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SYSTEMATIC REVIEW

Erector spinae plane block for breast surgery: an umbrella review of systematic reviews and meta-analyses

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Abstract

Background: Postoperative pain remains a significant clinical concern following breast surgery, negatively impacting patient recovery and satisfaction. The erector spinae plane (ESP) block has gained popularity due to its opioid-sparing effect and ease of application. However, despite numerous systematic reviews and meta-analyses evaluating the efficacy of ESP block in breast surgery, methodological heterogeneity, varying study quality, and inconsistent findings have led to uncertainty regarding the strength and reliability of the evidence. **Methods**: In this umbrella review, we aimed to critically appraise, synthesize, and consolidate existing systematic reviews and meta-analyses to clarify the efficacy of the ESP block in breast surgery. We systematically searched The Cochrane Central Register of Controlled Trials (CENTRAL), Embase, PubMed Central, and Scopus from 2016 to 2025, to identify relevant systematic reviews and meta-analyses including patients undergoing breast surgery with ESP block compared to control interventions. **Results**: A total of six systematic reviews were included. Based on the Assessment of Multiple Systematic Reviews (AMSTAR)-2 assessment, two were rated as high quality, two as low quality, and the remaining two as critically low quality. All reviews consistently demonstrated that ESP block significantly reduced opioid consumption at 24 hours (mean reduction range: −4.93 to −7.67 morphine milligram equivalents). Pain scores at 0–2, 12, and 24 hours postoperatively were also significantly reduced, although the clinical relevance diminished at later time points. Additionally, ESP block was associated with a reduction in the incidence of postoperative nausea and vomiting (PONV). **Conclusions**: The ESP block consistently demonstrates efficacy in reducing postoperative pain, opioid consumption, and PONV in patients undergoing breast surgery. However, substantial methodological limitations and heterogeneity among existing systematic reviews underscore the need for more rigorous research and standardized reporting practices. **The PROSPERO Registration**: CRD420251002414, https://www.crd.york.ac.uk/PROSPERO/view/CRD420251002414.

Keywords

Breast surgery; Erector spinae plane block; Meta-analysis; Postoperative analgesia

1. Introduction

Breast cancer remains the most frequently diagnosed cancer in the United States and significantly affects morbidity and quality of life [1]. Pain associated with breast cancer arises either from the disease itself or treatment-related factors, particularly surgery. Breast surgery commonly results in substantial postoperative pain, which may negatively affect patient recovery, satisfaction, and overall clinical outcomes [2]. Until recent decades, oncologic surgical procedures for breast cancer were notably radical, extensive, and associated with significant tissue trauma. Just as surgical practice has evolved—from radical mastectomies to more refined techniques such as modified radical procedures and breast-conserving surgeries—anesthesia and perioperative analgesia strategies have also undergone a substantial transformation. Over the past two decades, there has been a marked shift from central neuraxial techniques to more peripheral, targeted approaches. In the earlier surgical era, the magnitude of the procedure resulted in multiple and complex sources of pain, both acute and chronic, posing considerable challenges for clinicians and significantly affecting patients' quality of life. However, advancements in surgical techniques have rendered the perioperative period more manageable for both patients and healthcare providers.

In parallel, fascial plane blocks have gained prominence as effective and less invasive alternatives to traditional neuraxial methods, such as epidural and paravertebral blocks, and are now widely accepted in clinical practice [3].

Effective pain management in breast surgery is typically based on multimodal analgesic approaches, with regional anesthesia techniques becoming an essential component owing to their opioid-sparing effects. However, despite the widespread use of regional anesthesia, uncertainty persists regarding the optimal technique. The Procedure Specific Postoperative Pain Management (PROSPECT) guidelines for oncological breast surgery recommend the use of paravertebral or pectoral nerve (PECS) blocks (Grade A recommendation), whereas evidence supporting the erector spinae plane (ESP) block remains insufficient, highlighting the need for further high-quality studies evaluating its effectiveness in combination with basic analgesics [4, 5].

The ESP block, first described by Forero *et al*. [6], is a fascial plane block that has rapidly gained popularity owing to its relative technical simplicity, low complication rate, and potential analgesic efficacy in various surgical procedures, including breast, thoracic, spinal, and abdominal surgery. Although the exact analgesic mechanism of the ESP block has not been fully elucidated [7], its clinical utility has been widely explored in multiple randomized controlled trials and subsequent systematic reviews and meta-analyses, especially after the publication of the PROSPECT guidelines. Nevertheless, considerable heterogeneity exists among these systematic reviews and meta-analyses in terms of methodologies, reported outcomes, and overall study quality, leading to uncertainty regarding the robustness and consistency of available evidence. Therefore, to address these limitations and provide clinicians and researchers with a clearer understanding of the evidence, we conducted this umbrella review to critically appraise, synthesize, and consolidate existing systematic reviews and meta-analyses evaluating the efficacy of the ESP block in breast surgery.

2. Method

2.1 Study design

This umbrella review was designed to systematically synthesize and critically appraise existing systematic reviews and meta-analyses that have evaluated the efficacy and safety of ESP block in breast surgery. The protocol of this umbrella review was prospectively registered in the International Prospective Register of Systematic Reviews (PROSPERO) under the registration number CRD420251002414, available from https://www.crd.york.ac.uk/PROSPERO/view/CRD420251002414. This review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (see **Supplementary material**) [8].

2.2 Eligibility criteria

Studies were considered eligible for inclusion based on the following the Population, Intervention, Comparison, Outcome, and Study type (PICOS) criteria: (P) adult surgical patients aged 18 years or older undergoing breast surgery, including oncologic, reconstructive, or cosmetic procedures; (I) ESP block performed for perioperative analgesia; (C) placebo or no intervention; (O) postoperative opioid consumption expressed as morphine milligram equivalents (MME), pain scores at rest at 12 and 24 hours postoperatively, and postoperative nausea and vomiting (PONV); and (S) only systematic reviews and meta-analyses of randomized controlled trials (RCTs). Narrative reviews, scoping reviews, and systematic reviews without meta-analyses were excluded.

2.3 Search strategy

A systematic search of the literature was performed using CENTRAL, Embase, PubMed Central, and Scopus to identify relevant systematic reviews and meta-analyses evaluating the efficacy and safety of the ESP block in breast surgery. The search was limited to studies published in English language and to articles published since 2016, since ESP block was first introduced that year. The search was performed on 06 March 2025, and detailed search strategies for each database are provided in the **Supplementary material**. In addition to the database search, the reference lists of all the included studies were screened manually to identify any additional eligible systematic reviews and meta-analyses that were not captured in the initial search.

2.4 Study selection

The selection of studies was performed in two phases. First, all titles and abstracts retrieved from the initial search were screened independently by two researchers (MSOY and YEK) to assess their relevance according to the predefined eligibility criteria. In the second phase, the full texts of potentially eligible articles were independently assessed by the same researchers to determine their final inclusion. Any disagreements regarding study eligibility were resolved by discussion and consensus. If consensus could not be reached, a third researcher (BD) was consulted to resolve discrepancies.

2.5 Data extraction and data retrieval

Data extraction was performed using a standardized form developed for this umbrella review. The following information was extracted from each included systematic review and meta-analysis: first author, year of publication, country, number and type of included studies, total number of participants, type of intervention and comparator, conflicts of interest, prospective protocol registration, and PICOS criteria. Additionally, data were collected regarding the methodological approaches used to assess the robustness of the findings. In cases in which the data were incomplete or unclear, attempts were made to contact the corresponding authors of the included studies to obtain additional information. All opioids were converted to intravenous morphine using the GlobalRPh morphine equivalent calculator, considering a 0% cross-tolerance modifier (http://www.globalrph.com/narcotic).

2.6 Quality assessment

Two authors (ADC and MAY) assessed the methodological quality of the included systematic reviews and meta-analyses

using the Assessment of Multiple Systematic Reviews (AMSTAR)-2 tool [9], a validated instrument designed to evaluate the methodological rigor of systematic reviews that include randomized and/or non-randomized studies. The AMSTAR-2 tool assesses 16 domains, seven of which are considered critical and have a significant impact on the overall confidence in the review's findings. These critical domains included the comprehensiveness of the literature search, appropriate consideration of the risk of bias when interpreting results, use of adequate statistical methods for meta-analysis, assessment of publication bias, adequacy of study selection and data extraction processes, and protocol registration prior to review. The quality of the study was assessed using specific critical and non-critical domains and was classified into four categories based on this evaluation. Each review was rated as high, moderate, low, or critically low quality. High-quality studies had all critical domains marked as "no" or "partial yes", and no more than one non-critical domain marked as "no". Moderate Quality studies had all critical domains marked as "yes" or "partial yes", but more than one non-critical domain marked as "no". Low Quality studies had at least one critical domain marked as "no" with/without non-critical domains marked as "no". Critically Low Quality studies had more than one critical domain marked as "no" along with/without non-critical domains marked as "no". This structured evaluation assists in determining the reliability of studies and supports evidence-based clinical decisions.

Discrepancies between reviewers in the quality assessment were resolved through discussion and consensus; when necessary, a third researcher (BD) was consulted.

2.7 Study overlap

To assess the overlap of primary studies included in the different meta-analyses, we generated an Upset graph [10]. Unlike traditional Venn diagrams, which are difficult to interpret when comparing multiple sets, the Upset graph offers a clearer and more scalable visualization of intersections among a large number of meta-analyses. This approach allowed us to identify studies that were commonly included across systematic reviews as well as those that appeared uniquely in specific meta-analyses.

2.8 Statistical analysis

Data synthesis was performed and visualized using R version 4.4.2 (R Foundation for Statistical Computing, Vienna, Austria). Treatment effects on continuous outcomes were reported as mean differences (MD) or standardized mean differences (SMD), along with corresponding 95% confidence intervals (CIs). For dichotomous outcomes, treatment effects were presented as odds ratios (OR) and risk ratios (RR) with 95% CIs in accordance with the effect measures reported in the included systematic reviews and meta-analyses.

3. Results

3.1 Study selection and data retrieval

The study selection process is illustrated in the PRISMA flowchart (Fig. 1). The initial database search identified 487 articles. After screening titles and abstracts, nine systematic reviews (SRs) were selected for full-text assessment. Three SRs were excluded because they used other regional anesthesia techniques as comparators instead of placebo or sham blocks (a detailed list of excluded SRs is available in the **Supplementary material**). Ultimately, six SRs were included in the final analysis [11–16]. No additional articles were identified through manual reference list screening.

3.2 Characteristics of included systematic reviews

The main characteristics of the included studies are summarized in Table 1. Half of the SRs (n = 3) were conducted by Chinese authors. The earliest SRs were published in 2020 [16], whereas the most recent SR was released in 2023 [15]. All included SRs focused on breast cancer surgeries and exclusively analyzed randomized controlled trials. The different databases where each SR was retrieved are summarized in Table 2.

3.3 Study overlap

The Upset graph illustrates the overlap of the studies across the included SRs (Fig. 2). Although some studies were consistently identified in multiple SRs, others were unique to specific meta-analyses. This visualization highlights variations in study selection across reviews, emphasizing potential differences in inclusion criteria and search strategies.

3.4 Quality assessment

According to the AMSTAR-2 assessment, two SRs were rated as critically low quality, two as low quality, and two as high quality. A detailed evaluation of each domain for each study is available in Fig. 3. Notably, three studies (50%) did not pre-register their systematic review protocols, contributing to a critically low rating [11, 15, 16].

4. Outcomes

4.1 Morphine milligram equivalent (MME) at 24 hours

All included SRs evaluated MME consumption 24 h postoperatively and consistently identified the efficacy of the ESP block in reducing opioid consumption (Fig. 4). The mean reduction ranged from −4.93 [15] to −7.67 [11]. However, the statistical heterogeneity was high across all SRs and remained unexplained.

Zhang *et al.* [11] conducted a subgroup analysis comparing the efficacy of bupivacaine and ropivacaine in ESP block, demonstrating consistent results between the two anesthetics. Similarly, Guan *et al.* [15] performed a subgroup analysis to explore different local anesthetic concentrations, drug types, and single versus multiple block planes. Significant reductions in opioid consumption were observed across all the subgroups.

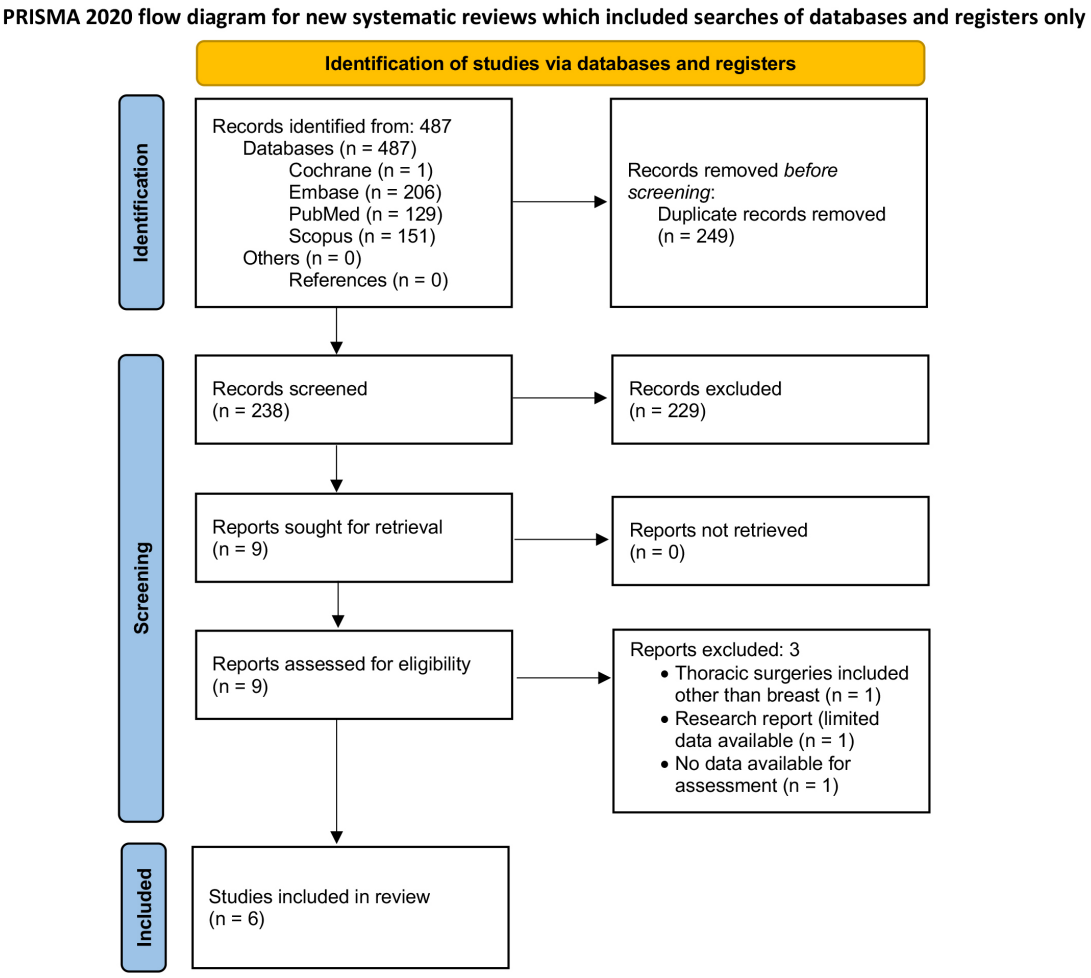

FIGURE 1. PRISMA flow diagram illustrating the study selection process. PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

TABLE 1. Main characteristics of the included systematic reviews and meta-analyses.

Author (year)	Country	Registration	Surgery	Studies included (n)	ESP (n)	Control (n)	Control	Studies	AMSTAR-2
Zhang (2021)	China	No	Breast cancer surgery	11	339	340	No block	RCTs	Low quality
Hussain (2021)	USA-Canada	PROSPERO	Breast cancer surgery	12	348	351	No block	RCTs	High quality
Li (2021)	China	PROSPERO	Breast surgery	6	195	195	No block	RCTs	Critically low
Leong (2021)	Singapore	PROSPERO	Breast surgery	13	418	215	No block	RCTs	High quality
Guan (2023)	China	No	Breast cancer surgery	20	649	644	No block	RCTs	Low quality
Singh (2020)	India	No	Breast cancer surgery	7	214	215	No block and Sham block	RCTs	Critically Low

ESP: Erector Spinae Plane; RCTs: Randomized Controlled Trials; PROSPERO: International Prospective Register of Systematic Reviews; AMSTAR: Assessment of Multiple Systematic Reviews.

TABLE 2. Database coverage and search sources for included studies.

Author (Year)	PubMed	Cochrane	Scopus	Embase	Web of Science	Other	References	Google Scholar	Registries
Zhang (2021)	X	X		X	X		X		X
Hussain (2021)		X		X		X	X		X
Li (2021)	X	X		X	X		X		
Leong (2021)	X	X	X	X			X		X
Guan (2023)	X	X		X	X	X	X		X
Singh (2020)	X	X		X			X	X	

X: indicates that the respective database or source was searched and archived the respective systematic review.

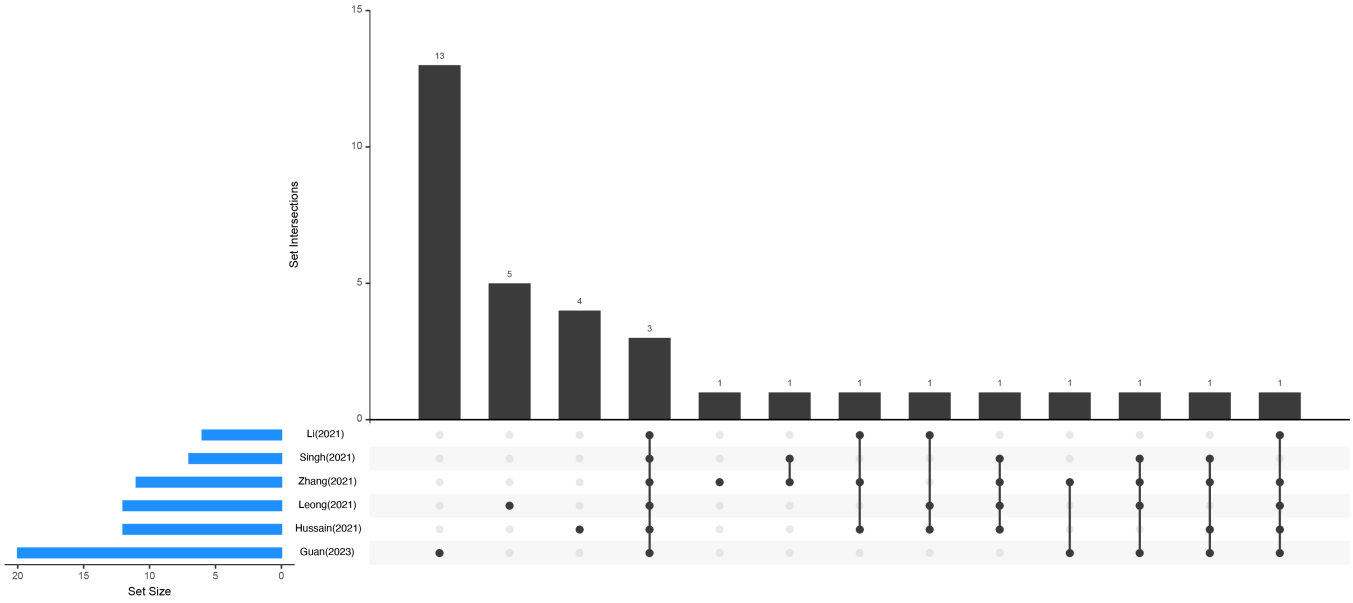

FIGURE 2. Upset diagram displaying systematic reviews' overlap in included studies.

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Item 14	Item 15	Item 16	Overall
Zhang (2021)	yes	no	yes	yes	yes	yes	Partial yes	yes	yes	no	yes	yes	yes	yes	yes	yes	Low Quality
Hussain (2021)	yes	yes	yes	yes	yes	yes	Partial yes	yes	yes	no	yes	yes	yes	yes	yes	yes	High Quality
Li (2021)	yes	yes	yes	Partial yes	yes	yes	Partial yes	yes	yes	no	Partial yes	no	no	no	no	yes	Critically Low Quality
Leong (2021)	yes	yes	yes	Partial yes	yes	yes	Partial yes	yes	yes	no	yes	yes	yes	yes	yes	yes	High Quality
Guan (2023)	yes	no	yes	yes	yes	yes	Partial yes	yes	yes	no	yes	yes	yes	yes	yes	yes	Low Quality
Singh (2020)	yes	no	yes	Partial yes	yes	yes	no	no	Partial yes	no	yes	yes	yes	yes	Partial yes	no	Critically Low Quality

FIGURE 3. Methodological quality assessment of included systematic reviews using the AMSTAR-2 tool.

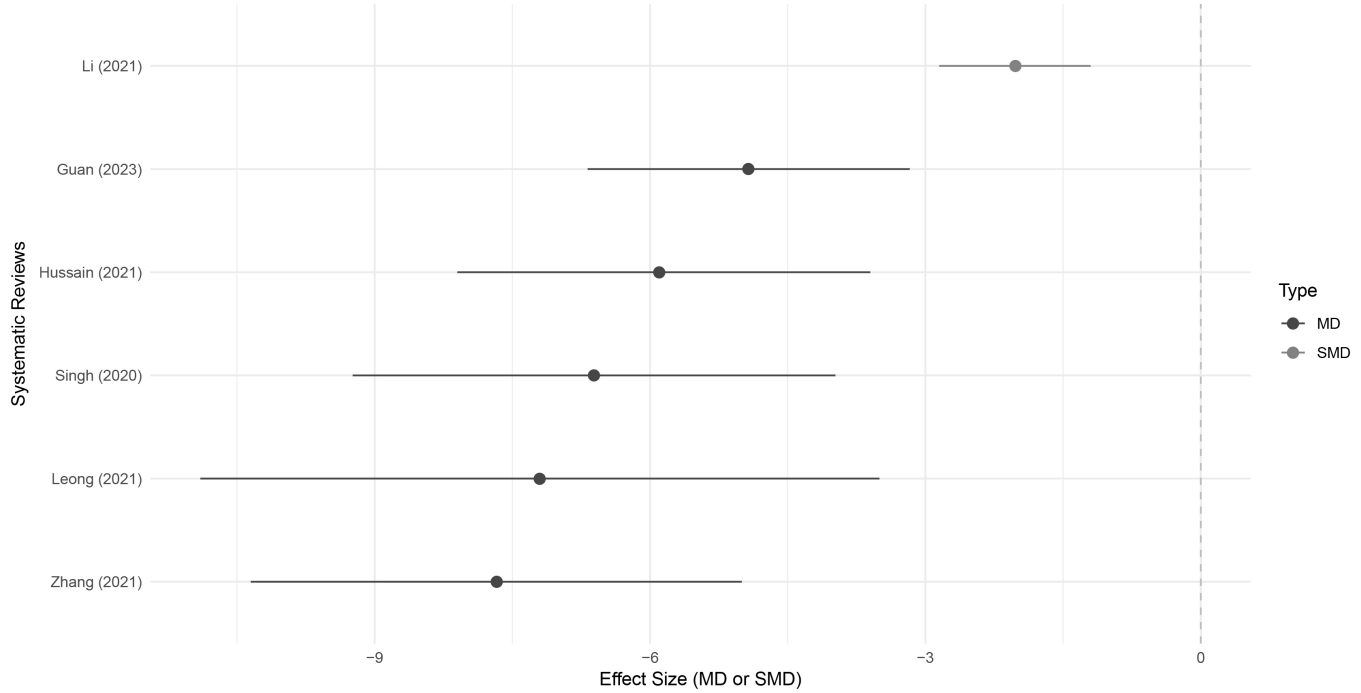

FIGURE 4. Modified forest plot showing the calculated effect of ESP block on MME in the included systematic reviews. MD: mean differences; SMD: standardized mean differences.

4.2 Pain at 0–2 postoperative hours

Five SRs assessed pain at 0–2 h postoperatively, and all reported a statistically significant effect of the ESP block. The mean reduction in pain scores ranged from −1.02 [11] to −1.73 [15]. All SRs reported clinically significant pain reduction (>1 point on the visual analogue scale (VAS) or numeric rating scale (NRS)). However, heterogeneity was high for this outcome across all the SRs.

4.3 Pain at 12 postoperative hours

All SRs evaluated pain 12 h postoperatively and showed a statistically significant reduction. However, the clinical relevance of this reduction was limited, except for the study by Guan *et al*. [15] which reported a clinically meaningful reduction (≥1 point on the pain scores), with a decrease of 1.44 points.

Li *et al*. [13] was the only SR to report low heterogeneity for this outcome, whereas other SRs, despite including a larger number of patients, exhibited high heterogeneity.

4.4 Pain at 24 postoperative hours

All SRs reported a statistically significant reduction in pain scores at 24 h postoperatively. However, similar to the findings at 12 hours, the clinical impact was minimal. Only one SR reported a clinically significant reduction (≥1 point on the pain scores), with a decrease of 1.44 points [15]. While one SR [13] reported low heterogeneity, the others reported high heterogeneity.

Guan *et al*. [15] conducted a subgroup analysis comparing different concentrations of local anesthetics, drug types, and treatment regimens for single versus multiple block planes. Significant reductions in pain scores were observed across all subgroups, except for the single versus multiple block plane regimens.

4.5 Postoperative nausea and vomiting (PONV)

Five SRs evaluated the effect of ESP block on PONV in patients undergoing breast surgery. Four SRs reported a statistically and clinically significant reduction in PONV, with relative risk values ranging from 0.59 [11] to 0.43 [12]. Only Li *et al*. [13] did not report a statistically significant reduction in PONV. Notably, the heterogeneity for this outcome was consistently low across all analyses.

5. Discussion

This umbrella review synthesizes evidence from systematic reviews and meta-analyses that evaluate the efficacy and safety of ESP block in breast surgery. Despite substantial heterogeneity among the included meta-analyses, the cumulative findings consistently demonstrated that the ESP block effectively reduced opioid consumption, postoperative pain scores, and the incidence of PONV. However, considerable variability in study methodologies, population characteristics, intervention techniques, and outcome assessments necessitates a cautious interpretation of these findings.

Postoperative pain continues to represent a significant clinical challenge in breast surgery, potentially affecting patient recovery and satisfaction [3]. Recent advancements in regional anesthesia have highlighted fascial plane blocks as promising opioid-sparing techniques. For example, a recent meta-analysis demonstrated that the interpectoral and pectoserratus blocks provide analgesic efficacy comparable to that of the traditional paravertebral block [17]. Similarly, the ESP block has gained popularity in breast surgery owing to its technical

simplicity, favorable safety profile, and effective analgesia [18]. The findings consistently support the efficacy of ESP block in reducing opioid consumption and early postoperative pain. However, pain reduction at 12 and 24 hours appears to be limited in clinical significance, as most studies reported a decrease of <1 point. This suggests that while ESP block provides effective early analgesia, its long-term effects may be modest. All systematic reviews included in this umbrella review consistently supported the analgesic efficacy of the ESP block; however, the significant heterogeneity across these reviews limits the strength and generalizability of this evidence. Potential contributors to this heterogeneity include differences in the type, volume and concentration of local anesthetics, variations in block techniques, differences in surgical procedures, and patient demographics. Guan *et al*. [15] conducted subgroup analyses to address these factors, yet heterogeneity remained high, particularly in comparisons of single versus multiple block planes. This highlights the need for further standardization in ESP block protocols.

The methodological quality of the included systematic reviews, as assessed using AMSTAR-2, was generally suboptimal. Only two reviews were rated as high-quality, while the majority were rated as either low or critically low-quality. Considering the methodological variability among the included studies, it may be more appropriate to prioritise high-quality meta-analyses when making clinical decisions. A major factor influencing these quality ratings was the lack of prospective protocol registration, which was identified as the critical AMSTAR-2 domain. Moreover, the Upset diagram revealed notable discrepancies, indicating that some primary studies were omitted from certain meta-analyses. These omissions likely reflect suboptimal search strategies or inadequate screening processes, potentially leading to loss of clinically relevant evidence. While minor variations in PICOS criteria among reviews might explain some discrepancies, insufficiently rigorous and comprehensive literature searches remain a significant limitation, weakening the overall robustness and completeness of the evidence synthesis.

Although the PROSPECT guideline [4] currently does not recommend the ESP block for breast surgery, it is important to note that all of the meta-analyses included in this umbrella review were published after the release of the PROSPECT recommendations. These meta-analyses consistently demonstrated findings in favor of the ESP block. The aggregation and synthesis of this recent evidence through our umbrella review may offer a renewed perspective on the potential utility of the ESP block in this surgical context. While the PROSPECT recommendations were based on the evidence available at the time, the accumulating data highlighted in our analysis may signal a promising role for the ESP block in future clinical practice guidelines.

This study had several limitations. First, the substantial heterogeneity observed across meta-analyses for most primary outcomes complicates definitive conclusions. Second, the predominance (75%) of low-or critically low-quality systematic reviews necessitates cautious interpretation and highlights the critical need to improve review methodologies in this research domain. Lastly, the lack of standardized protocols for postoperative pain management, heterogeneity in outcome measures, and the absence of clearly defined minimal clinically important differences across the included meta-analyses further diminished the robustness and clinical applicability of the results. Addressing these methodological and reporting gaps in future systematic reviews is essential to strengthen the quality of evidence and better inform clinical practice.

6. Conclusions

This umbrella review provides comprehensive evidence supporting the efficacy of ESP block in reducing opioid consumption, postoperative pain, and postoperative nausea and vomiting in patients undergoing breast surgery. Despite the consistency of beneficial outcomes, significant methodological heterogeneity and quality issues among existing systematic reviews limit the robustness and generalizability of these findings.

7. Key points

- The ESP block significantly reduces opioid consumption within the first 24 hours after breast surgery.
- ESP block effectively lowers postoperative pain scores, with the strongest clinical benefit observed in the early postoperative period.
- Included systematic reviews varied in methodological quality, with only two rated as high quality by AMSTAR-2.
- Substantial heterogeneity and inconsistent reporting across reviews underscore the need for standardized and high-quality research in this field.

AVAILABILITY OF DATA AND MATERIALS

The data that support the findings of this study are available from the corresponding author upon reasonable request.

AUTHOR CONTRIBUTIONS

BD, AA, ST, EK—concept. BD, YEK, ET—design. ADC, MB—supervision. BD, ADC, MB, ET—data collection and processing. ADC, MAY—analysis and/or interpretation. YEK, MSOY, MAY—literature search. BD, YEK, MSOY, MB—writing manuscript. AA, ST, EK—critical review.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

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Not applicable.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at https://oss.signavitae.com/mre-signavitae/article/1955167429431574528/attachment/Supplementary%20material.docx.

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