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RESEARCH

Comparing postoperative pain control after modified radical mastectomy: a pilot study of ultra-sound guided erector spinae plane block vs intraoperative tramadol administration in oncology patients

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Abstract

Purpose This study aimed to compare the effectiveness of ultrasound-guided erector spinae plane block (ESPB) with intraoperative Tramadol for postoperative pain management after modified radical mastectomy (MRM). The primary focus was on pain intensity within the first 24 h, while secondary outcomes included the need for rescue analgesia, nausea, vomiting, and patient satisfaction.

Methods In this retrospective cohort study, 49 female patients (ASA I-II, aged 30–80) who underwent MRM from 2021 to 2023 were analyzed. Patients were divided into two groups: one receiving ESPB preoperatively (25 patients) and the other receiving Tramadol during surgery (24 patients). Pain levels were measured using the Numeric Rating Scale (NRS), and data on rescue analgesia, vital signs, nausea, vomiting, and patient satisfaction were collected.

Results The ESPB group reported significantly lower pain levels during the first six postoperative hours (NRS scores of 0 vs. 3; $p=0.005$), along with a reduced need for rescue analgesia (88% vs. 54.2%; $p=0.010$). Moreover, patient satisfaction was higher in the ESPB group (64% vs. 37.5%; $p=0.03$). The intraoperative heart rate was also lower in the ESPB group (65.3 vs. 72.0 bpm; $p=0.030$). No significant differences were found in nausea, vomiting, or length of hospital stay.

Conclusion Overall, ESPB demonstrates superior early postoperative pain control and improved patient satisfaction compared to Tramadol. Further studies are needed to confirm these findings.

Keywords ESPB · Tramadol · Plane block · MRM

Introduction

Modified radical mastectomy (MRM) is one of the surgical treatment options for breast cancer. MRM accounts for 31% of all breast surgeries (Poleshuck et al. 2006). This surgery removes the entire breast including the breast tissue, skin, areola, nipple and most of the underarm (axillary) lymph. In contrast to other breast surgeries MRM requires extensive tissue dissection, with postoperative seroma formation and pain being the primary concerns for patients. Pain is one of the most frequently experienced symptoms, affecting up to 50% of women undergoing mastectomy (Wang et al. 2020). Among these, 40% of the females experienced acute postoperative pain, and between 25 to 60% developed persistent chronic postsurgical pain (Cheng and Ilfeld 2017; Abu Elyazed et al. 2020). Severe acute postoperative pain results in an increased incidence of persistent postoperative pain (Kehlet et al. 2006).

Unfortunately, there has been minimal progress in enhancing postoperative pain management following modified radical mastectomy (MRM). Preventive analgesia using multimodal strategies helps regulate ongoing inflammation and neuronal activity, ultimately reducing the occurrence of chronic pain, complications, and mortality (Huang et al.

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2018). This approach includes preventive and perioperative forms of analgesia and pharmacological agents, regional analgesia along with parenteral analgesics. While there are various regional analgesic techniques used for MRM, including neuraxial and regional analgesia they are not always ideal techniques and come with their complications and difficulties. The erector spinae plane block is novel promising block with many advantages and less disadvantages than other commonly used techniques.

Thoracic epidural anesthesia comes with an increased risk of complications such as hypotension**,** infection**,** nerve injury, and catheter migration. It is technically more challenging to perform and may also result in motor blockade**,** which can hinder the patient's mobility during the immediate postoperative period (Sertcakacilar et al. 2022). The pectoral nerve (Pecs) blocks may not offe**r** complete pain relief for deeper structures involved in mastectomy or axillary dissection**.** Pecs II can help with deeper coverage but might still leave gaps (Kim et al. 2018). While effective for superficial pain, the axillary dissection may require additional paravertebral blocks or ESPB for comprehensive pain control. Paravertebral blocks (PVB) carries a higher risk of complications such as pneumothorax, vascular puncture, and nerve injury, especially if performed incorrectly, require a higher level of skill and although less common, PVB can occasionally cause motor block if the anesthetic spreads to motor nerves, affecting mobility. (Slinchenkova et al. 2023).

By targeting the erector spinae muscle and delivering local anesthetic around the thoracic nerves, ESPB can help reduce pain in areas like the chest wall, axilla, and shoulder, which are commonly affected after this surgery (Li et al. 2021; Soni et al. 2024). Due to diffusion into the paravertebral space local anesthetic can induce sensory block at the multidermatomal levels across all chest walls. Beside its effect on rami communicans that supply sympathetic chain (Singh et al. 2019), ESPB targets dorsal and ventral rami of the thoracic nerves (Ince et al. 2018).

The ESP block has advantages over other techniques because it can provide both somatic and visceral pain relief, improving postoperative comfort and reducing the need for opioid medications. It's particularly beneficial for pain prevention, as it can help manage pain right from the start of the postoperative period and facilitates faster return to normal function potentially reducing the incidence of chronic pain and complications like seroma formation.

However, as with any technique, its effectiveness may vary from patient to patient, and it should be considered as part of a multimodal pain management plan.

Understanding of pain distribution before planning a regional nerve block for MRM is crucial. The anterior and lateral divisions of the intercostal nerves supply the skin overlying the chest and lateral thorax. The axilla is supplied by T1 and T2 dermatome, which includes the intercostobrachial nerve. The pectoral muscles, which are not affected with this procedure, are supplied by lateral and medial pectoral nerves (branches from the lateral and medial cord of the brachial plexus) (Blanco and Barrington 2017).

Our primary aim is to compare the intensity of pain in a group of patients who received a preoperative erector spinae block as part of multimodal analgesia versus a control group who received intravenous Trodon intraoperatively, within the first 24 postoperative hours.

Our secondary aim is to compare which group had a greater need for rescue analgesia, what type and how many additional analgesics were administered during breakthrough pain, and in which group the incidence of nausea and vomiting was higher during the first 24 postoperative hours, as well as patient satisfaction with the service provided in our institution.

Methods

Patients

This cohort pilot study retrospectively analyzes 49 female patients who underwent elective modified radical mastectomy, aged 30 to 80 years, with American Society of Anesthesiologist physical status I to II. This study was conducted between 2021 and 2023 in the Department of Anesthesia at the Institute for Oncology and Radiology of Serbia in Belgrade after approval of the local ethics committee. The goal was to find a better approach to pain management in our population of patients and potentially upgrade our standard of care. The patients were informed about the procedure, our standard care approach, ESP block, and the study. After this, the patients choose whether to be included in the study and confirm it with written consent.

The criteria for patient selection comprised individuals who met the following conditions: age >18, female gender, ASA I or II, patients who underwent unilateral MRM, patients who received an ESPB preoperatively and did not undergo other regional anesthesia techniques, patients who received Tramadol half an hour before the end of the surgery as part of the standard protocol at the Institute of Oncology and Radiology of Serbia, and those who were not given other analgesics besides Tramadol or any other regional anesthesia techniques.

We excluded patients who have depression, cardiovascular diseases, kidney failure, hematological disorders, a history of medication abuse or chronic opioid use, allergic reactions to any of the medications, morbidly obese (BMI >40), or if they were pregnant, those patients with incomplete data and every patient who were not treated according to our standard procedures for premedication, ESP block, monitoring during and after the anesthesia.

We collected patients for both groups from medical record system. All patients included in study had a clinical assessment on the preoperative visit.

All female patients in both groups were premedicated with midazolam at a dose of 0.03 mg/kg IV, dexamethasone 4 mg, and all received antibiotics as part of standard antibiotic prophylaxis, in the preoperative preparation room, as part of the routine procedure.

US-guided ESPB group

Our standard procedure for the Erector Spinae Plane Block (ESPB) is to perform the block one hour before the surgical procedure. Patients are positioned prone, and the transverse processes of the 2nd and 4 th thoracic vertebrae are located using a Siemens Acuson P500 ultrasound. The correct levels are identified by counting the vertebrae from the spinous process of the 7 th cervical vertebra.

After antiseptic preparation of the skin, the ESP block is performed under ultrasound guidance using the in-plane technique. We infiltrate 1% Lidocaine at the needle entry site on both levels and insert a 21G, 100 mm needle in alignment with the ultrasound probe until we make contact with the transverse process, first at the 2nd level, and then at the 4 th level. After confirming negative aspiration, 1 to 3 mL of saline solution is injected to confirm the elevation of the fascia of the erector spinae muscle over the transverse process. The ESP block is completed with a single-shot injection of 0.25% Bupivacaine, administered in a volume of 20 mL at each level.

After 45 min of the ESP block, the patient is taken to the operating room (OR), and anesthesia induction is performed. All patients were induced into general anesthesia using Fentanyl (1–2 mcg/kg induction dose) and Propofol, i-gel masks were applied for mechanical ventilation (volume control mode was used on the GE Avance CS2 Pro device). Anesthesia was maintained using Sevoflurane in combination with oxygen and air. Half an hour before the end of surgery, all patients received 4 mg of Ondansetron as an antiemetic.

The distribution of the local anesthetic is recorded caudally and cranially.

Tramadol group

These patients were also collected from medical record system. In the second control group, after the premedication described above, the patients were induced into general anesthesia in the same manner as in the previous group. Half an hour before the end of the surgery, the patients received 100 mg of Tramadol in a slow intravenous infusion and Ondansetron 4 mg, as in the ESPB group.

In both groups, we used data from medical records, including age, BMI, surgery duration, measured arterial tension, heart rate, and mean arterial pressure every five minutes, during anesthesia induction, and throughout the anesthesia. We also collected data on the amount of Fentanyl applied intraoperatively. For both groups of patients, after anesthesia weaning, we collected data on pain intensity. Pain intensity was recorded in the medical records as part of the usual postoperative documentation. The pain assessment was performed using Numeric Rating Scale (0-no pain and 10- maximum pain). From these files, for each patient, we collected data on pain intensity immediately after weaning, up to the 1 st hour, from the 1 st to the 3rd hour, from the 3rd to the 6 th hour, from the 6 th to the 12 th hour, and from the 12 th to the 24 th hour, using a numeric rating scale (NRS). At the same time, we recorded nausea and vomiting. We define nausea as the unpleasant sensation in the abdomen diferent from pain that precedes vomiting, and vomiting as the forceful retrograde expulsion of gastric contents from the body. Records of nausea and vomiting were clinical manifestations that were recorded by staff.

For rescue analgesia (RA), we use a non-steroidal anti-inflammatory drug (NSAID) or Tramadol. For patients with an NRS lower than 3 and 3, we do not administer RA. For patients with an NRS higher than 3 to 6, we apply Diclofenac 75 mg, and for those with an NRS higher than 6, we administered Tramadol 100 mg. All analgesics and their application times were recorded in detail in the patient files. We recorded patient satisfaction based on the postoperative pain and nausea and vomiting presence.Patient satisfaction was measured using a questionnaire consisting of questions about perioperative transparency, comfort in the pre-operative holding area, and postoperative complication management, which included managing breakthrough pain, nausea and vomiting, and staff availability. Patients could check the box next to the corresponding question indicating dissatisfaction. Based on the answers, satisfaction was evaluated as 0 marks—satisfied; 1–2 marks partly satisfied; 3 + marks unsatisfied. We also recorded the length of the hospital stay, expressed in days, from the day of surgery until hospital discharge.

Statistical analysis

Depending on the type of variables and the normality of the distribution, data will be presented as n (%), mean ± standard deviation, or median (range). Statistical hypotheses were tested using t-test, Mann–Whitney test, Fisher's exact test. All p-values less than 0.05 were considered significant. The ''IBM SPSS Statistics 24'' program (IBM Corporation, Armonk, NY, USA) was used to process all of the data.

Results

The demographic data (age, BMI), ASA status, surgery duration and Fentanyl consumption are comparable between the studied groups, as shown in Table 1 ($p > 0.05$). The mean age of participants in the ESPB group is 56.8 ± 12.0, while the mean age of participants in the Tramadol group was 62.5 ± 12.5, which is not a statistically significant difference ($t = 1.616$; $p = 0.113$). The mean BMI of participants in the ESPB group was 24.1 ± 2.3, while the mean BMI of participants in the Tramadol group was 24.1 ± 2.0, which is not a statistically significant difference ($t = 0.013$; $p = 0.990$). Surgery duration is 106.8 vs 106.0 min in ESPB vs Tramadol group, there is no statistical significance ($t = 0.195$, $p = 0.800$). There is no statistical difference in fentanyl consumption between groups ($Z = 0.575$, $p = 0.909$).

At the induction of anesthesia among the hemodynamic parameters (Table 2.), systolic pressure (t-test = − 1.525, p = 0,134) and diastolic pressure (t-test = − 0.949, p = 0.347) there is no statistically significant difference between the observed groups. However, a statistically significant

Table 1 Patients characteristics

	%	Mean	sd	Med	Min	Max	p
Age							
ESPB		56.8	12.0	55.0	36.0	12.0	0.113
TRAMADOL		62.5	12.5	65.0	42.0	78.0	
ASA 2							
ESPB	100						–
TRAMADOL	100						
BMI							
ESPB		24.1	2.3	24.7	19.6	27.1	0.990
TRAMADOL		24.1	2.0	24.2	20.9	27.9	
Fentanyl Consumption							
ESPB				250	150	350	0.990
TRAMADOL				200	150	350	
Surgery duration (min)							
ESPB		106.8	14.9	110.0	80.0	130.0	0.800
TRAMADOL		106.0	12.2	110.0	80.0	130.0	

Table 2 Hemodynamics

Anesthesia induction	Groups	Mean	sd	Med	Min	Max	p
Systolic pressure	ESPB	123.6	19.4	120.0	89.0	60.0	0.134
	TRAMADOL	133.4	25.5	140.0	80.0	200.0	
Dyastolic pressure	ESPB	72.2	15.4	71.0	41.0	100.0	0.347
	TRAMADOL	76.0	12.0	79.0	50.0	92.0	
Mean arterial Pr	ESPB	84.3	17.9	84.0	55.0	115.0	**0.029**
	TRAMADOL	95.2	15.5	95.6	67.0	127.0	
Heart rate	ESPB	72.1	13.3	70.0	60.0	120.0	0.205
	TRAMADOL	77.3	14.9	78.5	52.0	111.0	
Intraoperatively							
Systolic pressure	ESPB	106.5	14.0	110.0	80.0	130.0	0.144
	TRAMADOL	113.1	17.0	111.0	80.0	143.0	
Dyastolic pressure	ESPB	64.2	11.5	63.5	43.0	80.0	0.703
	TRAMADOL	62.9	12.0	63.5	43.0	80.0	
Mean arterial Pr	ESPB	76.7	12.7	77.0	59.0	103.0	0.212
	TRAMADOL	81.3	12.5	82.0	55.0	100.0	
Heart rate	ESPB	65.3	7.8	60.0	55.0	85.0	**0.030**
	TRAMADOL	72.0	12.3	73.0	49.0	95.0	

Bold text indicates statistically significant results ($p < 0.05$)

difference is registered in the mean arterial pressure for ESPB vs Tramadol group (T- test = − 2.256, p = 0.029).

Hemodynamic parameters intraoperatively (Table 2).,systolic pressure (t test = − 1.488, p = 0,144) and diastolic pressure (t-test = − 0.383, p = 0.703), mean arterial pressure (T test = − 1.266, p = 0.212) there was no statistically significant difference between the observed groups,

While there is not any statistical difference in heart rate at the induction of anesthesia (T-test = 1.286, p = 0.205), intraoperative heart rate is lower in the ESPB group vs Tramadol group, 65.3beats/min vs 77.3 beats/min, with a statistically significant decrease (T-test = − 2.270, p = 0.030), as shown in Tables 2.

The frequency of pain is less in the ESPB group compared to the Tramadol group 1 h after waking up from anesthesia until the third hour, 48 vs 79.2%, and also after the third till the sixth hour, 56 vs 83.3%, which was statistically significant in both cases (p = 0.024, p = 0.038). In the first hour and after the 6 th hour after surgery till the 24 th hour, there was no significant difference in the frequency of pain between these two groups of subjects.

In these same intervals from 1 st to 3rd hour and after 3rd to the 6 th hour, a decrease in pain intensity is found in the ESPB group compared to the Tramadol group according to the NRS score, 0 vs 3 and 2 vs 3, which was highly statistically significant in both cases (p = 0.005, p = 0.016), and in the 1 st hour as well as from the 6 th hour till 24 th hour there is not a statistically significant difference in NRS scores between groups as shown in Table 3.

Subjects from the ESPB and Tramadol groups were most often without rescue analgesia in the interval from the 1 st to 3rd hour (88.0% vs. 54.2%, respectively). There is a statistically significant difference in the frequency of categories between the examined groups (Fisher's exact probability test = 0.356; p = 0.010) as shown in Table 4. After 12 h of surgery till the 24 th hour, 96% in ESPB group did not receive rescue analgesia and only 4% received NSAID which is statistically significant (Fisher's exact probability test = 2.145, p = 0.007). There is no statistical significance between groups in other time intervals.

There is no statistically significant difference in the frequency of nausea and vomiting between groups, as shown in Table 5.

Regarding patient satisfaction, the data suggests that the ESPB group is associated with higher patient satisfaction compared to the Tramadol group, there is 64% satisfaction in the ESPB group and 37.5% in the Tramadol group with statistical significance, (Z = −2.104, p = 0,03), as shown in Table 6. The length of stay in hospital after surgery is without statistical significance between the groups.

Table 4 RA from 0 to 1 h

Time	Groups	No RA	NSAID	Opioid	p
0–1 h	ESPBG %	68	28	4	0.356
	TG %	62.5	20.8	16.7	
> 1–3 h	ESPBG %	88	8	4	**0.010**
	TG %	54.2	41.7	4.2	
> 3–6 h	ESPBG %	84	12	4	0.117
	TG %	58.3	33.3	8.3	
> 6–12 h	ESPBG %	76	16	8	0.426
	TG %	62.5	33.3	4.2	
> 12–24 h	ESPBG %	96	4	0	**0.007**
	TG %	62.5	29.2	8.3	

Bold text indicates statistically significant results ($p < 0.05$)

Table 3 Presence of pain after surgery, in time intervals

Time	ESPB, n = 25 (%)	TRAMADOL, n = 24 (%)	p
0 h–1 h	64	66.7	0.845
> 1 h–3 h	48	79.2	**0.024**
> 3 h–6 h	56	83.3	**0.038**
> 6 h–12 h	64	83.3	0.125
> 12 h–24 h	60	50	0.482
NRS after surgery in time intervals			
Time intervals	ESPB, n = 25 Med (Min–Max)	TRAMADOL, n = 24 Med (Min–Max)	p
0 h–1 h	2 (0–9)	2,5 (0–9)	0.524
> 1 h–3 h	0 (0–8)	3 (0–8)	**0.005**
> 3 h–6 h	2 (0–8)	3 (0–8)	**0.016**
> 6 h–12 h	2 (0–8)	3 (0.8)	0.119
> 12 h–24 h	1 (0–4)	1.5 (0–7)	0.211

Bold text indicates statistically significant results ($p < 0.05$)

Table 5 Nausea/vomiting in time intervals

Time	ESPBG (%)	TG (%)	p
0 h–1 h	16	12.5	1.000
> 1 h–3 h	8	25	0.138
> 3 h–6 h	16	28	0.725
> 6 h–12 h	0	16.7	0.50
> 12 h–24 h	0	8.3	0.235

Table 6 Patient satisfaction and Length of stay in hospital

	ESPB (%)	TRAMADOL (%)	p
Patient satisfaction			
Dissatisfied	8	29.2	**0.03**
Partially satisfied	28	33.3	
Satisfied	64	37.5	
LOS			
3 days	100	95.8	0.490
4 days	0	4.2	

Bold text indicates statistically significant results ($p < 0.05$)

Discussion

Satisfactory pain control is of great importance in postoperative pain management. Ferrero et al. first showed the value of ESPB as an analgesic technique in a case report presenting its effect after thoracotomy. Nowadays, it is known that ESPB is a valuable component of multimodal pain treatment.

This study compared the efficacy of the Erector Spinae Plan and Tramadol in preventing and managing postoperative pain after unilateral mastectomy with axillary dissection. Our results showed that ESPB provided significantly better pain relief in the early postoperative period (1–6 h), with lower pain intensity, less need for rescue analgesia, and greater satisfaction in the ESPB group compared to the Tramadol group.

Tramadol is a centrally acting analgesic widely used for postoperative pain management, including in breast surgery. It is typically administered at doses ranging from 50 to 100 mg every 4 to 6 h, with a maximum daily dose of 400 mg in adults. The drug has an elimination half-life of approximately 5–6 h, although this can vary based on individual metabolism and renal function.The mechanism of action of tramadol is dual in nature. It acts as a weak μ-opioid receptor agonist, providing moderate analgesia, while also inhibiting the reuptake of serotonin and norepinephrine, enhancing descending pain modulation. This dual action makes tramadol particularly useful in managing both nociceptive and neuropathic pain, which are commonly experienced after breast surgery.Despite its efficacy, tramadol is associated with several side effects. The most common include nausea, vomiting, dizziness, sedation, and constipation. In some patients, tramadol may lower the seizure threshold, increasing the risk of seizures, especially in those with a predisposition or when combined with other serotonergic medications. Additionally, tramadol carries a risk of serotonin syndrome when used with other serotonergic agents, which is an important consideration in postoperative pain management.In the context of breast surgery, tramadol is often preferred over stronger opioids due to its lower risk of respiratory depression and reduced potential for addiction. Additionally, because it modulates both opioid and non-opioid pain pathways, it may provide more balanced pain control, particularly for procedures involving both tissue trauma and nerve involvement, such as mastectomy or breast reconstruction. However, despite these advantages, newer regional anesthesia techniques—such as the erector spinae plane block (ESPB)—offer superior pain relief while reducing the need for systemic opioids like tramadol.

In a systematic review and meta-analysis which was undertaken to determine if the ESPB is effective at reducing pain scores and opioid consumption after breast surgery, it has been shown that the ESPB is more effective at reducing postoperative opioid consumption and pain scores up to 24 h compared with general anesthesia alone (Leong et al. 2021 Mar). In this analysis, which included 13 studies, of 861 patients, this block received 418 patients, 215 received no block, and 228 received other blocks. The ESPB significantly reduced pain in the first 2 h in 6,12, and 24 h after surgery. Despite the heterogeneity of the results, **I^2 values range from 58 to 99%**; analysis found that the ESPB effectively reduced postoperative pain. Our findings are consistent with previous studies, demonstrating that the Erector Spinae Plane Block (ESPB) group experiences significantly lower pain frequency and intensity 1 to 6 h after surgery, as indicated by the Numeric Rating Scale (NRS) scores. This suggests that ESPB offers superior postoperative pain relief, particularly in the immediate hours following surgery, compared to the group of patients who only received Tramadol during the procedure.

These results support other research highlighting the effectiveness of ESPB in providing early pain relief (Sharma et al. 2020; Gürkan et al. 2020 Feb). However, it should be noted that pain intensity immediately after surgery is generally bellow NRS 3 in both groups, which typically does not require any analgesic intervention. Nevertheless, the advantages of ESPB become more evident 6 h post-surgery, indicating a potential need for ongoing pain management strategies after the effects of the ESPB wear off.

In a recent systematic review focused on cardiac surgery, Greene et al. evaluated the benefits of single-shot Erector Spinae Plane Block (ESPB) in reducing pain at postoperative hours 4 and 12. They concluded that the single-shot ESPB arm exhibited statistically significant reductions in pain score at postoperative hour 4 but did not exhibit a statistically significant reduction in pain score at postoperative hour 12 (Greene et al. 2024 Apr).

Aks et al. compared ESPB to "no block control" after breast surgery; they enrolled fifty patients. In the ESPB group, there was a significant reduction in opioid use; the postoperative morphine requirement was significantly lower in the ESPB group compared to the control group during 24 h (Aksu et al. 2019). Our study has demonstrated that **ESPB** can reduce the need in the postoperative period for NSAID and **systemic opioids**, potentially upgrading recovery and patient satisfaction. Use of rescue analgesia is significantly lower in the first 3 h, and till the sixth hour, patients in the ESPB group received mostly NSAID. Interestingly, 12 h after the procedure, the ESPB group mostly (96%) did not need rescue analgesia compared to the Tramadol group. This finding can be understood as the final distribution and penetration of local anesthetic in paravertebral space or as potential synergism of this block and received rescue analgesics till the 12 th post-surgery period. These statements need further examination. According to our results, the superior efficacy of **ESPB** in the **early recovery phase** may be a preferable option for **patients undergoing surgeries with expected moderate to severe postoperative pain**. Also, the reduced need for **rescue analgesia** suggests that **ESPB** may help minimize the use of opioids, which can help reduce opioid consumption and its associated side effects, including nausea, vomiting, and dependence. In our study, Tramadol use is generally less effective in controlling moderate to severe postoperative pain compared to regional blocks, especially in the first few hours post-surgery.

According to hemodynamic changes, our results show some differences in blood pressure between the two groups, with the Tramadol group showing higher MAP, but heart rate and diastolic pressure are quite similar during the induction period. This may point to the different ways these interventions affect the cardiovascular system. Also, the intraoperative heart rate result shows a statistically significant reduction in the ESPB group during surgery (65.3 bpm vs. 72.0 bpm in the Tramadol group, $p = 0.030$). These findings suggest that ESPB may have some effect on the sympathetic nervous system. Liao et al., in their study, showed that the ESPB group demonstrated a lower intraoperative HR than the control group throughout the initial 90 min of surgery (Liao et al. 2024 Nov 20). These results could be explained by the slow penetration of local anesthetic into the peridural space, which somewhat blocks the sympathetic nervous system. Sørenstua M et al. explained that local anesthetic injected deep into the erector spinae muscle could thus reach the dorsal root ganglion by combining bulk flow and simple diffusion. The physical extent of this spread to the neural foramina, paravertebral, and intercostal spaces, has been confirmed by MRI in human subjects (Sørenstua et al. 2023 Feb).

The frequency of nausea and vomiting between the groups is almost the same and without significance, suggesting that neither ESPB nor Tramadol led to a major increase in these common side effects. This is a positive outcome, as it indicates that ESPB did not exacerbate unpleasant symptoms more than Tramadol.

Patients who perceive less pain and require less rescue analgesics are more likely to have a better recovery experience, contributing to increased satisfaction. Regarding patient satisfaction, the ESPB group had significantly higher satisfaction scores (64%) than the Tramadol group (37.5%), which may be attributed to better pain relief and reduced need for additional medications. This is also a significant finding, as patient satisfaction is an important goal of postoperative recovery and can influence both short- and long-term outcomes.

While our findings offer valuable insights, we recognize several limitations. The small sample size may affect the statistical power and increase the risk of statistical variability and limit broader applicability. Second, the retrospective design inherently introduces potential biases, including selection bias and confounders we could not fully control. Future prospective studies with larger cohorts would help clarify these relationships further. Additionally, the study is limited only to the short-term postoperative period, so the long-term effectiveness of ESPB compared to Tramadol remains unknown. Future studies could also investigate whether the ESPB could be combined with other treatment modalities to improve pain management and spare opioid consumption.

Conclusion

The ESPB appears to be a more effective pain management modality than Tramadol, particularly in the early postoperative period. It provides superior pain relief, reduces the need for rescue analgesia, and enhances patient satisfaction. However, to further validate these findings, larger prospective studies with diverse surgical populations are needed. Future research should aim to not only confirm these findings in larger prospective studies but also explore how ESPB affects long-term recovery, patient well-being, and overall quality of life beyond the immediate postoperative phase. Additionally, longitudinal follow-up

studies could provide valuable insights into how ESPB impacts pain control, rehabilitation, and overall well-being in the months following surgery.

Author contributions All authors contributed to the study conception and design. Material preparation and data collection were performed by Ana Cvetković, Andrej Jokić and analysis was performed by Zoran Bukumirićić. The first draft of the manuscript was written by Ana Cvetković and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data availability No datasets were generated or analysed during the current study.

Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose. The authors have declared that no competing interests exist.

Ethical approval This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of institute of Oncology and Radiology of Serbia on the 09.08.2023. approval no. 010/2023/1979.

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