Am J Transl Res 2022;14(4):2469-2479
www.ajtr.org /ISSN:1943-8141/AJTR0140191

Original Article

Comparison of Intra- and postoperative effectiveness of erector spinae plane block and patient controlled analgesia in patients undergoing coronary artery bypass grafting surgery

Lale Oğur[1], Selcan Akesen[2], Suna Gören[2], İrem İris Kan[3], Elif Başağan Moğol[2], Alp Gurbet[2]

[1]*Department of Anesthesiology and Reanimation, Bingöl Public Hospital, Bingöl 12000, Turkey;* [2]*Department of Anesthesiology and Reanimation, Bursa Uludağ University Faculty of Medicine, Bursa 16059, Turkey;* [3]*Department of Cardiovascular Surgery, Bursa Uludağ University Faculty of Medicine, Bursa 16059, Turkey*

Received October 29, 2021; Accepted March 21, 2022; Epub April 15, 2022; Published April 30, 2022

Abstract: The aim of our study was to compare bilateral erector spinae plane block (ESPB) efficacy on pain management with patient controlled analgesia (PCA) during the perioperative period in patients scheduled for coronary artery bypass grafting (CABG). After ethics committee approval (2019-7/31 dated 09.04.2019) from the Bursa Uludağ University Medical Trials Ethics Committee, (https://uludag.edu.tr/buuetikkurulu) ASA II-III, 50 patients aged between 18-80 years were included. They were randomly divided into two groups, ESPB (n=25) and control (n=25). In the preoperative period, bilateral ESPB with ultrasonography was applied to both groups with 0.25% bupivacaine (0.5 ml/kg) + dexamethasone (8 mg) or saline, respectively. PCA prepared with morphine was given to all patients postoperatively. Perioperative opioid use, extubation times, coughing/resting Visual Analog Scale (VAS) scores, duration for first PCA bolus dose requirement, rescue analgesia needs, mobilization times, and opioid side effects were evaluated. In the ESPB group, compared to the control group, intraoperative fentanyl consumption was lower (P=0.001). During the postoperative period; extubation time was shorter, the need for initial PCA was much later, morphine consumption and need for rescue analgesia was less (P=0.001; P<0.001; P<0.001; P=0.009, respectively). The postoperative VAS scores were lower for each measurement period (P<0.05). Opioid-related side effects were more common in the control group (P=0.040). First mobilization time in ESPB group was earlier (P<0.001). As a result, ESPB has a significant analgesic effect in CABG patients. It was concluded that bilateral ESPB reduces opioid requirement compared to intravenous morphine PCA alone and provides better pain management and more comfortable recovery.

Keywords: Erector spinae plane block, patient controlled analgesia, pain management, coronary artery bypass surgery, opioid side effects

Introduction

Each year, more than 800,000 coronary artery bypass grafting (CABG) surgeries are performed worldwide [1]. After cardiac surgery, 30-75% of patients report moderate to severe acute pain. In the postoperative period, 4-10% of patients may develop chronic post-sternotomy pain syndrome [2, 3]. High pain scores and increased analgesic requirements observed in the early postoperative period are strongly correlated with the development of chronic pain syndrome [4]. Adequate analgesia provides haemodynamic stability, improved myocardial oxygenation, and immunological and haemostatic modulation. This may decrease the duration of mechanical ventilation and reduce cardiac ischemic events and arrhythmias in the postoperative period. Improved pain control reduces surgery-related complications and has a significant impact on the duration of hospital stay and patient satisfaction. For this reason, adequate analgesia as well as intraoperative and postoperative anaesthesia should be a high priority for intensive care teams.

Opioid-based analgesia is associated with adverse effects, such as nausea, vomiting, seda-

tion, urinary retention, itching, respiratory depression, and delayed extubation [5]. Application of thoracic epidural catheter is another analgesia method. Thoracic epidural analgesia (TEA), which can provide excellent "opioid-free" analgesia after cardiac surgery, is associated with decreased respiratory complications, arrhythmias, and mortality. However, due to the use of anticoagulants and antiplatelet agents, patients scheduled for cardiac surgery with TEA have an increased risk of developing epidural hematoma in the perioperative period compared to non-cardiac surgeries [6]. Analgesia with serratus anterior plane block and pectoral muscle plane block, which are regional nerve blocks, do not cover midline sternotomy pain. On the other hand, even though intercostal block, infiltration block, and thoracic paravertebral block cover sternotomy pain, the rate of complications increases in these procedures as they require multiple injections and are performed close to pleura [7].

Alternatively, erector spinae plane block (ESPB), which was introduced in 2016 by Forero et al. [8] for thoracic neuropathic pain treatment provides multidermatomal sensory block when applied bilaterally at the target level and it can prevent somatic and visceral pain by affecting the dorsal and ventral rami regions of the spinal nerves. The block is applied by administering local anaesthetic between the vertebral transverse process and the deep surface of the erector spinae muscle. It is predicted that ESPB may be used for postoperative analgesia in breast, thoracic, and extremity surgeries as it is simple, reliable and effective [8]. There are a limited number of studies in the literature regarding its use in patients undergoing cardiac surgery.

With this study, we aimed to demonstrate the contribution of ESPB, which was bilaterally applied at the thoracic 4th or 5th vertebra (T4-5) level with ultrasonography (USG) guidance preoperatively, to intraoperative and postoperative analgesia in CABG cases by investigating its effects on patients' opioid use, extubation times, Visual Analogue Scale (VAS) scores during coughing and resting, first PCA use after ESPB, need for rescue analgesia, mobilization times, and opioid side effects as well as patient and surgeon satisfaction.

Materials and methods

This prospective, randomized controlled study was performed after obtaining Bursa Uludag University Medical Trials Ethics Committee approval (2019-7/31; 09-APR-2019) and of written informed consent from the patients.

Fifty patients scheduled for CABG surgery aged 18-80 years with American Society of Anaesthesiologists (ASA) Physical status class II-III were included in the study. Patients who were known to be allergic to local anaesthetic(s) and who had suspected coagulopathy, infection at the injection site, history of previous cardiac surgery, severe neurological or psychiatric disorders, severe respiratory disorder, hepatic failure, renal failure, and chronic opioid use were excluded from the study.

During pre-anaesthetic assessment at the outpatient clinic, all patients were informed about general anaesthesia, ESPB, VAS score, and PCA device usage. After information, written and verbal consent was obtained from the patients. The patients were randomized into two study groups as ESPB (n=25) and control (n=25) with a closed envelope method.

In the operating room, the patients were monitored with ECG, pulse oximetry, noninvasive arterial pressure monitoring and intravenous midazolam up to 0.05 mg/kg (Zolamid®, DEFARMA, Ankara, Turkey) was administered in divided doses for premedication. After application of infiltration anaesthesia with prilocaine (Priloc®, Vem, Istanbul, Turkey), radial artery cannulation was performed for invasive arterial pressure monitoring. ESPB was performed with 8-12 MHz linear probe of ultrasonography device (Logice®, GE, Boston, USA) and an ultrasound-visible stimulation needle (Stimuplex, ultra 360®, 50 mm Braun). After providing necessary sterile conditions in a sitting position prior to general anaesthesia, a total of 0.5 ml/kg saline (sodium chloride 0.9%) was injected bilaterally to the patients in the control group, and a total of 0.5 ml/kg bupivacaine solution 0.25% (Buvasin®, Vem, Istanbul, Turkey) and 8 mg dexamethasone (Onadron, I.E. Ulagay, Istanbul, Turkey) to the patients in the ESPB group. The blocks were applied by the same physician using the "in plane" approach between the erector spinae muscle and the transverse process at the level of the

T4 or T5 vertebrae. Local anesthetic distribution was observed in both cranial and caudal directions. After the application of ESPB, the efficacy of the block was confirmed using the pinprick test.

General anaesthesia induction was achieved with fentanyl 3 mcg/kg iv (Talinat®, Vem, Istanbul, Turkey), propofol 2 mg/kg (Propofol 1% Fresenius), rocuronium 0.6 mg/kg (Myocron®, Vem, Istanbul, Turkey) intravenously to all patients in both groups. General anaesthesia was maintained with Sevoflurane 0.8-1.2 MAC (Sevorane® Liquid 100%, AbbVie, Queenborough Kent, UK) in 50% O_2/50% air, 4 l/min fresh gas flow, after tracheal intubation. Central venous catheterization (Braun Certofix® double lumen, Germany) was performed via right internal jugular vein. All patients received fentanyl infusion (3-5 mcg/kg/h) and rocuronium (0.25 mg/kg) was given at intervals. When blood pressure or peak heart rate values increased 20-25% of baseline, intravenous fentanyl bolus (2 mcg/kg) was repeated for those patients. The patients were followed up with the bispectral index (BIS) monitoring (target BIS values 40-60). At the end of the LIMA dissection, patients undergoing surgery with cardiopulmonary bypass (CPB) were given 350 IU/kg heparin (Vasparin®, Vem, Istanbul, Turkey) and those undergoing "off-pump" surgery were administered 100-150 IU/kg heparin through the central venous access before clamping. "Activated Clotting Time" (ACT) was kept >450 sec in surgeries performed with CPB and >300-350 sec in "off-pump CABG" surgeries. Sevoflurane administration from the CPB machine was continued during CPB. The mean arterial pressure was kept between 50-70 mmHg. In addition to fentanyl infusion and intermittent rocuronium administration, midazolam (intravenous 0.02 mg/kg) was used when necessary. In "off-pump CABG" surgery patients, general anaesthesia was maintained in a similar way prior to coronary artery bypass. At the end of the coronary artery anastomoses, 1 mg protamine sulphate was given intravenously for every 100 IU heparin for initial heparin dose in surgeries performed with CPB and 0.5-0.75 mg for every 100 IU heparin in off-pump surgeries to keep ACT <150. During the operation, intermittent arterial blood gas monitoring and necessary replacements were performed as standard in all patients. At the end of the operation, fentanyl infusion was discontinued, and hemodynamically stable patients were intubated and transported to the Cardiovascular Surgery Intensive Care Unit after intravenous administration of rocuronium (0.25 mg/kg) and midazolam (0.03 mg/kg).

For postoperative analgesia, patient-controlled analgesia device (PCA) containing morphine (Morphine HCL 0.01 g® Galen, Istanbul, Turkey) 1 mg/ml, was set to deliver 0.3 mg/h continuous infusion with a 1 mg bolus dose, with an 15 min lockout time and dose limit of 3 mg per hour. PCA was initiated for each patient 15 minutes before the end of the operation, and the patients were followed up with PCA for the first 24 hours. Before extubation, the nurses were asked to apply a bolus dose from the PCA device when necessary. Also, a bolus dose was applied to each patient before extubation. The VAS (0-10) was used to assess patients' pain intensity. In case of a VAS score ≥4, paracetamol 1 g intravenous (Partemol® Vem, Istanbul, Turkey) was given as rescue analgesia. If VAS ≥4 persisted, 1 mg/kg intramuscular meperidine (Petisel® Haver Pharma, Istanbul, Turkey) was also administered.

Patients demographic data (gender, body weight, height, age, body mass index, body surface area, comorbidities (ASA class), and preoperative platelet numbers) was recorded. Intraoperative data including the type and duration of operation, number of coronary grafts, cross clamp times, duration of CPB and fentanyl consumption was also recorded. Moreover, intraoperative haemodynamic data was recorded before and after induction, during incision, after sternotomy, after pericardiotomy, before CPB and at the end of the operation.

In the postoperative period, the duration of intubation, the first mobilization time and patients' needs for vasoactive drugs were recorded. After extubation, patients' cough VAS scores at rest and during coughing were noted at the 0th minute and at the 1st, 2nd, 4th, 8th, 12th, 16th and 24th hours. Furthermore, the time to first PCA dose, amount of morphine administered as bolus doses at the specified times, need for additional analgesics, potential side effects of opioids (nausea-vomit-

Table 1. Patients' demographic data and characteristics

	ESPB Group (n=25) (Mean ± SD, n, %)	Control Group (n=25) (Mean ± SD, n, %)	*P* value
Age	64.2 ± 9.2	60.1 ± 10.3	0.137[t]
Gender			
Female	6 (24%)	5 (20%)	0.733[x²]
Male	19 (76%)	20 (80%)	
Weight (kg)	77.8 ± 13.0	81.8 ± 9.2	0.216[t]
Height (cm)	167.2 ± 8.7	168.2 ± 9.2	0.640[m]
BSA (m^2)	1.8 ± 0.2	1.9 ± 0.1	0,534[m]
BMI (kg/m^2)	27.8 ± 4.2	29.1 ± 4.3	0.275[t]
ASA			
II	12 (48%)	9 (36%)	0.390[x²]
III	13 (52%)	16 (64%)	
Preoperative platelet counts ($\times 10^3$)	209.7 ± 81.2	212.6 ± 71.3	0,893[t]
Number of coronary artery bypass grafts	3.1 ± 1.3	3.2 ± 1.0	0.495[m]
Comorbidities			
HT	2 (8%)	4 (16%)	0.384[x²]
HT+HL	3 (12%)	4 (16%)	0.684[x²]
HT+DM	13 (52%)	14 (56%)	0.777[x²]
HL	6 (24%)	2 (8%)	0.123[x²]
HT+COPD	1 (4%)	1 (4%)	1.000[x²]

[m]Mann-Whitney U test is used to compare difference in the dependent variable for two independent groups/[x²]Chi-square test was used to analyse the count data/[t]Independent sample t test used to statistical differences between the means of two groups. BSA: Body Surface Area, BMI: Body Mass Index, HT: Hypertension, HL: Hyperlipidemia, DM: Diabetes Mellitus, COPD: Chronic Obstructive Pulmonary Disease.

ing, respiratory depression, sedation, itching) were also recorded.

After the 24th hour data was obtained after extubation, a five-point Likert scale (1= very dissatisfied, 5= very satisfied) was used to evaluate the satisfaction of the patients and the surgical team [9].

Statistical analysis

Morphine consumption was taken as the primary parameter while calculating the sample size. Accordingly, considering the results of Gürkan et al. [10], it was predicted that there would be a 30% reduction in morphine consumption in the ESPB group. Based on these data, it was determined that there should be at least 20 patients in each group to be able to identify the desired differentiation with non-parametric tests as β=80% and α<0.05, and so 50 patients were planned to be included in the study. G*Power Version 3.1.7 was used to determine the statistical power and effect size of the study.

We used the mean, standard deviation, median, minimum-maximum, frequency, and ratio values for descriptive statistics. The Kolmogorov Smirnov test was used to evaluate the distribution of the variables. The independent sample t test and the Mann-Whitney U test were employed in the analysis of quantitative independent data. Independent quantitative data was analysed using the Chi-square test, but when the conditions for the Chi-square test were not met, the Fisher test was applied. We benefited from the SPSS 26.0 program for the analyses and P<0.05 was accepted as statistically significant.

Results

The patients enrolled in the study were found to be similar in terms of age, gender, height, body weight, body surface area, body mass index, ASA classification, preoperative platelet counts, comorbidities and the number of coronary artery bypass grafts performed (**Table 1**). As for comorbidities, 84% (n=42) of the patients had hypertension (HT), 54% (n=27) had

Table 2. Operation type, duration of operation and duration of cross-clamps for patients

	ESPB Group (n=25)		Control Group (n=25)		*P* value
	Mean ± SD/n%	Median	Mean ± SD/n%	Median	
"Off Pump" CABG	3/12.0%		2/8.0%		0.637[X2]
CABG with CPB	22/88.0%		23/92.0%		
Cross-Clamping Period (min)[a]	49.2 ± 28.9	46.0	54.8 ± 25.0	53.0	0.460[t]
CPB period (min)[b]	84.8 ± 45.6	82.0	93. ± 38.5	97.0	0.491[t]
Operation Duration (min)	259.6 ± 54.4	270.0	282.2 ± 47.2	295.0	0.074[m]

[m]Mann-Whitney U test is used to compare difference in the dependent variable for two independent groups/[x2]Chi-square test was used to analyse the count data/[t]Independent sample t tests used to statistical differences between the means of two groups. [a]For surgeries not performed with the "off-pump" technique. [b]Accepted as the time to complete coronary anastomoses for "off-pump" surgeries. CABG: Coronary artery bypass grafting surgery, CPB: Cardiopulmonary bypass.

Table 3. Intraoperative haemodynamic data

	ESPB Group (n=25)		Control Group (n=25)		*P* value
	Mean ± SD	Median	Mean ± SD	Median	
Mean Arterial Pressure (mmHg)					
Before Induction	102.7 ± 15.2	103.3	97.1 ± 19.3	101.0	0.257[t]
After Induction	76.2 ± 13.9	76.7	75.0 ± 10.6	76.3	0.744[t]
During incision	82.6 ± 10.2	83.3	85.4 ± 15.5	85.0	0.453[t]
After sternotomy	85.3 ± 9.4	86.0	89.1 ± 11.5	91.7	0.211[t]
After pericardiotomy	75.1 ± 10.1	75.7	80.5 ± 12.5	80.0	0.940[t]
Before CPB[a]	73.3 ± 10.5	72.0	74.7 ± 11.7	72.7	0.671[t]
At the end of operation	72.6 ± 7.6	73.0	76.3 ± 8.4	76.3	0.111[t]
Peak Heart Rate (beat/min)					
Before Induction	73.2 ± 8.76	71.3	73.08 ± 11.1	70.0	0.822[t]
After Induction	69.7 ± 7.67	67.5	68.12 ± 12.12	68.7	0.581[t]
During incision	68.7 ± 9.7	66.0	68.2 ± 11.8	65.0	0.886[t]
After sternotomy	69.2 ± 9.6	70.0	70.8 ± 12.2	71.0	0.599[t]
After pericardiotomy	67.4 ± 9.7	68.0	68.8 ± 9.1	68.0	0.591[t]
Before CPB[a]	69.3 ± 11.5	68.5	70.8 ± 9.9	69.0	0.625[t]
At the end of operation	80.6 ± 11.1	82.0	79.8 ± 9.9	78.0	0.800[t]

[t]Independent sample t test used to statistical differences between the means of two groups. [a]For "off-pump" surgeries, data from prior to coronary anastomoses were considered. CPB: Cardiopulmonary bypass.

diabetes mellitus (DM), 30% (n=15) had hyperlipidemia, and 4% (n=2) had chronic obstructive pulmonary disease (COPD).

Of all our patients, 10% (n=5) underwent surgery with the "off-pump" technique while 90% (n=45) underwent surgery with CPB. Patients' intraoperative characteristics are given in **Table 2**.

Mean arterial pressures measured before and after induction, during incision, after sternotomy and pericardiotomy, before CPB and at the end of the operation did not differ significantly between the ESPB and control groups (P=0.257, P=0.744, P=0.453, P=0.211, P=0.940, P=0.671, P=0.111, respectively). Also, the peak heart rate values measured at the aforementioned time points did not show a significant difference between the two groups (P=0.886, P=0.599, P=0.591, P=0.625, P=0.800, respectively) (**Table 3**).

Intraoperative fentanyl consumption, which was 362.8 ± 79.9 mcg in the ESPB group and 1093.0 ± 21.4 mcg in the control group, showed a significant difference between the groups (P<0.001).

Time to extubation was 304 ± 99.8 min in the ESPB group and 465.6 ± 217.8 min in the control group. When the two groups were com-

Table 4. Comparison of post-extubation VAS scores between the ESPB and control groups

	ESPB Group (n=25)		Control Group (n=25)		*P* value
	Mean ± SD	Median (min-max)	Mean ± SD	Median (min-max)	
VAS Score-Rest					
0. Minute	2.2 ± 1.4	2 (0-5)	3.0 ± 1.4	3 (0-6)	*0.033*[m]
1. Hour	1.5 ± 0.8	2 (0-3)	2.8 ± 1.3	3 (0-5)	*0.000*[m]
2. Hour	1.3 ± 0.9	1 (0-4)	2.5 ± 1.3	2 (1-5)	*0.001*[m]
4. Hour	1.2 ± 0.9	1 (0-3)	2.5 ± 1.1	3 (0-5)	*<0.001*[m]
8. Hour	0.9 ± 1.0	1 (0-4)	2.3 ± 1.1	2 (1-6)	*<0.001*[m]
12. Hour	0.8 ± 0.9	1 (0-3)	1.8 ± 0.7	2 (1-5)	*<0.001*[m]
16. Hour	0.6 ± 0.6	1 (0-3)	2.2 ± 0.7	2 (1-5)	*<0.001*[m]
24. Hour	0.3 ± 0.5	0 (0-4)	2.0 ± 0.6	2 (1-4)	*<0.001*[m]
VAS Score-Cough					
0. Minute	3.6 ± 1.4	3 (1-6)	4.6 ± 1.7	4 (1-8)	*0.013*[m]
1. Hour	2.8 ± 1.2	3 (1-5)	4.0 ± 1.7	4 (1-8)	*0.004*[m]
2. Hour	2.6 ± 1.3	3 (0-5)	3.6 ± 1.5	4 (2-7)	*0.027*[m]
4. Hour	2.4 ±1.3	2 (0-4)	3.8 ± 1.3	4 (1-6)	*0.002*[m]
8. Hour	2.0 ± 1.1	2 (0-5)	3.4 ± 1.4	3 (1-8)	*<0.001*[m]
12. Hour	1.9 ± 1.1	2 (0-4)	3.3 ± 0.8	3 (2-5)	*<0.001*[m]
16. Hour	1.4 ± 0.9	1 (0-4)	3.2 ± 0.9	3 (2-5)	*<0.001*[m]
24. Hour	0.8	1 (0-4)	3.0 ± 1.0	3 (2-6)	*<0.001*[m]

[m]Mann-Whitney u test is used to compare difference in the dependent variable for two independent groups. VAS: Visual Analogue Scale score (0-10).

Table 5. Comparison of the ESPB and control groups for morphine consumption

	ESPB Group (n=25)		Control Group (n=25)		*P* value
	Mean ± SD	Median	Mean ± SD	Median	
Morphine Consumption (mg)					
0. Minute	2.6 ± 0.5	2.5	3.6 ± 1.2	3.1	*0.001*[m]
1. Hour	3.1 ± 0.7	3.4	4.9 ± 1.3	4.4	*<0.001*[t]
2. Hour	3.6 ± 0.8	3.7	6.0 ± 1.5	5.4	*<0.001*[t]
4. Hour	4.4 ± 0.9	4.5	7.6 ± 1.7	7.0	*<0.001*[t]
8. Hour	5.7 ± 1.0	5.8	9.8 ± 1.7	9.2	*<0.001*[t]
12. Hour	7.1 ± 1.2	7.0	12.2 ± 2.0	11.6	*<0.001*[t]
16. Hour	8.4 ± 1.4	8.2	14.9 ± 2.1	14.6	*<0.001*[t]
24. Hour	11.2 ± 1.6	10.6	19.0 ± 2.6	18.3	*<0.001*[t]

[m]Mann-Whitney u test is used to compare difference in the dependent variable for two independent groups/[t]Independent sample t test used to statistical differences between the means of two groups.

pared, the time to extubation was found to be shorter in the ESPB group (P=0.001).

The VAS scores both during coughing and at rest were found to be lower in ESPB patients as compared to the controls at each measurement times (respectively P<0.05, P<0.05). **Table 4** summarizes the distribution of VAS scores by the measurement periods.

The time to first PCA usage was 10.6 ± 8.2 hours in the ESPB group and 1.7 ± 1.3 hours in the control group, which was significantly different between study groups (P=0.000).

Morphine consumption at the 0th minute and the 1st, 2nd, 4th, 8th, 12th, 16th and 24th hours was significantly lower in the ESPB group when compared to the control group (P≤0.001) (**Table 5**).

There was no need for additional analgesics in 80% (n=20) of ESPB patients and 40% (n=10) in the control group (p=0.009). Five (20%)

Table 6. Comparison of patients in terms of additional analgesic needs

		ESPB Group		Control Group		*P* value
		N	%	n	%	
Additional Analgesic	No Need	20	80.0%	10	40.0%	*0.009*[x²]
	Paracetamol	5	20.0%	9	36.0%	
	Paracetamol + meperidine	0	0.0%	6	24.0%	

[x²]Chi-square test was used to analyse the count data.

Table 7. Distribution of opioid-related side effects by groups

		ESPB Group		Control Group		*P* value
		N	%	n	%	
Opioid Side Effect(s)	None	23	92.0%	16	64.0%	*0.040*[x²]
	Somnolence	1	4.0%	3	12.0%	
	Nausea-Vomiting	1	4.0%	1	4.0%	
	Weakness	0	0.0%	1	4.0%	
	Respiratory Depression	0	0.0%	2	8.0%	
	Urinary Retention	0	0.0%	2	8.0%	

[x²]Chi-square test was used to analyse the count data.

Table 8. Comparison of patient and surgeon satisfaction between the groups

	ESPB Group (n=25)		Control Group (n=25)		*P* value
	Mean ± SD	Median (min-max)	Mean ± SD	Median (min-max)	
Patient Satisfaction	4.6 ± 0.5	5 (4-5)	3.8 ± 0.7	4 (2-5)	*<0.001*[m]
Surgeon Satisfaction	4.6 ± 0.6	5 (3-5)	3.6 ± 0.5	4 (3-5)	*<0.001*[m]

[m]Mann-Whitney u test is used to compare difference in the dependent variable for two independent groups.

patients in the ESPB group and 15 (60%) patients in the control group needed paracetamol. Also, 6 (24%) patients in the control group required meperidine in addition to paracetamol (**Table 6**).

Opioid-induced adverse effects were observed in 2 patients in the ESPB group: 1 (4%) showed somnolence and the other had nausea-vomiting. None of the ESPB patients experienced weakness, respiratory depression or urinary retention. On the other hand, a total of 6 patients had adverse effects in the control group: somnolence in 3 (12%) patients, weakness in 1 (4%) patient, respiratory depression in 2 (8%) patients and urinary retention in 2 (8%) patients. These data showed significant difference (p=0.040). No patient had other opioid-induced adverse effects (itching etc.). These data are summarized in **Table 7**.

The average time to mobilization was 556.2 ± 128.1 in the ESPB group and 859.2 ± 237.0 minutes in the control group, being significantly lower in the ESPB group (P<0.001).

During monitoring in the intensive care unit, 28% of the patients (n=7) in the ESPB group and 36% (n=9) in the control group required vasoactive drugs and the rate of usage was similar between two study groups (P=0.544).

When it came to the patient and surgeon satisfaction evaluated with a five-point Likert scale, they were respectively 4.6 ± 0.5 and 4.6 ± 0.6 in the ESPB group and 3.8 ± 0.7 and 3.6 ± 0.5 in the control group. The difference between the groups was significant (P<0.001 and P<0.001, respectively) (**Table 8**).

ESPB was successfully performed in all patients and none of them encountered any problems (complications such as muscle weakness due to central extension, hypotension, hematoma, pneumothorax, local anaesthetic toxicity) after ESPB application.

Discussion

In our study, we aimed to see how bilateral ESPB application affects intraoperative and

postoperative opioid consumption, pain scores and the possibility of experiencing opioid-related side effects in patients undergoing CABG with median sternotomy. The data obtained showed that ESPB application provided a decrease in opioid use in the study group, and the VAS scores measured at 24 hours after extubation were lower compared to the control group.

The number of studies in the literature addressing ESPB performed for cardiac surgery patients is limited. Moreover, the ESPB technique and preferred drugs and applied doses also vary between available studies.

Intraoperative haemodynamic stability may be achieved with lower doses of opioids in surgeries performed following the application of ESPB in the form of a single injection, intermittent bolus injection and/or infusion from the catheter placed between fascias. Krishna et al. [11] reported intraoperative fentanyl consumption to be lower in patients undergoing ESPB. In one study, in which they applied a catheter under the erector spinae muscle, Nagaraja et al. [12] stated that there was no significant difference between TEA and ESPB cases in intraoperative fentanyl consumption. There are studies in the literature showing that the solution administered for ESPB distributes between the fascia in the craniocaudal, posterior and lateral planes, through the costotransverse ligament in the posterior dorsal ramus, and in the paravertebral and epidural spaces [13-15]. The similar results between the two groups may be attributed to the fact that the solution distributes to a large area. High-dose heparin applied in cardiac surgery increases the risk of epidural hematoma for TEA [5, 6, 16]. Considering the results of these studies, ESPB seems to be a potential alternative to TEA as it provides effective analgesia and has decreased risk of complications. Similarly, intraoperative fentanyl consumption was lower in the ESPB group in our study. However, a study of paediatric cardiac surgery patients reported similar intraoperative fentanyl consumption in both groups [17]. But that study did not address intraoperative haemodynamic data of the patients. Also, the duration of the study was shorter compared to the other studies, which may have affected their results.

Early extubation after cardiac surgery is associated with improved survival [18]. It has also been shown that early extubation shortened the length of stay in the intensive care unit and at the hospital and therefore reduced the hospital costs [19]. Krishna et al. [11] reported the time to extubation to be shorter in the ESPB group compared to the control group. Nagaraja et al. [12] compared the efficiency of TEA and ESPB, and found the time to extubation to be similar in both groups. Muñoz-Levya et al. [20] stated that they extubated 4 patients in the operating room in their case series of 5 patients. Similar to the literature, we found shorter extubation times in patients receiving bilateral ESPB with the combination of bupivacaine and dexamethasone compared to the control group.

Comparing TEA and ESPB, Nagaraja et al. [12] did not identify a significant difference between the groups regarding dynamic and static VAS values at the 0th, 3rd, 6th and 12th hours. However, they stated that the VAS scores recorded at the 24th, 36th and 48th hours were lower in patients receiving ESPB. In their study in the paediatric age group, Kaushal et al. [17] indicated lower pain scores in the ESPB group at hours 0, 1, 2, 4, 6, 8, and 10. Krishna et al. [11] stated that VAS score was <4 in all cases during the first 8 hours in the ESPB group and added that at the 10th and 12th hours, 47.16% of the patients had VAS <4. However, when it came to the controls, those who received intravenous analgesia, VAS was reported to be <4 in all patients in the first 4 hours, and this rate decreased to 30.18% by the 6th hour, and all patients had a VAS score above 4 at the 8th hour. Macaire et al. [21] reported that the VAS scores measured after the withdrawal removal of the drains, during the first mobilization, and in the postoperative 1st month were lower in the group they applied continuous drug infusion with ESPB as compared to the intravenous drug group. In the present study, we evaluated the VAS scores during coughing and resting and demonstrated that ESPB patients had lower VAS scores at the 0th, 1st, 2nd, 4th, 8th, 12th, 16th and 24th hours as compared to the controls. We concluded that dexamethasone added to bupivacaine as an adjuvant drug in single-dose ESPB might have contributed to the achievement of low VAS

scores with prolonged analgesic effect up to 24 hours after surgery.

Krishna et al. [11] demonstrated significantly lower and later postoperative opioid use in the ESPB group compared to the intravenous drug group. Nagaraja et al. [12] compared TEA and ESPB, and evaluated postoperative opioid consumption data with rescue analgesia. They also reported that in total 7 patients required rescue analgesia in the ESPB group and 9 patients in the TEA group. As a result of their postoperative 48-hour period evaluation, Macaire et al. [21] demonstrated that the group undergoing ESPB did not need opioids while the groups receiving intravenous drug needed 40 mg (median value) morphine. In a study conducted in the paediatric age group, Kaushal et al. [17] found that the rate of rescue analgesia was lower in the ESPB group compared to the control group. Besides, the time to first rescue analgesia requirement was also found to be lower in the ESPB group. Çiftçi et al. [22] included 60 patients scheduled for video-assisted thoracic surgery in their study and they discovered that in the ESPB group needed less opioid consumption and less rescue analgesia during the 24-hour follow-up than the control group. Elhawary et al. [23] evaluated the data on the use of ESPB in patients undergoing breast surgery in their review including 32 studies and concluded that ESPB application reduced postoperative opioid use. When we compared our patients for the time needed for the first bolus dose, we found that it was 10.6 ± 8.2 hours in the ESPB group and 1.7 ± 1.3 hours in the control group. At the end of the postoperative 24 hours, we calculated the total opioid use of our patients as 11.2 ± 1.6 mg in the ESPB group and 19.0 ± 2.6 mg in the control group. Five patients in the ESPB group and 15 patients in the control group needed paracetamol as rescue analgesia, and 6 of the 15 patients in the control group also required meperidine in addition to paracetamol.

Minimizing the use of opioids ensures a more comfortable recovery period for patients by reducing the possibility of opioid-related side effects. In our study, 1 (4%) patient showed somnolence and 1 (4%) other patient had nausea-vomiting in the ESPB group. In the control group those who only received PCA with intravenous morphine, we observed somnolence in 3 (12%) patients, weakness in 1 (4%) patient, respiratory depression in 2 (8%) patients and urinary retention in 2 (8%) patients (a total of 9 side effects in 6 patients). Macaire et al. [21] reported lower rates of hypotensive periods, nausea-vomiting and hyperglycaemia in the ESPB group than in the control group. Kaushal et al. [17] compared postoperative Ramsey sedation scale scores of paediatric patients and reported that the sedation scores of the group to whom ESPB was applied was lower compared to the control group.

Delayed mobilization after cardiac surgery is associated with complications including prolonged immobility, thromboembolic disorder, weakness of skeletal muscles, and atelectasis. Early mobilization is thought to be a critical approach in providing better oxygenation by reducing the incidence of atelectasis and pleural effusion after CABG [24]. A review comparing opioid use and other block applications (intercostal block, infiltration block, parasternal block) in the postoperative period after cardiac surgery reported that patients who underwent block application were mobilized earlier [25]. Krishna et al. [11] expressed that mobilization was achieved earlier, the duration of intensive care stay was shorter, and the need for inotropic/vasoactive drugs was lower in patients who underwent ESPB than in the controls. Similar to the aforementioned studies, we found that the time to mobilization was shorter in the patients to whom we applied ESPB compared to the control group where we applied PCA with only intravenous morphine.

Considering satisfaction scales completed by the patients and the surgical team included in the study, the rate of satisfaction with the analgesia program applied in our study was higher in the ESPB group compared to the control group. There is no study in the literature reporting satisfaction levels of patients and surgical team after ESPB application in patients who had cardiac surgery. Addition of this aspect to further studies will contribute to the literature.

In a review investigating 182 cases that had ESPB application at different levels and with different agents in various surgical interventions or for chronic pain treatment, there were only 4 patients that developed complications: 1 patient had muscle weakness and the other 3 had local anaesthetic toxicity [26]. In another review of 242 cases, 1 case of pneumothorax

was reported [27]. Nevertheless, we did not face any problems in our patients after ESPB.

When it comes to the limitations of our study, we could have increased patients' comfort if we had applied ESPB after the induction general anaesthesia instead of applying it with ultrasound-guided light sedation. Another limitation is that although we controlled the efficacy of the block, we did not identify the area it distributed into. Furthermore, since we no longer followed up the patients after the first 24 hours in the postoperative period after extubation, we could not evaluate the long-term effects of the method used on pain scores after the 24th hour and the chronicity of pain. It is possible to provide longer analgesia with infusion or infusion + bolus applications through bilateral catheters. However, the difference in VAS scores, decrease in opioid consumption and increased patient/surgeon satisfaction showed that the method we used in CABG cases was effective in providing analgesia.

In conclusion, the data we obtained indicate that ESPB has a significant analgesic effect in patients scheduled for CABG surgery. ESPB reduced the use of opioids in the intraoperative period, provided lower VAS scores (while resting and coughing) during the postoperative period, shortened the time to extubation and mobilization, reduced the need for opioid and rescue analgesia, and thus, ensured lower incidence of opioid-related side effects and higher patient/surgeon satisfaction. We believe that using ESPB, one of the regional block techniques in pain management with a multi-modal approach, contributes significantly to the perioperative pain management, quality of recovery and patient comfort.

Disclosure of conflict of interest

None.

Address correspondence to: Lale Oğur, Department of Anesthesiology and Reanimation, Bingöl Public Hospital, Bingöl 12000, Turkey. Tel: +90554807-2925; Fax: +904264114717; E-mail: laledurna@gmail.com

References

[1] Nalysnyk L, Fahrbach K, Reynolds MW, Zhao SZ and Ross S. Adverse events in coronary artery bypass graft (cabg) trials: a systematic review and analysis. Heart 2003; 89: 767-772.

[2] Bigeleisen PE and Goehner N. Novel approaches in pain management in cardiac surgery. Curr Opin Anaesthesiol 2015; 28: 89-94.

[3] Kehlet H, Jensen TS and Woolf CJ. Persistent postsurgical pain: risk factors and prevention. Lancet 2006; 367: 1618-1625.

[4] Choinière M, Watt-Watson J, Victor JC, Baskett RJ, Bussières JS, Carrier M, Cogan J, Costello J, Feindel C, Guertin MC, Racine M and Taillefer MC. Prevalence of and risk factors for persistent postoperative nonanginal pain after cardiac surgery: a 2-year prospective multicentre study. CMAJ 2014; 186: 16-19.

[5] Huang APS and Sakata RK. Dor após esternotomia-revisão. Br J Anaesth 2016; 66: 395-401.

[6] Landoni G, Isella F, Greco M, Zangrillo A and Royse CF. Benefits and risks of epidural analgesia in cardiac surgery. Br J Anaesth 2015; 115: 25-32.

[7] Mittnacht AJC, Shariat A, Weiner MM, Malhotra A, Miller MA, Mahajan A and Bhatt HV. Regional techniques for cardiac and cardiac-related procedures. J Cardiothorac Vasc Anesth 2019; 33: 532-546.

[8] Forero M, Adhikary SD, Lopez H, Tsui C and Chin KJ. The erector spinae plane block a novel analgesic technique in thoracic neuropathic pain. Reg Anesth Pain Med 2016; 41: 621-627.

[9] Sullivan GM and Artino AR Jr. Analyzing and interpreting data from likert-type scales. J Grad Med Educ 2013; 5: 541-2.

[10] Gürkan Y, Aksu C, Kuş A, Yörükoğlu UH and Kılıç CT. Ultrasound guided erector spinae plane block reduces postoperative opioid consumption following breast surgery: a randomized controlled study. J Clin Anesth 2018; 50: 65-68.

[11] Krishna SN, Chauhan S, Bhoi D, Kaushal B, Hasija S, Sangdup T and Bisoi AK. Bilateral erector spinae plane block for acute post-surgical pain in adult cardiac surgical patients: a randomized controlled trial. J Cardiothorac Vasc Anesth 2019; 33: 368-375.

[12] Nagaraja P, Ragavendran S, Singh N, Asai O, Bhavya G, Manjunath N and Rajesh K. Comparison of continuous thoracic epidural analgesia with bilateral erector spinae plane block for perioperative pain management in cardiac surgery. Ann Card Anaesth 2018; 21: 323.

[13] Adhikary SD, Bernard S, Lopez H and Chin KJ. Erector spinae plane block versus retrolaminar block: a magnetic resonance imaging and anatomical study. Reg Anesth Pain Med 2018; 43: 756-762.

[14] Yang HM, Choi YJ, Kwon HJ, O J, Cho TH and Kim SH. Comparison of injectate spread and nerve involvement between retrolaminar and erector spinae plane blocks in the thoracic re-

gion: a cadaveric study. Anaesthesia 2018; 73: 1244-1250.
[15] Schwartzmann A, Peng P, Maciel MA and Forero M. Mechanism of the erector spinae plane block: insights from a magnetic resonance imaging study. Can J Anaesth 2018; 65: 1165-1166.
[16] Freise H and Van Aken HK. Risks and benefits of thoracic epidural anaesthesia. Br J Anaesth 2011; 107: 859-868.
[17] Kaushal B, Chauhan S, Magoon R, Krishna NS, Saini K, Bhoi D and Bisoi AK. Efficacy of bilateral erector spinae plane block in management of acute postoperative surgical pain after pediatric cardiac surgeries through a midline sternotomy. J Cardiothorac Vasc Anesth 2020; 34: 981-986.
[18] Camp SL, Stamou SC, Stiegel RM, Reames MK, Skipper ER, Madjarov J, Velardo B, Geller H, Nussbaum M, Geller R, Robicsek F and Lobdell KW. Can timing of tracheal extubation predict improved outcomes after cardiac surgery? HSR Proc Intensive Care Cardiovasc Anesth 2009; 1: 39-47.
[19] Wong WT, Lai VK, Chee YE and Lee A. Fast-track cardiac care for adult cardiac surgical patients. Cochrane Database Syst Rev 2016; 9: CD003587.
[20] Muñoz-Leyva F, Chin KJ, Mendiola WE, Cubillos J, Moreno DA, Zhong-Lin C and Bonilla AJ. Bilateral continuous erector spinae plane (esp) blockade for perioperative opioid-sparing in median sternotomy. J Cardiothorac Vasc Anesth 2019; 33: 1698-1703.
[21] Macaire P, Ho N, Nguyen T, Nguyen B, Vu V, Quach C, Roques V and Capdevila X. Ultrasound-guided continuous thoracic erector spinae plane block within an enhanced recovery program is associated with decreased opioid consumption and improved patient postoperative rehabilitation after open cardiac surgery-a patient-matched, controlled. J Cardiothorac Vasc Anesth 2019; 33: 1659-1667.
[22] Ciftci B, Ekinci M, Celik EC, Tukac IC, Bayrak Y and Atalay YO. Efficacy of an ultrasound-guided erector spinae plane block for postoperative analgesia management after video-assisted thoracic surgery: a prospective randomized study. J Cardiothorac Vasc Anesth 2020; 34: 444-449.
[23] Elhawary H, Abdelhamid K, Meng F and Janis JE. Erector spinae plane block decreases pain and opioid consumption in breast surgery: systematic review. Plast Reconstr Surg Glob Open 2019; 7: e2525.
[24] Moradian ST, Najafloo M, Mahmoudi H and Ghiasi MS. Early mobilization reduces the atelectasis and pleural effusion in patients undergoing coronary artery bypass graft surgery: a randomized clinical trial. J Vasc Nurs 2017; 35: 141-145.
[25] Nachiyunde B and Lam L. The efficacy of different modes of analgesia in postoperative pain management and early mobilization in postoperative cardiac surgical patients: a systematic review. Ann Card Anaesth 2018; 21: 371-375.
[26] Tulgar S, Selvi O, Senturk O, Serifsoy TE and Thomas DT. Ultrasound-guided erector spinae plane block: indications, complications, and effects on acute and chronic pain based on a single-center experience. Cureus 2019; 11: e3815.
[27] Tsui BCH, Fonseca A, Munshey F, McFadyen G and Caruso TJ. The erector spinae plane (esp) block: a pooled review of 242 cases. J Clin Anesth 2019; 53: 29-34.