MEDWIN PUBLISHERS
Committed to Create Value for Researchers

Anaesthesia & Critical Care Medicine Journal
ISSN: 2577-4301

Segmental Spinal Anaesthesia–Review

Gupta A*

Pes University Institute of Medical Sciences and Research, India

***Corresponding author:** Apoorva gupta (Professor and HOD Anaesthesia), Pes University Institute of Medical Sciences And Research, salarpuria greenage apartments, Bommanahalli, hosur road, India, Tel: 08867920226; Email: ranugupta@gmail.com

Mini Review

Volume 8 Issue 2

Received Date: October 24, 2023

Published Date: November 30, 2023

DOI: 10.23880/accmj-16000229

Abstract

Spinal anaesthesia, traditionally administered in the lumbar region to avoid spinal cord injury, has seen a paradigm shift due to a deeper comprehension of spinal anatomy. This understanding has prompted the exploration of higher thoracic levels for anaesthesia, specifically in patients deemed high-risk under general anaesthesia.

Segmental Thoracic Spinal anaesthesia, a neuraxial regional technique, offers the potential to serve as a viable alternative to general anaesthesia for specific cases. The passage underscores the importance of not hastily adopting new techniques or policy decisions based solely on isolated studies or expert opinions. Instead, it advocates for a comprehensive review of existing literature to evaluate the safety and feasibility of incorporating Segmental Thoracic Spinal anaesthesia into current anaesthesia practices.

After examining relevant articles documenting surgeries performed under Segmental Thoracic Spinal anaesthesia, the findings suggest that this technique is not only feasible but also safe and cost-effective for a range of abdominal and thoracic procedures. Moreover, it is linked to reduced postoperative complications and higher patient satisfaction.

In summary, this passage underscores the transformative potential of Segmental Thoracic Spinal anaesthesia, emphasizing its safety and efficacy for specific surgeries, particularly in high-risk patients. Nevertheless, the decision to utilize this technique should be informed by a thorough review of scientific literature and tailored to the unique requirements of each patient and surgical scenario.

Keywords: Segmental Spinal Anaesthesia; Thoracic Spinal Anaesthesia; General Anaesthesia

Introduction

Thoracic segmental spinal anaesthesia is a specialized approach primarily reserved for patients facing surgery with significant medical complications, making them high-risk candidates for general anaesthesia. While general anaesthesia remains the standard for most surgical procedures, it can entail drawbacks such as adverse drug reactions, prolonged recovery times, and suboptimal pain management. In recent times, there has been renewed interest in the use of thoracic segmental spinal anaesthesia for various common surgeries, offering a promising alternative [1].

This technique involves the intrathecal injection of anaesthetics, specifically above the point where the spinal cord terminates. Although there is some hesitation among anaesthesiologists to perform spinal anaesthesia above the termination of the conus medullaris due to concerns about

spinal cord injury, numerous studies have demonstrated the safety and efficacy of thoracic spinal anaesthesia in a range of surgical contexts, including laparoscopic cholecystectomies, breast cancer lumpectomies, and abdominal cancer surgeries.

By employing thoracic spinal anaesthesia, patients undergoing these common surgeries can potentially benefit from enhanced safety, shorter post-anaesthesia recovery periods, and more effective pain relief. The goal of this review is to provide an in-depth description of the technique, outline its indications and contraindications, and emphasize the collaborative role of an interprofessional healthcare team in managing patients undergoing thoracic segmental spinal anaesthesia [2,3].

Anatomy and Physiology

The anatomy of the thoracic and lumbar regions of the spine bears similarities but presents distinct differences crucial for administering anaesthesia in the thoracic spine. To better understand the spinal space for regional anaesthesia, anatomical studies have utilized MRI imaging. These images have revealed a notable dissimilarity: in the mid to lower thoracic segment, the spinal cord is situated anteriorly, creating a space filled with cerebrospinal fluid (CSF) between the dura and the cord. In contrast, in the lumbar region, the spinal cord and cauda equina make direct contact with the posterior aspect of the dura mater. Importantly, this indicates a more substantial depth of the posterior subarachnoid space in the thoracic spinal cord. For instance, in one MRI study involving 50 patients, it was found that the distance between the dura mater and spinal cord in the thoracic spine measured 7.75 mm at T5 and 5.88 mm at T10. This data underscores the necessity of maintaining a minimum safe distance to prevent the spinal needle from coming into contact with the spinal cord tissue during intrathecal injections at mid-thoracic levels [4-6].

Furthermore, the interlaminar spaces in the thoracic spine are relatively narrow and pose challenges for needle insertion due to the overlap of vertebral lamina. In contrast, the laminae of the lumbar vertebrae do not overlap, and the space between them is more extensive. Additionally, the spinous processes of the thoracic vertebrae point downward, unlike the posterior orientation of the spinous processes in the lumbar vertebrae. This variation in the orientation of spinous processes in the thoracic spine can influence the angle at which a needle is inserted during a midline approach and potentially complicate the procedure.

During thoracic segmental spinal anaesthesia, the layers of anatomy that the needle traverses are akin to those in the lumbar region, where conventional spinal anaesthesia is performed. In the midline approach, the needle passes through the skin, subcutaneous fat, supraspinous ligament, interspinous ligament, ligamentum flavum, dura mater, subdural space, arachnoid mater, and, finally, the subarachnoid space. When employing the paramedian technique, the needle traverses the skin, subcutaneous fat, paraspinous muscles, ligamentum flavum, dura mater, subdural space, arachnoid mater, and, ultimately, the subarachnoid space [7].

It's essential to note that during thoracic segmental spinal anaesthesia, a smaller number of nerve roots are covered by the anaesthetic within the subarachnoid space, ensuring adequate anaesthesia in the pertinent dermatomes of the surgical field. Furthermore, as this procedure results in less blockade of the lower extremities, a more substantial portion of the body does not experience venous dilation, which can help counteract potential adverse effects on blood pressure during surgery.

Indications

Thoracic segmental spinal anaesthesia is currently most appropriate for specific surgical procedures and certain patient profiles. This includes shorter surgeries where patients are at a higher risk of experiencing complications or even mortality when subjected to general anaesthesia. It is also an option for patients who are averse to undergoing general anaesthesia. Additionally, individuals who are not candidates for the conventional method of spinal anaesthesia in the lumbar region may find this approach beneficial. The at-risk patient group typically comprises older individuals with diminishing physiological reserves, underlying health conditions, a multitude of medications, cognitive challenges, and frailty [8].

Procedures that have seen success with thoracic segmental spinal anaesthesia encompass abdominal cancer surgeries, breast cancer surgeries, and laparoscopic cholecystectomies. Notably, some of these procedures have yielded positive outcomes in healthy individuals, suggesting that in the future, even those in good health may benefit from this technique. However, it's imperative to await further studies involving a larger patient cohort to validate the safety and effectiveness of this approach before recommending it for standard practice.

Before proceeding with thoracic segmental spinal anaesthesia, securing informed consent, signed by the patient, is a mandatory step. The patient must receive a comprehensive briefing on the rationale for employing this technique, what to anticipate during the procedure, as well as the potential advantages, risks, and alternative approaches. A thorough explanation of post-procedure expectations is critical, including the awareness that the patient will remain

awake during the surgical procedure. This can trigger significant apprehension in many patients, and, as such, they should be informed about what sensations to expect during the procedure, such as tugging or discomfort caused by pneumoperitoneum resulting from insufflation during laparoscopic surgeries.

Contraindications

There are well-established contraindications for all forms of neuraxial anaesthesia. Absolute contraindications encompass situations where neuraxial anaesthesia must not be administered under any circumstances. These include:

- Patient Refusal or Lack of Consent: Neuraxial anaesthesia cannot be performed without the explicit consent of the patient. It is a critical requirement to ensure patient autonomy and safety.
- Local Infection at the Procedure Site: If there is evidence of infection at the intended site of the procedure, such as an epidural or spinal injection, it is an absolute contraindication. Infection introduces the risk of introducing pathogens into the spinal or epidural space.
- True Allergy to Drugs Used: If the patient has a confirmed and severe allergic reaction to any of the medications used in neuraxial anaesthesia, such as local anaesthetics, it is an absolute contraindication due to the risk of anaphylaxis.
- Elevated Intracranial Pressure: Neuraxial anaesthesia is contraindicated when a patient has increased intracranial pressure, as it raises the risk of uncal herniation if cerebrospinal fluid (CSF) is lost through the needle during the procedure.
- Operation Duration Exceeds Block Duration: When the expected duration of the surgical procedure exceeds the duration of the nerve block provided by neuraxial anaesthesia, it is an absolute contraindication. This ensures that the patient remains adequately anesthetized throughout the surgery [9].

Relative contraindications are situations where caution is needed when considering neuraxial anaesthesia and the decision to proceed depends on careful assessment and balancing of risks and benefits. These include:

- Preexisting Neurological Diseases: Patients with certain neurological conditions, such as multiple sclerosis or other demyelinating diseases, are considered relative contraindications. The decision to use neuraxial anaesthesia should be made with the patient's medical history in mind.
- Sepsis: Patients with sepsis are relative contraindications, as their condition may affect their ability to tolerate the procedure and its potential complications.
- Severe Hypovolemia: Profound dehydration or low blood volume is a relative contraindication, as it can affect the patient's hemodynamic stability during the procedure.
- Coagulopathy: Coagulopathy (a disorder of blood clotting) is a relative contraindication, but the decision to proceed with neuraxial anaesthesia may depend on the severity of the coagulopathy and the patient's overall health.
- Severe Mitral and Aortic Stenosis and Left Ventricular Outflow Obstruction: Conditions such as severe mitral and aortic stenosis or left ventricular outflow obstruction, often seen in hypertrophic obstructive cardiomyopathy, are relative contraindications due to the potential hemodynamic effects of neuraxial anaesthesia. The decision to proceed depends on the patient's cardiac status.

In cases of relative contraindications, the healthcare team must carefully assess the patient's individual risk factors and weigh them against the potential benefits of neuraxial anaesthesia while taking steps to mitigate any associated risks [10].

Equipment

Thoracic spinal anaesthesia is conducted with strict attention to aseptic techniques, and the anaesthesiologist is responsible for maintaining a sterile environment throughout the procedure. The following steps and precautions are typically taken:

- Aseptic Technique: The entire process of thoracic spinal anaesthesia is performed under aseptic conditions to prevent infection. This involves strict cleanliness and sterilization procedures.
- Protective Gear: The anaesthesiologist must wear appropriate protective gear, including a surgical hat, mask, and sterile gloves to ensure sterility.
- Patient Monitoring: The patient should be closely monitored, including the use of a blood pressure cuff or an arterial line for invasive arterial blood pressure monitoring if the patient is at risk of hemodynamic instability. Routine monitoring includes electrocardiography (EKG) and pulse oximetry for oxygen level assessment.
- Sedation and Support Tools: If sedation is part of the plan, the necessary tools for ventilation, oxygenation, and circulatory support should be readily available to address any potential complications.
- Intravenous Access: Intravenous access should be established before commencing the procedure, allowing for the administration of medications or fluids if needed.
- Spinal Anaesthesia Kit: Prepackaged spinal anaesthesia kits are typically utilized and include various components such as.
- Antiseptic Preparation: A bactericidal antiseptic, often chlorhexidine, is used to prepare the patient's skin at the

site where the needle will be inserted.

- Sterile Drape: A sterile drape is employed to maintain a sterile field.
- Local Anaesthetic: A local anaesthetic, often 1% lidocaine, is used to anesthetize the skin and underlying tissues at the needle insertion site.
- Spinal Needle: The kit includes a spinal needle, which is designed for the safe administration of the anaesthetic into the subarachnoid space.
- Syringes: Syringes are used to withdraw the spinal anaesthetic solution and control its administration.
- Spinal Anaesthetic Solution: Various types of spinal anaesthetic solutions are available, with bupivacaine (0.5% or 0.75%) being the most commonly used due to its potency, relatively quick onset (5 to 8 minutes), duration of anaesthesia (90 to 150 minutes), and a lower incidence of transient neurologic symptoms (TNS). Less commonly used is 0.5% lidocaine, which has fallen out of favor due to a higher risk of Transient Neurological Symptoms.

In summary, the performance of thoracic spinal anaesthesia involves meticulous attention to sterility and patient safety. The use of prepackaged kits containing essential materials and medications ensures consistency and minimizes the risk of contamination during the procedure. It is important to follow strict protocols to maintain asepsis and monitor the patient's condition throughout the process.

Personnel

The administration of thoracic segmental spinal anaesthesia is ideally carried out by highly skilled anaesthesiologists with extensive expertise in performing neuraxial anaesthesia. Anaesthesiologists who are well-versed in this technique and comfortable with its intricacies are best suited for the task. Additionally, the presence of a supportive team is essential to ensure a safe and effective procedure. This team may include another anaesthesiologist, a nurse anaesthetist, or nursing staff who play crucial roles:

- Assistance with Equipment and Supplies: The support staff is responsible for assisting in the preparation and setup of the necessary equipment and supplies. This includes ensuring that all instruments and materials required for the procedure are readily available and properly organized.
- Patient Positioning and Safety: The patient's safety and comfort are of paramount importance. The team members help maintain the patient's posture and ensure they remain secure and well-positioned on the operating room table. This is critical to prevent any accidental movements or complications during the administration of anaesthesia.

The collaborative effort of an experienced anaesthesiologist and a well-coordinated team of healthcare professionals helps optimize patient safety and the successful execution of thoracic segmental spinal anaesthesia. This approach ensures that the procedure is performed with precision and that the patient's well-being is safeguarded throughout the process.

Technique/ Treatment

The initial setup for the thoracic segmental spinal anaesthesia procedure is crucial and involves several key steps:

- Patient Positioning: The patient is positioned either in the sitting or lateral decubitus position. The height of the operating room table is adjusted for the patient's comfort, and blankets are provided. Sedation may be administered if necessary. The sitting position is commonly preferred because it helps avoid potential spinal rotation that can occur in the lateral decubitus position. In the sitting position, the patient is instructed to flex the neck and arch the lower back to facilitate access to the thoracic intervertebral spaces. For the lateral decubitus position, the patient's back should align with the edge of the bed closest to the anaesthesiologist, with the knees flexed toward the abdomen.
- Identifying the Entry Level**:** The insertion level is identified through palpation and the use of anatomic landmarks. The space between two palpable spinous processes serves as the entry point. Landmarks such as the inferior angle of the scapula (T7 spinous process) and the 12th rib margin (L1 spinous process) are commonly used to estimate the level. Each thoracic vertebra is associated with ribs along the lateral border of its vertebral body, aiding in the determination of the lower thoracic and upper lumbar regions. The "counting up method" can be employed to identify other interspaces, depending on the desired needle insertion point. Another approach involves using ultrasound guidance to count up from the 12th rib to pinpoint the appropriate vertebral level. A skin mark is made to denote the correct block level.
- Preparation and Sterility: The identified area is prepared by cleansing it with an antiseptic solution and allowing it to dry. A sterile drape is placed over the prepared area to maintain sterility.
- Anaesthetic Infiltration: The skin at the puncture site is infiltrated with 1% lidocaine. The location of the infiltration depends on whether a midline or paramedian approach is chosen. In the midline approach, the needle is angled more cephalad, particularly in the mid-thoracic region where the long thoracic spinous processes are more caudally oriented. Beyond T10, they resemble lumbar spinous processes. In the paramedian approach,

the skin is infiltrated approximately 2 cm from the midline, and the spinal needle is inserted at an angle toward the midline. This approach avoids the supraspinous and interspinous ligaments and encounters less resistance before reaching the ligamentum flavum. The needle is advanced slowly and cautiously, and a characteristic "popping" sensation is felt upon penetration of the ligamentum flavum.(11)

- Cerebrospinal Fluid (CSF) Flow Confirmation: After passing through the ligamentum flavum, the stylet is removed from the needle, and a clear flow of CSF should be observed at the hub of the needle.
- Anaesthetic Injection: Approximately 1 to 2 ml of 0.5% to 0.75% bupivacaine, along with 15 to 20 ug of fentanyl, is injected intrathecally once the clear CSF flow is established. Depending on the surgical location, a hyperbaric, isobaric, or hypobaric anaesthetic solution may be used. Alternatively, a combined spinal-epidural (CSE) needle set can be employed, first identifying the epidural space using the "loss of resistance" method and subsequently advancing the spinal needle through the epidural needle. The CSE system helps limit the portion of the needle projecting beyond the tip of the epidural needle, reducing the risk of spinal cord injury.
- Needle Removal and Patient Positioning: Following the injection of the anaesthetic, the spinal needle is removed, and the patient is positioned in a supine (lying face up) posture.
- Sensory Block Assessment: The patient is assessed for an adequate sensory block to pinprick. If the sensory block is insufficient after 5 to 10 minutes, consideration is given to converting to general anaesthesia if feasible.

This meticulous process ensures the precise administration of thoracic segmental spinal anaesthesia while prioritizing patient safety and comfort throughout the procedure.

Complications

Complications associated with thoracic spinal anaesthesia can be categorized into major and minor, with major complications being relatively rare but more serious. The most significant complications of thoracic spinal anaesthesia include [12]:

- Direct Needle Trauma: Occurs when the spinal needle or catheter causes damage to spinal structures.
- Infection: This can lead to conditions such as abscess or meningitis and is a severe complication.
- Vertebral Canal Hematoma: Accumulation of blood within the vertebral canal, which can compress the spinal cord and nerve roots.
- Spinal Cord Ischemia: A condition where the spinal cord doesn't receive adequate blood supply, leading to potential damage.
- Arachnoiditis: Inflammation of the arachnoid membrane surrounding the spinal cord, which can cause pain and neurological symptoms.
- Total Spinal Anaesthesia: When the anaesthesia spreads too high and affects a large portion of the spinal cord, potentially causing respiratory depression and cardiovascular instability.
- Cardiovascular Collapse: A severe drop in blood pressure or other cardiac issues.
- Death: Although extremely rare, fatal complications can occur.
- Minor complications, while more common, should not be underestimated. They include:
- Hypotension: Low blood pressure, a common side effect of spinal anaesthesia.
- Nausea/Vomiting: Often a result of hypotension and can cause discomfort.
- Bradycardia: A slower than normal heart rate.
- Paresthesia: Abnormal sensations, such as tingling or numbness.
- Transient Mild Hearing Impairment: Temporary hearing issues, typically related to the anaesthetic agents used.
- Backache: Discomfort or pain in the back following the procedure.
- Urinary Retention: Difficulty or inability to urinate, a common side effect of spinal anaesthesia.
- Transient Neurologic Symptoms (TNS): Temporary neurological symptoms, typically affecting the lower back and legs.
- Post-Dural Puncture Headaches: While classified as a "minor" complication, these headaches can be quite debilitating for patients and are relatively common.

It's crucial for healthcare providers to be aware of and prepared to address these complications, and for patients to be informed of the potential risks associated with thoracic spinal anaesthesia. The likelihood and severity of complications can vary from person to person, and close monitoring and appropriate management are essential to ensure patient safety [13].

Clinical Significance

Thoracic segmental spinal anaesthesia offers numerous advantages that may not be attainable with general anaesthesia or, in some cases, lumbar spinal anaesthesia. This technique has opened the door to performing specific major surgeries on patients who remain awake during the procedure and are at high risk for complications under general anaesthesia. The benefits of thoracic segmental spinal anaesthesia are as follows:

- Enhanced Patient Safety**:** It allows for the execution of complex surgeries on high-risk patients without the

need for general anaesthesia, thereby minimizing the associated risks.

- Improved Pain Management: This technique provides superior pain control compared to opioid-based pain relief methods, leading to a reduction in the overall opioid requirement during and after the procedure. This, in turn, lowers the incidence of side effects associated with opioid medications [14,15].
- Accelerated Recovery: Patients undergoing thoracic segmental spinal anaesthesia experience a faster recovery of bowel function. This contributes to a reduction in postoperative complications and results in a shorter duration of in-hospital stay.
- Enhanced Patient Satisfaction: Patients typically report higher satisfaction levels due to the advantages of better pain control, a quicker recovery, and reduced opioid-related side effects.
- Postoperative Pain Management: Thoracic segmental spinal anaesthesia can be effectively used in combination with other pain management modalities to provide comprehensive postoperative pain relief.
- Minimal Hemodynamic Instability: The administration of a lower anaesthetic dose during thoracic spinal anaesthesia results in minimal hemodynamic instability, further contributing to patient safety.

Administering thoracic segmental spinal anaesthesia creates the potential for patients, particularly those requiring extended hospital stays, to undergo surgeries safely, even in high-risk scenarios. This technique has revolutionized surgical approaches by mitigating risks and enhancing patient outcomes.

References

1. Hamad MA, El-Khattary OA (2003) Laparoscopic cholecystectomy under spinal anesthesia with nitrous oxide pneumoperitoneum: a feasibility study. Surg Endosc 17(9): 1426-1428.

2. Elakany MH, Abdelhamid SA (2013) Segmental thoracic spinal has advantages over general anesthesia for breast cancer surgery. Anesth Essays Res 7(3): 390-395.

3. Ellakany MH (2014) Thoracic spinal anesthesia is safe for patients undergoing abdominal cancer surgery. Anesth Essays Res 8(2): 223-228.

4. Imbelloni LE, Quirici MB, Filho FJR, Cordeiro JA, Ganem EM, et al. (2010) The anatomy of the thoracic spinal canal investigated with magnetic resonance imaging. Anesth Analg 110(5): 1494-1505.

5. Chin KJ, Karmakar MK, Peng P (2011) Ultrasonography of the adult thoracic and lumbar spine for central neuraxial blockade. Anesthesiology 114(6): 1459-1485.

6. Olawin AM, M Das J (2022) StatPearls. StatPearls Publishing, Treasure Island, Florida, USA.

7. Zundert AVA, Stultiens G, Jakimowicz JJ, Peek D, Ham WVDG, et al. (2007) Laparoscopic cholecystectomy under segmental thoracic spinal anaesthesia: a feasibility study. Br J Anaesth 98(5): 682-686.

8. Carpenter RL, Caplan RA, Brown DL, Stephenson C, Wu R, et al. (1992) Incidence and risk factors for side effects of spinal anesthesia. Anesthesiology 76(6): 906-916.

9. Zaric D, Pace NL (2009) Transient neurologic symptoms (TNS) following spinal anaesthesia with lidocaine versus other local anaesthetics. Cochrane Database Syst Rev 15(2): CD003006.

10. Rocco AG, Raymond SA, Murray E, Dhingra U, Freiberger D, et al. (1985) Differential spread of blockade of touch, cold, and pinprick during spinal anesthesia. Anesth Analg 64(9): 917-923.

11. Cook TM, Counsell D, Wildsmith JA (2009) Royal College of Anaesthetists Third National Audit Project. Major complications of central neuraxial block: report on the Third National Audit Project of the Royal College of Anaesthetists. Br J Anaesth 102(2): 179-190.

12. Hartmann B, Junger A, Klasen J, Benson M, Jost A, et al. (2002) Hempelmann G. The incidence and risk factors for hypotension after spinal anesthesia induction: an analysis with automated data collection. Anesth Analg 94(6): 1521-1529.

13. Tarkkila P, Isola J (1992) A regression model for identifying patients at high risk of hypotension, bradycardia and nausea during spinal anesthesia. Acta Anaesthesiol Scand 36(6): 554-558.

14. Amorim JA, Barros GDMV, Valença MM (2012) Post-dural (post-lumbar) puncture headache: risk factors and clinical features. Cephalalgia 32(12): 916-923.

15. Imbelloni LE, Gouveia MA (2014) 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 8(1): 26-31.