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Original Article

Efficacy of pectoralis nerve blocks I & II with liposomal bupivacaine in patients undergoing elective breast reduction procedures: A retrospective study ☆

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ABSTRACT

Background: The pectoral nerve (PECs) block I and II nerve blocks with liposomal bupivacaine (LB, Exparel) are used for postoperative analgesia in breast surgery, but evidence on efficacy for breast reduction is limited. We examined the effect of the PECS I and II blocks with LB on perioperative opioid use and pain scores compared to no block and blocks with plain local anesthetic (LA). We hypothesized that patients receiving a block with LB would require lower opioid amounts.

Methods: This retrospective cohort analysis included 120 patients undergoing breast reduction from 2011-2023. Patients received: no

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block, PECs block with plain LA, or PECs block with LB. Primary outcomes were intraoperative, Post-Anesthesia Care Unit (PACU), and outpatient opioid requirements. The secondary outcomes were PACU pain scores.

Results: Forty patients had no block, twenty-six received plain LA block, and fifty-four received LB block. For intraoperative opioids, LB block significantly lowered use compared to no block. PACU opioid use showed no differences between groups. For outpatient opioids, both LB and plain LA blocks significantly lowered use compared to no block. No significant pain score differences were found between groups.

Conclusions: Patients receiving the PECS block had decreased outpatient narcotic requirements compared to those patients who did not get the block. Patients receiving PECS block with LB had the further benefit of having decreased intraoperative narcotic requirements compared to the other groups. This highlights the potential benefit of performing the PECS block for patients undergoing breast reduction surgery.

Background

Breast reduction surgery, or reduction mammoplasty, is a common surgical procedure to reduce breast volume while maintaining nipple-areola viability, with over 43,000 procedures performed in the US in 2018.[1] Common indications include physical discomfort or back pain, limited mobility, poor posture, fungal infection, irritation, and body image or self-esteem.[2] This procedure exposes patients to a host of possible complications, including acute and chronic pain.[3,4]

The dawning of Enhanced Recovery After Surgery (ERAS) pathways has vastly improved the recovery of patients across all surgical subspecialties and has been applied to minimally invasive procedures.[5–8] A major component of ERAS pathways is the use of regional anesthesia.[9] The optimal regional technique, if any, has yet to be identified for breast reduction procedures. Recent studies have investigated nerve blocks with long-acting anesthetics without clear recommendations.[10]

The pectoralis I and II blocks (PECs block) are a regional anesthesia technique performed by using an ultrasound to place local anesthetic (LA) between the pectoralis major and minor muscles targeting the pectoral nerves.[11,12] The PECs I block blocks the medial pectoral nerve and lateral pectoral nerve through interfascial injection between the pectoralis major and pectoralis minor muscles.[11] The PECs II block is a modified PECs I block that additionally blocks the anterior cutaneous branches of intercostal nerves 3 to 6, the long thoracic nerve, and the intercostobrachial nerves through injection between the pectoralis minor and serratus anterior muscles.[13] First described by Blanco in 2011, PECs block is a widely used procedure for postoperative analgesia in breast surgery; however, evidence is limited on its efficacy for pain control with only a few small-scale single-center studies having been performed.[11,12]

Liposomal bupivacaine (LB) is a multivesicular liposomal formulation of 1.3% bupivacaine which can provide up to 72 hours of pain control when added to regional blocks or infiltrated in surgical wounds.[14,15] Compared to plain LA, LB consists of multivesicular liposomes of bupivacaine which provide drug stability and a longer duration of drug release.[16] It is unclear if the placement of LB in fascial plane blocks extends the duration of action of a peripheral nerve block.[17] A randomized study with thirty-six patients concluded that PECs blocks with LA do not seem to decrease perioperative narcotic requirements or pain scores when administered as a solitary adjunct, limited evidence exists

about how the addition of liposomal bupivacaine (LB) with this block affects postoperative pain in adult patients undergoing breast surgeries.[12,18]

The purpose of this study was to evaluate the effect of performing PECs blocks with LB for patients undergoing breast reduction procedures. The primary outcome of this study was perioperative opioid use. Secondary outcomes included the effect of these blocks on postoperative pain scores.

Methods

This study was approved by the Institutional Review Board of The Central Virginia Veterans Affairs (VA) Healthcare System (study number 1735604-5). The study was granted a waiver of informed consent. The study design was a retrospective cohort study of adult patients who underwent breast reduction procedures at The Central Virginia Healthcare System between January 2011 and February 2023.

Inclusion criteria included patients over the age of eighteen years, American Society of Anesthesiologist (ASA) physical status classification 1-4, patients that underwent breast reduction procedures, and patients receiving bilateral PECs blocks with or without LB. The study included patients seeking breast reductions, mastopexy, insertion of tissue expanders (if part of a mastectomy procedure), excision of gynecomastia, or breast augmentation, including procedures for macromastia, revision reductions, and oncologic purposes. Exclusion criteria included those patients not undergoing the above procedures, patients who received a nerve block other than the ones listed above, those who received a repeated nerve block post-operatively, those with ASA physical status classification 5-6, and those patients undergoing urgent or emergent surgery. We reviewed all possible cases that fit this criteria.

Data was extracted from hospital records. Patient sociodemographic characteristics included age, gender, ASA physical status classification, history of chronic pain and current opioid use, and past medical history to calculate the Charlson Comorbidity Index (CCI) score. These included a diagnosis of myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular accident, transient ischemic attack, hemiplegia, dementia, chronic obstructive pulmonary disease, connective tissue disease, peptic ulcer disease, liver disease, diabetes mellitus, chronic kidney disease, solid tumor, leukemia, lymphoma, and acquired immunodeficiency syndrome.

Medical and surgical information extracted included surgery type, regional block technique, medications used in regional block, intraoperative narcotics, intraoperative multimodal medications (acetaminophen, ketamine, ketorolac), post-anesthesia care unite (PACU) narcotics, postoperative pain scores in the PACU, use of multimodal medications post-operatively in the PACU (acetaminophen, gabapentin, ketorolac, ibuprofen), nausea or vomiting post-operatively in the PACU, and pain scores in the PACU. All narcotics were converted to oral morphine equivalents (mg). Pain assessments were made by nurses using the Defense and Veterans Pain Rating Scale (DVPRS).[19]

The nerve blocks were performed in the operating room once the patient was placed under general anesthesia. The ultrasound-guided PEC blocks were placed in the lateral and/or posterior approach at the discretion of the anesthesiologist. For LB, the administration followed the manufacturer's recommendations (Pacria Pharmaceuticals, Inc., Parsippany, NJ, USA). This included a mixture of 20mL (255mg) of LB, 0.25% Bupivacaine, and sterile saline. The volume of injectate varied by proceduralist. The practice of administering LB in PECs blocks is not yet approved by the FDA.

The primary outcome of this study was intraoperative opioid requirements, PACU opioid requirements, and opioids needed in the outpatient setting. Secondary outcomes were postoperative pain scores in the PACU.

Descriptive statistics were stratified by the three categories (no block, block with plain LA), and block with LB) for patient demographic (age, gender), clinical (ASA, CCI), use of multimodal medications post-operatively in the PACU, and outcomes (PACU OME, intraoperative OME, outpatient OME, and median OME score). Patients fit into one of the three categories per clinical practice protocols at the facility throughout this study, with patients toward the earlier period receiving no block, patients in the middle of the time frame receiving block with LA, and patients near the end of the time period receiving block with LB. Chi-square tests were used for categorical variables and ANOVA for continuous variables to examine differences by categories. We constructed four multivariate linear regression models for four outcomes (PACU OME, intraoperative OME, OP OME, and median pain core), adjusting

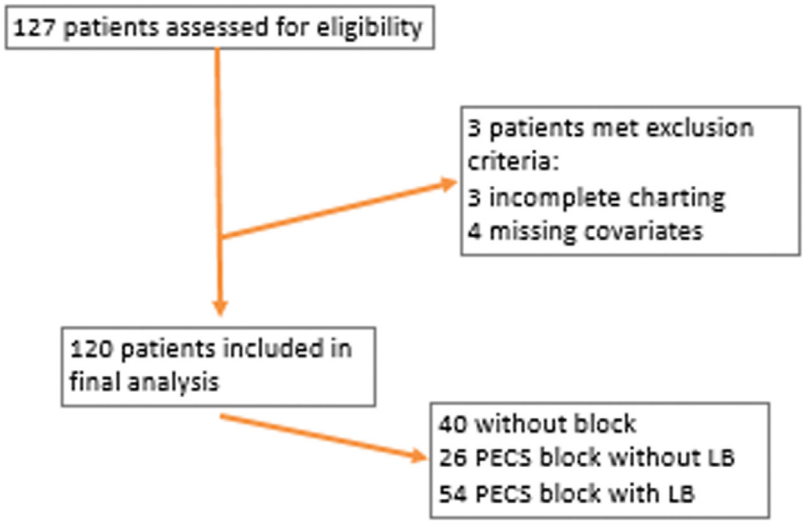

Figure 1. Diagram indicating the process of patient recruitment, with a breakdown of the number of patients at each step and in each final analysis group.

for the covariates and median pain scores (only for the three OME variables), with no block as the reference group for comparisons. Due to the non-availability of clinically meaningful cutoff values for the OME and pain variables, we maintained all those in a continuous data form. Therefore, we selected linear regression models for analysis, that would provide estimates associated with each of the treatment groups, relative to no block, while statistically controlling for the effect of the four covariates (age, ASA classification, CCI, and median pains core). The regression coefficients (β) are the estimates (with standard errors {SE}) representing changes in outcomes (for example, intraoperative OME) associated with every unit change in the primary variables of interest. A relative comparison between PECs block with LB to no block group; and between PECs block with plain LA to no block group. We predetermined the significance value of $p<0.05$ for all the analyses. All the statistical analyses were done using Python, and SAS 9.4 analytical programs.

Results

One hundred twenty-seven patients were assessed for eligibility, three patients had incomplete charting of required data, and four patients with missing data on covariates, 120 patients were included in the final analysis (Figure 1). Of those included, forty patients did not receive a block (33.1%), twenty-six received a block with plain LA (23.4%), and fifty-four received a block with LB (43.5%). There was no difference in the sociodemographic factors, including age, ASA classification, sex, and CCI (Table 1).

For intraoperative OME, relative to no block, we found a significant reduction in OME only for patients receiving the PECs block with LB (β=-19.9, SE=5.8, p=.0008), but not for patients receiving the PECs block with plain LA (β=-13.3, SE=7.0, p=.0589) (Table 2) (Figure 2). For PACU OME, no significant differences were found between the three groups (Table 2) (Figure 2). No significant differences were found in the median pain scores in PACU between the three groups. For OP OME, relative to no block, we found a significant reduction in OME for the block with LB (β=-563.6, SE=71.9, $p<0.001$), and for the block with plain LA (β=-343.5, SE=86.8, p=0.0001) (Table 2) (Figure 2).

Patients receiving the blocks with LB, however, received more intraoperative Tylenol (75.47%) than those not receiving a block (26.83%) and those receiving a block with plain LA (44.83, $p = <0.0001$) (Table 1). PACU Tylenol requirements were significantly higher in patients who received a block with plain LA (31.03%) compared to patients who did not receive a block (0.0%) and patients who received

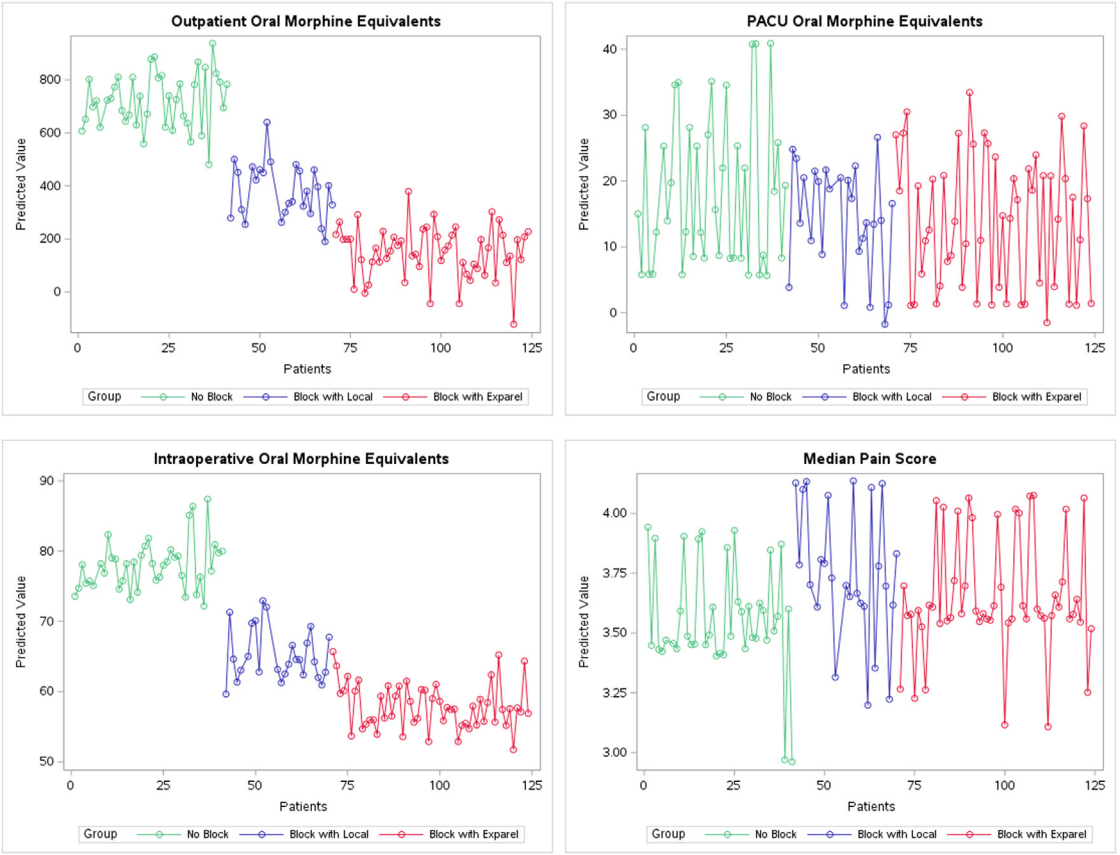

Figure 2. These graphs display the predicted oral morphine equivalent requirements in the perioperative period and PACU pain scores based on adjusted statistical models. Panel A: Outpatient OME. Panel B: PACU OME. Panel C: Intraoperative OME. Panel D: Median PACU Pain Scores.

Table 1
Patient Characteristics, Primary Outcomes, and Multimodal Use.

(i) Baseline Patient Characteristics					
Patient Characteristic	Overall N=124(100%)	No Block N=41(33.06%)	Block with Local N=29(23.4%)	Block with Exparel N=54(43.54%)	*P* value
Age (years)	45.9(11.3)	45.5(12.4)	47.7(11.35)	45.3(10.4)	0.6194
Female Gender	100%	100%	100%	100%	
American Society of Anesthesiologists Classification[a]					0.4359
1	6(4.96%)	2(4.88%)	2(7.69%)	2(3.7%)	
2	66(54.55%)	21(51.22%)	11(42.31%)	34(62.96%)	
3	49(40.50%)	18(43.9%)	13(50.00%)	18(33.33%)	
Charlson Comorbidity Index					0.2523
Mild (≤2)	95(76.61%)	32(78.05%)	19(65.62%)	44(81.48%)	
Moderate/High (>2)	29(23.39%)	9(21.95%)	10(34.48%)	10(18.52%)	
(ii) Primary Outcomes Following Procedure					
Post-Anesthesia Care Unit Oral Morphine Equivalents (mg)	15.7(16.3)	19.4(21.8)	13.9(13.9)	13.9(11.7)	0.2072
Outpatient Prescriptions Oral Morphine Equivalents (mg)	387.6(423.5)	714.0(558.8)	367.1(257.3)	150.8(75.6)	<0.0001
Intraoperative Narcotic Oral Morphine Equivalents (mg)	65.05(29.3)	77.6(31.7)	60.6(29.8)	57.9(23.9)	0.0028
Median Pain Score[a]	3.65(3.04)	3.56(3.51)	3.77(2.39)	3.64(3.02)	0.9601
(iii) Multimodal Use in Intraoperative and Postoperative Period					
Intraoperative Period					
Tylenol	64(52.03%)	11(26.83%)	13(44.83%)	40(75.47%)	<0.0001
Toradol	3(2.42%)	0(0%)	1(3.45%)	2(3.70%)	0.461
Ketamine	8(6.45%)	1(2.44%)	2(6.90%)	5(9.26%)	0.412
Postoperative Period					
Tylenol	12(9.68%)	0(0%)	9(31.03%)	3(5.56%)	<0.0001
Toradol	6(4.84%)	0(0%)	2(6.9%)	4(7.41%)	0.1346
Gabapentin	2(1.61%)	0(0%)	0(0%)	2(3.70%)	0.5043

[a] American Society of Anesthesiologists Classification and Median Pain Score had missing values in EMR.

a block with LB (5.56%, $p = <0.0001$) (Table 1). No other differences in multimodal analgesia use existed between the groups (Table 1).

Discussion

This retrospective study showed that the use of PECs blocks with plain local anesthetic and LB resulted in significantly lower outpatient opioid consumption compared to those who received no nerve block in patients undergoing breast reduction procedures. Patients with a PECs block with LB had lower intraoperative narcotic requirements as well. However, the PECs blocks did not affect the median pain scores in the PACU.

To our knowledge, this is one of the first studies to demonstrate a significant opioid-sparing effect from the utilization of PECs blocks in patients undergoing breast reduction procedures. It also provides some insight into the effect of the use of LB in PECs blocks for breast surgery. The blocks with LB were associated with lower intraoperative narcotic requirements and both block groups had a decreased outpatient requirement. This is interesting because it would be expected that the block group with plain LA would have immediate benefit and then not have the same long-term benefit as LB. This likely supports the idea that offering a PECs block to these patients is more important than whether or not LB is included.

Table 2
Regression Models.

	PACU OME	Intraoperative OME Unconditional Models	OP OME	Median Pain Score
Block with Exparel	-4.5(SE=3.3, p=0.1789)	-20.0(SE=5.7, p=0.0006)	-571.0(SE=73.4, $p \leq 0.0001$)	0.1(SE=0.6, p=0.8938)
Block with Local	-4.0(SE=4.0, p=0.3187)	-12.8(SE=6.9, p=0.0667)	-340.4(SE=88.7, p=0.0002)	0.2(SE=0.8, p=0.8087)
		Adjusted Models		
Block with Exparel	-4.5(SE=2.6, p=0.0889)	-19.9(SE=5.8, p=0.0008)	-563.6(SE=71.9, $p \leq 0.0001$)	0.1(SE=0.6, p=0.8546)
Block with Local	-4.7(SE=3.2, p=0.1424)	-13.3(SE=7.0, p=0.0589)	-343.5(SE=86.8, p=0.0001)	0.2(SE=0.8, p=0.7972)
Age	0.0(SE=0.1, p=0.9548)	-0.1(SE=0.2, p=0.6395)	-7.8(SE=3.0, p=0.0118)	0.0(SE=0.0, p=0.9205)
ASA Classification	2.8(SE=2.2, p=0.2059)	-0.5(SE=4.9, p=0.9234)	55.9(SE=60.4, p=0.3572)	0.4(SE=0.5, p=0.4116)
CCI (Mod/High)	-0.2(SE=3.2, p=0.954)	7.5(SE=6.9, p=0.2833)	119.3(SE=86.1, p=0.1685)	-0.3(SE=0.8, p=0.6597)
Median Pain Score	3.3(SE=0.4, $p \leq 0.0001$)	0.6(SE=0.8, p=0.4445)	15.7(SE=10.4, p=0.132)	(–)

Given the observed differences between plain LA and LB in terms of opioid requirement and pain control, it is important to better understand the difference between these two approaches. Our findings add evidence to the growing applications of PECs blocks and LB. There is a lack of data regarding the efficacy of PECs blocks in breast reduction procedures and we hope that our results will help other clinicians make decisions for their patients.

The use of regional anesthesia techniques, including pectoral nerve (PECs) blocks, has been utilized in a variety of breast procedures outside of breast reduction surgery, including augmentation, mastectomy, and reconstructive surgeries. Studies have consistently highlighted the efficacy of PECs blocks in decreasing perioperative opioid consumption and improving pain scores in these procedures. A meta-analysis by Meißner et al. highlighted the efficacy of PECs blocks in breast surgeries in reducing postoperative pain intensity, demonstrating their applicability in various procedures.[20] Similarly, Aarab et al. demonstrated improved postoperative pain management and patient satisfaction with the incorporation of PECS blocks in patients undergoing breast augmentation while Periera et al. demonstrated the same postoperative pain management advantage in breast reduction procedures in adolescent patients.[21,22] Schwemmer further underscores the reduction in systemic analgesic requirements and associated side effects with PECs blocks in breast surgery.[23] Lastly, Calì Cassi, et al. reviewed the broader benefits of PECs blocks and suggested that their implementation into multimodal analgesia protocols could improve patient recovery and outcomes for various breast procedures.[24] These studies and findings highlight the growing role of PECs blocks in breast surgery and underscore their potential for wider application.

While this study provides valuable insights, this study has several limitations that should be considered when interpreting the results. First, the retrospective, observational design introduces potential biases, including selection bias and information bias. The lack of randomization means that unmeasured confounders may have influenced some of the differences between the groups and resulting opioid usage and pain scores. For example, proceduralist preferences (volume of block injectate) and postoperative care protocols over the study period could not be controlled, potentially affecting the results.

Next, the introduction of PECs blocks in our anesthesia practice coincided with a shift in clinical practice minimizing opioid prescriptions, which might have influenced opioid administration and consumption patterns independently of the block's effect. This is evidenced by the higher intraoperative administration of Tylenol in patients receiving PECs blocks compared to those not receiving any blocks.

Moreover, the small sample size further limits the statistical power and generalizability of this study. Although efforts were made to adjust for confounding factors, the power to detect significant differences was limited. Additionally, the study population was drawn from a single healthcare system, potentially limiting the external validity of the findings to other settings or populations.

Finally, it is important to acknowledge the higher cost of LB compared to plain LA. The exact cost of the drugs varies significantly across different healthcare systems, with the VA pricing being independent from private and academic institutions.

While this study provides valuable insights, addressing these limitations in future studies is essential for substantiating the clinical benefits of PECs blocks with LB and informing best practices in pain management during breast reduction procedures. Prospective, multicentered, randomized controlled trials are necessary to elucidate an association between the block and immediate postoperative outcomes including pain scores, narcotic requirements, and patient satisfaction. Furthermore, incorporating the examination of long-term outcomes related to chronic pain and recovery time could provide a more comprehensive understanding of PECs blocks with LB. Moreover, future studies comparing clinical outcomes with a cost-benefit analysis would further clarify its broader applicability.

Conclusion

Patients receiving the PECs block had decreased outpatient narcotic requirements compared to those patients who did not get the block. Patients receiving PECs block with LB had the further benefit of having decreased intraoperative narcotic requirements compared to the other groups. This highlights the potential benefit of performing the PECs block for patients undergoing breast reduction surgery. While promising, further high-quality randomized studies are warranted to confirm the opioid-sparing advantages and utility of this regional anesthesia technique utilizing extended-release LB in the pain management of breast reduction procedures.

Declaration of Competing Interest

None.

Disclosures

All authors have nothing to disclose.

Ethics Approval

This study was approved by the Institutional Review Board of The Central Virginia Veterans Affairs (VA) Healthcare System (study number 1735604-5).

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