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ORIGINAL ARTICLE BREAST SURGERY

Ultrasound-Guided Bilateral Erector Spinae Block Versus Tumescent Anesthesia for Postoperative Analgesia in Patients Undergoing Reduction Mammoplasty: A Randomized Controlled Study

Gozen Oksuz[1] · Fatma Bilgen[2] · Mahmut Arslan[1] · Yakup Duman[3] · Aykut Urfalıoglu[1] · Bora Bilal[1]

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Abstract

Purpose The aim of this prospective, randomized, double-blind study was to compare the tumescent anesthesia method and erector spinae block with respect to postoperative analgesia consumption, pain scores and patient satisfaction, in patients receiving breast reduction surgery under general anesthesia.

Methods The study included 44 females, aged 20–65 years, who were to undergo breast reduction surgery, without adjunctive liposuction on the breast. Using the closed envelope method, the patients were randomly separated into two groups to receive tumescent anesthesia or erector spinae block (ESB). Patients in the ESB group received the block before general anesthesia by a single anesthetist (G.Ö.).

Results The 24-h tramadol consumption with PCA, which was the primary outcome of the study, was determined to be statistically significantly less in the ESB group ($p < 0.001$). The NRS scores were compared at 30 min postoperatively and then at 1, 2, 4, 6, 12 and 24 h. At all the measured time points, the pain scores of the ESB group were statistically significantly lower ($p < 0.001$). Additional analgesia was required by one patient in the ESB group and by seven patients in the tumescent group and was applied as 1 g paracetamol. The requirement for additional analgesia was statistically significantly lower in the ESB group ($p < 0.024$). Patient satisfaction was statistically significantly better in the ESB group ($p < 0.001$).

Conclusions According to the results of this study, bilateral ESB performed under ultrasound guidance in breast reduction surgery was more effective than tumescent anesthesia concerning postoperative analgesia consumption and pain scores. ESB could be an appropriate, effective and safe postoperative analgesia method for patients undergoing reduction mammoplasty surgery.

Level of Evidence II This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Erector spinae block · Mammoplasty · Pain

✉ Fatma Bilgen
fatmabilgen81@gmail.com

Gozen Oksuz
gozencoskun@gmail.com.tr

Mahmut Arslan
mahmtarslan@ksu.edu.tr

Yakup Duman
dryakupduman@gmail.com

Aykut Urfalıoglu
aykuturfalioglu@ksu.edu.tr

Bora Bilal
bbilal@ksu.edu.tr

[1] Anesthesiology and Reanimation, Kahramanmaraş Sutcu Imam University School of Medicine, Kahramanmaras, Turkey

[2] Plastic, Reconstructive and Aesthetic Surgery, Kahramanmaraş Sutcu Imam University School of Medicine, Kahramanmaras, Turkey

[3] Plastic, Reconstructive and Aesthetic Surgery, Tokat Gaziosmanpasa University School of Medicine, Tokat, Turkey

Introduction

In aesthetic plastic surgery, reduction mammoplasty is often implemented to eliminate problems of large breasts, which lead to back and shoulder pain, respiratory difficulties and aesthetic problems [1]. Successful postoperative pain management reduces complications and contributes to early discharge from the hospital [2]. The use of regional anesthesia and local anesthesia techniques reduces opioid consumption and complications such as nausea and vomiting caused by opioid consumption, constipation and sedation [3]. Pain control in breast reduction surgery is usually through the application of tumescent anesthesia, thoracic epidural anesthesia, intercostal nerve blocks and paravertebral blocks [4–7]. Although studies are showing that tumescent anesthesia is useful in controlling bleeding, it is of concern to anesthetists and plastic surgeons with respect to toxicity of the high dose of local anesthesia used [8].

With the more frequent use of ultrasound in regional anesthesia practice, new nerve blocks have come to prominence. The erector spinae block (ESB) was first defined by Forero in 2016. With the administration of local anesthesia between the transverse process of the vertebra and the erector spinae muscle, it is stated that the effect mechanism of ESB is that spread blocks the ventral and dorsal rami to the paravertebral area [9]. Despite similar efficacy to a paravertebral block, it is thought that this is a more reliable block because of the orientation of the needle far from the pleura [10]. Cases have been reported of the efficacy of ESB in postoperative analgesia in breast surgery [11, 12].

The aim of this prospective, randomized, double-blind study was to compare the tumescent anesthesia method and erector spinae block with respect to postoperative analgesia consumption, pain scores and patient satisfaction, in patients receiving breast reduction surgery under general anesthesia.

Materials and Methods

Approval for the study was granted by the Ethics Committee of Kahramanmaraş Sütçü İmam University (decision no: KAEK 2017/11-3). The study was registered at clinical trials.gov.tr (NCT03558880). The Declaration of Helsinki conducted all procedures. Informed consent was obtained from all patients. The study included 44 females, aged 20–65 years, who were to undergo breast reduction surgery, without adjunctive liposuction on the breast. Patients were excluded if they had local anesthesia allergy, coagulation impairment, any renal, cardiac, neurological or hepatic disease, or if they did not wish to participate in the study. Using the closed envelope method, the patients were randomly separated into two groups to receive tumescent anesthesia or erector spinae block.

All patients were premedicated with oral midazolam 0.5 mg/kg preoperatively. Patients in the ESB group received the block before general anesthesia by a single anesthetist (G.Ö.). In the ESB group, following the standard general anesthesia protocol, a tumescent solution containing 1 mL 0.1% adrenalin (1/1000) in 1000 mL ringer lactate with no local anesthetic was applied equally to the two breasts for intra-operative bleeding control by the surgeon before the operation. In the tumescent group, following the standard general anesthesia protocol, a tumescent solution containing 1 mL 0.1% adrenalin (1/1000) in 1000 mL ringer lactate with 20 mL 0.5% bupivacaine was applied equally to the two breasts for postoperative analgesia and intra-operative bleeding control by the surgeon before the operation.

Erector Spinae Block Application

With the patient in a sitting position, an area including 2 cm lateral of the T4 and T5 vertebrae was cleaned with povidone-iodine. A high-frequency (10–18 MHz) ultrasound linear probe (Esaote MyLab Five, Esaote, Florence, Italy) covered with a sterile sheath was placed 2 cm lateral of the T4 vertebra, first to the right or left. After visualization of the T4 transverse process and the overlying erector spinae muscle, a 22-gauge, 80-mm insulated Quincke-type needle (Uniplex, Pajunk, Geisingen, Germany) was inserted using the in-plane technique and with entry made from the lower end of the probe was advanced toward the transverse process. When the transverse process was touched, the needle was withdrawn and after a negative aspiration test with 0.5 mL normal saline, and visualization of a hypoechogenic image and that there was hydrodissection, a local anesthetic solution was administered to the fascia below the erector spinae muscle. Bupivacaine 0.25% at a dose of 20 mL was injected, confirming spread to both above and below the T4 level.

Standard Anesthesia Protocol

All patients received standard general anesthesia protocol as induction with 2–3 mg/kg iv propofol and 1–1.5 mcg/kg fentanyl and 0.6 mg/kg iv rocuronium. Endotracheal intubations were performed using a 7.0 or 7.5 tube with the patient in a supine position. Anesthesia maintenance was performed with 0.5/kg/mg sevoflurane and remifentanil infusion in a 50% O_2–50% air mixture.

When breast measurements of all the patients in the study were taken, the distance between the sternal notch–nipple–areola complex was 32–42 cm (mean 36 cm), and

taking the size of the breasts into consideration, the most appropriate technique, the inferior pedicle technique with inverted-T scar was applied in all patients.

Standard monitoring of the patients included heart rate, invasive systolic, diastolic and mean blood pressure and peripheral oxygen saturation, and the operating times were recorded.

At approximately 30 min before the end of surgery, 50 mg dexketoprofen IV was administered to all patients.

At the end of the operation, iv patient-controlled analgesia (PCA) was attached to all patients. A record was made of the demographic data of the patients, including age, height, weight, resected tissue and operation times. Patients were informed about pain scoring, and Numeric Rating Scale (NRS) pain scores were recorded at 30 min and 1, 2, 4, 6, 12 and 24 h by the nurses in the recovery room and the surgical ward. When the NRS score in the post-anesthesia care unit (PACU) and ward was ≥ 4, iv paracetamol 1 g was administered. The primary outcome was tramadol consumption in the first 24 h with PCA, and secondary outcomes were NRS scores, the use of additional analgesia and patient satisfaction.

PCA Protocol

All patients received iv PCA, using a prepared iv PCA (APM II Ambulatory Pump, Abbott Laboratories, San Diego, CA, USA), which was then attached to all patients at the end of the operation. The PCA was set to deliver an infusion of 10 mg tramadol on each press, at a maximum of three times per hour with a 20-min locked period, without continuous delivery.

Sample Size Estimation

The approximate sample size was calculated using the G* Power 3 analysis program (Heinrich-Heine-Universitat Düsseldorf, Germany) before the study. A pilot study was conducted on five patients from each group. The power analysis was based on the mean postoperative analgesia consumption with PCA. The mean tramadol consumption was 196 (67.3) in the tumescent group and 122 (56.74) in the ESB group. The sample size was calculated at a power of 95% and a significance level of 5%, and it was determined that it would be necessary to have approximately 20 patients per group to obtain significant statistical value.

Statistical Analysis

Statistical analysis was carried out using the SPSS program for Mac, version 17.0 (SPSS, Chicago, IL, USA). Descriptive statistics were presented as the mean ± standard deviation (SD) and as the number of cases (n) and the corresponding percentage (%) for nominal variables. T tests were carried out for continuous variables with normal distribution, and the Mann–Whitney U test was used for nonparametric variables. A value of $p < 0.05$ was considered statistically significant.

Results

Of the 44 patients included in the study according to the CONSORT diagram, one patient was excluded due to unilateral (right-side) retention of the block that was applied bilaterally. Thus, 43 patients received reduction mammoplasty surgery under general anesthesia and were randomly separated into two groups: 21 with ESB and 22 with tumescent anesthesia (Fig. 1). Both groups were similar concerning demographic data on age, height, weight, resected tissue and operation times (Table 1).

The 24-h tramadol consumption with PCA, which was the primary outcome of the study, was determined to be statistically significantly less in the ESB group ($p < 0.001$) (Fig. 2). The NRS scores were compared at 30 min postoperatively and then at 1, 2, 4, 6, 12 and 24 h. At all the measured time points, the pain scores of the ESB group were significantly lower ($p < 0.001$) (Table 2). Additional analgesia was required by one patient in the ESB group and by seven patients in the tumescent group and was applied as 1 g paracetamol. The requirement for additional analgesia was significantly lower in the ESB group ($p < 0.024$). Patient satisfaction was significantly better in the ESB group ($p < 0.001$). When complications were examined, such as postoperative nausea, vomiting, hypotension, bradycardia, bleeding or edema, there was a significantly lower rate of nausea in the ESB group ($p < 0.005$). Hypotension was seen in two patients in both groups, and no other complications were seen in either group (Table 1).

Discussion

In the comparison in this study of patients received reduction mammoplasty under general anesthesia with tumescent anesthesia or bilateral ultrasound-guided ESB block, the postoperative analgesia consumption and pain scores were lower and patient satisfaction scores were higher in the ESB group. To our knowledge, this is the first study to compare ESB and tumescent anesthesia in reduction mammoplasty.

One randomized controlled study in the literature has shown the efficacy of ESB block in breast surgery. Gürkan et al. [13] reported that ESB block provided adequate

Fig. 1 Flowchart

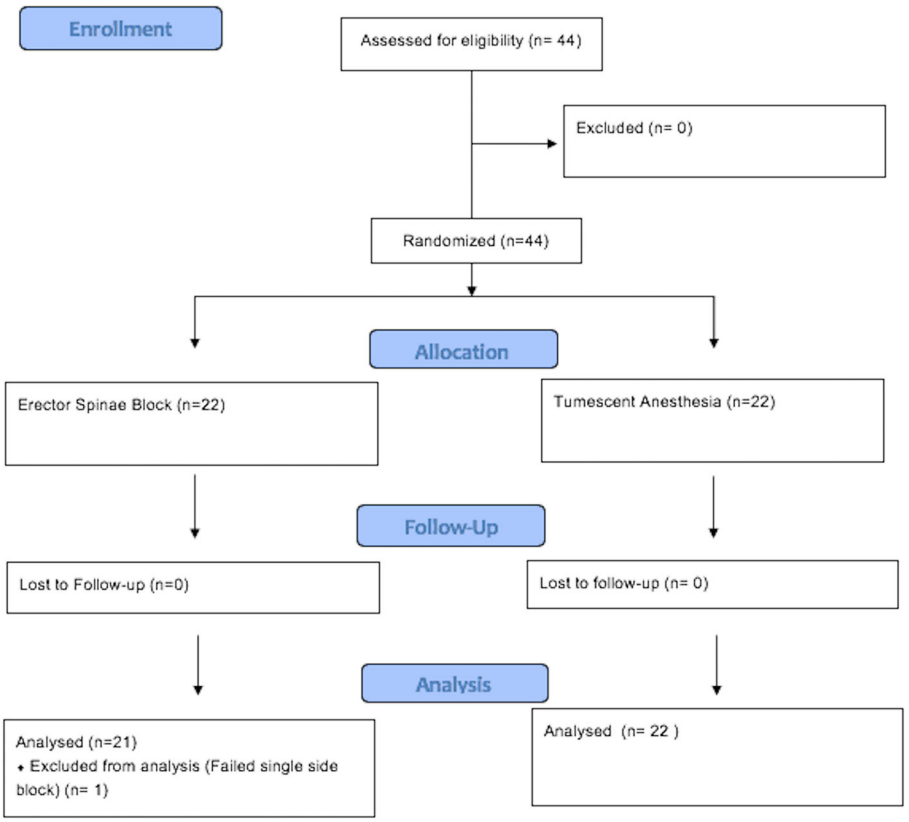

Table 1 Demographic and clinical data

	ESB group (n = 21)	TA group (n = 22)	p
Age (years)	48.70 ± 17.061	45.73 ± 18.846	0.623
Weight (kg)	68.80 ± 10.345	73.00 ± 7.93	0.10
Height (cm)	166.75 ± 6.904	168.45 ± 7.701	0.402
ASA (I/II/III)	12/9/0	14/8/3	0.667
Operation time (min)	159.5 ± 37.48	154.09 ± 40.67	0.684
Resected tissue (g)	860 ± 222	847 ± 112	0.40
Nausea	0	4	0.043*
Vomiting	0	0	1
Hypotension	1	1	1
Bradycardia	0	0	1
Bleeding/edema	0	0	1
Additional analgesic	1	7	0.024*
Patient satisfaction score	9.14 ± 0.72	7.4 ± 0.66	0.001*

ASA American Society of Anesthesiologist Classification, operation time; not including TA or ESB performed time, *ESB* erector spinae block and *TA* tumescent anesthesia group

*$p < 0.05$ when comparing ESB and TA groups. Data are presented as mean ± standard deviation or ratio p value < 0.05 is considered as a statistical difference. Minute: min

analgesia and reduced opioid consumption in breast surgery.

In the postoperative pain management of breast reduction operations, epidural anesthesia, intercostal blocks, paravertebral block and the newly defined but increasingly used PECS I, PECS II and serratus anterior plane block are the methods applied by anesthetists, while tumescent anesthesia is a method used by plastic surgeons [14, 15]. Although tumescent anesthesia is a method often selected by plastic surgeons in reduction mammoplasty, the efficacy with respect to postoperative pain remains controversial. In a randomized controlled study by Christine et al., patients

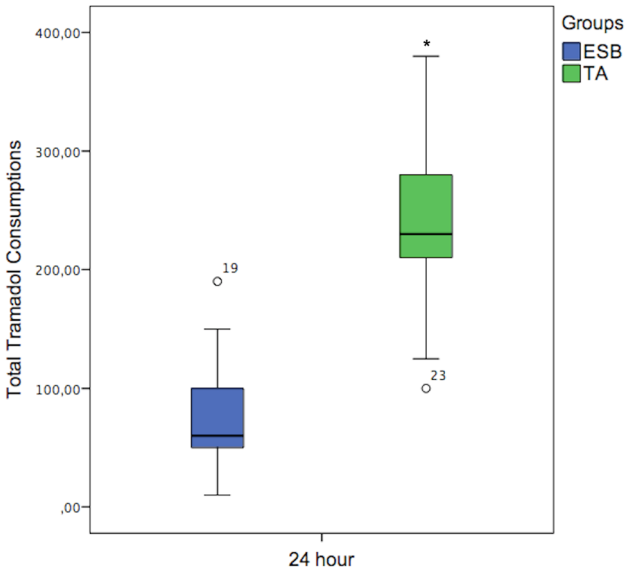

Fig. 2 Total tramadol consumption. *ESB* erector spinae block group, *TA* tumescent anesthesia group

Table 2 Numeric Rating Scale (NRS) scores across postoperative time points

	ESB group (n = 21)	TA group (n = 22)	p
0.5 h	4.19 ± 1.43	5.68 ± 1.04	0.001*
1 h	2.19 ± 0.92	4.27 ± 0.63	0.001*
2 h	1.61 ± 0.58	3.59 ± 0.73	0.001*
4 h	1.33 ± 0.48	3.18 ± 0.58	0.001*
6 h	1.23 ± 0.43	2.81 ± 0.58	0.001*
12 h	1.09 ± 0.03	2.31 ± 0.64	0.001*
24 h	0.95 ± 0.49	2.09 ± 0.61	0.001*

Data are presented as mean and SD

SD standard deviation, *ESB* erector spinae block, *TA* tumescent anesthesia group

*$p < 0.05$ when comparing ESB and TA groups

undergoing breast reduction surgery with tumescent solution were divided into two groups with one group administered with a solution containing epinephrine only and the other group administered with a solution containing lidocaine and epinephrine. No difference was determined between the groups with respect to postoperative analgesia and nausea and vomiting, and the addition of lidocaine to the tumescent solution was not sufficiently beneficial and had a potential risk [16]. Bupivacaine, with the addition or not of epinephrine, is generally used in tumescent anesthesia as it is a longer-lasting local anesthetic than lidocaine [17]. The reason for not using bupivacaine in the ESB performed in the current study was that bupivacaine was added as a local anesthetic to the tumescent anesthesia solution in the group not receiving ESB. To benefit from the effect of reducing potential bleeding of the tumescent solution with adrenalin, local anesthetic was not added to the ESB block, and tumescent anesthesia was made with epinephrine only.

Erector spinae is a newly defined interfascial plane block. Forero [9] demonstrated that it provided successful analgesia in thoracic neuropathic pain. In the literature, there are a few studies. Tulgar et al. [18] reported successful postoperative analgesia in laparoscopic cholecystectomy surgery when ESB block was performed at the T7 level. In the case of breast cancer and reduction surgery, Bonvicini et al. [19] performed bilateral ESB at the T5 level, and successful analgesia was reported to have been obtained. In the current study, bilateral ESB was performed at the T4 level.

When Forero first described ESB, it was reported that as a result of the bilateral block in two cadavers, the dye had spread to the whole erector spinae and intercostal muscles and reached the ventral and dorsal spinal rami. It is thought that the 20 mL of local anesthetic administered spread in a cranial and caudal direction and reached the paravertebral area [9]. Although it has not been fully clarified, there are views that the local anesthetic could take the route from the costotransverse foramen to the dorsal ramus, or could spread to the paravertebral area through intertransverse connective tissue [20].

ESB is a novel block that provides good analgesia when performed by an experienced anesthesiologist in the use of ultrasound in regional anesthesia and which can be used as an alternative to paravertebral block in breast surgery. Compared to paravertebral block, it is an easily applied block with less risk of pneumothorax; it is nearer the surface and safer. Although pneumothorax was reported in a few cases [21, 22], there have been no reports of complications such as hypotension or bradycardia which can develop associated with the epidural spread seen in a paravertebral block. In the current study, no postoperative hypotension or bradycardia or any block-related complications were observed. Nausea and vomiting were reported less, and patient satisfaction was higher in the ESB group than in the tumescent anesthesia group.

Limitations of the current study include that the dermatome levels provided with analgesia could not be measured as the ESB was performed after general anesthesia and because of the postoperative bandage. There is a need for further studies to understand the efficacy and the effect mechanism of ESB better.

Conclusion

According to the results of this study, bilateral ESB performed under ultrasound guidance in breast reduction surgery was found to be more effective than tumescent

anesthesia concerning postoperative analgesia consumption and pain scores. ESB could be an appropriate, effective and safe postoperative analgesia method for patients undergoing reduction mammoplasty surgery.

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