RESEARCH PAPER

Segmental Thoracic Spinal Anaesthesia versus General Anaesthesia for Breast Surgery: A Comprehensive Review of Current Evidence and Clinical Outcomes

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Abstract
Few operations are performed as often worldwide as breast surgery, a category that spans everything from removing a benign lump to a modified radical mastectomy or breast reconstruction. General anaesthesia (GA) has long been the default choice for these procedures, valued for the complete unconsciousness, controlled ventilation, and favourable operating conditions it provides. Its downsides are well documented, though: postoperative nausea and vomiting (PONV), slower recovery, heavier opioid use, airway complications, impaired lung function afterward, and longer hospital stays — problems that hit elderly patients and those with cardiopulmonary disease especially hard. These drawbacks are what have pushed clinicians to look more seriously at regional anaesthetic techniques that can deliver adequate surgical anaesthesia with fewer systemic side effects.

Segmental thoracic spinal anaesthesia (STSA) belongs to this category. It works by placing a small, carefully measured dose of local anaesthetic straight into the cerebrospinal fluid at the level of the chest, numbing the skin segments overlying the operative site without the widespread loss of leg movement or blood-pressure control that comes with a standard lower-spine block. Since the numbness stays limited to the operative area itself, STSA tends to keep blood pressure steadier, control pain better after surgery, cut opioid needs, and get patients out of bed and out of hospital sooner. Roughly ten years' worth of accumulating evidence now suggests that, in the hands of a skilled anaesthesiologist who selects patients carefully and follows a careful technique, nerve injury from STSA is genuinely rare.

Between 2015 and 2026, a range of randomised trials, prospective observational studies, systematic reviews, and meta-analyses have set STSA against GA in breast-surgery patients. Most point the same way: STSA cuts postoperative pain scores, opioid use, PONV, and pulmonary complications, while boosting patient satisfaction and fitting neatly into what's now called enhanced recovery after surgery. That said, brief episodes of low blood pressure and a slowed heart rate, together with the technical demands of the block itself, mean intraoperative monitoring still has to stay close.

This review pulls together the evidence published from 2015 to 2026 on STSA versus GA for breast surgery — how well each works, how safe each is, the physiology behind them, the outcomes they produce, and where each falls short — with particular attention to perioperative pain control, haemodynamic effects, recovery, patient satisfaction, complications, and the more recent developments that are pushing STSA toward wider use.

Keywords: Segmental thoracic spinal anaesthesia; Breast surgery; General anaesthesia; Regional anaesthesia; Postoperative analgesia; Enhanced Recovery After Surgery (ERAS); Thoracic spinal block; Clinical outcomes.
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INTRODUCTION

Disorders of the breast account for a large share of surgery performed worldwide, and breast cancer remains the single most common cancer diagnosed in women. Better screening, earlier detection, and multidisciplinary treatment planning have pushed up the yearly number of lumpectomies, modified radical mastectomies, sentinel-node biopsies, reconstructive operations, and oncoplastic procedures. With that growth has come a sharper focus on getting perioperative anaesthetic care right, since the technique used shapes postoperative pain, how fast a patient recovers, how satisfied they end up, complication rates, and even the overall cost of care (1).

General anaesthesia has held the position of gold standard for breast surgery for a long time now, largely because it reliably delivers unconsciousness, immobility, controlled ventilation, and good operating conditions all at once. A typical balanced GA regimen combines an IV induction agent, an inhalational agent, muscle relaxants, opioids, and airway instrumentation to get there. Effective as this is, it comes with a recognisable set of downsides — airway trauma, sore throat afterward, pulmonary complications, PONV, slower recovery, opioid side effects, cognitive changes in older patients, and longer hospital stays (2,3).

Perioperative medicine more broadly has been shifting toward what's now branded enhanced recovery after surgery, a philosophy built around opioid-sparing analgesia, getting patients out of bed early, and limiting postoperative illness generally. That shift has pulled regional anaesthetic techniques back into the spotlight, since they can limit how much systemic drug a patient is exposed to without giving up good operating conditions. A number of regional options have found growing favour in clinical practice as a result: the erector spinae plane block and the serratus anterior plane block among the newer fascial-plane techniques, alongside longer-established approaches such as thoracic epidural anaesthesia, paravertebral block, pectoral nerve (PECS) block, and thoracic spinal anaesthesia (4–6).

Segmental thoracic spinal anaesthesia stands out among these as a genuinely distinct development in neuraxial technique. Where conventional lumbar spinal anaesthesia lets local anaesthetic spread widely through the CSF and block the lower thoracic, lumbar, and sacral roots, STSA instead places a deliberately tiny volume of anaesthetic straight into the cerebrospinal fluid at chest level, usually somewhere around the T4 to T8 vertebrae. What results is a block that stays largely confined to the thoracic dermatomes over the surgical field, sparing lower-limb motor function and keeping sympathetic blockade to a minimum (7).

For a long time, puncturing the thoracic spine was viewed as risky, mainly out of fear of injuring the spinal cord itself. That view has shifted following anatomical work using MRI, cadaver dissection, and ultrasound, which showed that the thoracic cord sits toward the front of the spinal canal, leaving a measurable cerebrospinal fluid space behind it through which a needle can be advanced safely if the technique is careful. This anatomical evidence has done a lot to change how thoracic spinal anaesthesia is perceived and has opened the door to further clinical study (8,9).

Better needle technology has also played a part in bringing STSA back into favour. Pencil-point tips, finer gauges, improved positioning, ultrasound guidance, and a better working knowledge of thoracic anatomy have together cut rates of post-dural puncture headache, traumatic puncture, nerve injury, and failed blocks. As a result, a number of tertiary centres now routinely use STSA in their breast surgery protocols, particularly for patients with significant lung disease or high anaesthetic risk (10,11).

A key physiological selling point of STSA is how selective its sympathetic block is, staying confined to the thoracic segments rather than spreading widely. This avoids much of the marked vasodilation that comes with lumbar spinal anaesthesia, which in turn cuts down on severe hypotension while still providing adequate surgical anaesthesia. Because diaphragmatic function and spontaneous breathing are largely preserved, respiratory outcomes tend to be better too, particularly for elderly, obese, or chronically pulmonary-compromised patients (12).

How well pain is controlled afterward is one of the biggest factors in how smoothly a patient recovers from breast surgery. Poorly managed pain keeps patients in bed longer, drives up opioid use, extends hospital stays, hurts lung function, and can even set the stage for chronic post-mastectomy pain. Because STSA gives dense sensory block during surgery that carries over into extended postoperative analgesia, several studies have found lower pain scores, less opioid use, fewer rescue doses, and greater comfort with STSA than with GA (13–15).

The choice of anaesthetic technique also has a real effect on postoperative nausea and vomiting, which patients often rate among the worst parts of the recovery experience — anywhere from roughly 30% to 70% of GA patients are affected, depending on their individual risk factors and how much opioid they receive. Regional techniques need far less volatile agent and systemic opioid, and that translates into both fewer and milder episodes of PONV, which in turn lets patients eat and go home sooner (16).

There's also growing interest in what anaesthetic choice might mean immunologically in cancer surgery specifically. Surgical stress itself, along with volatile agents, opioids, and the neuroendocrine response, can temporarily dampen natural killer cell activity and cell-mediated immunity. Regional techniques dial down the body's stress reaction to surgery and mean the patient needs less opioid overall, which may in turn help protect immune function around the time of the operation. The evidence on long-term cancer recurrence isn't conclusive yet, but a handful of observational studies hint at a possible oncological advantage for regional techniques (17).

A good number of randomised trials published across 2015 to 2026 have tested STSA head-to-head against GA in various breast operations, and the pattern that emerges is fairly consistent: better postoperative analgesia, lower opioid use, earlier walking, less PONV, shorter time in the post-anaesthesia care unit, higher satisfaction, and surgical conditions that hold up just as well as GA. What continues to limit wider uptake, though, is the combination of transient hypotension, bradycardia, the technical skill the block demands, and simply how few anaesthesiologists are yet comfortable performing it (18–22).

Several recent systematic reviews and meta-analyses have added further weight to the case for thoracic neuraxial anaesthesia in breast surgery, concluding that STSA can substitute for GA reasonably well in appropriately chosen patients, provided an experienced practitioner performs it with proper monitoring and a standardised protocol. Even so, the underlying studies still tend to be small, use inconsistent drug regimens, cover a range of different procedures, and rarely follow patients for long — all reasons why larger multicentre trials are still needed (23–25).

With that background, this review sets out to work through the evidence published between 2015 and 2026 comparing STSA and GA for breast surgery, covering the relevant anatomy, the physiology behind the technique, perioperative pain control, haemodynamic stability, respiratory outcomes, recovery, patient satisfaction, complications, overall safety, and where clinical practice might be headed next.

MATERIALS AND METHODS

This review is based on a wide search of what has been published comparing STSA with GA specifically as used in breast surgery, restricted to studies from January 2015 through June 2026. The search spanned general biomedical databases (PubMed/MEDLINE, Embase, Scopus, and Web of Science), specialist and trial registries (the Cochrane Library and ClinicalTrials.gov), the NCBI repository, Google Scholar, and several full-text publisher platforms — ScienceDirect, SpringerLink, Wiley Online Library, Taylor & Francis Online, and DOAJ, the Directory of Open Access Journals.

Search terms combined free-text keywords with the corresponding MeSH headings, among them breast surgery, breast cancer surgery, modified radical mastectomy, general anaesthesia, regional anaesthesia, thoracic neuraxial block, thoracic spinal anesthesia, segmental thoracic spinal anaesthesia, postoperative analgesia, postoperative nausea and vomiting, haemodynamic stability, and enhanced recovery after surgery. The Boolean connectors AND, OR, and NOT tied these together.

To be eligible, a study had to be in English, involve adult patients undergoing breast surgery under STSA or GA, and fall into one of the accepted study types: randomised controlled trials, cohort or other observational research (prospective or retrospective), systematic reviews and meta-analyses, or clinical guidance issued internationally. Left out were editorials, conference material without a full text, case reports, letters, animal research, and anything predating 2015.

From each included study, details were pulled on the study design, patient population, anaesthetic used, perioperative haemodynamics, postoperative pain, opioid use, PONV, pulmonary outcomes, recovery, patient satisfaction, complications, and overall clinical outcomes, all of which were then critically assessed. Because of how varied the studies were, this evidence was brought together narratively rather than statistically, aiming for a rounded picture of where STSA currently stands in breast surgery.

RESULTS

Altogether, 38 studies spanning 2015 to 2026 were included in this review, drawing on randomised trials, prospective observational work, retrospective comparisons, systematic reviews, meta-analyses, and guidance documents issued by international bodies. Taken as a group, they back STSA up as a workable, low-risk option in place of GA for suitably chosen breast-surgery patients.

Most of the randomised trials found that STSA gave excellent intraoperative anaesthesia, letting lumpectomy, modified radical mastectomy, straightforward mastectomy, and axillary procedures go ahead without needing to convert to GA in the large majority of patients. A low dose of local anaesthetic reliably produced sensory block across roughly the T2 to T8 dermatomes, which was enough for good surgical conditions while sparing lower-limb movement and normal breathing.

Almost every comparative study found pain scores meaningfully lower with STSA than GA over the first 24 hours after surgery. Patients in the STSA group also went noticeably longer before needing a rescue dose of analgesic, which fed through into a real drop in overall opioid use — and, with less opioid on board, side effects like nausea, vomiting, oversedation, and respiratory depression showed up less often too.

Several studies also credited a carefully performed STSA with steadier haemodynamics. Some patients did have brief drops in blood pressure or heart rate from the sympathetic block, but these tended to be mild and settled quickly with IV fluids or a small dose of vasopressor, rarely forcing a switch to GA.

Severe cardiovascular instability stayed uncommon overall, provided the dose was kept low and patients were chosen carefully.

Breathing-related outcomes leaned in STSA's favour too. Because patients keep breathing on their own, avoid intubation, and are exposed to less inhalational agent, pulmonary complications afterward were less common, an effect most visible in elderly patients and those with chronic respiratory disease. A number of studies also reported better oxygenation, quicker return of normal lung function, and less atelectasis compared with GA.

One finding that showed up again and again was a clear drop in PONV with STSA, largely attributed to needing less opioid and avoiding volatile agents altogether. Patients also tended to get back to eating and moving around sooner, and generally reported more comfort overall.

Most studies found STSA patients getting up and about sooner, needing less time to recover before leaving the anaesthesia recovery area, and going home earlier overall than those who had GA — findings that make a reasonable case for building STSA into enhanced-recovery pathways for breast surgery.

Patients themselves consistently rated STSA higher, citing good pain control, minimal discomfort afterward, a quick recovery, and fewer side effects from the anaesthetic itself. Surgeons were generally satisfied too, with most studies describing acceptable operating conditions, sufficient muscle relaxation, and little patient movement during the procedure.

STSA's overall safety record looked good. Neurological complications turned up rarely if at all across the literature reviewed, and none of the more recent studies reported a permanent neurological deficit tied to the thoracic puncture itself. What complications did occur were minor — transient hypotension, bradycardia, itching, urinary retention, shivering, occasionally a post-dural puncture headache — and all resolved with conservative management, without lasting effects.

More recent systematic reviews and meta-analyses, published between 2022 and 2026, back this up, confirming that STSA meaningfully reduces pain, opioid use, PONV, and recovery time while matching GA on surgical conditions. They too flagged the need for larger, multicentre, standardised trials with longer follow-up before the evidence base can be considered fully mature.

Pulled together, the evidence suggests STSA delivers effective surgical anaesthesia along with better postoperative pain relief, less opioid use, less PONV, faster recovery, higher patient satisfaction, and an acceptable safety profile relative to GA, at least in appropriately selected breast-surgery patients.

DISCUSSION

This review has brought together the 2015–2026 evidence on STSA versus GA for breast surgery, and on balance the literature supports STSA as a sound, low-risk option in the right patients. Randomised trials, prospective studies, and systematic reviews line up fairly consistently: excellent surgical anaesthesia, better postoperative analgesia, less opioid use, less PONV, quicker recovery, and higher patient satisfaction. Worries about thoracic puncture have historically slowed adoption, but the more recent evidence suggests serious neurological complications are genuinely rare when an experienced anaesthesiologist performs the block correctly (26).

Among the most consistent findings is that STSA simply provides better postoperative pain relief. GA is mainly an intraoperative tool — it doesn't leave much analgesia behind once the patient wakes — whereas STSA's dense segmental block carries over into the early postoperative period. Comparative studies recorded meaningfully lower visual-analogue pain scores across the first postoperative day, together with analgesia that lasted longer and a longer stretch before rescue medication was needed. Good pain control, in turn, gets patients moving sooner, helps their breathing mechanics, eases anxiety, and generally speeds up recovery (27).

STSA's lower opioid requirement is another significant advantage. Opioids remain a major driver of postoperative problems — nausea, vomiting, oversedation, ileus, urinary retention, respiratory depression — and nearly every comparative study in this review found STSA patients needed noticeably less of them. That opioid-sparing effect matters most in elderly patients and those with respiratory disease, where opioid-related ventilatory depression can do real harm, and it also fits naturally with current ERAS protocols and multimodal analgesic strategies (28).

PONV rates run particularly high after breast surgery, driven by the combination of volatile agents, opioids, being female, and the surgical manipulation itself, and it remains one of the biggest reasons patients are unhappy with GA or end up staying in hospital longer than planned. Across the randomised trials reviewed here, STSA consistently produced lower PONV rates than GA, an effect that seems to trace mainly back to using less opioid and avoiding inhalational agents altogether. Patients also tended to tolerate food sooner and reported greater comfort, both of which further support recovery (29).

Haemodynamic stability is always a factor in choosing an anaesthetic technique. Spinal anaesthesia in general has a reputation for causing significant hypotension through sympathetic blockade, but the low-dose, segmental nature of thoracic spinal anaesthesia keeps that block fairly localised and limits the vasodilation that drives blood pressure down. Most of the more recent studies saw only transient hypotension and the occasional bout of bradycardia, both of which resolved quickly with IV fluids or a small vasopressor dose and without lasting consequences. Careful patient selection, gradual positioning, adequate preoperative hydration, and close haemodynamic monitoring all help keep the cardiovascular system stable during STSA (30).

Respiratory outcomes matter a great deal in breast surgery, especially in patients who are elderly, obese, or living with COPD or other lung disease. GA requires airway instrumentation and mechanical ventilation, both of which can contribute to postoperative atelectasis, poorer mucociliary clearance, and pulmonary complications generally. STSA avoids much of this because its block stays within the thoracic dermatomes and leaves the cervical nerves controlling breathing untouched, so spontaneous respiration and diaphragm function are preserved. Several prospective studies have reported better oxygenation, fewer pulmonary complications, and a quicker return to normal respiratory function with STSA, which is why it looks like an attractive option for patients at higher respiratory risk (31).

Recent studies keep pointing to STSA's positive effect on recovery and how well it fits ERAS pathways, which emphasise multimodal analgesia, early oral intake, early mobilisation, reduced opioid use, and a shorter hospital stay. Because STSA gives good intraoperative anaesthesia plus lasting postoperative analgesia, patients tend to recover faster than under GA. Several randomised trials found STSA patients walking sooner, returning to normal physiological function faster, spending less time in the PACU, and going home earlier — findings that matter increasingly in modern breast surgery, where day-case procedures and early discharge are being pushed to improve efficiency and lower cost (32).

Patient satisfaction is a useful yardstick for any anaesthetic technique, and here too STSA came out ahead across the literature reviewed, with patients citing better comfort, minimal nausea and vomiting, longer-lasting pain relief, quick return of consciousness, earlier eating, and fewer opioid-related side effects. Not having an airway device in place, and being able to recover without heavy sedation, were also things patients appreciated. Surgeons were similarly satisfied, reporting adequate sensory block, good operating conditions, little patient movement, and satisfactory muscle relaxation throughout — all of which supports bringing STSA more fully into routine breast surgery practice at centres with the necessary expertise (33).

None of this comes without caveats, though. Thoracic spinal puncture demands a solid grasp of thoracic vertebral anatomy, precise needle placement, and real clinical skill, and plenty of anaesthesiologists still hesitate to attempt it for fear of injuring the spinal cord. Modern MRI-based anatomical work has shown there is, in fact, enough posterior cerebrospinal fluid space behind the thoracic cord to advance a needle safely, provided standard precautions are followed, and the combination of fine pencil-point needles, meticulous asepsis, careful positioning, and proper monitoring accounts for the strong neurological safety record reported in recent studies. Importantly, no permanent neurological deficit tied to STSA turned up anywhere in the literature reviewed here, provided the procedure was performed correctly (34).

Strong as the evidence for STSA's effectiveness is, the underlying literature has real limitations worth naming. Most published trials are small and single-centre, which limits how far the findings can be generalised, and there's considerable variation across studies in the local anaesthetic used, dosing, adjuvant drugs, puncture level, surgical procedure, and how outcomes were even measured. Very few studies have followed patients long enough to capture things like persistent pain after mastectomy, quality of life, cancer prognosis, or lasting neurological safety, and this methodological patchwork makes direct comparison between studies difficult, pointing again to the need for large, standardised, multicentre trials before firm recommendations can be made. Still, the fact that favourable perioperative outcomes keep showing up across such a range of study designs is itself a reasonably strong argument for STSA's growing role as an alternative to GA in carefully chosen breast-surgery patients (35).

The 2023–2026 systematic reviews and meta-analyses add further support, with pooled data consistently showing STSA outperforming GA on postoperative analgesia, opioid consumption, PONV, and time to mobilisation. These reviews also found comparable surgical conditions, high success rates for the block itself, and a very low rate of major complications, all of which supports folding STSA further into contemporary perioperative pathways, especially at centres already skilled in regional anaesthesia. The authors of these reviews were nonetheless clear that standardised protocols and larger multicentre trials are still needed before any universal recommendation can be made (36).

A newer strand of research is looking at whether anaesthetic choice affects oncological outcomes after breast cancer surgery specifically. Surgical trauma triggers the neuroendocrine stress response, which causes a transient dip in immune function that could, in theory, influence how a tumour spreads or recurs. GA and systemic opioids have both been linked to suppressed natural killer cell activity and altered cell-mediated immunity, while regional techniques blunt the stress response and cut opioid exposure. Nothing conclusive has emerged yet linking STSA to better long-term cancer survival, but several observational studies point to a more favourable immunological profile that's worth investigating further — ideally through well-designed prospective trials with long follow-up that can settle whether STSA actually affects recurrence, disease-free survival, or overall survival (37).

Taken as a whole, the current evidence base makes a reasonable case for Segmental Thoracic Spinal Anaesthesia as a genuinely useful substitute for GA in appropriately chosen breast surgery cases — excellent intraoperative anaesthesia, extended postoperative analgesia, less opioid use, less PONV, preserved spontaneous breathing, earlier mobilisation, shorter hospital stays, high patient satisfaction, and a strong safety record when performed by an experienced anaesthesiologist. As more clinicians gain expertise and more high-quality evidence accumulates, STSA seems likely to take on a bigger role in breast surgery, particularly within ERAS programmes and for patients with significant cardiopulmonary comorbidities. Future research should focus on refining anaesthetic protocols, tracking long-term neurological and oncological outcomes, and working out exactly which patients stand to benefit most from this technique (38).

CONCLUSION

Segmental Thoracic Spinal Anaesthesia has proven itself a trustworthy, well-working stand-in for General Anaesthesia in appropriately chosen breast surgery cases. The evidence from 2015 to 2026 shows it delivering better postoperative analgesia, lower opioid use, less PONV, faster recovery, higher patient satisfaction, and preserved respiratory function, all without compromising the surgical field. In the hands of an experienced anaesthesiologist, with the right patients chosen and properly monitored, STSA offers real advantages and sits comfortably within enhanced-recovery principles. What remains is for larger, multicentre randomised trials to standardise the technique and confirm its long-term clinical and oncological outcomes.

Limitations

The evidence available right now is constrained by small sample sizes, inconsistent anaesthetic protocols, and a shortage of multicentre randomised trials. Both long-term neurological safety and oncological outcomes still need proper investigation through well-designed prospective studies.

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