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Preoperative Thoracic Paravertebral Blocks Reduce Opioid Exposure in Patients Undergoing Reduction Mammoplasty

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Abstract

Background: Thoracic paravertebral blocks have been shown in mastectomy to decrease pain and aid in early discharge; however, the use of this technique has not been explored in outpatient procedures such as Breast Reduction Mammoplasty (BRM). We seek to determine the effects of thoracic paravertebral blocks on pain and opioid consumption in patients undergoing BRM.

Methods: A retrospective review of all patients that underwent BRM by a single surgeon between 2016 and 2020 was conducted. Patients were divided into two cohorts: Those who received preoperative bilateral paravertebral blocks in addition to general anesthesia, and those who underwent general anesthesia alone. The primary outcome measure was opioid consumption measured in Morphine Milligram Equivalents (MME).

Results: One hundred and thirty-one patients were included for analysis (block n=58, no block n=73). Median intraoperative opioid consumption was significantly lower in patients that received paravertebral blocks as compared to controls (45.0 vs. 70.0 MME, p<0.001). On multivariable analysis, having received a paravertebral block was associated with a 19.3 MME (95% CI: 6.7-32.0, p<0.01) reduction in intraoperative opioid dose independent of hypertensive status. In the immediate postoperative period, there was no significant difference in opioid consumption between groups, however a significantly higher proportion of patients without blocks received non-opioid analgesics for pain management as compared to those that received blocks (56.2 vs. 27.6%, p=0.001). Patient-reported pain scores did not significantly differ between groups.

Conclusion: The use of preoperative paravertebral blocks in concert with postoperative non-opioid analgesia reduces overall opioid and non-opioid analgesic exposure after BRM.

Keywords: Opioid; Paravertebral; Block; Breast; Mammoplasty; BRM

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Introduction

The opioid epidemic has been linked to increased use of prescription opioid drugs in the United States and Canada starting in the late 1990's [1]. This crisis is partially due to an increase in opioid prescription practices, which has been significantly influenced by directed pharmaceutical advertising [2]. The medical community has acknowledged this emergency and taken substantial steps to tackle the misuse of opioids in the setting of chronic pain [3]. However, recent evidence demonstrates that excessive opioid use related to pain in the acute postoperative period setting is linked to eventual opioid addiction [4,5].

Although many specialties have taken steps to recognize and measure the impact of the opioid epidemic on their patients, the plastic surgery community has lingered in this aspect of patient care [3]. Since patients are recovering at home, assessing pain and obtaining adequate pain control can be difficult. Bilateral breast reduction mammoplasty is one of the most common surgical procedures performed in an ambulatory setting: According to the American Society of Plastic Surgeons, a total of 43,591 breast reduction mammoplasties and 109,638 mastopexies were performed in 2018 alone [6]. Furthermore, these procedures are associated with considerable early postoperative pain, sometimes leading to chronic pain up to one year later [7]. As a result, opioids had previously been used to mitigate pain; however given the potential for abuse, alternate modalities are now being utilized to improve pain control while limiting the use of opioids.

Recent studies have demonstrated the efficacy of thoracic paravertebral blocks for analgesia as an adjunct to general anesthesia in patients undergoing mastectomy and thoracic operations

[8,9]. The thoracic paravertebral block has offered several advantages to patients, including improved postoperative pain control, lower opioid consumption and postoperative nausea and vomiting, shorter hospital stay, and improved quality of recovery [10]. Multiple studies have demonstrated that same-day, outpatient breast operations done with a paravertebral thoracic block were successful in providing excellent pain control to patients in the perioperative setting [11,12]. Despite the evidence of improved analgesia and decreased opioid use using the thoracic paravertebral block in oncologic surgery, there is a paucity of literature on the advantages of this block, particularly for patients undergoing reduction mammoplasty. The purpose of this study was to determine the effects of preoperative bilateral thoracic paravertebral blocks on post-operative analgesia of patients undergoing bilateral reduction mammoplasty in the ambulatory setting.

Methods

Study population

After approval was obtained from the institutional review board, a retrospective review of all patients who underwent elective bilateral reduction mammoplasty at Montefiore Medical Center by senior author (K.E.W.) between January 2016 and March 2020 was performed. Patients were divided into two cohorts: Patients undergoing general anesthesia (control) and patients who received preoperative ultrasound-guided bilateral thoracic paravertebral blocks in addition to general anesthesia. Paravertebral blocks were performed in a random sample of patients, but patients were not randomized, based on numerous factors including: Lack of delay of procedure into the OR, surgeon agreement with timing of procedure, and anesthesiology availability for the procedure. Patient specific concerns did not play into decision making. Patients were then analyzed based on demographic information including age, medical co-morbidities, Body Mass Index (BMI), American Society of Anesthesiologists (ASA) physical status, smoking status, resection weight (grams), and length of surgery (minutes). Outcome measures included: Intraoperative opiate requirements (morphine equivalents), rescue analgesic consumption in recovery (morphine equivalents), non-opioid pain medications in recovery, pain rating score in the recovery room, time to discharge from recovery, and any postoperative complications, including hematoma, seroma, soft tissue infection, nipple necrosis, and wound dehiscence. Additionally, cost of preoperative paravertebral block was obtained. Patients were included for analysis if they had all data fields necessary for analysis and were above the age of 17. Patients were excluded from analysis if they underwent oncoplastic reduction, an alternative regional block such as erector spinae plane block, retrospinal block, or pectoralis block, or combined procedures such as liposuction to the breast, or if they had missing data points. This manuscript adheres to the applicable STROBE guidelines.

Pre-operative intervention

Patients who underwent preoperative paravertebral block provided written informed consent by board-certified anesthesiologists in the preoperative holding area. Spinous processes were identified from C7-T7 with the patient in the sitting position. After appropriate skin disinfection, a high-frequency linear ultrasound probe (SonoSite S-Nerve HFL38 13 MHz to 6 MHz probe) was placed approximately 2 cm lateral to the spinous processes to identify consecutive transverse processes and the pleura in between. Bilateral single-injection thoracic paravertebral blocks were then performed at the T4 to T5 levels to block the dermatomes between T2 to T6 using a 21-gauge, 10-cm insulated stimulating needle (StimuQuik Insulated Peripheral Nerve Block 21-gauge Needle). 0.25% Ropivacaine with or without added dexamethasone (based on anesthesia physician preference) was injected into the paravertebral space after negative aspiration.

Intra-operative general anesthesia

Data regarding the concentration and amount of various anesthetic agents were reviewed and converted to morphine equivalents [13]. General anesthesia was induced with propofol (2 mg/kg to 3 mg/kg) and rocuronium (0.6 mg/kg) in both groups. Prophylactic ondansetron (4 mg to 8 mg) and cefazolin (1 g to 2 g based on weight) were injected intravenously prior to procedure start. Intraoperative boluses of fentanyl (50 μg) were administered intravenously if the heart rate and/or mean arterial pressure increased greater than 20 percent above pre-induction values. Ephedrine (5 mg) was also administered intravenously if the heart rate was less than 50 beats/min or mean arterial pressure decreased greater than 20 percent below pre-induction value. Duration of surgery was defined as the period between the induction of anesthesia and extubation. The duration of recovery time was defined as the period between extubation and discharge from the recovery room. Postoperative numeric patient-reported pain scores based on the Visual Analogue Scale (V.A.S.), a 10-cm visual scale defined from 0 as no pain to 10 as worst pain imaginable, from two times points in the recovery room (initial and just prior to discharge) were determined.

Statistical analysis

Statistical analyses were performed using STATA software, version 16.0 (StataCorp LP, College Station, Texas). Patients were divided into two groups for analyses: Patients who received paravertebral blocks preoperatively and those who did not. Bivariate analyses were computed using Chi-square or Fischer's exact test for categorical variables, and Mann-Whitney test for continuous variables. Multivariable linear regression was performed to evaluate the association between paravertebral block and the outcome of intraoperative opioid administration while adjusting for potential confounders. Variables evaluated for inclusion in the model were those associated with either intraoperative opioid administration or block status (as determined by a p value cutoff of 0.20). Variables of interest were entered into the model in a backward stepping manner, and only those that were noted to confound the relationship between block status and the outcome (altering the regression coefficient by 15% or greater) or those that were independently associated with the outcome were included in the final model. All test assumptions were assessed, and violations of test assumptions were appropriately addressed. Alpha was set at the 0.05 level.

Results

Demographics

A total of 131 breast reductions were included for analysis, 73 (55.7%) in the control group and 58 (44.3%) in the block group. Neither median BMI (33.4 [IQR: 29.0-36.0] *vs.* 32.0 [IQR: 28.0-35.3] kg/m^2; p=0.18) nor reduction weight (671 [IQR: 470-982] *vs.* 652 [IQR: 482-1040] g; p>0.99) were significantly different between control versus block groups, respectively (Table 1). Patients in both block and control groups had a similar prevalence of comorbidities, including hypertension, diabetes, anxiety, and depression. Thirty-four patients (26.0%) were American Society of Anesthesiologists (ASA) class 1, 85 (64.9%) were ASA class 2, and 12 (9.2%) were ASA

Table 1: Patient baseline characteristics.

	Total (n=131)	Control (n=73)	Block (n=58)	p-value
Age (years)	34 (25–49)	37 (26–51)	32 (24–44)	0.09
Body Mass Index (Kg/m²)	32.4 (28.3–35.9)	33.4 (29.0–36.0)	32.0 (28.0–35.3)	0.18
Reduction Weight (grams)	656 (475–999)	671 (470-982)	652 (482-1040)	>0.99
Comorbidities				
Hypertension	19 (14.5)	10 (13.7)	9 (15.2)	0.77
Diabetes mellitus	9 (6.9)	7 (9.6)	2 (3.5)	0.3
Anxiety	2 (1.5)	1 (1.4)	1 (1.7)	>0.99
Depression	3 (2.3)	0 (0.0)	3 (5.2)	0.08

Table 2: Outcomes.

	Total (n=131)	No Block (n=73)	Block (n=58)	p-value
Intraoperative MME*	60.0 (35.0–75.0)	70.0 (50.0–95.0)	45.0 (28.0–600.0)	<0.001
Postop rescue MME	15.5 (7.5–25.0)	15.0 (7.5–25.0)	20.8 (10.0–25.0)	0.35
Initial PACU post-op pain	6 (4–8)	7(4–8)	6 (0–8)	0.23
Final PACU post-op pain	3 (1–5)	3 (2–4)	3 (1–5)	0.72
Non-opioid rescue pain medication in PACU	57 (43.5)	41 (56.2)	16 (27.6)	0.001
Length of Operation (minutes)	179 (165–200)	188 (167–205)	176 (163–187)	0.02
Time to discharge, minutes	282 (196–369)	309 (197–398)	252 (184–320)	0.02

*Morphine milligram equivalents (MME); Post Anesthesia Care Unit (PACU)

Table 3: Multivariable linear regression analysis for intraoperative opioid administration in MME.

	Regression coefficient (95% CI)	P value
Block (ref: no block)	-19.3 (-32.0– -6.7)	<0.01
Hypertension (ref: no hypertension)	-25.3 (-43.2– -7.4)	<0.01

R2=0.12; n=131; MME: Morphine Milligram Equivalents

class 3. Of note, no patients had a history of chronic pain conditions or pre-operative narcotic use.

Outcomes

As compared to the control group, which received a median intraoperative opioid dose of 70.0 (IQR: 50.0-95.0) MME, the block group received a significantly lower dose of opioids (45.0 [IQR: 28.0-60.0] MME, p<0.001) (Table 2). However, a significant difference in median opioid dose administered during the immediate postoperative period was not observed between control (15.0 [IQR: 7.5-25.0] MME) and block (20.8 [IQR: 10.0-25.0] MME, p=0.35) groups. The amount of patients that received non-opioid rescue pain medication immediately postoperatively was significantly less in the block group (16 [27.6%]) as compared to the control group (41 [56.2%], p=0.001). Intraoperative opioid dose was regressed on block status while adjusting for history of hypertension (R2=0.12) (Table 3). Having received a thoracic paravertebral block was associated with a 19.3 (95% CI: 6.7-32.0, p<0.01) MME reduction in intraoperative opioid dose independent of hypertensive status. Of note, a history of hypertension was associated with a 25.3 (95% CI: 7.4-43.2, p<0.01) MME reduction in intraoperative opioid dose.

Initial patient-reported postoperative pain scores did not significantly differ between control and block groups, with patients in the control group reporting a median pain score of 7 (IQR: 4-8) and those in the block group reporting a median pain score of 6 (IQR: 0-8, p=0.23) (Table 2). Final postoperative pain scores were also not significantly different between control and block groups, with patients in the control group reporting a median pain score of 3 (IQR: 2-4) and those in the block group reporting a median pain score of 3 (IQR: 1-5, p=0.72).

Total operative time, defined as the period between induction and extubation, was significantly shorter for patients in the block group (176 [IQR: 163-187] min) as compared to the control group (188 [IQR: 167-205] min, p=0.02) (Table 2). Additionally, time to discharge was significantly decreased for patients in the block group (252 [IQR: 184-320] min) as compared to patients in the control group (309 [IQR: 197-398] min, p=0.02). Given that the total unit cost of a patient remaining in a recovery room at our institution is $132.66 every 30 min, there was a median cost savings of $252.05 per patient who received a block. The estimated cost of a thoracic paravertebral block at our institution is $215.64, which yielded a net cost-savings of $36.41 in patients who received a paravertebral block compared to those who did not. Of note, all patients except one were discharged from the surgical center on the day of operation.

Complications

Twenty five patients (19.1%) experienced post-operative complications, the majority of which were managed on an outpatient basis. These include eight cases (6.1%) of wound breakdown requiring local wound care, ten cases (7.6%) of hypertrophic scarring requiring intralesional steroid injections or scar revision, four cases (3.1%) of hematomas requiring re-exploration and drainage (two of which were in the control group and two in the block group), one case (0.8%) of cellulitis managed with oral antibiotics, one case (0.8%) of breast abscess requiring drainage and antibiotics, and one case (0.8%) of seroma requiring drainage and antibiotics.

Discussion

Breast reduction mammoplasty is a common procedure conducted by plastic surgeons not only at our institution but also nationwide. To improve postoperative pain control and reduce opiate consumption, a bilateral thoracic paravertebral block was administered pre-operatively. Patients who received the block pre-

operatively were found to have a significantly decreased requirement for opiates during their operation as well as shorter operative times equating to less exposure to general anesthesia. In addition to decreased opiate consumption intraoperatively, patients who had received a block were found to have similar levels of postoperative pain upon arrival to the recovery room as well as upon discharge to home compared to those who had not.

The thoracic paravertebral block has previously been shown to be effective in decreasing opiate use and reducing pain in a variety of settings. Salviz et al. [10] had shown that patients who had received a thoracic paravertebral block demonstrated decreased intraoperative mean arterial pressure values and intraoperative heart values, thus decreasing the need for intraoperative opiates in the setting of reduction mammoplasty. In the setting of breast cancer surgery, Pei et al. had shown that use of the block also decreased intraoperative fentanyl requirements, and decreased postoperative pain based on a visual analog scale score [14]. Of note, we did find thoracic paravertebral block to be associated with decreased intraoperative opioid administration independent of hypertensive status. This association is crucial to recognize given the phenomenon of hypertension-associated hypoalgesia, which poses as a potential confounder in our sample. Briefly, patients with a history of hypertension have demonstrated a decreased sensitivity to acute pain [15]. Although incompletely understood, the mechanism likely involves an increase in endogenous opioids in those with elevated blood pressure, as well as a baroreceptor-mediated activation of descending inhibitory pain pathways [16,17]. An alternative explanation for the observed decrease in intraoperative opioids administered to hypertensive patients is that these patients are likely to be taking antihypertensive medication. Given that an increase in intraoperative blood pressure greater than 20% of baseline was criteria for the anesthesiologist to administer an opioid bolus, and that patients taking antihypertensive medication may be more resistant to intraoperative increases in blood pressure, these patients may have received less intraoperative opioids for this reason. Regardless of the etiology, it is imperative that the association between block status and intraoperative opioid administration be adjusted for a history of hypertension.

Interestingly, we noted that patients who had received the paravertebral block had a shorter operative time compared to those who underwent general anesthesia alone. While statistically significant the difference was only 12 min, which was unlikely to be clinically different or significant. Additionally, the increase in surgery length by 12 min is unlikely to have affected the increased administration of morphine equivalents. However, insufficient data with regards to the hemodynamic factors throughout the duration of the case were and would certainly be of further use to determine if these blocks do enhance surgical anesthesia.

Although both groups of patients required similar levels of postoperative rescue opiates, a greater proportion of patients who did not receive the block required non-opiate rescue pain medications, most commonly ibuprofen or acetaminophen, prior to discharge to achieve that same level of pain control. Our findings are consistent with prior investigations which have demonstrated that multimodal analgesia, including the use of non-opiate analgesics, can effectively decrease post-anesthesia care unit narcotic use [12]. Barker et al. [12] had shown that preoperative use of multimodal analgesia, including acetaminophen, gabapentin, and celecoxib, were all effective in reducing postoperative pain in patients undergoing ambulatory breast surgery. Additionally, multimodal analgesia for postsurgical pain management is a critical component of ERAS, with multiple societies and governmental organizations endorsing evidence-based guidelines supporting the use of multimodal analgesia to manage post-surgical pain [18]. Given these findings, we plan to encourage administration of postoperative non-narcotic rescue medications prior to administration of narcotic rescue medications to diminish overall exposure.

Among the 19.1% of patients who experienced a post-operative complication, ranging from breast hematoma requiring drainage to wound breakdown managed by local wound care, there were no significant differences in prevalence between the control and block groups. Of particular importance was the rate of hematoma, as all four patients complicated by hematoma required a return to the operating room for evacuation however two (or 50% of all hematomas) patients received a block and two patients did not. Furthermore, the rate of hematoma in our sample was nearly identical to the overall 3.2% hematoma risk with breast reduction demonstrated by Nguyen et al. [19], so it was unlikely that thoracic paravertebral blocks conferred any additional risk of hematoma.

We calculated a net cost-savings of $36.41 in patients who received a paravertebral block compared to those who did not. A variety of studies in different specialties have demonstrated that regional blocks accelerate discharge and are cost effective [20]. It is unclear at this time the exact etiology of shorter time to discharge in block patients when post-operative pain scores did not significantly differ between groups such as post-operative nausea, time to regain baseline ambulation, or voiding time; however, this is a subject of further investigation worth clarifying. In an era of increasing healthcare costs, the inclusion of pre-operative blocks does appear to correlate not only with a reduction in the consumption of opiates, but also appears to be, at minimum, cost neutral and without a substantial change in management or an increased prevalence of complications.

The present study was not without limitations. The study was a retrospective review and both patients and providers were not blinded or formally randomized to determine whether who would receive a block. Although we did not identify any significant differences in preoperative factors between block and control groups, the lack of randomization incurs a potential selection bias driven by latent confounders. The lack of standardization among different anesthesiology providers may further confound our results given difference in choice of medications, including if dexamethasone was added to Ropivacaine during block and whether opioid or non-opioid medications were given both intra-operatively and post-operatively, as well as variations in determining factors for administration. Additionally, the medication regimen that was given to patients in the recovery room was not pre-determined, but rather given at the discretion of the nursing staff based on subjective patient responses to pain score and the doses administered were provider-dependent. Given the retrospective nature of this review, we were also limited in the data that could be collected. For example, we were unable to track post-discharge opioid consumption including agent, strength, and ultimate patient usage, which could be valuable in evaluating the efficacy of the paravertebral block in reducing opiate consumption in the long-term postoperative period. However, we are currently in the process of prospectively investigating a regimen which includes the use of the paravertebral block in conjunction with a non-opiate multimodal pain regimen to ultimately reduce intraoperative

opiate exposure and eliminate the use of opiates postoperatively with a longer follow-up period. Furthermore, we are interested in investigating the use of paravertebral blocks in reducing the number of patients requiring general anesthesia.

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