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Review Article

Ultrasound-Guided Erector Spinae Plane Block for Mastectomy: A Systematic Narrative Review of Anatomical Basis, Technique, Analgesic Efficacy and Clinical Applications

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Abstract

Background: Mastectomy is frequently associated with moderate-to-severe acute postoperative pain. Inadequate analgesia may delay mobilization, increase opioid requirements and adversely affect recovery. Regional anaesthesia has become an important component of multimodal analgesia for breast surgery. The ultrasound-guided erector spinae plane block (ESPB) is a relatively recent fascial plane block that has attracted considerable interest due to its superficial anatomical target, technical simplicity and potential to provide Multi dermatomal thoracic analgesia.

Objective: This systematic narrative review summarizes the available evidence regarding the anatomical basis, mechanism, technical considerations, analgesic efficacy, opioid-sparing effects, safety and clinical applications of ultrasound-guided ESPB in breast surgery.

Methods: A PRISMA 2020-informed literature search was conducted using PubMed/MEDLINE, Embase, Scopus, Web of Science, Cochrane Library, and Google Scholar. Search terms included "erector spinae plane block," "ESPB," "mastectomy," "breast surgery," "paravertebral block," "postoperative pain," and "opioid consumption." Randomized trials, comparative studies, systematic reviews, meta-analyses, anatomical studies, and relevant narrative reviews were considered, with emphasis on mastectomy and breast cancer surgery. Non-breast surgical studies were excluded. Findings were synthesized descriptively without calculating new pooled estimates.

Results: Evidence from randomized trials and systematic reviews consistently demonstrates that ESPB provides clinically relevant reductions in postoperative pain and opioid consumption compared with systemic analgesia alone. A 2020 systematic review of 13 randomized trials involving 861 patients found lower pain scores through the first 24 postoperative hours and a reduction in oral morphine-equivalent consumption of approximately 21.6 mg compared with no block, although there was substantial heterogeneity. Subsequent reviews and trials have broadly supported these findings. ESPB has also been associated with improved quality of recovery, delayed time to first rescue analgesia and reduced intraoperative opioid requirements. Compared to paravertebral block, generally similar analgesia has been observed in earlier studies, although more recent evidence has challenged the assumption of equivalence, particularly for analgesia during movement and reliability of dermatomal coverage. ESPB is technically simpler and has a superficial target, while paravertebral block may provide more predictable neural blockade. Compared with pectoral and serratus anterior plane blocks, ESPB is an effective alternative but superiority over these techniques has not been established.

Conclusion: Ultrasound-guided ESPB is an effective component of multimodal analgesia for mastectomy. Its primary advantages are technical accessibility, a superficial bony endpoint, multi dermatomal spread and opioid-sparing potential. However, variability in block level, local anaesthetic volume, surgical procedure and multimodal analgesic protocols complicate direct comparison among studies. It should therefore be considered a valuable regional analgesic option rather than a universally superior technique. Further adequately powered randomized trials using standardized techniques, clinically meaningful outcomes and long-term follow-up are required.

Keywords: Erector Spinae Plane Block; ESPB; Ultrasound-Guided Regional Anaesthesia; Mastectomy; Modified Radical Mastectomy; Breast Surgery; Postoperative Analgesia; Opioid-Sparing Analgesia; Paravertebral Block; Regional Anaesthesia.

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Introduction

Breast cancer surgery is one of the most frequently performed oncological surgical procedures worldwide. Although improvements in surgical techniques, anaesthesia and perioperative care have contributed to shorter hospital stays and enhanced recovery, acute postoperative pain remains an important problem following mastectomy, particularly when axillary lymph-node dissection is performed.

Pain following mastectomy results from tissue dissection involving the breast, skin, subcutaneous tissues, pectoral fascia and, in many patients, the axillary region. Nociceptive input may arise from the anterior and lateral branches of the thoracic intercostal nerves, pectoral nerves and intercostobrachial nerve. Consequently, breast surgery presents a complex regional analgesic challenge, and no single regional technique necessarily provides complete coverage in every patient.

Poorly controlled acute postoperative pain has consequences beyond immediate patient discomfort. Severe pain can interfere with coughing, deep breathing, sleep, shoulder movement and early mobilization. Increased postoperative opioid administration may additionally contribute to nausea, vomiting, sedation, constipation and respiratory depression. Enhanced recovery strategies therefore increasingly emphasize multimodal analgesia and opioid-sparing regional anaesthesia. The PROSPECT guideline for oncological breast surgery recommends basic analgesics such as paracetamol and non-steroidal anti-inflammatory drugs and considers regional techniques such as paravertebral and pectoral nerve blocks appropriate components of analgesia for major breast surgery. At the time of that guideline, evidence for ESPB remained insufficient for a specific recommendation, highlighting the rapid evolution of evidence since then.[1]

Thoracic paravertebral block (PVB) has traditionally been an important regional technique for breast surgery. Meta-analyses have demonstrated reductions in postoperative pain and opioid consumption with PVB compared with systemic analgesia alone.[2,3] However, PVB requires needle placement close to the pleura, intercostal vessels and neuraxial structures. Potential complications include vascular puncture, pneumothorax, epidural spread, hypotension and inadvertent neuraxial blockade.[2,3]

The erector spinae plane block was introduced by Forero et al. in 2016 as an ultrasound-guided technique for thoracic neuropathic pain.[4] The technique involves deposition of local anaesthetic in the fascial plane between the erector spinae muscle and the underlying transverse process. Because the injection is superficial to the transverse process and can spread longitudinally, ESPB was proposed as a technically straightforward approach capable of producing extensive thoracic sensory blockade.

The technique was subsequently adopted for breast surgery. Early randomized studies reported reductions in postoperative opioid consumption following breast cancer surgery.5 Subsequent randomized trials investigated its use specifically in modified radical mastectomy, while comparative studies examined ESPB against PVB, pectoral nerve block, serratus anterior plane block and other regional techniques. [6-12]

The evidence base has expanded substantially. A systematic review published in 2020 identified 13 randomized controlled trials involving 861 patients and found reductions in pain and oral morphine-equivalent consumption following ESPB compared with no block.13 Additional systematic reviews subsequently confirmed an opioid-sparing effect.[14-17] More recently, a 2025 practical review identified 68 publications concerning ESPB in breast surgery, including 31 randomized controlled trials, illustrating the rapid expansion of the literature.[18]

Importantly, newer comparative evidence has questioned whether ESPB should be considered equivalent to PVB for major oncological breast surgery. A 2025 multicentre randomized trial involving 292 women reported that ESPB did not meet the prespecified non-inferiority criterion compared with PVB for the requirement for morphine during the first two postoperative hours, and ESPB produced less reliable dermatomal coverage.[19]

The objective of the present review is therefore to provide an updated, clinically focused synthesis of ESPB for mastectomy, incorporating its anatomical basis, technique, efficacy, opioid-sparing properties, comparison with other regional blocks, safety and limitations.

Anatomical Basis of ESPB: The erector spinae muscle complex is composed of 3 longitudinal muscle groups: iliocostalis, longissimus and spinalis located on the posterior aspect of the vertebral column, covered by the thoracolumbar fascia. For breast surgery, the level to perform erector spinae plane block (ESPB) has been traditionally selected in the upper thoracic region, at the level of T3-T5, mostly T4, where the transverse process can be easily identified using ultrasound as a hyperechoic bony structure with posterior acoustic shadowing. The erector spinae muscle is located superficially to the transverse process. The needle is inserted in plane and directed to the target area between the erector spinae muscle and the transverse process. Injecting the local anaesthetic agent in this plane leads to the separation of the erector spinae muscle from the transverse process and allows it to spread caudally and cranially.

The initial description of the ESPB suggested that the spread was mainly to the dorsal rami and intercostal nerves. Anatomical and imaging studies have shown since then that the spread was quite variable in the anterior direction, sometimes reaching the paravertebral and intercostal spaces. This variability has clinical relevance, since it is possible that the block may lead to extensive sensory loss of the posterior chest but relatively limited sensory analgesia of the anterior chest wall. This cannot be predicted based on the spread seen during the procedure.

Proposed Mechanisms of Analgesia: Several mechanisms have been proposed for the analgesic effect of ESPB. First, local anaesthetic may block the dorsal rami of spinal nerves after spreading posteriorly around the transverse processes. Second, anterior extension may allow local anaesthetic to reach the ventral rami and intercostal nerves. Third, spread toward the paravertebral space may result in blockade of spinal nerves and sympathetic Fibers. Fourth, local anaesthetic may spread longitudinally within the fascial plane to produce analgesia over multiple thoracic dermatomes. The relative contribution of each mechanism is uncertain, and the extent of anterior spread seems to vary according to injection level, volume, fascial anatomy and individual patient characteristics.[20,21] The uncertainty about mechanism is relevant because ESPB is often described as a "paravertebral-equivalent" block.

While some patients have paravertebral spread, this is not universal. The clinical evidence therefore suggests that ESPB is a distinct regional technique rather than assuming that its mechanism is identical to PVB.

Technique of Ultrasound-Guided ESPB

Patient Positioning: ESPB can be performed with the patient sitting, lateral or prone. With patients undergoing mastectomy, it is often convenient to perform the block in the sitting position before induction of general anaesthesia, although it may also be performed after induction.

A recent randomized study specifically investigated the influence of patient position on ESPB spread in women undergoing modified radical mastectomy.

The investigators reported differences in dermatomal spread according to whether the block was performed in the sitting or lateral position, suggesting that patient positioning may influence distribution of injectate.[22]

Ultrasound Identification: A linear high-frequency ultrasound probe is generally sufficient in most patients. The probe is placed longitudinally approximately 2-3 cm lateral to the midline. The transverse process is identified first, followed superficially by the erector spinae muscle. Depending on the level and anatomy, the trapezius and rhomboid major muscles may also be visualized.

Needle Placement: The needle is advanced in-plane toward the transverse process. The final needle tip is positioned deep to the erector spinae muscle and superficial to the transverse process. After negative aspiration, a small amount of local anaesthetic or saline may be injected to confirm separation of the muscle from the transverse process. The remaining solution is then injected incrementally.

Figure 1: USG guided ESPB

Local Anaesthetic Volume: There is substantial variation in reported ESPB regimens.

Commonly studied techniques have used approximately 20-30 mL of local anaesthetic. Gürkan et al. used 20 mL of 0.25% bupivacaine at T4 in an early randomized breast-surgery study.5MRM trials have subsequently used 20-25 mL of bupivacaine or ropivacaine. [6,7,23]

More recent research has examined whether increasing volume improves analgesia. Demirel et al. conducted a randomized double-blind trial evaluating different ESPB volumes in breast surgery, demonstrating continued interest in optimizing the relationship between injectate volume and clinical efficacy.[24]

Large volumes may increase the potential extent of spread but also increase systemic local-anaesthetic exposure. Therefore, total dose rather than volume alone must guide clinical decision-making.

Evidence From Randomized Clinical Trials

Early Evidence: The first randomized evidence specifically evaluating ESPB in breast surgery was published by Gürkan et al. in 2018. Fifty women undergoing breast cancer surgery were randomized to ESPB or control. The ESPB group received 20 mL of 0.25% bupivacaine at T4. Morphine consumption was significantly reduced at 1, 6, 12 and 24 hours.[5]

This study provided early clinical evidence that a single injection at the thoracic erector spinae plane could provide meaningful opioid-sparing analgesia after breast surgery.

A randomized study by Moustafa et al. subsequently evaluated ESPB in modified radical mastectomy and compared its technical performance with PVB.[25] The study contributed to the growing perception that ESPB could provide a technically accessible alternative to deeper regional techniques.

The randomized study by Yao et al. included 82 women undergoing modified radical mastectomy. Patients receiving ESPB had a significantly higher QoR-15 score 24 hours after surgery than controls, with reduced postoperative pain and cumulative opioid consumption.[7] These studies shifted the focus of ESPB from simply reducing pain scores to improving patient-centered outcomes.

ESPB and Quality of Recovery: Quality of recovery is increasingly recognized as an important perioperative endpoint because pain scores and opioid consumption alone may not capture the patient's overall postoperative experience.

Yao et al. reported a median QoR-15 score of 120 in the ESPB group compared with 110 in the control group at 24 hours after modified radical mastectomy, with a median difference of 10 points.[7] The improvement in QoR may reflect multiple consequences of better analgesia, including improved physical comfort, emotional state and ability to perform activities of daily living.

A pilot randomized trial involving thoracic and breast surgery also explored patient-centered outcomes with continuous ESPB. Although only five patients undergoing mastectomy were included, the study demonstrated the feasibility of assessing QoR-15 and longer-term pain outcomes in future trials.[26] Thus, future ESPB trials should increasingly include validated quality-of-recovery measures rather than relying exclusively on pain intensity and opioid consumption.

Opioid-Sparing Effect: Opioid reduction is one of the most consistently reported advantages of ESPB. The 2020 systematic review by Chen et al. included 13 randomized trials and 861 patients. Compared with no block, ESPB reduced postoperative pain at 0-2, 6, 12 and 24 hours. The pooled difference in oral morphine-equivalent consumption was approximately -21.55 mg.[13]

A separate systematic review of breast cancer surgery found reduced 24-hour opioid consumption and lower pain scores with ESPB.[14]

Another meta-analysis including six randomized studies and 415 patients reported significantly lower opioid consumption in the ESPB group, although heterogeneity was substantial.[15] The findings have been reproduced in individual MRM trials. A randomized study involving 65 enrolled patients and 58 patients in the final analysis found reduced 24-hour analgesic consumption, lower intraoperative fentanyl use and delayed rescue analgesia following ESPB.[27]

Continuous ESPB may further extend opioid-sparing effects. A randomized trial of continuous ESPB in breast cancer surgery reported markedly lower 24-hour tramadol consumption in the ESPB group, along with reduced intraoperative fentanyl use and lower postoperative pain scores.[28] These results support ESPB as an opioid-sparing intervention within multimodal analgesia.

ESPB and Rescue Analgesia: Several randomized studies demonstrate a longer interval to first rescue analgesia following ESPB. The delay in rescue analgesic requirement is clinically relevant because it reflects not merely statistical reduction in pain scores but prolonged analgesic effect.

However, the duration of analgesia varies considerably across studies. Differences in local anaesthetic concentration, injection volume, timing of block and postoperative analgesic protocols make direct comparison difficult. The use of adjuvants such as dexmedetomidine and hydromorphone has also been investigated.

A randomized trial published in 2024 examined hydromorphone combined with ropivacaine for ESPB in modified radical mastectomy. Patients were divided into general anaesthesia, ESPB with ropivacaine and ESPB with ropivacaine plus hydromorphone groups.[29]

Similarly, more recent trial have investigated dexmedetomidine as an adjuvant to bupivacaine or ropivacaine.30,31 Although these studies suggest potential prolongation of analgesia, adjuvant use should be interpreted cautiously because optimal dose, safety and regulatory considerations remain incompletely established.

ESPB Versus Paravertebral Block: One of the most clinically relevant questions regarding breast regional anaesthesia concerns the comparative efficacy of ESPB and PVB.

PVB provides a relatively direct blockade of the spinal nerves in the paravertebral space, though the technique requires needle placement in closer proximity to the pleura and neuraxis.

Early comparative studies suggested that ESPB could provide analgesia broadly comparable to that of PVB. Gürkan et al. randomized 75 women under-going breast surgery to receive ESPB, PVB or intravenous morphine. Both regional techniques reduced opioid requirements compared with systemic analgesia.[32]

A 2020 systematic review and meta-analysis of randomized trials found similar analgesic efficacy between ESPB and PVB.[16] However, the evidence has not been completely consistent.

Swisher et al. performed a randomized clinical trial comparing ESPB with PVB in 100 women undergoing non-mastectomy breast surgery. Pain scores and opioid consumption were higher following ESPB, with no block-related adverse events occurring.[33]

A later randomized double-blind trial by Wittayapairoj et al. directly compared ESPB and thoracic PVB for post-operative analgesia following breast surgery.[34] This study, along with others, contributes to the growing body of literature suggesting that differences between the two techniques may depend on the surgical population and block protocol. The most important recent evidence comes from Raft et al. who conducted a multicentre randomized double-blind trial involving 292 women undergoing major oncological breast surgery. Morphine was required during the first two post-operative hours in 75.2% of patients receiving ESPB compared with 50.3% receiving PVB. Thus, ESPB did not satisfy the predefined non-inferiority criterion. Morphine consumption overall was similar, though pain scores, particularly during mobilization, were higher in the ESPB group. Dermatomal coverage was also less reliable, with the required area inadequately covered in 55.9% of ESPB patients compared with 20.4% of PVB patients.[19]

This study is important because it demonstrates that technical simplicity does not necessarily equate with equal analgesic coverage. The appropriate conclusion is therefore not that ESPB is ineffective, but that its clinical performance may be less predictable than PVB for extensive oncological breast surgery.

ESPB Versus Pectoral Nerve Blocks: Pectoral nerve blocks – particularly PECS II – offer another regional option for breast surgery. PECS II targets the lateral and medial pectoral nerves, intercostobrachial nerve and lateral cutaneous branches of intercostal nerves. Since these structures are heavily involved in the innervation of both the breast and axilla, PECS II may prove to be more effective analgesia for procedures involving axillary dissection.

Sinha et al. compared PECS and ESPB in 64 women undergoing unilateral modified radical mastectomy.35 The study demonstrated that PECS techniques may offer more targeted analgesia for the anterior chest-wall and axilla.

Bakeer and Abdallah later performed a randomized trial of 60 women undergoing unilateral MRM. Patients who received PECS II had less postoperative morphine use, longer analgesia duration and decreased pain intensity when compared to those who received ESPB.[36]

The 2020 systematic review by Chen et al. also concluded that while ESPB showed analgesic efficacy comparable with PVB, it was inferior to PECS block in the trials included in their work.[13]

These studies highlight an important concept – the most effective block will be dictated by the distribution of traumatic insult. For extensive breast and axillary surgery, PECS II may allow for more direct blockade of relevant nerves, while ESPB provides a broader approach over the thoracic fascial-plane.

ESPB Versus Serratus Anterior Plane Block: Serratus anterior plane block (SAPB) is a technique of regional anaesthesia that targets the lateral thoracic wall and can potentially provide blockade of lateral cutaneous branches of thoracic intercostal nerves. Several randomized trials have investigated the efficacy of both ESPB and SAPB following modified radical mastectomy.

A randomized trial in 80 women compared the use of ultrasound guided ESPB versus SAPB and employed weight adjusted doses of ropivacaine.[37]

Nyima et al. randomized 80 women undergoing MRM for either ESPB or serratus anterior muscle block using 20 mL of 0.25% ropivacaine.[38]

The available evidence suggests that both techniques provide clinically meaningful analgesia, but neither one has shown consistent superiority.

ESPB and Mastectomy with Immediate Reconstruction: It has been reported that mastectomy followed by immediate breast reconstruction may be associated with considerable postoperative discomfort, since surgical trauma may involve both breast and chest-wall tissues.

A randomized clinical trial evaluated ESA after mastectomy with immediate breast reconstruction using a tissue expander. Fifty-eight patients completed the study. At 24 hours, total opioid consumption was significantly lower in the ESA group than in the intravenous PCA-only group. Intraoperative and postoperative fentanyl requirements were also lower.[37]

This finding is of relevance since reconstruction procedures may entail pain from both the mastectomy and reconstructive components. Reconstruction-specific analgesia may need to be considered in addition, since implant or expander placement may elicit pectoral muscle pain that is not entirely covered by ESA.

Continuous ESPB: Although single-shot ESPB is the most common approach, continuous ESPB utilizing a catheter has been investigated.

The key theoretical advantage is the prolonged analgesia beyond that achievable with a single local anaesthetic injection.

The randomized study of continuous ESPB in breast cancer surgery reported significant decreases in postoperative tramadol requirements and lower pain scores when compared to controls.[28]

However, continuous catheter techniques add to the procedural complexity and require surveillance for catheter migration, infection and local anaesthetic accumulation.

Given the generally short hospitalization following many mastectomy procedures, the added complexity may not be indicated for every patient. Continuous ESPB may be most useful in patients undergoing extensive surgery, reconstruction or procedures associated with prolonged postoperative pain.

Influence of Injection Volume: One of the unresolved questions is an optimal volume of a local anaesthetic. Reported volumes of ESPB in breast surgery are highly variable and frequently range from 15 to 30ml. Higher volumes may achieve a better longitudinal and anterior spread, but they also expose the patient to a larger amount of the local anaesthetic.

Demirel et al. specifically studied different volumes of ESPB in breast surgery in a randomized, prospective, and double-blind study.[24] They emphasize the need for distinguishing between the influence of concentration and volume since the former defines the total dose of the local anaesthetic, which determines the systemic exposure, while the latter dictates the spread within the fascial planes. Currently, there is no enough evidence to define the optimal volume. Practically, a prudent strategy would be to choose the lowest dose that provides sufficient spread and does not exceed the established maximum volume of a single injection.

Influence of Patient Position: The position in which ESPB is performed may influence the local anaesthetic spread.

Hozien et al. compared ESPB performed in sitting and lateral positions in women undergoing unilateral MRM with axillary dissection. Computed tomography assessment demonstrated differences in dermatomal spread, particularly along the midaxillary and scapular lines.[22]

This finding may have practical implications because postoperative analgesia requires adequate anterior and lateral chest-wall coverage rather than posterior sensory blockade.

Future research should standardize patient positioning when evaluating ESPB efficacy.

Safety Profile: One of the major attractions of ESPB is its superficial anatomical target.

Unlike PVB, the needle does not need to enter the paravertebral space. The transverse process provides a readily identifiable bony endpoint.

Published randomized trials have generally reported few serious block-related complications.

The 2020 systematic review by Chen et al. found no reported pneumothorax or local anaesthetic systemic toxicity attributable to ESPB among the included trials, whereas pneumothorax was reported in the PVB literature.[13]

Nevertheless, absence of reported complications in relatively small randomized trials should not be interpreted as proof that serious complications cannot occur.

Potential complications include:

1. vascular puncture;
2. infection;
3. hematoma;
4. local anaesthetic systemic toxicity;

5. inadvertent pleural puncture;
6. incomplete block;
7. epidural or paravertebral spread; and
8. catheter-related complications with continuous techniques.

The true incidence of rare complications requires large observational datasets rather than small randomized trials.

Hemodynamic Effects: A theoretical advantage of ESPB is the potential for less extensive sympathetic blockade compared with epidural and paravertebral techniques. Most clinical studies report satisfactory hemodynamic stability following ESPB. A recent randomized study comparing ESPB with thoracic epidural analgesia in unilateral mastectomy specifically investigated sympathetic blockade, hemodynamic effects and sensory distribution. The investigators found no statistically significant difference in the principal measures of sympathetic blockade between the two techniques.[37,38]

This finding is relevant because it challenges overly simplistic assumptions that ESPB produces no sympathetic effect. The physiological effects of ESPB appear to depend on local anaesthetic spread and may be more complex than initially proposed.

ESPB and Postoperative Nausea and Vomiting: Postoperative nausea and vomiting is common after breast surgery and is influenced by female sex, opioid administration and general anaesthesia. ESPB may reduce PONV indirectly through opioid sparing. Some meta-analyses have reported lower nausea or vomiting with regional analgesia, although differences between individual regional techniques are inconsistent.[14,17] Therefore, ESPB should not be considered an antiemetic intervention in itself. Its potential benefit is more appropriately understood as a consequence of reduced opioid requirements within a multimodal analgesic regimen.

ESPB and Chronic Postmastectomy Pain: Persistent postsurgical pain is an important long-term complication of breast cancer surgery.

Acute postoperative pain, nerve injury, psychological factors and adjuvant cancer treatment may contribute to chronic pain.

Theoretically, effective acute analgesia could reduce peripheral and central sensitization.

However, evidence specifically demonstrating that ESPB prevents chronic postmastectomy pain remains limited. A broader network meta-analysis of regional techniques in breast cancer surgery found that regional anaesthesia techniques reduced acute pain and opioid consumption but did not establish a significant reduction in chronic pain.

Similarly, evidence for PVB has not definitively demonstrated prevention of persistent pain. A trial-sequential analysis concluded that available evidence was insufficient to establish a definitive reduction in persistent postoperative breast pain with PVB.

Consequently, future ESPB trials should include long-term outcomes at 3, 6 and 12 months.

Summary of Systematic Reviews and Meta-Analyses

Table 1: Major evidence syntheses evaluating ESPB in breast surgery

Review	**Included evidence**	**Principal conclusion**
Wang et al., 2020 [16]	RCTs in breast/thoracic surgery	ESPB reduced postoperative opioid use
Chen et al., 2020 [13]	13 RCTs, 861 patients	Lower pain and opioid use versus no block
Liu et al., 2021 [14]	RCTs in breast cancer surgery	Analgesic and opioid-sparing benefit
Zhou et al., 2021 [15]	6 RCTs, 415 patients	Lower pain and opioid consumption
El-Boghdadly et al. [20]	Systematic anatomical/clinical analysis	Mechanism and spread remain variable
ESPB vs PVB/systemic analgesia	Broadly similar to PVB	Comparable analgesic efficacy
Guan et al., 2023 [17]	Breast cancer RCTs	Supported analgesic efficacy and safety
Macdonald et al. [18] 2025	68 breast-surgery publications	ESPB generally effective and technically accessible

Individual Studies Specifically Relevant to Mastectomy and Major Breast Surgery

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Table 2: Representative randomized and prospective studies of ESPB in mastectomy/breast cancer surgery

Study	Design/Sample	Surgery	ESPB Technique	Main Findings
Gürkan et al., 2018 [5]	RCT, n=50	Breast cancer surgery	T4, 20 mL 0.25% bupivacaine	Reduced morphine consumption at 1, 6, 12 and 24 h
Moustafa et al.[25]	Comparative RCT	Modified radical mastectomy	ESPB vs PVB	ESPB technically feasible; comparative analgesic efficacy investigated
Yao et al.[27], 2019	RCT, n=82	MRM	Preoperative ESPB with ropivacaine	Improved QoR-15, lower pain and opioid use
Sinha et al.[35]	RCT, n=64	Unilateral MRM	ESPB vs PECS	Comparative analgesic efficacy demonstrated
Gürkan et al.[32], 2020	RCT, n=75	Breast cancer surgery	ESPB vs PVB vs IV morphine	Regional blocks reduced opioid requirement
He et al.[8], 2020	RCT	Breast cancer surgery	US-guided ESPB	Improved postoperative analgesia
Swisher et al.[33], 2020	RCT, n=100	Non-mastectomy breast surgery	ESPB vs PVB	PVB produced lower pain and opioid use
Kim et al.[40]	RCT, n=58 analyzed	Mastectomy + reconstruction	ESPB + IV PCA vs IV PCA	Lower 24-h opioid consumption
Bakeer & Abdallah,[35] 2022	RCT, n=60	Unilateral MRM	ESPB vs PECS II	PECS II produced lower morphine use and longer analgesia
Wittayapairoj et al., 2022 [41]	Double-blind RCT	Breast surgery	ESPB vs TPVB	Direct comparative assessment
Ambedkar et al., 2022 [37]	RCT, n=80	MRM	ESPB vs SAPB	Both techniques provided postoperative analgesia
Nyima et al., 2023 [38]	RCT, n=80	MRM	ESPB vs serratus block	Comparative analgesic efficacy
Continuous ESPB trial	RCT, n=50	Breast cancer surgery	Continuous catheter	Markedly reduced 24-h tramadol and fentanyl use
Cao et al., 2024 [29]	RCT, n=90	MRM	ESPB ± hydromorphone	Adjuvant investigated for prolonged analgesia
Demirel et al., 2024 [24]	Double-blind RCT	Breast surgery	Different ESPB volumes	Evaluated dose/volume relationship
Hozien et al., 2025 [22]	Prospective randomized	MRM + axillary dissection	Sitting vs lateral ESPB	Position influenced dermatomal spread
Raft et al., 2025 [19]	Multicentre double-blind RCT, n=292	Major oncological breast surgery	ESPB vs PVB	ESPB failed non-inferiority criterion; less reliable dermatomal coverage
Barakat et al., 2025 [30]	RCT, n=44	Mastectomy + axillary dissection	ESPB ± dexmedetomidine	Evaluated opioid-sparing effect of adjuvant

The individual trials demonstrate considerable heterogeneity in surgical procedure, injection level, local anaesthetic dose, timing of block and comparator analgesic regimen. This heterogeneity is an important explanation for differences among published studies.

Limitations: The main limitation of the available evidence is substantial variability between studies. Spread of local anesthetic within the erector spinae plane does not always result in complete sensory blockade of the surgical field, and anterior chest-wall analgesia may be inconsistent. Considerable heterogeneity exists in vertebral level, injection volume and concentration, local anesthetic and adjuvant choice, timing, patient position, postoperative analgesic protocols, and definitions of rescue analgesia, making it difficult to establish an optimal ESPB protocol. Many studies also have relatively small sample sizes, limiting the ability to detect rare complications or subtle differences between techniques. Furthermore, long-term outcomes have been evaluated in relatively few studies.

Future Research Priorities: Future research should focus on standardizing ESPB techniques by clearly defining the vertebral level, patient position, needle approach, local anesthetic concentration, volume, and timing of injection. Opioid consumption should be consistently reported as morphine milligram equivalents, and studies should provide procedure-specific analyses for simple mastectomy, modified radical mastectomy, axillary dissection, nipple-sparing and skin-sparing mastectomy, and mastectomy with reconstruction. Patient-centered outcomes such as QoR-15/40, time to ambulation, shoulder function, length of hospital stay, patient satisfaction, return to normal activity, and long-term pain should be incorporated. Follow-up at 3, 6, and 12 months is desirable to assess persistent postmastectomy pain, while large multicentre studies are needed to better evaluate rare complications and establish the safety profile of ESPB.

Conclusion

Ultrasound-guided erector spinae plane block is a useful regional analgesic technique for mastectomy, with evidence of reduced postoperative pain, opioid consumption, and rescue analgesic requirements. Its superficial target, predictable bony endpoint, multidermatomal spread, and technical simplicity make it suitable for multimodal analgesia. However, it is not universally superior to other regional techniques, and paravertebral block may provide more consistent analgesia in extensive breast surgery. The choice of block should therefore be individualized according to surgical extent, patient factors, and clinician expertise. Further standardized multicentre trials with long-term follow-up are needed to define its optimal role.

Author Contributions:

Author 1 contributed to conceptualization, literature review, and manuscript drafting. Author 2 contributed to literature review and critical revision. Author 3 contributed to supervision and final review. All authors approved the final manuscript.

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