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Paravertebral Blocks Reduce Narcotic Use without Affecting Perfusion in Patients Undergoing Autologous Breast Reconstruction

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Abstract

Background: Autologous breast reconstruction offers excellent long term outcomes after mastectomy. However maintaining adequate post-operative analgesia remains challenging. Use of paravertebral blocks (PVBs) reduces postoperative narcotic use and length of stay, and enhanced recovery protocols with mixed analgesia methods are gaining popularity, but few studies have explored the intraoperative effects of these interventions.

Methods: Patients who underwent abdominally-based autologous breast reconstruction between 2010 and 2016 were compiled into a retrospective database. We used electronic medical records to determine demographics as well as perioperative and intraoperative vital signs and narcotic, anxiolytic, crystalloid, colloid, blood product, and vasopressor requirements, and postoperative complications. Results were compared between patients who had a PVB and those who did not, and those who had a PVB alone and those who followed our enhanced recovery protocol using standard statistical methods and adjusting for preoperative values.

Results: 170 patients were included in the study. Sixty-six had a PVB, and 104 did not. Of the 66 who had a PVB, 19 followed our enhanced recovery protocol. Patients who did not have a PVB required 171.6mg of total narcotic medication in the perioperative period, those with a PVB alone required 146.9mg, and those who followed the ERAS protocol 95.2mg ($p=0.01$). There was no difference in intraoperative mean arterial pressure, time with mean arterial pressure $<80\%$ of baseline, vasopressor use, or fluid requirement. There was no difference in complication rate.

Conclusions: PVBs and an enhanced recovery protocol reduce the use of narcotic medications in autologous breast reconstruction without impacting intraoperative hemodynamics.

Background

Breast reconstruction after mastectomy restores body image and improves health-related quality of life, satisfaction with appearance and physical, psychosocial, and sexual well-

being.¹⁻³ For patients pursuing breast reconstruction, there are two major options: prosthetic (tissue expander/implant) or autologous reconstruction. However, while providing exceptional long-term outcomes, postoperative pain and length of hospital stay remains a major challenge preventing more widespread adoption of autologous breast reconstruction.⁴⁻⁷ Acute postoperative pain contributes to prolonged hospital stays, increased narcotic use, and associated risks of the aforementioned.

Opioids are associated with increased nausea and vomiting, central nervous system depression, urinary retention, constipation, and pruritus among other effects. Over half of the 44,000 deaths due to drug overdoses (51.8%) were related to prescription drugs, the majority being opioid medications.⁸ Strategies to minimize the use of these medications are key to increasing patient satisfaction, shortening hospitalizations, and decreasing complication rates.^{9,10}

Regional anesthesia, namely the paravertebral block (PVB), has been proven to be an effective technique at reducing acute and chronic postoperative pain, intravenous narcotic use, and hospital length of stay for patients undergoing all types of surgery.¹⁰⁻¹⁵ In other studies, PVBs and other local and regional anesthesia techniques have been shown to give superior analgesia with less narcotic use and thereby fewer side effects in the postoperative period.^{16,17} The effect of PVBs on intraoperative narcotic requirements, fluid requirements, and hemodynamics in patients undergoing autologous breast reconstruction is unknown. Hemodynamic stability in patients undergoing autologous breast reconstruction is critical, as flaps depend greatly on consistent perfusion throughout their dissection and anastomosis of vessels. Both fluid under- and over-resuscitation have been linked to increased flap failure rates.^{18,19}

Thoracic PVBs typically are administered in the wedge-shaped space between the transverse processes of spinal column and provide analgesia to the intercostal nerves and sympathetic chain surrounding the level targeted.²⁰ While some studies have cited an increased vasopressor requirement to treat intraoperative hypotension,⁹ not all studies evaluating the effects of PVBs have found differences in hemodynamics when compared with general anesthesia alone.²¹

Furthermore, enhanced recovery after surgery (ERAS) protocols in autologous breast reconstruction are gaining acceptance and have been shown to decrease length of stay and narcotic use.^{22,23} The ERAS protocol at our institution includes preoperative medications - including OxyContin, gabapentin, celecoxib, and acetaminophen. The effect of this combination of medications on intraoperative hemodynamics, and fluid and medication requirements is unknown.

The goal of this study is to explore the effect of the paravertebral block and preoperative medications used in our ERAS pathway on intraoperative blood pressure, fluid requirements, and narcotic requirements. We hypothesize that use of a PVB lowers narcotic and anesthetic gas use, but may lead to a decrease in average MAP during the procedure, which could have an effect on flap survival and outcomes.

Methods

After approval from the Institutional Review Board (#201610048), we compiled data from all patients who underwent abdominally based autologous breast reconstruction by the senior author (TMM) between the years of 2010 and 2016. Patients were ineligible if they underwent prior prosthetic breast reconstruction, a non-breast procedure at time of reconstruction, non-abdominally based microvascular reconstruction, or pedicled, non-microvascular, autologous reconstruction (e.g., latissimus dorsi flap or pedicled TRAM flap).

From the electronic medical record, we collected basic demographic and surgical data, including age, baseline narcotic and benzodiazepine use (mg used per day as an outpatient), date of surgery, ASA class, flap type, laterality, and preoperative PVB and/or inclusion in the ERAS protocol that was developed and implemented in October 2015 (Appendix 1). We then queried the Metavision anesthesia tracking system to obtain preoperative variables and intraoperative variables. Fellowship-trained regional anesthesiologists gave all blocks in the pre-operative holding area prior to general anesthesia, and included all patients who were a) willing to undergo PVB and b) were physically able to undergo PVB. We followed appropriate standards per ASA recommendations with supplemental oxygen and cardiovascular monitoring and adhered to sterile technique throughout the procedure. Under ultrasound guidance (Sonosite S-nerve), a 20- or 21- gauge needle was used to deliver 15-20 mL of 0.5% bupivacaine (per side) at the T2-4 paravertebral space(s). Patients were positioned in the sitting position for the paravertebral block with the para-sagittal technique.

In 2015, we initiated an ERAS protocol and all patients eligible for a PVB and without allergies to the agents in Appendix 1 were also eligible for this protocol. Patients on the ERAS protocol were given either 30 mL of bupivacaine or 30mL of liposomal bupivacaine to the abdominal wall via transversus abdominal plane (TAP) block immediately prior to closure of the abdominal donor incision and conclusion of the operation. All procedures were done under general anesthesia with sevoflurane and desflurane as the primary agents.

Preoperative heart rate and blood pressure are an average of the first two readings upon arrival to pre-operative holding. Intraoperative heart rate, blood pressure, and MAC were an average of all values from induction to anesthesia emergence. To further characterize the degree of hypotension, and maximize our sensitivity to detect a difference, an area under the curve (AUC) analysis was also performed.

Summary statistics were generated using established methods, 2-sided Student's T-testing and Fisher Exact testing, and are reported in Table 1 as mean $\pm$ standard deviation or number (percent) for continuous and categorical variables, respectively. Analysis of covariance (ANCOVA) was used to adjust intraoperative heart rate, systolic blood pressure (SBP), diastolic blood pressure (DBP), and MAP for preoperative values. A similar method was used to adjust for baseline narcotic and benzodiazepine use. All results are reported with this adjustment. Intraoperative and post-operative narcotic and benzodiazepine use were not adjusted for antecedent doses due to their short duration of activity. All narcotics given were converted to IV morphine equivalents, and all benzodiazepines given to IV midazolam. All

statistics were performed in SAS 9.4 (Cary, NC). Two-sided alpha <0.05 indicated significance in all tests.

Results

A total of 170 patients were included in the study. There were no patients excluded. Sixty-six had a PVB preoperatively, and 104 did not. Demographic and surgical variables are included in Table 1.

Effects of the PVB

When comparing patients who had a PVB and those who did not, there were no differences in age, weight, preoperative vital signs, preoperative narcotic use, or proportion of patients undergoing immediate or delayed reconstruction. Those who received a PVB did receive more preoperative crystalloid fluid than those who did not (403.4 cc vs 286.5 cc, $p<0.001$), Table 1. There were no differences in intraoperative vital signs either prior to or after adjusting for preoperative vital signs, the number of minutes or area under the curve MAP was less than 65mmHg, the AUC or time MAP was less than 80% of baseline, nor total crystalloid fluid given. Those who did not have a PVB did receive more colloid fluids (Table 2). Overall, 30 (43.5%) patients who got a PVB and 39 (56.2%) who did not receive PVB required pressors ($p=0.34$). Of these patients, there was no difference in number of doses of pressor medication given.

In terms of medication use, patients who had a paravertebral block received preoperative narcotic and anxiolytic before their block placement, and therefore were given more preoperative medication than those who did not receive a block (Table 2). While there was no difference in intraoperative or post-operative narcotic use, those who received a PVB did use less narcotic medication than those who did not after adjusting for baseline narcotic usage (132.6 mg vs 171.6 mg, $p<0.01$). Again patients receiving a PVB did receive more benzodiazepines in total than those who did not, including after adjusting for baseline use (5.8 mg vs 4.0 mg, $p<0.01$).

Effects of the ERAS protocol

Of the 66 patients who had a PVB, 19 followed the ERAS protocol and also received preoperative OxyContin, gabapentin, acetaminophen, and celecoxib preoperatively, as well as intraoperative dexamethasone and ondansetron. Demographics and surgical variables are included in Table 3. In this subgroup, there was no difference in age, weight, preoperative heart rate or fluids, or type or timing of flap reconstruction. There was a significant difference in preoperative MAP (82.8 mmHg PVB only group vs 90.9 mmHg ERAS group, $p=0.01$) and SBP (117.7 mmHg PVB only group vs 131.6 mmHg ERAS group, $p=0.01$) and therefore intraoperative values were adjusted for these preoperative differences as shown in Table 4.

We found that there were no differences in most adjusted intraoperative vital signs, nor in time spent in the OR with MAP < 65 mmHg or <80% of baseline. However, patients following the ERAS protocol did have significantly less AUC (the integral of minutes <80% of baseline and the degree of hypotension), indicating that since they started with a lower

MAP than their non-ERAS counterparts, they also had less deviation from their baseline blood pressure during their surgery, despite spending similar time with MAP <65 mmHg. ERAS patients also had a significantly lower average MAC than those with a PVB alone. There were no differences in the amount of fluid administered, the percentage of patients requiring blood products or pressors, nor the number of pressor doses given (Table 4).

In terms of medication requirements, we found that patients who followed the ERAS protocol received more narcotic medication preoperatively than those who had a PVB alone, as per the protocol guidelines (Appendix 1), with ERAS patients receiving 35.1 mg and PVB only patients receiving 22.6 mg. However, patients following the ERAS protocol received significantly less intraoperative narcotic (49.5 mg vs 116.7 mg, $p<0.01$) and used significantly less narcotic medication in the entire perioperative period after adjusting for baseline use (100.6 mg vs 146.8 mg, $p<0.01$). Patients following the ERAS protocol received more benzodiazepines than those with a PVB alone intraoperatively, despite preoperative use being similar (4.1 mg vs 1.5 mg, $p<0.01$). They also used more benzodiazepines in total than those with a PVB alone after adjusting for baseline use (7.6 mg vs 5.1 mg, $p<0.01$).

Discussion

In this study, we evaluated the effects of paravertebral blocks on intraoperative and immediate post-operative vital signs, fluid administration, blood product use, pressor, anxiolytic, and narcotic requirement. As paravertebral blocks and ERAS protocols gain widespread use and acceptance in our field, it is critical their effects on intraoperative physiology are explored thoroughly to avoid any adverse effects on patient and flap outcomes. We found no difference in intraoperative SBP, DBP, MAP, heart rate, or total fluid use between patients with a PVB and those who did not. This is likely due to careful attention to changes in vital signs throughout the case and subsequent adjustments and resuscitation when necessary by the anesthesia team. Prior to adjusting for preoperative vital signs, patients who underwent reconstruction with the ERAS protocol did have lower intraoperative MAP (66.5 mmHg vs 70.1 mmHg, $p=0.01$). However, this difference is entirely accounted for by adjusting for differences in preoperative blood pressure (67.4 mmHg vs 69.9 mmHg after adjustment, $p=0.23$). The intraoperative blood pressure difference is in fact much less than the baseline blood pressure difference between groups. Patients following the ERAS protocol also had significantly less deviation from their baseline MAP than patients with a PVB who did not follow this protocol, again likely due to baseline blood pressure differences. This evidence leads us to recommend optimization of blood pressure prior to the day of surgery to minimize deviation from baseline blood pressures intraoperatively. There is evidence that preoperative hypertension may be related to postoperative complications in free flap surgery,²⁴ so the addition of preoperative blood pressure control to our ERAS protocol may be beneficial.

Furthermore, patients who underwent preoperative PVB received less total narcotic medication than patients who did not, and patients who followed the ERAS protocol (Appendix 1) received less narcotic medication than those who had a PVB alone. This has been shown in prior literature, and decreases the risk of narcotic associated complications

during the recovery period and reduction in narcotic use may also decrease overall length of stay.^{10, 13, 14} Due to the increase in opioid-related complications and deaths in the United States, minimizing use of these medications at any point in care may be a benefit to our patients and society.

Less deviation from baseline MAP may have also been dependent on less narcotic use. However, patients who had PVBs placed did receive more benzodiazepines than those who did not, and patients who followed the ERAS protocol received more than those with a PVB alone. Blocks are being placed earlier in the perioperative area due to an established order set for the ERAS protocol, and patients may receive a second dose of benzodiazepines prior to induction of anesthesia.

Despite increasing popularity and literature supporting improvements in postoperative pain control,^{10, 25, 26} nausea,^{13, 26} patient satisfaction,²⁵ and decreased length of stay, there are no studies to our knowledge that look at the effects of PVB blocks on hemodynamics and intraoperative medication use during autologous breast reconstruction. PVBs are found to be relatively safe, and hypotension is rare in normovolemic patients.^{27 {Naja, 2006 #74, 28, 29}}

However, in patients who are hypovolemic, there may be a greater risk of associated hypotension with use of regional anesthesia.²⁸ Hypotension and hypovolemia – factors that lead to decrease cardiac output and vasoconstriction – have been associated with adverse outcomes in free tissue transfer.^{30, 31} Conversely, existing literature also shows that fluid overload is associated with both perioperative morbidity³² and flap thrombosis¹⁸ – the balance of maintaining adequate perfusion and preventing excess fluid administration is delicate. Our PVB groups and ERAS subgroup had similar blood pressure measurements and fluid administration throughout the intraoperative period, and similar doses of vasopressor medications. The use of vasopressors for management of intraoperative hypotension, while previously avoided in microsurgery, has not been found to have a significant adverse effect on flap outcomes,³³ although caution is still recommended based on known effects of vasoconstriction in animal models.^{31, 34} In our study, neither the use of a PVB or our ERAS protocol had an effect on use of vasopressor medications.

One limitation of these findings is that data were collected retrospectively and results may be biased due to this. Furthermore, this is a single institution trial, and trends in anesthesia and operative technique may differ from those at other institutions limiting external applicability. Lastly, there are limited numbers of patients in the ERAS protocol group since it was recently implemented. We will continue to study the effects of this protocol.

Despite the limitations described above, we feel confident that use of paravertebral blocks is safe from a hemodynamic standpoint, and reduces the amount of narcotic medication used during the perioperative period. Furthermore, the addition of the medications in our ERAS protocol (OxyContin, acetaminophen, gabapentin, and celecoxib) did not alter intraoperative blood pressure, heart rate, or fluid administration, while decreasing narcotic requirement. In turn, we may optimize patient satisfaction and minimize cost of autologous breast reconstruction.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Donovan K, Sanson-Fisher RW, Redman S. Measuring quality of life in cancer patients. *J Clin Oncol.* 1989;7(7):959–968. [PubMed: 2661736]
2. Eltahir Y, Werners LL, Dreise MM, et al. Quality-of-life outcomes between mastectomy alone and breast reconstruction: comparison of patient-reported BREAST-Q and other health-related quality-of-life measures. *Plast Reconstr Surg.* 2013;132(2):201e–209e.
3. Jagsi R, Li Y, Morrow M, et al. Patient-reported Quality of Life and Satisfaction With Cosmetic Outcomes After Breast Conservation and Mastectomy With and Without Reconstruction: Results of a Survey of Breast Cancer Survivors. *Ann Surg.* 2015;261(6): 1198–1206. [PubMed: 25654742]
4. Albornoz CR, Bach PB, Mehrara BJ, et al. A paradigm shift in U.S. Breast reconstruction: increasing implant rates. *Plast Reconstr Surg.* 2013; 131(1):15–23. [PubMed: 23271515]
5. Gurunluoglu R, Gurunluoglu A, Williams SA, Tebockhorst S. Current trends in breast reconstruction: survey of American Society of Plastic Surgeons 2010. *Ann Plast Surg.* 2013;70(1): 103–110. [PubMed: 21862916]
6. Kulkarni AR, Sears ED, Atisha DM, Alderman AK. Use of autologous and microsurgical breast reconstruction by U.S. plastic surgeons. *Plast Reconstr Surg.* 2013; 132(3):534–541. [PubMed: 23985629]
7. Sbitany H, Amalfi AN, Langstein HN. Preferences in choosing between breast reconstruction options: a survey of female plastic surgeons. *Plast Reconstr Surg.* 2009;124(6):1781–1789. [PubMed: 19952634]
8. Rwjf. Deaths From Injuries Up Significantly Over Past Four Years in 17 States. 2015-6-17, 2015.
9. Oderda GM, Said Q, Evans RS, et al. Opioid-related adverse drug events in surgical hospitalizations: impact on costs and length of stay. *Ann Pharmacother.* 2007;41(3):400–406. [PubMed: 17341537]
10. Parikh RP, Sharma K, Guffey R, Myckatyn TM. Preoperative Paravertebral Block Improves Postoperative Pain Control and Reduces Hospital Length of Stay in Patients Undergoing Autologous Breast Reconstruction after Mastectomy for Breast Cancer. *Ann Surg Oncol.* 2016;23(13):4262–4269. [PubMed: 27489056]
11. Coopey SB, Specht MC, Warren L, Smith BL, Winograd JM, Fleischmann K. Use of preoperative paravertebral block decreases length of stay in patients undergoing mastectomy plus immediate reconstruction. *Ann Surg Oncol.* 2013;20(4): 1282–1286. [PubMed: 23064793]
12. Andreae MH, Andreae DA. Regional anaesthesia to prevent chronic pain after surgery: a Cochrane systematic review and meta-analysis. *Br J Anaesth.* 2013; 111(5):711–720. [PubMed: 23811426]
13. Coveney E, Weltz CR, Greengrass R, et al. Use of paravertebral block anesthesia in the surgical management of breast cancer: experience in 156 cases. *Ann Surg.* 1998;227(4):496–501. [PubMed: 9563536]
14. Fahy AS, Jakub JW, Dy BM, et al. Paravertebral blocks in patients undergoing mastectomy with or without immediate reconstruction provides improved pain control and decreased postoperative nausea and vomiting. *Ann Surg Oncol.* 2014;21(10):3284–3289. [PubMed: 25034821]
15. Shah A, Rowlands M, Krishnan N, Patel A, Ott-Young A. Thoracic Intercostal Nerve Blocks Reduce Opioid Consumption and Length of Stay in Patients Undergoing Implant-Based Breast Reconstruction. *Plast Reconstr Surg.* 2015;136(5):584e–591e.

16. Abdelsattar JM, Boughey JC, Fahy AS, et al. Comparative Study of Liposomal Bupivacaine Versus Paravertebral Block for Pain Control Following Mastectomy with Immediate Tissue Expander Reconstruction. *Ann Surg Oncol*. 2016;23(2):465–470. [PubMed: 26307232]
17. Wolf O, Clemens MW, Purugganan RV, et al. A Prospective, Randomized, Controlled Trial of Paravertebral Block versus General Anesthesia Alone for Prosthetic Breast Reconstruction. *Plast Reconstr Surg*. 2016;137(4):660e–666e. [PubMed: 26818304]
18. Booi DI. Perioperative fluid overload increases anastomosis thrombosis in the free TRAM flap used for breast reconstruction. *Eur J Plast Surg*. 2011;34(2):81–86. [PubMed: 21475651]
19. Nelson JA, Fischer JP, Grover R, et al. Intraoperative perfusion management impacts postoperative outcomes: an analysis of 682 autologous breast reconstruction patients. *J Plast Reconstr Aesthet Surg*. 2015;68(2): 175–183. [PubMed: 25456289]
20. Richardson J, Lönqvist PA, Naja Z. Bilateral thoracic paravertebral block: potential and practice. *Br J Anaesth*. 2011;106(2): 164–171. [PubMed: 21233114]
21. Okitsu K, Iritakenishi T, Iwasaki M, Imada T, Kamibayashi T, Fujino Y. Paravertebral block decreases opioid administration without causing hypotension during transapical transcatheter aortic valve implantation. *Heart Vessels*. 2016;31(9):1484–1490. [PubMed: 26384505]
22. Batdorf NJ, Lemaine V, Lovely JK, et al. Enhanced recovery after surgery in microvascular breast reconstruction. *J Plast Reconstr Aesthet Surg*. 2015;68(3):395–402. [PubMed: 25488326]
23. Gnaneswaran N, Perera M, Perera N, Peters M. Enhanced recovery after surgery (ERAS) pathways in autologous breast reconstruction: a systematic review. *European Journal of Plastic Surgery*. 2016;39(3): 165–172.
24. Salgado CJ, Chim H, Schoenoff S, Mardini S. Postoperative Care and Monitoring of the Reconstructed Head and Neck Patient. *Seminars in Plastic Surgery*. 2010;24(3):281–287. [PubMed: 22550449]
25. Weltz CR, Greengrass RA, Lysterly HK. Ambulatory surgical management of breast carcinoma using paravertebral block. *Ann Surg*. 1995;222(1):19–26. [PubMed: 7618963]
26. Pusch F, Freitag H, Weinstabl C, Obwegeser R, Huber E, Wildling E. Single-injection paravertebral block compared to general anaesthesia in breast surgery. *Acta Anaesthesiol Scand*. 1999;43(7): 770–774. [PubMed: 10456819]
27. Naja Z, Lonnqvist PA. Somatic paravertebral nerve blockade Incidence of failed block and complications. *Anaesthesia*. 2001;56(12): 1181–1201. [PubMed: 11736776]
28. Lonnqvist PA, MacKenzie J, Soni AK, Conacher ID. Paravertebral blockade. Failure rate and complications. *Anaesthesia*. 1995;50(9):813–815. [PubMed: 7573876]
29. Karmakar MK. Thoracic paravertebral block. *Anesthesiology*. 2001;95(3):771–780. [PubMed: 11575553]
30. Hagau N, Longrois D. Anesthesia for free vascularized tissue transfer. *Microsurgery*. 2009;29(2): 161–167. [PubMed: 18946883]
31. Chen C, Nguyen MD, Bar-Meir E, et al. Effects of vasopressor administration on the outcomes of microsurgical breast reconstruction. *Ann Plast Surg*. 2010;65(1):28–31. [PubMed: 20548236]
32. Brandstrup B, Tonnesen H, Beier-Holgersen R, et al. Effects of intravenous fluid restriction on postoperative complications: comparison of two perioperative fluid regimens: a randomized assessor-blinded multicenter trial. *Ann Surg*. 2003;238(5):641–648. [PubMed: 14578723]
33. Kelly DA, Reynolds M, Crantford C, Pestana IA. Impact of intraoperative vasopressor use in free tissue transfer for head, neck, and extremity reconstruction. *Ann Plast Surg*. 2014;72(6):S135–138. [PubMed: 24691344]
34. Cordeiro PG, Santamaria E, Hu QY, Heerdt P. Effects of vasoactive medications on the blood flow of island musculocutaneous flaps in swine. *Ann Plast Surg*. 1997;39(5):524–531 [PubMed: 9374150]

Synopsis:

Use of paravertebral blocks in abdominally-based autologous breast reconstruction reduces the amount of intraoperative narcotic medication required without causing a significant deviation in hemodynamic variables. Addition of an enhanced recovery protocol with multimodal analgesia further reduced narcotic use.

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Table 1.

Summary statistics for patients PVB vs no PVB

Summary Statistics PVB							
	PVB (n=66)			No PVB (n=104)			p
Age (y)	49.2	±	8.6	48.0	±	8.6	0.39
Weight (kg)	78.6	±	14.0	78.3	±	13.6	0.90
Pre-op MAP (mmHg)	88.6	±	14.4	87.1	±	11.0	0.49
Pre-op SBP (mmHg)	127.6	±	20.2	128.8	±	18.0	0.70
Pre-op DBP (mmHg)	76.9	±	13.0	74.5	±	10.5	0.20
Pre-op HR	79.0	±	13.2	77.6	±	11.1	0.45
Preop Crystalloid (mL)	403.4	±	354.7	286.5	±	157.9	<0.01
ASA Class							0.49
1	6		8.7%	9		9.1%	
2	55		83.6%	87		83.3%	
3	5		4.8%	5		7.6%	
EBL (ml)	98.1	±	92.4	112.0	±	98.4	0.37
Case Duration (min)	471.9	±	10.4	479.4	±	86.6	0.38
Bilateral, n (%)	38		(58%)	63		(62%)	0.70
DIEP, n (%)	55		(83%)	60		(58%)	<0.01
Delayed recon, n (%)	51		(77%)	78		(75%)	0.85

Table 2.

Intraoperative variables by group, PVB vs no PVB.

Intraoperative Effects of PVB						
	PVB (n=66)			No PVB (n=104)		p
Intraoperative Variables						
	Mean	SE	Mean	SE	p	
Intraop Heart Rate	81.0	± 8.8	80.7	± 9.0	0.8	
Intraop MAP ^a (mmHg)	69.0	± 7.0	68.3	± 6.6	0.5	
Intraop SBP (mmHg)	105.6	± 9.5	106.1	± 8.1	0.7	
Intraop DBP (mmHg)	57.7	± 7.0	56.9	± 7.6	0.5	
Time MAP < 65mmHg (min)	216.7	± 167.9	255.4	± 180.2	0.5	
AUC MAP <65mmHg	1433.1	± 1687.8	1806.9	± 1692.9	0.16	
Time MAP <80% baseline (min)	336.1	± 214.8	340.5	± 228.1	0.9	
AUC <80% of baseline	3747.4	± 4124.3	3999.2	± 4124.3	0.70	
MAC	0.93	± 0.1	0.95	± 0.1	0.4	
Intraop Crystalloid (mL)	4073.3	± 1365.5	3841.8	± 1217.4	0.3	
Total Crystalloid (mL)	4476.7	± 1350.5	4128.3	± 1214.8	0.1	
Total Colloid (mL)	463.1	± 150.0	716.3	± 264.7	<0.01	
PRBC, n (%)	1.0	0.0	3.0	0.0	1.0	
Vasopressors, n (%)	30.0	0.4	39.0	0.6	0.3	
Vasopressor doses	4.1	± 3.8	3.9	± 4.2	0.8	
Medication Requirement						
Baseline Narcotic Use (mg/day)	2.5	± 1.2	1.7	± 6.0	0.52	
Pre-op Narcotic ^b (mg)	26.2	± 1.2	3.0	± 1.0	<0.01	
Intra-op Narcotic (mg)	96.3	± 10.3	161.2	± 8.2	<0.01	
Post-op Narcotic (mg)	10.1	± 1.9	7.4	± 1.5	0.27	
Total Narcotic (mg)	132.6	± 78.5	171.6	± 92.2	<0.01	
Baseline Benzodiazepine (mg/day)	27.1	± 124.4	10.0	± 49.5	0.29	
Pre-op Benzodiazepine ^b (mg)	3.5	± 0.2	2.3	± 0.2	<0.01	
Intra-op Benzodiazepine (mg)	2.3	± 0.2	1.7	± 0.2	0.09	
Post-op Benzodiazepine (mg)	0.03	± 0.03	0.04	± 0.02	0.72	
Total Benzodiazepine use (mg)	5.8	± 2.9	4.0	± 2.3	<0.01	

^a Intraoperative MAP, SBP, and DBP, and minutes with MAP < 65mmHg were adjusted for preoperative values.

^b Preoperative, intraoperative, post-operative, and total narcotic and benzodiazepine requirements were adjusted for baseline use. Narcotic use is reported in IV morphine equivalents. Benzodiazepine use is reported in IV midazolam equivalents.

Table 3.

Summary statistics for ERAS vs no ERAS subgroup. All patients had PVB.

Summary Statistics ERAS							
	ERAS (n=19)			No ERAS (n=47)			p
	Mean	SD		Mean	SD		
Age (y)	49.8	± 6.7		49.0	± 9.3		0.65
Weight (kg)	77.3	± 15.3		79.1	± 13.6		0.65
Pre-op MAP (mmHg)	82.8	± 8.2		90.9	± 15.7		0.01
Pre-op SBP (mmHg)	117.7	± 9.8		131.6	± 21.9		0.01
Pre-op DBP (mmHg)	72.5	± 8.9		78.8	± 14.0		0.07
Pre-op HR	76.4	± 13.2		80.1	± 13.2		0.30
Preop Crystalloid (mL)	415.1	167.5		374.4	261.7		0.45
ASA Class							0.10
1	0.0	0.0		6.0	0.1		
2	16.0	0.8		39.0	0.8		
3	3.0	0.2		2.0	0.0		
EBL (mL)	115.8	± 103.3		90.9	± 87.8		0.34
Case Duration (min)	473.4	± 8.5		471.3	± 11.1		0.45
Bilateral, n (%)	12	(63%)		26	(55%)		0.60
% DIEP, n (%)	15	(79%)		40	(85%)		0.72
Delayed recon, n (%)	15	(79%)		36	(77%)	1	

Table 4.

Intraoperative variables by ERAS protocol vs PVB block alone.

Intraoperative Effects of ERAS							
	ERAS (n=19)			No ERAS (n=47)			P
Intraoperative Variables							
	Mean		SD	Mean		SD	P
Intraop Heart Rate	81.2	± 7.3		81.5	± 9.4		0.87
Intraop MAP (mmHg)	67.4	± 3.3		69.7	± 7.9		0.23
Intraop SBP (mmHg)	105.7	± 5.4		105.4	± 10.6		0.89
Intraop DBP (mmHg)	56.4	± 3.8		58.2	± 7.8		0.28
Time MAP < 65mmHg (min)	245.3	± 108.5		202.7	± 186.2		0.25
AUC MAP <65mmHg	1440.9	± 906.0		1430.0	± 1924.6		<0.01
Time MAP <80% baseline (min)	264.8	± 155.4		364.9	± 229.8		0.09
AUC <80% baseline	1997.5	± 1959.4		4454.8	± 4794.9		0.93
MAC	0.88	± 0.1		0.94	± 0.1		0.05
Intraop Crystalloid (mL)	4016.9	± 1028.2		4096.2	± 1489.8		0.83
Total Crystalloid (mL)	4391.3	± 917.5		4511.2	± 1497.9		0.69
Total Colloid (mL)	447.4	± 157.7		470.2	± 148.2		0.59
PRBC, n (%)	1.0	0.1		0.0	0.0		0.29
Pressors, n (%)	9.0	0.5		21.0	0.4		1.00
Pressor doses	4.4	± 5.2		4	± 3.2		0.77
Medication Requirement							
Baseline Narcotic Use (mg/day)	1.2	± 0.5		3.0	± 1.1		0.35
Pre-op Narcotic (mg)	35.1	± 2.6		22.6	± 1.7		<0.01
Intra-op Narcotic (mg)	49.5	± 13.9		114.4	± 8.8		<0.01
Post-op Narcotic (mg)	10.27	± 4.1		9.9	± 2.6		0.94
Total Narcotic (mg)	95.2	±		146.9	± 9.3		0.01
Baseline Benzodiazepine (mg/day)	13.2	± 57.6		32.7	± 143.1		0.43
Pre-op Benzodiazepine (mg)	3.4	± 0.4		3.5	± 0.2		0.74
Intra-op Benzodiazepine (mg)	4.2	± 0.5		1.5	± 0.3		<0.01
Post-op Benzodiazepine (mg)	0.1	± 0.04		0.02	± 0.03		0.48
Total Benzodiazepine use (mg)	7.6	± 0.4		5.1	± 0.2		0.01

^a Intraoperative MAP, SBP, and DBP, and minutes with MAP < 65mmHg were adjusted for preoperative values.

^b Preoperative, intraoperative, post-operative, and total narcotic and benzodiazepine requirements were adjusted for baseline use. Narcotic use is reported in IV morphine equivalents. Benzodiazepine use is reported in IV midazolam equivalents.

Table 5.

Complications by study group

	Complications by study group			
	No PVB (n=104)	PVB only (n=47)	ERAS (n=19)	p
Total flap loss	2 (1.9%)	1 (2.1%)	2 (10.5%)	0.14
Partial Flap Loss	1 (1%)	2 (4.3%)	0	0.46
Abdominal wound dehiscence	1 (1%)	1 (2.1%)	1 (5.3%)	0.19