narra j

Review Article

Effectiveness and safety of thoracic segmental spinal anesthesia for breast surgery: A systematic review and meta-analysis

Tasrif Hamdi[1,2*], Ekawaty S. Mastari[3], Andriamuri P. Lubis[1,2], Imam Ghozali[4], Nadia Kemalasari[5] and Awi TM. Harahap[5]

[1]Department of Anesthesiology and Intensive Care, Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia; [2]Department of Anesthesiology and Intensive Care, Adam Malik Hospital, Medan, Indonesia; [3]Institut Kesehatan Helvetia, Medan, Indonesia; [4]Faculty of Medicine, Universitas Lampung, Bandar Lampung, Indonesia; [5]Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia

*Corresponding author: tasrif.hamdi@usu.ac.id

Abstract

General anesthesia is the standard approach for thoracic and abdominal procedures; however, it has notable limitations, particularly in high-risk patients. Regional anesthesia techniques, such as thoracic segmental spinal anesthesia, have gained popularity due to their potential to reduce these associated risks. The aim of this study was to assess the effectiveness and safety of thoracic segmental spinal anesthesia in breast cancer surgery using systematic review and meta-analysis. This study adhered to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) 2020 guidelines, conducting a comprehensive literature search across ScienceDirect, Cochrane Library, and PubMed databases up to July 4, 2024. The inclusion criteria focused on studies that provided specific information on the effectiveness (postoperative pain reduction) and safety (incidence of adverse events and complications) of thoracic segmental spinal anesthesia, as well as satisfaction among patients and surgeons. Out of 4,060 articles, six studies were included for qualitative assessment, with four further analyzed quantitatively. Meta-analysis findings indicated that thoracic segmental spinal anesthesia provided significantly better pain control at 12 hours postoperatively (SMD: -1.25; 95%CI: -1.54 to -0.96; $p<0.0001$), although no significant difference was noted at 0 hours (SMD: -1.07; 95%CI: -2.33 to 0.18; $p=0.09$). Thoracic segmental spinal anesthesia was associated with a lower incidence of postoperative vomiting (RR: 0.46; 95%CI: 0.22–0.95; $p=0.04$), but it presented a higher risk of hypotension (RR: 2.57; 95%CI: 1.41–4.71; $p=0.002$). Importantly, no anesthesia-related mortalities were reported. The technique resulted in higher satisfaction levels among both patients (SMD: 0.63; 95%CI: 0.33–0.92; $p<0.0001$) and surgeons (SMD: 0.81; 95%CI: 0.51–1.11; $p<0.0001$) compared to general anesthesia. The study highlights that thoracic segmental spinal anesthesia is a safe and effective alternative to general anesthesia for breast cancer surgery, offering superior postoperative pain control, enhanced patient and surgeon satisfaction, and a reduced incidence of postoperative vomiting.

Keywords: Thoracic segmental spinal anesthesia, breast cancer, postoperative pain, patient satisfaction, surgeon satisfaction

Introduction

Open thoracic and abdominal surgeries are predominantly conducted under general anesthesia [1]. However, due to several disadvantages, including limitations in treating certain populations,

https://narraj.org/

Received: October 14, 2024 - Accepted: January 15, 2025 - Published online: January 26, 2025

such as elderly patients or individuals with cardiac disorders, the potential for adverse reactions to anesthetic agents, and extended recovery times, general anesthesia is typically reserved for patients at higher risk of complications [1]. Additionally, cost and safety concerns further limit the use of general anesthesia, with anesthesia duration associated with postoperative mortality [2].

Regional anesthesia techniques have recently gained popularity across various surgical procedures, particularly thoracic segmental spinal anesthesia for patients at high risk under general anesthesia [3]. While concerns about spinal cord injury warrant caution, thoracic segmental spinal anesthesia is favored for its potential to reduce the risks and adverse effects of general anesthesia [3]. Thoracic segmental spinal anesthesia is regarded as the most appropriate option for specific procedures and patient populations, particularly for shorter surgeries or for patients unable to tolerate conventional lumbar spinal anesthesia [3,4]. This patient group frequently includes older adults with reduced physiological reserves, multiple comorbidities, polypharmacy, cognitive impairments, and frailty [4].

Thoracic segmental spinal anesthesia has shown success in laparoscopic cholecystectomy [5], breast cancer [6], and abdominal cancer surgeries [7], demonstrating its feasibility as an alternative to general anesthesia [3,5-7]. This procedure has also been used in individuals without comorbidities, suggesting broader potential benefits for a wider patient population [4]. However, further studies involving larger patient groups are necessary to confirm the effectiveness and safety of thoracic segmental spinal anesthesia before recommending this procedure for routine use. The aim of this study was to assess the effectiveness and safety of thoracic segmental spinal anesthesia in breast cancer surgery.

Methods

Study design and setting

The present systematic review and meta-analysis adhered to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) 2020 guidelines and has been registered in the PROSPERO database under registration number CRD42024574168. Initially, the population, intervention, comparator, outcome (PICO) framework was established to formulate the objective of this study and based on this the keywords as well as inclusion and exclusion criteria for the literature search were determined. The systematic search was conducted on three databases (ScienceDirect, Cochrane Library, and PubMed) as of July 4, 2024. After the initial screening process of the title and abstract, full-text articles of each study were further reviewed and analyzed to confirm that the study was a good fit for our particular analysis. Eventually, qualitative and quantitative analysis was conducted to determine the effectiveness and safety of thoracic segmental spinal anesthesia in breast cancer surgery.

Eligibility criteria

The PICO framework of the present study was structured as follows: (1) population: patients undergoing breast surgery who received thoracic segmental spinal anesthesia; (2) intervention: thoracic segmental spinal anesthesia; (3) comparator: general anesthesia; (4) outcome: the primary outcome metrics included: (a) the effectiveness of thoracic segmental spinal anesthesia in reducing postoperative pain; (b) the incidence of adverse events; and (c) the incidence of complications compared to general anesthesia or other control groups. The secondary outcome was the satisfaction of patients and surgeons with thoracic segmental spinal anesthesia. Only studies that were written in English published between 2014 and 2024 and had full-text availability were included in this analysis. Studies that did not report essential outcomes (postoperative pain) were excluded.

Search strategy

A comprehensive literature search was performed as of July 4, 2024, using the ScienceDirect, Cochrane Library, and PubMed databases. The predefined keywords utilized in the search included: (thoracic segmental spinal OR segmental thoracic spinal OR thoracic segmental anesthesia OR thoracic spinal anesthesia OR segmental thoracic spinal anesthesia OR thoracic

segmental spinal anesthesia OR segmental anesthesia) AND (breast OR breast surgery OR breast cancer). Articles with relevant abstracts and titles were selected for full-text evaluation, along with further qualitative and quantitative analysis, which were independently conducted by six investigators (TH, ESM, APL, IG, NK and ATH) through literature searches and data analysis.

Data extraction

Duplicates were screened and removed using the Mendeley reference manager. After assessing the studies' eligibility, four investigators (TH, ESM, NK and ATH) extracted the data, resolving any disagreements through discussion with the other two authors (APL and IG). The data extraction process included collecting information on author names, year of publication, study design, anesthesia and surgical methods, postoperative pain scale, the effectiveness of thoracic segmental spinal anesthesia in reducing postoperative pain, the incidence of adverse events, the incidence of complications, the satisfaction of patients and surgeons to thoracic segmental spinal anesthesia.

Study outcomes

The outcomes reported in this study were: (a) the effectiveness of thoracic segmental spinal anesthesia in reducing postoperative pain; (b) the incidence of adverse events, including the incidence of hypotension, nausea, and vomiting; and (c) the incidence of complications compared to general anesthesia or other control groups. The secondary outcome was the satisfaction of the patient and surgeon with thoracic segmental spinal anesthesia.

Risk of bias assessment

The quality of the included studies was assessed using the Newcastle-Ottawa Scale (NOS) [8] for cohort and case-control studies, while the Risk of Bias tool (RoB-2 tool) provided by Cochrane was used for randomized controlled trials [9]. Quality assessment was performed collaboratively by all authors until consensus was achieved. RoB-2 assessment encompasses five domains: bias arising from the randomization process, bias due to deviations from intended interventions, bias due to missing outcome data, bias in outcome measurement, and bias in the selection of reported results.

Statistical analysis

The data obtained were evaluated as mean difference (MD) or standardized mean difference (SMD) with their respective standard deviations, which were categorized as continuous data types. Various reported data formats were converted into relative risk (RR) with 95% confidence intervals (CI) for analysis. A random-effects model, using the DerSimonian and Laird method, was employed to account for potential population differences across studies. Continuous variables were analyzed to calculate the SMD and its 95%CI, followed by the computation of the corresponding SMD standard errors (SE). The SMD and 95%CI for each study were visually represented in a forest plot, illustrating effect sizes and variability. This plot enabled the identification of heterogeneity among studies when comparing the effectiveness of thoracic segmental spinal anesthesia to general anesthesia. The pooled SMD and 95%CI from the random-effects model summarized the combined effect estimate across all studies. Heterogeneity was assessed using the Higgins I-squared (I^2) statistical model, which categorized results as negligible (0–25%), low (25–50%), moderate (50–75%), or high (>75%).

Results

Study selection process

The database search, which included PubMed, Cochrane Library, and ScienceDirect, yielded a total of 4,060 articles. These articles were exported, and duplicates were subsequently removed. Six independent authors (TH, ESM, APL, IG, NK, and ATH) screened the remaining articles by reviewing their titles and abstracts. After this initial screening, 4,044 studies were excluded. Finally, six studies [10-15] were included for qualitative analysis, consisting of three observational studies [10,11,13] and three randomized controlled trials [12,14,15]. Out of six studies, four studies [10,12,14,15] were included for quantitative synthesis, consisting of one observational [10] and

three randomized controlled trials [12,14,15]. The screening and selection process is summarized in the PRISMA schematic diagram in **Figure 1**.

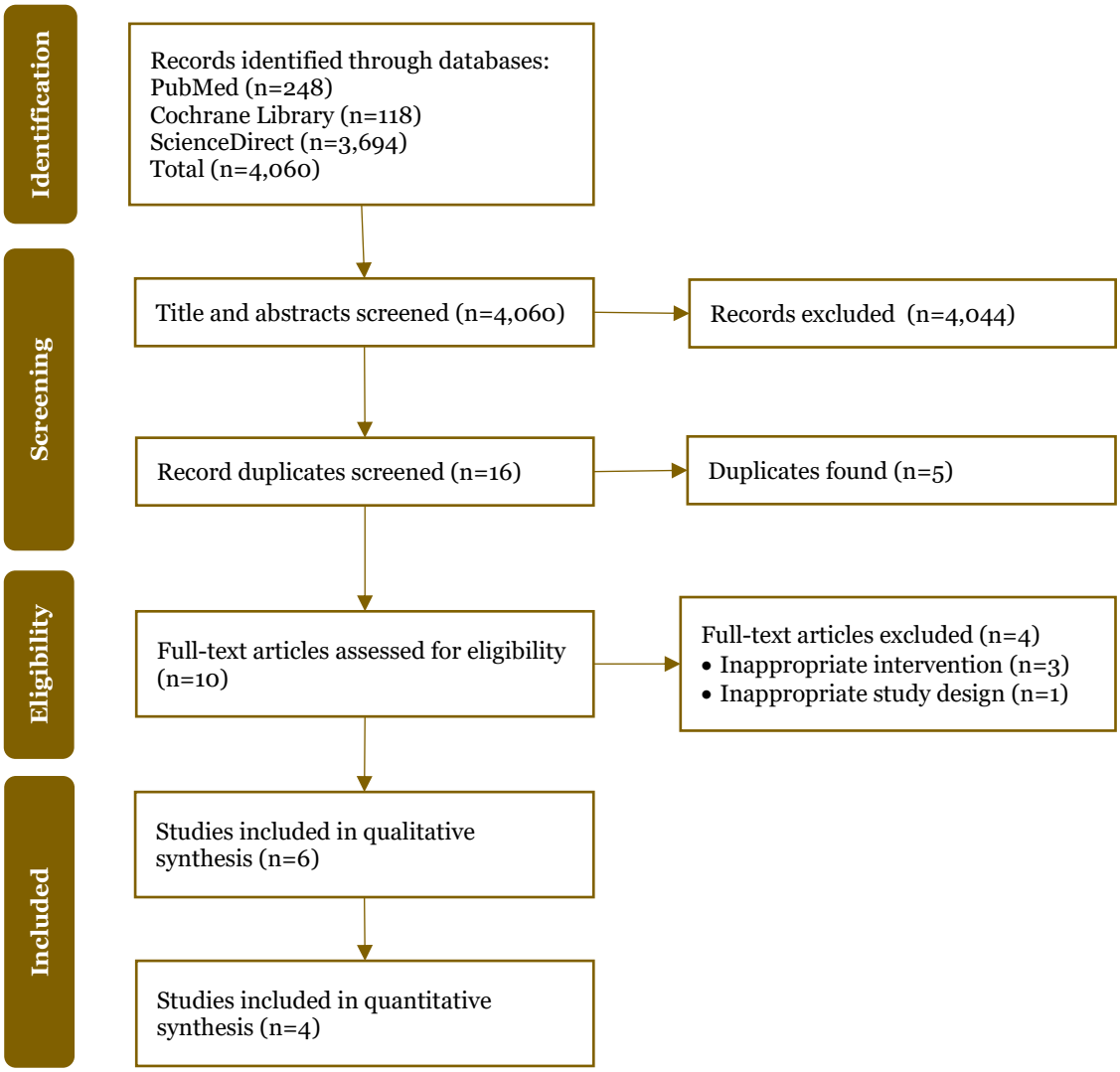

Figure 1. PRISMA schematic diagram for the screening and selection of eligible studies.

Characteristics of the included studies

Out of six studies included in qualitative synthesis, three were randomized controlled trials [12,14,15] and the other three were observational studies [10,11,13]. From those six studies, four studies were included in the meta-analysis [10,12,14,15]. Most of the thoracic segmental spinal anesthesia used in the studies was bupivacaine compared to general anesthesia.

The primary outcomes were assessed in different number of studies: (a) postoperative pain scale was assessed in four studies [10,12,14,15]; (b) the incidence of adverse events was measured in four studies [10,12,14,15]; (c) the incidence of complication was only reported for bradycardia in five studies [11-15] and urinary retention in one study [10]. The secondary outcomes, including patient satisfaction [10,12,14] and surgeon satisfaction [10,12,14] were reported in three studies each. All of the included studies' characteristics are presented in **Table 1**.

Quality assessment

The quality of the included observational studies was evaluated using a risk of bias assessment, based on the Newcastle-Ottawa Scale, and the results are presented in **Table 2**. The Newcastle-Ottawa Scale focuses on three key domains: selection, comparison, and outcome. Two studies were identified as having a low risk of bias, whereas one study was classified as having a moderate risk of bias across all assessed domains, with only 66% of its criteria meeting the low-risk threshold.

Table 1. Characteristics of the included studies

Author	Year	Study design	TSA group (n)	Control group (n)	Intervention	Control	Puncture site	Type of surgery
Alim *et al.* [10]	2024	Observational study	30	30	1 mL of 0.5% isobaric bupivacaine combined with 20 µg of fentanyl (total volume: 1.4 mL)	General anesthesia	T5-T6	Radical mastectomy
Deshpande *et al.* [11]	2023	Observational study	40	N/A	1.2 mL of 0.5% levobupivacaine combined with either 3 µg of dexmedetomidine or 20 µg of fentanyl	-	T5-T6	Radical mastectomy
Chandra *et al.* [13]	2023	Observational study	78	N/A	1.5 mL of 0.5% isobaric bupivacaine combined with 5 µg of dexmedetomidine	-	T5-T6 or T6-T7	Modified radical mastectomy
Mazy *et al.* [12]	2022	Randomized controlled trial	37	35	1.5 mL of 0.5% plain bupivacaine combined with 5 µg of dexmedetomidine	Thoracic paravertebral block using 0.3 mL of 0.5% bupivacaine combined with 5 µg of dexmedetomidine	T5-T6	Modified radical mastectomy
Paliwal *et al.* [14]	2022	Randomized controlled trial	28	28	1 mL of 0.5% isobaric levobupivacaine combined with 20 µg of fentanyl	General anesthesia	T5-T6	Modified radical mastectomy
Elakany *et al.* [15]	2018	Randomized controlled trial	20	20	1 mL of 0.5% bupivacaine combined with 20 µg of fentanyl	General anesthesia	T5-T6	Mastectomy with axillary dissection

N/A: not available; TSA: thoracic segmental anesthesia

Table 1. Characteristics of the included studies (continued)

Author	Mean surgery duration (minutes)		Onset of sensory block (minutes)		Time for regression of sensory block (minutes)		Intraoperative complication			
	TSA, mean±SD	Control, mean±SD	TSA, mean±SD	Control, mean±SD	TSA, mean±SD	Control, mean±SD	Hypotension		Bradycardia	
							TSA, n (%)	Control, n (%)	TSA, n (%)	Control, n (%)
Alim *et al.* [10]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Deshpande *et al.* [11]	98,24±16.86	N/A	N/A	N/A	N/A	-	4 (10.0)	-	3 (7.5)	-
Chandra *et al.* [13]	N/A	N/A	N/A	N/A	139 (122–154)	-	12 (9.0)	-	8 (6.0)	-
Mazy *et al.* [12]	74.5±10.5	73.5±11.6	6.4±1.4	20.2±3.0	175.0±12.0	164±18	22 (62.9)	9 (25.7)	3 (8.6)	2 (5.7)
Paliwal *et al.* [14]	75.53±24.43	66.96±12.34	NA	N/A	N/A	N/A	0 (0)	0 (0)	0 (0)	0 (0)
Elakany *et al.* [15]	116.1 ± 28.3	112.5 ± 31.6	NA	N/A	N/A	N/A	3 (15)	0 (0)	3 (15)	0 (0)

N/A: not available; TSA: thoracic segmental anesthesia

Table 1. Characteristics of the included studies (continued)

Author	Postoperative complication					Satisfaction			Postoperative pain scale					
	Nausea		Vomiting		Urine retention	Patient satisfaction			Surgeon satisfaction		0-hour postoperative		12-hour postoperative	
	TSA, n (%)	Control, n (%)	TSA, n (%)	Control, n (%)	TSA, n (%)	Control, n (%)	TSA, mean±SD	Control, mean±SD	TSA, mean±SD	Control, mean±SD	TSA, mean±SD	Control, mean±SD	TSA, mean±SD	Control, mean±SD
Alim *et al.* [10]	3 (10)	8 (26.7)	4 (13.3)	10 (33.3)	1 (3.3)	9 (30%)	9.4±0.9	8.6±0.7	9.5±0.7	8.9±0.7	0	0	0,8	0,9
Deshpande *et al.* [11]	4 (10)	N/A	4 (10)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.54±0.98	N/A	3.86±1.34	-
Chandra *et al.* [13]	N/A	N/A	N/A	N/A	N/A	N/A	78 (100)	N/A	76 (97)	N/A	N/A	N/A	N/A	N/A
Mazy *et al.* [12]	1 (2.9)	0 (0)	1 (2.9)	0 (0)	N/A	N/A	9.6±0.8	9.1±1.0	9.3±1.0	8.7±0.8	N/A	N/A	N/A	N/A
Paliwal *et al.* [14]	Higher in control group (p<0.05)		Higher in control group (p<0.05)		N/A	N/A	5/5 (VRS score)	4/5 (VRS score)	5/5 (VRS score)	4/5 (VRS score)	1 (NRS score)	6 (NRS score)	3 (NRS score)	4 (NRS score)
Elakany *et al.* [15]	Higher in control group (p<0.05)		Higher in control group (p<0.05)		N/A	N/A	18 (90)	16 (80)	N/A	N/A	1.2±1.1	3.2±1.8	1.1±0.8	2.3±1.4

N/A: not available; NRS: numeric rating scale; TSA: thoracic segmental anesthesia; VRS: verbal rating scale

Table 2. Results of risk of bias quality assessment using the Newcastle-Ottawa Scale for observational studies in this systematic review and meta-analysis

Studies	Selection domain [a]	Comparison domain [b]	Outcome domain [c]	Potential risk of bias
Alim *et al.*, 2024 [10]	****	**	***	9/9 (low risk)
Deshpande *et al.*, 2023 [11]	***	*	**	6/9 (moderate risk)
Chandra *et al.*, 2023 [13]	****	*	**	7/9 (low risk)

[a,b,c] An increase in the number of asterisks (*) indicates better quality in the assessed domain criteria. The maximum number of asterisks that can be assigned to each domain criterion is as follows: selection=4, comparison=2, and outcome=3

The RoB 2.0 quality assessment tool was used to evaluate the quality of the included randomized controlled trials, with the results presented in **Figure 2**. Two studies were classified as having a low risk of bias, while one study was assessed as having a moderate risk of bias across all domains, except for the domain related to missing outcome data, where only 66% of the criteria were deemed low risk.

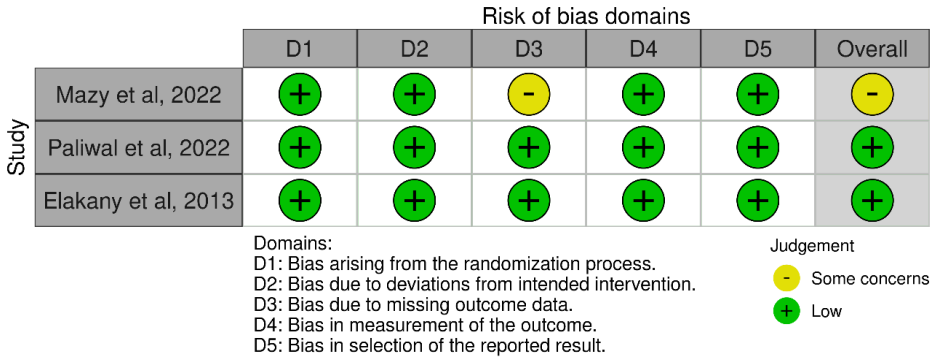

Figure 2. Results of risk of bias quality assessment using the Risk of Bias (RoB) 2.0 for randomized controlled trials included in this systematic review and meta-analysis.

Effectiveness and safety of thoracic segmental spinal anesthesia for breast surgery

Postoperative pain scale

Four studies [10,12,14,15] were included in the meta-analysis to evaluate postoperative pain using the visual analog scale (VAS) or numeric rating scale (NRS) between thoracic segmental spinal anesthesia and control groups. The results suggested that thoracic segmental spinal anesthesia did not significantly reduce the postoperative pain scale for breast surgery compared to the control group, as observed in the 0-hour postoperative pain scale (SMD: -1.07; 95%CI: -2.33 to 0.18; p=0.09) (**Figure 3A**). However, thoracic segmental spinal anesthesia was significantly associated with reduced pain at the 12-hour postoperative interval (SMD: -1.25; 95%CI: -1.54 to -0.96; p<0.0001) (**Figure 3B**). Heterogeneity was high and statistically significant for the 0-hour postoperative pain scale (I^2=94%; p<0.0001) and moderate but significant for the 12-hour postoperative pain scale (I^2=65%; p=0.04) (**Figure 3**).

Incidence of adverse events

Four studies [10,12,14,15] were included in the meta-analysis to evaluate adverse events of thoracic segmental spinal anesthesia compared to the control group, focusing on nausea, vomiting, and hypotension reported by the patients. The results suggested that the thoracic segmental spinal anesthesia group had a significantly higher risk of hypotension (RR: 2.57; 95%CI: 1.41–4.71; p=0.002) (**Figure 4A**) and a significantly lower risk of vomiting (RR: 0.46; 95%CI: 0.22–0.95; p=0.04) (**Figure 4B**) compared to the control group. However, thoracic segmental spinal anesthesia did not significantly differ from the control group regarding the risk of nausea, which showed a lower but nonsignificant incidence (RR: 0.45; 95%CI: 0.19–1.05; p=0.07) (**Figure 4C**). All included studies demonstrated low and nonsignificant heterogeneity (**Figure 4**).

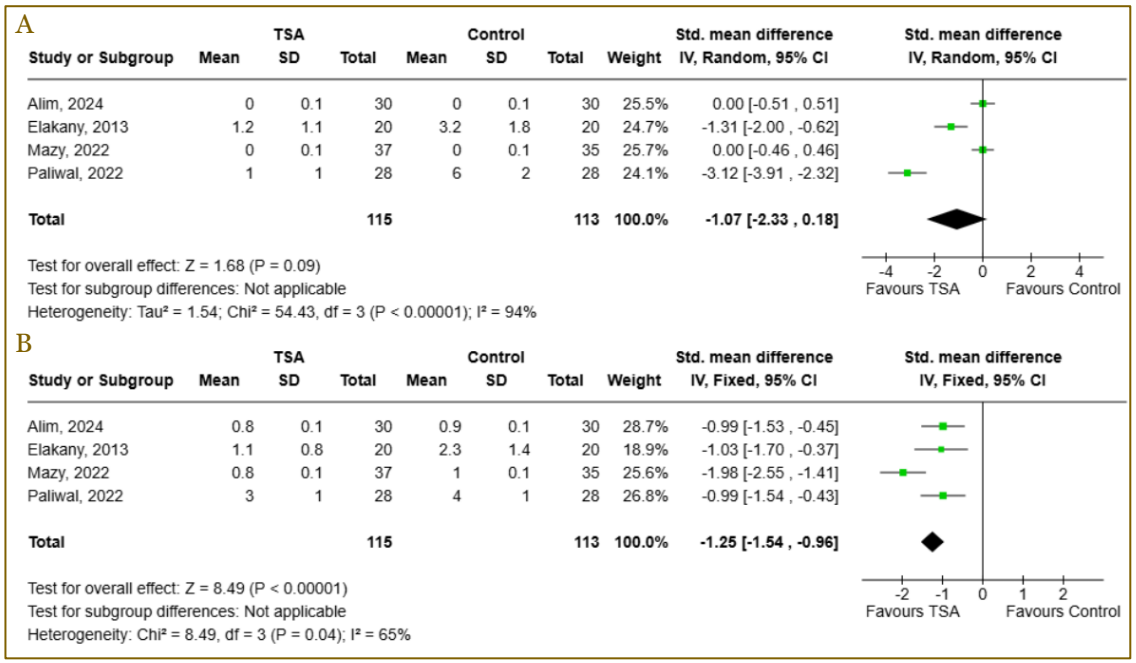

Figure 3. Forest plot showing the effectiveness of thoracic segmental spinal anesthesia to reduce postoperative pain scale on 0 hours postoperative (A) and 12 hours postoperative (B) compared to general anesthesia among patients receiving breast surgery.

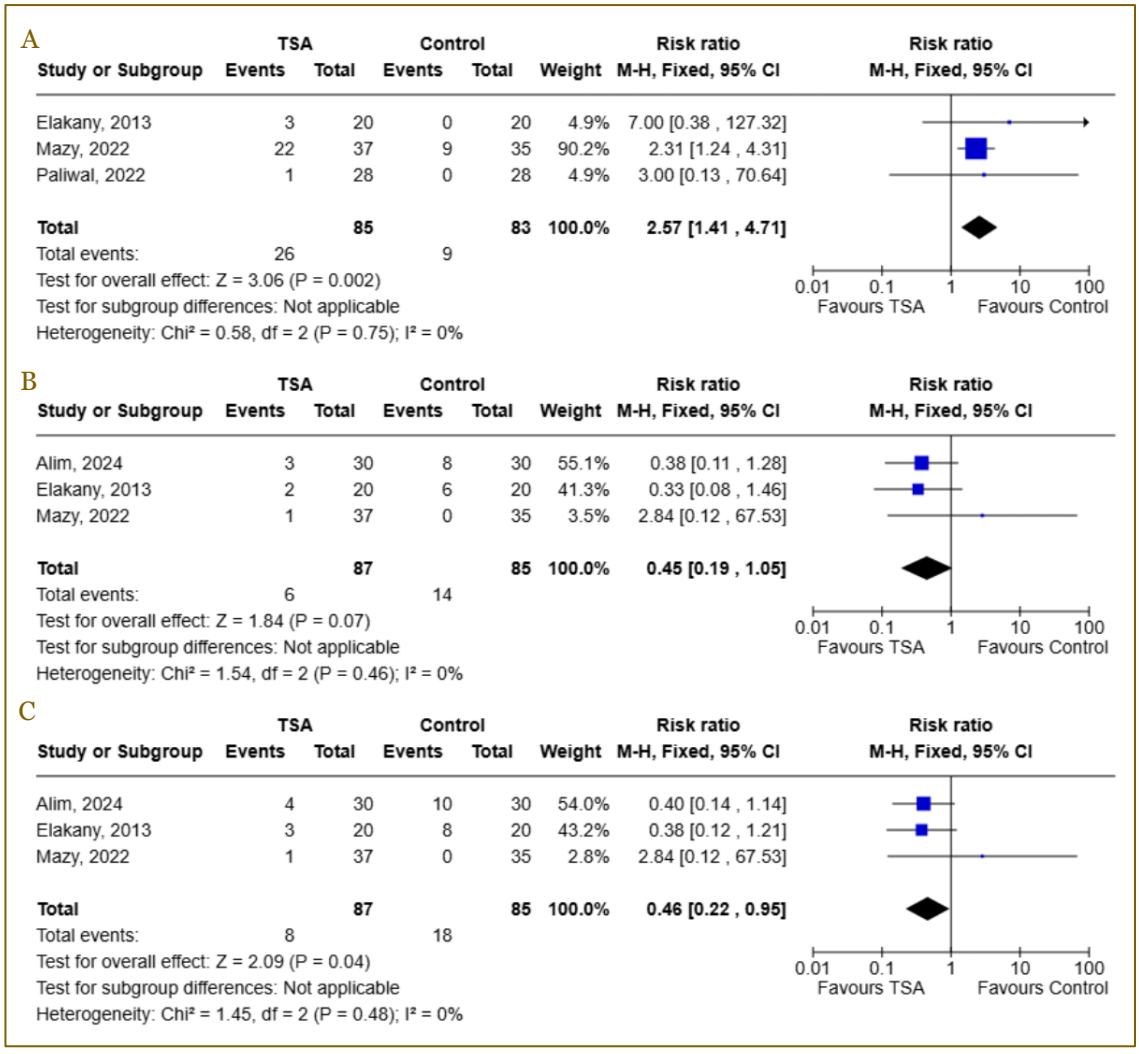

Figure 4. Forest plot showing the adverse events of thoracic segmental spinal anesthesia compared to control group among patients receiving breast surgery: (A) hypotension, (B) nausea, and (C) vomiting.

Incidence of complications

Complications related to thoracic segmental spinal anesthesia were reported in five studies for bradycardia [11-15] and in one study for urinary retention [10]. However, none of these complications could be included in the meta-analysis. The incidence of bradycardia among patients receiving thoracic segmental spinal anesthesia ranged from 6.0% [13], 7.5% [11], and 8.6% [12] to 15% [15]. Among the studies that reported bradycardia incidence in both groups, two showed a slightly higher percentage in the thoracic segmental spinal anesthesia group compared to the control group: 8.5% vs 5.7% [12] and 15% vs 0% [15]. One study reported equal incidence in both groups at 0% [14]. Urinary retention was documented in only one patient who received thoracic segmental spinal anesthesia [10].

Patient satisfaction

Three studies [10,12,14] were included in the meta-analysis to evaluate patient satisfaction with thoracic segmental spinal anesthesia using questionnaires focused on the pain aspects of both the anesthesia and surgical procedures. Patient satisfaction was assessed after the surgery using Likert scales (ranging from 0–10 or 0–5, depending on the study) to compare thoracic segmental spinal anesthesia with the control group. The results suggested that the control group had significantly lower patient satisfaction compared to the thoracic segmental spinal anesthesia group (SMD: 0.63; 95%CI: 0.33–0.92; p<0.0001). Heterogeneity among the studies was low and not statistically significant (I^2=22%; p=0.28) (**Figure 5**).

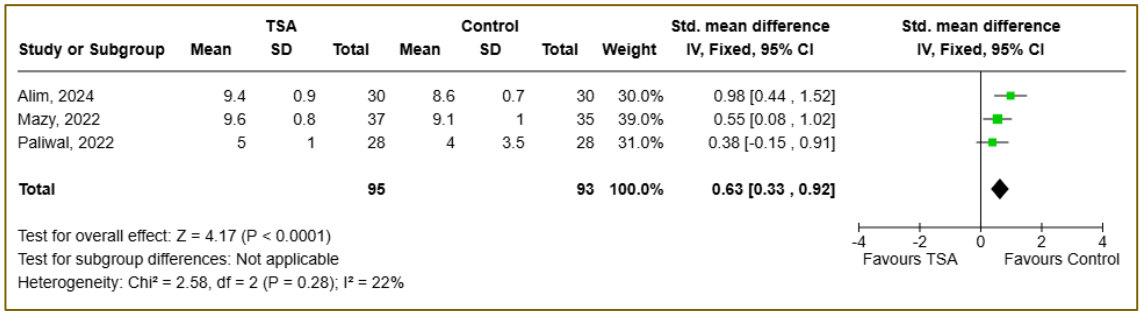

Figure 5. Forest plot showing the patient satisfaction with thoracic segmental spinal anesthesia focused on the pain aspects of both the anesthesia and surgical procedures compared to the control group among patients receiving breast surgery.

Surgeon satisfaction

Three studies [10,12,14] were included in the meta-analysis to evaluate surgeon satisfaction using questionnaires focused on the anesthesia procedure, particularly regarding its complexity and the onset of anesthesia. Satisfaction was assessed using Likert scales (ranging from 0–10 or 0–5, depending on the study) to compare thoracic segmental spinal anesthesia with the control group. The results suggested that the control group showed significantly lower surgeon satisfaction for breast surgery compared to the thoracic segmental spinal anesthesia group (SMD: 0.81; 95%CI: 0.51–1.11; p<0.0001). Heterogeneity among the studies was low (I^2=0%; p=0.66) (**Figure 6**).

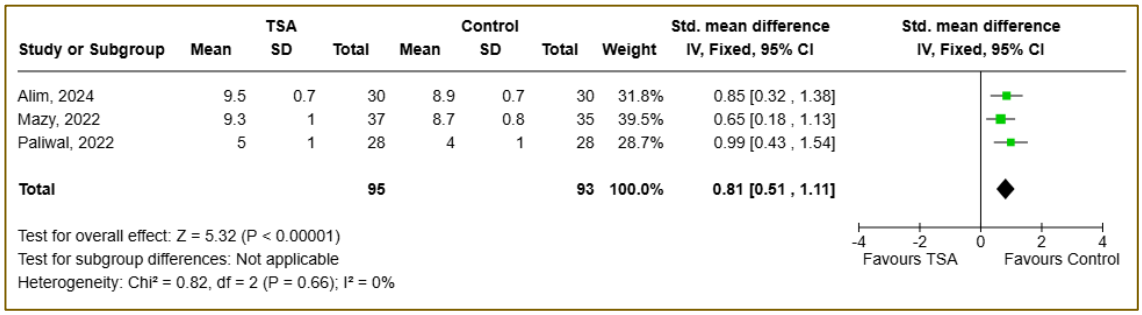

Figure 6. Forest plot showing the surgeon's satisfaction with thoracic segmental spinal anesthesia focused on the anesthesia procedure compared to the control group for breast surgery cases.

Discussion

This systematic review and meta-analysis aimed to evaluate the effectiveness and safety of thoracic segmental spinal anesthesia in breast cancer surgery. The findings demonstrated that

this technique provides superior pain control at 12 hours postoperatively, reduces postoperative vomiting, and increases both patient and surgeon satisfaction compared to general anesthesia. Importantly, no anesthesia-related mortalities were reported.

All included studies utilized thoracic segmental spinal anesthesia at the T5-T6 intervertebral levels, with one study incorporating the T6-T7 level [12]. Anatomical advantages at mid-thoracic levels, such as a greater distance between the dura mater and spinal cord, facilitate safer administration of intrathecal medications [16,17]. This distance is further enhanced in the sitting position, which reduces the risk of spinal cord injury during dural puncture [18,19]. Magnetic resonance imaging (MRI) data further support the safety of this approach, showing adequate separation between the dura mater and spinal cord at various thoracic levels [17-19]. Despite concerns about potential neuronal damage and high spinal anesthesia risks, studies indicate no evidence of neurological injury following dural puncture at thoracic levels [16,17,20,21]. The approximately 50° angle of needle insertion at the T5-T6 levels increases the safety margin, further mitigating the risk of spinal cord contact [20].

Most studies administered 1–1.2 mL of isobaric bupivacaine 0.5%, often combined with adjuvants such as fentanyl or dexmedetomidine, for thoracic segmental spinal anesthesia. Lower cerebrospinal fluid volume and thinner nerve roots in the thoracic region allow for an effective sensory blockade with smaller doses of local anesthetic [20,21]. Thoracic segmental spinal anesthesia has been effectively used in minor breast surgeries, such as lumpectomy and simple mastectomy, with similar dosing regimens [22].

Notably, none of the included studies required transitions to general anesthesia, and no respiratory complications, such as dyspnea or hypoxia, were reported [10-15]. The diaphragm's innervation by the phrenic nerve (C3-C6) remains unaffected, allowing normal respiratory function even at higher thoracic levels [22]. These findings align with previous reports of successful thoracic spinal anesthesia in high-risk patients undergoing non-breast surgeries, such as laparoscopic cholecystectomy [23,24].

Effective pain management is critical in breast cancer surgery to optimize recovery and minimize complications [3]. The present study found significantly better pain control at 12 hours postoperatively in the thoracic segmental spinal anesthesia group compared to controls. Additionally, this technique was associated with a lower incidence of postoperative vomiting, a common issue in breast surgeries that can delay recovery and prolong hospital stays [25,26]. Consistent with previous research, regional anesthesia, including thoracic segmental spinal anesthesia, appears to reduce the likelihood of postoperative nausea and vomiting compared to general anesthesia [27-31]. In this study, all reported complications were effectively managed with appropriate interventions, and no anesthesia-related mortalities occurred.

The meta-analysis also revealed significant improvements in satisfaction levels among both patients and surgeons. Patients expressed higher satisfaction due to preserved lower limb motor control, early mobilization, effective analgesia, and fewer adverse events. Surgeons also preferred this approach, appreciating its ability to provide a controlled and stable anesthetic environment.

This study has some limitations. Firstly, the use of SMD instead of MD may reduce interpretability for clinicians, as the outcomes in the included studies were measured using different instruments. Secondly, variations in control groups, including placebo and general anesthesia, could affect the comparative results. Thirdly, the number of randomized controlled trials focusing on thoracic segmental spinal anesthesia remains limited. Finally, the clinical adoption of this technique is still uncommon due to the scarcity of evidence-based research. Further studies are needed to explore its long-term safety, refine dosing protocols, and expand its application in broader patient populations and surgical contexts. Despite these limitations, thoracic segmental spinal anesthesia shows promise as a safe and effective alternative to general anesthesia in breast cancer surgery, offering improved postoperative outcomes and enhanced patient and surgeon satisfaction.

Conclusion

Thoracic segmental spinal anesthesia among patients receiving breast cancer surgery was associated with improved postoperative pain management, reduced incidence of postoperative vomiting and increased patient and surgeon satisfaction when used in breast cancer surgery. This

finding highlights the potential for thoracic segmental spinal anesthesia to become a preferred technique in breast cancer surgery, particularly for patients at high risk of complications associated with general anesthesia. Further studies are warranted to explore its long-term safety profile, optimal protocols, and broader applications across diverse patient populations and surgical contexts.

Ethics approval

Not required.

Acknowledgments

There are no acknowledgments to declare.

Competing interests

All the authors declare that there are no conflicts of interest.

Funding

This study received no external funding.

Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

Declaration of artificial intelligence use

We hereby confirm that no artificial intelligence (AI) tools or methodologies were utilized at any stage of this study, including during data collection, analysis, visualization, or manuscript preparation. All work presented in this study was conducted manually by the authors without the assistance of AI-based tools or systems.

How to cite

Hamdi T, Mastari ES, Lubis AP, *et al*. Effectiveness and safety of thoracic segmental spinal anesthesia for breast surgery: A systematic review and meta-analysis. Narra J 2025; 5 (1): e1630 - http://doi.org/10.52225/narra.v5i1.1630.

References

1. Cheng GS, Ilfeld BM. An evidence-based review of the efficacy of perioperative analgesic techniques for breast cancer-related surgery. Pain Med 2017;18(7):1344-1365.
2. Shatri G, Singh A. Thoracic segmental spinal anesthesia. Treasure Island (FL): StatPearls Publishing; 2023.
3. le Roux JJ, Wakabayashi K, Jooma Z. Defining the role of thoracic spinal anesthesia in the 21st century: A narrative review. Br J Anaesth 2023;130(1):e56-e65.
4. Paul A, Borkar A. Anesthetic management for mastectomy in a male with unilateral gynecomastia: The utilization of thoracic segmental spinal anesthesia and erector spinae plane block. Cureus 2023;15(10):e47502.
5. Mehta N, Gupta KC, Sharma S, *et al*. Thoracic combined spinal epidural anesthesia in patient of dilated cardiomyopathy undergoing laparoscopic cholecystectomy. J Anaesthesiol Clin Pharmacol 2016;32(2):269-270.
6. Elakany MH, Abdelhamid SA. Segmental thoracic spinal has advantages over general anesthesia for breast cancer surgery. Anesth Essays Res 2013;7(3):390-395.
7. Spannella F, Giulietti F, Damiani E, *et al*. Thoracic continuous spinal anesthesia for high-risk comorbid older patients undergoing major abdominal surgery: One-year experience of an Italian geriatric hospital. Minerva Anestesiol 2020;86(3):261-269.
8. Wells GA, Shea B, O'Connell D, *et al*. The Newcastle–Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. 2021. Available from: https://www.ohri.ca/programs/clinical_epidemiology/oxford.asp. Accessed: 1 April 2024.

9. Sterne JAC, Savović J, Page MJ, *et al*. RoB 2: A revised tool for assessing risk of bias in randomised trials. BMJ 2019;366:l4898.
10. Alim MA, Islam MS, Bhowmick DK, *et al*. Comparison between segmental thoracic spinal anesthesia and general anesthesia in breast cancer surgery. J Dent Med Sci 2024;23(3):17-20.
11. Deshpande N, Agarwal K, Hatgaonkar R, *et al*. Efficacy of thoracic segmental spinal anesthesia along with unilateral erector spinae block in patients undergoing unilateral modified radical mastectomy and axillary dissection: A novel multicentric study. Asian J Pharm Clin Res 2023;16(6):158-163.
12. Mazy A, Domiaty A, Mageed NA, *et al*. Comparison between thoracic paravertebral block and segmental thoracic spinal anesthesia in breast cancer surgery. Ain-Shams J Anesthesiol 2022;14:88.
13. Chandra R, Misra G, Langoo SA. A prospective observational study on the effectiveness of segmental spinal anesthesia in patients posted for modified radical mastectomies. Ann Case Reports 2023;8:1349.
14. Paliwal N, Maurya N, Suthar OP, *et al*. Segmental thoracic spinal anesthesia versus general anesthesia for breast cancer surgery: A prospective randomized-controlled open-label trial. J Anesth Clin Pharmacol 2022;38(4):560-565.
15. Elakany MH, Abdelhamid SA. Segmental thoracic spinal has advantages over general anesthesia for breast cancer surgery. Anesth Essays Res 2013;7(3):390-395.
16. Scherer R, Schmutzler M, Giebler R, *et al*. Complications related to thoracic epidural analgesia: A prospective study in 1071 surgical patients. Acta Anaesthesiol Scand 1993;37(4):370-374.
17. Lee RA, van Zundert AAJ, Breedveld P, *et al*. The anatomy of the thoracic spinal canal investigated with magnetic resonance imaging (MRI). Acta Anesthesiol Belg 2007;58(3):163-167.
18. Imbelloni LE, Quirici MB, Filho JRF, *et al*. The anatomy of the thoracic spinal canal investigated with magnetic resonance imaging. Anesth Analg 2010;110(5):1494-1495.
19. Lee RA, van Zundert AAJ, Botha C, *et al*. The anatomy of the thoracic spinal canal in different postures: A magnetic resonance imaging investigation. Reg Anest Pain Med 2010;35(4):364-369.
20. Hogan QH, Prost R, Kulier A, *et al*. Magnetic resonance imaging of cerebrospinal fluid volume and the influence of body habitus and abdominal pressure. Anesthesiology 1996;84(6):1341-1349.
21. Hogan Q. Size of human lower thoracic and lumbosacral nerve roots. Anesthesiology 1996;85(1):37-42.
22. Mahmoud A, Hussein H, Girgis K, *et al*. The novel use of spinal anesthesia at the mid-thoracic level: A feasibility study. Egypt J Cardiothorac Anesth 2014;8(1):21-26.
23. van Zundert AAJ, Stultiens G, Jakimowicz JJ, *et al*. Segmental spinal anesthesia for cholecystectomy in a patient with severe lung disease. Br J Anesth 2006;96(4):464-466.
24. Yousef GT, Lasheen AE. General anesthesia versus segmental thoracic or conventional lumbar spinal anesthesia for patients undergoing laparoscopic cholecystectomy. Anesth Essays Res 2012;6(2):167-173.
25. Borgeat A, Ekatodramis G, Schenker CA. Postoperative nausea and vomiting in regional anesthesia: A review. Anesthesiology 2003;98(2):530-547.
26. Bansal P, Saxena KN, Taneja B, *et al*. A comparative randomized study of paravertebral block versus wound infiltration of bupivacaine in modified radical mastectomy. J Anaesthesiol Clin Pharmacol 2012;28(1):76-80.
27. Zorrilla-Vaca A, Healy RJ, Mirski MA. A comparison of regional versus general anesthesia for lumbar spine surgery: A meta-analysis of randomized studies. J Neurosurg Anesthesiol 2017;29(4):415-425.
28. Hutton M, Brull R, Macfarlane AJR. Regional anaesthesia and outcomes. BJA Educ 2018;18(2):52-56.
29. Sinclair DR, Chung F, Mezei G. Can postoperative nausea and vomiting be predicted? Anesthesiology 1999;91(1):109-118.
30. Rickford JK, Speedy HM, Tytler JA, *et al*. Comparative evaluation of general, epidural and spinal anaesthesia for extracorporeal shockwave lithotripsy. Ann R Coll Surg Engl 1988;70(2):69-73
31. Shaikh SI, Nagarekha D, Hegade G, *et al*. Postoperative nausea and vomiting: A simple yet complex problem. Anesth Essays Res 2016;10(3):388-396.