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Indications and Technique for Thoracic Segmental Spinal Anesthesia in Clinical Practice: A Narrative Review

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Abstract

Thoracic segmental spinal anesthesia (TSSA) represents an advanced technique in present clinical anesthetic practice. By lowering the systemic effects of anesthesia, preserving improved hemodynamic stability, and accelerating postoperative recovery, its targeted approach provides significant benefits in certain upper abdominal and thoracic procedures, particularly in high-risk patients. However, careful patient selection, exact technical execution, and in-depth understanding of thoracic anatomy are necessary for its successful implementation. Despite its advantages, TSSA is not yet widely adopted. The major concerns remain related to its technical complexity, principally the risk of spinal cord injury, and the necessity for specialized training and imaging guidance during needle placement. In recent years, there has been a surge in the number of articles describing the safety of TSSA for varying surgeries. This review aims to summarize various indications and the techniques described in the literature related to TSSA.

Categories: Anesthesiology
Keywords: acute postoperative pain, `anesthesia, regional anesthesia, subarachnoid block, thoracic segmental spinal anesthesia

Introduction And Background

Spinal anesthesia (SA) or subarachnoid block is a common regional anesthesia technique introduced in the late 19th century. Traditionally, lumbar spinal anesthesia (LSA) has been the preferred technique due to its well-documented safety profile and widespread applicability across various surgical procedures [1]. However, there has been growing interest in thoracic segmental spinal anesthesia (TSSA) in recent years. This technique involves administering intrathecal local anesthetics at thoracic vertebral levels to achieve segmental blockade [2]. Unlike LSA, which often results in a more extensive sympathetic block and associated hemodynamic instability, particularly in patients with compromised cardiovascular reserve, TSSA offers a more targeted approach with better hemodynamic stability and reduced side effects [3].

TSSA has emerged as an alternative to LSA and general anesthesia (GA) for several surgical procedures. The technique has been refined with the advent of low-dose intrathecal anesthetics (isobaric and hypobaric local anesthetics)and improved imaging modalities, like ultrasonography, ensuring safer administration [4]. By limiting the spread of the anesthetic agent to specific thoracic dermatomes, TSSA minimizes the impact on lower limb motor function and preserves sympathetic tone, thereby reducing the risk of hypotension and bradycardia [5]. Additionally, TSSA has been associated with decreased opioid consumption, reduced postoperative nausea and vomiting, and faster recovery times compared to GA and LSA [6].

Despite its potential advantages, TSSA remains underutilized in routine clinical practice, primarily due to concerns regarding its safety and the technical expertise required for its administration [7]. However, emerging evidence suggests that TSSA is not only feasible but also beneficial across multiple surgical specialties, including orthopedic, abdominal, thoracic, and obstetric surgeries [3,8]. Given the expanding body of literature on TSSA, a comprehensive review is warranted to evaluate its varied clinical indications, identify areas where it offers superior outcomes, and highlight potential challenges in its implementation. This narrative review aims to evaluate and synthesize current evidence regarding the clinical indications for TSSA across different surgical specialties. By systematically analyzing the literature, we seek to provide insights into its technique and applicability, ultimately guiding anesthesiologists in optimizing its use in modern anesthesia practice.

Review

Methods

A broad search strategy was used to incorporate the maximum relevant articles.

Search Strategy

A comprehensive literature search was conducted in databases and search engines including PubMed/MEDLINE, Embase, Scopus, and Google Scholar. Search terms and Boolean strategy were applied using primary keywords “thoracic segmental spinal anesthesia” OR segmental thoracic spinal anesthesia”, OR “thoracic spinal anesthesia”, AND “segmental spinal anesthesia”.

Eligibility Criteria

The study inclusion criteria were decided beforehand and presented according to the PICO (Population, Intervention, Comparison, Outcome) framework (Table *1*).

Component	Details
Population (P)	Patients undergoing surgical procedures where TSSA was used as an anesthetic technique (e.g., general surgery, laparoscopic surgery, cesarean section, orthopedic surgery, urological surgery, and thoracic surgery)
Intervention (I)	TSSA
Comparison (C)	Other anesthesia techniques (e.g., LSA, epidural anesthesia, and general anesthesia) or no direct comparison in some cases
Outcome (O)	Varied clinical indications and applications of TSSA, including feasibility, safety, efficacy, and advantages over other techniques

TABLE 1: PICO framework of the study

TSSA: thoracic segmental spinal anesthesia; PICO: Population, Intervention, Comparison, Outcome; LSA: lumbar spinal anesthesia

Inclusion Criteria

Studies reporting clinical indications of TSSA, consisting of randomized controlled trials (RCTs), comparative studies, observational studies, case reports, and case series, published in the English language. In comparative studies, only those data were included that reported TSSA participants.

Exclusion Criteria

Studies on LSA and GA without specific TSSA data were excluded. Any type of review article, editorials, expert opinions, and animal studies were also excluded.

Study Selection and Data Extraction

Two independent investigators (IAK and KS) screened titles and abstracts from databases PubMed, Medline, Scopus, Embase, and Google Scholar search engine till January 2025 using predefined keywords and Boolean operators ("Thoracic segmental spinal anesthesia" OR "segmental spinal anesthesia" OR "segmental thoracic spinal anesthesia” OR “thoracic spinal anesthesia” OR "spinal anesthesia in thoracic region"). Full-text reviews for eligible studies were conducted by the same two investigators. Disagreements between investigators were resolved through discussion, and in cases where consensus could not be reached, a third reviewer (AN) was consulted. Full-text articles were retrieved for the studies shortlisted based on the eligibility criteria. Data extraction included author, country, year of publication, study design, sample size, level of spinal block, LA and adjuvants used, surgical procedure, comorbidities, and clinical complications.

Results

A total of 604 potentially relevant articles were identified from PubMed (43), Medline (40), Embase (30), Scopus (48), and Google Scholar (443). After removing 30 records marked as ineligible by automation tools and 161 duplicate articles, 413 were available for title and abstract screening. The screening through titles and abstracts further removed 292 articles. Out of the remaining 121, the full text of 18 articles was not retrieved and was removed. The full text of the remaining 103 articles was retrieved and assessed, and based on the selection criteria, seven articles were excluded at this stage. Finally, the remaining 96 articles were selected for the review presented in Figure *1*.

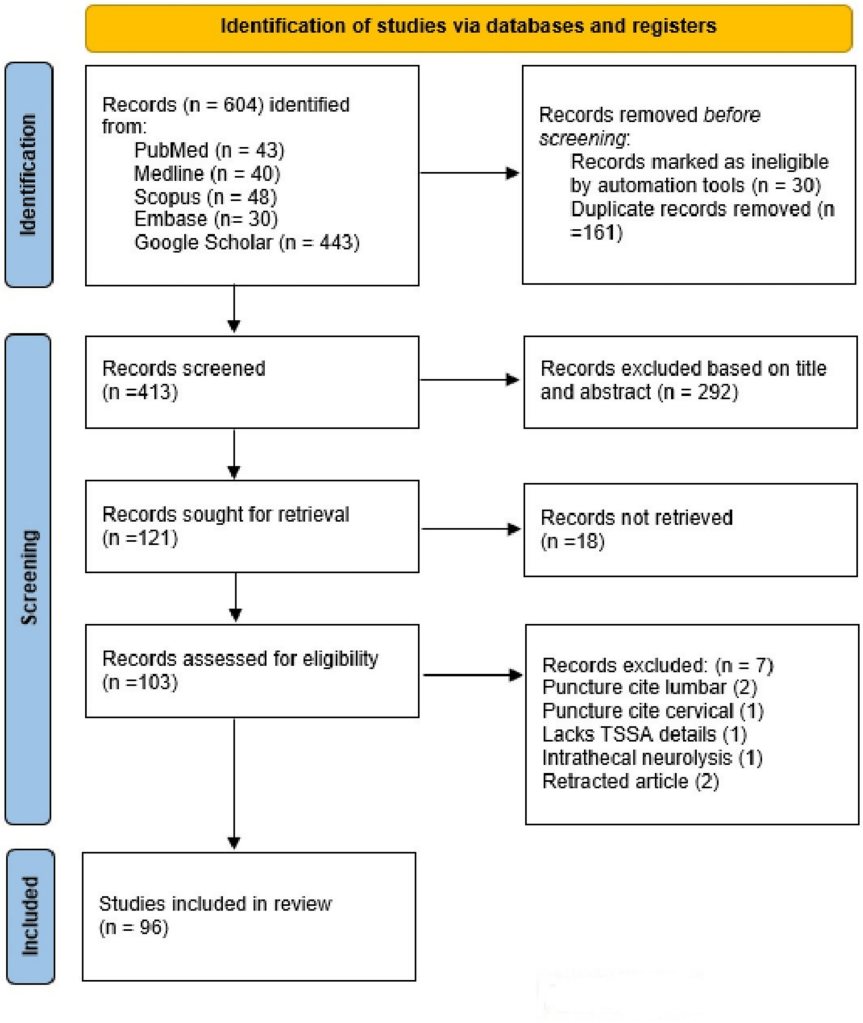

FIGURE 1: PRISMA flow diagram

TSSA: thoracic segmental spinal anesthesia

A total of 6270 patients from 15 countries were included in 96 studies. A maximum of 46 articles were published from India (Figure *2*).

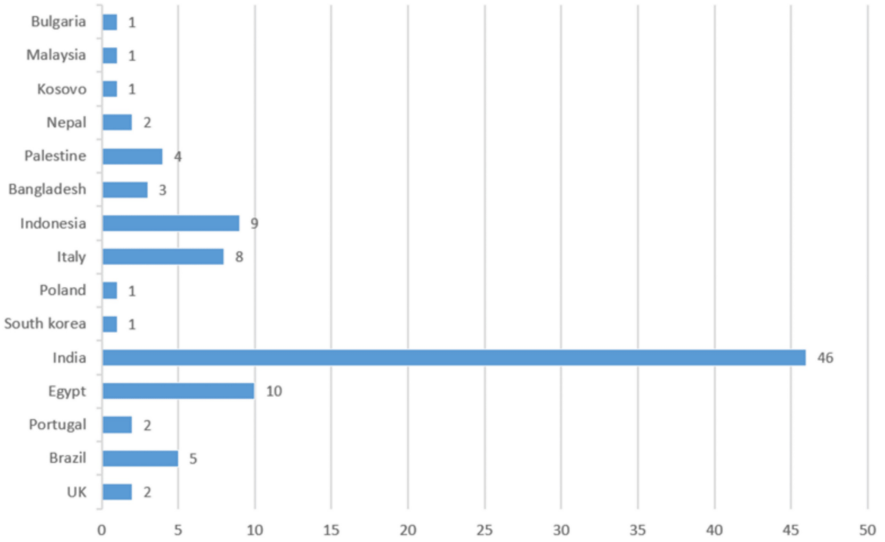

FIGURE 2: Country-wise publication on TSSA

TSSA: thoracic segmental spinal anesthesia

The most common study type was a case report (Figure 3). There are 13 RCTs and an additional 13 unregistered RCTs. In most studies, comparisons of TSSA were done with GA and LSA.

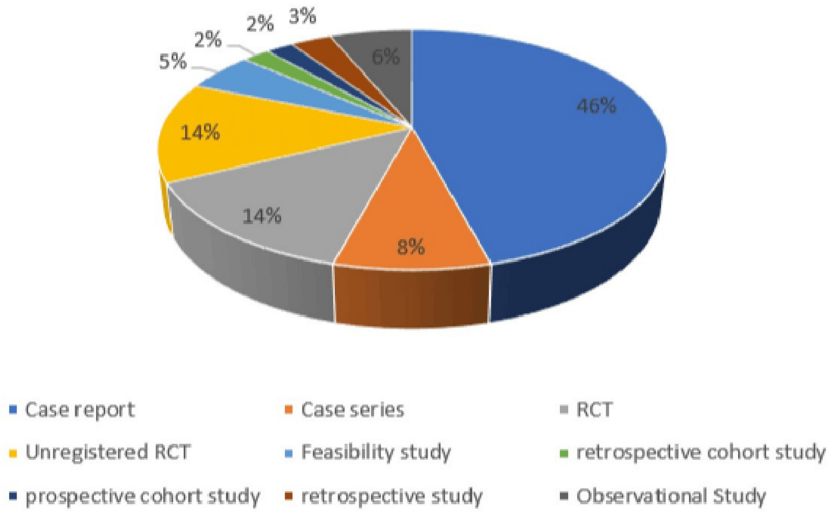

FIGURE 3: Categories of publications

RCT: randomized controlled trial

TSSA was given in isolation in 77 (80%) studies, and in 14 (14.6%) cases, it was given as CSE. One case reported ESPB with TSSA, and four cases were continuous TSSA. Needle sizes 25 and 27 were the most commonly reported spinal needles in 32 (33.3%) studies, each followed by size 26 in 14 (14.6%) studies. Bupivacaine, levobupivacaine, and ropivacaine with different baricities were used during TSSA. Two studies reported the use of hypobaric local anesthetics. The most common adjuvants were fentanyl (59 studies) and dexmedetomidine (19 studies). Other adjuvants were sufentanil, clonidine, buprenorphine, dexamethasone, and morphine. Ketamine and midazolam were used for intrathecal sedation in two studies. Adjuvants details were not provided in 11 studies (Figure 4).

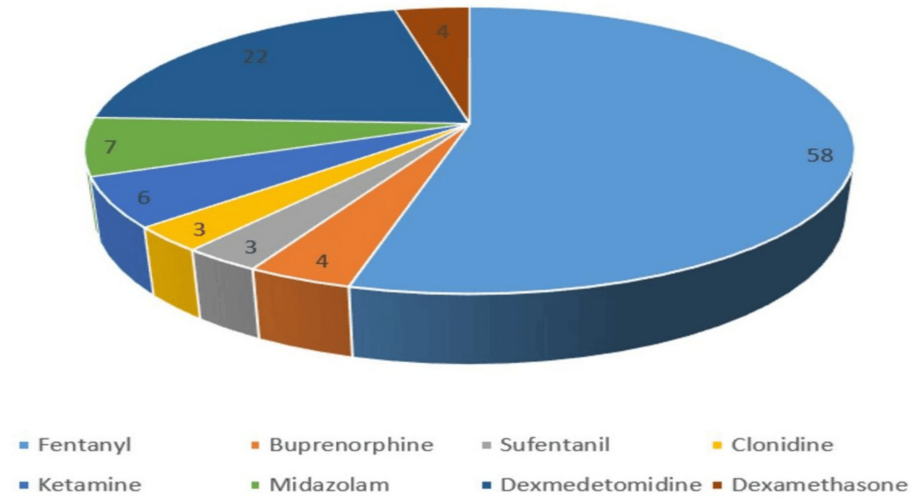

FIGURE 4: Intrathecal adjuvants used with local anesthetic

Figure *5* showcases the number of publications related to TSSA over the years.

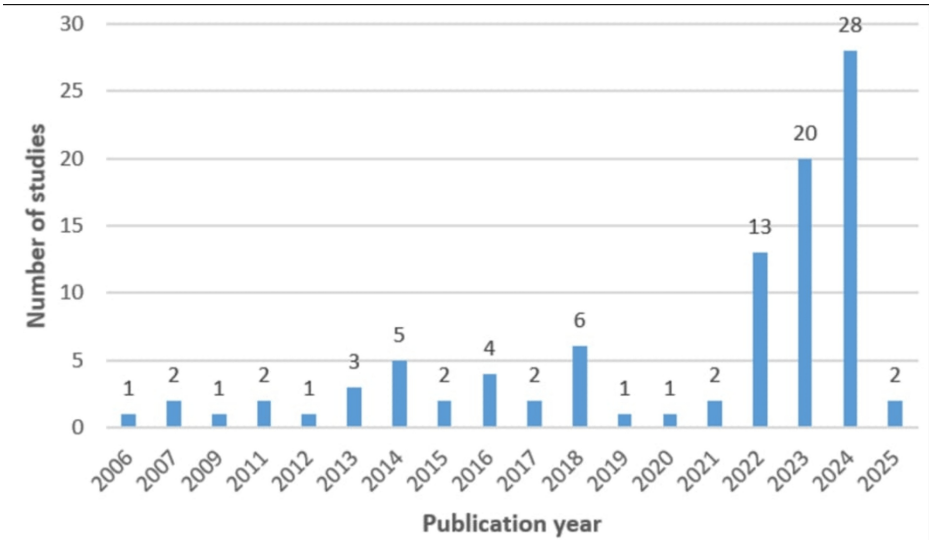

FIGURE 5: Number of publications related to TSSA over the years

TSSA: thoracic segmental spinal anesthesia

A total of 36 articles reported Laparoscopic surgeries, including 30 laparoscopic cholecystectomies. Other major indications were upper and lower abdominal surgeries (25 studies) and breast surgeries (19 studies) where TSSA was used. Some other operative procedures where TSSA was used included laparoscopic and open gynecological, PCNL, nephrectomy, laparotomy, lipoma, thoracoscopy, kyphoplasty, and upper extremity surgeries. Diabetes mellitus (DM), hypertension, chronic obstructive pulmonary disease (COPD), chronic kidney disease (CKD), and ischemic heart disease (IHD) were the comorbidities in which TSSA was used for operative procedures. Several studies also reported the use of TSSA in ASA-PS I and II patients (Table *2*).

Comorbidities	Studies (number)
Cardiovascular	Hypertension, DCM, pacemaker, apical hypokinesia, IHD, CHF, heart transplant recipient, situs inversus, and ASD
Pulmonary	COPD, asthma, byssinosis, postpneumonectomy, ILD, and bronchiectasis
Endocrine	DM, obesity, and hyperthyroidism
Others	Coagulopathy, amyotrophic lateral sclerosis, squamous cell carcinoma, multiple comorbidities, Parkinson's disease, pre-eclampsia, electrolyte imbalance, spinal deformities or previous spine surgeries, anemia, and Birt-Hogg-Dube syndrome

TABLE 2: Comorbidities among patients who received TSSA

DCM: dilated cardiomyopathy, IHD: ischemic heart disease, CHF: congestive heart failure, ASD: atrial septal defect, COPD: chronic obstructive pulmonary disease, DM: diabetes mellitus, ILD: interstitial lung disease,

Table *3* summarizes the various types of surgery in which TSSA was used.

Indications	Number of studies (%)
Laparoscopic surgery	36 (37.5)
Abdominal surgery	25 (26.0)
Breast surgery	19 (19.8)
Thoracotomy and thoracoscopic surgery	3 (3.1)
Incisional and inguinal hernia	3 (3.1)
Orthopedic surgery	3 (3.1)
Chest wall surgery	4 (4.2)
Spine surgery	3 (3.1)

TABLE 3: Summary of various surgeries in which TSSA was used

Discussion

This study provides a comprehensive review of TSSA and highlights the growing clinical interest and expanding utility of TSSA across a wide spectrum of surgical specialties. The findings suggest that TSSA is not only a feasible and effective anesthetic technique but also offers distinct advantages over traditional LSA and GA, particularly in terms of hemodynamic stability, reduced opioid consumption, and expedited recovery [9-11]. Despite the concerns regarding technical expertise and safety, the inclusion of 13 RCTs [12-24] and 13 unregistered RCTs [9,25-36], along with numerous observational studies and case reports, reinforces the growing acceptance and reliability of TSSA in clinical practice.

While laparoscopic cholecystectomy and breast surgeries remain the most commonly reported applications, emerging indications include thoracoscopic procedures, kyphoplasty, nephrectomy, and even select upper extremity and gynecological surgeries [24,36]. The feasibility of TSSA in patients with significant comorbidities, such as DM, hypertension, CKD, and IHD, further suggests its potential as a preferred anesthetic technique in high-risk surgical populations [11,31,32].

The review highlights a growing trend of utilizing TSSA beyond conventional domains. TSSA was successfully used in a post-pneumonectomy patient for laparoscopic cholecystectomy [16]. Laparoscopic cholecystectomy was performed under TSSA in a high-risk patient with a cardiac pacemaker, dilated cardiac myopathy, and an ejection fraction of 20% [37]. Continuous TSSA with intrathecal midazolam, ketamine, and fentanyl was used in elderly patients having multiple comorbidities for conducting major abdominal surgeries [38]. The use of TSSA was also documented in a patient with Situs Inversus Totalis and Birt-Hogg-Dube syndrome [39,40].

Additionally, the evolving use of adjuvants and hypobaric solutions opens avenues for customized segmental blockade suited to specific surgical needs [39,41-103]. Future applications may extend to

incorporate TSSA to enhanced recovery after surgery (ERAS) protocols, ambulatory surgical settings, and elderly or frail patients where minimizing hemodynamic fluctuations is crucial.

Despite the encouraging findings, several limitations in the current evidence base should be acknowledged. A significant proportion of studies are case reports and small observational studies, limiting the generalizability of results. Only a limited number of RCTs exist, and many comparative studies lack uniformity in methodology, drug dosing, and outcome measures. Furthermore, heterogeneity in patient populations, surgical procedures, and anesthetic techniques makes it challenging to draw definitive conclusions. There is also a lack of long-term safety data and standardized protocols for TSSA administration. Lastly, publication bias and underreporting of complications in smaller studies may skew the perceived safety profile. Robust, multicentric trials with standardized outcome reporting are essential to validate the routine use of TSSA in broader clinical practice.

Conclusions

This review underscores the expanding role of TSSA as an effective and versatile technique across a wide range of surgical procedures. TSSA offers notable advantages over traditional anesthesia methods, including accepted hemodynamic stability, reduced opioid use, and faster recovery. Its successful application in patients with comorbidities and various surgical specialties, supported by evidence from case reports/series and observational studies, highlights its growing indications in clinical practice. With appropriate expertise and careful patient selection, TSSA has the potential to be a valuable addition to modern anesthesia protocols.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

References

1. Balavenkatasubramanian, Senthilkumar, Kumar V: Current indications for spinal anesthesia-a narrative review. Best Pract Res Clin Anaesthesiol. 2023, 37:89-99. 10.1016/j.bpa.2023.04.001
2. Khan IA, Ansari MA: Thoracic segmental anesthesia: a new paradigm in anesthesiology practice . Arch Anesth Crit Care. 2023, 10:203-4. 10.18502/aacc.v10i2.15074
3. le Roux JJ, Wakabayashi K, Jooma Z: Defining the role of thoracic spinal anaesthesia in the 21st century: a narrative review. Br J Anaesth. 2023, 130:e56-65. 10.1016/j.bja.2022.03.008
4. Hamdi T, Mastari ES, Lubis AP, Ghozali I, Kemalasari N, Harahap AT: Effectiveness and safety of thoracic segmental spinal anesthesia for breast surgery: a systematic review and meta-analysis. Narra J. 2025, 5:e1630. 10.52225/narra.v5i1.1630
5. Khan I, Paliwal N, Ahmad S: Safety and feasibility of segmental thoracic spinal anaesthesia (STSA): a scoping review. Sch J App Med Sci. 2022, 10:1718-22. 10.36347/sjams.2022.v10i10.022
6. Gautam SN, Yadav R, Khanal A, Dangol S: The safety and feasibility of segmental thoracic spinal anesthesia above umbilicus and breast surgery. Nepal Med Coll J. 2024, 26:104-11. 10.3126/nmcj.v26i2.67196
7. Khan IA, Paliwal NW: Challenges in implementing thoracic segmental spinal anesthesia in routine anesthesia practice. SBV J Basic Clin Appl Health Sci. 2025, 8:25-6. 10.4103/SBVJ.SBVJ_13_25
8. Kurdi MS, Agrawal P, Thakkar P, Arora D, Barde SM, Eswaran K: Recent advancements in regional

anaesthesia. Indian J Anaesth. 2023, 67:63-70. 10.4103/ija.ija_1021_22
9. Abdelmonem A: Low dose hyperbaric bupivicaine injected at T12-L1 provides adequate anesthesia with stable hemodynamics for elderly patients undergoing TURP. Egypt J Anaesth. 20111, 27:95-100. 10.1016/j.egja.2011.04.001
10. Imbelloni LE, Sant'anna R, Fornasari M, Fialho JC: Laparoscopic cholecystectomy under spinal anesthesia: comparative study between conventional-dose and low-dose hyperbaric bupivacaine. Local Reg Anesth. 2011, 4:41-6. 10.2147/LRA.S19979
11. Imbelloni LE: Spinal anesthesia for laparoscopic cholecystectomy: thoracic vs. lumbar technique . Saudi J Anaesth. 2014, 8:477-83. 10.4103/1658-354X.140853
12. Imbelloni LE, Gouveia MA: A comparison of thoracic spinal anesthesia with low-dose isobaric and low-dose hyperbaric bupivacaine for orthopedic surgery: a randomized controlled trial. Anesth Essays Res. 2014, 8:26-31. 10.4103/0259-1162.128900
13. Ellakany MH: Thoracic spinal anesthesia is safe for patients undergoing abdominal cancer surgery . Anesth Essays Res. 2014, 8:223-8. 10.4103/0259-1162.134516
14. ELdeen HM: Ultrasound guided pectoral nerve blockade versus thoracic spinal blockade for conservative breast surgery in cancer breast: A randomized controlled trial. Egypt J Anaesth. 2016, 32:29-35. 10.1016/j.egja.2015.08.005
15. Mazy A, El-Domiaty A, Mageed NA, Motawi AA, Messeha M: Comparison between thoracic paravertebral block and segmental thoracic spinal anesthesia in breast cancer surgery. Ain-Shams J Anesthesiol. 2022, 14:88. 10.1186/s42077-022-00281-8
16. Haq HU, Raghunath SV, Sushma V: A comparison of general anesthesia and segmental thoracic spinalanesthesia regarding hemodynamic and respiratory stability Forlaparoscopic cholecystectomy. IAR J Med Surg Res. 2022, 30:1-6.
17. Paliwal N, Maurya N, Suthar OP, Janweja S: Segmental thoracic spinal anesthesia versus general anesthesia for breast cancer surgery: a prospective randomized-controlled open-label trial. J Anaesthesiol Clin Pharmacol. 2022, 38:560-5. 10.4103/joacp.JOACP_679_20
18. Singhal G, Choudhary S, Saxena AK: Comparison of thoracic segmental spinal anaesthesia and lumbar spinal anaesthesia for percutaneous nephrolithotomy. Int J Res Med Sci. 2023, 11:1. 10.18203/2320-6012.ijrms20233390
19. Elzohry AA, Hegab AS, Khalifa OY, Elhossieny KM, Abdel Hameed FA: Safety and efficacy of ultrasound-guided combined segmental thoracic spinal epidural anesthesia in abdominal surgeries and laparoscopic procedures: a prospective randomized clinical study. Anesth Pain Med. 2023, 13:e138825. 10.5812/aapm-138825
20. Verma AK, Kumar N, Srinivas C, Sahu P: Comparison of the effectiveness and safety of segmental thoracic spinal anesthesia using isobaric levobupivacaine 0.5% versus hyperbaric levobupivacaine 0.5% in performing laparoscopic cholecystectomy: a prospective randomized controlled trial. Cureus. 2024, 16:e76060. 10.7759/cureus.76060
21. Singhal G, Kaur P: Comparison of hemodynamic changes in thoracic segmental spinal anaesthesia and general anaesthesia for laparoscopic cholecystectomy. Indian J Clin Anaesth. 2024, 11:125-31.
22. Karthik GS, Srinivasan R, Sudheer R, Amabareesha M, Monisha TS, Kumar MD: Thoracic spinal anaesthesia - An effective alternative to general anaesthesia in breast surgeries: a randomised, non-blinded study. Indian J Anaesth. 2024, 68:902-8. 10.4103/ija.ija_629_24
23. Sangadala P, Talawar P, Tripathy DK, Kaushal A, Gupta A, Raj N: Comparison of block characteristics and outcomes in opioid-free and opioid-based thoracic continuous spinal anaesthesia in patients undergoing major abdominal surgery: a double-blinded randomised controlled trial. Indian J Anaesth. 2024, 68:280-6. 10.4103/ija.ija_729_23
24. Karthik GS, Chandra M, Sudheer R, Shwetha AH: Combined thoracic segmental spinal anesthesia and erector spinae plane block in high-risk patients undergoing thoracoscopic surgery: a case series. Saudi J Anaesth. 2025, 19:98-101. 10.4103/sja.sja_378_24
25. van Zundert AA, Stultiens G, Jakimowicz JJ, Peek D, van der Ham WG, Korsten HH, Wildsmith JA: Laparoscopic cholecystectomy under segmental thoracic spinal anaesthesia: a feasibility study . Br J Anaesth. 2007, 98:682-6. 10.1093/bja/aem058
26. Elakany MH, Abdelhamid SA: Segmental thoracic spinal has advantages over general anesthesia for breast cancer surgery. Anesth Essays Res. 2013, 7:390-5. 10.4103/0259-1162.123263
27. Ellakany M: Comparative study between general and thoracic spinal anesthesia for laparoscopic cholecystectomy. Egypt J Anaesth. 2013, 29:375-81. 10.1016/j.egja.2013.05.004
28. Kour L, Rasool A: Comparison of low dose bupivacaine and ropivacaine in low thoracic combined spinal epidural anaesthesia for laparoscopic cholecystectomy. JK Science. 2017, 19:210-4.
29. Ahmed AM, Ali H, Helal O, Sobhi T: Comparative study between continuous thoracic epidural vs. thoracic spinal anaesthesia in breast surgery. J Pain Relief. 2017, 6:2167-846.
30. Hobaika AB, Silva CH, Alves NG, Isoni NC: Two cases of thoracic spinal anaesthesia in patients with severe diseases. Egypt J Anaesth. 20151, 31:251-3. 10.1016/j.egja.2015.04.002
31. Mehta N, Gupta S, Sharma A, Dar MR: Thoracic combined spinal epidural anesthesia for laparoscopic cholecystectomy in a geriatric patient with ischemic heart disease and renal insufficiency. Local Reg Anesth. 2015, 8:101-4. 10.2147/LRA.S86390
32. Daszkiewicz A, Copik M, Misiolek H: Thoracic combined spinal-epidural anesthesia for laparoscopic cholecystectomy in an obese patient with asthma and multiple drug allergies: a case report. Innov Surg Sci. 2016, 1:105-8. 10.1515/iss-2016-0024
33. Bhalavi M, Shakya ML, Dandotiya D: Comparison of two different doses of hyperbaric bupivacaine in segmental spinal anesthesia for laparoscopic cholecystectomy. Asian J Pharm Clin Res. 2023, 16:194-7.
34. Deshpande N, Agarwal K, Hatgaonkar R, Paliwal N: Efficacy of thoracic segmental spinal anaesthesia along with unilateral erector spinae block in patients undergoing unilateral modified radical mastectomy and axillary dissection: A novel multicentric study. Asian J Pharm Clin. 2023, 16:
35. Kumbhare N, Dubey A, Mishra CS, Yadav V, Chakravarty N: To compare isobaric thoracic spinal anaesthesia

versus general anaesthesia in laparascopy cholecystectomy. Int J Pure Med Res. 2023, 8:
36. Manasra MR, Heih OQ, Adwan RF, Maraqa MA: The use of thoracic segmental spinal anaesthesia for thoracoscopic diaphragmatic hernia repair in an adult with cardiac compromise. Cureus. 2024, 16:e56029.
37. Mehta N, Gupta KC, Sharma S, Dar MR: Thoracic combined spinal epidural anesthesia in patient of dilated cardiomyopathy undergoing laparoscopic cholecystectomy. J Anaesthesiol Clin Pharmacol. 2016, 32:269-70. 10.4103/0970-9185.173321
38. Vincenzi P, Starnari R, Faloia L, et al.: Continuous thoracic spinal anesthesia with local anesthetic plus midazolam and ketamine is superior to local anesthetic plus fentanyl in major abdominal surgery. Surg Open Sci. 2020, 2:5-11. 10.1016/j.sopen.2020.07.002
39. Deshpande J, Jacob ME: Fibroadenoma excision under thoracic segmental spinal anaesthesia in isolated situs inversus totalis: a case report. Arch anesthesiol crit care. 2023, 9:
40. Ghosh TK, Roy P: Thoracic segmental spinal anaesthesia for laparoscopic cholecystectomy in a case of birt-hogg-dube syndrome. Asian J Med Sci. 2023, 14:265-8. 10.3126/ajms.v14i3.46763
41. Ghozali I, Hamdi T, Yusmaidi Y, Sitepu JF: Single-shot thoracic spinal anesthesia (TSA) in pediatric patient under laparoscopic cholecystectomy: a case report. J Soc Med. 2022, 1:93-6. 10.47353/jsocmed.v1i3.15
42. Vincenzi P, Stronati M, Garelli P, Gaudenzi D, Boccoli G, Starnari R: Segmental thoracic spinal anesthesia for laparoscopic cholecystectomy with the “hypobaric” technique: a case series. Local Reg Anesth. 2023, 16:31-40. 10.2147/LRA.S395376
43. van Zundert AA, Stultiens G, Jakimowicz JJ, van den Borne BE, van der Ham WG, Wildsmith JA: Segmental spinal anaesthesia for cholecystectomy in a patient with severe lung disease. Br J Anaesth. 2006, 96:464-6. 10.1093/bja/ael036
44. Hobaika AB: Thoracic spinal anesthesia for gastrostomy in a patient with severe lung disease . Acta Anaesthesiol Scand. 2007, 51:783. 10.1111/j.1399-6576.2007.01315.x
45. Imbelloni LE, Fornasari M, Fialho JC: Combined spinal epidural anesthesia during colon surgery in a high-risk patient: case report. Rev Bras Anestesiol. 2009, 59:741-5. 10.1016/s0034-7094(09)70099-6
46. Patel K, Salgaonkar S: Segmental thoracic spinal anesthesia in patient with byssinosis undergoing nephrectomy. Anesth Essays Res. 2012, 6:236-8. 10.4103/0259-1162.108352
47. Kim BS, Joo SH, Joh JH, Yi JW: Laparoscopic cholecystectomy in patients with anesthetic problems . World J Gastroenterol. 2013, 19:4832-5. 10.3748/wjg.v19.i29.4832
48. Mahmoud AA, Hussein HA, Girgis K, Kamal AM, Nafady HA: The novel use of spinal anesthesia at the mid-thoracic level: a feasibility study. Egypt J Cardiothorac Anesth. 20141, 8:21-6.
49. Paria R, Surroy S, Majumder M, Paria B: Spinal at T10 (10th thoracic) . IOSR-JDMS. 2014, 13:28-32. 10.9790/0853-13822832
50. Mehta N, Dar MR, Sharma S, Mehta KS: Thoracic combined spinal epidural anesthesia for laparoscopic cholecystectomy: a feasibility study. J Anaesthesiol Clin Pharmacol. 2016, 32:224-8. 10.4103/0970-9185.173384
51. Kejriwal AK, Begum S, Krishan G, Agrawal R: Laparoscopic cholecystectomy under segmental thoracic spinal anesthesia: a feasible economical alternative. Anesth Essays Res. 2017, 11:781-3. 10.4103/0259-1162.174467
52. Castellani D, Starnari R, Faloia L, et al.: Radical cystectomy in frail octogenarians in thoracic continuous spinal anesthesia and analgesia: a pilot study. Ther Adv Urol. 2018, 10:343-9. 10.1177/1756287218795427
53. El Moutaz H, Wahab HA, Ghany JM: Comparative study of segmental thoracic spinal versus thoracic epidural anesthesia for laparoscopic cholecystectomy. Ann Med. 2018, 2:730-6.
54. Kour L, Gupta KC: Comparison of effect of isobaric bupivacaine vs hyperbaric bupivacaine on haemodynamic variables in thoracic combined spinal epidural anaesthesia for laparoscopic cholecystectomies. Int J Res Med Sci. 2018, 6:3413-7. 10.18203/2320-6012.ijrms20184056
55. Kour L, Gupta KC, Mehta N, Mehta KS: Laparoscopic cholecystectomy under low thoracic combined spinal epidural anaesthesia: a comparative study between isobaric and hyperbaric bupivacaine. IOSR-JDMS. 2018, 17:1-4.
56. Parthasarathy S, Arthi PR: Administration of segmental thoracic spinal anaesthesia for excision of lipoma back of chest - a case report. Br J Pharm Med Res. 2018, 3:870-3.
57. Cotugno M, Dallaglio M, Cantadori L, et al.: Right open nephrectomy under combined spinal and peridural operative anesthesia and analgesia (CSE): a new anesthetic approach in abdominal surgery. Arch Ital Urol Androl. 2020, 91:267-8. 10.4081/aiua.2019.4.267
58. Fitrisyah A, Zainal R, Darwis E: Laparoscopic cholecystectomy under segmental thoracic spinal anesthesia . Arch Med Case Rep. 2021, 2:147-53. 10.37275/amcr.v2i3.24
59. Chauhan R, Sabharwal P, Sarna R, Meena S: Thoracic spinal anesthesia for cesarean section in severe pre-eclampsia: exploring a new dimension. Ain-Shams J Anesthesiol. 2021, 13:1-4. 10.1186/s42077-021-00143-9
60. Atmawan DB, Kurniawan HA, Priyambada P: Thoracic spinal anaesthesia for modified radical mastectomy (MRM). J Anaesth Pain. 2022, 3:1-4. 10.21776/ub.jap.2022.003.01.01
61. Suryo C, Widana IW: Thoracal segmental spinal anesthesia for lower back lipoma excision . MEDICINUS. 20221, 35:17-9. 10.56951/medicinus.v35i3.103
62. Arora G: Breast surgery under thoracic spinal anesthesia - a case report . Int J Anesthesiol Res. 2022, 4:11-3. 10.33545/26648849.2022.v4.i1a.23
63. Khan MK, Uddin MA, Uddin MA, Rab WR: Thoracic segmental spinal anesthesia in patient with severe COPD in open cholecystectomy. Cent Med Coll J. 2022, 6:97-100. 10.3329/cemecj.v6i2.67075
64. Imbelloni LE, Fornasari M, Ant’Anna Filho RGB: Thoracic spinal anesthesia is safe and without neurological sequelae: study with 1,406 patients. Int J Anesth Anesthesiol. 2022, 9:1410148. 10.23937/2377-4630/1410148
65. Vincenzi P, Stronati M, Isidori P, Iuorio S, Gaudenzi D, Boccoli G, Starnari R: Opioid-free segmental thoracic spinal anesthesia with intrathecal sedation for breast and axillary surgery: report of four cases. Local Reg Anesth. 2022, 15:23-9. 10.2147/LRA.S358157
66. Giampaolino P, Della Corte L, Mercorio A, et al.: Laparoscopic gynecological surgery under minimally invasive anesthesia: a prospective cohort study. Updates Surg. 2022, 74:1755-62. 10.1007/s13304-022-01310-9

67. Ullah MM, Kamal MM, Begum SA, Hassan AF, Islam MJ, Khan MS: Effectiveness of segmental thoracic spinal anaesthesia in breast surgery: an observational study. J Shaheed Suhrawardy Med Coll. 2022, 14:47-52. 10.3329/jssmc.v14i2.73178
68. Aljuba YM Sr, Amro AM, Alkadi AT, Taamrah H, Hamamdh MG: Thoracic segmental spinal anesthesia for emergency cholecystectomy: a case report. Cureus. 2022, 14:e30184. 10.7759/cureus.30184
69. Prima A, Hamdi T, Sitepu JF, Ghozali I, Lubis A: Thoracic spinal anaesthesia for paediatric upper extremity surgery in limited-resource hospital: a case report. Ain Shams J Anesth. 2023, 15:72. 10.1186/s42077-023-00369-9
70. Paul A, Borkar A: Anaesthetic management for mastectomy in a male with unilateral gynecomastia: the utilization of thoracic segmental spinal anaesthesia and erector spinae plane block. Cureus. 2023, 15:e47502. 10.7759/cureus.47502
71. Singhal G, Mathur BL, Mathur AK: Efficacy and safety of segmental spinal anaesthesia in laparoscopic cholecystectomy: a prospective study. Indian J Clin Anaesth. 2023, 10:3-10. 10.18231/j.ijca.2023.002
72. Ghozali I, Danayati N: Segmental thoracic spinal anesthesia (TSA) for open reduction with Internal Fixation (ORIF) surgery in right humeral fracture patients: a case report. MEDULA. 2023, 13:1025-32.
73. Ghozali I, Hendroko HT, Rudyanto D, Fernanda MD: A case report of Modified radical mastectomy (MRM) in a 59-year-old female patient with comorbid bronchiectasis using Thoracic segmental Spinal Anesthesia (TSA). MEDULA. 2023, 13:1020-4.
74. Ghozali I, Hamdi T, Arisandi R, Rahmadilla AP: Single-shot Spinal Anesthesia segmental Thoracic or Thoracic Spinal Anesthesia (TSA) for embolectomy in acute Limb ischemia (Ali) Stage IIB: a case report. MEDULA. 2022, 12:812-7. 10.53089/medula.v12i4.530
75. Patel J, Ponnusamy K, Patel A: Thoracic spinal anaesthesia in upper abdominal surgeries . Indian J Clin Anaesth. 2023, 10:85-8. 10.18231/j.ijca.2023.015
76. Venkatesh TK, Parthasarathy S: Single-shot segmental thoracic spinal anesthesia for a giant lipoma of the back of the chest. India J Med specialities. 2023, 14:63-4. 10.4103/injms.injms_129_22
77. Kokare M, Goasavi Y, Upasani S, Goyal B: Benefits of segmental spinal anaesthesia in patients undergoing laproscopic cholecystectomy: a retrospective study. Sch J App Med Sci. 2023, 4:765-9. 10.36347/sjams.2023.v11i04.016
78. Haloi P, Biswas R, Bora A: Thoracic segmental spinal anesthesia for radical nephrectomy in a patient with amyotrophic lateral sclerosis-a case report. Ain Shams J Anesth. 2023, 15:32. 10.1186/s42077-023-00326-6
79. Chandra R, Misra G, Datta G: Thoracic spinal anesthesia for laparoscopic cholecystectomy: an observational feasibility study. Cureus. 2023, 15:e36617. 10.7759/cureus.36617
80. 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 Report. 2023, 8:1349. 10.29011/2574-7754.101349
81. Nagar S, Lohia R, Saluja V, Gupta S: Segmental spinal anaesthesia for routine surgeries: efficacy and safety in ASA 1 & 2 patients-a case series study. Eur J Cardiovasc Med. 2023, 13:1736-47.
82. Basta B, Vailati D, Mori L, Magistro C, Marino G: Thoracic segmental anesthesia for major laparoscopic abdominal surgery in a heart transplant recipient: a case report. Cureus. 2024, 16:e74309. 10.7759/cureus.74309
83. Vailati D, Bonvecchio E, Secco G, Magistro C, Basta B: Neuraxial anesthesia for combined left nephrectomy and left hemicolectomy in a one-lung patient. Cureus. 2024, 16:e59854. 10.7759/cureus.59854
84. Yusmita D, Ghozali I, Rahmadilla AP: Single-shot thoracic spinal anesthesia (TSA) in posterior segment VI of the liver abscess for laparoscopy: a case report. MEDULA. 2024, 8:1067-71.
85. Sada F, Kavaja F, Hamza A, Ukperaj BM: A 74-year-old man with severe comorbidities and successful abdominal aortic aneurysm repair with thoracic segmental spinal anesthesia: a case report. Am J Case Rep. 2024, 25:e943702. 10.12659/AJCR.943702
86. Haloi P, Biswas R, Bora AK, Mahanta D, Choudhury D: Thoracic segmental spinal anesthesia in kyphoplasty: a case series. Bali J Anesthesiol. 2024, 8:247-50. 10.4103/bjoa.bjoa_187_24
87. Haloi P, Biswas R, Bora A, Devi S: Efficacy of thoracic segmental spinal anaesthesia in percutaneous nephrolithotomy: a retrospective observational study. J Clin Diagn Res. 2024, 18:UC31-5. 10.7860/JCDR/2024/68910.19307
88. Deshpande JP, Nath RR, Kulkarni PB, Atram S: Thoracic segmental spinal anaesthesia a boon in challenging case scenarios: a case series. Indian J Clin Anaesth. 2024, 11:421-5. 10.18231/j.ijca.2024.076
89. Gujarkar Mahatme K, Deshmukh PU, Borkar A, Bankar NJ, Mahatme P: A high index of awareness about the inherent complications of thoracic segmental spinal anesthesia: a case of mastectomy with bronchiectasis under thoracic segmental spinal anesthesia. Cureus. 2024, 16:e76586. 10.7759/cureus.76586
90. Goyal L, Gupta S, Nagar S, Bhargava V: Feasibility, safety, and efficacy of segmental spinal anesthesia with predominantly isobaric levobupivacaine: a tertiary care hospital study. Int J Integr Health Sci. 2024, 30:87-94. 10.15850/ijihs.v12.n2.3988
91. Thalji M, Tarayrah R, Ruzaygat A, Motawe D, Ibedo F: Classic incisional hernia repair under awake thoracic combined spinal -epidural anesthesia in a geriatric patient with multiple co-morbidities. Int J Surg Case Rep. 2024, 119:109744. 10.1016/j.ijscr.2024.109744
92. Awang MA, bin Mohamad Yusof MF, bin Abd Razak MH: Segmental thoracic spinal anesthesia for abdominal surgery; a report of three cases. Anaesth pain intensive care. 2024, 28:582-4. 10.35975/apic.v28i3.2334
93. Gupta NA, Agarwal SO, Goyal GA: Quality and efficacy of general anesthesia versus segmental thoracic spinal anesthesia in modified radical mastectomy surgery: a single-center observational study. Asian J Pharm Cl in Res. 2024, 17:40-3.
94. Boykov N, Ferdinandov D, Vasileva P, Yankov D, Burev S, Tanova R: Thoracic spinal anesthesia with intrathecal sedation for lower back surgery: a retrospective cohort study. Front Med (Lausanne). 2024, 11:1387935. 10.3389/fmed.2024.1387935
95. Patel N, Makwana H, Gadhavi A, Gadhavi R: A study of the efficacy of segmental spinal anesthesia in patients undergoing laparoscopic surgeries. Int J Pharm Clin Res. 2024, 16:1584-91.
96. Bajracharya NR, Joshi P, Neupane B, Shrestha R, Milan KC, Parajuli B: Thoracic segmental spinal anesthesia

for laparoscopic cholecystectomy: a case report. J Inst Med Nepal. 2024, 30:75-8. 10.59779/jiomnepal.1315
97. Haloi P: Thoracic segmental spinal anesthesia for cesarean section in a parturient with atrial septal defect-a case report: TSSA in ASD patient for LSCS. Rev Soc Port Anestesiol. 2024, 15:33. 10.25751/rspa.35006
98. Raj PG, Avinash L, Bhagyashree AB, Kumar KR: Layered and thoracic segmental spinal anaesthesia in patients with kyphoscoliosis for various surgeries: a case series. J Clin Diagn Res. 2024, 1:UR01-5. 10.7860/JCDR/2024/69108.19154
99. Chandra R, Sonawane K: Revolutionizing breast surgery: A case report on the excision of a large fibroadenoma suggestive of phyllodes tumor under thoracic spinal anesthesia. Cureus. 2024, 16:e73650. 10.7759/cureus.73650
100. Thakuria R, A S AJ, Kumar G, Talawar P: Thoracic continuous spinal anesthesia in patients with destroyed lung resulted in favorable perioperative outcome. A A Pract. 2024, 18:e01862. 10.1213/XAA.0000000000001862
101. Saha SK, Saha H, Ullah MA, Ranjan R, Adhikary AB: Awake thoracic surgery for severe pulmonary hypertension: a case report. Bangabandhu Sheikh Mujib Med Univ J. 2024, 17:75451.
102. Aljuba YM, Alkadi AT, Hamamdh MG: Segmental thoracic spinal anesthesia for critical patients undergoing abdominal surgeries: a case series and literature review. Cureus. 2024, 16:e74348. 10.7759/cureus.74348
103. Singhal G, Choudhary R, Choudhary P: Comparison between general anesthesia and thoracic spinal anesthesia in total laparoscopic hysterectomy. Indian J Clin Anaesth. 2025, 12:92-98. 10.18231/j.ijca.2025.014