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Intraoperative Interpectoral and Subserratus Nerve Blocks in Breast Augmentation Surgery

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Background: An essential component in ambulatory breast augmentation surgery is good analgesia. The demographic undergoing this operation is usually fit, low risk with few comorbidities. These patients do not require long-term hospitalization and do not want to spend excessive time in the hospital for financial reasons. Opiate analgesia can have significant side effects such as nausea, vomiting, and sedation. Reducing volumes of postoperative opiates allows faster ambulation and discharge from day surgery. We have developed two targeted nerve blocks that the operating surgeon can apply in minutes under direct vision, not requiring imaging. Anecdotally, we found that these targeted nerve blocks reduced opiate requirements and allowed accelerated discharge and faster return to normal activities. We conducted a prospective randomized, double-blind trial to test this theory.
Methods: Twenty patients were randomized into saline (n = 10) or ropivacaine adrenaline solution (n = 10). The operating surgeons and anesthetists were blinded to the solution. All patients were closely followed up, and morphine equivalents were accurately recorded. Follow-up pain scores were recorded using the Overall Benefit of Analgesia pain questionnaire.
Results: The ropivacaine nerve blocks significantly reduced opiate requirements postoperatively ($P < 0.05$). Pain scores were significantly decreased in the study group ($P < 0.05$). There were no side effects attributable to the nerve blocks.
Conclusion: Intraoperative targeted nerve blocks significantly reduce postoperative opiate requirements in breast augmentation surgery resulting in faster recovery and higher patient satisfaction. *(Plast Reconstr Surg Glob Open 2022;10:e4584; doi: 10.1097/GOX.0000000000004584; Published online 19 October 2022.)*

INTRODUCTION

Breast augmentation surgery is the most commonly performed aesthetic plastic surgery procedure worldwide.[1] A total of 1,862,506 breast augmentations were performed in 2018, an increase of 6.1% compared to 2017.[2] Over 20,000 breast augmentations were performed in Australia alone.

The demographic undergoing this procedure is usually fit and low risk with minor comorbidities. These patients do not require long-term hospitalization and do not want to spend excessive time in the hospital for financial reasons. The ambulatory nature of this procedure is beneficial to both parties due to its practicality and affordability. However, readmission following the same-day surgery can affect morbidity, cost, and satisfaction.[3] Pain is the most critical factor in hospital revisits and patient satisfaction.[4]

Conventionally, patients have been treated with high opiate analgesics to ameliorate pain.[5,6] However, opiate analgesia can have significant side effects for patients, such as nausea, vomiting, ileus, sedation, addiction, increased hospital costs, and length of stay.[7] Reducing volumes of postoperative opiates allows faster ambulation and discharge postsurgery.

Conversely, under controlled pain in the acute period can lead to prolonged hospital stays, development of chronic pain, increased readmissions, and decreased patient satisfaction.[3,8–10] Therefore, a delicate balance exists in the postoperative management of patients' pain.

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Over the past 20 years, an increasing emphasis has been placed on using regional anesthesia in breast surgery to optimize postoperative pain, opiate consumption, and decreased hospital stays. However, there remains incongruity in the literature as to which regional anesthetic technique is most effective in mitigating pain.

Blanco et al[11] first described the subserratus block in 2013, reporting dense T2-T9 dermatome paraesthesia with an average duration of 12.5 hours for sensory and 13 hours for motor nerves (Fig. 1). Furthermore, the study also noted that some participants experienced up to 24 hours of paraesthesia.[11] Inspired by this, the senior surgeon leading this article developed two targeted intraoperative nerve blocks (INBs), interpectoral and subserratus, which can be administered easily and quickly by the operating surgeon under direct vision, not requiring imaging. Over years of practice, he found that the combination of these targeted nerve blocks reduced postoperative pain scores and opiate requirements, and allowed an accelerated return to normal activities.

To our knowledge, this is the first prospective randomized controlled study that involves the application of surgeon applied INB under direct visualization.

This study aimed to demonstrate that our targeted INB led to decreased pain scores and reduced volumes of opiate consumption postoperatively.

Takeaways

Question: Can targeted intraoperative nerve blocks reduce postoperative opiate consumption in breast augmentation surgery?

Findings: The authors of this study developed easy to use interpectoral and subserratus nerve blocks that can be administered under direct vision intraoperatively. The study group reported statistically significantly less opiate consumption and lower pain scores compared to the control.

Meaning: Our targeted intraoperative nerve blocks are the quickest, easiest, most inexpensive modification any breast surgeon can adopt to improve their practice.

METHODS

Patient Cohort

This single-center prospective randomized control trial was conducted at St. John of God, Subiaco, Perth, Western Australia, between September 2020 and October 2020.

All patients who underwent primary breast augmentation with implants were included. All patients received the same size implants. Patients who had previous breast surgery, including mastectomy or lumpectomy for previous malignancy, reaugmentation, reduction mammoplasty or mastopexy, were excluded from the study.

Power calculation was performed using the G Power program, and a clinically significant decrease of 33% of total opiate use was postulated to be of interest. The average use of opiates on postoperative day (POD) 7 was estimated to be 100 mg, with a two-sided significance of 0.05 and power of 0.8; it was predicted that 80% of the control group and 50% of the treatment group would surpass the target, with a minimum of 18 patients required.

A total of 20 patients were enrolled in the study, randomly assigned either to a control group or the study group. The study group received intraoperative interpectoral and subserratus nerve blocks, whereas the control group did not. Patients were allocated to the control or study arm randomly using a randomizer software program. Patient consent for the procedure and the study was obtained according to the principles outlined in the Declaration of Helsinki.[12]

Each participant underwent a comprehensive preoperative assessment, including focused history and examination. Patient characteristics and relevant comorbidities were recorded, including age, body mass index (BMI), and the American Society of Anesthesiology (ASA) score.

Operation and Injection Technique

Before surgery, an independent third party organized for either ropivacaine or normal saline to be present in the syringe delivering the block. The operating surgeon, assistant, and anesthetist were not informed whether the patient was allocated to the study or control group.

Two targeted blocks are performed intraoperatively under direct visualization. A 200 mL bag of ropivacaine 0.2% is mixed with 1 mL of 1/1000 epinephrine, equating to a patient dose of 1 mL/kg. We use approximately 25 mL on each side—half for each of the two blocks. (**See Video [online],** which shows the clinical application of blocks.)

Interpectoral Block

After subpectoral operative dissection, a rigid plastic mixing cannula is attached to the 25-mL syringe and gently advanced into the loose areolar tissue between the pectoralis major and minor.

Approximately 12.5 mL is forcibly injected into this area, supersaturating it and thus blocking the majority of motor medial and lateral pectoral nerves (Fig. 2).

Subserratus Block

Using large artery forceps directly over a rib to avoid intercostal puncture, the serratus anterior muscle is identified. The forceps are carefully teased between fibers and pushed through the muscle along the rib line from medial to lateral. The blunt mixing cannula is then gently inserted and must go in without resistance to endure entering the subserratus space. The remainder of the syringe contents is injected, filling the subserratus plane to block T2 to T9 dermatomes (Fig. 3).

Magnetic Resonance Imaging

To illustrate the movement of the block along anatomical planes, a volunteer was injected with ropivacaine mixed with 0.1 mmol/kg gadolinium. We then performed an MRI

Fig. 1. Area of sensory loss following Blanco's subserratus block (Copyright 2013 Blanco et al[11]). Used with permission from John Wiley and Sons.

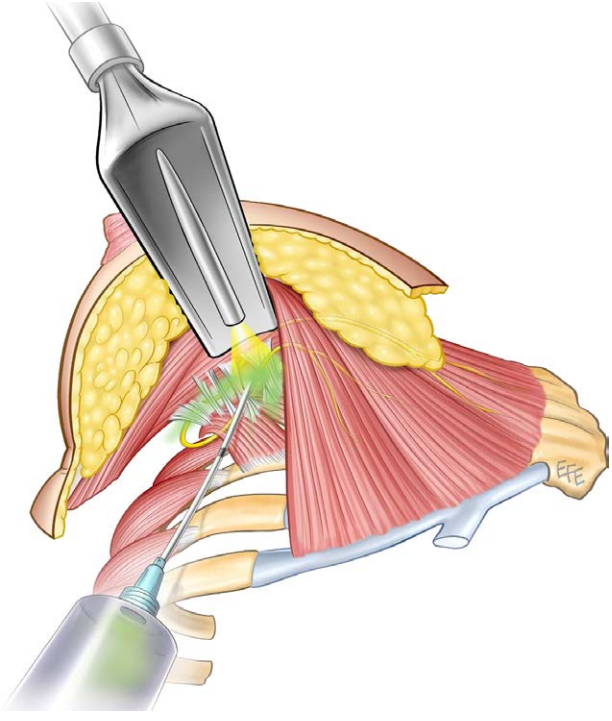

Fig. 2. Interpectoral nerve block.

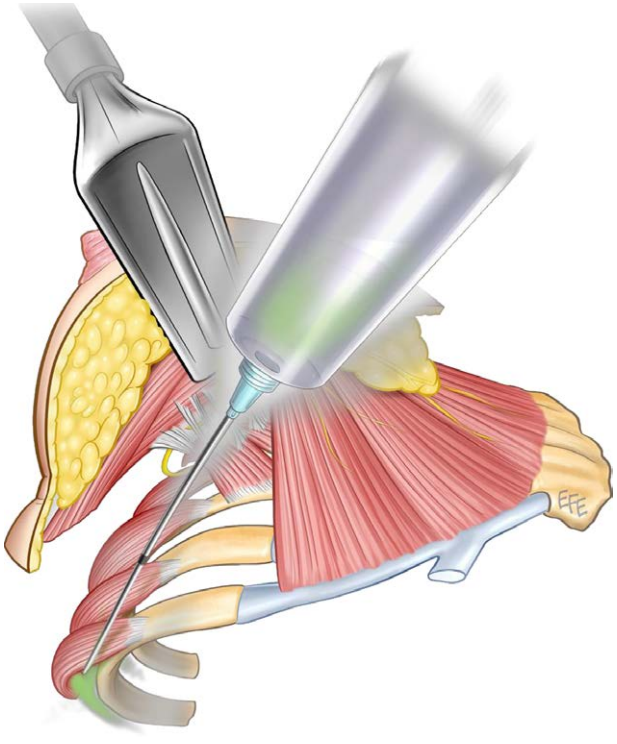

Fig. 3. Subserratus block.

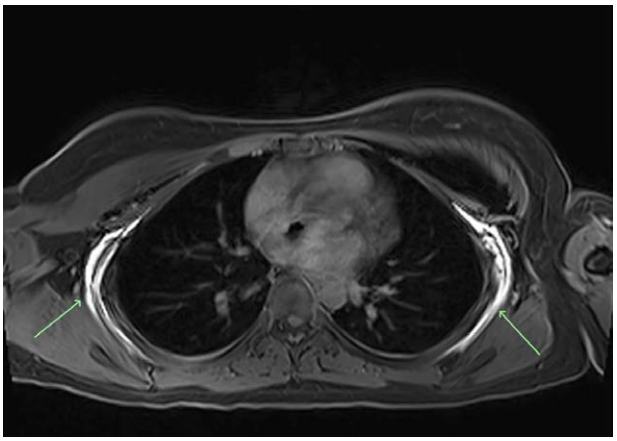

Fig. 4. Coronal MRI demonstrating subserratus block.

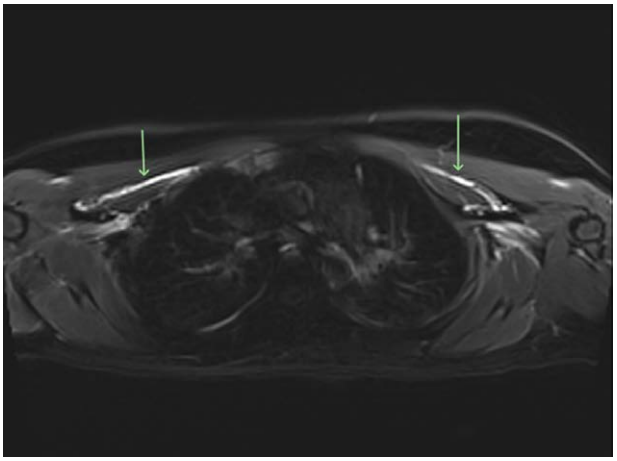

Fig. 5. Coronal MRI demonstrating interpectoral block.

1 hour later using two sequences to show T1-weighted, fat-suppressed, and T1 dynamic 3D gradient fast field echo high-resolution images to demonstrate the spread of the contrast. Figures 4 and 5 are coronal MRIs of subserratus and interpectoral blocks. Figure 6 is a sagittal view of the subserratus block.

Postoperative Course

Before discharge, each patient received formal education on the postoperative course of the study and the follow-up period.

The postoperative assessment was conducted via telehealth consultation. Each patient was closely followed up on POD1 and POD7. The Overall Benefit of Analgesia (OBAS) questionnaire (Fig. 7) was utilized to ascertain patients' postoperative pain, opiate side effect profile, and functional status.

Patient opiate usage was carefully documented. The opiate drugs were converted to morphine equivalents to calculate total narcotic usage to enable accurate comparison. Total opiate usage on days 1 and 7 were recorded during the telehealth consultations. Patient medical records were examined retrospectively to determine hospital analgesic requirement, length of operation and length of postanesthesia care unit (PACU) stay.

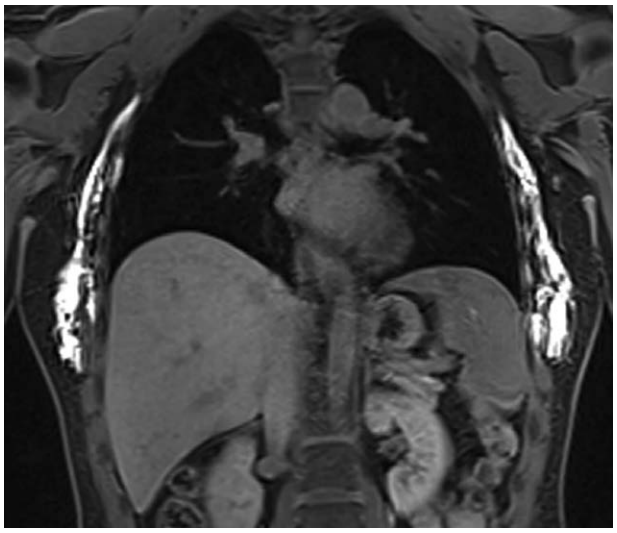

Fig. 6. Sagittal MRI demonstrating subserratus block.

Statistical Analysis

SPSS was used to analyze data (IBM Corp, Released 2016, IBM SPSS Statistics for Windows, version 24.0, Armonk, N.Y.). A two-sample t-test was employed to ascertain the statistical significance of INB group results compared to control.

RESULTS

Of the 20 patients, 10 were allocated to the INB group and 10 to the control group. The average age of patients was 36 ± 11 years. Patients' average weight, height, and BMI were 64 ± 7 kg, 164 ± 7 cm, and 24 ± 2. Sixteen of the patients were ASA grade 1. Four patients were ASA grade 2: two patients with previous thyroid surgery, one with previous difficult intubation, and one on immunologic therapy. All patients underwent primary subpectoral breast augmentation with implants. The average length of operation was 51.35 ± 13.48 minutes. Patient PACU stay was 35.67 ± 8.51 and 43.22 ± 18.01 minutes for INB and control groups. Patient demographics are recorded in Table 1.

The total in hospital morphine usage was 53.1 ± 44.95 versus 60.35 ± 50.40 mg for INB and the control, respectively ($P = 0.7381$). Morphine consumption on POD1 was 32.41 ± 20.31 versus 50.91 ± 14.80 mg ($P = 0.0318$), INB and control group. The overall morphine consumption on discharge at POD7 was 80.75 ± 52.55 versus 161.25 ± 56.72 mg ($P = 0.0040$). Figure 8 and Table 2 illustrate opiate consumption, measured in milligrams of morphine.

OBAS scores for INB and the control group were 2.8 ± 1.69 and 6.2 ± 2.3 on POD1 ($P = 0.0014$); 2.0 ± 2.40 and 4.40 ± 2.12 on POD7, respectively ($P = 0.0292$). Figure 9 highlights the overall OBAS scores. Table 3 breaks down the OBAS scores for patients, including the adverse effects. No adverse effects were noted during the administration of the intraoperative blocks.

Overall Benefit of Analgesia Score

1. Please rate your current pain at rest on a scale of 0 to 4

No pain 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ *Maximum pain imaginable*

2. Please grade any distress and bother from vomiting in the past 24 hrs

Not at all 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ *Very much*

3. Please grade any distress and bother from itching in the past 24 hrs

Not at all 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ *Very much*

4. Please grade any distress and bother from sweating in the past 24 hrs

Not at all 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ *Very much*

5. Please grade any distress and bother from freezing in the past 24 hrs

Not at all 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ *Very much*

6. Please grade any distress and bother from dizziness in the past 24 hrs

Not at all 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ *Very much*

7. How satisfied are you with your pain treatment during the past 24 hrs?

Not at all 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ *Very much*

To calculate the OBAS score, add the scores of Q1-6, add 4 then minus the score of Q7.

OBAS score =

Fig. 7. Overall benefit of analgesia score.

DISCUSSION

In patients undergoing ambulant breast reconstructive surgery, targeted INBs are found to significantly lower pain scores and decrease opiate consumption, facilitating faster recovery and increased patient satisfaction.

Pain is highest in the first 24–48 hours postoperative.[13] Traditionally, high doses of opiate analgesia have been the cornerstone of the pain paradigm.[5,6] Despite being highly effective analgesic agents, they have a notorious side effect profile.[7] In addition to the health repercussions, overprescribing opiates also has a disastrous social and economic effect. Deaths related to opioid usage were ten times higher in 2018 than in 1999.[14] It is estimated that over 95 billion dollars are lost per year in the United States.[15] For

Table 1. Patient Demographics

	INB	Control	*P**
Age, y	38±11.96	34.60±10.28	0.5041
Weight (kg)	63.6±8.78	64.49±6.14	0.7969
Height (cm)	160.7±5.40	166.5±6.82	0.0492†
BMI (kg/m$^{2)}$	23.8±2.03	24.57±2.71	0.2253
ASA	1.3±0.48	1.1±0.32	0.2878
Operation length (mins)	33.3±9.7	43.6±17.51	0.1210
PACU stay (mins)	49.5±12.35	53.2±14.96	0.5539

Results presented as means ± SDs.
*Two-sample t-test.
†Statistically significant.

the most part, increased physician prescribing has been the lead cause. Plastic surgery has not escaped this trend, with a recent study highlighting that plastic surgeons prescribe almost double the number of opiates on discharge as used in the immediate postoperative period.[16]

The use of regional anesthesia in patients undergoing breast surgery is not a novel idea. McCann[17] first introduced the idea of intercostal nerve blocks as an adjunct to general anesthetic in a mastectomy. Furthermore, Huang et al[18] performed approximately 300 outpatient breast surgeries using intercostal nerve blocks and sedatives. Shah et al[19] evaluated the effect of intraoperative bupivacaine in subpectoral implant reconstruction and found significantly lower opiate consumption and length of stay compared to the control group.

Our study used a set of targeted INB, subserratus and interpectoral, to decrease opiate consumption postoperatively and improve patient pain scores. On average, patients who received our INB used fewer opiates than the control group. The study group reported a 12% decrease in opiate consumption on day 0 while in hospital, a statistically significant 31% on POD 1 and 50% on POD 7 ($P < 0.05$).

The OBAS questionnaire has yielded a higher evaluation of pain scores compared with pain intensity scores alone.[20] The combination of pain intensity measurement and opiate side effects allows for a more accurate pain management evaluation. Given that our primary outcomes were pain scores and opiate consumption, we found it pertinent to use this questionnaire, as it provides a holistic analysis of patients' pain management instead of relying on pain scores alone, such as the visual analogue scale score.

The use of INB significantly decreased the OBAS scores in the test cohort compared to the control group. Patients reported over 50% decrease in pain scores after receiving the block on POD 1 and POD 7, 54.8% and 54.5%, respectively. This substantial reduction in overall scores mirrored happiness with analgesia in the INB group reporting a 28.5% increase in pain management satisfaction on POD 1. Interestingly, both groups reported similar happiness with analgesia on POD 7. On examination of the data, two focal points can be extrapolated.

This alludes to the fact that the difference in overall pain scores can be attributed to the side effect profile of opiates. The control group used significantly more opiates throughout this study and experienced a considerable increase in side effects. Table 3 illustrates that the control group reported twice as much nausea and vomiting, twice as much itchiness, three times more sweating, and five times as much dizziness on POD 1. On POD 7, patients in the control group reported four times as much nausea and vomiting, 12 times more itchiness, and had comparable other side effects to the INB group.

In the authors' opinion, the difference in happiness with analgesia scores on POD 1 demonstrates the beneficial impact of the INBs. In this study, we used 0.75% ropivacaine, the mean duration of which has been reported to be up to 19 hours when used for peripheral nerve blocks.[21,22] With a block lasting nearly up to 24 hours, it is not surprising that the study cohort reported higher happiness scores and used fewer opiates. The postoperative MRI demonstrated the movement contrast along with the subserratus and interpectoral planes (Figs. 4–6). It allows correlation of the clinical outcome with a radiological picture and provides an anatomical illustration of the INB.

The pathophysiology of sensory pain in surgery is well documented.[23–25] The sensory supply of the breast derives from the anterior divisions of the thoracic intercostal nerve, arising from T2 to T6.[26] These nerves pass in the plane between the intercostal muscles and give off two branches—lateral and anterior. The lateral cutaneous branch emerges from the intercostal muscles at the anterior axillary line to run anterior to serratus anterior and pierce the breast parenchyma.[27] The anterior cutaneous branch tracks across the intercostal membrane and pectoralis major to supply the medial aspect of the breast.[28] The intercostal nerves are the most commonly injured, occurring in 74% of breast surgeries.[29]

However, postoperative pain following breast reconstruction is not only sensory. The pain postinsertion of tissue expanders and implants is often secondary to division and tension placed on the pectoralis major.[30] In subpectoral implants, the muscular spasm of the pectoralis major is a significant source of discomfort in the immediate

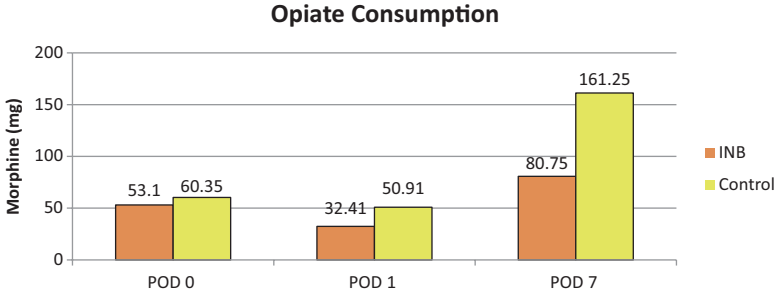

Fig. 8. Opiate consumption postoperative day 0, day 1, and day 7.

Table 2. Opiate Consumption in Milligrams of Morphine

	INB	Control	*P**
In hospital	53.1 ± 44.95	60.35 ± 50.40	0.7381
Postoperative day 1	32.41 ± 20.31	50.91 ± 14.80	0.0318†
Postoperative day 7	80.75 ± 52.55	161.25 ± 56.72	0.0040†

Results presented as means ± SD or %.
*Two-sample t-test.
†Statistically significant.

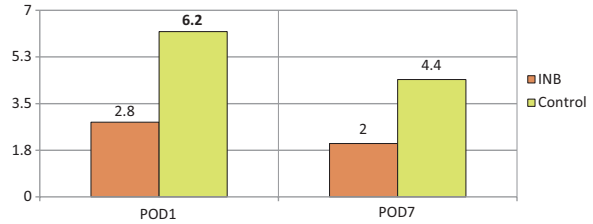

Fig. 9. OBAS overall scores.

postoperative period.[31,32] Blockage of the motor nerves and medial (C8-T1) and lateral (C5-7) pectoral nerves alleviates the initial spasm. As described in our study, these nerves are easily identified and targeted in the fascial plane between the pectoralis major and minor (Fig. 5).

Another set of nerves vital to the thoracic wall is the long thoracic nerve (C5-C7) and thoracodorsal nerve (C6-8), which lay within the subserratus plane. Figure 4 shows the spread along with the subserratus fascial plane. They supply serratus anterior and latissimus dorsi, respectively, which play an integral role in supporting the thoracic wall. Moreover, they are easily accessed through local anesthetic injection into the subserratus plane.

In addition, in subpectoral reconstruction, damage to the periosteum from dissection of the subpectoral space, hemostasis, and direct compression from the implant can cause significant pain.[33]

Many blocks are described in the literature; however, there remains discordance regarding the best approach to deliver regional anesthesia. Traditionally, the gold standard amongst regional anesthesia has been paravertebral blocks (PVBs) and thoracic spinal epidural, which provide dense blockade of the neural supply to the thoracic wall.[34] However, these techniques are not without complications. PVB is performed by injecting local anesthetic immediately lateral to the paravertebral foramen where spinal roots emerge. Complications of PVB include hypotension, vascular puncture, pleural puncture, pneumothorax, epidural spread, and epinephrine absorption. The primary neurological effects of neuraxial blockage prevent the use in ambulatory day surgery.

More recently, Blanco et al have described ultrasound-guided blocks that utilize thoracic wall anatomy to achieve targeted regional anesthesia. PECs 1 block targets lateral and medial pectoral nerves in the interpectoral fascia between the pectoralis major and minor, creating a dense motor block—that is ideally suited for a subpectoral prosthesis.[35] PECs 2 or modified PECs block injects local anesthetic between pectoralis minor and serratus, breaking the "axillary door" reaching the long thoracic nerve and at least two intercostal nerves.[36] Blanco et al went one step further and developed the subserratus block, which demonstrated paraesthesia from dermatomes T2 to T9 and numbness in all volunteers.[11]

However, not all studies praise the use of regional anesthesia. Lanier et al[37] have shown that nerve blocks failed to improve pain scores in patients undergoing subpectoral implant reconstruction.

Inspired by the disagreement in the literature, the authors of this study sought to perfect a technique that would be safe and easy to administer while providing dense reliable blockage.

This is the first study to use intraoperative subserratus and pectoral blocks under direct visualization to the best of our knowledge. There are numerous advantages to the use of intraoperative blocks under visualization.

The administration of this block method is fast and reliable. Tissue dissection during surgery exposes the appropriate anatomy, allowing the operating surgeon to administer the block quickly. We have estimated the time to perform our two blocks, subserratus and interpectoral, to be under 20 seconds. This method is considerably faster compared to the others outlined in the literature.

Complications derived from intercostal nerve blocks range from pneumothorax to toxic effects of the local anesthetic. Pneumothorax has varying incidences in the literature. The risk of complications in performing the technique described in this study is virtually zero since the operating surgeon can visualize the anatomy and be reassured that they are delivering the block in the correct location, away from any significant structures.

The use of surgeon-administered intraoperative blocks also eliminates the need for ultrasound machines in the procedure, which can take time to locate, set up, and use, and can delay the procedure length and theater list.

Table 3. Breakdown of OBAS Questionnaire Scores

	POD 1			POD7		
	INB	Control	*P**	INB	Control	*P*
Pain	1.6 ± 0.7	2.1 ± 0.74	0.1380	1 ± 0.94	1.2 ± 0.42	0.5467
Vomiting	0.2 ± 0.63	0.6 ± 0.97	0.2885	0.2 ± 0.42	1 ± 1.15	0.05351
Itchiness	0.4 ± 0.52	1.3 ± 1.42	0.0761	0.1 ± 0.32	1.3 ± 1.77	0.0491
Sweating	0.1 ± 0.32	0.4 ± 0.84	0.3052	0.2 ± 0.63	0.2 ± 0.63	1.0000
Chills	—	—	—	0.2 ± 0.63	0.1 ± 0.32	0.6598
Dizziness	0.1 ± 0.32	0.6 ± 0.7	0.0548	—	0.2 ± 0.63	—
Happiness	3.6 ± 0.7	2.8 ± 0.92	0.0421†	3.7 ± 0.67	3.6 ± 0.52	0.7136
Score	2.8 ± 1.69	6.2 ± 2.3	0.0014†	2 ± 2.4	4.4 ± 2.12	0.0292†

Results presented as means ± SDs.
*Two-sample t-test.
†Statistically significant.

Additionally, ultrasound requires a specialized anesthetist skilled in administering guided regional blocks.

CONCLUSION

The INBs described in this article not only significantly reduce pain scores and opiate consumption but they are also quick, safe, and inexpensive blocks that require little special equipment that any surgeon can administer intraoperatively.

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