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ORIGINAL RESEARCH REGIONAL ANESTHESIA

Analgesic efficacy of erector spinae plane block versus retrolaminar block in patients undergoing major oncological breast surgery: A randomized controlled trial

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ABSTRACT

Background and Objective: Breast cancer is the most common cancer in females. Acute pain after major oncological breast surgery is an important concern. The erector spinae plane block (ESPB) and retrolaminar block (RLB) are ultrasound-guided techniques used for thoracoabdominal wall analgesia. We compared postoperative pain scores using the Numerical Rating Scale (NRS) at multiple time points and opioid consumption during the first 24 hours in patients undergoing major oncological breast surgery.

Methodology: This randomized controlled trial comprised 90 adult females aged 18 to 60 years who were scheduled for major breast surgery under general anesthesia, and had an American Society of Anesthesiologists (ASA) physical status of I or II. Exclusion criteria included bleeding or coagulation diathesis, prior breast surgery, known diabetes, a history of ischemic heart disease or heart block, pedicled flap reconstruction breast surgery, allergy to local anesthetics, local infection at the site of needle puncture, and emergency cases. Participants were randomized into two groups using a computer-generated randomization sequence. Group ESPB received an erector spinae plane block under ultrasound guidance, while Group RLB underwent a retrolaminar block under ultrasound guidance. During the intraoperative phase, rescue analgesia with morphine (dose adjusted according to body weight) was administered if the mean arterial pressure or heart rate increased by more than 20%.

Results: The mean NRS pain scores at 2, 4, 8, 12, and 24 hours were 1.24 ± 0.65, 1.38 ± 0.58, 1.49 ± 0.66, 1.56 ± 0.62, and 1.66 ± 0.67 in the RLB group, and 1.91 ± 0.76, 2.27 ± 0.72, 2.27 ± 0.84, 2.67 ± 0.83, and 2.82 ± 0.75 in the ESPB group, respectively. Mean opioid consumption was significantly lower in the RLB group compared with the ESPB group (2.67 ± 1.54 mg vs. 4.16 ± 1.17 mg; $P < 0.001$).

Conclusion: Following major breast surgery, both ultrasound-guided RLB and ESPB effectively relieved postoperative pain. However, RLB was associated with significantly lower pain scores and opioid consumption compared with ESPB, suggesting it may provide superior analgesia.

Keywords: Breast surgery, retrolaminar block, analgesia, erector spinae plane block, ultrasound-guided.

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1. INTRODUCTION

Pain is a highly unpleasant sensation and has been shown to have a deleterious effect on normal physiological processes.[1] According to the World Health Organization, people who experience persistent pain are four times more likely to suffer from stress than pain-free individuals.[1] Breast cancer is the most prevalent cancer in women, and its incidence is increasing daily.[2,3] In 2020, there were 2.3 million new cases worldwide.[4] Adjuvant therapy and surgery are associated with pain in breast cancer cases.[5] Compared with breast-preserving surgery, women undergoing mastectomy with immediate reconstruction typically experience higher peak pain intensity.[3] Between 30% and 50% of patients report moderate to severe acute postoperative pain, whereas 8% to 25% develop persistent postoperative pain.[6] Research has indicated that acute discomfort following surgery can progress into chronic pain.[7,8] Effective management of acute pain improves recovery, reduces complications, and shortens hospital stay.[9,10] Ultrasound-guided nerve blocks are an important component of multimodal analgesia.[11] Nerve block techniques include paravertebral block, pectoralis block, and serratus anterior block. Thoracic paravertebral block has a well-established analgesic effect in various surgeries, such as breast, kidney, and thoracic procedures.[12] However, locating the paravertebral space is technically challenging and carries a risk of complications.[12] Therefore, newer approaches such as the retrolaminar block (RLB) and erector spinae plane block (ESPB) are now preferred.[11,12] These ultrasound-guided blocks provide adequate postoperative analgesia for breast, thoracic, abdominal, and lumbar surgeries.[8] Both techniques share similar puncture sites and are relatively safe, as the needle tip is not advanced into the paravertebral space.[11,13] In the erector spinae plane block, the target site is between the erector spinae muscle and the transverse process.[12,18] In the retrolaminar block, the target site is between the vertebral lamina and the transversospinalis muscle.[12,18] This avoids the close proximity of the needle tip to the pleura, which is required for accurate placement of a paravertebral block.[12] A previous study showed that both blocks provided similar effectiveness for postoperative analgesia after breast surgery.[7] In that study, the mean post-block pain score after 4 hours was 2.2 ± 1.1 for the retrolaminar block and 2.8 ± 0.9 for the erector spinae plane block.[12]

The aim of this randomized controlled trial was to compare the analgesic efficacy of ultrasound-guided erector spinae plane block and retrolaminar block in adult female patients undergoing major oncological breast surgery, in terms of postoperative pain scores measured by the Numerical Rating Scale (NRS) and total opioid consumption during the first 24 postoperative hours.

2. METHODOLOGY

This randomized controlled trial was conducted in the Department of Anesthesia and Pain Management, Shaukat Khanum Memorial Cancer Hospital and Research Centre, Lahore, between 2022 and 2024. The sample size was calculated based on a previous study by Zhao et al. (2021). Mean post-block pain scores after 4 hours in the retrolaminar versus erector spinae plane block were 2.2 ± 1.1 vs. 2.8 ± 0.9, respectively.[12] At 80% power and a 95% confidence interval, a total of 90 patients (45 in each group) were required for this study. Adult female patients aged 18–60 years with American Society of Anesthesiologists (ASA) physical status I or II, scheduled for major breast surgery, were included. Major oncological breast surgery in this study included simple mastectomy and modified radical mastectomy (MRM). Simple mastectomy refers to removal of the breast tissue with or without sentinel lymph node biopsy, whereas MRM includes breast removal with axillary lymph node dissection.[2] Patients with local anesthetic allergic reactions, local infection at the needle puncture site, emergency cases, bleeding or coagulation diathesis, body mass index (BMI) greater than 35, chronic pain, prior breast surgery, bilateral breast surgery, known diabetes, a history of ischemic heart disease or heart block, and pedicled flap reconstruction breast surgery were excluded.

After receiving approval from the Scientific Review Committee (SRC) and the Institutional Review Board (IRB), the study was conducted. Ninety individuals provided written informed consent. This study was designed as a prospective, single-center, randomized controlled trial. Participants were allocated into two groups using simple randomization generated by a computer-based random number table. Allocation concealment was ensured using sealed, opaque, sequentially numbered envelopes opened only after patient enrollment. The study was single-blinded: patients and postoperative outcome assessors were blinded to group allocation, while the anesthesiologist performing the block was not blinded due to the nature of the intervention.

On arrival in the operating room, standard monitoring was attached as per ASA guidelines, and intravenous access was secured. After oxygenation, induction was done with intravenous propofol (1–2 mg/kg) and atracurium (0.5 mg/kg), and the airway was secured with a supraglottic airway device. Every patient was given paracetamol 1 g IV (if not contraindicated), along with 4 mg dexamethasone. Maintenance anesthesia was standardized with inhalational sevoflurane at approximately 1.0 MAC, with minimal adjustment according to clinical parameters. The MAC was kept consistent across patients to avoid variability in stress response and rescue analgesia requirements. Blocks were performed by two designated consultants with procedural privileges.

Table 1: Comparative age and BMI in two groups

Variable	RLB (n = 45)	ESPB (n = 45)	P-value
Age (years)	39.62 ± 10.57	41.20 ± 8.96	0.446
Age group (years)			
18–40	21 (46.7)	20 (44.4)	0.832
41–60	24 (53.3)	25 (55.6)	
BMI (kg/m²)	28.53 ± 3.86	28.60 ± 3.68	0.930
≤ 30	27 (60.0)	28 (62.2)	0.829
> 30	18 (40.0)	17 (37.8)	

Independent-samples t-test (Welch) or Chi-square test used; as appropriate; Data presented as mean ± SD or n (%)

Table 2: Type of surgery performed (n = 90)

Type of surgery	RLB (n = 45)	ESPB (n = 45)	P-value
Mastectomy	31 (68.9)	30 (66.7)	0.822
Modified radical mastectomy (MRM)	14 (31.1)	15 (33.3)	

Chi-square test used; Data presented as n (%)

Following induction, the patient was placed in the lateral decubitus position. On the patient's back, an ultrasonographic probe (GE Logiq 12L-RS, 13 MHz; parallel design SAS, Valbonne, France) was positioned under aseptic conditions. A Visioplex 20G × 50 mm block needle was used to make contact with the tip of the T5 lamina in the case of a retrolaminar approach or the T5 transverse process in the case of the erector spinae approach. The total dose was kept within a safe range by injecting 30 mL of 0.375% bupivacaine with 0.5 mcg/kg dexmedetomidine following negative aspiration at the hub.

The erector spinae block was performed in Group ESPB under ultrasound guidance. The ultrasound-guided retrolaminar block was administered to Group RLB. During the intraoperative phase, rescue analgesia with morphine (depending on the patient's anticipated dose) was administered if the mean arterial pressure (MAP) or heart rate increased by more than 20%.

All data were collected on a predesigned proforma. Postoperative pain in the recovery room was assessed using the NRS by trained nursing staff, and rescue analgesia was given using morphine when the NRS pain score was ≥4.

Total postoperative opioid consumption during the first 24 hours was recorded and expressed in milligrams of intravenous morphine equivalents. For admitted patients, opioid use was documented through review of the hospital information system (HIS) medication records, whereas patients discharged within 24 hours were contacted telephonically at predetermined intervals to record pain scores and opioid intake. The majority of patients remained hospitalized for at least 24 hours postoperatively, allowing direct in-hospital assessment of pain scores and opioid consumption. At the time of telephonic follow-up, patients who had been discharged within 24 hours reported no requirement for morphine for breakthrough pain. Prior to discharge, all patients were educated on the use of the NRS and instructed to take opioid analgesics only on demand for breakthrough pain. At each follow-up contact, reported pain scores and opioid consumption were reconfirmed and documented.

2.1. Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics version 20. Qualitative data, such as the type of surgery, were organized using frequencies and percentages, while quantitative data, such as age, morphine intake, and pain scores, were summarized using the mean ± standard deviation or median. The mean difference in morphine intake and postoperative pain between the two groups was determined using the post-stratification t-test. A p-value of less than 0.05 was considered statistically significant.

3. RESULTS

All randomized participants received the allocated intervention and completed the study protocol. No patient was lost to follow-up, and all participants were included in the final analysis.

The mean age of the study participants was 40.52 ± 9.12 years, with a range of 18 to 60 years. The mean age of the patients in groups RLB and ESPB was 39.62 ± 10.57 and 41.20 ± 8.96 years, respectively. Table 1 shows that 49 patients, or 54.44% of the total, were between the ages of 41 and 60. All patients were classified as American Society of Anesthesiologists (ASA) physical status II. Table 1 shows that the average body mass index (BMI) was 28.69 ± 3.79 kg/m2. The patient distribution by type of surgery is shown in Table 2.

The mean NRS scores at 2, 4, 8, 12 & 24 hours and the opioid consumption in the groups is given in Table 3.

Independent-sample t-tests demonstrated statistically significant differences in postoperative pain scores between the two groups at all assessed time points. Mean Numerical Rating Scale pain scores at 2, 4, 8, 12, and 24 hours postoperatively were significantly lower in the retrolaminar block group compared with the erector spinae plane block group (t = 4.49, 6.46,

Table 3: Comparison of the outcome between erector spinae plane block and retrolaminar block for major breast surgery (n=90).

Outcome measure	RLB group (n = 45)	ESPB group (n = 45)	t-statistic	P value
Pain score at 2 hours	1.24 ± 0.65	1.91 ± 0.76	4.49	0.0001
Pain score at 4 hours	1.38 ± 0.58	2.27 ± 0.72	6.46	0.0001
Pain score at 8 hours	1.49 ± 0.66	2.27 ± 0.84	4.89	0.0001
Pain score at 12 hours	1.56 ± 0.62	2.67 ± 0.83	7.19	0.0001
Pain score at 24 hours	1.66 ± 0.67	2.82 ± 0.75	7.74	0.0001
Total opioid consumption (mg)	2.67 ± 1.54	4.16 ± 1.17	5.17	0.0001

Independent-sample t-tests used; P < 0.05 is considered significant

4.89, 7.19, and 7.74, respectively; P = 0.0001 for all comparisons).

Similarly, total postoperative opioid consumption during the first 24 hours was significantly lower in the retrolaminar block group than in the erector spinae plane block group (2.67 ± 1.54 mg vs 4.16 ± 1.17 mg; t = 5.17; P = 0.0001).

4. DISCUSSION

This study showed that in individuals undergoing major breast surgery, the analgesic efficacy of RLB and ESPB differed. The two methods differed significantly in terms of postoperative morphine intake, analgesia duration, and pain intensity up to 24 hours after surgery. Modified radical mastectomy includes axillary lymph node dissection and is therefore considered a more invasive surgical procedure.[2] Previous studies have recognized surgical invasiveness as an important factor influencing postoperative pain outcomes in breast surgery.[2,7] In the present study, the distribution of mastectomy and MRM was comparable between the two groups, thereby minimizing potential confounding related to surgical extent.

As a new option to paravertebral block (PVB), the retrolaminar plane block (RLB) was presented as a simpler and more straightforward replacement for the traditional PVB. After making contact with the vertebral lamina, the RLB needle injects the local anesthetic agent (LA).[14] Erector spinae plane block (ESPB), which involves the needle further laterally to reach the transverse process tip, was proposed as a substitute for PVB.[8] The precise process by which RLB and ESPB produce their analgesic effects is yet unclear. While RLB may work via deep dispersion as PVB, even though the injection sites for the two procedures are only a few millimeters apart, ESPB primarily acts via transverse distribution on the lateral cutaneous branch and small branches of the intercostal nerve to produce the analgesic effect.[15,11]

The intercostal nerves' anterior and lateral cutaneous branches are essential for transmitting postoperative pain signals during breast cancer surgery.[16] According to Elsharkawy et al., the lateral cutaneous branch is laterally related to the retrolaminar area and passes through the interfacial plane between the external intercostal muscles and the serratus anterior.[16,17] Consequently, postoperative analgesia following breast cancer surgery may benefit from RLB's blocking of the lateral cutaneous branch. Previous cadaveric studies found inconclusive results.

Previous cadaveric studies demonstrated that contrast dye diffused to one segment only after RLB but to intercostal gaps over 5 to 9 levels after 20 mL in ESPB.[18] In a different investigation, the ESPB injection dye did not color the intercostal nerves or penetrate the paravertebral region.[19] In contrast, Onishi et al. verified lateral distribution after ESPB; nonetheless, in both ESPB and RLB, the diffusion into the paravertebral area was restricted.[15] In contrast to RLB, Yang et al. showed greater lateral dye distribution with ESPB.[20]

Following breast surgery, new prospective, randomized, controlled clinical research showed that RLB and ESPB had comparable analgesic effectiveness. Twenty milliliters of 0.375% levobupivacaine were injected at the level of the fourth thoracic vertebra. The length of analgesia, intraoperative remifentanil intake, and pain severity did not significantly differ between the two methods, according to the authors. Both blocks in the current investigation received 20 mL of levobupivacaine at a concentration of 0.25%. The right amount and dosage of local anesthetic needed for ESPB remain under debate.[21]

In breast surgery, ESPB has been thoroughly explored despite being a relatively recent technique. After breast cancer surgery, the analgesic effectiveness of ESPB was investigated in a meta-analysis that included 679 participants. ESPB was found to be more effective than general anesthesia alone in reducing postoperative morphine use and pain intensity during the first 24 hours following surgery.[8] However, there are limited publications regarding RLB's efficacy in breast surgery. It was discovered to significantly reduce pain and extend the duration of analgesia following breast cancer surgery.[15] Conversely, Hwang et al. demonstrated that RLB administered as a single injection did not lessen the need for postoperative

analgesics or the severity of pain following breast surgery.[14] Continuous RLB and PVB following MRM under GA were compared for their analgesic profiles in a prospective, randomized, double-blind research study. After mastectomy, continuous RLB was effective and, with the exception of the first 24 hours, was not inferior to PVB.[19]

According to Sotome et al.[7], there was no discernible difference between the ESPB and RLB groups' levels of discomfort during the 24 hours after surgery. Consistent with our findings, the ESPB group had a shorter median time before the first postoperative rescue analgesic following block placement than the RLB group. Furthermore, there was no significant variation in the quantity of remifentanil given during anesthesia, according to the study. The analgesic effects of ultrasound-guided RLB and ESPB after retroperitoneal laparoscopic surgery were examined by Liu et al.[13] The two groups' postoperative pain levels during rest and coughing did not significantly differ.

5. LIMITATIONS

It was a small-sample, single-center study. To validate the findings of this investigation, multicenter large-sample clinical trials are necessary. We calculated the sample size, which may have reduced the statistical power to detect differences, assuming that postoperative analgesia of RLB was not inferior to ESPB. We used a specific type of LA at a particular concentration and volume. As a result, we are unable to extrapolate the findings to other LA types and volumes.

6. CONCLUSION

Both retrolaminar block (RLB) and erector spinae plane block (ESPB) provided effective postoperative analgesia following major oncological breast surgery. However, patients who received RLB experienced significantly lower pain scores and reduced opioid requirements compared with those who received ESPB. These findings suggest that while either block may be safely used as part of multimodal analgesia, RLB may offer superior pain control in this surgical population. Larger multicenter trials are recommended to confirm these results and guide clinical practice.

7. Data availability

The numerical data generated during this research is available with the authors.

8. Conflict of interest

All authors declare that there was no conflict of interest.

9. Funding

The study utilized the hospital resources only, and no external or industry funding was involved.

10. Authors' contribution

SMZN: Principal investigator, writer, literature search, and manuscript preparation.

SRM: Conceptualization of the study and conduction of nerve blocks

HS: Manuscript editing and identification of errors.

AA, AI: Conduction of nerve blocks and assistance in data collection

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