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Ultrasound –Guided Erector Spinae Plane Block for Postoperative Analgesia after Breast Surgery

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Original Study

Ultrasound-guided Erector Spinae Plane Block for Postoperative Analgesia After Breast Surgery


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Abstract

Objectives: To evaluate the effect of the erector spinae plane block (ESPB) on postoperative pain after breast surgeries, evaluated by visual analog scale (VAS), time to first rescue analgesia and 24 h postoperative consumption of analgesia.

Background: Postoperative analgesia after breast surgeries is a challenge for anesthesiologists. ESPB can be considered a safe alternative to the paravertebral block.

Patients and methods: This prospective and single-blinded randomized controlled study was conducted on 60 patients with American Society of Anesthesiologists I and II, aged more than or equal to 18 to less than or equal to 60 years, scheduled for elective breast surgeries. Patients were divided equally into two groups, group 1 received only general anesthesia, and group 2 received ultrasound-guided ESPB with 20 ml of 0.25% bupivacaine and 8 mg dexamethasone after general anesthesia.

Results: The ESPB group showed a significantly lower VAS_{static} score than the control group at 0 time, 2, and 4 h postoperatively (P < 0.001). Also, the VAS_{dynamic} score was significantly lower in the ESPB group than in the control group at 0 time, 2, 4, and 6 h postoperatively (P < 0.001). Postoperative 24-h morphine consumption was significantly lower in the ESPB group than in the control group (2.30 ± 2.18 vs. 10.10 ± 3.56 mg, respectively, P < 0.001). Similarly, the time until the first required analgesia was significantly longer in ESPB group than control group [5 (3–6) vs. 0.5 (0.5–0.5) in hours, respectively; with P < 0.001].

Conclusion: Our results showed that ultrasound-guided single-shot ESPB provided appropriate analgesia following breast surgeries.

Keywords: Breast surgeries, Erector spinae plane block, Postoperative pain, Ultrasound-guided, Visual analog scale

1. Introduction

Breast surgery is one of the most common surgeries due to the high incidence of breast cancer. It is the most common malignancy of women all over the world [1]. Postoperative pain constitutes a major problem for anesthetists due to the complex innervation of the breast and dissections of both thoracic and axillary regions. The type of surgery is important to understand the neural origin of pain. While postoperative pain after lumpectomy surgery derives mainly from intercostal nerves and supraclavicular nerves, the origin of pain after modified radical mastectomy (MRM) also involves the brachial plexus [2]. Regional anesthesia techniques for breast surgeries are attractive anesthetic options. They improve overall recovery and reduce opioid consumption with all potential opioid-related side effects. Also, they decrease the incidence of chronic postsurgical pain [3]. Thoracic epidural, interscalene brachial plexus block, paravertebral block (PVB), pectoral nerve I, and pectoral nerve II blocks (PECS) have been used in different studies [2,4–6]. Although PVB is considered a gold standard regional technique for breast surgeries, the technique is an advanced one and is not commonly used by anesthesiologists [5]. Erector spinae plane block (ESPB) was first defined by Forero et al. [7] as an analgesia method for thoracic neuropathic pain. Since then, it has been studied for many different...
indicators. ESPB is gaining popularity because of its ease of application and relatively safer block area [8–10]. For ESPB, the local anesthetic injection is performed beneath the erector spinae muscle. An MRI study showed that the spread of the local anesthetic involved both the ventral and dorsal rami of the spinal nerves and achieved a paravertebral spread of three vertebral levels cranially and four levels caudally causing a sensory blockade over the anterolateral thorax [11].

The aim of this work is to evaluate the effect of ESPB on postoperative pain after breast surgeries, evaluated by visual analog scale (VAS) score and 24 h postoperative consumption of analgesia.

2. Patients and Methods

After approval of the study protocol by the research committee and ethics committee of the Department of Anesthesiology, Intensive Care, and Pain Management, Faculty of Medicine, Menoufia University (under code no. 1/2020ANES 48) and after obtaining written informed consent from all patients, we conducted this prospective randomized, controlled, single-blinded study in the operative theaters of Menoufia University hospitals on 60 female patients. They were randomized equally into two groups using a sealed envelope technique in sequentially numbered opaque envelopes that were opened by a research assistant at a site remote from the study procedure, group 1 control group in which patients received only general anesthesia and group 2 ESPB group in which patients received ultrasound (US)-guided ESPB with 20 ml of 0.25% bupivacaine and 8 mg dexamethasone as a local anesthetic adjuvant after general anesthesia.

Primary outcome: effect of the ESPB on postoperative pain after breast surgeries that evaluated by VAS.

Secondary outcomes: time to first rescue analgesia, total postoperative consumption of opioid, nonopioid analgesia, and adverse effects related to the technique and drugs used.

The inclusion criteria were, female patients aged more than or equal to 18 to less than or equal to 60 years old, American Society of Anesthesiologists physical status I–II who were scheduled for elective unilateral breast surgeries (simple mastectomy and lumpectomy).

The exclusion criteria were patients who refused to give informed consent, had skin infection at the site of needle puncture, had history of allergy to any of the study drugs, had psychological disorders, patients who received radiotherapy, and patients need axillary dissection.

Preoperative assessment was done in the general surgery preadmission clinic not more than 2 weeks before surgery with a complete medical examination. Patients were informed about the study and consented for it. VAS for pain assessment ranging from 0 (no pain) to 10 (worst imaginable pain) was explained to patients.

2.1. General anesthesia

A peripheral intravenous (i.v.) cannula (18 G) was inserted in the nonoperating side. A premedication of 1–2 mg of midazolam i.v. was administered, 20 min before induction of general anesthesia, and lactated Ringer’s was infused 8 ml/kg to replenish the overnight fasting hours.

In the operative theater, standard monitoring devices (pulse oximetry, ECG, noninvasive arterial blood pressure, and capnography) were attached to the patient.

General anesthesia induction was achieved using propofol at a dose of 2 mg/kg (i.v.), fentanyl 1.5 μg/kg (i.v.), and atracurium 0.5 mg/kg (i.v.). Tracheal intubation was done. The patients were then mechanically ventilated with isoflurane/air/O2 mixture. Tidal volume was adjusted at 6–8 ml/kg and the respiratory rate was adjusted to maintain end-tidal CO2 35–40 mmHg.

I.v. ketorolac 30 mg was administered to all patients 15 min from the start of the operation.

2.2. Erector spinae plane block technique

ESPB was performed after induction of general anesthesia and with standardized monitoring. The block was performed as described by Chin et al. [12], unilaterally, with patients in the lateral position. Skin preparation was performed using 10% povidone-iodine. The probe was covered with a sterile cover. Multifrequency convex probe (1–8 MHz) of sonosite US was used for block performance. A 22 G, 90-mm spinal needle was used during all blocks. The block was performed at the T4 level of the spine using an in-plane approach.

A convex probe was placed 2–3 cm laterally to the spine using a sagittal approach. Once the erector spinae muscle and the transverse process were identified, the needle was inserted deep into the muscle. The needle was directed from a cranial to a caudal direction. Under continuous US guidance, the local anesthesia solution (20 ml of 0.25% bupivacaine and 8 mg dexamethasone) was injected beneath the erector spinae muscle on the transverse process with a frequent aspiration to avoid i.v. injection.
At the end of the surgery, neuromuscular reversal was provided with the administration of 0.05 mg/kg (i.v.) of neostigmine and 0.02 mg/kg (i.v.) of atropine. Hundred percent oxygen was administered and tracheal extubation was done after fulfillment of the extubation criteria.

Dermatomal distribution of the extent of the blockade was assessed in the postanesthesia care unit (PACU) by the pinprick method when the patient became fully conscious and communicating (about half an hour after recovery) to evaluate the success or failure of the block. In case of failure, the patient was excluded from the study and replaced by another one.

2.3. Data recording and outcome measures

Hemodynamic parameters were recorded before induction in the operating room, then every 15 min till the end of surgery. The same parameters were recorded at 0 time (half an hour after recovery in PACU), 2, 4, 6, 8, 16, and 24 h postoperatively.

Static and dynamic postoperative pain was assessed by an anesthesiologist who was not included in the study (single-blinded) using a VAS at 0 time (half an hour after recovery) in PACU and then at 2, 4, 6, 8, 16, and 24 h in the ward. I.v. paracetamol 1 g was given if static VAS for pain is at least 4 or upon the patient’s request with a 6 h time interval. If VAS was still at least 4 after 40 min from the administration of paracetamol (the onset of analgesia after i.v. paracetamol occurs within 5 min, peaking at 40–60 min) i.v. morphine 3 mg boluses were given (not to exceed 0.2 mg per kg every 4 h) [13,14].

The time until the first request of analgesia, and the total morphine and paracetamol consumption during the first postoperative 24-h were recorded.

Side effects and complications such as nausea, vomiting, infection at the injection site, bleeding, nerve injury, pneumothorax, and local anesthetic toxicity were recorded.

2.4. Statistical analysis

The statistical analysis was performed using a standard SPSS software package, version 23 (SPSS Inc., Chicago, Illinois, USA). Normally distributed numerical data are presented as mean ± SD and differences between groups were compared using the independent Student’s t test; data not normally distributed were compared using the Mann–Whitney U test and are presented as median [interquartile range (IQR)] and categorical variables were analyzed using the χ² test or Fisher exact test and are presented as n (%). All P values are two sided. P value less than 0.05 is considered statistically significant.

3. Results

The present study included 60 patients who were equally randomized into ESPB group and control group. Both groups were comparable regarding the demographic data and the type of surgery (Table 1).

As regards our primary outcome, the ESPB group showed a significantly lower VASstatic score than the control group at 0 time (half an hour after recovery), 2, and 4 h postoperatively (P < 0.001). Also, the VASdynamic score was significantly lower in the ESPB group than in the control group at 0 time, 2, 4, and 6 h postoperatively (P < 0.001) (Table 2).

The time until the first required analgesia was significantly longer in ESPB group than control group [5 (3–6) vs. 0.5 (0.5–0.5) in hours, respectively; with P < 0.001]; while the postoperative 24 h morphine consumption was significantly lower in ESPB group than the control group (2.30 ± 2.18 vs. 10.10 ± 3.56 mg, respectively; with P < 0.001). Similarly, the frequency of paracetamol (1 g) intake was significantly lower in ESPB group than in the control group (P < 0.001) (Table 3).

There were no statistically significant differences between the two studied groups regarding the perioperative hemodynamics (heart rate, blood pressure) at any point of evaluation (Figs. 1–3).

Table 1. Demographic data and patients’ clinical characteristics among the studied groups.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group 1 (N = 30)</th>
<th>Group 2 (N = 30)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>47.5 ± 8.63</td>
<td>47.2 ± 9.18</td>
<td>0.897</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>84.76 ± 8.55</td>
<td>85.72 ± 6.87</td>
<td>0.664</td>
</tr>
<tr>
<td>ASA (I/II)</td>
<td>13/17</td>
<td>12/18</td>
<td>1</td>
</tr>
<tr>
<td>Simple mastectomy</td>
<td>20</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Lumpectomy</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

Data are presented as mean ± SD, number of patients, or ratio.
Group 1 (control group) and group 2 (erector spinae plane block group).
ASA, American Society of Anesthesiologists.
P value less than 0.05 is considered statistically significant.
Our study showed no statistically significant difference between the two studied groups regarding postoperative nausea (eight patients in the ESPB group and 13 in the control group). There was clinical significance between both groups as regards vomiting (four patients in the ESPB group and seven in the control group) but the difference was not statistically significant (Table 3).

None of the patients experienced any block-related complications such as infection at the injection site, bleeding, nerve injury, pneumothorax, and local anesthetic toxicity.

4. Discussion

Postoperative analgesia in breast surgery is difficult due to the complex innervation of the breast and the extensive nature of the surgery [2].

Regional anesthesia techniques provide better-quality acute pain control and subsequently less chronic pain after breast surgeries. Moreover, adequate control of acute pain preserves the immune function by suppressing the stress response to surgery and decreasing the requirements for opioids, particularly morphine which can inhibit cellular and humoral immune functions [3].

Our study demonstrated that a single shot of ESPB with 20 ml of 0.25% bupivacaine and 8 mg dexamethasone provided a considerable analgesic effect after breast surgeries. It significantly reduced postoperative static VAS scores at 0 time, 2, and 4 h and dynamic VAS scores at 0 time, 2, 4, and 6 h.

Gürkan et al. [15], mentioned that they conducted a first controlled trial to demonstrate the effect of ESPB as postoperative analgesia after breast surgeries. Their study enrolled 50 patients who were
randomized equally to receive either a single-shot ESPB with 20 ml of 0.25% bupivacaine after general anesthesia or no intervention. In contrast to our results, they reported no significant difference in the numerical rating scale (NRS) at all measurement intervals between the two groups. This result could be contributed to their usage of local anesthetic only without any additives but in our study, we used 8 mg dexamethasone as a local anesthetic adjuvant. Also, may be because they used a patient-controlled analgesia device for all patients immediately after recovery.

Our results were in agreement with the study by Singh and Kumar [16], they reported lower pain scores at different follow-up periods in the ESPB group compared to the control group. Their study included 40 patients posted for MRM. Patients were randomly allocated equally into a control group and an ESPB group using 20 ml 0.5% bupivacaine. The difference between their results and the results
reported by Gürkan and colleagues., may be explained by using a double concentration of local local anesthesia (0.5% bupivacaine) in their study.

Also, in harmony with our findings, Yao et al. [17], documented significantly lower postoperative VAS pain scores in ESPB group at rest and on movement compared to the control group. They conducted their clinical trial on 82 patients who were randomly assigned to undergo ESPB with either 25 ml of 0.5% ropivacaine or 0.9% physiological saline before MRM.

As regards total morphine consumption, our study showed a statistically significant lowering in the ESPB group compared to the control group (2.30 ± 2.18 vs. 10.10 ± 3.56 mg, respectively, \( P < 0.001 \)).

The results documented by Singh and Kumar [16], were in agreement with our results. They conducted their controlled trial on 40 patients who were randomly allocated into a control group and an ESPB group. The block was performed after general anesthesia using 20 ml 0.5% bupivacaine in MRM. Postoperative rescue analgesia was given with i.v. morphine 3 mg boluses on demand or whenever the NRS pain score was more than or equal to 4 in both

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Fig. 2. Comparison between the studied groups regarding MAP at different follow-up periods. MAP, mean arterial pressure.

Fig. 3. Comparison between the studied groups regarding heart rate at different follow-up periods.
groups. Their results documented that ESPB significantly reduced the postoperative 24 h morphine consumption when compared to the control group (1.95 ± 2.01 vs. 9.3 ± 2.36 mg, P = 0.01).

Another study was performed on 82 patients who were randomly assigned to undergo ESPB with either 25 ml of 0.5% ropivacaine or 0.9% physiological saline after general anesthesia in MRM. All patients received PCA with sufentanil for postoperative analgesia. Their results showed a significant decrease in sufentanil consumption during the first 24 h after surgery in the ESPB group compared to the control group (median 24 µg, IQR 24–28 vs. median 40 µg, IQR 36–42; P < 0.001) [17].

Concerning the study by Sharma et al. [18], their results showed that the ESPB group consumed morphine 42% less than the control group. They enrolled 60 patients scheduled for mastectomy surgery. Patients were randomly allocated equally into a control group and an ESPB group (the block was performed with ropivacaine 0.5%, 0.4 ml/kg after general anesthesia).

In our study, the first required analgesic time was significantly longer in the ESPB group when compared with the control group [5 (3–6) vs. 0.5 (0.5–0.5) in hours, respectively; with P < 0.001].

In harmony with our findings, He et al. [19], performed a prospective, controlled clinical trial on 40 patients to demonstrate the effect of ESPB with 20 ml of 0.5% ropivacaine after breast cancer surgeries and reported a significantly longer time to first request for analgesia in the ESPB group compared to the control group.

Comparing ESPB with the thoracic PVB in breast surgeries, Gürkan et al. [20], conducted a randomized controlled trial on 75 patients who were randomized into three groups ESPB, PVB, and control group. US-guided ESPB and PVB with 20 ml 0.25% bupivacaine were done preoperatively to the patients according to their groups. They reported that there were no significant differences between the ESPB and PVB groups for the 24-h postoperative morphine consumptions (P > 0.05). Both PVB and ESPB significantly reduced morphine consumption at 6, 12, and 24 h postoperatively (P < 0.001 for each time interval) compared to the control group. There was no statistically significant difference between ESP and PVB groups for NRS in any time interval (P > 0.05 for each time interval). This study concluded that the ESPB might be a simple and safe alternative to the PVB after breast surgeries.

Similar results were recorded by Moustafa et al. [21], who conducted their study on 102 female patients. Patients were randomly categorized into PVB and ESPB groups, the two blocks were performed with 20 ml of 0.25% bupivacaine after general anesthesia. They reported that after MRM, there were no significant differences between the ESPB and the PVB for 24 h postoperative morphine consumption. Also, pain scores were comparable between the two groups at all times of assessment. They reported a 100% success rate with performing the ESPB while it was 77.8% in the PVB, with faster performance in the ESPB compared to PVB.

Comparing the ESPB with the serratus plane block (SPB), a pilot randomized trial was performed on 60 patients to compare the analgesic effect of the two blocks after video-assisted thoracoscopy. The results showed that the ESPB technique provided a longer time until the first required analgesia than the SPB technique. In addition, the ESPB technique led to statistically significant lower postoperative pain scores, although the difference was clinically subtle. A significantly lower proportion of patients required total 24-h consumption of two doses of pethidine in the ESPB group than in the SPB group. Moreover, the ESPB group showed a numerically lower VAS static score than the SPB group throughout the study duration [22]. These results can be attributed to the regional extent of the cutaneous sensory block. SPB was reported to provide analgesia to the anterolateral chest wall and axilla only because it may miss the posterior primary rami and anterior cutaneous branches of intercostal nerves. Whereas ESPB allows for more extensive local anesthetic diffusion to affect both dorsal and ventral rami of spinal nerves [23].

Comparing the ESPB with the PECS block in breast surgeries, Altiparmak et al. [24], conducted a prospective, randomized, controlled trial on 40 women and reported that US-guided modified PECS block reduced postoperative tramadol consumption more effectively than ESPB in the first 24 h. Moreover, NRS scores were significantly higher in the ESP group than in the PECS group. These results can be interpreted as the modified PECS block affecting the lateral and medial pectoral nerves, intercostobrachial nerves, thoracic intercostal nerves, and long thoracic nerves. MRI studies revealed that local anesthetic agents could extend to the thoracodorsal nerve area. As a result, the PECS block can provide regional anesthesia both for the chest wall and axillary areas [25].

Our study demonstrated that ESPB lowered the incidence of nausea and vomiting PONV compared to the control group, but the difference was not statistically significant. The increase in the number of patients who had PONV in the control group may be owing to the use of more postoperative opioids.
In agreement with our study, the work of Gürkan et al. [15], reported no statistically significant difference between the ESPB group and the control group regarding PONV. None of the patients in our study experienced any block-related complications, such as injection at the injection site, bleeding, nerve injury, pneumothorax, or local anesthetic toxicity. These results are supported by the data from a systematic review and meta-analysis by Leong et al. [26], which included 13 randomized controlled trials and 861 patients and studied the use of the ESPB in breast surgeries. It reported that there were no complications related to ESPB in any study. Similar results were reported from a systematic review by De Cassai et al. [27], which studied the thoracic ESPB and included 1386 patients. It documented that ESPB is a practical, simple, and safe technique with no complications reported in any study.

More evidence and studies with a larger sample size are needed to confirm these findings and future clinical trials should focus on factors that affect the efficacy of ESPB, such as the volume of local anesthetic, single versus multiple injections, and the dermatomal dispersion of the block.

4.1. Conclusion

Our study concluded that US-guided single-shot ESPB is considered a simple, safe, and effective technique, providing appropriate analgesia following breast surgeries.

Conflicts of interest

There are no conflicts of interest.

References


