*P*
Time for requirement of first morphine dose (hrs)	14.81 ± 3.52	10.58 ± 2.35	T = 26.75	< 0.0001 (HS)
Total morphine consumption (mg) in 24 hrs	6.02 ± 1.2	7.31 ± 2.3	T = –2.4	0.01 (S)
Postoperative complications No. (%)				
Nausea	2 (8.33%)	6 (25%)	$\chi^2 = 2.35$	0.12 (NS)
Vomiting	1 (4.165)	4 (16.6%)	$\chi^2 = 1.95$	0.16 (NS)

Data are expressed as mean ± standard deviation, or number (%), $P < 0.0001$ was highly significant.
χ^2, chi-square test; HS, highly significant; NS, nonsignificant; S, significant.

superior analgesic efficacy after discharge from the postanesthesia care unit, nor did it reduce the total length of hospital stay in a study comparing TAP block with the conventional postoperative management. The explanation for the reduced TAP block effectiveness includes anatomic variations, which prevent the spread of local anesthetics, and the variable segmental origin of nerves in the anterior abdominal wall, which limit the usefulness of TAP block in lower abdominal procedures. Moreover, TAP blocks have been shown to be effective to relieve parietal pain (pain from skin and muscles from surgical incision) and not visceral pain (pain from intraabdominal structures) (21,22).

There were few studies that measured the time for requirement of first morphine in both ESP and TAP blocks severally and no study jointly. In the current study, the time to requirement of first morphine was 14.81 ± 3.52 hours in the ES group and 10.58 ± 2.35 hours in the TA group with a highly statistically significant increase in the ES group. These findings were in an array with a case series done by Luis-Navarro et al (23) who reported that the first rescue analgesic was required only at 16 hours after ESP block, whereas in a study comparing between ultrasound-guided TAP block and PVB in upper abdominal surgeries, the time to first order analgesia was ranging from 8 to 12 hours in the TAP group compared with 16 to 22 hours in the paravertebral group (20). In a recent cadaveric study, the results showed that ESP block produced epidural, neural foraminal, and intercostal spread of local anesthetics, and this more extensive spread of local anesthetics covered a larger dermatomal area than the TAP block (24).

Hamed et al (9) concluded that bilateral ESP block markedly decreased 24 hours postoperative fentanyl consumption compared with control group after total abdominal hysterectomy. Also, Altiparmak et al (17) found that postoperative tramadol consumption had been reduced > 30% in the ESP group compared with oblique subcostal TAP group. Moreover, Gurkan et al (25) reported that the mean morphine consumption at postoperative 24 hours was 5.6 ± 3.43 mg in the ESP group compared with 5.64 ± 4.15 mg in the PVB group, and 14.92 ± 7.44 mg in the control group. These agreed with our result as the total amount of morphine consumption in 24 hours was 6.02 ± 1.2 mg in the ES group compared with 7.31 ± 2.3 mg in the TA group with P = 0.01.

Postoperative nausea and vomiting is one of the most common problems and is an adverse reaction to opioids (26). In the Melnikov et al (10) study, the number of patients who developed nausea and vomiting were lower in the PVB group compared with TAP block group (4 patients need antiemetics in PVB group vs. 8 patients in TAP block group). No side effects or complications were recorded in the ESP block group compared with control group for postoperative analgesia after total abdominal hysterectomy (9). In our study, the total number of patients who developed nausea and vomiting was greater in the TA group but statistically insignificant compared with the ES group, otherwise no other opioid or bupivacaine side effects and no technique-related complications were noted. The explanations were as follows: first, TAP block dose not block visceral pain fibers, plus the area of block is of relatively poor vasculature decreasing occurrence of systemic side effects of local anesthetics (5). Second, the use of ultrasound technique reduces the occurrence of complication of both blocks. Third, the ESP block targets the musculofascial plane superficial to the TP, and the needle tip remains distant from pleura, major vessels, and discrete nerves. Finally, low volume of bupivacaine (14,27).

Table 3. *Patient satisfaction score in both groups.*

	Group ES (n = 24)	Group TA (n = 24)	χ^2	*P*
Unsatisfied	0 (0%)	4 (16.6%)	4.25	0.03 (S)
Satisfied	14 (58.3%)	12 (50%)	0.32	0.56 (NS)
Excellent	10 (41.6%)	8 (33.3%)	0.34	0.55 (NS)

Data are expressed as number (%). $P < 0.05$ was significant.
χ^2, chi-square test; NS, nonsignificant; S, significant.

In the present study, both groups were comparable regarding satisfaction analgesia, except there were 4 statistically significant unsatisfied patients in the TA group compared with zero in the ES group: this was in alignment with the Melnikov et al (10) study. The 4 unsatisfied patients in the TAP block group may be explained in a meta-analysis by Zhou et al (28) that showed TAP block is a safe postoperative analgesia for hysterectomy, but does not provide significant improvement in the recovery of the patients after hysterectomy.

Limitations

Sensorial evaluation of patients was not performed because both blocks had been done under general anesthesia but did not affect outcome. Therefore we recommended further studies comparing between both blocks.

Conclusions

Bilateral ultrasound-guided ESP block provides more potent and longer postoperative analgesia with less morphine consumption than TAP block after open total abdominal hysterectomy.

References

1. Pandy D, Sehgal K, Saxena A, Hebbar S, Nambiar J, Bhat RG. An audit of indications, complications, and justification of hysterectomies at a teaching hospital in India. *Int J Reprod Med* 2014; 2014:279273.
2. Imani F, Rahimzadeh P. Gabapentinoids gabapentin and pregabalin for postoperative pain management. *Anesth Pain Med* 2012; 2:52-53.
3. Woodhouse A, Mather LE. The effect of duration of dose delivery with patient-controlled analgesia on the incidence of nausea and vomiting after hysterectomy. *Br J Clin Phamacol* 1998; 45:57-62.
4. Elmarakbi WA, Kaki AM. Addition of dexmedetomidine to bupivacaine in transversus abdominis plane block potentiates post-operative pain relief among abdominal hysterectomy patients: A prospective randomized controlled trial. *Saudi J Anaesth* 2014; 8:161-166.
5. Forero M, Adhikary SD, Lopez H, Tsui C, Chin KJ. The erector spinae plane block: A novel analgesic technique in thoracic neuropathic pain. *Reg Anesth Pain Med* 2016; 41:621-627.
6. Tulgar S, Selvi O, Senturk O, Serifsoy TE, Thomas DT. Ultrasound-guided erector spinae plane block: Indication, complication, and effects on acute and chronic pain based on a single-center experience. *Cureus* 2019; 11:e3815.
7. Tulgar S, Senturk O. Ultrasound guided erector spinae plane block at L4 transverse process level provides effective postoperative analgesia for total hip arthroplasty. *J Clin Anesth* 2018; 44:68.
8. McCormack HM, Horne DJ, Sheather S. Clinical applications of visual analogue scales: A critical review. *Psychol Med* 1988; 18:1007-1019.
9. Hamed MA, Goda AS, Basiony MM, Fargaly OS, Abdelhady MA. Erector spinae plane block for postoperative analgesia in patients undergoing total abdominal hysterectomy: A randomized controlled study original study. *J Pain Res* 2019; 12:1393-1398.
10. Melnikov AL, Bjorgo S, Kongsgaard UE. Thoracic paravertebral block versus transversus abdominis plane block in major gynecological surgery: A prospective randomized, controlled, observer-blinded study. *Local Reg Anesth* 2012; 5:55-61.
11. Ross VH, Pan PH, Owen MD, et al. Neostigmine decreases bupivacaine use by patient-controlled epidural analgesia during labor: A randomized controlled study. *Anesth Analg* 2009; 109:524-531.
12. Adhikary SD, Liu WM, Fuller E, Cruz-Eng H, Chin KJ. The effect of erector spinae plane block on respiratory and analgesic outcomes in multiple rib fractures: A retrospective cohort study. *Anaesthesia* 2019; 74:585-593.
13. Dai C, Zhang K, Huang J. The efficacy of transversus abdominis plane block for abdominal hysterectomy post-operative analgesia. *Cureus* 2018; 10:e3131.
14. Hebbard PD. Transversalis fascia plane block, a novel ultrasound-guided abdominal wall nerve block. *Can J Anaesth* 2009; 56:618-620.
15. Thiruvenkatarajan V, Cruz Eng H, Adhikary SD. An update on regional analgesia for rib fractures. *Curr Opin Anaesthesiol.* 2018; 31:601-607.
16. Chin KJ, Malhas L, Perlas A. The erector spinae plane block provides visceral abdominal analgesia in bariatric surgery: A report of 3 cases. *Reg Anesth Pain Med* 2017; 42:372-376.
17. Altiparmak B, Toker Mk, Uysal AI, Kuscu Y, Demirbilek SG. Ultrasound-guided erector spinae plane block versus oblique subcostal transversus abdominis plane block for postoperative analgesia of adult patients undergoing laparoscopic cholecystectomy. *J Clin Anesth* 2019; 57:31-36.
18. Tulgar S, Kapakli MS, Senturk O, Selvi O, Serifsory TE, Ozer Z. Evaluation of ultrasound-guided erector spinae plane block for postoperative analgesia in laparoscopic cholecystectomy: A prospective, randomized, controlled clinical trial. *J Clin Trial* 2018; 49:101-106.
19. Chin KJ, Adhiky S, Sarwani N, Forero M. The analgesic efficacy of pre-operative bilateral erector spinae plane (ESP) blocks in patients having ventral hernia repair. *Anesthesia* 2017; 72:452-462.
20. Goda RME, Eldahshan TAE. Comparative study between ultrasound guided TAP and paravertebral block in upper abdominal surgeries. *Egypt J Anaesth* 2017; 33:41-45.
21. Rozen WM, Tran TM, Ashton MW, Barrington MJ, Ivanusic JJ, Taylor GI. Refining the course of the thoracolumbar nerves: A new understanding of the anterior abdominal wall. *Clin Anat* 2008; 21:325-333.
22. Gasanova I, Grant E, Way M, Rosero EB, Joshi GP. Ultrasound-guided transversus abdominal plane block with multimodal analgesia for pain management after total abdominal hysterectomy. *Arch Gynecol Obstet* 2013; 288:105-111.
23. Luis-Navarro JC, Seda-Guzman M, Luis-Moreno C, Chin KJ. Erector spinae plane block in abdominal surgery: Case series. *Indian J Anaesth* 2018; 62:549-554.
24. Das Adhikary S, Bernard S, Lopez H, Chin KJ. Erector spinae block versus retrolaminar block. *Reg Anesth Pain Med* 2018; 43:1.
25. Gurkan Y, Aksu C, Kus A, Yörükoglu UH. Erector spinae plane block and thoracic paravertebral block for breast surgery compared to IV-morphine: A randomized controlled trial. *J Clin Anesth* 2020; 59:84-88.
26. Watcha FM, White PF. Postoperative nausea and vomiting. Its etiology, treatment and prevention. *Anesthesiology* 1992; 77:162-184.
27. Carney J, Finnerty O, Rauf J, Curley G, McDonnell JG, Laffey JG. Ipsilateral transversus abdominis plane block provides effective analgesia after appendectomy in children: A randomized controlled trial. *Anesth Analg* 2010; 111:998-1003.
28. Zhou H, Ma X, Pan J, et al. Effects of transversus abdominis lane blocks after hysterectomy: A meta-analysis of randomized controlled trial. *J Pain Res* 2018; 11:2477-2489.