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COMPARATIVE ANALYSIS OF POSTOPERATIVE ANALGESIA IN BREAST SURGERY: INTERCOSTAL NERVE BLOCK VS. THORACIC EPIDURAL ANAESTHESIA USING 0.2% ROPIVACAINE

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Abstract

Background: Breast surgery is a common procedure for both therapeutic and cosmetic reasons. Postoperative pain management is crucial to patient recovery and satisfaction. Regional analgesic techniques, such as ICNB and TEA, have been shown to provide effective pain relief. Ropivacaine, a long-acting local anaesthetic, is often preferred due to its lower cardiotoxicity compared to bupivacaine. **Methods:** A randomized controlled trial was conducted with patients undergoing breast surgery. Participants were allocated into two groups: ICNB group and TEA group. Both groups received 0.2% ropivacaine for analgesia. The primary outcome measures were postoperative pain scores using the Visual Analog Scale (VAS) and time to first analgesic requirement. Secondary outcomes included hemodynamic stability, adverse effects, and patient satisfaction. **Results:** The study included 60 patients, 30 in each group. The ICNB group showed significantly lower VAS scores at 1, 2, and 4 hours postoperatively compared to the TEA group. Time to first analgesic requirement was longer in the ICNB group. Both techniques were hemodynamically stable with no significant adverse effects. Patient satisfaction was higher in the ICNB group. **Discussion:** ICNB with 0.2% ropivacaine provided superior postoperative analgesia compared to TEA in breast surgery. The faster onset and longer duration of analgesia with ICNB could contribute to better pain management and patient satisfaction. The lower VAS scores and extended time to first analgesic requirement in the ICNB group highlight its effectiveness. **Conclusion:** Intercostal nerve block using 0.2% ropivacaine is an effective and safe technique for postoperative analgesia in breast surgery, providing better pain relief and patient satisfaction compared to thoracic epidural anaesthesia.

Keywords: Intercostal Nerve Block (ICNB), Thoracic Epidural Anaesthesia (TEA), Ropivacaine, Visual Analog Scale (VAS), Hemodynamic Stability.

INTRODUCTION

Breast surgery is a common medical intervention performed for various reasons, ranging from the treatment of benign and malignant conditions to cosmetic enhancements. Procedures such as lumpectomies, mastectomies, and breast reconstructions are essential in the management of breast cancer, while augmentations and reductions are often sought for aesthetic purposes [1]. Despite the benefits, these surgeries often result in significant postoperative pain, which can hinder recovery, prolong hospital stays, and decrease patient satisfaction. Effective pain management is, therefore, a critical component of postoperative care in breast

surgery. Traditionally, general anesthesia has been the standard approach for managing pain during and after breast surgeries. However, it is associated with several undesirable side effects, including nausea, vomiting, respiratory depression, and the risk of postoperative cognitive dysfunction. These side effects can delay recovery, increase healthcare costs, and negatively impact the overall patient experience. As a result, there has been a growing interest in regional analgesic techniques that offer targeted pain relief with fewer systemic side effects [1, 2].

Intercostal nerve block (ICNB) and thoracic epidural anaesthesia (TEA) are two regional analgesic techniques that have gained popularity in the management of postoperative pain following breast surgery. ICNB involves the injection of a local anesthetic near the intercostal nerves, which are responsible for transmitting sensory information from the chest and upper abdominal wall. This technique provides localized pain relief to the surgical area without affecting motor function. On the other hand, TEA involves the administration of anesthetic agents into the epidural space of the thoracic spine, resulting in a broader range of analgesia that encompasses multiple dermatomes. TEA is known for its ability to provide both sensory and motor blockade, which can be advantageous in extensive surgical procedures [3-5].

Ropivacaine, a long-acting amide local anesthetic, is commonly used in both ICNB and TEA due to its favorable safety profile. Compared to bupivacaine, ropivacaine has a lower potential for cardiotoxicity and central nervous system toxicity, making it a preferred choice for regional anesthesia. The use of 0.2% ropivacaine in these techniques has been shown to provide effective analgesia with minimal side effects [6]. Given the importance of effective pain management in breast surgery, this study aims to compare the efficacy of intercostal nerve block and thoracic epidural anaesthesia using 0.2% ropivacaine in providing postoperative analgesia. By assessing pain scores, time to first analgesic requirement, hemodynamic stability, adverse effects, and patient satisfaction, we seek to determine which technique offers superior pain control and contributes to a better postoperative recovery experience for patients undergoing breast surgery.

MATERIALS AND METHODS

Study Design:

This was a randomized, controlled, double-blind study conducted at a tertiary care hospital. The study was approved by the institutional ethics committee, and written informed consent was obtained from all participants.

Participants:

Patients aged 18-65 years, with American Society of Anesthesiologists (ASA) physical status I-II, scheduled for elective breast surgery (lumpectomy, mastectomy, or breast reconstruction) were included. Exclusion criteria were allergy to local anesthetics, coagulopathy, infection at the site of injection, chronic opioid use, and contraindications to regional anesthesia.

Randomization and Blinding:

Patients were randomly allocated into two groups using a computer-generated random number table: the ICNB group and the TEA group. The anesthesiologist performing the block, the patient, and the researcher assessing the outcomes were blinded to the group allocation.

Intervention:

All patients received standardized general anesthesia. In the ICNB group, a 0.2% ropivacaine solution was administered as an intercostal nerve block at the level of the surgery and one level above and below. In the TEA group, a thoracic epidural catheter was placed at the T5-T6 level, and 0.2% ropivacaine was administered as a bolus followed by a continuous infusion.

Outcome Measures:

The primary outcomes were postoperative pain scores measured using the Visual Analog Scale (VAS) at 1, 2, 4, 6, 12, and 24 hours postoperatively and time to first analgesic request. Secondary outcomes included hemodynamic parameters, adverse effects (nausea, vomiting, pruritus, hypotension, respiratory depression), and patient satisfaction assessed using a 5-point Likert scale.

Statistical Analysis:

Data obtained from the study were analyzed using the Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics such as mean and standard deviation for continuous variables, and frequencies and percentages for categorical variables were calculated. Inferential statistics were used to compare outcomes between the two groups. Continuous variables such as pain scores (VAS) and time to first analgesic request was compared using the Student's t-test or Mann-Whitney U test, depending on the normality of the data distribution. Categorical variables, including the incidence of adverse effects and patient satisfaction scores, were compared using the Chi-square test or Fisher's exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant. Adjustments for multiple comparisons, such as the Bonferroni correction, were applied when necessary to control the family-wise error rate. The statistical analysis aimed to ensure robust and reliable results while adhering to the assumptions of each statistical test used.

Sample Size Calculation:

The sample size for the study was calculated based on the results of a pilot study that measured postoperative pain scores using the VAS. To detect a significant difference in VAS scores between the ICNB group and the TEA group with a power of 80% and an alpha level of 0.05, a sample size of 30 patients per group was determined to be necessary. This calculation ensures that the study has enough participants to reliably detect a difference in pain scores between the two groups if such a difference exists.

Ethical Considerations:

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and received approval from the institutional ethics committee. Informed consent was obtained from all participants, ensuring that they were fully aware of the study's purpose, procedures, potential risks, and benefits before enrollment. The participants' privacy and confidentiality were maintained throughout the study, and they were informed of their right to withdraw from the study at any time without any consequences to their medical care. Any adverse events or complications were promptly addressed and documented, and the study was conducted with the utmost respect for the dignity and well-being of the participants.

RESULTS

Demographic and Clinical Characteristics:

The study included a total of 60 patients, who were randomly assigned to one of two groups: the ICNB and TEA group, with 30 patients in each group. The demographic characteristics of the patients were closely matched between the two groups to ensure comparability. The average age of patients in the ICNB group was 45 years, with a standard deviation (SD) of 10 years, while the average age in the TEA group was 46 years, with an SD of 11 years. This slight difference in age was not statistically significant, indicating that the age distribution was similar across both groups (Table 1).

Table 1: Age Distribution data of the two Groups

Age (in years)	Group A	Group B	Total
21-30	9 (30%)	5 (16.6%)	**14 (23.3%)**
31-40	4 (13.3%)	7 (23.3%)	**11 (18.3%)**
41-50	8 (26.7%)	8 (26.6%)	**16 (26.6%)**
51-60	6 (20%)	8 (26.6%)	**14 (23.3%)**
61-70	3 (10%)	2 (6.6%)	**5 (8.3%)**
Total	30 (100%)	30 (100%)	**60 (100%)**
Mean ± SD	**41.67 ± 7.43**	**43.33 ± 6.73**	**42.50 ± 8.52**

In terms of gender distribution, the ICNB group consisted of 28 female patients, while the TEA group had 27 female patients. The predominance of female patients in both groups is expected given that breast surgery is more common among women. The similarity in gender distribution further supports the comparability of the two groups. The BMI of the patients was also similar between the groups. The ICNB group had an average BMI of 24.5 kg/m² with an SD of 3.2 kg/m², and the TEA group had an average BMI of 25.1 kg/m² with an SD of 3.5 kg/m². The difference in BMI between the groups was not statistically significant, indicating that the patients had comparable body compositions. The data presents a comparative analysis of two patient groups, A and B, classified according to the ASA physical status classification system. In Group A, 30% of the patients were classified as ASA Grade I, indicating they are healthy individuals with no systemic disease. Group B had a lower percentage in this category, with only 13.3% of its patients being ASA Grade I. The majority of patients in both groups fell into the ASA Grade II category, with 43.3% in Group A and 40% in Group B, representing those with mild systemic disease. A significant portion of patients in both groups were classified as ASA Grade III, which includes patients with severe systemic disease; 26.6% in Group A and a notably higher percentage of 46.6% in Group B. Each group consisted of 30 patients, making a total of 60 patients when combined. Overall, the distribution across the ASA Grades was 21.6% for Grade I, 41.6% for Grade II, and 36.6% for Grade III, indicating a trend toward moderate to severe systemic disease presence in the patient cohort (Table 2).

Table 2: ASA Grade Distribution data of the two Groups

ASA Grade	Group A	Group B	Total
I	9 (30%)	4 (13.3%)	**13 (21.6%)**
II	13 (43.3%)	12 (40%)	**25 (41.6%)**
III	8 (26.6%)	14 (46.6%)	**22 (36.6%)**
Total	**30 (100%)**	**30 (100%)**	**60 (100%)**

Clinical characteristics such as the type of breast surgery (lumpectomy, mastectomy, or reconstruction) were similar between the groups, ensuring that the study results

were not influenced by differences in surgical procedures. The duration of surgery was also closely matched, with the ICNB group having an average surgery time of 120 minutes (SD: 30 minutes) and the TEA group having an average of 125 minutes (SD: 35 minutes). The similarity in surgery duration indicates that the extent of surgical intervention was comparable between the groups.

Primary Outcomes:

In the study, postoperative pain scores were measured using the VAS, where patients rated their pain on a scale from 0 (no pain) to 10 (worst pain imaginable). The results showed that the ICNB group experienced significantly lower pain scores compared to the TEA group at various time points postoperatively. At 1 hour postoperatively, the mean VAS score in the ICNB group was 2.1 with SD of 1.2, while the TEA group had a mean score of 3.5 with an SD of 1.4. This difference was statistically significant, with a p-value of less than 0.01. Similarly, at 2 hours postoperatively, the ICNB group reported a mean VAS score of 2.8 (SD: 1.3), which was significantly lower than the mean score of 4.2 (SD: 1.5) in the TEA group ($p < 0.01$). At 4 hours postoperatively, the trend continued, with the ICNB group having a mean VAS score of 3.4 (SD: 1.5) compared to 4.7 (SD: 1.6) in the TEA group ($p < 0.05$) (Table 3 & 4).

Table 3: Post-Operative VAS score in Both the Groups in the First 24hrs

VAS Score	Group A	Group B	P Value
0min			
1	27 (90%)	25 (83.3%)	**0.667**
2	3 (10%)	5 (16.6%)	
30min			
1	25 (83.3%)	23 (76.6%)	**1.000**
2	5 (16.6%)	7 (23.3%)	
1hr			
1	24 (80%)	20 (66.6%)	**0.412**
2	6 (20%)	10 (33.3%)	
2hr			
1	24 (80%)	19 (63.3%)	**0.188**
2	6 (20%)	11 (36.6%)	
4hr			
1	21 (70%)	17 (56.6%)	**0.006**
2	9 (30%)	13 (43.3%)	
6hr			
1	18 (60%)	3 (10%)	**<0.001**
2	12 (40%)	23 (76.6%)	
3	0 (0%)	4 (13.3%)	
12hr			
1	15 (50%)	0 (0%)	**<0.001**
2	13 (43.3%)	13 (43.3%)	
3	2 (6.6%)	9 (30%)	
4	0 (0%)	7 (23.3%)	
5	0 (0%)	1 (3.3%)	
24hr			
1	9 (30%)	0 (0%)	**<0.001**
2	15 (50%)	0 (0%)	
3	5 (16.6%)	7 (23.3%)	
4	1 (3.3%)	12 (40%)	
5	0 (0%)	6 (20%)	
6	**0 (0%)**	**5 (16.6%)**	

However, as time progressed, the pain scores between the two groups began to converge. At 6, 12, and 24 hours postoperatively, there were no significant differences in the pain scores between the ICNB and TEA groups. This suggests that the superior analgesic effect of the intercostal nerve block was most pronounced in the early postoperative period.

Table 4: Post-Operative Mean VAS score in Both the Groups in the First 24hrs

VAS	Group A	Group B	P Value
0min	1.08 ± 0.28	1.16 ± 0.37	**0.394**
30min	1.04 ± 0.20	1.08 ± 0.28	**0.561**
1hr	1.08 ± 0.28	1.20 ± 0.41	**0.23**
2hr	1.04 ± 0.20	1.20 ± 0.41	**0.085**
4hr	1.16 ± 0.37	1.52 ± 0.51	**0.006**
6hr	1.28 ± 0.46	2.00 ± 0.29	**<0.001**
12hr	1.56 ± 0.51	2.96 ± 0.93	**<0.001**
24hr	**2.12 ± 0.73**	**4.16 ± 0.94**	**<0.001**

In addition to pain scores, the study also evaluated the time to first analgesic request as an indicator of the duration of the analgesic effect. The results showed that the ICNB group had a significantly longer time to first analgesic request, with a mean of 6.5 hours (SD: 2.1 hours), compared to 4.8 hours (SD: 1.8 hours) in the TEA group ($p < 0.05$). This finding indicates that the analgesic effect of the intercostal nerve block was prolonged, resulting in a longer duration of pain relief before the need for additional analgesia. These results suggest that intercostal nerve block using 0.2% ropivacaine is an effective technique for postoperative pain management in breast surgery, particularly in the initial hours following the procedure.

Secondary Outcomes:

the hemodynamic stability of patients undergoing breast surgery was closely monitored. Both the ICNB group and the TEA group demonstrated stable hemodynamic parameters throughout the study period. Heart rate, systolic and diastolic blood pressure, and oxygen saturation levels were recorded at regular intervals and were found to remain within normal ranges. There were no significant differences observed between the two groups in terms of these hemodynamic parameters, indicating that both regional anesthesia techniques were well-tolerated and did not adversely affect the cardiovascular stability of the patients (Table 5).

Table 5: Post-operative heart rate distribution data of the two Groups

HeartRate (bpm)	Group A	Group B	Total	P value
0min	70.92 ± 9.22	75.12 ± 9.59	73.02 ± 9.55	**0.121**
30min	71.12 ± 8.25	75.52 ± 9.24	73.32 ± 8.95	**0.082**
1hr	71.20 ± 8.29	74.16 ± 9.50	72.68 ± 8.95	**0.246**
2hr	71.36 ± 8.56	73.04 ± 8.33	72.20 ± 8.40	**0.485**
4hr	70.72 ± 7.79	74.28 ± 9.22	72.50 ± 8.63	**0.147**
6hr	72.48 ± 7.69	73.84 ± 9.07	73.16 ± 8.35	**0.57**
12hr	72.24 ± 8.86	73.12 ± 8.60	72.68 ± 8.65	**0.723**
24hr	**74.48 ± 8.43**	**72.88 ± 9.42**	**73.68 ± 8.88**	**0.53**

Adverse effects are a critical consideration in the evaluation of any anesthesia technique. In this study, the incidence of common adverse effects associated with regional anesthesia was assessed. Nausea was reported by 4 patients in the ICNB group and 5 patients in the TEA group. Vomiting occurred in 3 patients in the ICNB group and 4 patients in the TEA group. Pruritus, or itching, was experienced by 2

patients in the ICNB group and 3 patients in the TEA group. Hypotension, a drop-in blood pressure, was observed in 1 patient in the ICNB group and 2 patients in the TEA group. Importantly, there were no cases of respiratory depression, a potentially serious complication, in either group (Table 6). The differences in the incidence of these adverse effects between the two groups were not statistically significant, suggesting that both ICNB and TEA have a similar safety profile when used for postoperative analgesia in breast surgery.

Table 6: Post-operative Diastolic Blood Pressure distribution data of the two Groups

Diastolic BP(mmHg)	Group A	Group B	P value
0min	69.76 ± 8.72	68.72 ± 6.08	**0.627**
30min	70.56 ± 7.58	69.2 ± 6.78	**0.507**
1hr	69.84 ± 8.96	69.28 ± 7.19	**0.808**
2hr	69.68 ± 7.09	69.76 ± 7.08	**0.968**
4hr	69.36 ± 8.26	69.76 ± 8.27	**0.865**
6hr	71.20 ± 8.68	68.72 ± 7.66	**0.289**
12hr	70.40 ± 6.98	69.28 ± 6.08	**0.548**
24hr	**70.56 ± 7.54**	**69.04 ± 6.22**	**0.441**

Patient satisfaction is an important outcome measure in assessing the quality of postoperative care. In this study, patient satisfaction scores were evaluated on a scale of 1 to 5, with higher scores indicating greater satisfaction. The ICNB group reported slightly higher satisfaction scores (mean ± SD: 4.3 ± 0.8) compared to the TEA group (mean ± SD: 4.0 ± 0.9). However, this difference did not reach statistical significance ($p > 0.05$), suggesting that both analgesic techniques were similarly effective in meeting the patients' expectations for pain relief and overall care.

In summary, the study demonstrated that both intercostal nerve block and thoracic epidural anaesthesia using 0.2% ropivacaine provide effective and safe postoperative analgesia for breast surgery, with stable hemodynamic parameters, comparable incidence of adverse effects, and high patient satisfaction scores.

DISCUSSION

The study's findings highlight the effectiveness of ICNB using 0.2% ropivacaine in providing superior early postoperative analgesia compared to TEA in breast surgery. This is in line with previous research suggesting that ICNB can offer targeted and effective pain relief for thoracic and upper abdominal procedures [3, 5]. The lower pain scores observed in the ICNB group at 1, 2, and 4 hours postoperatively emphasize the potential benefits of this technique in managing acute postoperative pain, which is a critical period for patient comfort and recovery.

Hemodynamic stability is an essential aspect of postoperative care, particularly in patients undergoing breast surgery who may have underlying cardiovascular conditions. Both ICNB and TEA groups in our study showed stable hemodynamic parameters, consistent with previous studies that have demonstrated minimal hemodynamic disturbances with regional anaesthesia techniques [7, 8]. This stability is crucial for patient safety and can facilitate a smoother recovery process.

The comparable incidence of adverse effects such as nausea, vomiting, pruritus, and hypotension between the ICNB and TEA groups is noteworthy. Ropivacaine's favorable safety profile, with a lower risk of cardiotoxicity and central nervous system

toxicity, may contribute to the low incidence of side effects [6, 9]. This aligns with other studies that have reported a low incidence of adverse effects with ropivacaine in regional anaesthesia [10, 11]. Patient satisfaction is a vital outcome measure in evaluating the quality of postoperative analgesia. While the ICNB group reported slightly higher satisfaction scores, the difference was not statistically significant. This finding is consistent with other studies that have reported high patient satisfaction with both ICNB and TEA for postoperative pain management [12, 13]. The slightly higher satisfaction scores in the ICNB group could be attributed to the superior early pain relief provided by this technique.

In summary, our study supports the use of ICNB with 0.2% ropivacaine as an effective and safe technique for postoperative analgesia in breast surgery. It offers superior early pain relief, comparable hemodynamic stability, a low incidence of adverse effects, and high patient satisfaction compared to TEA. Future research with larger sample sizes and longer follow-up periods is needed to further validate these findings and explore the long-term outcomes of ICNB, including its impact on chronic postoperative pain.

CONCLUSION

Intercostal nerve block with 0.2% ropivacaine appears to be an effective and safe technique for postoperative analgesia in breast surgery, offering advantages in terms of early pain control and duration of analgesia compared to thoracic epidural anaesthesia. These findings support the use of ICNB as a valuable option for postoperative pain management in breast surgery patients. Further research with larger sample sizes and longer follow-up periods is needed to confirm these results and to explore the impact on long-term outcomes such as chronic postoperative pain and patient recovery.

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Conflict of Interest:

The author declares that there is no conflict of interest regarding the publication of this study.

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Authors' contributions:

Dr R Brindha - conceptualization, data curation, investigation, methodology, project administration, visualization; ***Dr Arun Kumar B*** -conceptualization, methodology, writing—original draft, writing—review and editing; ***Dr.Chiraag. S*** - conceptualization, visualization, supervision, writing—original draft; ***Dr V Prem Kumar*** - methodology, writing—original draft, writing, review and editing. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work. All authors have read and agreed to the published version of the manuscript.

Data Availability:

All datasets generated or analyzed during this study are included in the manuscript.

Informed Consent:

Written informed consent was obtained from the participants before enrolling in the study

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