ORIGINAL ARTICLE

Comparative analysis of PECS-2 and ESP for acute and chronic pain control in breast-conserving surgery. A prospective study

Análisis comparativo de PECS-2 y ESP para el control del dolor agudo y crónico en la cirugía conservadora de mama. Un estudio prospectivo

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Abstract

Objective: *The aim of this study was to compare the effects of Pectoral Nerve Block 2 (PECS-2) and Erector Spinae Plane Block (ESP), which are accepted to have an effect on post-operative pain control after breast cancer surgery, on both acute and chronic pain.* **Method:** *In this double-blind, prospective, randomized study, patients were randomized using a sealed envelope method into two groups: those who underwent PECS-2 (Group P) and those who underwent ESP (Group E) before extubation at the end of the operation. The numerical rating scale (NRS) of patients was queried by a blinded researcher at post-operative 1, 2, 6, 12, and 24 h. In addition, patients were queried for the presence of chronic pain at the 3rd month using NRS.* **Results:** *The NRS scores at 1 h and 2 h in Group P were significantly lower compared to Group E. There was no significant difference in NRS scores at 6 h, 12 h, and 24 h between the groups. The rate of chronic pain was similar between the groups.* **Conclusion:** *In this study examining the effects of ESP and PECS-2 on acute and chronic pain after BCS due to breast cancer, PECS-2 was associated with less post-operative pain.*

Keywords: *Breast-conserving surgery. Chronic post-operative pain. Nerve block. Pain. Post-operative pain. Ultrasonography.*

Resumen

Objetivo: *El propósito de este estudio fue comparar los efectos del pectoral nerve block 2 (PECS-2) y el erector spinae plane block (ESP) en el dolor post-operatorio del cáncer de mama, tanto agudo como crónico.* **Método:** *En este estudio doble ciego, prospectivo y aleatorizado, las pacientes se asignaron aleatoriamente a dos grupos: PECS-2 (grupo P) y BES (grupo E) antes de la extubación al final de la operación. Un investigador ciego evaluó la numerical rating scale (NRS) de las pacientes a las 1, 2, 6, 12 y 24 horas del post-operatorio. Además, se preguntó a las pacientes por la presencia de dolor crónico al tercer mes utilizando la NRS.* **Resultados:** *Las puntuaciones NRS a 1 y 2 horas en el grupo P fueron significativamente menores que las del grupo E. No hubo diferencias significativas en las puntuaciones NRS a las 6, 12 y 24 horas entre ambos grupos. La tasa de dolor crónico fue similar entre ellos.* **Conclusión:** *En este estudio, en el que se examinaron los efectos de ESP y PECS-2 sobre el dolor agudo y crónico después de una BCS por cáncer de mama, el PECS-2 se asoció con menos dolor post-operatorio.*

Palabras clave: *Cirugía conservadora de la mama. Dolor post-operatorio crónico. Bloqueo nervioso. Dolor. Dolor post-operatorio. Ultrasonografía.*

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Date of reception: 17-04-2024
Date of acceptance: 19-06-2024
DOI: 10.24875/CIRU.24000223

Cir Cir. 2025;93(2):145-150
Contents available at PubMed
www.cirugiaycirujanos.com

Introduction

Breast-conserving surgery (BCS) is a surgical method designed to remove cancer by leaving as much of the breast intact as possible. The combination of BCS and sentinel lymph node biopsy has become the standard treatment for patients with early-stage breast cancer. Many patients experience severe acute post-operative pain after breast cancer surgery[1].

Opioid treatment can bring both the pain itself and the accompanying side effects, which can be really distressing for the patient. In addition, acute post-operative pain is a risk factor for chronic post-operative pain and low quality of life after breast cancer surgery[2]. Post-operative chronic pain is defined as pain localized to the surgical area, lasting for at least 3 months, and continuing from acute post-operative pain after excluding other causes of pain[3]. Chronic pain after breast cancer treatment is a significant clinical problem affecting 25-60% of patients. Therefore, the management of post-operative pain is important for outcomes in patients undergoing breast cancer surgery[4].

Perioperative management during breast cancer surgery typically consists of combinations of regional anesthesia techniques combined with general anesthesia. Regional anesthesia also provides better post-operative analgesia, reduced opioid use, and decreased post-operative nausea and vomiting. New regional anesthesia techniques, such as fascial plane blocks have replaced traditional thoracic paravertebral block due to their comparable analgesia with lower complication prevalence[5]. Pectoral Nerve Plane Block 2 (PECS-2) was developed to provide analgesia after breast surgery[6]. This ultrasound-guided block is administered by injecting local anesthetic below the pectoralis minor and serratus anterior muscles at the level of the third rib. Erector Spinae Plane Block (ESP), another commonly used plane block for post-operative pain management, is a relatively simple and safe technique involving the injection of local anesthetic deep into the erector spinae muscle, which can also reduce opioid consumption[7].

The aim of this study is to investigate the effects of two established plane blocks (PECS-2 and ESP) on both acute and chronic pain after BCS in terms of post-operative pain control.

Method

This double-blind, prospective, randomized study was conducted at (Institution name here) between June 2023 and January 2024 after obtaining ethics committee approval (No: 2023/514/250/32, Date: 29 May 2023). Written consent was obtained from all patients. Patient registration and allocation were performed using a consort diagram (Fig. 1). The study included women aged ≥ 18 years who were scheduled for BCS, with or without axillary lymph node clearance and had an ASA physical status of 1-3. Patients who were pregnant, allergic to study drugs, had coagulopathy, injection site infection, chronic pain, or alcohol or drug dependence were excluded from the study. Patients were randomized using a sealed envelope method into two groups: those who underwent PECS-2 (Group P) and ESP (Group E) at the end of the operation. A priori power analysis conducted using GPower 3.1.9.7 software estimated that a minimum sample size of 17 participants per group would be required, assuming an effect size of 1.0, a significance level (α) of 0.05, and 80% power.

Patients were examined and written consent was obtained during the pre-operative period. All operations were performed by the same surgeon. All post-operative blocks were performed under ultrasound guidance (Samsung HM70 EVO) by an anesthesiologist experienced in regional anesthesia (Blocks were applied to all patients by the same anesthesiologist). The anesthesiologists who performed intraoperative patient monitoring and post-operative pain assessment were blinded to the study.

Anesthesia management

All patients received a standard general anesthesia protocol (2 mg/kg IV propofol, 1 μg/kg IV fentanyl, and 0.6-0.8 mg/kg IV rocuronium for intubation). All patients were intubated and connected to the anesthesia machine using volume-controlled ventilation with a tidal volume of 6-8 mL/kg and EtCO2 maintained at 35-45 mmHg. Anesthesia maintenance was achieved with a mixture of 50% oxygen and 50% air and adjusted desflurane and IV remifentanil infusion (0.25-0.5 μg/kg/min) according to 4-6 minimal alveolar concentration. All patients received 10 mg/kg paracetamol and 1 mg/kg tramadol IV at the end of surgery. Based on randomization compliance, a plan block was applied according to the group before extubation.

Ultrasound-guided plan block application

For PECS-2 application in Group P, under sterile conditions, a high-frequency linear ultrasound probe was

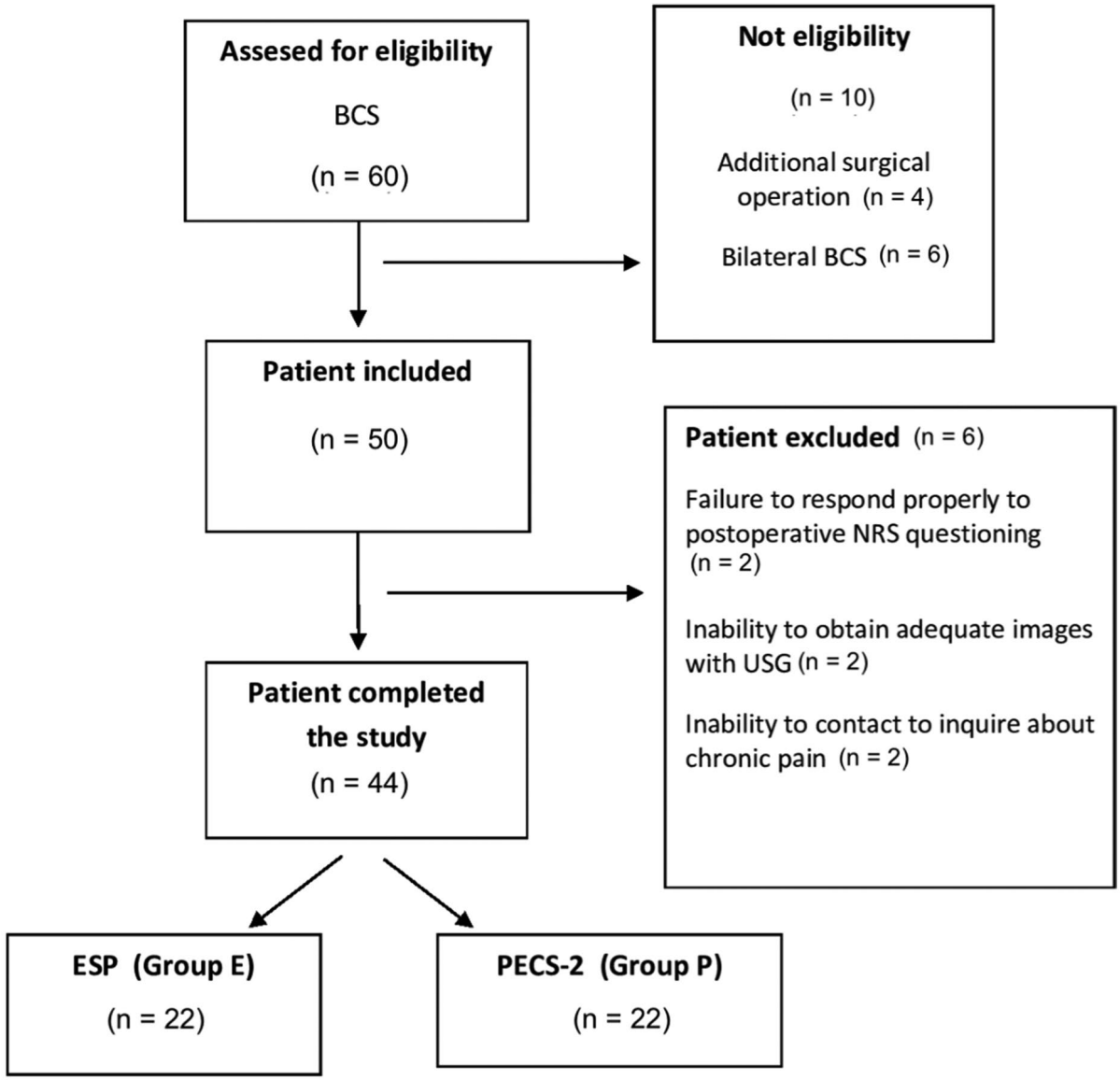

Figure 1. *Flow chart of the consort.*
BCS: breast-conserving surgery; NRS: numerical rating scale; ESP: Erector Spinae Plane; PECS-2: Pectoralis Plane Block 2.

placed in a sagittal plane below the clavicle. A 21-gauge 50 mm isolated facet-tipped needle was inserted from cephalad to caudal under ultrasound guidance and 10 ml of 0.25% bupivacaine was injected between pectoralis minor and major and 20 ml of 0.25% bupivacaine was injected between pectoralis minor and serratus anterior muscles. Bupivacaine was injected slowly with aspiration every 5 ml. For Group E receiving ESP, under ultrasound guidance, a linear USG probe was placed sagittally 2-3 cm lateral to the spine. After identifying the erector spinae muscle and transverse processes, the needle was inserted from the deep aspect of the erector spinae muscle, and 20 ml of 0.25% bupivacaine was applied. A 15-min waiting period was observed for any potential complications. Patients were monitored and followed up for at least 30 minutes in the recovery unit after tracheal extubation.

Post-operative pain assessment

Acute post-operative pain was assessed using the numerical rating scale (NRS) ranging from 0 (no pain) to 10 (worst imaginable pain). In cases where NRS was ≥ 4 at post-operative 30 minutes in the post-anesthetic care unit, patients were given 25 mg IV pethidine as rescue analgesia. Patients requiring

additional analgesia were observed in the post-anesthetic care unit for 1 h.

Post-operative IV analgesia was standardized for all patients. IV Paracetamol 10 mg/kg was administered every 6 h and 25 mg IV Dexketoprofen Trometamol was administered every 12 h. The NRS scores of patients were queried by a blinded researcher at post-operative 1, 2, 6, 12, and 24 h. Each patient was reassessed at post-operative 3 months for the presence of any pain, signs, and symptoms developing or worsening in the breast area (For patients unable to come for follow-up, NRS scores were queried over the phone).

Statistical methods

Descriptive statistics such as mean, standard deviation, median, minimum, maximum, frequency, and ratio values were used to describe the data. Discrete and continuous data were analyzed for normal distribution using the Shapiro-Wilk test. The Independent samples t-test and Mann-Whitney U test were used for the analysis of continuous data which showed normal and skewed distribution. Fisher's exact test or chi-square test was applied to assess statistical significance for discrete and categorical data. All statistical analyses were performed using SPSS Statistics for Windows, version 29.0 (IBM Corp., Armonk, NY, USA). A $p < 0.05$ was considered statistically significant.

Results

A total of 50 patients were included in the study to undergo BCS surgery. The study excluded a total of 6 patients: 2 due to non-cooperation during the NRS assessment, 2 because sufficient ultrasound images couldn't be obtained, and 2 others because communication couldn't be established with them 3 months later. The study was completed with a total of 44 patients (Fig. 1). All patients were female (100%). The mean age was 54.3 ± 7.9 years, and the mean BMI was 28.1 ± 3.5 kg/m². 61.4% of the patients underwent surgery on the left breast, while 38.6% underwent surgery on the right breast.

There were 22 patients in each group. There were no significant differences in age, weight, height, or BMI between Group P and Group E ($p = 0.173$). There was no significant difference between the groups in terms of side (right-left) ($p = 0.353$). The rate of chronic diseases in Group P was significantly higher than in Group E ($p = 0.030$) (Table 1).

There were no significant differences between the groups in terms of pre-operative, intraoperative systolic, and diastolic blood pressure ($p = 0.475$, $p = 0.232$, $p = 0.205$, $p = 0.392$). The pre-operative heart rate in Group P was significantly higher than in Group E ($p = 0.027$). There were no significant differences between the groups in terms of pre-operative and intraoperative saturation and intraoperative heart rate ($p = 0.636$, $p = 0.198$, $p = 0.116$). In addition, surgical duration, anesthesia duration, total fluid, and total bleeding were similar between the groups ($p = 0.162$, $p = 0.490$, $p = 0.811$, $p = 0.382$).

The NRS scores at 1 h and 2 h were significantly lower in Group P compared to Group E ($p < 0.001$, $p < 0.001$). There were no significant differences between the groups in terms of NRS scores at 6 h, 12 h, and 24 h ($p = 0.128$, $p = 0.159$, $p = 0.657$) (Fig. 2). The rate of chronic pain was similar between the groups ($p = 0.294$) (Table 1).

Discussion

In this study, the effect of two different plane blocks applied in the pre-extubation period on post-operative acute and chronic pain was compared in breast cancer patients undergoing BCS. The PECS-2 had significantly lower NRS scores compared to ESP. No difference was observed in NRS scores queried at other times (6, 12, and 24 h) between the groups. We could not detect any difference in the effect of these two plane blocks on post-operative chronic pain.

Gürkan et al. showed a decrease in total morphine consumption in the post-operative period with the ESP applied in the pre-operative period in patients undergoing mastectomy. However, in this study, no difference was observed in NRS scores between patients who did not receive blocks[8]. On the contrary, in a meta-analysis including 679 patients and 11 articles examining recent studies, it was found that ESP performed under USG guidance significantly reduced post-operative pain intensity after breast cancer surgery[9]. In our study, the mean NRS scores at 1, 2, 6, 12, and 24 h remained below 5 in Group E. No complications were encountered during block application.

Yu et al. conducted a comprehensive study with 526 patients undergoing breast cancer surgery, comparing patients who underwent PECS-2 block in the pre-operative period under general anesthesia with those who did not. It was observed that PECS-2 reduced intraoperative remifentanil consumption[10]. In the study by Versyck et al., which compared patients undergoing PECS-2 with those undergoing thoracic paravertebral blocks, no significant difference was found in

Table 1. Comparison of pre and post-operative period data of patients who underwent ESP and PECS-2 procedures

Variable	ESP group		PECS-2 group		p
	Mean ± SD/n-%	Median	Mean ± SD/n-%	Median	
Age (year)	52.6 ± 7.0	52.5	56.0 ± 8.5	58.5	0.150
Weight (kg)	73.4 ± 4.7	73.0	71.8 ± 11.0	70.0	0.534
Height (cm)	161.0 ± 3.6	160.0	160.6 ± 3.2	160.0	0.652
BMI (kg/m^2)	28.4 ± 2.0	28.4	27.9 ± 4.6	27.2	0.173
Side					
Left	12 (54.5%)		15 (68.2%)		0.353
Right	10 (45.5%)		7 (31.8%)		
Chronic disease					
(-)	12 (54.5%)		5 (22.7%)		0.030
(+)	10 (45.5%)		17 (77.3%)		
Chronic pain					
(-)	19 (86.4%)		21 (95.5%)		0.294
(+)	3 (13.6%)		1 (4.5%)		
Systolic blood pressure (mmHg)					
Pre-operative	135.8 ± 9.9	135.5	138.5 ± 10.1	140.0	0.475
Peroperative	126.3 ± 11.4	129.0	122.3 ± 11.6	120.0	0.232
Diastolic blood pressure (mmHg)					
Pre-operative	80.2 ± 8.7	80.0	83.4 ± 7.4	82.0	0.205
Peroperative	74.1 ± 5.0	75.5	75.6 ± 4.6	76.0	0.392
Heart rate (bpm)					
Pre-operative	81.9 ± 5.0	82.0	86.8 ± 7.3	85.0	0.027
Peroperative	78.3 ± 6.0	76.0	81.0 ± 7.6	80.0	0.116
Saturation (%)					
Pre-operative	99.0 ± 1.0	99.0	99.0 ± 1.3	99.5	0.636
Peroperative	99.1 ± 0.8	99.0	99.4 ± 0.5	99.0	0.198
Surgical duration (min)					
Anesthesia duration (min)	114.3 ± 23.1	120.0	104.1 ± 16.4	105.0	0.162
Total fluid (mL)	131 ± 24.9	130.0	123.0 ± 13.9	125.0	0.490
Total blood loss (mL)	1272.7 ± 281.5	1200.0	1220.5 ± 140.3	1200.0	0.811
	64.8 ± 22.2	65.0	59.8 ± 14.3	50.0	0.382
NRS score (h)					
1	4.9 ± 1.0	5.0	2.8 ± 1.1	3.0	< 0.001
2	4.9 ± 1.0	5.0	3.4 ± 0.7	3.0	< 0.001
6	4.2 ± 0.6	4.0	3.9 ± 0.8	4.0	0.128
12	3.6 ± 0.5	4.0	3.3 ± 0.6	3.0	0.159
24	2.9 ± 0.7	3.0	2.8 ± 0.7	3.0	0.657

BMI: body mass index; ESP: erector spinae plane block; PECS-2: pectoral nerve block type 2; NRS: numeric rating scale.

post-operative pain scores, time to first analgesic request, and 24-h opioid consumption. PECS-2, being a less invasive method compared to thoracic paravertebral block, is important in terms of its efficacy in pain management[11]. Barrington et al. found that in patients undergoing a smaller intervention such as BCS, PECS-2, and surgical local infiltration resulted in similar pain scores in terms of post-operative pain in breast cancer patients[12].

In a meta-analysis involving 17 studies with 1069 patients, it was shown that both PECS-2 and ESP blocks were more effective than systemic analgesia in terms of post-operative analgesia following modified radical mastectomy[13]. In the study by Altıparmak et al., PECS-2 effectively reduced post-operative tramadol consumption and pain scores compared to ESP after radical mastectomy[14]. Similarly, in the study by Bakeer et al., total morphine consumption was found to be lower in patients undergoing PECS-2 after mastectomy

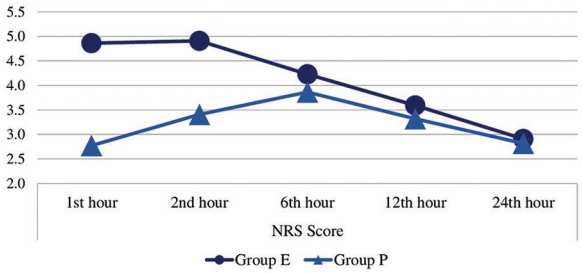

Figure 2. *Comparison of NRS scores between groups. NRS: numeric rating scale.*

compared to ESP. In addition, pain intensity was higher in the ESP group at 1, 2, and 6 h after surgery[15]. In our study, the NRS score in Group P was lower than Group E at 1 and 2 h post-operatively. Unlike this study, there was no difference in NRS scores between groups at other times (6, 12, 24 h) in our study.

In the study by Fujii et al., where they investigated chronic pain after mastectomy, the rate of chronic pain reported 6 months after surgery in patients who underwent PECS-2 was observed to be lower compared to Serratus Plane Block[16]. De Cassai et al. also showed in their study that PECS-2 reduced chronic pain at 3 months after mastectomy[4]. In our study, the rate of chronic pain after BCS was 9.1%. This rate was lower than the reported rates of chronic pain after mastectomy, which range from 20% to 60% in some studies[2]. This may be because BCS is a smaller surgical intervention compared to mastectomy, resulting in a lower rate of chronic pain. In addition, since we applied plane blocks in both groups, the relatively lower incidence of acute pain in the participants could be associated with this. Although three out of four patients with chronic pain were in Group E, we didn't observe a significant difference in terms of chronic pain between PECS-2 and ESP.

Conclusion

In this study, we examined the effects of ESP and PECS-2 on post-operative acute and chronic pain in patients undergoing BCS for breast cancer. According to our findings, PECS-2 was associated with less pain in the post-operative 1st and 2nd h. However, neither block was effective in reducing chronic pain. Our results indicate that PECS-2 is effective in reducing early-stage pain in patients undergoing BCS surgery.

Funding

The authors declare that they have not received funding.

Conflicts of interest

The authors declare no conflicts of interest.

Ethical considerations

Protection of humans and animals. The authors declare that no experiments involving humans or animals were conducted for this research.

Confidentiality, informed consent, and ethical approval. This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Kartal Dr. Lutfi Kirdar City Hospital (June 30, 2022/No:2022/514/228/22).

Declaration on the use of artificial intelligence. The authors declare that no generative artificial intelligence was used in the writing of this manuscript.

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