

Evaluation of Analgesic Effectiveness of Continuous Erector Spinae Plane Block in Patients Undergoing Thoracotomy

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Torakotomi Yapılan Hastalarda Sürekli Erektör Spina Düzlem Bloğunun Analjezik Etkinliğinin Değerlendirilmesi

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ABSTRACT

Objective: The erector spinae plane block (ESPB) is performed by injection of local anesthetic deep into the erector spinae muscle. It is a relatively simple and safe technique for pain management. It has been started to be widely used in pain relief. This randomized, controlled study aimed to report continue comparing the effectiveness of ESPB and intercostal block applications in thoracic surgery.

Method: Forty patients who were scheduled to undergo elective thoracotomy and Video-Assisted Thoracic Surgery (VATS) were included in the study. Patients in first group underwent erector spinae plane block. In the second group intercostal block(ICB) was applied. Static, and dynamic Pain scores in the ESPB group were lower than the ICB group in the early postoperative period. In the postoperative period, the time to the first analgesic requirement was longer in the ESPB group.

Results: The difference between the groups in terms of time to the first analgesia requirement was found to be statistically significant ($p<0.001$). There was no difference in the number of doses of tramadol hydrochloride and dexketoprofen used. It was found that the static VAS value was higher in the ICB group in all time periods except the second hour and this difference was statistically significant. It was determined that dynamic VAS values; in all time periods, were higher in the ICB group than the ESPB group. Dynamic VAS values were found to be statistically significantly higher in the ICB group from the 3rd up to the 24th hour.

Conclusion: ESPB performed in thoracic surgery is very effective for postoperative analgesia plan. Few complications were also noted.

Keywords: erector spinae plane block, catheter, ultrasonography, thoracotomy, pain

ÖZ

Amaç: Erektör omurga düzlem bloğu (ESPB), erektör omurga kasına derinlemesine enjekte edilen bir lokal anesteziiktir. Ağrı tedavisi için nispeten basit ve güvenli bir tekniktir. Ağrı kesmede yaygın olarak kullanılmaya başlanmıştır. Bu randomize, kontrollü çalışma, ESPN ve interkostal blok uygulamalarının göğüs cerrahisindeki etkinliğini karşılaştırmaya devam etmeyi bildirmeyi amaçlamaktadır.

Yöntem: Çalışmaya elektif torakotomi ve Video Destekli Göğüs Cerrahisi yapılması planlanan 40 hasta dâhil edildi. Birinci gruptaki hastalara erektör omurga düzlem bloğu uygulandı. İkinci grupta interkostal blok (ICB) uygulandı. ESPB grubunda istirahat ve hareketli ağrı skorları ameliyat sonrası erken dönemde ICB grubuna göre daha düşüktü. Postoperatif dönemde ESPB grubunda ilk analjezik gereksinim süresi daha uzundu.

Bulgular: İlk analjezi gereksinimi açısından gruplar arasındaki fark istatistiksel olarak anlamlı bulundu ($p<0,001$). Tramadol hidroklorür sayısında ve deksketoprofen kullanımında farklılık yoktu. İkinci saat hariç tüm zaman dilimlerinde ICB grubunda statik VAS değerinin daha yüksek olduğu ve bu farkın istatistiksel olarak anlamlı olduğu görüldü. Dinamik VAS değerleri; Tüm zaman dilimlerinde İDB grubunun ESPB grubuna göre daha yüksek olduğu belirlendi. Dinamik VAS değerleri, ICB grubunda üçüncü saatten sonraki yirmi dördüncü saate kadar istatistiksel olarak anlamlı derecede yüksek bulundu.

Sonuç: Torasik cerrahide yapılan ESPB, postoperatif analjezi planı için çok etkilidir. Birkaç komplikasyon da kaydedildi.

Anahtar kelimeler: erektör spina düzlem bloğu, kateter, ultrasonografi, torakotomi, ağrı

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INTRODUCTION

The treatment of pain is important in thoracic surgery. It has an important role in the development of pain and complications after thoracotomy. Therefore; in patients undergoing thoracic surgery; it is very important to prevent respiratory and thromboembolic complications in the postoperative period and to provide effective analgesia that can provide early mobilization of patients. After thoracic surgery, especially thoracic epidural analgesia; effective analgesia is achieved without creating respiratory depression and pulmonary morbidity has been reported to be decreased by ensuring adequate use of respiratory volumes [1]. Different methods used have different adverse effects, such as hypotension, motor blockade, hematoma, and abscess [2,3].

In recent years, with the effective use of ultrasonography, different regional anesthesia methods have been developed to prevent complications related to regional anesthesia [4]. As a novel regional anesthesia technique first described in 2013 by Ferrero et al [5], erector spinae plane block (ESPB) is used in the management of postoperative pain of the thoracoabdominal region, The ESPB is a fascial plane block in which local anesthetic is injected deep into the erector spinae muscle [6] [Figure 1]. The target points - the transverse process and erector spinae muscle -



Figure 1. Erector spinae plane block (ESPB).

are easily visualized on ultrasound [Figure 2]. These target points are distant from the pleura and neuraxis, thus decreasing the risk of complications associated with injury to these structures and they create analgesia by blocking the dorsal and ventral branches of local spinal nerves [7]. ESPB has a wide range of applications in thoracic and abdominal surgeries. It is an easier and reliable method in thoracic surgery than thoracalepidural and paravertebral block [8]. There are publications showing that it prevents both somatic and visceral pain in thoracic and hip surgery [9,10]. However; there are no previously published large case series in thoracic surgery.

In the study, we aimed to compare the effects of ESBP or intercostal block application on postoperative pain relief, analgesic consumption and developing complications in pain control after thoracotomy.

MATERIAL and METHODS

For this study planned as a prospective randomized control, permission was obtained from the Institutional Ethics Committee. (2020/514/169/14 - 02.01.2020). Forty patients with the American



Figure 2. USG image of the Erector spinae plane block (ESPB).

Society of Anesthesiology (ASA) physical score of 1,2,3 between the ages of 18-67, who were scheduled for elective thoracotomy and VATS (Video-Assisted Thoracic Surgery) under general anesthesia by the thoracic surgery clinic were included in the study. The patients were randomly divided into two groups (Figure 3). Patients in Group ESPB (n=20) were administered ESPB (0.5% bupivacaine 20 ml) and a local anesthetic (bupivacaine 0.25% 20 mL) for

24 hours at 6- hour intervals. In ICB group (n=20), only intercostal block (ICB) was applied to the upper and lower area of the site before postoperative awakening. Patients who refused to participate in the study,, and did not give their written consent, and had bleeding diathesis, patients who used corticosteroids, those with psychiatric disorders, and history of allergy to local anesthetics were excluded from the study. For better standardization of data,

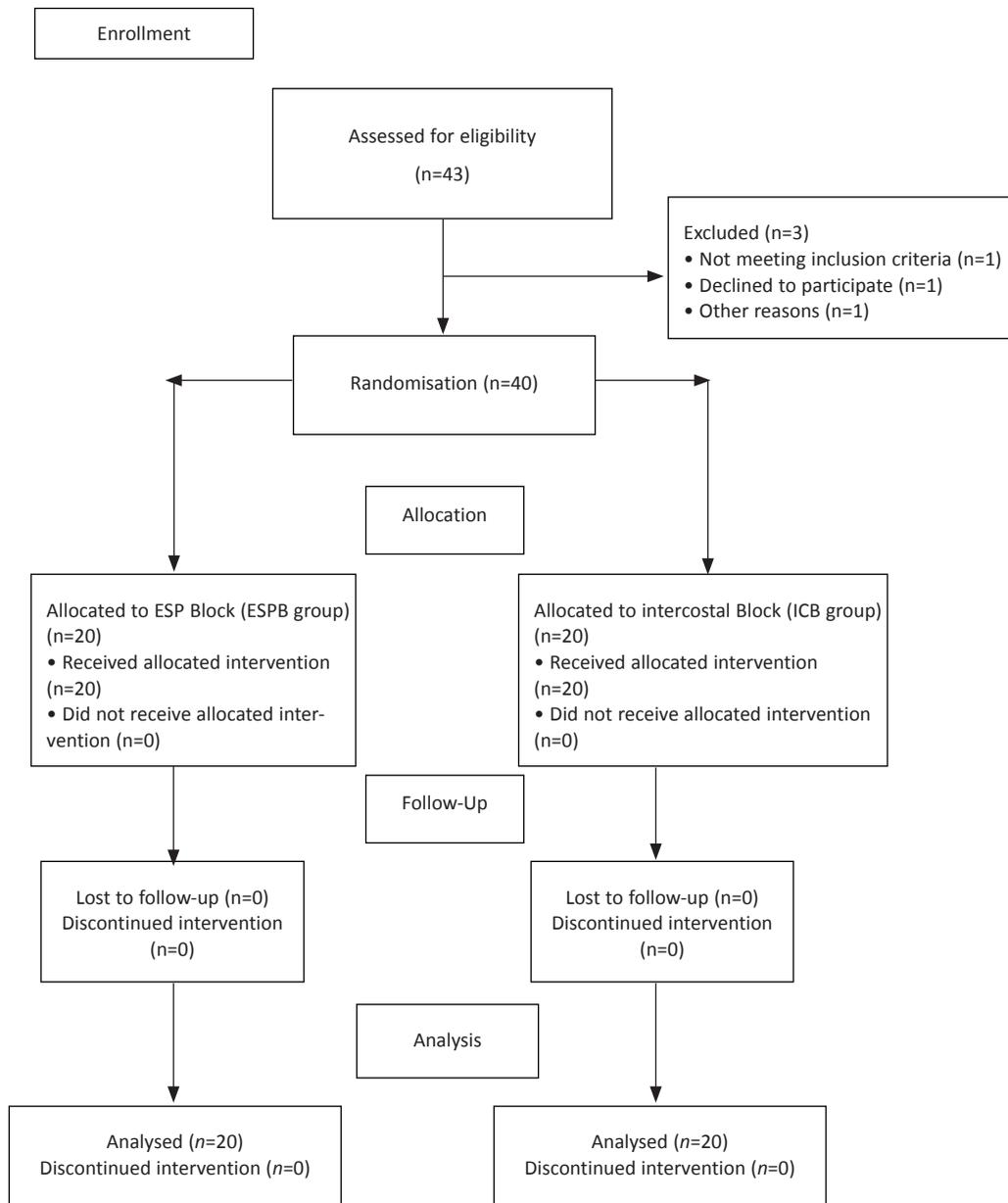


Figure 3. Consort flow diagram.

patients who would undergo surgical procedures lasting <60 min or >180 min were also excluded from the study.

After obtaining informed consent forms of the patients, standard preoperative monitoring was performed. Propofol (2-3 mg/kg) and fentanyl (2 mg/kg) iv were used for general anesthesia induction for standard balanced general anesthesia induction in patients in both groups. Rocuronium 0.6 mg/kg was administered iv for tracheal intubation followed by intubation with a double lumen tube. The operation was allowed to start after the proper placement of the tube was confirmed by auscultation and fiberoptic bronchoscopy. Combination of desflurane with air-oxygen (2:1) mixture in 2 L of fresh gas flow was used for anesthesia maintenance. At the end of the surgery paracetamol 1 g and tramadol 100 mg iv were administered for providing postoperative analgesia and also ondansetron 8 mg was given for the prevention of postoperative nausea and vomiting ^[11].

All ESP blocks were performed with technique described by Chin et al ^[1,13] under general anesthesia with the patient in the lateral position under sterile conditions before the commencement of the surgical procedure. All blocks were performed under ultrasonographic guidance using a linear ultrasound transducer (Saote, Via E. Melen, 77 16152 Genova-Italy). <https://www.aeronline.org/article.asp?>

At the end of the surgery, 4-7 thoracolumbar vertebral levels were estimated using the traditional approach (imaginary line between two crystal iliacs) for ESPB group patients. The convex USG transducer was positioned on the mid-vertebral line of the sagittal plane. The transducer was relocated from the midline, 3.5-4 cm laterally to the side of the surgery to image the erector spinal muscle and the transverse process. Using an in-plane procedure, a 16 gauge, 100 mm needle (Egemen, TMT Tibbi Medikal San ve Tic A. ş. Fatih Mah. 1188 Sokak No: 14 Izmir-Turkey) was progressed before the transverse phase was achieved. A 0.5-1 ml of the formulated LA solu-

tion (20 ml of 0.5 % bupivacaine) was injected to achieve hydro-dissection to validate the right location. The needle was repositioned by pushing back a few millimeters when there was resistance to local anesthesia. All LA was administered at this location between the transverse process and the erector spinae muscle. Twenty ml of 0.25% bupivacaine was administered through the postoperative catheter at an interval of 6 hours. All patients received 100 mg of tramadol and 1 g of paracetamol 30 minutes before the completion of the surgical procedure.

The VAS was used for the measurement of postoperative pain. VAS is a segmented numeric variant of the visual analog scale (VAS) in which the respondent chooses an integer ranging between 0, and 10 that best represents the severity of his/her suffering. It is called a one-dimensional indicator of pain sensitivity in adults. The 10-point numerical scale varies from "0" representing one pain extreme ("no pain") to "10" representing the other pain extreme ("pain as bad as you can imagine" or worst pain imaginable"). IV 0.5 mg/kg pethidine Hcl was administered to the patients with VAS value of 5 or more in the recovery room. Despite the analgesia applied to patients whose VAS value was above 3 for 24 hours postoperatively, paracetamol and tramadol were also administered. Total postoperative analgesic consumption were recorded. The researcher blinded to the sample reported VAS scores at postoperative 1st, 2nd, 6th, 12th and 24th hrs. The same researcher also documented the occurrence of nausea and vomiting during the postoperative phase.

Statistical method

IBM SPSS for Windows® version 20.0 (SPSS, Chicago, IL, USA) was used for all statistical analysis. In the descriptive statistics of the data, mean, standard deviation, median lowest, highest, frequency and ratio values were used. Distribution of variables was measured by Kolmogorov-Smirnov test. Mann-Whitney U test was used in the analysis of quantitative independent data. Wilcoxon test was used to analyze dependent quantitative data. In the analysis

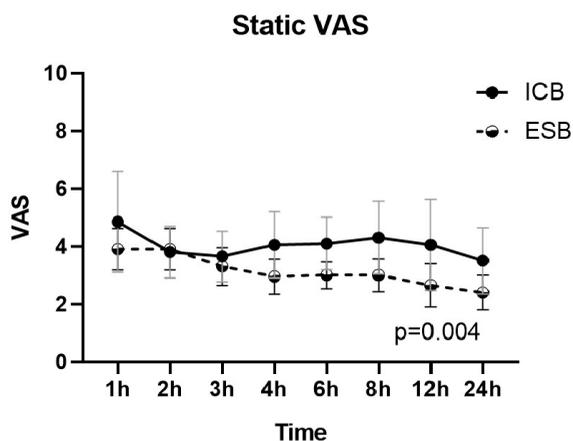


Figure 4. Static VAS change over time and comparison between groups.

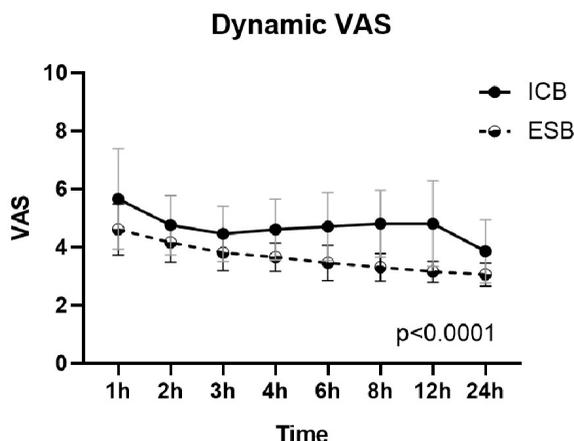


Figure 5. Dynamic VAS change over time and comparison between groups.

of qualitative independent data, chi-square test and Fischer test were used when chi-square test conditions were not met.

RESULTS

There was no difference between groups in terms of gender, height, weight, ASA score, comorbidity rate, and type of operation. Although the operation time was found to be 38 minutes longer than the ESP group, the difference between them was not statistically significant. Patients in the ESP group were statistically older than those in the ICB group ($p=0.007$). In addition, patients in the ESP group had undergone greater number of open surgeries than those in the ICB group (75% vs. 35%) and the intergroup difference was statistically significant ($p=0.01$).

Mean time interval up to the first analgesia requirement for all patients was 4.1 ± 2.6 hours. It was determined that the first analgesic was used after 6.4 ± 1.6 hours in the ESPB group and after 1.8 ± 0.9 hours in the ICB group. The difference between the groups in terms of the time elapsed up to the first analgesia requirement was found to be statistically significant ($p < 0.001$).

Patients in the ICB group were more likely to receive dexketoprofen ($p=0.02$). It was observed that the

patients who used tramadol were included in the ESPB group at a higher rate, but the difference was close to statistical significance ($p=0.065$).

The amounts of additional analgesics used by the patients are shown in Table 2. It was observed that higher doses of pethidine hydrochloride ($p=0.002$) and paracetamol ($p=0.001$) were administered to patients in the ICB group. There was no difference between groups as for the frequency of tramadol hydrochloride and dexketoprofen usage.

Static VAS was observed to be longer in the ICB group in all time periods except the second hour (Figure 1). It was found that the static VAS value was higher in the ICB group (Figure 4) in all time periods except the second hour (Figure 4) and this difference was statistically significant (Table 3). It was determined that dynamic VAS values; in all time periods in the ICB group was higher than the ESPB group (Figure 5). Dynamic VAS values were found to be statistically significantly higher in the ICB group until the twenty-fourth hour after the third hour (Table 3).

Similarly, it was found that the dynamic VAS values were statistically significantly higher in the ICB group.

Postoperative nausea was observed in 65% ($n=13$),

Table 1. Patients' demographic characteristics and comparison between groups.

	Total	ICB (n=20)	ESPB (n=20)	p
Age	57.7±13.2	52.3±15.9	63.2±6.6	0.007
Gender				1.000
Male	31	15	16	
Female	9	5	4	
Height (cm)	170.2±7.5	170.6±9.5	169.9±5.0	0.773
Weight (kgr)	75.8±9.5	76.3±11.9	75.3±6.7	0.734
ASA				
1	5 (12.5%)	3 (15.0%)	2 (10.0%)	0.885
2	23 (57.5%)	11 (55.0%)	12 (60.0%)	
3	12 (30.0%)	6 (30.0%)	6 (30.0%)	
Comorbidity rate	26 (65.0%)	11 (55.0%)	15 (75.0%)	0.185
Operation type				0.01
Open	22 (55.0%)	7 (35.0%)	15 (75.0%)	
Closed	18 (45.0%)	13 (65.0%)	5 (25.0%)	
Operation type				0.197
LobectomyWedge resect.	20 (50.0%)	8 (40.0%)	12 (60.0%)	
Other*	14 (35.0%)	8 (40.0%)	6 (30.0%)	
Other*	6 (15.0%)	4 (20.0%)	2 (10.0%)	
Operation time	179.2±73.0	198.0±93.0	160.5±39.4	0.105

* Two of them are bullectomy, one is cystectomy, one is hematoma drainage

and 15% (n=3) of the patients in the ICB, and ESPB groups, respectively ($p=0.008$). When the patient satisfaction score evaluated over ten points was examined, the mean scores given by the patients in the ESPB, and the ICB groups were 7.8 ± 0.6 , and 6.9 ± 0.6 , respectively ($p=0.001$).

DISCUSSION

Our research has shown that USG- guided ESPB using 40 ml of LA mixture applied at T4 contributes to successful postoperative analgesia in thoracic surgery. ESPB dramatically reduced the VAS pain score within the 1st hr, and the analgesic demand within the first 24 hrs relative to the ICB protocol.

In the study, patients in the ESP group had undergone greater number of surgical interventions than those in the ICB group (75% vs. 35%) with a statistically significantly intergroup difference ($p=0.01$). Neuralgia and postoperative pain are more common in open surgery secondary to intercostal nerve strain [14]. Therefore, postoperative pain is expected to be more severe in the ESP group. Fewer analgesics were used in the ESP group with lower VAS values, and also the open surgery was more frequently applied

in the ESP group because of its relatively higher effectiveness.

ESPB was first defined as an analgesic technique for thoracic neuropathic pain. In that manuscript, the authors also studied the spread of dye in two fresh cadavers and reported that the spread of the dye reached both to ventral and dorsal rami of spinal nerves, which could cause a sensory blockade over the anterolateral thorax. Adhikary et al [15] showed that LA spread after ESPB could be as 2 to 5 level epidural and 5 to 9 level intercostal. This could explain the mechanism of this block but further studies with larger samples are needed to verify these findings.

In addition, the duration of surgery performed was determined to be longer in the ESPB group. The prolongation of this period is important for the development of pain and its severity. However, in the study, the first analgesia requirement for all patients was longer in the ESPB group than the ICB group (6.4 ± 1.6 vs 1.8 ± 0.9 hours). Static and dynamic pain scores in the ESPB group were relatively lower starting from the early postoperative period and prolonged postoperative analgesic requirement time is the result of the effect of ESPB applied in the preoperative period

Table 2. Comparison of postoperative analgesic requirement hours, analgesics used and amounts between groups.

	ICB (n=20)	ESPB (n=20)	p
First analgesia hour	1.8±0.9	6.4±1.6	<0.001
Proportion of patients using petidine hydrochloride	17 (85.0%)	12 (60.0%)	0.155
Petidine hydrochloride amount (mg)	43.5±12.7	29.1±5.1	0.002
Proportion of patients using tramadol hydrochloride	12 (60.0%)	18 (90.0%)	0.06
Amount of tramadol hydrochloride (mg)	133.3±49.2	161.1±50.1	0.215
Paracetamol amount (gr)	2.9±0.3	2.2±0.6	0.001

Table 3. The difference between static and dynamic VAS between groups.

Static VAS	ICB (n=20)	ESPB (n=20)	p	Dynamic VAS	ICB (n=20)	ESPB (n=20)	p
1. hour	4.8±1.7	3.9±0.7	0.102	1. hour	5.6±1.7	4.6±0.8	0.052
2. hour	3.8±0.8	3.9±0.7	0.758	2. hour	4.7±1.0	4.1±0.6	0.060
3. hour	3.6±0.8	3.3±0.6	0.289	3. hour	4.4±0.9	3.8±0.6	0.03
4. hour	4.0±1.1	2.9±0.6	0.001	4. hour	4.6±1.0	3.6±0.6	0.004
6. hour	4.1±0.9	3.0±0.4	<0.001	6. hour	4.7±1.1	3.4±0.6	<0.001
8. hour	4.3±1.2	3.0±0.5	<0.001	8. hour	4.8±1.1	3.3±0.4	<0.001
12. hour	4.0±1.5	2.6±0.7	0.002	12. hour	4.8±1.4	3.1±0.3	<0.001
24. hour	3.5±1.1	2.4±0.5	0.001	24. hour	3.8±1.0	3.0±0.3	0.01

even though the surgery time is longer.

Since the first introduction of ESPB in thoracic neuropathic, its use has been widely recognized. ESPB has been used in different pathologies at various stages, such as chronic shoulder pain (T2), breast and thoracic surgery (T4-5) and upper abdominal surgery (T7-8) [13,16]. ESPB has been reported to be used in both adults and infants, notwithstanding its recent definition in the literature [13,17]. When ESPB is performed from the thoracic floor, it is stated that LA spreads to the paravertebral space, resulting in somatic and visceral analgesia. In studies investigating pain after thoracotomy, either one analgesic method was compared with another [18,19] or only one analgesic method was compared with the combined analgesic approach [20,21]. Debreceni et al. [18] compared the application of 0.25% bupivacaine through intercostal or thoracic epidural catheter, and found low pain scores in the group where they delivered bupivacaine through epidural catheter. In another study involving the two groups that compared the efficacy of continuous ICB and epidural morphine with bupivacaine in the management of postoperative pain,

comparable pain scores were obtained in the postoperative period, but it was reported that additional analgesic requirement was higher in the ICB group [22]. In our study, it was determined that the consumption rate of pethidine and paracetamol was higher in the ICB group. In both groups, there was no difference in terms of tramadol HCl and dexketoprofen consumption. In a study using IV paracetamol for postoperative pain, it was shown that it increased patient satisfaction by providing early recovery and discharge from the hospital [22]. The rate of nausea (65% vs 15%) was more common in ICB cases which might be related with higher opioid consumption. Patient satisfaction was found to be statistically higher (p=0.001) in the ESPB group in our study.

CONCLUSION

USG-guided ESPB performed preoperatively under general anesthesia, decreases the need for postoperative analgesia and increases the level of analgesia relative to the ICB group.

Peer-review: Externally peer-reviewed.

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