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Original Article

Efficacy and safety of the serratus anterior block compared to thoracic epidural analgesia in surgery: Systematic review and meta-analysis

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Abstract

Objectives: The objective of this study was to compare the efficacy and safety of serratus anterior plane block (SAPB) and thoracic epidural analgesia (TEA) in thoracic region surgery. **Materials and Methods:** We implemented a systematic search of PubMed, ScienceDirect, SCOPUS, and Web of Science and through gray literature for all randomized controlled trials that compared SAPB, a novel thoracic wall nerve block, and TEA in surgery. The evaluated outcomes included the Visual Analog Scale (VAS), hypotension, and postoperative nausea and vomiting (PONV). Review Manager, version 5.4.1, was implemented for the analysis of statistics. **Results:** The pooled analysis included six trials that fulfilled the inclusion criteria. In total 384, surgery had received regional blocks (162 – SAPB and 163 – TEA). VAS did not differ significantly between SAPB and TEA, with a mean difference of 0.71, $P = 0.08$. PONV incidence did not differ significantly between SAPB and TEA (odds ratio = 0.25, $P = 0.07$). Hypotension incidence was lower in SAPB compared to TEA (odds ratio = 0.10, $P = 0.0001$). **Conclusion:** SAPB yielded comparable VAS with TEA in pain management of thoracic region surgery. The incidence of hypotension was lower in SAPB than in TEA. No difference in PONV incidence was observed. SAPB can be a viable alternative to TEA in thoracic region surgery.

Keywords: *Epidural analgesia, Hypotension, Nerve block, Surgery, Visual Analog Scale*

Introduction

Thoracic surgery is a procedure that frequently causes severe postoperative pain [1]. The severity and incidence of postthoracotomy surgery according to Bendixen is more than 7 in pain scale (severe) with 63% incidence [2]. Similar in severity and incidence to postthoracotomy pain, severe acute postoperative pain after breast surgery occurs in 61%–67% of cases [3]. Good pain management after a thoracic surgery should encompass reduced pulmonary complication and encourage early recovery [4]. Effective analgesia is proven to lower the risk of complication by letting the patient have deeper inspiration, effective cough, and early mobilization [5]. The gold standard to manage this pain is thoracic epidural analgesia (TEA) [6]. Not only does it inhibit pain transmission to the brain, but it also has the added benefit of reducing postoperative stress by inhibiting sympathetic activity [7]. However, using this technique has a lot of downsides. Side effects may include hypotension and an increased probability of postoperative nausea and vomiting (PONV), bradycardia, and respiratory depression [8]. Insertion of epidural catheter also has a high degree of error up to 30% [9]. Several research studying the effects of TEA have revealed a greater prevalence of hypotension [10-12]. A 10-year single-center study of 3126 patients reported multiple incidences of TEA complications such as hypotension (4.8%), pruritus (4.4%), weakness of motor function (2.0%), PONV (1.8%), and postdural puncture headache (PDPH) (0.5%), and though rare, major complication can occur including epidural abscess which led to permanent sequela (0.03%) [13].

Serratus anterior plane block (SAPB) was first introduced by Blanco *et al*. in 2013. Their study reported an effective block on all volunteers with no side effects. Moreover, they indicate that the SAPB technique seems simple to implement [14]. They also suggest that SAPB approach seemed easy to perform [14]. A meta-analysis concluded that SAPB could have a major impact on the management of pain following thoracic surgery and reported fewer incidence of PONV compared to the control group [15]. Another meta-analysis also reported that SAPB significantly reduced postoperative

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pain and PONV in patients receiving video-assisted thoracoscopic surgery (VATS) [16]. However, both of these studies did not compare SAPB with recommended analgesic for thoracic surgery, TEA. The occurrence of PONV in two studies suggests a lower incidence in SAPB compared to TEA [17,18], while other studies reported an equal [10] or a higher incidence of PONV in SAPB [11,12,19].

Three studies [10-12] showed lower Visual Analog Scale (VAS) in TEA than SAPB. Studies from Abdelrahman *et al*. and Ali *et al*. showed a lower VAS in SAPB than TEA [17,20]. Abdelzaam *et al*. [19] found no statistically significant disparity between SAPB and TEA in the case of VAS. This dispute encourages the current study to perform a comparison between SAPB and TEA to determine which is the safer and effective pain prevention and management for surgeries.

Materials and Methods

Literature review

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses declaration explication, elaboration document, and checklist guided the search and selection processes. Studies were found through searches in PubMed, ScienceDirect, SCOPUS, Web of Science, and gray literature.

We used the terms "surgery," "breast surgery," "thoracic surgery," "serratus anterior block," "serratus anterior plane block," "thoracic epidural analgesia," "epidural analgesia," and "thoracotomy" as keywords for literature search until October 2022. Chronic pain words from the Medical Subject Headings were left out. Ethical approval is not required because the main investigators will retrieve and analyze data from previously published studies in which informed consent was acquired. Protocol registered with PROSPERO (ID CRD42022366712).

Study selection

This study consisted of randomized controlled trials (RCTs) comparing patients who had undergone a TEA or a SAPB for surgery and had outcome data such as VAS, hypotension, and PONV.

The following were the exclusion criteria: (1) studies in animals, (2) studies in other languages than English, (3) studies that abstract only, (4) studies that have not been publicized yet.

Data extraction and quality assessment

We extracted the following data from each research: patient characteristics (age and sex), study design, criteria of inclusion and exclusion, intervention (drug, loading time, and maintenance time), and period of follow-up. The quality of the research was assessed by two authors, LUS and CDKW. A third reviewer was consulted to settle any disputes (CJS). Using the RoB 2 tool, the risk of bias in those trials included was evaluated according to the adherence to specifications: the process of randomization, changes from planned procedures, missing result data, measurement of the result, choosing the reported result, and overall bias.

Data synthesis and analysis

The endpoints combined for analysis included the VAS, PONV, and hypotension between SAPB and TEA. VAS, PONV, and hypotension were the combined endpoints analyzed between SAPB and TEA. We performed the analysis using a statistical program (Review Manager®, version 5.4.1, Cochrane Collaboration, Oxford, England). In the absence of significant heterogeneity, meta-analysis was carried out utilizing the fixed-effects technique. When there was statistically significant heterogeneity, the random-effects method was applied ($P < 0.05$). The summary statistics show the continuous variables as mean difference (MD) and odds ratios (ORs) for dichotomous outcomes, respectively. Controlled trial heterogeneity was evaluated using an I^2 test and Chi-square statistical tests (Q statistics). The publication bias was estimated using a funnel plot analysis. In the absence of publication bias, the effect sizes of each included study are typically symmetrically distributed around the center of a funnel plot. As much as feasible, the results of the study were interpreted comprehensively by analyzing subgroups. Data from different hour postoperative VAS (2 h, 4 h, 6 h, 8 h, and 12 h), different events when VAS is checked (cough), different locations of injection (superficial serratus plane block [SSPB]/deep serratus plane block [DSPB]), and different timing of regional anesthesia loading dose (before incision and at the end of surgery) were analyzed independently.

Results

The flowchart for searching, screening, and selection process for published studies is illustrated in Figure 1. Initial search results yielded 14,749 articles. After excluding from the title and abstract 14,735 articles that were irrelevant to the study topic, we ultimately obtained the full text of 16 studies for evaluation. We also included one study from gray literature. Six RCTs were finally included for subsequent analysis. The pooled analysis included a total of 384 patients, 162 with SAPB and 162 with TEA. Table 1 displays the research designs, inclusion/exclusion criteria, and baseline patient characteristics (age and gender) between the SAPB and TEA groups. Table 2 outlines the perioperative parameters. Figure 2a and 2b illustrates the risk of bias evaluation for the selected studies. Random allocation was applied in almost all included trials [10,12,19,21,22], except in one trial [9]. Bias from intended interventions was low due to the awareness of participants and people delivering the intervention. The analysis of three trials was based on the intention-to-treat principle, while the remainder were analyzed according to per-protocol analysis. Bias in the measurement of outcomes was low in all trials resulting from the appropriate method of measuring the outcome. All trials utilized a predefined analysis plan, so there was minimal selection bias in the reported results.

Perioperative parameters

Table 2 lists the perioperative parameters: anesthesia, loading drug, maintenance drug, length of surgery, and follow-up timing, as revealed by the included trials.

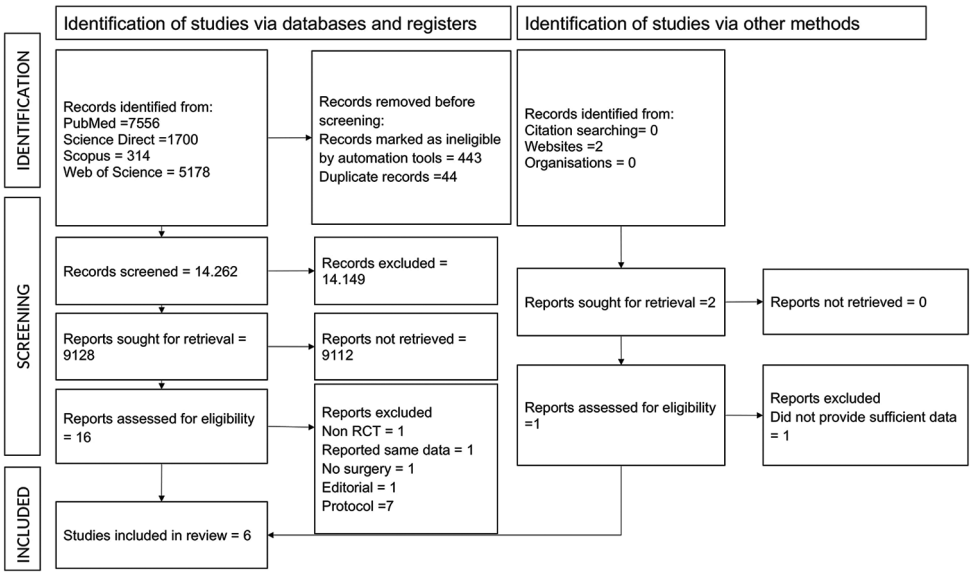

Figure 1: PRISMA 2020 Flow Diagram SAPB and TEA. PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses, TEA: Thoracic epidural analgesia, SAPB: Serratus anterior plane block

Visual Analog Scale

All included studies report 24-h postoperative VAS [10,11,12,17,19,20]. There was significant heterogeneity among the trials (χ^2 = 361.54, P < 0.00001, I^2 = 99%). No significant difference was found between the VAS scores of SAPB and TEA (MD = 0.71, 95% confidence interval [CI] = −0.08 to 1.5, Z = 1.75, P = 0.08) [Figure 3a].

Five studies reported the VAS score on 2 h postoperative [10,11,12,17,20]. Heterogeneity was found in the pooled results of the trials (χ^2 = 48.33, P < 0.00001, I^2 = 92%) and significantly no difference in pain on 2 h postoperative in both the groups (MD = 0.62, Z = 1.92, P = 0.05) [Figure 3b].

Four studies reported the VAS score on 4 h postoperative [10,11,12,17]. Heterogeneity was found in the pooled results of the trials (χ^2 = 401.19, P < 0.00001, I^2 = 99%) and significantly no difference in pain on 4 h postoperative in both the groups (MD = −0.30, Z = 0.27, P = 0.78) [Figure 3c].

Five studies reported the VAS score on 6 h postoperative [11,12,17,19,20]. Heterogeneity was found in the pooled results of the trials (χ^2 = 115.65, P < 0.00001, I^2 = 97%) and significantly no difference in pain on 6 h postoperative in both the groups (MD = -0.03, Z = 0.08, P = 0.93) [Figure 3d].

Three studies reported the VAS score on 8 h postoperative [10,11,17]. Heterogeneity was found in the pooled results of the trials (χ^2 = 48.09, P < 0.00001, I^2 = 96%) and significantly no difference in pain on 8 h postoperative in both the groups (MD = 0.56, Z = 0.98, P = 0.33) [Figure 4a].

Five studies reported the VAS score on 12 h postoperative [11,12,17,19,20]. Heterogeneity was found in the pooled results of the trials (χ^2 = 170.56, P < 0.00001, I^2 = 98%) and significantly no difference in pain on 12 h postoperative in both the groups (MD = -0.06, Z = 0.15, P = 0.88) [Figure 4b].

Four studies reported the VAS score on cough postoperative [10,12,19,20]. Heterogeneity was found in the pooled results of the trials (χ^2 = 188.73, P < 0.00001, I^2 = 98%) and significantly no difference in pain on cough postoperative in both the groups (MD = 1.65, Z = 3.06, P = 0.002) [Figure 4c].

Additionally, we perform subgroup analysis to compare SSPB versus TEA and DSPB versus TEA. Five studies reported the VAS score on SSPB versus TEA [11,12,17,19,20]. Heterogeneity was found in the pooled results of the trials (χ^2 = 315.69, P < 0.00001, I^2 = 99%) and significantly no difference in pain in both the groups (MD = 0.46, Z = 1.09, P = 0.27). Two research reported the VAS score on DSPB versus TEA [8,18]. Heterogeneity was found in the pooled results of the trials (χ^2 = 47.49, P < 0.00001, I^2 = 98%) and significantly no difference in pain in both the groups (MD = 0.98, Z = 0.98, P = 0.33) [Figure 5a].

VAS was compared between SAPB and TEA with local anesthetic performed before and after the incision. Four studies reported the VAS score on loading dose before incision [10,12,17,20]. Heterogeneity was found in the pooled results of the trials (χ^2 = 308.39, P < 0.00001, I^2 = 99%) and significantly no difference in pain in both the groups (MD = 1.06, Z = 1.23, P = 0.22). Two studies reported the VAS score on loading dose after incision [9,17]. The pooled results revealed heterogeneity among the trials (χ^2 = 38.87, P < 0.00001, I^2 = 97%) and significantly no difference in pain in both the groups (MD = 0.02, Z = 0.05, P = 0.96) [Figure 5b].

Complications

Postoperative nausea and vomiting

Five trials documented PONV incidence [10,11,12,17,19]. The incidences of PONV were 12.4% (13/105) and 9.6% (10/104) in the SAPB and TEA groups, respectively.

Table 1: Research characteristics

Author, year	Research design	Inclusion criteria	Exclusion criteria	Group	Total patient number	Gender (male/female)	Age
Mostafa *et al*., 2021 [12]	RCT	Patients were 20–60 years old ASA II or III BMI less than 40 kg/m^2 Planned thoracic surgery for lung cancer	Coagulation disorder Patient rejection Localized infection on the point of injection Chronic use of opioid Cancer cells spread to the bone Known allergy to the used drugs	SSPB TEA	28 27	16/12 13/14	52.3±5.7 50.3±6.2
Khalil *et al*., 2016 [11]	RCT	Patients were 20–60 years old ASA II and III	Patients receiving ongoing long-term painkiller analgesic therapy History of opioid addiction Incapable of communicating with the investigators On anticoagulation therapy Having bleeding disorder	SSPB TEA	20 20	10/10 11/9	34.9±10.1 35.4±8.3
Elsabeeny *et al*., 2021 [10]	RCT	Patients were 18–65 years ASA I or II Planned elective thoracotomy for lung cancer	Refusal of the patient Local infection at the injection site Bony metastasis Coagulation disorder Thrombocytopenia Impaired hepatic or renal function Chronic pain medication use	DSPB TEA	17 17	10/7 11/6	41.94±18.71 38.65±17.53
Abdelzaam *et al*., 2020 [19]	RCT	Patients were 20–60 years ASA I, II, and III Planned thoracotomy with general anesthesia	Subject suffering from bleeding disorders Coagulopathy Receiving an anticoagulant therapy Morbid obese Neurologic dysfunction Uncompensated cardiac, respiratory, hepatic, or renal dysfunction Subject with known medication allergies	DSPB TEA	20 20	11/9 13/7	42.6±11.55 42.35±12.19
Abdelrahman *et al*., 2021 [20]	RCT	Lung cancer patients with age 18–60 years Physical status ASA class II The patients were planned to undergo thoracic operations (metastasectomy or lobectomy)	Patients with cognitive impairment Coagulation disorder Puncture site infection	SSPB DSPB	57 59	32/25 31/28	44.19±9.41 45.47±9.36
Ali *et al*., 2021 [17]	RCT	Female patients with breast cancer Aged 20–50 years Underwent breast surgery (simple mastectomy) ASA I–II	Physical status ASA III–IV Patient rejection Contraindicated against regional anesthesia (as coagulopathy, etc.) Allergic to local anesthetics or opioids Subject with coronary or peripheral artery disease Nerve disorder Abnormalities of the thoracic vertebra Sensory level block failure Impaired respiratory and cardiac function Malignancy of both breasts Comorbidities associated with morbid obese	SSPB TEA	20 20	0/20 0/20	34.7±8.18 34.7±8.18

Contd...

Table 1: Contd...

Author, year	Research design	Inclusion criteria	Exclusion criteria	Group	Total patient number	Gender (male/female)	Age
			Patient with hepatic impairment (bleeding disorder)				

RCT: Randomized controlled trials, SSPB: Superficial serratus plane block, DSPB: Deep serratus plane block, TEA: Thoracic epidural analgesia, ASA: American Society of Anesthesiologists

Table 2: Perioperative parameters: loading dose, maintenance dose, length of surgery, and follow-up timing

Author/year	Anesthesia	Loading	Maintenance	Length of surgery	Follow-up timing
Mostafa *et al*., 2021 [12]	SSPB	Before incision levobupivacaine 0.25% 30 mL	Postoperative levobupivacaine 0 125% 5 mL/h	149±21	PACU, 2 h, 4 h, 6 h, 8 h, 10 h, 12 h, 18 h, and 24 h
	TEA	Before incision levobupivacaine 0.25% 10 mL	Postoperative levobupivacaine 0.125% 5 mL/h	151.2±22.5	
Khalil *et al*., 2016 [11]	SSPB	End of surgery levobupivacaine 0.25% 30 mL	End of surgery levobupivacaine 0.125% 5 mL/h	145.2±8.0	Baseline, 2 h, 4 h, 6 h, 8 h, 10 h, 12 h, 14 h, 16 h, 18 h, 20 h, 22 h, and 24 h
	TEA	End of surgery levobupivacaine 0.25% 15 mL	End of surgery levobupivacaine 0.125% 5 mL/h	149.3±6.3	
Elsabeeny *et al*., 2021[10]	DSPB	Before incision bupivacaine 0.25% 30 mL	Postoperative bupivacaine 0.125% 8–10 mL/h	217.06±24.94	PACU, 2 h, 4 h, 8 h, 16 h, and 24 h
	TEA	Before incision bupivacaine 0.25% 7.5 mL	Durante surgery bupivacaine 1/3 loading dose every 60 min, after surgery bupivacaine 0.125% 4–6 mL/h	206.47±27.83	
Abdelzaam *et al*., 2020 [19]	DSPB	End of surgery bupivacaine 0.25% 30 mL	End of surgery bupivacaine 0.125% 5 mL/h	93.5±31.5	Baseline, 6 h, 12 h, 18 h, and 24 h
	TEA	End of surgery bupivacaine 0.25% 15 mL	End of surgery bupivacaine 0.125% 5 mL/h	95.75±30.6	
Abdelrahman *et al*., 2021 [20]	SSPB	Before induction bupivacaine 0.25% 30 mL	None	191.78±19.67	At admission, 1 h, 2 h, 3 h, 4 h, 5 h, 6 h, 9 h, 12 h, and 24 h
	DSPB	Before induction bupivacaine 0.25% 30 mL	None	195.93±18.74	
	TEA	Before induction bupivacaine 0.25% 10 mL	None	196.10±19.98	
Ali *et al*., 2021 [17]	SSPB	After induction bupivacaine 0.25% 30 mL	After induction bupivacaine 0.125% 5 mL/h	N/A	0 min, 2 h, 4 h, 6 h, 8 h, 12 h, and 24 h
	TEA	After induction bupivacaine 0.125% + fentanyl 1.5 mcg/mL loading 6–8 mL	After induction bupivacaine 0.125% + fentanyl 1.5 mcg/mL 0.1 mL/kg/h	N/A	

SSPB: Superficial serratus plane block, DSPB; Deep serratus plane block, TEA: Thoracic epidural analgesia, N/A: Not available, PACU: Pediatric postanesthesia care unit

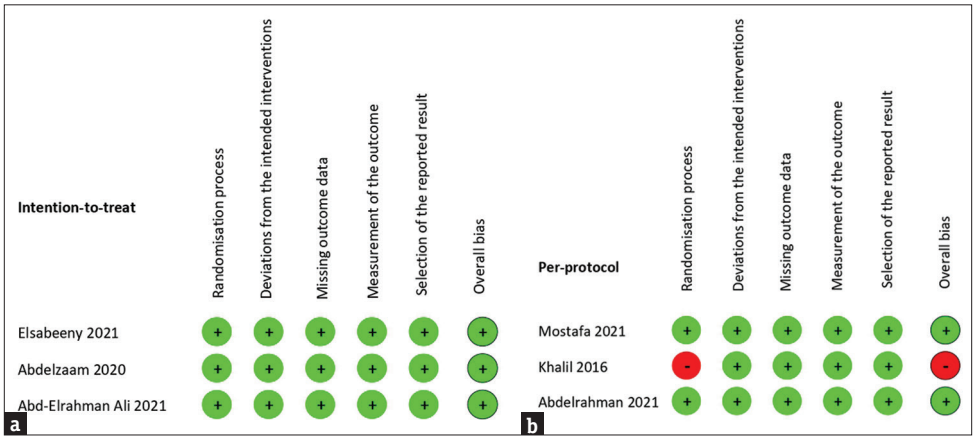

Figure 2: Risk of bias (a) intention-to-treat principle, (b) per-protocol principle

There was no heterogeneity (χ^2 = 1.08, P = 0.90, I^2 = 0%) and no significant disparity in the PONV incidence within both the groups (OR = 1.31, 95% CI = 0.56–3.10, P = 0.54) [Figure 5c].

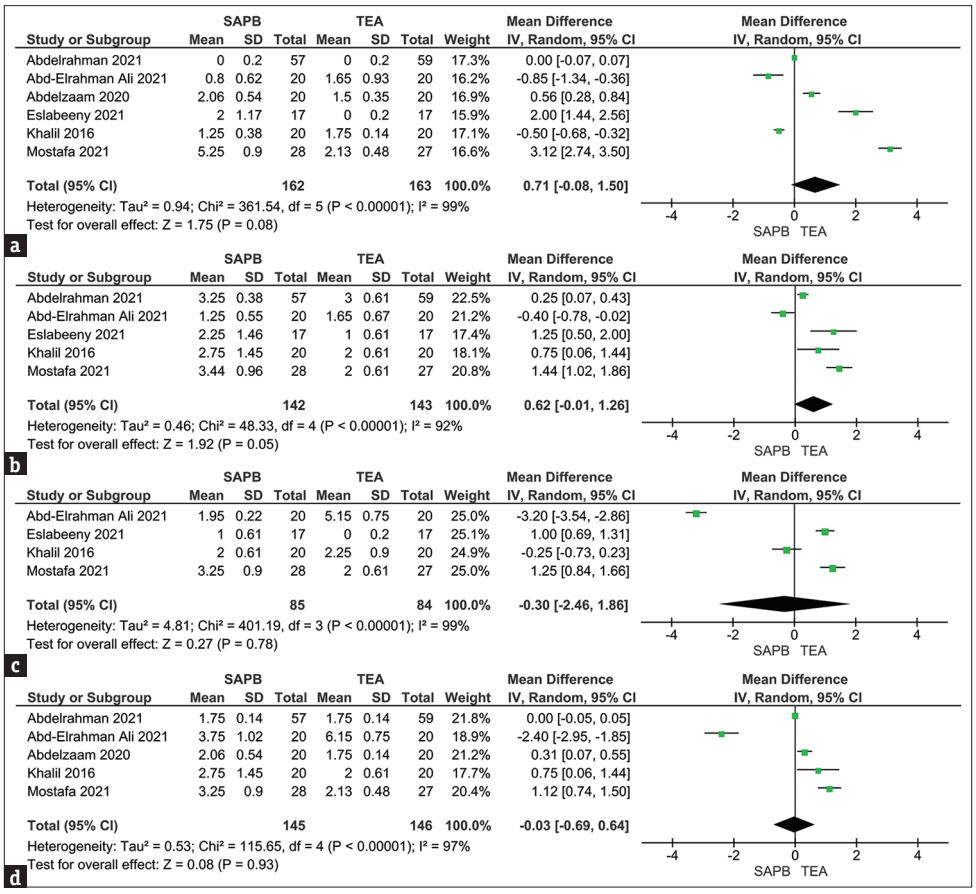

Figure 3: Forest plot for comparison between SAPB and TEA: (a) 24-h VAS, (b) subgroup 2-h VAS, (c) subgroup 4-h VAS, (d) subgroup 6-h VAS. TEA: Thoracic epidural analgesia, VAS: Visual Analog Scale, SAPB: Serratus anterior plane block

Hypotension

Three studies reported the incidence of hypotension [10,11,12]. The incidences of hypotension were 4.6% (3/65) and 35.9% (23/64) in the SAPB and TEA groups, respectively. There was no heterogeneity (χ^2 = 3.92, P = 0.14, I^2 = 49%), and there was a significantly different incidence of hypotension within both the groups (OR = 0.10, 95% CI = 0.03–0.32, P = 0.0001) [Figure 5d].

Sensitivity analysis

We used an influence analysis with leave-one-out method to detect the presence of outliers that may influence the estimated pooled effect and to evaluate the robustness of our results. Except for the Abd-Elrahman Ali 2021 study, the leave-one-out sensitivity analysis revealed that omitting a single study had no effect on the overall combined effect.

Discussion

The controversy over whether SAPB can replace TEA in surgery remains unresolved. The gold standard TEA is associated with many risks such as arachnoiditis, back pain, PDPH, cauda equina syndrome, spinal cord injury, epidural abscess, total spinal anesthesia, epidural hematoma, anterior spinal artery syndrome, and cardiac arrest [6,8]. Considering its space size, it is difficult to perform TEA [9]. SAPB is a new interfascial plane block in the thoracic region. SABP does not block the autonomic nervous system and has minimal side effects. Its sonoanatomy makes it easy to perform the block [11]. Three studies [10,11,12] showed lower VAS in TEA than in SAPB. Studies from Abdelrahman *et al*. and Ali *et al*. showed a lower VAS in SAPB than in TEA [17,20]. Abdelzaam *et al*. [19] determined that the difference between SAPB and TEA on the VAS was not statistically significant. Therefore, we performed the first systematic review and meta-analysis comparing the efficacy and safety of SAPB compared to TEA.

SAPB inhibits lateral and anterior cutaneous branches that come from the second to sixth intercostal nerves [21]. Southgate found that SAPB is recommended for conditions requiring pain management, including thoracotomy, breast surgery, and postmastectomy pain syndrome [22]. Wilgaard also found that persistent postoperative pain in postthoracotomy and postmastectomy is mainly caused by a lesion in peripheral nerves, which both can be prevented with SAPB [22,23]. Other systematic reviews discovered that mastectomy and thoracotomy are associated with a similar mechanism, a combination of nociceptive and neuropathic symptoms, and bear a high risk for chronic pain [24]. Both pain mechanisms in mastectomy and thoracotomy are caused by an injury of intercostal nerves [25] Thus, we include both thoracotomy and mastectomy surgeries in our study.

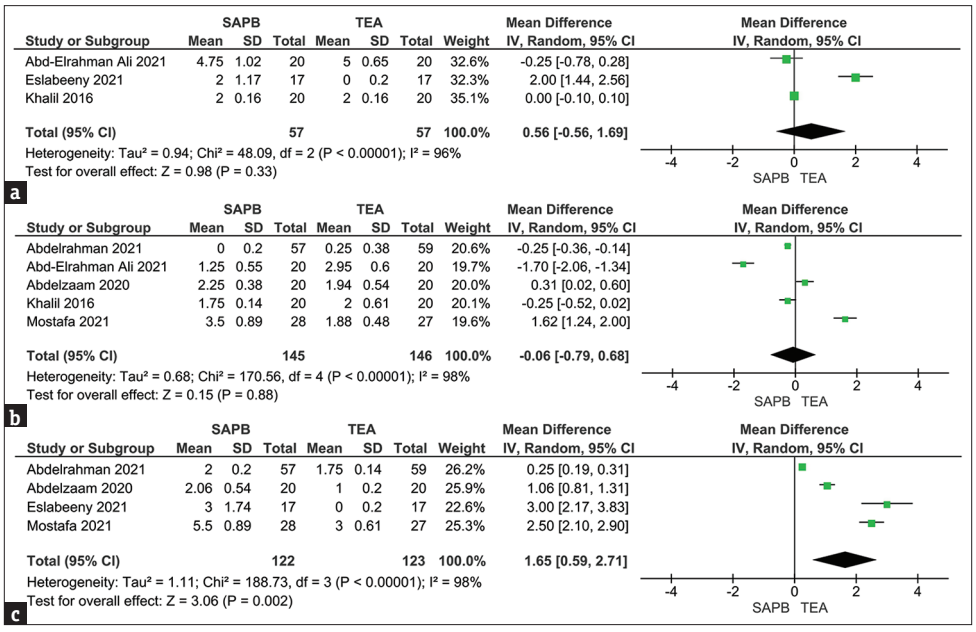

Figure 4: Subgroup forest plot for comparison between SAPB and TEA: (a) 8-h VAS, (b) 12-h VAS, (c) cough VAS. TEA: Thoracic epidural analgesia, VAS: Visual Analog Scale, SAPB: Serratus anterior plane block

Our meta-analysis of six RCTs revealed that VAS did not substantially differ in both the groups (MD = 0.71, 95% CI = 0.08–1.5, P = 0.08). However, due to the ununiform of drugs used, drug loading timing, and drug maintenance, this result should be interpreted carefully.

Subgroup analysis of the 2nd-, 4th-, 6th-, 8th-, and 12th-hour postoperative VAS showed no significant difference between SAPB and TEA. This result is consistent with a study from Okmen *et al*. comparing 2nd-, 6th-, 12th-, and 24th-h postoperative VAS [26]. After the initial dose, local anesthesia in both SAPB and TEA was given as a continued dose in five studies, while a participant in the Abdelrahman *et al*.'s study was given a combination of morphine, ketorolac, and granisetron as a continuous dose.

VAS subgroup analysis on coughing showed a statistically significant MD where SAPB had a higher VAS score compared to TEA. Although higher (MD = 1.65, P = 0.002), it is not considered a minimal clinically important difference (MCID) (range: 1.86–2.26) for the VAS for Pain (VAS-P) [27]. The importance of postoperative pain management after thoracic surgery is considered in early recovery. Postoperative patients with a higher VAS score tend to refrain from coughing and had a late mobilization. According to a study of patients undergoing VATS, contraction of the serratus anterior muscle (SAM) could inflame the injured intercostal muscle and cause more tension, which would make the pain after surgery worse. This may seem also to be the case for shoulder or arm movement and SAM contraction during inspiration [28]. This will increase the time to recover and hospital stay, because they may develop atelectasis and sputum retention which in turn results in hypoxemia, hypercapnia, and respiratory failure [29].

SSPB and DSPB did not differ significantly from TEA in terms of VAS 24 h postoperatively. There was no significant difference of 24-h VAS between SSPB and DSPB compared to TEA. SSPB blocks the anterior branch portion of the intercostal nerve that penetrates the serratus anterior muscle, and this makes it possible to dull the pain adequately from T2 to T9 [28]. DSPB blocks the cutaneous branch of the lateral intercostal nerves by injecting under SAM [30].

A study suggested the benefit of a preemptive peripheral nerve block (PNB) as a lower VAS score in postoperative analgesia evaluation [31]. SAPB and TEA did not have a significant difference in VAS scores on either preemptive or postoperative PNB. In this study, we separated the six studies into two groups by the difference in the timing of the regional block. Four studies [10,12,17,20] initiated the initial dose of SAPB and TEA before incision, while two other studies [11,19] initiated the initial dose postoperatively. We found that no difference in VAS score between SAPB and TEA was consistent in both the groups.

Pooled PONV incidence showed no statistical difference between SAPB and TEA. PONV contributing factors include age, gender, previous experience with PONV, previous history of motion sickness, length and kind of surgery, no smoking history, postoperative opioid use, and inhalation anesthetic use [32]. Mostafa and Eslabeeny reported that the incidence of PONV in their study did not differ significantly between both the groups. Two studies also found a similar incidence of PONV in SAPB and TEA [18,26].

The pooled incidence of hypotension involving three studies [10,11,12] was substantially lower in the SAPB group in comparison with the TEA group (OR = 0.10, P = 0.0001). Hypotension that happened during the lower thoracic epidural (T5-L4) is primarily caused by the peripheral

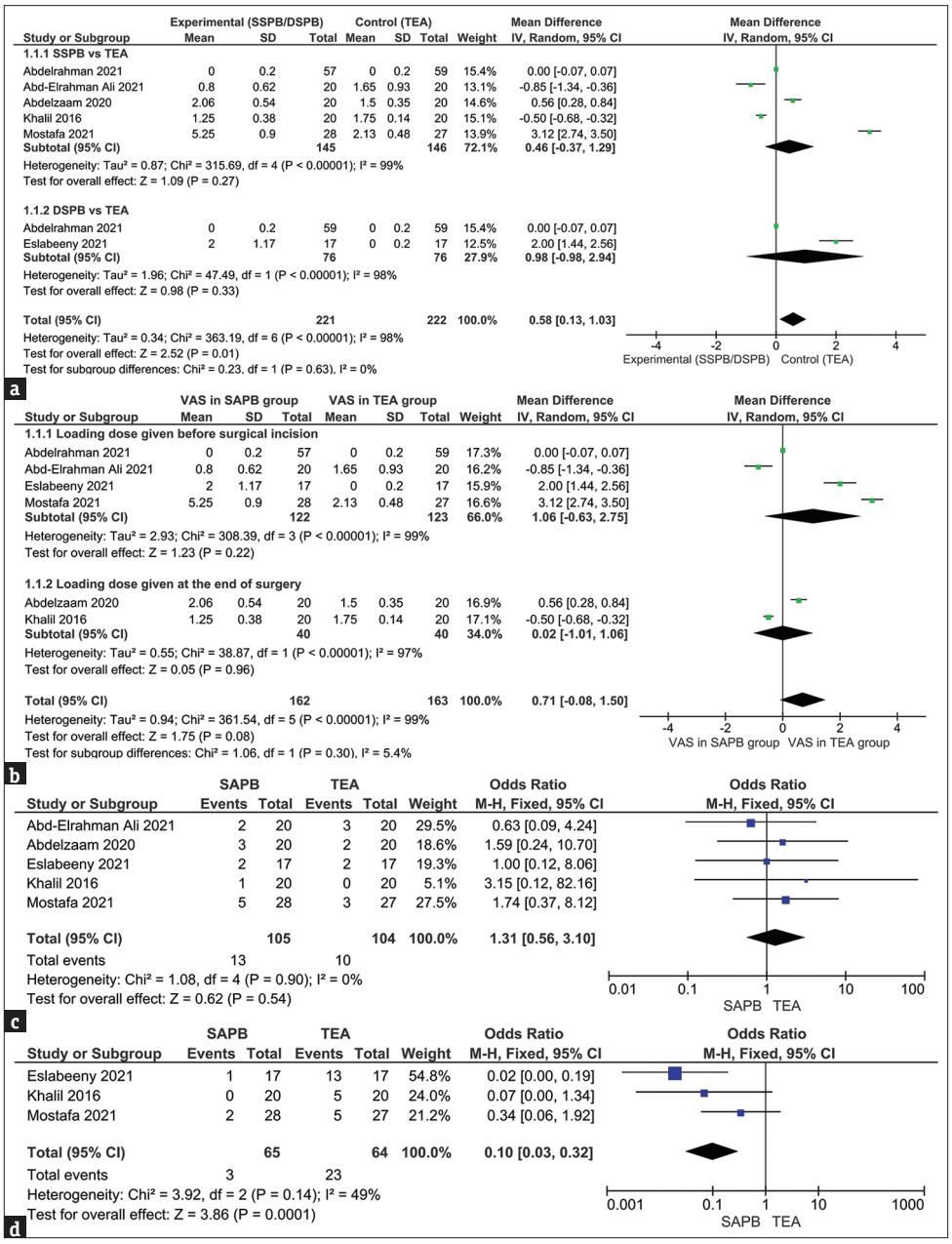

Figure 5: Forest plot for comparison between SAPB and TEA: (a) subgroup SSPB/DSPB, (b) subgroup initial dose timing, (c) PONV, (d) hypotension. SSPB: Superficial serratus plane block, DSPB: Deep serratus plane block, TEA: Thoracic epidural analgesia, PONV: Postoperative nausea and vomiting, SAPB: Serratus anterior plane block

sympathetic block with the splanchnic nerve block. Anesthesia in the high thoracic epidural (T1-T5) causes hypotension by blocking the cardiac afferent nerve and sympathetic efferent nerve, which causes the cessation of the chronotropic and inotropic trigger on the myocardium [33]. The mechanism of hypotension caused by SAPB could be due to local anesthetic systemic toxicity (LAST) [22]. There was no significant difference in hypotension incidence compared to general anesthesia alone [34].

Limitation

There are several limitations in the current studies. First, the sample size of each study is considered small. Second, there was a difference in technique, type of surgery, type of drugs used for local anesthetics, dosage, and timing of injection between RCTs. Third, one study had a high risk of bias due to unexplained randomization and allocation method. Fourth, factors affecting PONV and hypotension were not identified in most of the studies.

Regardless of these limitations, this current study included six high-quality RCTs that provide a comprehensive review to support SAPB as better and safer regional anesthesia than TEA for thoracic region surgery.

Conclusions

SAPB can be a safer and equally effective alternative to TEA. The benefits of SAPB included a lower

incidence of hypotension and equal pain management in thoracic surgery.

Data availability statement

All data generated or analyzed during this study are included in this published article and its supplementary information files.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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