RESEARCH PAPER

# Thoracic Segmental Spinal: Treading Into Unexplored Waters A Case Series.

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**ABSTRACT**

Background: General anaesthesia is still good but has some drawbacks, e.g adverse effects of the drugs, delayed and prolonged recovery, and unjustified less pain control. Thoracic spinal anesthesia has provided a way for the surgeries which were difficult to be done under general anaesthesia due to their adverse effects Material and methods: 8 patients were operated under thoracic spinal anaesthesia in Anaesthesia department of Maharishi Markandeshwar Institute of Medical Sciences And Research, Mullana, Ambala.

Conclusion: Thoracic segmental spinal is a technique that utilises low dose of local anesthetic and opioid as a substitute to GA for major surgery, as it results in faster recovery with higher patient satisfaction, better post-operative pain control, and lower incidence of postoperative nausea vomitting with early hospital discharge.

**Keywords**: Thoracic segmental spinal, opioid anaesthesia, low dose spinal.

**How to cite this article:** Kour A, Khader A, Panwar R, Singh A, Thoracic Segmental Spinal: Treading Into Unexplored Waters A Case Series...Int J Drug Deliv Technol. 2026;16 (6s): 124-130; DOI: 10.25258/ijddt.16.6s.15

**Source of support:**. None

**Conflict of interest:** None

## INTRODUCTION

Segmental spinal is a newly emerging regional anaesthesia technique that is a potential alternative to general anaesthesia in patients who are not fit for the same. It is typically utilized for patients undergoing surgery with major medical issues which are otherwise considered as a greater risk for general anaesthesia. General anaesthesia has its own sets of drawbacks, that are inadequate pain control due to lack of residual analgesia, high incidences of nausea and vomiting and increased hospital stay.(1)

In 1909, Thomas Jannesco, proposed that general spinal block can be used for surgeries of skull, head, neck and thorax. He demonstrated this by performing punctures between 1st and 2nd thoracic vertebrae, thereby producing deep analgesia for that dermatome including head, neck and upper limbs. He also performed puncture between 12th thoracic and 1st lumbar vertebrae, which produced anaesthesia for lower portion of body.(2)

In 1932, Kirschner described approaching the subarachnoid space with patient in lateral position with head up as a technique for segmental spinal anaesthesia in which cerebrospinal fluid was aspirated and replaced by air injection following which a hypobaric solution of nupercaine was injected a space below the air. Subsequent air injections would move the local anaesthetic agent to the head region.(3) This technique however was modified in 1937 by removing the air injection and obtaining segmental spinal anesthesia(4). In 1934, two needles were used for performing segmental anaesthesia, one by subarachnoid puncture lumbar and one by puncture in the cisterna magna(5).

Various studies investigating the anatomy of the thoracic spinal canal with magnetic resonance imaging demonstrated that the space between the dura mater and spinal cord in the thoracic region was 5.19 mm at T2, 7.75 mm at T5, and 5.88 mm at T10 [6]. On calculating the angle of entry between the intersection of T5 and T6, an angle of 45° was found on MRI, thereby increasing the distance between the tip of the needle to the posterior surface of the cord. MRI also confirms that the spinal cord and the cauda equina touch the dura mater anteriorly in the thoracic region and posteriorly in the lumbar region [6]. This increases the distance that allows needle advancement without touching the cord. These results confirm to those of a previous study that found the posterior subarachnoid space at midthoracic levels to have greater depths than at lumbar and upper thoracic levels [7]. These findings can be used an anatomical explanation as to why there is low incidence of neurologic complication during accidental perforation of the dura mater in thoracic epidural block [8] and this explains the safety of the segmental spinal anesthesia via thoracic approach [9,10] .

Cerebrospinal fluid (CSF) in the brain and spinal cord is about 125-150 mL at any one time, and about 500 mL is generated every day [11]. The CSF volume influences the duration of spinal sensory anesthesia in a seated position and CSF dynamics are highly sensitive to respiratory performance in spinal region, as forced inspiration and expiration lead to upward and downward CSF flow in the spinal canal, respectively [12]. CSF density

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and volume also influence the spread of spinal anesthesia depending on the baricity of the drug used. In 1907, the principles of gravity control of the technique came into light, that are accepted until today(13). The solutions frequently used in segmental spinal anesthesia cover all known local anesthetics available. In the beginning, hypobaric solutions were used and eventually isobaric solutions became popular. In modern era, hyperbaric and isobaric solutions both are used, depending on what you want to achieve with segmental spinal anesthesia. Isobaric solutions injected at the level of the 5th thoracic space can simultaneously block sensitive and motor roots, providing safe anesthesia. Likewise, if the hyperbaric solution is used, it can diffuse more by bathing sensitive fibers, providing a longer-lasting sensory block than motor block(4). Likewise, the puncture can be performed in the sitting or lateral position and immediately the patient must be placed in a cephalic position with the isobaric solution and cephalic position with the hyperbaric solution. Both solutions may migrate to the cervical regions, preventing diffusion to the lower regions and providing segmental spinal anesthesia.

Spinal anaesthesia is one of the most popular and widely used anesthetic procedures nowadays. It is a simple, cost effective and efficient technique that provides complete sensory and motor block, as well as postoperative analgesia with a high success rate. In segmental spinal anesthesia, a limited number of nerve roots are blocked by an anesthetic solution within the subarachnoid space, providing surgical anesthesia in the surgical field dermatomes. Segmental spinal anesthesia can be obtained with thoracic puncture and single injection of isobaric or hyperbaric local anesthetic. Likewise, it can be achieved through combined epidural-spinal block, with intrathecal injection and later passage of the epidural catheter. Here we are presenting a series of 6 cases which were performed under segmental spinal anesthesia as the patients were at high risk for general anesthesia due to underlying comorbidities.

## Material and method

This was a case series, which was carried out in Anaesthesia department of Maharishi Markandeshwar Institute of Medical Sciences And Research, Mullana, Ambala :

Inclusion criteria:

1. Patients with physical status ASA grade III or IV.
2. All patients giving written informed consent.
3. Patients undergoing thoracic, abdominal surgeries unfit for general anaesthesia.
4. Patients belonging to age group of 18 to 75 years.
5. Patient with renal or liver disease.
6. Patients with increased risk of aspiration.
7. Patients with BMI > 35 kg/m2
8. Patients with difficult airway.
9. Patients having cervical spine diseases

Exclusion Criteria:

1. Patient refusal for the procedure.
2. Patient with anaemia.
3. Patient with significant coagulopathies.

## METHODOLOGY

A thorough pre anaesthesia check-up (PAC) was done prior to the surgery and all the necessary routine investigations were carried out. All the patients fulfilling inclusion criteria were considered for this technique. Other than routine methods of airway assessment, Wilsons's score and Mallampati score were used. A written informed consent was taken from the patients. In the operation theatre, pulse oximeter, non-invasive blood pressure cuff and electrocardiogram (ECG) was placed on all patients. A total of 7 patients were operated under thoracic spinal anaesthesia as follows:

### Case 1 - Laparatomy

A 36 yr old female who was posted for "exploratory laparotomy due to repeated collections. The patient was referred from periphery hospital where she had undergone laparotomy followed by colostomy for intestinal obstruction and perforation. She had undergone colostomy closure after 15 days after which she developed feature suggestive of obstruction and was referred to us for management. The patient was married female, nulliparous with no co-morbidity. On arrival her vitals were stable. However patient had history of pulmonary Koch's with fibrotic bands in both lungs, her room air saturation was 96 %. Thus the patient was taken for laparotomy for the 4th time and illestomy was planned. Keeping in mind, the repeated exposures and the underlying lung conditions, the plan of anaesthesia was combined thoracic segmental spinal and epidural. As the duration of surgery was unpredictable due to multiple laparotomies and anticipation of adhesions as well as for post-operative analgesia epidural was also chosen. Patient was explained about the procedure and consent was obtained .OT was prepared and patient was shifted with two wide bore 18G cannula. After attaching all the necessary monitors like EGG, NIBH and Spo2, patient was made to sit on OT table. Under aseptic conditions using 18G Touhy's needle epidural was given at T7-T8 using loss of resistance technique and catheter secured. Spinal was given at T8-T9 using 26 G Quincke Needle using Fentanyl 25 mcg + Bupivacaine 0.5 % heavy 1.5 ml and isobaric 0.75 % Ropivacaine 1.5 ml in separate syringes .Level achieved was T4 and patient was able to move her legs. Vitals remained stable and patient was comfortable with 1 mg of midazolam, the surgery went on for 3.5hrs and epidural top up was given after 2 hrs 15 minutes using 3 ml of 0.75 / ropivacaine . At the end of the procedure, the patient was shifted pain free. The patient was discharged after 10 days of hospital stay.

**Case 2. Laparoscopy cholecystectomy**

62yrs old female with history of cholelithiasis was posted for Laparoscopic cholecystectomy. The patient had history of Cough with MET < 4 and Breath holding time of 14 seconds, In view of NYHA IV, PFT was done which showed early small airway obstruction and HRCT chest showed multiple ground glass opacities. Room air saturation of patient was 89%. ECHO was done showed EF of 58%. The patient was planned under thoracic segmental spinal, keeping the under lying chest conditions in view. Using 25G Quincke Needle subarachnoid block, was given at T8 – T9 using 1.5 ml 0.75%isobric ropivacaine with 25 mcg of fentanyl. Level achieved was T4 and patient tolerated pneumoperitoneum well. Intraoperative vitals remained stable with MAP maintained around 68mm HG are surgery was completed in 40 minutes and post operatively patient was comfortable breathing spontaneously. The patient was ambulated in the evening and was discharged on the 3rd day.

**Case 3. Biliary Stenting**

70 years female posted for Biliary Stenting underlying ca head of pancreases had Diabetes since 3-4 years on OHA and Hypertension on Amlodipine. Patient was 120 kg with NYHA Grade III Chest X-Ray showed Increased Bronchovascular markings with B / L CP angles blunting and right basal homogenous opacity. On ECHO EF was 68 % with diastolic dysfunction, the patient was planned for segmental spinal. There was risk of postoperative ventillatory support requirement under General anaesthesia. After skin preparation the patient was placed in the right lateral position T9-T10 intervertebral space was identified and after free flow of CSF subarachnoid block was given using 1ml ( 0.75% ) Isobaric Ropivacaine + 25 mg fentanyl and 0 . 5 ml of hyperbaric bupivicane in separate syringes. The block achieved the dermatomes from T6 toT12. Patient was moving her limbs. Her respiratory efforts were normal with 6 liters of oxygen. Surgery lasted for one hour and Post-operative period was uneventful.

**Case 4. Hiatus Hernia**

A middle male aged patient, with H/o of recurrent regurgitation and epigastric pains. The patient was diagnosed as Hiatus Hernia and was posted for Heller myotomy. The patient was known case of diabetes on OHA. Patient was smoker with multiple hilar infiltrates on chest x ray. On room Air ABG showed PCO2 of 62 mmHg and saturation of 92 % . The abdomen of the patient was distended .the patient has history of OSA with a stop bang score of 4. Usually this procedure is done under general anaesthesia but in this case there was risk of postoperative ventillatory requirement. After discussing with surgeon how gave an estimated duration of 2-2.5 hrs , our team decided for segmental spinal to maintain spontaneous breathing.

Under all aseptic conditions using 1.5ml (0.75 %) Isobaric ropivacaine with 25 mcg fentanyl and 1.5 ml 0.5% hyperbaric bupivacaine in separate syringes, subarachnord block was given at T8 – T9 inter space . As the duration of surgery was unpredictable we also secured an epidural catheter at T8 – T9 intervertebral space. The patient had two episodes of hypotension which was managed by fluid and vasopressor mephentermine 6 mg, the surgery lasted for 2-5 hrs and post operatively patient was shifted to HDU and vitals remained stable.

**Case 5: CA colon.**

60 years old man a known case of HTN, restrictive lung disease with diagnosis of Ca Colon was planned for hemicolectomy, the patient was planned for segmental spinal anaesthesia keeping in view of the unpredicted surgical time which otherwise was estimated to be 2.5 hours under all aseptic conditions an epidural catheter was secured at T8-T9 interspaces. Using 1.5 ml of hyperbaric bupivacaine and 1.5ml of isobaric ropivacane and 25 mcg fentanyl in separate syringes, subarachnoid block was given at T8-T9 innterspace using 25 G quinckes needle. The dermatome block level achieved was T4 level and the patient was able to flex his legs but was not able to lift against gravity, the surgical duration was 2 hours 40 min. Epidural top-ups were used for postoperative analgesia.

**Case 6. Laparoscopic Cholecystectomy.**

A female patient 53 years with history of dyspepsia and right upper quadrant pain posted for laparoscopic cholecystectomy, the patient was 107 kg in wt with BHT<15 sec and dyspnea grade III . Cardiac evaluation showed LVH wuth normal syastoilc function. Chest X-ray showed hilar opacities as the patient had history of tuberculosis 10 years back. Keeping in view the patients respiratory state and high BMI we planned thoracic segmental spinal. Under all aseptic conditions using 23G Quincke's needle spinal was performed at T9 – T10 interspaces using 1.2 ml of 0.75 ml of isobaric ropivaciane plus 25 mcg fentanyl. The block level obtained was T2 to L1 with no motor weakness in the both upper and lower limbs, the patient was breathing spontaneously with 4 liters oxygen via nasal prongs, the procedure went uneventful with no requirement of sedation .

**Case 7. Pregnant female with stab injury for exploration of liver laceration.**

32 year old female with history of stab injury was posted for exploration of liver laceration and planned primary suturing. The female was 11 weeks pregnant with no history of any comorbidity. The investigations were within normal limits and foetal viability was assessed by a

gynaecologist before posting the patient for the surgery. Since general anaesthesia could be a threat to the developing fetus and the surgery didn't require much exploration of the abdominal, so we decided to take the patient under thoracic segmental spinal. Using 26 gauge quincke's needle and 1ml of isobaric ropivacaine subarachnoid space was entered at T8-T9 interspace. The level of the block was obtained at T6-T12 with no motor weakness and spontaneous respiration. The surgery lasted for 40 minutes and patient was comfortable without sedation during the whole procedure. The foetal status was checked postoperatively as well and was satisfactory.

**Case 8: Feeding jejunostomy with Ca tongue**

76 year old male itch history of diabetes, hypertension was posted for feeding jejunostomy. Patient was a diagnosed case of carcinoma tongue with mass filling the whole of the mouth. The mass was friable with risk of bleeding on manupilation. The ECG of the patient showed LAD with normal sinus rhythm, X-ray chest showed bronchovascular markings. The patient had HB of 8 gm % and weight of the patient was 45 kg. Since the approach to airway was difficult with risk of bleeding from the growth and no room for laryngoscopy so we decided for thoracic segmental spinal. Using 26 G quinckes needle at T10-T11 interspace subarachnoid block was given using 1 ml 0.75% isobaric ropivacaine with 25mcg fentanyl. The level of the block achieved was T8-L1 and the patient was haemodynamically stable throughout the procedure. Postoperatively patient remained stable and was discharged on 3rd day postoperatively

**Indications**

Thoracic segmental spinal anesthesia is currently best suited for select procedures and patient populations. These typically include shorter procedures with patients considered at high risk of perioperative morbidity and mortality while under general anesthesia or patients unwilling to undergo general anesthesia.[2] In addition, patients who are unable to undergo the traditional method of spinal anesthesia in the lumbar region can benefit as well. Individuals at risk tend to be older patients who decline in physiological reserves, comorbidities, polypharmacy, cognitive dysfunction, and frailty.

Operations that have been performed with success include abdominal cancer surgeries, breast cancer surgeries, and laparoscopic cholecystectomies. In some of these surgeries, the procedure was performed in healthy individuals with excellent outcomes, so, in the future, the procedure may provide benefits for healthy patients as well. The safety of this technique needs to be confirmed by further studies involving a larger number of patients before it can be advised for routine use.

Before proceeding, signed informed consent from the patient is necessary for this procedure. The indication for thoracic segmental spinal anesthesia and what to expect during the procedure, as well as the benefits, risks, and alternative procedures should be described in detail for the patient. A patient must be informed of what to expect after the procedure is performed and that they will be awake during surgery. This will cause a great deal of anxiety in many patients, and as such, they should be informed of feeling certain aspects of the procedure, such as tugging or pain from pneumoperitoneum due to insufflation during a laparoscopic case.[7]

**Contraindications**

There are major known contraindications to all neuraxial anesthesia. The absolute contraindications are patient refusal or lack of consent, local infection at the site of the procedure, a true allergy to drugs given, and elevated intracranial pressure, which increases the risk of uncal herniation when CSF is lost through the needle. In addition, spinal anesthesia is contraindicated when the operation is expected to take longer than the duration of the nerve block.

The relative contraindications are preexisting neurological diseases (multiple sclerosis and other demyelinating diseases), sepsis, severe hypovolemia, and coagulopathy. In the setting of coagulopathy, performing spinal anesthesia can be considered depending on the level of severity. Other relative contraindications include severe mitral and aortic stenosis and left ventricular outflow obstruction, as seen with hypertrophic obstructive cardiomyopathy.[8]

**Equipment**

The performance of thoracic spinal anesthesia is performed under an aseptic technique, and the anesthesiologist is expected to maintain a sterile environment. A surgical hat, masks, and sterile gloves are required to maintain sterility. The patient should be monitored with a blood pressure cuff and/or have an arterial line placed for invasive arterial blood pressure monitoring if the patient is at risk for hemodynamic instability. Routine monitoring with EKG as well as a pulse oximeter for oxygenation is also necessary. If the plan is to use sedation before starting, the tools needed to assist in ventilation, oxygenation, and circulatory support should be in place. Intravenous access should be established before starting.

Prepackaged spinal anesthesia kits are available, which usually include an antiseptic preparation that is bactericidal such as chlorhexidine, a sterile drape, and 1% lidocaine used as a local anesthetic for the site of needle insertion. Other items include the spinal needle, syringes, and the spinal anesthetic solution. Spinal anesthetics can range from a variety of different types; however, the most widely used is bupivacaine (0.5% or 0.75%) due to its potency, its onset of 5 to 8 minutes, with a duration of anesthesia that lasts from 90 to 150 minutes, and lower incidence of transient neurologic symptoms (TNS). Less commonly, 0.5% lidocaine has also been used in the past; however, this fell out of favor due to higher chances of TNS.[9]

**Personnel**

It is recommended that thoracic segmental spinal anesthesia be performed by highly experienced anesthesiologists who have extensive practice with neuraxial anesthesia and are comfortable performing this procedure. Additional support from other staff such as another anesthesiologist, nurse anesthetist, or nursing staff is also necessary for assistance. The other team members are present to assist with equipment and supplies. In addition, the patient needs someone to ensure they maintain their posture and keep them safe in their position on the operating room table.

**Preparation**

Pertinent history and physical examination should be performed before starting. The most important for patient history is any allergies, prior adverse effects to anesthetics, or any family history of complications with anesthetics. The physical exam includes evaluating the thoracic spine for any signs of scoliosis, surgery, infection, severely restricted range of motion, or findings that will make thoracic spinal anesthesia more challenging or impossible. In addition, a basic neurologic exam of gross motor and sensory function should be assessed. Lastly, A review of laboratory studies and vital signs (normal blood pressure and absence of fever) should be conducted to identify patients who may be at risk of complications. A procedural time-out is then performed, confirming the patient's name, the procedure, any known allergies, and confirm consent was given.

**Technique**

The initial setup for the procedure is patient positioning which is performed in the sitting or lateral decubitus position. The positioning also includes the height of the OR table, providing blankets for comfort, and sedation for the patient if required. The sitting position is commonly favored because it avoids a potential rotation of the spine that can occur with the lateral decubitus position. The patient should flex the neck and push out the lower back to open up the thoracic intervertebral spaces. For the lateral decubitus position, the ideal positioning consists of having the patient's back in line with the edge of the bed closest to the anesthesiologist, with the patient's knees flexed up to their abdomen.

Once the patient is positioned correctly, the insertion level is identified by palpation and the use of anatomic landmarks to identify the corresponding spinous process. The space between 2 palpable spinous processes is the site of entry. The inferior angle of the scapula (T7 spinous process) and the 12th rib margin (L1 spinous process) are widely used as landmarks to estimate the level. Each thoracic vertebra articulates with ribs along the lateral border of its vertebral body, which helps determine the lower thoracic and upper lumbar areas. Other interspaces can then be identified, depending on where the needle needs to be inserted, using the 'counting up method.'

Another approach is to use ultrasound guidance with the 'counting up' method starting from the 12th rib and moving up until the corresponding vertebral level is found.[5] A skin mark is then made to identify the correct level of the block. Once located, the area is cleaned with antiseptic preparation and is given time to dry. A drape is placed on the area of focus to maintain sterility. The skin of the puncture site is infiltrated with 1% lidocaine in the midline or paramedian location, depending on the approach chosen.

In the midline approach, the needle is angled more cephalad for thoracic segmental anesthesia as the long thoracic spinous processes point caudally and are most sharply angled between T4 and T9, making insertion of the needle in the midline more difficult in the midthoracic region. Beyond T10, they start to resemble those in the lumbar region.[5] The skin is infiltrated about 2 cm from the midline for the paramedian approach, and the spinal needle advances at an angle toward the midline. In this approach, the supraspinous and interspinous ligaments are not encountered, and there is less resistance before reaching the ligamentum flavum. After needle insertion, which should be slow and cautious, there will be an increase in resistance followed by a characteristic "popping" sensation through the ligamentum flavum.

Once the needle is through the ligamentum flavum, the stylet is removed, and a clear flow of CSF should be seen at the hub of the needle. Once the flow of clear CSF begins, approximately 1 to 2 ml of 0.5% to 0.75% bupivacaine is injected, plus the addition of 15 to 20 ug of fentanyl intrathecally. Depending on the operative location, a hyper, iso, or hypobaric anesthetic solution can be injected. Alternatively, a combined spinal-epidural (CSE) needle set can be used to first identify the epidural space with the "loss of resistance" method followed by the advancement of the spinal needle through the epidural needle. The CSE system can limit the amount of the needle that projects beyond the tip of the epidural needle, minimizing the risk of injuring the spinal cord.[3]

Once the anesthetic is injected, the spinal needle is removed, and the patient is placed in a supine position. The patients should be assessed for an adequate sensory block to pinprick.[10] If the sensory block is inadequate after 5 to 10 minutes, the patient should go under general anesthesia if possible.

**Complications**

There are major and minor complications to the thoracic spinal blockade; however, the major complications are rare. The most serious complications of thoracic spinal anesthesia include:[11]

- Direct needle trauma
- Infection (abscess, meningitis)
- Vertebral canal hematoma

- Spinal cord ischemia
- Arachnoiditis
- Total spinal anesthesia
- Cardiovascular collapse
- Death

Minor complications, on the other hand, are common and shouldn't be disregarded. Some of the more common minor complications include hypotension, nausea/vomiting (typically caused by hypotension), bradycardia, paresthesia, transient mild hearing impairment, backache, urinary retention, and TNS. Lastly, post-dural puncture headaches, which are considered a "minor" complication, can be severely debilitating for patients and are common in occurrence.[12][13][14]

**Clinical Significance**

Thoracic segmental spinal anesthesia offers many benefits not available with general anesthesia or with lumbar spinal anesthesia in some cases. This technique has made it possible to perform certain major operations on an awake patient at high risk for morbidity and mortality under general anesthesia. Other benefits include better pain control than opioids and a decrease in the opioid requirement during or after a procedure, which lowers the incidence of the side effects with these drugs. Furthermore, there is an earlier recovery of bowel function and decreased complications which result in a shorter length of in-hospital stay and patient satisfaction.[3]

This procedure can also be valuable for postop pain in combination with other modalities. Lastly, the anesthetic dose is lower, so hemodynamic instability becomes minimal.[15] Administering thoracic spinal anesthesia may allow for the potential that such surgeries, which need a prolonged hospital course, can occur with high-risk patients and safely.

**Discussion**

This case series presents few of the cases in which an ancient anaesthesia technique which has now come up with the name of segmental spinal has been used. This technique in various studies has shown good satisfaction of the surgeon and the patient as well as also lesser complication rate at the hands of an expert.[16] Various studies have been done to evaluate patient satisfaction and the results of these studies are relevant to anaesthesiologists those who are in resource limited setups and this technique is also beneficial to patients who have relative contraindication for general anaesthesia. Neuraxial anaesthesia has the property of attenuating the neuroendocrine , immune and metabolic responses to surgery as well as reduced post operative opioid requirement.[17]

In our series we presented a variety of cases in which different doses and approaches to segmental spinal were used. In all these cases the hemodynamics were maintained and no complications were encountered. The intraoperative relaxation was adequate and the patient was also not compromised. Postoperative complications nausea vomitting, prolonged motor block hampering early mobility and sore throat were not encountered.

Segmental spinal has many benefits over general anaesthesia and conventional spinal anaesthesia. It is due to this technique that cases with high risk for morbidity and mortality under general anaesthesia can be performed on awake patients. Further an early recovery of bowel function results in shorter lengths of hospital stay.[18] The attraction of this technique is lower doses of anaesthetic drugs thereby reducing the potential for various complications.

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