Turan *et al.*
Ain-Shams Journal of Anesthesiology (2023) 15:52
https://doi.org/10.1186/s42077-023-00346-2

Ain-Shams Journal of Anesthesiology

ORIGINAL ARTICLE

Open Access

Effects of ultrasound-guided erector spinae plane block in radical prostatectomy surgery on pain and surgical stress response

Damla Turan[1], Mesure Gul Nihan Ozden[2*] and Hasan Kocoglu[2]

Abstract

Background Erector spina plane block, as a part of a multimodal approach in perioperative pain management, is effective in many surgical procedures on pain management. The aim of this prospective, randomized, controlled study was to investigate the effects of erector spinae plane block on pain, analgesic consumption, and surgical stress in radical prostatectomy operations.

Results Forty-six patients operated for elective open radical prostatectomy surgery were randomly allocated to Group B ($n=23$) and Group K ($n=23$). Ultrasound-guided erector spinae plane block was performed bilaterally on patients in Group B, while group K was the control group. Remifentanil and tramadol consumption, rescue analgesic need, pain scores, and nausea-vomiting scores were less in Group B. While there was no difference in glucose, cortisol, insulin, and C-reactive protein values at all times between groups, postoperative 24-h prolactin values were higher in Group B. Shapiro–Wilk test, Student *t*-test, and Mann–Whitney *U*-test were used for statistical analysis.

Conclusions Ultrasound-guided erector spinae plane block is an effective analgesic method in radical retropubic prostatectomy surgeries providing a reduction in intraoperative and postoperative opioid consumption but has limited effect on the surgical stress response.

Trial registration ClinicalTrials NCT05170373, Registered 11/03/2021 — retrospectively registered.

Key messages

Acute pain develops as a result of tissue damage caused by surgical trauma in radical prostatectomy. Erector spina plane block applying local anesthetic between the erector spina muscle and the vertebral transverse has provided effective perioperative pain management.

Keywords Nerve blocks, Postoperative pain, Postoperative nausea and vomiting, Regional anesthesia

Background

Retropubic radical prostatectomy is the preferred surgical method in prostate cancer (Lepor 2001). But acute pain in open surgery is one of the causes of postoperative morbidity and mortality (Coluzzi et al. 2009). Regional anesthesia has been shown to be effective in suppressing the stress response to surgery (Desborough 2000, Capdevila et al. 2017).

*Correspondence:
Mesure Gul Nihan Ozden
nihanozdenn@gmail.com
[1] Kocaeli Darıca Farabi Training and Research Hospital, Darica, Kocaeli, Turkey
[2] Istanbul Medeniyet University Goztepe Prof. Dr. Suleyman Yalcın City Hospital, Darica, Turkey

Erector spinae plane block (ESPB) was first used by Forero et al. in 2016, and it has been performed in different surgeries later on (Forero et al. 2016).

In this study, we aimed to investigate the effects of ultrasound-guided erector spinae plane block on perioperative pain and stress response to surgery in patients undergoing radical prostatectomy operation.

Methods

This prospective, randomized, controlled study was conducted in Istanbul Medeniyet University Goztepe Prof. Dr. Suleyman Yalcın City Hospital. Anesthesiology and Reanimation Clinic after receiving the permission of the local ethical committee (no: 2020/0343, date: 24 June 2020) and registering on ClinicalTrials.gov (NCT05170373). It has been completed with 46 patients aged 30–74 years, ASA I–III, who underwent radical prostatectomy. Patients with coagulopathy, local anesthetic drug allergy, hormonal disorder, advanced organ failure, history of steroid use, vertebral anomalies, and mental retardation were not included in the study. All necessary written consents were obtained from the patients before the operation.

The patients were divided into two groups: Group B ($n=23$) and Group K ($n=23$) by randomization method using closed envelopes and computer-generated randomization codes by the SPSS v23.0 (IBM, New York, USA). Considering the diurnal rhythm of the hormones, the patients were planned to be operated on as the first case in the morning. In addition to heart rate (HR), peripheral oxygen saturation (SpO2), and noninvasive arterial blood pressure monitoring, bispectral index (BIS) (A-2000 Aspect Medical Systems, USA) monitoring was also applied during the operation.

Before general anesthesia induction, ESP block was performed to the patients in Group B. After the prone position was placed, the transverse processes of the T11 vertebra were visualized by ultrasound (Samsung Ultrasound H60; Hampshire, Korea) with the linear probe. Bupivacaine HCl (Buvacin 0.5% 20, Vem drug, Tekirdag, Turkey) 10 mL, lidocaine HCl (Aritmal 2% 5, Osel drug, Istanbul, Turkey) 5 mL, and 0.9% NaCl 5 mL were injected via a needle (Stimuplex B, 21-gauge 50 mm, Braun R, Melsungen, AG, Germany) above the erector spinae muscles bilaterally. ESP block was not applied to Group K patients.

All patients have received midazolam (Zolamide 5 mg, Vem drug, Tekirdag, Turkey) 0.1 mg/kg iv, fentanyl (Talinat 0.5 mg, Vem drug, Tekirdag, Turkey) 1 mcg/kg iv, and propofol (Propofol %1 Fresenius, Fresenius Kabi, Australia GmbH) 2 mg/kg iv for induction of anesthesia. Muscle relaxation was provided with rocuronium bromide (Esmeron 50 mg, MSD drug, Istanbul, Turkey) 0.6 mg/kg iv, and patients were intubated with an appropriate-size endotracheal tube. Volume-controlled mechanical ventilation (Datex-ohmeda S/5 Avance GE Healthcare, Madison, USA) with a tidal volume of 6–8 mL/kg, frequency of 10–12/min, and 40% FiO2 oxygen in the air was set to keep EtCO2 between 35 and 45 mmHg. For the maintenance of anesthesia, sevoflurane (Sevorane®100 mL, Abbott, UK) MAC was adjusted to 0.8–1, and remifentanil (Ultiva®, Glaxo Smith Kline, Istanbul, Turkey) 0.05–0.1 mcg/kg/min infusion was administered to keep BIS value between 40 and 60. Intraoperative adequate muscle relaxation provided with rocuronium 10-mg iv boluses. Crystalloid fluids were given for fluid replacement therapy according to fluid deficits, loss of blood, and urine output. Mean arterial pressure (MAP), HR, SpO_2, and BIS of the patients were recorded intraoperatively. All patients received paracetamol 1 g iv for postoperative analgesia at the end of the surgery. Patients were received with atropine (Atropine Sulfate, Osel, Istanbul, Turkey) 0.015 mg/kg iv and neostigmine (Neostigmine® Ampoule 0.5 mg/mL, Adeka, Samsun, Turkey) 0.03 mg/kg iv before extubated. The total amount of remifentanil consumed during the surgery was recorded.

Patient-controlled analgesia (PCA) (CADD-Legacy® PCA, Smith Medical ASO, Inc., St. Paul) was prepared with tramadol (Tramosel, 100 mg/2-mL amp, Haver, Turkey) 500 mg in 100 mL of 0.9% NaCl and adjusted to a 2-mL bolus, 20-min lockout time.

Postoperative pain of the patients was evaluated by numerical rating scale (NRS), with 0 = no pain and 10 = most severe pain. Patients with modified Aldrete score of > 8 and $NRS \leq 4$ in the recovery room were transferred to the ward. Patients with NRS score of 4 and above were planned to receive paracetamol (Parol flakon®, 100 mL, Atabey, Istanbul, Turkey) 1 g iv and Tenoxicam (Tilcotil®, Roche, Istanbul, Turkey) 20 mg iv as rescue analgesia. Postoperative nausea and vomiting (PONV) were evaluated with verbal descriptive scale (0 = none, 1 = mild nausea, 2 = moderate nausea, 3 = vomiting once, 4 = multiple vomiting), and ondansetron (Kemoset, 8 mg/4 mL, Deva, Turkey) 4 mg iv was planned to receive when the PONV score was above 2. NRS scores, need for rescue analgesia, and nausea-vomiting scores were recorded at the time of transferring the recovery room, 5th min, 20th min, 1st, 3rd, 6th, 12th, 18th, and 24th h, postoperatively. Postoperative 24-h tramadol consumption of all patients was recorded.

Blood samples (15 mL) were taken at 06:00 on operation day, end of the operation, and postoperative 24th h. The samples were transported with cold chain conditions, then centrifuged at 4000 rpm for 10 min in the laboratory, and separated into serum and plasma. They

were taken into 3 separate Eppendorf tubes and stored at − 80 °C. On the day of the study, the blood was brought back to room temperature. Glucose and CRP were studied in the Abbott Architect c16000 biochemistry device, and cortisol, insulin, and prolactin were studied in the Abbott Architect i2000SR immunoassay device.

Statistical evaluation of the data in the study was made with the IBM SPSS 22 (Statistical Package for Social Sciences 22) program. While evaluating the study data, numbers and percentages were presented for descriptive statistical categorical variables and mean ± standard deviation for normally distributed continuous variables. The existence of normal distribution in the quantitative data was checked with the Shapiro–Wilk test, the Student *t*-test was used for the comparisons of the normally distributed parameters, and the Mann–Whitney *U*-test was used for the intergroup comparisons of the non-normally distributed parameters. In intragroup comparisons, paired sample *t*-test was used for parameters with normal distribution, and Wilcoxon sign test was used for parameters that did not show normal distribution. The results were considered statistically significant when the two-way *p*-value was $p < 0.05$, with a confidence interval of 95%.

G*Power 3.1 software package (G*Power 2, Heinrich-Heine University, Dusseldorf, Germany) was used for power analysis. In the power analysis based on sample literature studies, the minimum number of patients to be included in the study was determined as 42 in both groups.

Results

This study was conducted with 46 patients who underwent radical prostatectomy in a city hospital between June 2020 and May 2021. No statistical difference was found in demographic data ($p > 0.05$) and nausea-vomiting scores ($p = 0.67$) of patients (Table 1).

There was no statistical difference in BIS values except for the 60th min which was measured lower in Group B ($p = 0.002$). While there was no statistically significant difference in the HR between the groups during the operation ($p > 0.05$), the HR at the 0th min and 15th min at recovery were found statistically lower in Group B ($p = 0.047$, $p = 0.042$). There was no statistically significant difference in MAP and SpO_2 values between the groups ($p > 0.05$).

While there was no statistically significant difference in the duration of surgery and duration of anesthesia between the groups ($p > 0.05$), remifentanil consumption was found to be significantly lower in Group B ($p = 0.028$). While all-time NRS scores were found to be statistically significantly lower in Group B ($p < 0.05$), the differences in the 5th min, 20th min, 1st h, 3rd h, and 6th h were highly significant ($p < 0.001$). Postoperative tramadol consumption was found to be significantly lower in Group B ($p < 0.001$) (Table 1). While no statistically significant difference was found between groups in rescue analgesia requirement ($p > 0.05$), the total number of patients receiving rescue analgesia was lower in Group B ($p = 0.003$) (Fig. 1).

While prolactin values were statistically high in Group B when the surgical incision started to close ($p = 0.027$), there was no statistical difference between the groups in preoperative and postoperative values ($p > 0.05$). There was no statistical difference between the groups in the same time measurements of cortisol, insulin, glucose, and CRP values at all times ($p > 0.05$) (Table 2).

Discussion

Regional anesthesia, which is a part of the multimodal approach in perioperative pain management, is highly effective on somatic and visceral pain (Chitnis et al.

Table 1 Patient demographics, clinical characteristics, analgesic requirements, and NV scores

	Group K (*n*: 23)	Group B (*n*: 23)	*p*-value
Age (years)	65.17 ± 4.9	66.35 ± 6.7	0.122
Weight (kg)	82.39 ± 14.7	79.82 ± 9.6	0.072
Height (cm)	176.09 ± 8.1	174.22 ± 7.7	0.858
ASA (I, II)	2 (%8.7), 21 (%91.3)	5 (%21.7), 18 (%78.3)	0.094
Anesthesia time (min)	142.39 ± 36.1	164.56 ± 37.9	0.666
Surgery time (min)	120.43 ± 28.6	135.65 ± 31.5	0.383
Remifentanyl consumption rate (μg/kg/min)	0.0812 ± 0.037	0.0233 ± 0.020	**0.028**
Tramadol consumption (mg)	442.17 ± 64.0	208.70 ± 88.9	**< 0.001**
PONV scores	1.26 ± 0.8	1.17 ± 0.8	0.671

Data are given as mean ± standard deviation or frequency and percentage

ASA American Society of Anesthesiologists, *kg* kilogram, *cm* centimeter, *m* meter, *μg* microgram, *mg* milligram, *min* minute

PONV postoperative nausea and vomiting

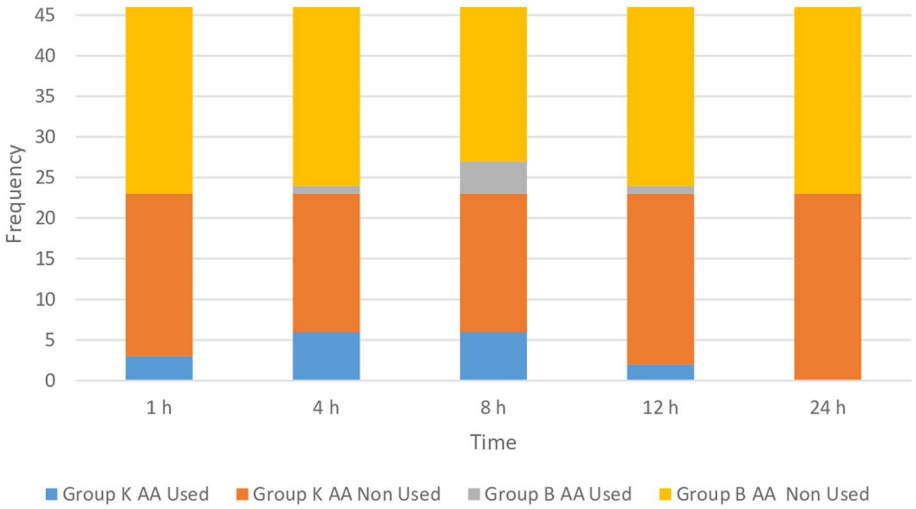

Fig. 1 Number of patients that need rescue analgesia

Table 2 Biochemistry data of groups

		Group K (n: 23)	Group B (n: 23)	*p*-value
Prolactin	Preop[a] at 06:00 (μg/L)	23.39 ± 18.4	28.52 ± 16.9	0.170
	When the surgical incision is started to closing (μg/L)	39.99 ± 25.2	47.61 ± 15.8	**0.027**
	Post-op[2] 24 h (μg/L)	10.88 ± 5.4	15.31 ± 9.1	0.077
Cortisol	Preop[a] at 06:00 (μg/L)	13.81 ± 3.5	14.81 ± 6.1	0.725
	When the surgical incision is started to closing (μg/L)	15.74 ± 11.2	16.66 ± 8.01	0.385
	Post-op[2] 24 h (μg/L)	18.13 ± 10.0	16.06 ± 6.0	0.684
Insulin	Preop[a] at 06:00 (μg/L)	7.09 ± 5.3	6.21 ± 4.6	0.462
	When the surgical incision is started to closing (μg/L)	8.88 ± 9.8	6.52 ± 4.6	0.800
	Post-op[2] 24 h (μg/L)	19.42 ± 19.1	15.50 ± 7.7	0.717
Glucose	Preop[a] at 06:00 (μg/L)	110.26 ± 20.3	109.34 ± 21.2	0.367
	When the surgical incision is started to closing (μg/L)	128.78 ± 20.8	140.87 ± 37.5	0.442
	Post-op[b] 24 h (μg/L)	132.35 ± 28.4	133.48 ± 56.7	0.240
CRP	Preop[a] at 06:00 (μg/L)	0.33 ± 0.8	0.34 ± 0.6	0.751
	When the surgical incision is started to closing (μg/L)	0.41 ± 0.7	0.34 ± 0.5	0.409
	Post-op[b] 24 h (μg/L)	78.16 ± 28.8	83.62 ± 31.2	0.846

[a] Preoperative

[b] Postoperative

2020). In recent years, ESP block, which is defined as a field block, has become widespread in pain management due to its ease of application and fewer complications (Saadawi et al. 2021). Providing effective analgesia with a single injection and reducing the number of repeated invasive procedures are an important advantage of ESP block. Studies have shown that the local anesthetic applied in ESP block spreads to the paravertebral area and reaches the ventral branches of the spinal branches via the costa transfer foramen (Choi et al. 2019, Elsharkawy et al. 2019). ESP block administered at a single vertebral level can be effective at least five levels (Ueshima and Hiroshi 2018). Greater dermatomal spread and greater block efficiency can be achieved by applying more volume in the ESP block, as in other volume-dependent area blocks (Choi et al. 2019, Tulgar et al. 2019a).

A study similar to ours was conducted by Dost et al. 2021 performed in open radical prostatectomy operations. They found that ESP block at the T11 level decreased postoperative first-hour NRS scores, but did not decrease total morphine consumption for 24 h, and rescue analgesia requirement was lesser in the first hour postoperatively in patients with block. Tulgar, Selvi, Senturk, Serifsoy, and

Thomas have created effective and long-lasting postoperative analgesia with ESP block at the T9 level in radical retropubic prostatectomy (Tulgar et al. 2019b). In a different study, paravertebral block, which is one of the field blocks, provided effective postoperative analgesia when applied at T10-11–12 levels in radical retropubic prostatectomy operations (Chelly et al. 2011). ESP block performed at the T9 level in patients who had total abdominal hysterectomy reduced postoperative 24-h VAS scores and fentanyl consumption (Hamed et al. 2019). It has been reported that intraoperative and postoperative opioid consumption is less in patients who underwent laparoscopic cholecystectomy with ESP block added to the rectus sheath block (Kwon et al. 2020). In hip fracture surgeries, ESP block, quadratus lumborum block, and standard IV analgesia protocol were compared, and they found that ESP block and quadratus lumborum block reduce pain scores and decrease opioid consumption similarly (Tulgar et al. 2018). ESP block not only reduced 24-h NRS scores and tramadol consumption but also reduced the need for rescue analgesics in laparoscopic cholecystectomy surgeries (Beverly et al. 2017). A meta-analysis mentioned ESP block has moderate evidence of reducing postoperative pain, opioid consumption, and PONV (Kendall et al. 2020). In our study, similar to the studies in the literature, postoperative NRS was found to be lower in patients in the block group at all times, and also, intraoperative total remifentanil and postoperative tramadol consumption were found to be lower in the ESP block group. The total number of patients who received rescue therapy with paracetamol and/or tenoxicam in addition to PCA was less in the block group. Although there was no statistical difference between the groups when evaluated hourly, we observed that the additional analgesic consumption was lower in the ESP block group. But the nausea and vomiting scores of our patients were similar in both groups, unlike the literature.

Since there is no study in the literature examining the effect of ESP block on surgical stress, we compared our findings with studies of area blocks and epidural blocks. Studies have shown that epidural block from the upper thoracic level does not increase serum ACTH and cortisol level and suppresses the hormonal response to surgical stress when compared to blocks from the lower thoracic level (Naito et al. 1992). It was reported that sensory block at the T4 level, which occurs with the epidural block in major urology surgeries, reduces catecholamine and cortisol levels, reduces stress response, and provides rapid recovery (Brodner et al. 2001). We think that the reason for the lack of significant changes in hormones indicating surgical stress is related to the level of the block. The block at the T11 level may not have suppressed the hormonal response sufficiently. While the MAP values of the groups were similar in our study, HR values were found to be lower in Group B at the time of recovery, but not during surgery, suggesting that ESP block may have positive effects in controlling the hemodynamic response to a surgical stimulus.

It has been shown when epidural anesthesia is applied in addition to general anesthesia, CRP values start to increase in the postoperative 12th h and remain high until the 48th h, similar to patients who achieved only general anesthesia (Moore et al. 1994). Bagry et al. found that lumbar plexus and sciatic nerve block decreased CRP values and leukocyte count (Bagry et al. 2008). CRP values were found to be high postoperatively in both groups, and no effect of ESP block on CRP has been demonstrated in our study.

Our study includes some limitations. Since pain is a subjective concept, and pain treatment needs to be tailored to the patient, standardization could not be established. Also, the patients were observed only for the first 24 h, and the long-term effects of ESP block on pain scores could not be evaluated.

Conclusions

We have found in our study that ultrasound-guided ESP block, which is a part of multimodal analgesia, has a positive effect on pain control as it reduces intraoperative and postoperative analgesic consumption and decreases pain scores in radical retropubic prostatectomy operations. In our study, no positive effect of ESP block applied at the T11 level before general anesthesia on the current surgical stress was observed. We believe that studies with a higher number of patients are needed in this regard.

Abbreviations

ESPB	Erector spinae plane block
HR	Heart rate
SpO2	Peripheral oxygen saturation
BIS	Bispectral index

Acknowledgements

Nil

Authors' contributions

Concept and design of study were made by DT and MGNO. DT, MGNO, and HK were involved in defining intellectual content, literature search, data acquisition, data analysis, statistical analysis, manuscript preparation, manuscript editing, and manuscript review of the article. All authors have read and approved the final manuscript.

Funding

Nil

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Ethical approval was taken from Ethics Committee of Istanbul Medeniyet University Goztepe Research Hospital, via reference number 2020/0343, dated 24 June 2020. Written informed consent for participation was obtained from the patient.

Consent for publication
Written informed consent was taken from the participants.

Competing interests
The authors declare that they have no competing interests.

Received: 4 October 2022 Accepted: 16 June 2023
Published online: 11 July 2023

References

Bagry H, de la Cuadra Fontaine JC, Asenjo JF, Bracco D, Carli F (2008) Effect of a continuous peripheral nerve block on the inflammatory response in knee arthroplasty. Reg Anesth Pain Med Jan-Feb 33(1):17–23. https://doi.org/10.1016/j.rapm.2007.06.398

BeverlyKayeLjungqvistUrman AADORD (2017) Essential elements of multimodal analgesia in enhanced recovery after surgery (ERAS) guidelines. Anesthesiol Clin 35(2):e115–e143. https://doi.org/10.1016/j.anclin.2017.01.018

Brodner G, Aken HV, Hertle L, Fobker M, Von Eckardstein A, Goeters C, Buerkle H, Harks A, Kehlet H (2001) Multimodal perioperative management–combining thoracic epidural analgesia, forced mobilization and oral nutrition–reduces hormonal and metabolic stress and improves convalescence after major urologic surgery. Anesth Analg 92(6):1594–1600. https://doi.org/10.1097/00000539-200106000-00049

CapdevilaRaminCapdevila MSX (2017) Regional anesthesia and analgesia after surgery in ICU. Curr Opin Crit Care 23(5):430–439. https://doi.org/10.1097/MCC.0000000000000440

ChellyPloskanychDaiNelson JETFJB (2011) Multimodal analgesic approach incorporating paravertebral blocks for open radical retropubic prostatectomy: a randomized double-blind placebo-controlled study. Can J Anaesth 58(4):371–378. https://doi.org/10.1007/s12630-010-9442-x

ChitnisTangMariano SSRER (2020) The role of regional analgesia in personalized postoperative pain management. Korean J Anesthesiol 73(5):363–371. https://doi.org/10.4097/kja.20323

Choi YJ, Kwon HJ, O J, Cho TH, Won JY, Yang HM, Kim SH. Influence of injectate volume on paravertebral spread in erector spinae plane block: an endoscopic and anatomical evaluation. PLoS One. 2019;14(10):e0224487. https://doi.org/10.1371/journal.pone.0224487

Coluzzi F, Savoia G, Paoletti F, Costantini A, Mattia C (2009) Postoperative pain survey in Italy (POPSI): a snapshot of current national practices. Minerva Anestesiol 75(11):622–631

Desborough JP (2000) The stress response to trauma and surgery. Br J Anaesth 85(1):109–117. https://doi.org/10.1093/bja/85.1.109

**Dost B, Kaya C, Ozdemir E, Ustun YB, Koksal E, Bilgin S, Bostancı Y. Ultrasound-guided erector spinae plane block for postoperative analgesia in patients undergoing open radical prostatectomy: a randomized, placebo-controlled trial. J Clin Anesth. 2021 Sep;72:110277. https://doi.org/10.1016/j.jclinane.2021.110277

Elsharkawy H, Bajracharya GR, El-Boghdadly K, Drake RL, Mariano ER. Comparing two posterior quadratus lumborum block approaches with low thoracic erector spinae plane block: an anatomic study. Reg Anesth Pain Med. 2019 Mar 28;rapm-2018–100147. https://doi.org/10.1136/rapm-2018-100147

Forero M, Adhikary SD, Lopez H, Tsui C, Chin KJ (2016) The erector spinae plane block a novel analgesic technique in thoracic neuropathic pain. Reg Anesth Pain Med 41(5):621–627. https://doi.org/10.1097/AAP.0000000000000451

HamedGodaBasionyFargalyAbdelhady MAASMMOSMA (2019) Erector spinae plane block for postoperative analgesia in patients undergoing total abdominal hysterectomy: a randomized controlled study original study. J Pain Res 30(12):1393–1398. https://doi.org/10.2147/JPR.S196501

KendallAlvesTraillOliveira MCLLLGS (2020) The effect of ultrasound-guided erector spinae plane block on postsurgical pain: a meta-analysis of randomized controlled trials. BMC Anesthesiol 20(1):99. https://doi.org/10.1186/s12871-020-01016-8

Kwon HM, Kim DH, Jeong SM, Choi KT, Park S, Kwon HJ, Lee JH (2020) Does erector spinae plane block have a visceral analgesic effect?: A randomized controlled trial. Sci Rep 10(1):8389. https://doi.org/10.1038/s41598-020-65172-0

Lepor H. Radical retropubic prostatectomy. Urol Clin North Am. 2001 Aug;28(3):509–19, viii. https://doi.org/10.1016/s0094-0143(05)70159-2

MooreDesboroughPowellBurrinHall CMJPHJMGM (1994) Effects of extradural anaesthesia on interleukin-6 and acute phase response to surgery. Br J Anaesth 72(3):272–279. https://doi.org/10.1093/bja/72.3.272

NaitoTamaiShinguShindoMatsuiSegawaNakaiMori YSKKTHYK (1992) Responses of plasma adrenocorticotropic hormone, cortisol and cytokines during and after upper abdominal surgery. Anesthesiology 77(3):426–431. https://doi.org/10.1097/00000542-199209000-00004

*Saadawi M, Layera S, Aliste J, Bravo D, Leurcharusmee P, Tran DQ. Erector spinae plane block: a narrative review with systematic analysis of the evidence pertaining to clinical indications and alternative truncal blocks. J Clin Anesth . 2021 Feb;68:110063. https://doi.org/10.1016/j.jclinane.2020.110063

Tulgar S, Ahiskalioglu A, De Cassai A, Gurkan Y (2019a) Efficacy of bilateral erector spinae plane block in the management of pain: current insights. J Pain Res 12:2597–2613. https://doi.org/10.2147/JPR.S182128

Tulgar S, Kose HC, Selvi O, Senturk O, Thomas DT, Ermis MN, Ozer Z (2018) Comparison of ultrasound-guided lumbar erector spinae plane block and transmuscular quadratus lumborum block for postoperative analgesia in hip and proximal femur surgery: a prospective randomized feasibility study. Anesth Essays Res Oct-Dec 12(4):825–831. https://doi.org/10.4103/aer.AER_142_18

Tulgar S, Selvi O, Senturk O, Serifsoy TE, Thomas DT. Ultrasound-guided erector spinae plane block: indications, complications, and effects on acute and chronic pain based on a single-center experience. Cureus . 2019b Jan 2;11(1):e3815. https://doi.org/10.7759/cureus.3815

Ueshima H, Hiroshi O (2018) Spread of local anesthetic solution in the erector spinae plane block. J Clin Anesth 45:23. https://doi.org/10.1016/j.jclinane.2017.12.007

Publisher's Note