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COMPARISON OF THE PERIOPERATIVE ANALGESIC OUTCOMES OF THORACIC PARAVERTEBRAL BLOCK VERSUS ERECTOR SPINAE PLANE BLOCK IN REDUCTION MAMMAPLASTY SURGERIES: A RETROSPECTIVE COHORT STUDY*

REDÜKSİYON MAMOPLASTİ AMELİYATLARINDA TORASİK PARAVERTEBRAL BLOK İLE EREKTOR SPİN PLAN BLOĞUNUN PERİOPERATİF ANALJEZİK SONUÇLARININ KARŞILAŞTIRILMASI: RETROSPEKTİF KOHORT ÇALIŞMA

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ABSTRACT

Objective: Thoracic paravertebral block (TPVB) and Erector spinae plane block (ESPB) are the most preferred regional analgesia techniques for breast surgeries. However, the literature is still lack of reliable evidence to prove superiority of one over another. We hypothesized that TPVB would provide better pain control for the acute postoperative period.
Material and Methods: In this retrospective cohort study, macromastia patients who underwent bilateral reduction mammaplasty surgery were grouped according to the regional technique performed prior to general anesthesia induction that are provided with 0.375% bupivacaine bilaterally (TPVB or ESPB). Presurgery (10th min, 20th min, and 30th min) and postoperative number of dermatomal sensory block, and postoperative pain scores were screened which referred to postoperative 0 minute,1st hour, 2nd hour, 4th hour, 6th hour, 12th hour, 24th hour and 48th hour examination. Intraoperative and postoperative analgesic administration, and comfort parameters such as time-to-first pain, nausea-vomiting (PONV) incidence, sleep duration, complications and patient/surgeon satisfaction scores were also investigated.
Results: Total 58 patients were screened. Pain scores were lower in TPVB group for the postoperative first 2 hours (P<0.05). TPVB blocked more dermatomes during postoperative 1st day (P<0.05) whereas postoperative tramadol consumption were similar with both blocks (P>0.05). On the other hand, postoperative 2nd day paracetamol consumption was less with TPVB (P=0.03). Time-to-first pain and sleep duration on the postoperative 1st day was shorter with ESPB (P<0.05).
Conclusions: Thoracic paravertebral block represents better analgesic features than erector spinae plane block for reduction mammaplasty. However, ESPB may still be considered to provide favorable analgesia.

Keywords: Thoracic paravertebral block, erector spinae plane block, macromastia, reduction mammoplasty, thoracic wall block, acute pain, nerve block, regional anesthesia

ÖZ

Amaç: Torasik paravertebral blok (TPVB) ve Erektor spina plan bloğu (ESPB) meme ameliyatlarında en çok tercih edilen rejyonal analjezi tekniklerindendir. Literatürde bu iki bloğun birbirine üstünlüğünü gösteren güvenilir kanıtlar kısıtlıdır. Hipotezimizi TPVB'nin akut postoperatif dönemde daha iyi analjezi sağlayacağı yönünde kurduk.
Gereç ve Yöntem: Bu retrospektif kohort çalışmada bilateral redüksiyon mamoplasti uygulanan hastalar genel anestezi öncesinde uygulanmış olan rejyonal tekniğe göre (bilateral TPVB veya ESPB, %0,375 bupivakain ile) gruplandırıldı. Ameliyat öncesi (Blok sonrası 10. dakika, 20. dakika ve 30. dakika) ve ameliyat sonrası 0. dakika, 1. saat, 2. saat, 4. saat, 6. saat, 12. saat, 24. saat ve 48. saatte duyu bloğu oluşmuş dermatom sayısı ve postoperatif ağrı skorları tarandı. İntraoperatif ve postoperatif verilen analjezik miktarı, ağrının ilk ortaya çıkışı süresi, bulantı-kusma (POBK) insidansı, uyku süresi, komplikasyonlar ve hasta/cerrah memnuniyet skorları gibi konfor parametreleri araştırıldı.
Bulgular: Toplam 58 hasta tarandı. Postoperatif ilk 2 saat ağrı skorları TPVB grubunda daha düşüktü (p<0,05). TPVB, postoperatif 1. günde daha fazla dermatomu bloke ederken (p<0,05), postoperatif tramadol tüketimi her iki blokta benzerdi (p>0,05). Postoperatif 2. gün parasetamol tüketimi ise TPVB ile daha azdı (p=0,03). Postoperatif 1. gün ilk ağrı süresi ve uyku süresi ESPB ile daha kısaydı (p<0,05).
Sonuç: Redüksiyon mamoplasti için torasik paravertebral blok, erektor spina plan bloğundan daha etkili analjezik özellikler göstermektedir. Bununla birlikte, ESPB yeterli analjezi sağlanmasında faydalıdır.

Anahtar kelimeler: Torasik paravertebral blok, erektor spina plan bloğu, makromasti, redüksiyon mamoplasti, torasik duvar bloğu, akut ağrı, sinir bloğu, rejyonal anestezi

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INTRODUCTION

Breast surgeries vary depending on the underlying pathology among which malignancy surgeries are more common. According to grade of the tumor and the lymphatic involvement, surgical indications may include a wide spectrum covering from simple excision to radical mastectomy with lymphatic dissection. This particular situation may affect proper examination of clinical pain and construct a homogenous patient group for regional anesthesia studies. On the other hand, bilateral reduction mammaplasty surgery is known to require large amounts for breast tissue extraction which causes severe acute pain postoperatively. Surgical techniques may differ according to the pedicle types or nipple grafting; but in the end, the patients face severe clinical pain related to the extracted tissue that is generally around two kilograms in total. Therefore, preemptive thoracic wall blocks are widely used to control postoperative pain and provide perioperative comfort as a part of multimodal analgesia.

Thoracic Paravertebral Block (TPVB) and Erector Spinae Plane Block (ESPB) are well-described regional techniques, mainly chosen for chronic pain predisposing operations such as thoracic and breast surgeries (1,2). TPVB is an advanced method which necessitates deep tissue puncture that targets the paravertebral space close to the pleura. On the other hand, ESPB is another method considered to be safer since the needle is proceeded in between erector spinae muscle and a bony structure (Transverse process) (3). The literature represents more clinical experience with TPVB; however, ESPB is equally popular with a claim to be safer (4). Yet, there is an ongoing debate regarding the superiority of one over another in terms of analgesic efficacy.

Both techniques are generally used as a part of multimodal analgesia under ultrasound (US) guidance. However, the question upon the efficacy and reliability of ESPB in comparison to TPVB still remains. Current study is designed to evaluate these regional techniques from the analgesic efficacy, analgesic consumption and perioperative comfort aspects. Our primary outcome was the numeric rating scales for pain (NRS) for the acute postoperative period.

Despite the well-investigated nature of the comparison of these two techniques, existing clinical trials include different types of breast surgeries. Here, in this study, we aimed to demonstrate our results in one single surgical indication which was reduction mammaplasty in macromastia patients. To our knowledge, the literature does not have any clinical trial for this specific issue which compares these blocks for the mentioned patient group.

MATERIALS and METHODS

Data colection and regulatory aspects

This retrospective cohort investigation was approved by the local ethics committee (Istanbul Faculty of Medicine Clinical Research Ethics Committee: Date: 16.10.2020, No:25). Informed consent was obtained from all the patients prior to surgery for scientific data presentation anonymously in the future. Data of total 61 macromastia patients who underwent bilateral reduction mammaplasty surgery between April 2017 and June 2019 in our tertiary university hospital were reviewed, but three patients were excluded due to the missing data. Among the 58 patients, 28 patients had received single injection US guided Erector Spinae Plane block while 30 had received single injection US guided Thoracic Paravertebral Block prior to macromastia surgery. The data screening was accomplished from the departmental written sources with regard to the intraoperative (operating room) and postoperative period (recovery room and ward). Our institutional standard anesthesiologic approach for bilateral reduction mammaplasty is described below.

Perioperative care and outcome measures

After the patients arrived to the operating room, standard monitoring (electrocardiography, pulse oximetry and non-invasive blood pressure monitoring) was applied to them, and mild sedation with 2 mg midazolam IV and 50 mcg fentanyl IV was provided. The patients were kept in the sitting position to perform thoracic wall blocks. After the skin disinfection with 10% povidone-iodine, a linear ultrasonography (USG) probe (Logiq, GE, USA, 4-12 hz) was placed on the level of T3 and shifted laterally to visualize T3 and T4 transverse processes and the pleura in between. An insulated peripheral block needle (50 mm, BBraun, Sonoplex, Melsungen, Germany) was advanced through the tissues in-plane towards the paravertebral space. Once the needle tip was inserted into the targeted area, the downward shifting of pleura was checked with 1 ml of saline injection, and 20 cc 0.375% bupivacaine was injected to provide TPVB, afterwards (Group TPVB). Similarly, ESPB was applied on the T3 level for the other group. Under linear USG probe visualization, the transverse process was identified to be approximately 2-3 cm lateral to the spinous process, and the needle was inserted out-of-plane until contacting the bone. Again, 1 ml saline was injected to the area to observe expansion of interfascial area between the erector spinae muscle and the transverse process. Followingly, 20 cc 0.375% bupivacaine was administered to perform ESPB (Group ESPB). Both procedures were performed bilaterally for each patient since the surgeries were both sided.

After performing the blocks, dermatomal distribution of the sensorial block was checked via pin-prick test on related dermatomes at 10^{th}, 20^{th} and 30^{th} minutes, and "number" of the dermatomes with a complete loss of sensation on the midclavicular line was recorded. After the sensory examination, general anesthesia was induced in the supine position with additional 2 mcg/kg fentanyl IV, 3 mg/kg propofol IV and 0.5 mg/kg rocuronium IV, and the hypnosis was maintained via sevoflurane inhalation. If an increase more than 20% in the heart rate or systolic blood pressure was observed, additional 50 mcg fentanyl was administered and recorded as "intraoperative additional fentanyl requirement". After the extubation, patients were transported to post-anesthesia care unit (PACU) where the dermatomal sensory examination was continued. Discharge to the ward was granted once the Aldrete score was nine or

more. The entrance to PACU was accepted as minute zero, and ongoing examinations were made at 1st,2nd,4th,6th,12th,24th, and 48th hours. All patients were asked to rate pain intensity on a standard numeric rating scale (NRS) ranging from 0 (no pain) to 10 (the worst imaginable pain) at the defined time points and this was recorded as our primary outcome.

Table 1: Patient demographics, surgical characteristics, block procedural time, durations of surgery and general anesthesia

	ESPB (n=28, 48.3%)	TPVB (n=30, 51.7%)	*P*
Age (year) (Median (min-max))	46 (24-61)	44 (25-60)	0.8[a]
BMI (kg/m²) (Mean±Std)	31±4.1	31.43±3.9	0.7[b]
ASA physical status (n, %)			
1	3, 10.7%	5, 16.7%	
2	22, 78.6%	23, 76.7%	0.7[c]
3	3, 10.7%	2, 6.7%	
Duration of block performance (min) (Median (min-max))	7 (4-12)	7 (4-15)	0.1[a]
Duration of anesthesia (min) (Mean±Std)	154.6±30.5	157.2±35.2	0.8[b]
Duration of surgery (min) (Median (min-max))	135 (90-200)	137.5 (85-220)	0.8[a]
Intraoperative fentanyl requirement (mcg) (Median (min-max))	0 (0-50)	0 (0-100)	0.1[a]
Breast reduction incision types (n, %)			
Wise pattern	25, 89.3%	26, 86.7%	1.0[d]
Circumvertical with short horizontal scar	3, 10.7%	4, 13.3%	
Breast reduction pedicle types (n, %)			
Superomedial pedicle	17, 60.7%	17, 56.7%	
Inferior pedicle	6, 21.4%	6, 20%	0.8[d]
Superior pedicle	4, 14.3%	4, 13.3%	
Free nipple grafts	1, 3.6%	3, 10%	
Weight of breast reduction (g) (Median (min-max))	732 (600-1020)	732 (580-1076)	0.9[a]

ESPB: Erector spinae plane block, TPVB: Thoracic paravertebral block, BMI: Body Mass Index, ASA: American Society of Anesthesiologists, a: Mann Whitney-U test, b: Student-t test, c: Pearson Chi-Square test, d: Fischer's Exact test

Rescue analgesic was administered once the NRS was more than 4 and recorded as "time-to-first pain". Accordingly, paracetamol 1 g IV was administered, and if the pain persisted in the following 1st hour, an additional tramadol 50 mg IV was also added. Intraoperative opioid requirement (fentanyl IV mcg), length of stay in PACU, amount of postoperative paracetamol (g) and tramadol (mg) requirement, procedural complications (hematoma, pneumothorax, local anesthetic toxicity etc), PONV incidence (%), sleep duration (hours), and patient/surgeon satisfaction were also recorded, which are presented here as secondary outcomes. Satisfaction scores were determined as follows: 0: Not satisfied, 1:Neutral, 2: Slightly satisfied, 3: Completely satisfied.

Statistical analysis

Based on an assumption of 25% difference in the postoperative 1st hour mean NRS scores, 27 patients were required per group for statistical evaluation (G*Power 3.1, Düsseldorf, Germany). Statistical analysis was completed via Statistical Package for the Social Sciences for Mac version 25 (IBM, New York, USA). Categorical data were evaluated with chi-square test. Intergroup analyses were made via student's t-test if the data were distributed homogenously, and Mann Whitney-U was chosen for the heterogenous data. Normally distributed data were expressed as mean±standard deviation, and heterogeneously distributed data were expressed as median (min-max).

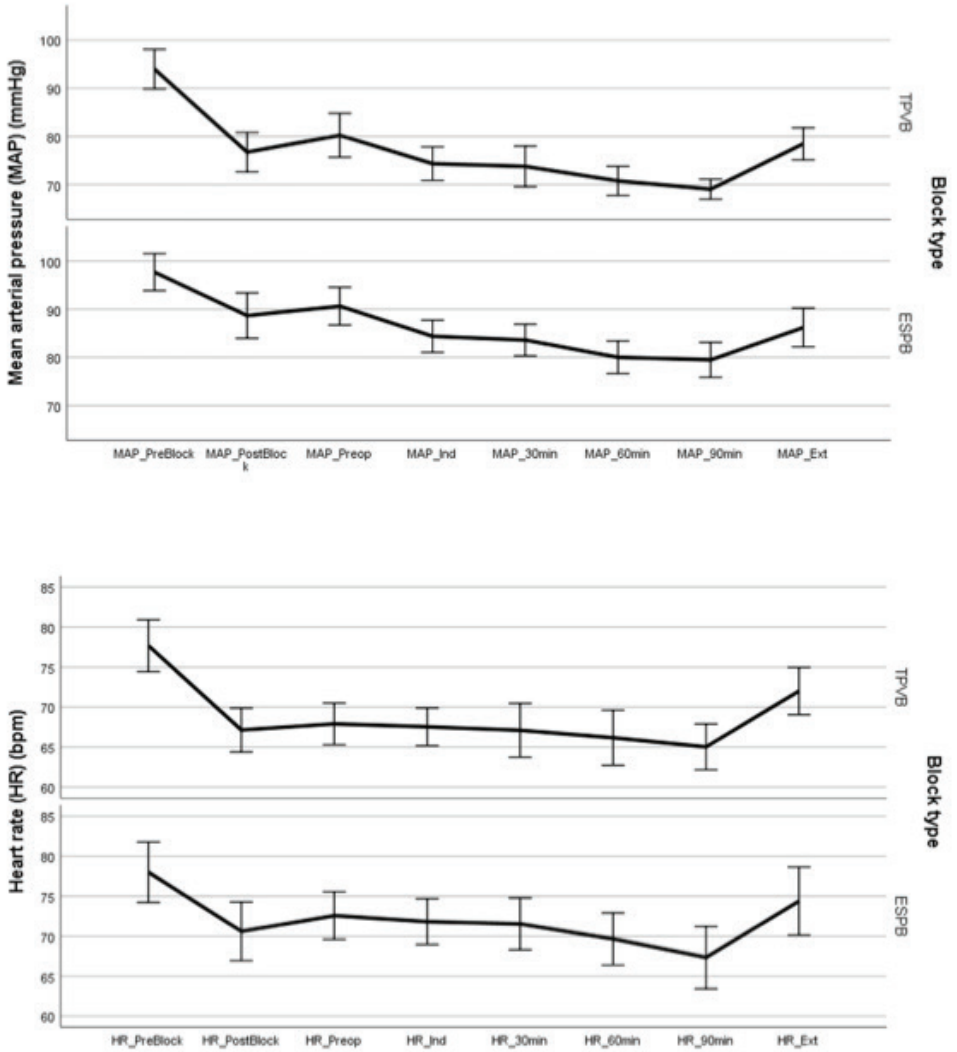
RESULTS

Age, ASA physical status, body mass index (BMI), surgery types, resected breast tissue mass, and duration of block performance, anesthesia, and surgery did not differ between the groups (*P*>0.05). Amount of administered intraoperative fentanyl IV was also similar (*P*>0.05). The data were summarized in Table 1. Also, intraoperative mean arterial pressure (MAP) and heart rate (HR) data were represented in Figure 1.

Presurgery pin-prick evaluation exhibited more dermatomal block distribution on the right and left midclavicular line in Group TPVB at 10th, 20th, and 30th minutes (Right: *P*=0.02, *P*=0.02, *P*=0.04; left: *P*=0.01, *P*=0.02, *P*=0.03) (Figure 2).

Postoperative NRS values were lower in Group TPVB than in Group ESPB for the 0th min, 1th and 2nd hours (Right: *P*= 0.01, *P*= 0.004, *P*= 0.02; Left: *P*= 0.02, *P*=0.005, *P*= 0.03) (Figure 3). However, postoperative pin-prick examination demonstrated more distinct differences. During the postoperative first 24 hours, TPVB group patients described more dermatomal coverage (*P*<0.05) (Figure 2).

Length of PACU stay, incidence of PONV, and postoperative tramadol consumption were not different between the groups (*P*>0.05). Time-to-first pain was shorter in Group ESPB (411.8±270.5 min vs 605±324.6 min, *P*<0.05). First day paracetamol consumption was also similar between the groups, but Group ESPB consumed more paracetamol on the postoperative 2nd day (1 (0-2) g vs 0 (0-2) g, *P*=0.03). Postoperative first day sleep duration was significantly more in group TPVB (6 (2-7) vs 6.25 (5-8), *P*=0.01). Both patients and surgeons had more satisfaction with the TPVB (*P*=0.04 for patients, and *P*=0.04 for surgeons) overall. The data are summarized in table 2.



MAP: Mean arterial pressure, TPVB: Thoracic paravertebral block, ESPB: Erector spinae plane block

Figure 1: Intraoperative hemodynamic variables.

According to our data screening; none of the possible complications (hematoma, pneumothorax or local anesthetic toxicity) were observed in any patients.

DISCUSSION

Our results revealed a better performance with thoracic paravertebral block in many aspects including perioperative pain control, total number of dermatomal coverage and postoperative comfort parameters. Among these, numerical rating scores as our primary outcome demonstrated a clinically better pain control for the acute postoperative period up to 2 hours with TPVB. However, this analgesic effect being balanced with ESPB after the 6th hour can be interpreted as "comparable" which should be further debated because "maximum" pain scores were higher on every time point with ESPB, which may indicate an inferiority with a larger sample size. Actually, this possibility was demonstrated by Swisher et al. with a relatively high pain scores and increased morphine consumption with ESPB in comparison to TPVB (5). Their results are based on intra-day pain spectrum of NRS which is different from our design that assess NRS values hourly. While examining the data "daily" may be a very good indicator of providing long-term analgesia, it doesn't make it possible to identify the certain time point when TPVB separates from ESPB. However, Gürkan et al. have not observed a different NRS between TPVB and ESPB at multiple time points. Of note, the primary outcome was postoperative morphine consumption in this specific trial (6).

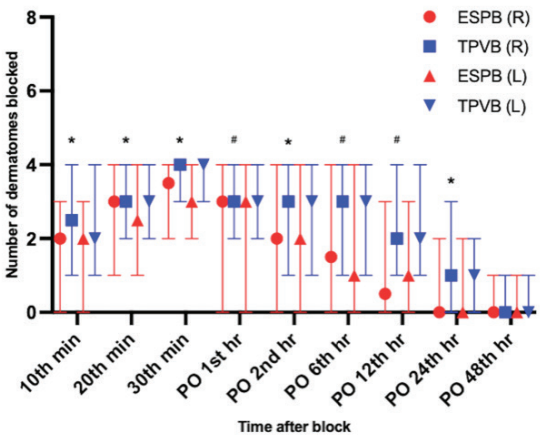


Figure 2: Number of dermatomes blocked at different time points after related thoracic wall block execution. Data are presented as median (min-max).
TPVB: Thoracic Paravertebral Block, ESPB: Erector Spinae Plane Block, R: Right, L: Left, PO: Postoperative, *: P<0.05 (valid for both right and left side), #: p<0.001 (valid for both right and left side)

There is an ongoing debate regarding the efficacy of ESPB which is under examination against TPVB for the recent years (7-10). ESPB gained excessive popularity due to its simplicity and "unexpected" effectiveness which is eventually questioned more and more by anesthetists. Despite the increasing number of randomized clinical trials for different types of surgeries, existing evidence is still low and arguable in the literature. For that, main reasons may be the limited participant numbers and changing study designs (single, bi-level or multi-level block techniques…), yet existing analyses show better features on behalf of TPVB (1, 11-13). One should note that ESPB is still more beneficial than "IV opioid only" analgesia regimen as the meta-analyses represent (14-16). Therefore, we believe ESPB should still be considered as a part of multimodal analgesia.

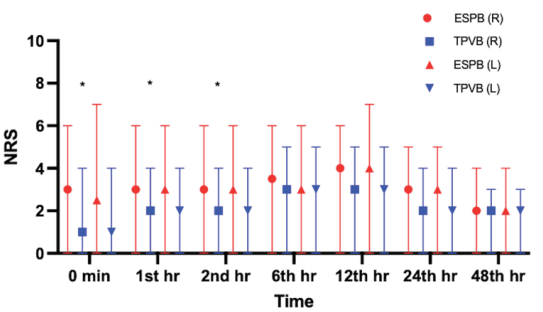


Figure 3: Postoperative Pain Numeric Rating Scale values at different time points. Data are presented as median (min-max).
NRS: Numeric Rating Scale, ESPB: Erector Spinae Plane Block, TPVB: Thoracic Paravertebral Block, R: Right, L: Left, *: P<0.05 (valid for both right and left side)

Table 2: Length of stay in postoperative care unit, postoperative time until first pain, postoperative analgesic consumption/the numbers of paracetamol and tramadol requirements, incidence of postoperative nausea and vomiting and duration of sleep on postoperative days 1 and 2, patient and surgeon satisfaction scores.

	ESPB (n=28, 48.3%)	TPVB (n=30, 51.7%)	*P*
Length of stay in postoperative care unit (min) (Mean±Std)	19.2±7.7	16.8±7.1	0.2[a]
Time to first pain (min) (Mean±Std)	411.8±270.5	605±324.6	**0.02**[a]
Incidence of PONV (n, %)			
Postoperative day1	5, 17.9%	6, 20%	0,8b
Postoperative day2	-	-	
Paracetamol consumption (g) (Median (min-max))			
Postoperative day1	2 (0-3)	1 (0-3)	0.1[c]
Postoperative day2	1 (0-2)	0 (0-2)	**0.03**[c]
Tramadol consumption (mg)			
Postoperative day1	50 (0-150)	50 (0-150)	0.2[c]
Postoperative day2	0 (0-100)	0 (0-50)	0.3[c]
Postoperative sleep duration (hour) (Median (min-max))			
Postoperative day1	6 (2-7)	6.25 (5-8)	**0.01**[c]
Postoperative day2	7 (4-8)	7 (6-8)	0.8[c]
Patient satisfaction (0-3) (Median (min-max))	3 (0-3)	3 (2-3)	**0.04**[c]
Surgeon satisfaction (0-3) (Median (min-max))	3 (2-3)	3 (2-3)	**0.04**[c]

ESPB: erector spinae plane block, TPVB: thoracic paravertebral block, PONV: Postoperative nause and vomiting, a: Student-t test, b: Pearson Chi-Square,, c: Mann Whitney-U test.

Another aspect of this dilemma is the anatomical implications and the spread of the local anesthetics (LA). Current trials are incapable of explaining the mechanism of ESPB. Cadaver studies exhibit epidural LA spread in at least 40% of the subjects with TPVB (17,18). On the other hand, ESPB is known not to cause epidural stain (18,19). This specific feature may arguably be the explanation of more and long-lasting dermatomal blockade coverage starting from the presurgical period until postoperative 24 hours with TPVB which is underlined in our results earlier. Yet, we do not have solid evidence.

Preemptive regional analgesia techniques are meant to provide a comfortable perioperative period for the patients. According

to our design, the "comfort" parameters indicate several entities such as time-to-first pain (NRS>4), length of stay in PACU, PONV incidence, analgesic consumption, and sleep duration. Our current results support TPVB as it delays "time-to-first pain". Although this specific parameter may be perceived subjectively by the patient, postoperative 1st day rescue analgesic consumption did not change among the groups. This result is similar with Zhao et al.'s and El Ghamry et al.'s studies in which one of them was even based on thoracic surgery (20,21). Generally speaking, both ESPB and TPVB represented similar analgesic features, but TPVB takes it slightly further with increased postoperative 1st day sleep duration and reduced postoperative 2nd day paracetamol consumption. Perhaps, these small differences should be interpreted in the light of patient/surgeon satisfaction, which was better on behalf of TPVB, meaning that small matters may lead to greater comfort. Evaluating pain density with such subjective classifications like NRS can cause confusion occasionally. Neither intraoperative/postoperative opioid administration nor NRS scores exhibited suggestive discrepancies between the two techniques. However, TPVB group patients declared more satisfaction with their perioperative process which is compatible with outcomes in several studies in the literature (13, 22, 23).

Clearly, ESPB is preferred due to its easy-to-perform and procedural properties (24). We believe appropriate techniques should be chosen based on the operating anesthetists' experience. Physicians should consider particular anatomic difficulties that harden paravertebral space US visualization such as obesity (25). In case of presence of a greater possibility of complication, TPVB may be avoided and can be replaced with ESPB which is obviously more beneficial than sole IV analgesics.

The retrospective nature of this study stands as a limitation which we aimed to overcome with our detailed data recording practice. Still, it would be an upside if the chronic pain was examined for long-term results which is lacking also. However, our study group has a rather specific and target-driven surgical indication (reduction mammaplasty only) that may benefit from the correct thoracic wall block choice. Considering most of the studies in the literature covering mastectomies with axillary incisions and lymph node extractions, our study group represents a well reflection for pain evaluation after thoracic wall blocks. Yet, well-designed randomized clinical trials comparing TPVB versus ESPB are quite sparse in the literature, and reliable data are still needed from this aspect. We believe our results provide an effective insight into this subject.

Thoracic paravertebral block provides better analgesia and postoperative comfort than erector spinae plane block for the acute postoperative period in reduction mammaplasty surgeries. However, ESPB still provides efficient analgesia, and since the procedural difficulty of paravertebral block represents a solid handicap, ESPB may be chosen to avoid possible complications of paravertebral block.

Ethics Committee Approval: This study was approved by Istanbul Faculty of Medicine Clinical Research Ethics Committee (Date: 16.10.2020, No: 25).

Peer Review: Externally peer-reviewed.

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