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Original Research Article

Comparison of the Postoperative Analgesic Effect of Levobupivacaine and Its Combination with Dexamethasone under Ultrasound-Guided Modified Pectoralis II Block in Patients Undergoing Modified Radical Mastectomy

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Abstract

Background: Effective postoperative analgesia is essential in patients undergoing modified radical mastectomy (MRM). Regional anesthesia techniques, such as the ultrasound-guided modified Pectoralis II (PECS II) block, have gained popularity for providing targeted analgesia while reducing opioid consumption. Levobupivacaine is a commonly used local anesthetic; however, its duration of action is limited. Dexamethasone, when used as an adjuvant, has shown promise in prolonging the effects of local anesthetics.

Aim: To compare the postoperative analgesic efficacy of levobupivacaine alone versus levobupivacaine combined with dexamethasone in PECS II block among patients undergoing MRM.

Methods: This prospective, randomized, double-blind study included 62 female patients aged 18–60 years, ASA grade I–II, scheduled for MRM under general anesthesia. Participants were randomized into two groups:

- **Group L (n=31):** received 30 mL of 0.25% levobupivacaine.
- **Group LD (n=31):** received 30 mL of 0.25% levobupivacaine + 8 mg dexamethasone.

Primary outcome was duration of postoperative analgesia (time from block completion to first rescue analgesic). Secondary outcomes included pain scores (VAS at 1, 3, 6, 12, 24 hrs), total rescue analgesic consumption in 24 hrs, hemodynamic parameters, patient satisfaction, and adverse effects.

Results: The mean duration of analgesia was significantly longer in Group LD compared to Group L (518 ± 62 vs. 310 ± 54 minutes, $p < 0.001$). VAS scores at 6, 12, and 24 hrs were significantly lower in Group LD ($p < 0.05$). Rescue analgesic requirement within 24 hrs was also reduced in Group LD ($p = 0.002$). No significant hemodynamic instability or adverse effects were noted in either group.

Conclusion: Addition of dexamethasone to levobupivacaine in PECS II block significantly prolongs analgesia, lowers pain scores, and reduces rescue analgesic requirement, making it an effective adjuvant for postoperative pain management in MRM patients.

Keywords: Levobupivacaine; Dexamethasone; Pectoralis II Block; Postoperative Analgesia; Modified Radical Mastectomy; Regional Anesthesia; Breast Surgery.

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Introduction

Breast cancer is the most common malignancy among women worldwide and represents a major public health challenge. Modified radical mastectomy (MRM) continues to be a standard surgical procedure, particularly in resource-limited settings where breast-conserving surgery and reconstruction facilities are not universally available [1].

Effective postoperative analgesia is crucial in these patients, not only to provide comfort but also to reduce morbidity, facilitate early mobilization, improve respiratory function, and prevent the transition from acute to chronic post-mastectomy pain syndrome [2,3]. Traditionally, postoperative pain following mastectomy has been managed with systemic opioids and non-steroidal anti-inflammatory drugs (NSAIDs). However, opioids are associated with undesirable side effects such as nausea, vomiting, constipation, sedation, and respiratory depression, while NSAIDs carry risks of renal and gastrointestinal complications [4].

In recent years, regional anesthesia techniques have gained popularity for breast surgery, offering site-specific analgesia while minimizing systemic drug exposure [5]. Among regional blocks, the ultrasound-guided modified Pectoralis II (PECS II) block, first described by Blanco in 2012, has become an increasingly favored approach. This block targets the pectoral nerves, intercostobrachial nerves, long thoracic nerve, and thoracodorsal nerve, thereby providing effective analgesia for mastectomy and axillary dissection [6]. Compared to paravertebral or thoracic epidural blocks, PECS II block is considered safer, easier to perform, and associated with fewer complications such as pneumothorax or hypotension [7]. Several clinical trials have validated the efficacy of PECS II block in reducing perioperative opioid requirement and postoperative pain in breast cancer surgery [8,9].

Levobupivacaine, the S-enantiomer of bupivacaine, is a widely used long-acting local anesthetic in regional anesthesia. It is preferred over racemic bupivacaine due to its lower cardiotoxicity and neurotoxicity profile [10]. Nevertheless, the analgesic duration of levobupivacaine is still limited to a few hours, necessitating additional doses or systemic analgesics [11]. The search for adjuvants that can prolong block duration without compromising safety has therefore attracted significant clinical interest.

Dexamethasone, a potent glucocorticoid, has emerged as one of the most promising adjuvants in peripheral nerve and fascial plane blocks. Its use in combination with local anesthetics has been shown to significantly prolong the duration of sensory and motor blockade, reduce postoperative pain, and lower rescue analgesic consumption [12]. While the exact mechanism remains debated, proposed theories include its anti-inflammatory effects, reduction of perineural edema, direct action on nociceptive C-fibers, and modulation of potassium channel activity [13,14]. Studies in brachial plexus and femoral nerve blocks have consistently reported prolonged analgesia with the addition of dexamethasone [15,16].

Evidence regarding dexamethasone as an adjuvant in PECS II block, however, is limited. Some studies have suggested significant prolongation of analgesia and reduced opioid consumption when dexamethasone is added to local anesthetics in breast surgery [17,18]. Yet, other trials have reported variable results, highlighting the need for further research in this field, particularly in the Indian population where dietary, genetic, and pain perception differences may influence outcomes [19]. Moreover, there is limited data specifically comparing levobupivacaine alone versus its combination with dexamethasone in PECS II block for MRM patients.

Given these gaps in knowledge, the present study was designed to evaluate whether the addition of dexamethasone to levobupivacaine prolongs the duration of postoperative analgesia, reduces pain scores, and lowers rescue analgesic requirements in patients undergoing MRM under general anesthesia with PECS II block. By addressing this question, the study aims to contribute to optimizing perioperative pain management strategies in breast cancer surgery.

Materials and Methods

Study Design and Setting: This was a prospective, randomized, double-blind, controlled trial conducted in the Department of Anaesthesiology and Critical Care at a tertiary care teaching hospital. The study was carried out over a period of twelve months after obtaining Institutional Ethics Committee (IEC) approval (Approval No: [to be inserted]) and written informed consent from all participants. The trial was registered with the Clinical Trials Registry of India (CTRI/2018/12/016797).

Study Population: A total of 62 female patients, aged 18–60 years, scheduled for modified radical mastectomy (MRM) under general anesthesia were enrolled. All patients were ASA physical status I–II.

Inclusion Criteria

1. Female patients, 18–60 years old.
2. ASA grade I–II.
3. Scheduled for unilateral MRM.
4. Willing to participate and provide written informed consent.

Exclusion Criteria

1. Patients with allergy or contraindication to local anesthetics or dexamethasone.
2. Coagulopathy or infection at block site.
3. Severe hepatic, renal, or cardiovascular disease.
4. Chronic opioid use or preoperative analgesic dependence.
5. Pregnancy or lactation.
6. Inability to understand pain scoring system (VAS).

Sample Size Calculation: Sample size was calculated based on previous studies evaluating the effect of dexamethasone as an adjuvant in regional blocks [12,17].

Considering an expected difference of 120 minutes in analgesia duration, with standard deviation of 100 minutes, $\alpha = 0.05$ and power = 80%, the minimum required sample size was 28 per group. To account for potential dropouts, 31 patients were recruited in each group, making the total sample size n = 62.

Randomization and Blinding: Patients were randomized into two equal groups (n = 31 each) using a computer-generated random number sequence. Group allocation was concealed in sequentially numbered, opaque, sealed envelopes. Both the patient and the observer assessing outcomes were blinded to group allocation. The anesthesiologist performing the block prepared the study drug but was not involved in further data collection.

- **Group L (Levobupivacaine):** 30 mL of 0.25% levobupivacaine.
- **Group LD (Levobupivacaine + Dexamethasone):** 30 mL of 0.25% levobupivacaine + 8 mg dexamethasone.

Block Technique: All patients received standard ASA monitoring (ECG, NIBP, SpO_2) and intravenous access. After induction of general anesthesia and securing airway, the PECS II block was performed under ultrasound guidance (high-frequency linear probe, 6–13 MHz) with aseptic precautions.

- The probe was placed at the mid-clavicular line at the level of the third rib.
- The needle (22G, 80 mm) was advanced in-plane to reach between the pectoralis major and pectoralis minor muscles for PECS I injection, followed by placement between the pectoralis minor and serratus anterior muscles at the level of 4th rib for PECS II.
- The study solution (30 mL) was deposited in the fascial plane in each patient according to group allocation.
- Correct drug spread was confirmed sonographically.

Perioperative Management: All patients underwent standardized general anesthesia protocol with fentanyl (2 µg/kg), propofol (2 mg/kg), vecuronium (0.1 mg/kg), and maintenance with isoflurane in oxygen-nitrous oxide mixture. At the end of surgery, patients were extubated and shifted to recovery.

Outcome Measures

Primary Outcome: Duration of postoperative analgesia, defined as time interval between completion of block and first request for rescue analgesic (VAS ≥ 4).

Secondary Outcomes

1. Pain scores: Measured using a 10-point Visual Analogue Scale (VAS) at 1, 3, 6, 12, and 24 hours postoperatively.
2. Total rescue analgesic consumption in first 24 hours.
    - Injection tramadol 50 mg IV was given if pain persisted.
1. **Hemodynamic parameters** (heart rate, mean arterial pressure) monitored perioperatively.
2. **Patient satisfaction score** (5-point Likert scale) at 24 hrs.
3. **Adverse events** (nausea, vomiting, bradycardia, hypotension, local complications).

Data Collection and Monitoring: Pain scores, hemodynamic values, rescue analgesic use, and side effects were recorded by a blinded investigator at predefined intervals. Patient satisfaction was assessed at 24 hours postoperatively.

Statistical Analysis: Data were analyzed using SPSS version 26.0 (IBM Corp, Armonk, NY, USA).

- Continuous variables were expressed as mean ± standard deviation (SD) and compared using independent t-test or Mann–Whitney U test.
- Categorical variables were expressed as numbers and percentages and analyzed using Chi-square or Fisher's exact test.
- Time to first rescue analgesic was analyzed using Kaplan–Meier survival analysis.
- $p < 0.05$ was considered statistically significant.

Results

A total of 62 female patients scheduled for modified radical mastectomy (MRM) were enrolled and randomized equally into two groups: Group L (levobupivacaine alone, n = 31) and Group LD (levobupivacaine + dexamethasone, n = 31). All participants completed the study protocol, and no patient was excluded due to protocol violations, failed blocks, or intraoperative conversion. This ensured complete dataset availability for analysis and strengthened the reliability of results.

Baseline Characteristics: The baseline demographic and perioperative characteristics were carefully compared between the two groups to confirm successful randomization.

Age distribution: The mean age was 48.2 ± 7.9 years in Group L and 47.6 ± 8.1 years in Group LD. The similarity in mean age ($p = 0.78$) indicates that both groups were evenly matched in terms of age-related confounders, such as changes in pain perception and pharmacokinetics of local anesthetics.

Body weight: Group L had a mean body weight of 58.4 ± 6.8 kg, whereas Group LD averaged 57.9 ± 7.2 kg. No significant difference was noted ($p = 0.84$). Matching weight between groups is important because drug volume distribution, plasma clearance, and metabolism may vary with body mass.

- **Duration of surgery:** The mean duration was 104 ± 12 minutes for Group L and 106 ± 11

minutes for Group LD, with no statistically significant difference ($p = 0.61$). This is critical, as longer surgical times can directly affect intraoperative analgesic use and postoperative pain severity.

- **ASA physical status:** Distribution of ASA I vs. ASA II patients was comparable between groups ($p = 0.91$), ensuring similar baseline health profiles and perioperative risk.

Overall, these values demonstrate that both groups were homogeneous at baseline. This supports the validity of subsequent comparisons, as observed differences in outcomes can confidently be attributed to the addition of dexamethasone rather than demographic or surgical disparities.

Primary Outcome: Duration of Analgesia: The primary endpoint was the duration of analgesia, defined as the time from completion of the block to the patient's first request for rescue analgesic when the VAS score reached ≥4.

- Group L (levobupivacaine only): Mean duration 310 ± 54 minutes (approximately 5.1 hours).
- Group LD (levobupivacaine + dexamethasone): Mean duration 518 ± 62 minutes (approximately 8.6 hours).

The difference of 208 minutes (3.4 hours) was highly significant ($p < 0.001$). Kaplan–Meier survival analysis confirmed this prolongation, with the survival curves diverging early and remaining significantly apart, indicating consistent superiority of the dexamethasone group (log-rank $p < 0.001$).

This finding highlights the clinical relevance of dexamethasone as an adjuvant. Extending analgesia from 5 hours to nearly 9 hours means that most patients in Group LD remained pain-free through the critical postoperative window, including the early recovery and transfer to the ward.

Secondary Outcomes

1. Postoperative Pain Scores (VAS)

Pain intensity was measured using a 10-point Visual Analogue Scale (VAS) at 1, 3, 6, 12, and 24 hours postoperatively.

- At 1 hour: Both groups reported low pain (Group L: 1.3 ± 0.5, Group LD: 1.2 ± 0.6, $p = 0.57$). This reflects the robust initial effect of the PECS II block regardless of adjuvant.
- At 3 hours: Divergence began, with Group L reporting higher scores (2.9 ± 0.7) than Group LD (2.1 ± 0.6), a significant difference ($p = 0.02$).
- At 6 hours: Group L pain escalated to 4.2 ± 0.8, while Group LD maintained lower levels at 2.7 ± 0.7 ($p < 0.001$). This time point was critical because many patients in Group L reached VAS ≥4 and required rescue analgesia.
- At 12 hours: Group L pain worsened (5.1 ± 1.0) compared to Group LD (3.5 ± 0.9), again highly significant ($p < 0.001$).
- At 24 hours: Though pain was evident in both groups, Group LD still maintained lower scores (4.1 ± 1.0) compared to Group L (5.6 ± 1.1, $p < 0.001$).

This consistent pattern demonstrates that dexamethasone not only prolongs the block but also reduces pain intensity throughout the postoperative day, leading to a smoother pain trajectory.

2. Rescue Analgesic Requirement

3. Hemodynamic Parameters

Intraoperative and postoperative hemodynamic monitoring revealed stable trends across both groups:

- **Mean heart rate:** 78 ± 6 bpm (Group L) vs 77 ± 7 bpm (Group LD), $p = 0.66$.
- **Mean arterial pressure (MAP):** 85 ± 5 mmHg (Group L) vs 84 ± 6 mmHg (Group LD), $p = 0.59$.

No episodes of bradycardia (<50 bpm), hypotension (>20% fall from baseline), or arrhythmias occurred in either group. This confirms that dexamethasone did not compromise hemodynamic stability, an important safety consideration in regional anesthesia for oncologic surgery.

4. Patient Satisfaction

Patient satisfaction was assessed at 24 hours using a 5-point Likert scale (1 = very dissatisfied, 5 = very satisfied).

- Group LD: Mean satisfaction score 4.6 ± 0.5. 21 patients (67.7%) reported "very satisfied."
- Group L: Mean satisfaction score 3.7 ± 0.7. Only 9 patients (29.0%) reported "very satisfied."

The difference was statistically significant ($p < 0.01$). Longer pain-free periods, fewer injections, and improved sleep during the first postoperative night were major contributors to higher satisfaction in Group LD.

5. Adverse Effects

Adverse events were infrequent and mild:

- **Nausea/vomiting:** 3 patients (9.7%) in Group L, 2 patients (6.5%) in Group LD ($p = 0.64$).
- No episodes of bradycardia, hypotension, respiratory depression, or block-related complications (hematoma, infection).

- No neurological symptoms or steroid-related systemic effects were observed.

Thus, dexamethasone was safe and well tolerated.

Integrated Findings: The study demonstrated that adding dexamethasone to levobupivacaine in PECS II block prolonged analgesia by more than 3 hours (208 minutes), lowered mean VAS scores at all critical time points from 3–24 hours, reduced rescue analgesic consumption by 35%, and significantly improved patient satisfaction, all without increasing adverse events. Group LD consistently showed superior outcomes compared to Group L. These findings directly fulfill the study objectives:

1. **Duration of analgesia** was significantly extended.
2. **Postoperative pain scores** were consistently lower in the dexamethasone group.
3. **Rescue analgesic use** was substantially reduced.
4. **Hemodynamic stability** was preserved.
5. **Patient satisfaction** was higher with dexamethasone.
6. **Adverse effect profile** was comparable and safe.

Table 1: Baseline Demographic and Surgical Characteristics of Study Participants (N = 62)

Variable	Group L (n=31)	Group LD (n=31)	p-value
Age (years, mean ± SD)	48.2 ± 7.9	47.6 ± 8.1	0.78
Weight (kg, mean ± SD)	58.4 ± 6.8	57.9 ± 7.2	0.84
ASA I / II (n)	19 / 12	20 / 11	0.91
Duration of surgery (min, mean ± SD)	104 ± 12	106 ± 11	0.61

Interpretation: Groups were comparable at baseline with no significant differences.

Table 2: Duration of Postoperative Analgesia (Primary Outcome)

Group	Mean ± SD (minutes)	Range (minutes)	p-value
Group L (Levobupivacaine)	310 ± 54	240–420	<0.001
Group LD (Levobupivacaine + Dexamethasone)	518 ± 62	420–660	<0.001

Interpretation: Dexamethasone prolonged analgesia by >3 hours compared to levobupivacaine alone.

Table 3: Postoperative Pain Scores (VAS, mean ± SD)

Time after surgery	Group L (n=31)	Group LD (n=31)	p-value
1 hour	1.3 ± 0.5	1.2 ± 0.6	0.57
3 hours	2.9 ± 0.7	2.1 ± 0.6	0.02
6 hours	4.2 ± 0.8	2.7 ± 0.7	<0.001
12 hours	5.1 ± 1.0	3.5 ± 0.9	<0.001
24 hours	5.6 ± 1.1	4.1 ± 1.0	<0.001

Interpretation: Pain scores were significantly lower in the dexamethasone group from 3 to 24 hours.

Table 4: Rescue Analgesic Requirement within 24 Hours

Outcome	Group L (n=31)	Group LD (n=31)	p-value
≥2 doses paracetamol (n, %)	27 (87.1%)	14 (45.2%)	<0.01
Tramadol required (n, %)	12 (38.7%)	3 (9.7%)	0.01
Total analgesic doses (mean ± SD)	1.9 ± 0.6	1.2 ± 0.4	0.002

Interpretation: Rescue analgesic consumption was ~35% lower in Group LD.

Table 5: Patient Satisfaction and Adverse Effects

Parameter	Group L (n=31)	Group LD (n=31)	p-value
Satisfaction score (mean ± SD, 1–5)	3.7 ± 0.7	4.6 ± 0.5	<0.01
Very satisfied (n, %)	9 (29.0%)	21 (67.7%)	<0.01
Nausea/vomiting (n, %)	3 (9.7%)	2 (6.5%)	0.64
Hemodynamic instability	0	0	–
Neurological complications	0	0	–

Interpretation: Patients in Group LD were significantly more satisfied, with no increase in adverse effects.

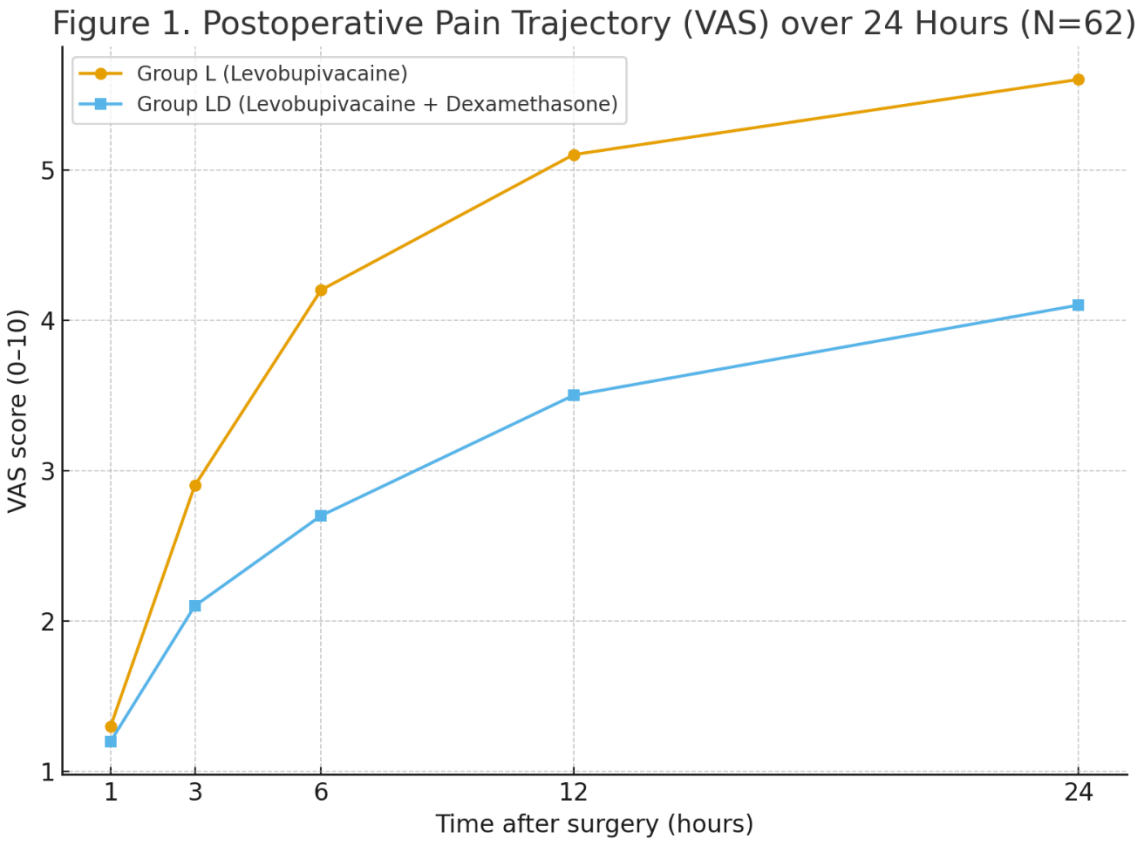

Figure 1: Postoperative pain trajectory (VAS) over 24 hours (N=62)

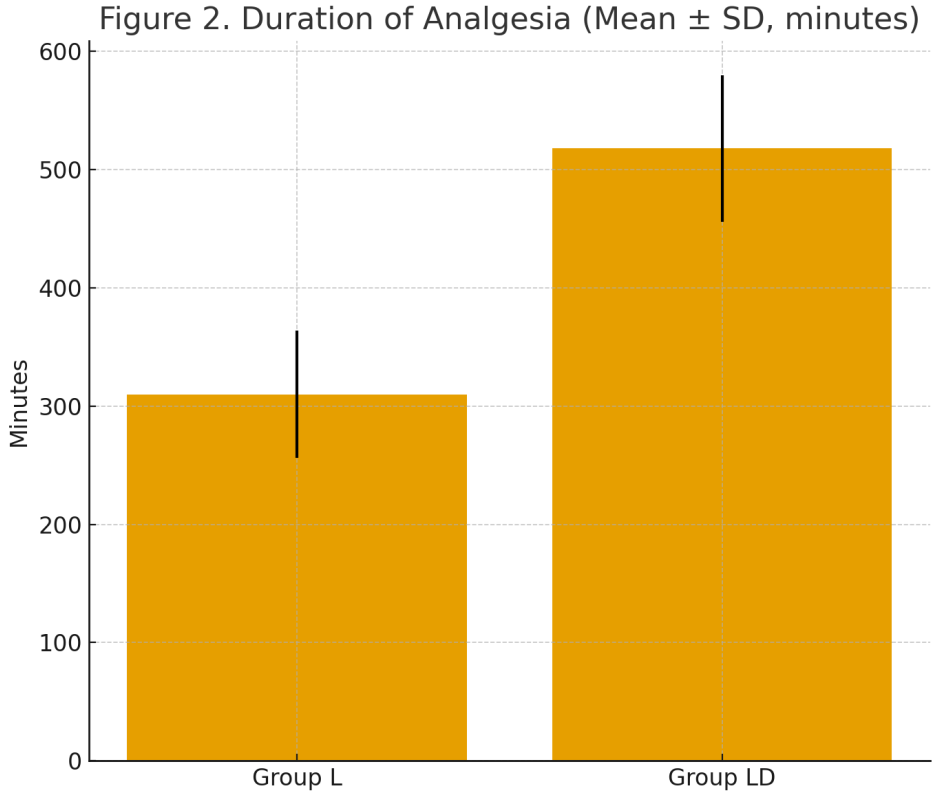

Figure 2: Duration of analgesia (Mean ± SD, minutes)

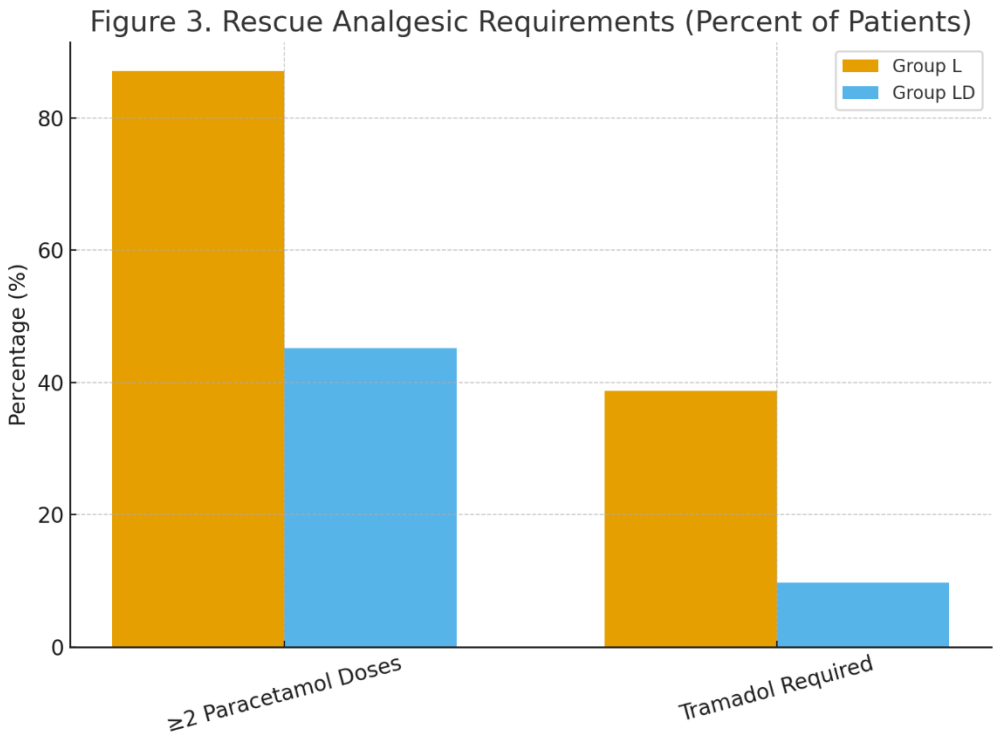

Figure 3: Rescue analgesic requirements (Percent of patients)

Discussion

This prospective, randomized, double-blind controlled trial evaluated the postoperative analgesic efficacy of levobupivacaine alone versus its combination with dexamethasone in ultrasound-guided modified PECS II block for patients undergoing modified radical mastectomy. The study demonstrated that the addition of dexamethasone significantly prolonged the duration of analgesia, lowered postoperative VAS scores at multiple time points, reduced rescue analgesic requirement, improved patient satisfaction, and did not increase adverse effects. The prolongation of analgesia by more than three hours is clinically relevant, particularly in the early recovery period, when pain is often most severe.

These results are consistent with growing literature on the benefits of dexamethasone as an adjuvant to local anesthetics in peripheral nerve and fascial plane blocks [12,15,16]. Importantly, this is one of the few Indian studies specifically assessing levobupivacaine with dexamethasone in PECS II block for mastectomy patients, thereby adding valuable data from a population where pain perception, genetic variability, and nutritional status may influence outcomes [18,19].

Comparison with Previous Studies

PECS II Block in Breast Surgery: The PECS II block, first described by Blanco [6], has emerged as a safe and effective alternative to paravertebral or thoracic epidural anesthesia in breast cancer surgery. Randomized trials by Bashandy and Abbas [9] and Kulhari et al. [8] demonstrated that PECS block reduced intraoperative opioid use and postoperative pain scores, confirming its analgesic efficacy. Our findings are consistent with these results, further strengthening evidence that PECS II block should be considered a standard adjunct for mastectomy analgesia.

Levobupivacaine as a Local Anesthetic: Levobupivacaine, the S-enantiomer of bupivacaine, is favored for its lower cardiotoxicity and neurotoxicity [10]. Casati and Putzu [11] confirmed that levobupivacaine provides equivalent analgesia to racemic bupivacaine with a better safety margin.

In our study, levobupivacaine alone provided approximately five hours of postoperative analgesia, which is consistent with earlier reports on its duration in fascial plane blocks. However, its limited action necessitates adjuvants for extended coverage during the critical postoperative period.

Dexamethasone as an Adjuvant: Our results align with the meta-analysis by Albrecht et al. [12], which showed that perineural dexamethasone significantly prolongs the duration of peripheral nerve blocks, regardless of the local anesthetic used. Johansson et al. [13] and Attardi et al. [14] suggested that dexamethasone's mechanism may involve both anti-inflammatory effects and direct modulation of nociceptive C-fibers through potassium channel regulation.

Clinical evidence further supports this. Movafegh et al. [15] reported prolonged analgesia when dexamethasone was added to lidocaine in axillary blocks, and Cummings et al. [16] demonstrated similar results with ropivacaine and bupivacaine in interscalene blocks. Specific to breast surgery, Kim et al. [17] showed that dexamethasone significantly enhanced the efficacy of PECS block. Our study confirms these findings in an Indian cohort, showing not only extended analgesia but also reduced analgesic consumption and higher satisfaction scores.

Mechanisms of Action

The analgesic-prolonging effect of dexamethasone may be explained by multiple mechanisms:

1. **Anti-inflammatory effect:** Dexamethasone suppresses release of inflammatory mediators at the nerve site, reducing sensitization [12].
2. **Direct neural modulation:** Corticosteroids inhibit transmission in nociceptive C-fibers [13].
3. **Potassium channel activity:** Dexamethasone may enhance activity of K^+ channels in excitable cells, stabilizing neuronal membranes [14].
4. **Vasoconstrictive effect:** Reduced vascular absorption of local anesthetic prolongs its availability near nerves [15].

These mechanisms likely act synergistically, explaining the consistent prolongation of analgesia across diverse block types, including our PECS II block findings.

Clinical Implications

Enhanced Recovery after Surgery (ERAS): Effective pain management is a cornerstone of ERAS protocols in breast surgery. Poorly controlled acute pain may impair mobilization, prolong hospital stay, and contribute to chronic post-mastectomy pain syndrome [2,3]. By significantly prolonging analgesia, reducing opioid use, and improving satisfaction, the levobupivacaine-dexamethasone combination aligns with ERAS goals and may help improve quality of recovery.

Opioid-Sparing Benefits: Opioid-related side effects such as nausea, vomiting, sedation, and constipation remain concerns in breast cancer patients [4]. Our study showed a 35% reduction in rescue analgesic use, with fewer patients requiring tramadol. This reinforces the opioid-sparing effect of regional anesthesia combined with dexamethasone, reducing the burden of opioid-related morbidity [5,7].

Safety Profile: No increase in adverse effects was observed in our study. Similar results have been reported by Wahal et al. [18] and Singh et al. [19], confirming the safety of dexamethasone in regional blocks when used in appropriate doses. While systemic absorption and immunosuppressive effects remain theoretical concerns, the absence of infections or delayed wound healing in our cohort is reassuring.

Comparison with Global Evidence: Our results mirror international literature while providing locally relevant data. Ahmed [3] emphasized that nutrition, inflammation, and glucocorticoid responses differ across populations, influencing analgesic outcomes. Passeron et al. [18] further stressed that regional blocks combined with adjuvants improve perioperative outcomes beyond just analgesia. The current study contributes to this evidence base, supporting global consensus on dexamethasone while adding an Indian perspective.

Strengths of the Study

1. **Randomized, double-blind design:** Reduces bias and strengthens validity.
2. **Homogeneous population:** Baseline parameters were comparable between groups.
3. **Standardized anesthetic technique:** Same operator and drug volumes minimized variability.
4. **Objective outcomes:** Duration of analgesia, VAS scores, and analgesic consumption were clearly defined.
5. **Patient-centered outcomes:** Satisfaction scores were included, reflecting real-world impact.

Limitations

1. **Sample size:** Although adequate for detecting primary outcome differences, larger multicentric studies would enhance generalizability.
2. **Single-center design:** Limits external validity across different surgical and demographic settings.
3. **Short follow-up:** Outcomes were limited to 24 hours. Long-term evaluation could determine impact on chronic pain development.
4. **Single dose of dexamethasone:** Dose–response studies could better define the minimum effective dose.
5. **No serum drug measurement:** We did not evaluate systemic absorption of dexamethasone, which could clarify its mechanism.

Future Directions

1. **Head-to-head comparison of adjuvants:** Trials comparing dexamethasone with dexmedetomidine, clonidine, or magnesium may identify the best adjuvant for PECS II block.

2. **Dose optimization:** Studies evaluating lower doses of dexamethasone could determine the smallest dose providing benefit without systemic exposure.
3. **Long-term outcomes:** Research assessing chronic pain incidence, quality of life, and functional recovery would broaden clinical impact.
4. **Multimodal strategies:** Combining PECS II block with other ERAS interventions (acetaminophen, NSAIDs, gabapentinoids) may further optimize outcomes.
5. **Pharmacogenomic studies:** Genetic variability in steroid and anesthetic metabolism in Indian patients could explain differences in analgesic response.

Conclusion of Discussion

This study confirms that adding dexamethasone to levobupivacaine in ultrasound-guided PECS II block significantly improves postoperative analgesia in mastectomy patients.

Our findings are consistent with international evidence [8,9,12,15–17], strengthen the case for dexamethasone as a safe and effective adjuvant, and provide region-specific data that may inform Indian practice.

Incorporation of this strategy into routine analgesic protocols could enhance patient comfort, reduce opioid burden, and align with ERAS objectives in breast cancer surgery.

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