Received: 6 January 2020 | Accepted: 6 February 2020

DOI: 10.1002/cac2.12013

CANCER COMMUNICATIONS Open Access

LETTER TO THE EDITOR

Application of erector spinae plane block guided by ultrasound for postoperative analgesia in breast cancer surgery: A randomized controlled trial

Dear Editor,

Breast cancer is the most common malignant tumor in women and surgical management remains a key component of treatment and cure [1]. However, the surgical procedure is often associated with varying degrees of postoperative pain. Approximately 60% of women after breast cancer surgery complain of severe acute pain [2]. In addition, failure to manage acute postoperative pain may lead to the development of chronic pain which may be persistent for years [3, 4]. As chronic persistent pain arises in approximately 50% of patients after breast cancer surgery [5], it is therefore necessary to explore efficacious techniques that can reduce postoperative pain for such patients.

The innervation of the skin and gland of the breasts is supplied mainly by the T2-T6 spinal nerves. In addition, branches of the brachial plexus, including the long thoracic nerve, thoracodorsal nerve, medial pectoral nerve, and lateral pectoral nerve, are also involved in conveying sensation to the breasts and axillary region [6]. Therefore, to provide complete postoperative analgesia for breast cancer surgery, it is necessary to theoretically block the ten spinal nerve dermatomes from vertebral C5 to T6.

Various regional techniques have been widely used to decrease postoperative pain after breast cancer surgery, including epidural, paravertebral, and intercostal blocks. However, an optimal method has not yet been defined and each of these blocks has some drawbacks. The epidural block involves unnecessary contralateral block, epidural hematoma, abscess, and dural puncture. The paravertebral block can achieve a perfect analgesic effect but it may cause pneumothorax and is difficult to implement. The intercostal nerve block is easy to perform but needs to be implemented in multiple segments.

The erector spinae plane (ESP) block was first described for managing thoracic neuropathic pain [7]. Subsequently, this technique was applied for pain management following lung cancer surgery and the analgesic effect was encouraging [8]. The aim of this study was to evaluate the safety and efficacy of an ultrasound-guided ESP block for postoperative analgesia after breast cancer surgery.

The study was conducted after receiving approval from the Medical Ethics Committee of the First Hospital of Qinhuangdao. Written informed consent was obtained from each enrolled patient. The inclusion criteria for patient selection were as follows: 1) aged 18-65 years, 2) had an American Society of Anesthesiologists (ASA) physical status of I or II, and 3) female patients with unilateral breast cancer who were to undergo modified radical mastectomy (MRM) with or without axillary lymph node dissection (ALND). The exclusion criteria included the following: 1) history of allergy to local anesthetic, 2) puncture site infection, 3) coagulation dysfunction, 4) morbid obesity (body mass index [BMI] > 35 kg/m^2), and 5) psychosis.

A total of 40 patients were selected and entered into our prospective, randomized, controlled clinical trial. The patients were allocated into an ESP or control group, with 20 patients in each group. Patients in the ESP group received the ESP block immediately before the induction of general anesthesia, whereas patients in the control group only received general anesthesia. In the ESP group, the ESP block was administered at the vertebral T3 level. A total of 20 mL of 0.5% ropivacaine (AstraZeneca AB, Goteborg, Sweden) was injected into the fascial plane between the erector spinae muscle and the transverse process through in-plane technology.

Flurbiprofen axetil (Beijing Tide Pharmaceutical Co., Ltd., Beijing, China) at an intravenous dose of 50 mg was given as

Abbreviations: ALND, axillary lymph node dissection; ASA, American society of anesthesiologists; BMI, body mass index; DBP, diastolic blood pressure; ESM, erector spinae muscle; ESP, erector spinae plane; HR, heart rate; MAP, mean arterial pressure; MRM, modified radical mastectomy; SBP, systolic blood pressure; SD, standard deviation; SpO_2, peripheral capillary oxygen saturation (SpO_2); SPSS, statistical product and service solutions; VAS, visual analog scale.

a postoperative analgesic upon the patient's request. Opioids are not usually provided as routine postoperative analgesics for this kind of surgery in our hospital.

The patients were followed up for 48 hours after surgery by anesthesia nurses in the ward. The primary outcome measure was visual analog scale (VAS) at 1, 6, 12, 24, and 48 h after surgery during motion as well as at rest. The motion VAS score was assessed when the patient coughed and abduced the shoulder to 90°. The highest VAS score within 48 h after surgery was recorded. Secondary outcome measures included the time to first request for analgesia and the cumulative dose of analgesics. If a patient did not ask for an analgesic within 48 h after surgery, the time to first request for analgesia was taken as 48 h.

In addition, the hemodynamic parameters (systolic blood pressure [SBP], diastolic blood pressure [DBP], mean arterial pressure [MAP], and heart rate [HR]) during surgery were also recorded. Potential complications of the ESP block were taken note in detail.

The Statistical Product and Service Solutions (SPSS) software (version 17, SPSS Inc., Chicago, IL, USA) was used for statistical analyses. Data are presented as mean ± standard deviation (SD), median (interquartile range), or frequency (percentage). For quantitative data, a parametric test with normal distribution was performed using the Student's *t* test and a nonparametric test with abnormal distribution was performed using the Mann-Whitney *U* test. For qualitative data, the Chi-square test was used for parametric analysis. $P < 0.05$ was considered as statistically significant for all tests. The VAS score 1 h after surgery in patients without analgesia technique was 3.8, with an SD of 1.2 in a pilot study (based on unpublished results from one of our preliminary research). It was estimated that 18 subjects would be required per group to detect at least a 30% decrease in this parameter with 80% power and a 5% probability of Type I error. Thus, 20 patients were recruited in each group to allow for a probable 10% dropout rate in the study.

Forty patients were included and no patient was withdrawn from this present study. The patients and surgical characteristics are presented in Table 1. These characteristics did not differ significantly between the 2 groups.

Satisfactory pain relief (mean VAS score < 3) was observed in the ESP group throughout the study period. The rest and motion VAS scores in the ESP group were significantly lower than those in the control group at 1, 6, 12, 24, and 48 h after surgery ($P < 0.05$). The highest VAS score within 48 h after surgery was significantly lower in the ESP group than in the control group, both at rest and during motion (both $P < 0.05$) (Table 2).

Eleven (55%) patients in the ESP group and 1 (5%) in the control group did not ask for an analgesic within 48 h after surgery ($P < 0.05$). The time to first request for analgesia was significantly prolonged in the ESP group [48 (38.75) h] compared with that in the control group [4.5 (7.5) h, $P < 0.001$]. Similarly, the patients in the ESP group consumed less flurbiprofen axetil than those in the control group [0(100) mg *vs.* 150(100) mg, $P < 0.001$].

TABLE 1 Patient characteristics and surgical characteristics

Characteristics	ESP group	Control group	*P* value
Total (cases)	20	20	
Age (years)	51.30 ± 8.00	50.50 ± 7.75	0.691
Height (cm)	163.05 ± 7.21	159.65 ± 5.55	0.157
Weight (Kg)	57.60 ± 9.39	56.60 ± 9.56	0.832
Duration of surgery (min)	63.10 ± 11.72	67.65 ± 13.35	0.306
ALND (yes/no)	13/7	11/9	0.519

Note: Values are expressed as the mean ± standard deviation (SD) or number of patients. Differences in quantitative variables are compared using 2-sample Student *t* test, and differences in qualitative variables are compared using the Chi-square test. ALND: axillary lymph node dissection.

TABLE 2 Comparison of VAS between the 2 groups

Type	Time	ESP group	Control group	*P* value
Rest VAS	1 h	1.40 ± 0.99	3.90 ± 1.17	<0.001*
	6 h	1.65 ± 0.88	4.75 ± 1.33	<0.001*
	12 h	1.75 ± 0.79	4.95 ± 1.10	<0.001*
	24 h	1.50 ± 0.76	4.65 ± 1.18	<0.001*
	48 h	1.10 ± 0.72	3.30 ± 0.86	<0.001*
	highest VAS	2.65 ± 0.81	6.25 ± 0.72	<0.001*
Motion VAS	1 h	2.05 ± 1.00	4.70 ± 1.26	<0.001*
	6 h	2.75 ± 0.85	5.80 ± 1.40	<0.001*
	12 h	2.80 ± 0.83	5.90 ± 1.21	<0.001*
	24 h	2.45 ± 0.83	5.10 ± 1.07	<0.001*
	48 h	1.95 ± 0.69	3.95 ± 1.15	<0.001*
	highest VAS	3.90 ± 0.85	6.95 ± 0.94	<0.001*

Note: Values are expressed as the means± standard deviation (SD) and differences are compared using 2-sample Student *t* test. *$P < 0.05$, the difference was statistically significant.

The rates of complications were comparable between the 2 groups. There were no significant differences in HR and peripheral capillary oxygen saturation (SpO_2) between the two groups during the perioperative period. Postoperative nausea and vomiting occurred in 2 patients (10%) in the ESP group and in 6 patients (30%) in the control group ($P > 0.05$), whereas hypotension occurred in 8 patients (40%) in the ESP group and in 5 patients (25%) in the control group ($P > 0.05$). No block-related complications such as vascular puncture, nerve injury, spinal and epidural anesthesia, signs of local anesthetic toxicity and pneumothorax were recorded in the ESP group.

In the present study, we observed significantly decreased pain scores at rest and during motion in patients who received

an ESP block. Furthermore, the time to first request for flurbiprofen axetil was delayed and there was a decreased consumption of postoperative flurbiprofen axetil during the first 48 postoperative hours in these patients.

Breast cancer requires various surgical therapies, and MRM with or without ALND is the most common surgical procedure. Postoperative pain remains a significant clinical problem contributing to increased postoperative complications and reduced quality of life after surgery.

The ESP block is a new fascia block technique that can engender sensory blockade of multiple segments of the chest wall [7]. Our findings showed that ultrasound-guided ESP block exhibited a significant analgesic effect for breast cancer surgery.

Considering the operative region of breast cancer, we selected T3 transverse process as the injection site. To appraise the analgesia efficiency of the ESP block at the T3 level for the axillary region, we measured the motion VAS score not only when patients coughed but also when patients abduced the ipsilateral shoulder. In the present study, patients with the ESP block suffered only mild pain when they abduced the ipsilateral shoulder, signifying that the ESP block at T3 level was effective in relieving pain in the axillary region as well as the chest wall.

In addition to developing substantial blockade, the ESP block slightly decreased the rate of postoperative nausea and vomiting (10% vs 30%). This might be because the use of ESP block might have decreased the dosage for intraoperative opioids.

Furthermore, the ESP block was found to be safer compared with epidural or paravertebral block as the injection was administered into a tissue plane distant from major blood vessels, pleura, and nerves [9]. No puncture-related complications such as pneumothorax were observed. However, hypotension was recorded in 8 patients in the ESP group but found in only 5 patients in the control group. Hypotension might have been due to the sympathetic blockade because local anesthetic penetrated anteriorly through the costotransverse foramen and intertransverse connective tissue, then entered into the thoracic paravertebral space where it could potentially block the communicans between the rami of spinal nerves and sympathetic fibers [10] but this could be effectively corrected by the use of vasoactive drugs.

There were some limitations in the present study worth mentioning. First, we did not measure the exact plane of sensory block nor investigated the flow and spread of local anesthetic through imaging evidence in the ESP group, although we did confirm that the ESP block achieved satisfactory analgesic effects. Second, based on humanitarian consideration, a sham block was not performed in the control group, so the patients were not blinded to the group distribution. However, the persons who participated in data collection were not aware of the group assignments. Lastly, we did not evaluate the effects of ESP block on chronic pain after breast cancer surgery. A long-term follow-up study can be designed to focus on the effects of ESP block on chronic pain after breast cancer surgery.

ESP block was found to be an effective and safe technique that provided favorable pain relief and reduced postoperative analgesic consumption. Therefore, ESP block can be used safely for postoperative analgesia in patients undergoing breast cancer surgery.

DECLARATIONS ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was conducted after receiving approval from the Medical Ethics Committee of the First Hospital of Qinhuangdao, on December 8, 2017 (IRB no. 2017F003). Written informed consent was obtained from each enrolled patient.

CLINICAL TRIAL REGISTRATION

Registered in Chinese Clinical Trial Register (URL chictr.org.cn), ID. ChiCTR1800015725, dated April 16, 2018. The first patient was enrolled on April 20, 2018 and the last patient was enrolled on June 16, 2018.

CONSENT FOR PUBLICATION

Written informed consent was obtained from the patients for publication of their individual details and accompanying images.

STATEMENT FOR METHODS

All methods were performed in accordance with the relevant guidelines and regulations.

AVAILABILITY OF DATA AND MATERIALS

The data used during the present study are available from the corresponding author upon reasonable request.

COMPETING INTERESTS

There are no financial or non-financial competing interests for each contributing author.

FUNDING

Not applicable.

AUTHORS' CONTRIBUTIONS

Study design/planning: WSH, ZYW, LJ Z. Study execution: WSH, ZYW. Data analysis: LJ Z, HJS. Writing paper: WSH, XCY. Revising the paper: all authors.

ACKNOWLEDGMENTS

No.

Wensheng He[1]
Zhenyu Wu[1]
Lingjie Zu[2]
Haijun Sun[1]
Xiaochun Yang[1]

[1]Department of Anesthesia, the First Hospital of Qinhuangdao, Qinhuangdao, Hebei 066000, P. R. China
[2]Department of Family Planning, Maternal and Child Health Care Hospital of Qinhuangdao, Qinhuangdao, Hebei 066000, P. R. China

Correspondence
Wensheng He, Department of Anesthesia, the First Hospital of Qinhuangdao, Qinhuangdao, Hebei 066000, P. R. China
Email: hws2008hws@163.com

ORCID

Wensheng He https://orcid.org/0000-0002-4893-1344

REFERENCES

1. Gu X, Zheng R, Xia C, Zeng H, Zhang S, Zou X, et al.: Interactions between life expectancy and the incidence and mortality rates of cancer in China: a population-based cluster analysis. Cancer Commun (Lond). 2018;38:44.
2. Fecho K, Miller NR, Merritt SA, Klauber-Demore N, Hultman CS, Blau WS: Acute and persistent postoperative pain after breast surgery. Pain Med. 2009;10:708–15.
3. Andersen KG, Kehlet H: Persistent pain after breast cancer treatment: a critical review of risk factors and strategies for prevention. J Pain. 2011;12:725–46.
4. Hickey OT, Burke SM, Hafeez P, Mudrakouski AL, Hayes ID, Shorten GD: Severity of acute pain after breast surgery is associated with the likelihood of subsequently developing persistent pain. Clin J Pain. 2010;26:556–60.
5. Gartner R, Jensen MB, Nielsen J, Ewertz M, Kroman N, Kehlet H: Prevalence of and factors associated with persistent pain following breast cancer surgery. JAMA. 2009;302:1985–92.
6. Kaya M, Oguz G, Senel G, Kadiogullari N: Postoperative analgesia after modified radical mastectomy: The efficacy of interscalene brachial plexus block. J Anesth. 2013;27:862–7.
7. Forero M, Adhikary SD, Lopez H, Tsui C, Chin KJ: The Erector Spinae Plane Block: A Novel Analgesic Technique in Thoracic Neuropathic Pain. Reg Anesth Pain Med. 2016;41:621–7.
8. Bang S, Chung K, Chung J, Yoo S, Baek S, Lee SM: The erector spinae plane block for effective analgesia after lung lobectomy: Three cases report. Medicine (Baltimore). 2019;98:e16262.
9. Chin KJ, Adhikary S, Sarwani N, Forero M: The analgesic efficacy of pre-operative bilateral erector spinae plane (ESP) blocks in patients having ventral hernia repair. Anaesthesia. 2017;72:452–60.
10. Chin KJ, Malhas L, Perlas A: The Erector Spinae Plane Block Provides Visceral Abdominal Analgesia in Bariatric Surgery: A Report of 3 Cases. Reg Anesth Pain Med. 2017;42:372–6.