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ORIGINAL ARTICLE

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Comparative study of the efficacy of ultrasound-guided erector spinae block and oblique subcostal transversus abdominis plane block for postoperative analgesia after laparoscopic cholecystectomy

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Abstract

Background: Laparoscopic cholecystectomy has changed the surgical management of cholelithiasis and has become the mainstay of the management of uncomplicated gallstone disease. Adequate postoperative pain relief leading to early ambulation is imperative for patient satisfaction and early discharge of the patient. The use of ultrasound in anesthetic practice has ushered in a new era of ultrasound-guided blocks for postoperative analgesia, replacing the conventional methods. This study compares two modalities of postoperative pain relief, namely the oblique subcostal transversus abdominis plane block and the newer erector spinae plane block for patients undergoing laparoscopic cholecystectomy.

Results: Sixty patients between the age group 18 to 75 of ASA grades I, II, and III were enrolled in the study. The erector spinae plane block group showed lower numerical rating scores up to 12 h, a longer time period for the requirement of first rescue analgesic, and lower total analgesic consumption postoperatively compared to the oblique subcostal transversus abdominis plane block group. Both blocks were found to have minimal side effects.

Conclusions: The erector spinae plane block is superior to the oblique subcostal transversus abdominis plane block in that it affords lower pain scores and a longer duration of analgesia and reduces the total analgesic consumption after laparoscopic cholecystectomy.

Trial registration: Clinical Trials Registry of India/CTRI/2020/10/028603/ registered on 23 October 2020
http://ctri.nic.in/Clinicaltrials/rmaindet.php?trialid=47807&EncHid=18303.55562&modid=1&compid=19

Keywords: Postoperative analgesia, Laparoscopic cholecystectomy, Oblique subcostal transversus abdominis plane block, Erector spinae plane block

Background

Laparoscopic cholecystectomy is a minimally invasive surgery, which is the procedure of choice for the majority of patients with gallbladder pathologies. The traditional methods used for providing analgesia during the postoperative period include port-site infiltration with local anesthetics, intraperitoneal instillation of local anesthetics, analgesics given via insertion of epidural catheter,

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paravertebral blocks, or intravenous non-steroidal anti-inflammatory drugs/opioid administration.

Ultrasound-guided oblique subcostal transversus abdominis block (OSTAP) blocks somatic pain fibers and the deeper fibers of the anterior and lateral cutaneous branches of the 9th to 11th thoracic intercostal nerves.

Ultrasound-guided erector spinae plane block (ESPB) is a relatively new technique used for analgesia. It targets the ventral rami, dorsal rami, and rami communicantes of the spinal nerves and thus results in the blockage of both somatic and visceral pain.

Very few studies have been done comparing these two blocks for postoperative pain relief (Altiparmak et al. 2019; Malawat et al. 2020; Kamel et al. 2020). Moreover, further research is essential to evaluate the drug combination and concentration required to optimize the quality and duration of analgesia.

This study aimed to compare these two blocks, with the primary outcome being the estimation of the quality and duration of analgesia using the Numerical Rating Score (NRS), and the secondary outcome being the evaluation of the total consumption of rescue analgesics (tramadol and diclofenac), recording changes in hemodynamic parameters between the groups, and documentation of any complications.

Methods

This study was planned as a prospective, single-blind randomized study, and commenced after the Institutional Ethical Committee approval, and registration at Central Trials Registry. It was conducted in the general surgery operation theatre with postoperative follow-up of up to 24 h in the post-anesthesia care unit as well as in the postoperative wards.

This study comprised 60 patients, of ASA grades I–III, between the age group 18 and 75 years, planned for elective laparoscopic cholecystectomy. Patients with bleeding disorders, on anticoagulants, pre-existing cardiovascular disease, hypertension, hepatic or renal failure, or advanced psychiatric illness were not considered for the study; however, patients with diabetes on anti-diabetic treatment, with mild jaundice, were included after optimization of blood sugar levels.

Pre-anesthetic evaluation was conducted on the day preceding surgery. Baseline vitals of the patients including the heart rate, non-invasive blood pressure, and SpO_2 were recorded and baseline blood investigations were reviewed. Patients were informed regarding the numerical rating scale (NRS) with 0 being the absence of pain, and 10 being the worst pain imaginable, and how to quantify pain intensity between these two values.

Preoperatively, informed written consent was obtained from patients. After entering the operation theater, intravenous access was established, and patients were premedicated with ondansetron 0.15mg/kg, glycopyrrolate 0.004mg/kg, and fentanyl 2mcg/kg intravenously. All monitors including electrocardiogram, non-invasive blood pressure, pulse oximetry, and capnometry were applied. After premedication, preoxygenation was done with 100% oxygen and the patient was induced using propofol 2mg/kg and succinylcholine 2mg/kg. After the airway was secured, anesthesia was maintained using oxygen and sevoflurane 0.8–1.5% and atracurium 0.5mg/kg intravenously. Intraoperative local infiltration at the port site or intraperitoneal instillation was not done.

The CONSORT flow diagram of the study is shown in Fig. 1. Patients were randomly allocated into two groups, Group O (n=30) and Group E (n=30) with the help of computer-generated software. Group O (OSTAP group) was administered oblique subcostal transversus abdominis plane block, using 10ml of 0.375% bupivacaine 10 and 10ml of 1.5% lignoadrenaline. Group E (ESPB group) was administered erector spinae plane block at the T9 level using the same drug concentration.

All blocks were performed under complete aseptic precaution (under ultrasonographic guidance) using a high-frequency linear ultrasound probe. OSTAP block was performed in supine position. The transducer was placed immediately below the costal margin in the oblique plane and the rectus abdominis, transverse abdominis, internal oblique, and external oblique muscles were identified. A 21-gauge 8-cm needle was introduced using an in-plane approach, 2–3 cm lateral to the transducer from medial to the lateral direction. One to 2 mL of solution was injected between the rectus abdominis muscle and the transversus abdominis muscle. After confirming the correct placement of the needle, the rest of the anesthetic substance was injected along the subcostal line in the transversus abdominis plane. The block was performed bilaterally. ESP block was performed in lateral position and the transducer was placed in a longitudinal parasagittal orientation 3-cm lateral to the T9 spinous process. The erector spinae muscle was identified superficial to the tip of the T9 transverse process. An 18-gauge 8-cm needle was inserted using an in-plane superior to inferior approach to place the tip into the fascial plane on the deep (anterior) aspect of the erector spinae muscle. The location of the needle tip was confirmed by visible fluid spread lifting the erector spinae muscle off the bony shadow of the transverse process. The procedure was repeated on the other side.

After completing the block procedure, the neuromuscular block was reversed with neostigmine 0.05 mg/kg and glycopyrrolate 0.008mg/kg intravenously. Extubation was performed after the patient regained consciousness, and the patient was shifted to the postoperative room.

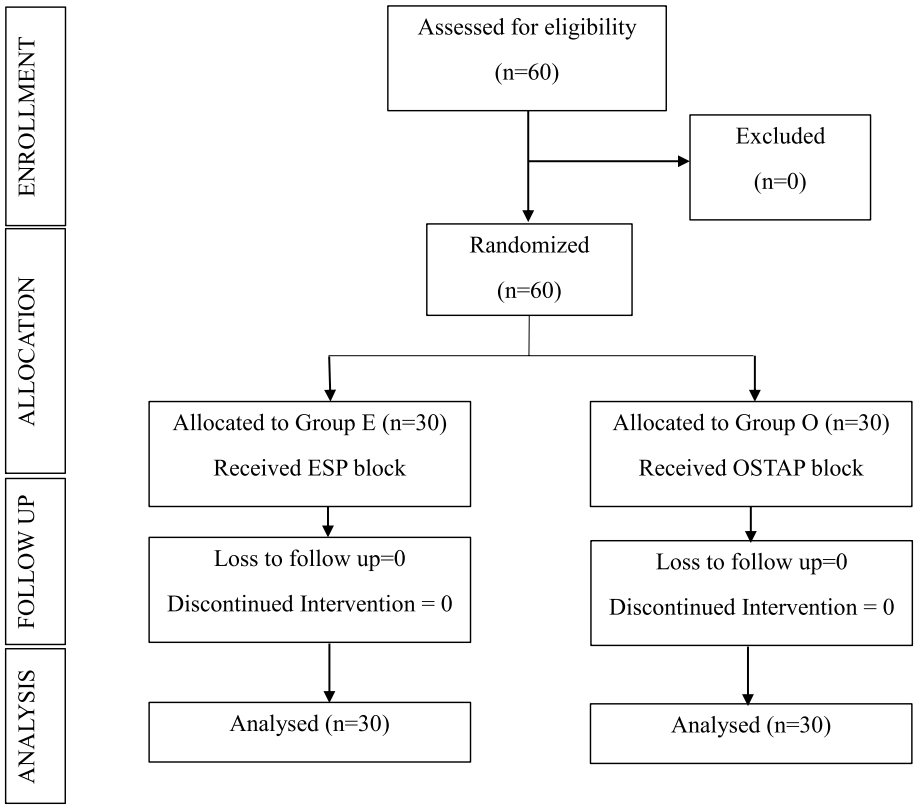

Fig. 1 CONSORT flow diagram of the study

The numeric rating scale (NRS) pain score was recorded from the 20th minute in the recovery room followed-up by 1, 3, 6, 12, and 24 h postoperatively. Intravenous tramadol 50–100mg as rescue analgesia was administered in patients with a NRS score of 3 and over, while intramuscular diclofenac was also administered for patients with NRS score of 7 and above in the postoperative period along with tramadol. In 24 h, the time of administration of first rescue analgesic given was noted. Postoperative vitals were documented.

Patients were also observed for complications such as local hematoma, subcutaneous emphysema, pneumothorax, signs of local anesthetic toxicity, signs of visceral or peritoneal injury, or motor weakness.

The sample size was calculated based on the previous study (Altiparmak et al. 2019) which revealed that at least 30 patients were needed in each group for the detection of 25% variation in NRS score at the 120th minute postoperatively with a power of 0.1 and a significance level 95% (α=0.05, $\beta = 0.9$).

The statistical analysis was done using Microsoft Excel. To find the significant difference between the bivariate samples in independent groups, the unpaired sample *t* test was used while chi-square test was used to find the significance in categorical data. In all the above statistical tools, the probability value *P* value <0.05 was considered significant.

Results

Demographic data and other baseline variables were comparable between the two groups (Table 1).

The hemodynamic parameters were also found to be comparable between the two groups at all time frames (Table 2)

The NRS scores were found to be significantly lower at 20min, 1 h, 3 h, 6 h, and 12 h post-procedure in Group E when compared to Group O (*P* value <0.05). The median NRS scores for all time periods are shown in Fig. 2.

The mean time to first rescue analgesic requirement was 10.7±7.4 h in Group E and 3.8±4.64 h in Group O,

Table 1 Demographic Characteristics and ASA Grades

	Group O	Group E	*P* value
Age in years (mean ± SD)	44 ±12.1	44± 10.1	0.96
M/F	10/20	13/17	0.43
BMI in kg/m^2 (mean ± SD)	23.9±3.1	24.3±2.8	0.63
ASA grade I/II/III	3/22/5	2/24/4	0.92

Table 2 Hemodynamic parameters of the two groups

	Group O (mean ± SD)	Group E (mean ± SD)	*P* value
HR (beats/min)	85± 9.33	84± 9.05	0.25
SBP (mmHg)	131± 11.4	129± 11.8	0.08
DBP (mmHg)	82± 9.7	81± 9.7	0.08

which was found to be statistically significant. The total tramadol consumption per patient in the 24-h period was significantly greater in Group O compared to Group E; however, the total diclofenac requirement was found to be comparable between the two groups (Table 3).

All blocks were performed smoothly without any incidence of significant bleeding, local hematoma, subcutaneous emphysema, pneumothorax, or signs of LA toxicity. Complications like peritoneal or visceral injured associated with OSTAP blocks were also not encountered in our study.

Discussion

Good postoperative analgesia is a significant component of adequate perioperative care. Truncal blocks are commonly used for postoperative pain management in various anterior and posterior abdominal surgeries and have gained popularity in anesthetic practice hand in hand with the gain in popularity of ultrasound-guided blocks, in view of their lower incidence of complications and higher safety margin. They are associated with improved perioperative outcomes, reduction in perioperative stress, improved patient satisfaction, coupled with a reduction in opioid consumption, fewer adverse effects, and lesser requirement of rescue analgesia.

In this study, postoperative NRS scores were found to be significantly lower in the ESPB group compared to the OSTAP group up to 12 h postoperatively. The NRS scores were found to be <3 of up to 6 h postoperatively in the ESPB group, and <3 only up to the 1st hour in the OSTAP group. The ESPB group was found to have a median NRS score of 3 up to 12 h postoperatively, whereas in the OSTAP group, the median NRS score remained 4 persistently from the 3rd postoperative hour up to the 24th hour.

The difference in duration in the results of the current study and the ones which were conducted previously could presumably be due to the difference in the local anesthetic agents used, shown in Table 4. The previously conducted studies reported a longer duration of analgesia and better NRS scores than were found in our study, suggesting that higher drug dosages of bupivacaine or use of ropivacaine would provide a significantly longer analgesic effect than the lignoadrenaline-bupivacaine combination

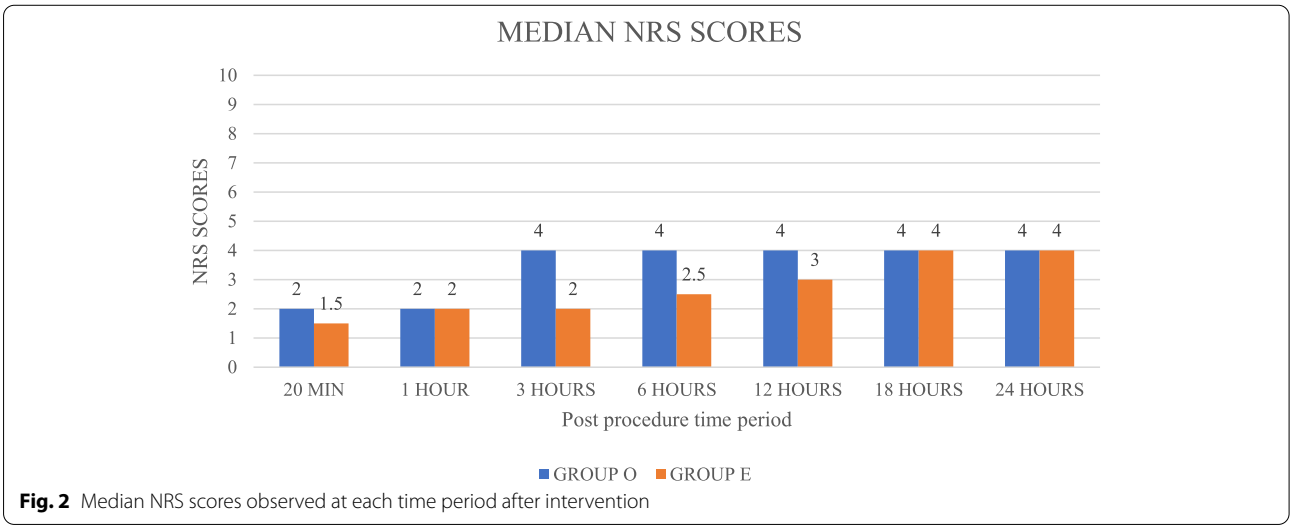

Fig. 2 Median NRS scores observed at each time period after intervention

Table 3 Rescue analgesic requirements of the two groups

	Group O	Group E	*P* value
Total tramadol consumption per patient in 24 h (mg) (mean ± SD)	150± 40.5	108± 51.4	0.001
95% confidence interval (lower limit, upper limit)	134.87, 165.13	88.82, 127.18	
Total diclofenac requirement per patient in 24 h (mg) (mean± SD)	9.3± 29.59	5.6± 17.3	0.56
95% confidence interval (lower limit, upper limit)	−1.7, 20.38	−0.18, 12.15	

(1:1 mixture of 0.375% bupivacaine and 1.5% lignoadrenaline) which was used in this study. Another difference to be noted is that these studies administered the blocks before the surgery, whereas the interventions in our study were carried out after the completion of the surgery, suggesting that administration of the blocks prior to surgery would result in a superior analgesic effect.

The time to first rescue analgesic was found to be 10.7±7.4 hours for the ESPB group, while it was 3.8±4.6 h for the OSTAP group. The difference between the two was found to be significant (P value < 0.05). Our findings are in agreement with a case series done by Luis Navarro (Luis-Navarro et al. 2018), who reported that the first rescue analgesic was required only at 16 h after ESP block, whereas in a study done by Goda (Goda et al. 2016) comparing ultrasound-guided TAP block and paravertebral block in upper abdominal surgeries, the time to first rescue analgesic was ranging from 8 to 12 h in the TAP group compared with 16 to 22 h in the paravertebral group. The case report done by Petsas (Petsas et al. 2018) on ESPB block in laparoscopic cholecystectomy also reported that the first rescue analgesic was given at 10 h post-procedure.

In the study conducted by Malawat (Malawat et al. 2020), comparing ESPB and TAP block in cesarean section patients using 0.2% ropivacaine, they found that the first rescue analgesic was given at a mean of 43.53 h in the ESPB group, compared to 12.07 h in the TAP group. Kamel (Kamel et al. 2020), who used 0.5% bupivacaine with adrenaline 5mcg/ml) also found that the mean time for the first requirement of morphine was 14.8 h in the ESPB group, compared to 10.5 h in the TAP group in patients who underwent a total hysterectomy. Both these studies are comparable to our study, though the difference in time duration could be attributed to the difference in the drugs used.

The results of the present study demonstrated that the total tramadol consumption per patient was significantly lower in the ESPB group compared to the OSTAP group. However, the total diclofenac requirement was found to be comparable between the two groups.

Similarly, Verma (Verma et al. 2020) recorded a significantly lower number of patients who required rescue analgesics (diclofenac) in the ESPB group (66%) compared to the control group (88%) in the first 24 h postoperatively (P value = 0.019). However, total diclofenac consumption was found to be comparable between the two groups. They also found intraoperative fentanyl consumption to be significantly lower in the ESPB group compared to the control group.

In this study, ESP block was administered at T9 vertebral level, taking into consideration the previously conducted studies, which have documented ESP block given between levels T6–T10 for laparoscopic cholecystectomies (Petsas et al. 2018; Altiparmak et al. 2019; Verma et al. 2020; Aksu

Table 4 Methods and observations of prior studies

Study	Groups	Drug	Observation
Altiparmak et al. 2019	OSTAP	Pre-emptive Bupivacaine 0.375%	NRS≤ 3.5 (12 h), ≤ 1.5 (24 h)
	ESPB at T7 level	Pre-emptive Bupivacaine 0.375%	NRS≤3 (12 h), ≤ 1.25 (24 h)
Suseela et al. 2018	OSTAP	Bupivacaine 0.25%	NRS ≤2 with rescue tramadol
	Port site infiltration	Bupivacaine 0.5%	NRS ≤3 with rescue tramadol + diclofenac
Verma et al. 2020	ESPB at T7 level	Pre-emptive Ropivacaine 0.375%	VAS score ≤3 (static), ≤4.5 (dynamic) up to 48 hours
	control group	Normal saline	VAS score ≤5 (static), ≤6.5 (dynamic) up to 48 h
Breazu et al. 2016	OSTAP	Pre-emptive Bupivacaine 0.25%	NRS<3 up to 24 h
	Control group	Normal saline	NRS≤4 up to 24 h
Aksu et al. 2019	ESPB at T8 level	Pre-emptive Bupivacaine 0.25%	NRS=0, 78.3% patients at 12 h, 82.6% patients at 24 h
	Control group	No intervention	NRS=0, 43.5% patients at 12 and 24 h
Vrsajkov et al. 2018	OSTAP	Pre-emptive Bupivacaine 0.33%	NRS <4 up to 2 h, <3 up to 16 h
	Control	Postoperative Systemic analgesics	NRS <6 up to 2 h, <4 up to 16 h
Shin et al. 2014	OSTAP	Pre-emptive Ropivacaine 0.375%	NRS <3 at rest, <4 on coughing (24 h)
	TAP	Pre-emptive Ropivacaine 0.375%	NRS<4.5 at rest, <5 on coughing (24 h)
	Control group	Postoperative Systemic analgesics	NRS 3–7 at rest, 3–8 on coughing (24 h)
Tolchard et al. 2012	OSTAP	Pre-emptive Bupivacaine 1mg/kg	VPAS <40 (1st hour), <20 (4th hour)
	Port site	Postoperative Bupivacaine 1mg/kg	VPAS <50 (1st hour), <40 (4th hour)
Petsas et al. 2018 (case report)	ESPB at T6-T7 level	Pre-emptive Ropivacaine 0.375%+ 2 mg dexamethasone	NRS = 0 (<6 , 2–3 (at the 6th hour), 4–5 (at the 10th hour)
Baran et al. 2020 (case report)	ESPB at T10 level	Pre-emptive Bupivacaine 0.25%	VAS <2 up to 12 h, 4 after 12 h

et al. 2019; Baran et al. 2020), detailed in Table 4. Different studies have theorized regarding the possible spread of the local anesthetic drug after injection into the erector spinae plane. Chin (Chin et al. 2017) hypothesized that injection of 20mL of the drug into the erector spinae plane would result in the local spread of the drug at least three segments cranially and four segments caudally and that it would perhaps be most appropriate to inject the drug at the vertebral level corresponding to the midpoint of the desired analgesic field, while Hannig (Hannig et al. 2018) postulated that injection between level T7 and T9 would result in drug spread to levels T6–T12 segments.

The main limitation of this study was the relatively small number of patients. Sensory testing for the mapping of the ESP block area was not performed. Further research is still required to determine the optimal volume and concentration of the drugs to be administered.

Conclusions

Erector spinae plane block under ultrasound guidance for laparoscopic cholecystectomy provides a longer duration and better quality of postoperative analgesia, as well as reducing the postoperative analgesic consumption when compared to oblique subcostal transversus abdominis plane block for laparoscopic cholecystectomy. Both blocks are mostly devoid of complications, and they provide reliable and effective postoperative analgesia in patients undergoing laparoscopic cholecystectomy.

Abbreviations

%: Percentage; ASA: American Society of Anesthesiologists; BP: Blood pressure; HR: Heart rate; M: Male; F: Female; SD: Standard deviation; ESPB: Erector spinae plane block; OSTAP: Oblique subcostal transversus abdominis plane block; NRS: Numerical rating scale.

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Authors' contributions

SE: design of the work, acquisition, analysis, and interpretation of the data and contribution to the paper writing and work revision. *AD*: acquisition, analysis, and interpretation of the data and contribution to the paper writing and paper submission. *MK*: acquisition, analysis, and interpretation of the data and contribution to the paper writing. The authors have read and approved the final manuscript.

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Declarations

Ethics approval and consent to participate

This single-blind randomized control study was conducted after approval from the Institutional Ethics Committee, BJ Medical College and Civil Hospital, Ahmedabad, and after obtaining informed consent from patients.
Ethical Committee Registration Number: ECR/72/Inst/GJ/2013/RR-2019
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Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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References

Aksu C, Kus A, Yorukoglu HU, Kilic CT, Gurkan Y (2019) The effect of erector spinae plane block on postoperative pain following laparoscopic cholecystectomy: a randomized controlled study. Anestezi Dergisi 27:9–14. https://doi.org/10.5222/jarss.2019.14632

Altıparmak B, Korkmaz Toker M, Uysal AI, Kuşçu Y, Gümüş DS (2019) Ultrasound-guided erector spinae plane block versus oblique subcostal transversus abdominis plane block for postoperative analgesia of adult patients undergoing laparoscopic cholecystectomy: randomized, controlled trial. J Clin Anesth 57:31–36. https://doi.org/10.1016/j.jclinane.2019.03.012

Baran O, Kır B, Şahin A et al (2020) Erector spinae plane block in laparoscopic cholecystectomy: a case report. Ain-Shams J Anesthesiol 12:2. https://doi.org/10.1186/s42077-020-0053-7

Breazu CM, Ciobanu L, Hadade A, Bartos A, Mitre C, Mircea PA, Ionescu D (2016) The efficacy of oblique subcostal transversus abdominis plane block in laparoscopic cholecystectomy - a prospective, placebo controlled study. Rom J Anaesth Intensive Care 23(1):12–18. https://doi.org/10.21454/rjaic.7518.231.obq

Chin KJ, Adhikary S, Sarwani N, Forero M (2017) The analgesic efficacy of preoperative bilateral erector spinae plane (ESP) blocks in patients having ventral hernia repair. Anaesthesia 72(4):452–460. https://doi.org/10.1111/anae.13814

Elsayed Goda RM, Eldahshan TAEK (2016) Comparative study between ultrasound guided TAP block and paravertebral block in upper abdominal surgeries. Egypt J Anaesth. https://doi.org/10.1016/j.egja.2016.11.004

Hannig KE, Jessen C, Soni UK, Børglum J, Bendtsen TF (2018) Erector spinae plane block for elective laparoscopic cholecystectomy in the ambulatory surgical setting. Case Rep Anesthesiol 2018:5492527. https://doi.org/10.1155/2018/5492527

Kamel AAF, Amin OAI, Ibrahem MAM (2020) Bilateral ultrasound-guided erector spinae plane block versus transversus abdominis plane block on postoperative analgesia after total abdominal hysterectomy. Pain Physician 23(4):375–382 PMID: 32709172

Luis-Navarro JC, Seda-Guzmán M, Luis-Moreno C, Chin KJ (2018) Erector spinae plane block in abdominal surgery: case series. Indian J Anaesth 62(7):549–554. https://doi.org/10.4103/ija.IJA_57_18

Malawat A, Verma K, Jethava D, Jethava DD (2020) Erector spinae plane block and transversus abdominis plane block for postoperative analgesia in cesarean section: a prospective randomized comparative study. J Anaesthesiol Clin Pharmacol 36(2):201–206. https://doi.org/10.4103/joacp.JOACP_116_19

Petsas D, Pogiatzi V, Galatidis T, Drogouti M, Sofianou I, Michail A, Chatzis I, Donas G (2018) Erector spinae plane block for postoperative analgesia in laparoscopic cholecystectomy: a case report. J Pain Res 11:1983–1990. https://doi.org/10.2147/JPR.S164489

Shin HJ, Oh AY, Baik JS, Kim JH, Han SH, Hwang JW (2014) Ultrasound-guided oblique subcostal transversus abdominis plane block for analgesia after laparoscopic cholecystectomy: a randomized, controlled, observer-blinded study. Minerva Anestesiol 80(2):185–193

Suseela I, Anandan K, Aravind A, Kaniyil S (2018) Comparison of ultrasound-guided bilateral subcostal transversus abdominis plane block and port-site infiltration with bupivacaine in laparoscopic cholecystectomy. Indian J Anaesth 62(7):497–501. https://doi.org/10.4103/ija.IJA_55_18

Tolchard S, Davies R, Martindale S (2012) Efficacy of the subcostal transversus abdominis plane block in laparoscopic cholecystectomy: comparison with conventional port-site infiltration. J Anaesthesiol Clin Pharmacol 28(3):339–343. https://doi.org/10.4103/0970-9185.98331

Verma R, Srivastava D, Saxena R, Singh TK, Gupta D, Agarwal A, Mishra P (2020) Ultrasound-guided bilateral erector spinae plane block for postoperative analgesia in laparoscopic cholecystectomy: a randomized controlled trial. Anesth Essays Res 14(2):226–232. https://doi.org/10.4103/aer.AER_41_20

Vrsajkov V, Mančić N, Mihajlović D, Milićević ST, Uvelin A, Vrsajkov JP (2018) O bloqueio do plano transverso abdominal subcostal pode melhorar a analgesia após colecistectomia laparoscópica [Subcostal transversus abdominis plane block can improve analgesia after laparoscopic cholecystectomy]. Braz J Anesthesiol 68(2):149–153. https://doi.org/10.1016/j.bjan.2017.10.006

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