

Segmental Spinal: Is It Possible?

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How to cite this article:

Naresh W Paliwal, Sunil S Lawhale. Segmental Spinal: Is It Possible? Indian J Anesth Analg. 2020;7(6):1445-1450.

Abstract

The name Segmental spinal anaesthesia is often widely used synonymously with Thoracic spinal anaesthesia. But in real sense segmental spinal anaesthesia means “blocking of the required dermatomes essential for the proposed surgical procedure with very low effective local anaesthetic drug dose”. This often necessitates dural puncture at high lumbar or thoracic levels apart from the conventional spinal. Segmental spinal anaesthesia has been found to be feasible, safe, and effective alternative to conventional general anaesthesia in abdominal and some thoracic surgeries. The objective of this special article is to demonstrate the safety, benefits, risks and utility of this technique as a sole anaesthetic technique or combined with epidurals.

Keywords: Segmental spinal; Combined segmental spinal epidural; Subarachnoid space; Continuous segmental spinal anaesthesia.

Introduction

Anaesthetic management for patients with comorbidities undergoing major surgeries is challenging, especially in patients with some respiratory issues when regional techniques are a possible option. Neuraxial anaesthesia is one of the regional techniques that can provide good surgical fields with added benefits of postoperative analgesia and reduced postoperative pulmonary complications. Apart from the conventional spinal anaesthesia done at lower lumbar levels, segmental spinal performed at mid to lower thoracolumbar levels has been found to be very useful for abdominal and some thoracic procedures. Spinal anaesthesia till date is commonly used for lower abdominal surgeries with good effects. But for upper abdominal surgeries when done under routine spinal anaesthesia requires a high dose of local anaesthetic drugs, producing great haemodynamic changes and delayed recovery. Segmental spinal with low doses of drugs have

demonstrated certain advantages like minimal haemodynamic fluctuations, minimal motor weakness, early recovery and voiding.

History

In 1909 Thomas Jenessco proposed the term general spinal anaesthesia for surgeries of head, neck, and thorax puncturing the subarachnoid space between first and second thoracic vertebra. He also punctured the SAS at mid and lower thoracic levels for thoracic and abdominal surgeries. It was in 2006, new era of studies on segmental spinal begun when A Van Zundart gave spinal anaesthesia puncturing SAS at T10 for laparoscopic cholecystectomy in a patient with severe obstructive lung disease.¹ Since then there have been many studies about segmental spinal exploring its utility in many different surgical procedures like awake thoracic/ thoracoscopic, laparoscopic / open abdominal surgeries, breast surgeries etc.



Segmental spinal definition and feasibility

The name segmental spinal anaesthesia is often widely used synonymously with thoracic spinal anaesthesia. But in real sense segmental spinal anaesthesia means “blocking of the required dermatomes essential for the proposed surgical procedure with very low effective local anaesthetic drug dose”. This often necessitates dural puncture at high lumbar or thoracic levels apart from the conventional spinal anaesthesia at regular spaces. Lower the volume/dose of drug used, more likely it to produce true segmental block. Is it possible? YES, practically all the abdominal surgeries be it an upper abdominal or lower abdominal, laparoscopic or open, major or minor, day-care or not, all are possible with segmental spinal alone or combined with epidural (CSSE) anaesthesia. If that's not all then the option of continuous segmental spinal anaesthesia (CSSA) is also possible. In short “Subarachnoid block can be tamed according to need with the use of different drugs and techniques.”²

Important anatomical aspects

Understanding of the anatomy of spinal canal is the key to successful introduction of spinal medications at thoracic vertebral levels. There is a natural thoracic kyphosis at T7,6,5 levels. Amount of CSF at thoracic levels is diminished as compared to lumbar and cervical levels. Thoracic nerve roots are slight and thin as compared to segments above and below. Thus there is less anaesthetic dilution per segmental unit of distance from the site of injection and the roots are easily blocked due to their small size. Both factors producing efficient blockade of thoracic segments. Many studies performed using myelography shows that the thoracic cord lies anteriorly in the theca, while the lumbar spinal cord is situated more dorsally. The space between the dura mater and the mid to lower thoracic spinal cord on its width is actually greater than that of

the epidural space at lumbar region because of the lumbar enlargement. Midline MRI of the spinal column shows that the cervical enlargement of the spinal cord fills almost the entire spinal canal at that level. In the thoracic segments the spinal cord is positioned anteriorly leaving a significant space between the posterior dura and the spinal cord. (Fig 1 and 4) At the lumbar level the latter space disappears completely.

Major issues and queries related to segmental spinal

1. *Neurological injuries with dura punctured at thoracic level:* As mentioned above there are many studies performed using myelography and MRI which shows that at thoracic levels the spinal cord lies more anteriorly leaving a sufficient space between posterior dura and the spinal cord. A possible anatomical explanation for the absence of spinal cord lesion during accidental perforation of thoracic dura mater was proposed by Imbelloni and Gouveia through a study using MRI, which showed following measurements - 5.19mm at T2, 7.75mm at T5 and 5.88mm at T10 vertebral levels.³ (Fig. 2) A space sufficiently large to allow the entrance of a needle during accidental perforation of dura (a hazard - as we are not ready for it) or intentional puncture of dura (lower risk, as we are ready for it) with a fine needle. This distance is found to be more in all positions, more so in lateral and sitting positions, in which the patients are usually placed for giving spinal anaesthesia. (Fig. 3) The angle required to perform spinal anaesthesia at mid thoracic levels, further increases the distance between posterior dura and spinal cord. It is nearly double (8mm at mid thoracic level and 4.5 mm at thoracic-lumbar level) at the mid thoracic levels compared to levels below. (Fig. 5 and 6) These are the possible explanations for the very low rate of neurological injuries after thoracic epidurals.

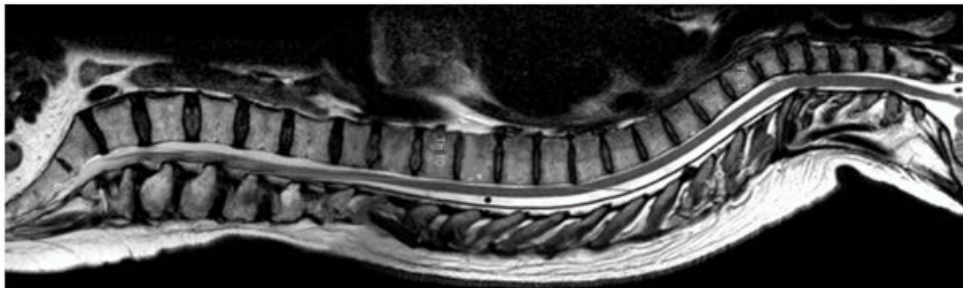


Fig. 1: Mid-line MRI of the spinal column. The cervical enlargement fills almost the entire spinal canal at the level. In the thoracic segments, the spinal cord is positioned anteriorly leaving a significant space between the posterior dura and the spinal cord. At the lumbar level the latter space disappears almost completely.

2. *Respiratory embarrassment due to extensive thoracic nerve blockade:* The main inspiratory muscle of respiration is diaphragm, which is unaffected and expiration at rest is a passive process. However forceful expiration and coughing may get affected because of paralysis of anterior abdominal wall muscles. However, the low dose of drugs used for segmental spinal preserves the coughing ability by causing minimal motor weakness of expiratory accessory muscles⁴.
3. *Cardio-accelerator fibres T1 to 4 getting blocked, causing bradycardia and hypotension:* Heart rate may decrease with high neuraxial blocks as a result of blockade of cardio-accelerator fibres arising from T1 to T4. But as the right atrial filling is maintained due to lumbosacral sparing and less veno-dilatation in lower limbs, that sustains the outflow from intrinsic chronotropic stretch receptors located in the right atrium and great veins. There is also less hypotension because of low dose of drugs used and less venodilatation in lower limbs.⁵



Fig 2: Distances measured at different thoracic level.

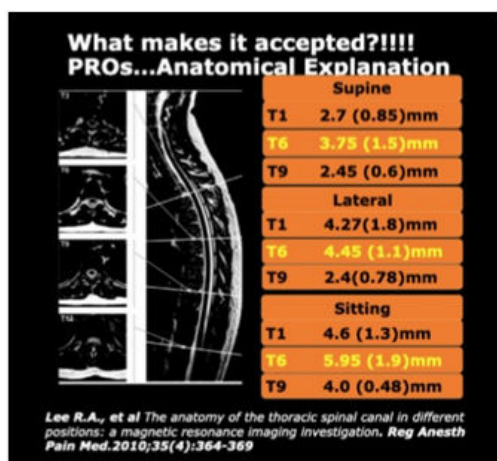


Fig. 3: Distances measured in different positions- supine, lateral, and sitting.

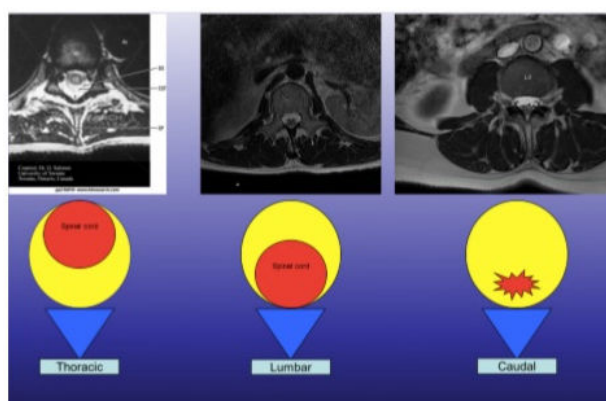


Fig. 4: Diagrammatic representation spinal cord level at different spine levels.

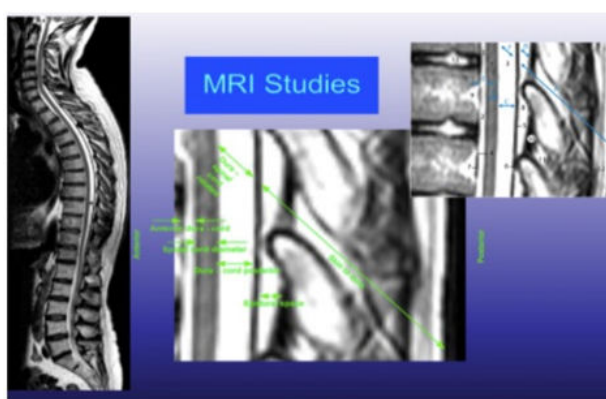


Fig. 5: MRI showing increased distance required to reach at spinal cord and dura at mid thoracic levels.

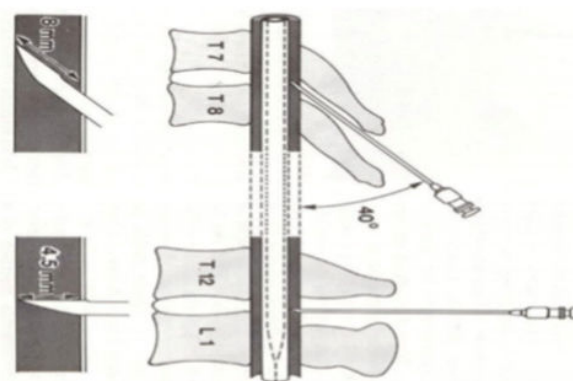


Fig. 6: Angle required at mid thoracic level further increases the distance between posterior dura and spinal cord.

Segmental spinal - indications, drugs, technique, advantages and disadvantages

1. *Indications:* Till date segmental spinal was used mainly in patients with multiple co-morbidities for gall bladder surgeries either laparoscopic or open method. But it can be a useful technique in many thoracic and practically all the intra-abdominal surgeries. Reports of its successful use in awake thoracoscopic surgeries

(Thymectomy, lung volume reduction surgeries and wedge resections) and breast surgeries is available. All the intra-abdominal surgeries, be it upper abdominal or lower abdominal, open or laparoscopic, major or minor, day care or not, all are possible under segmental spinal alone or combined with epidurals (CSSE). Segmental spinal has certain advantages when used in breast cancer surgeries, recurrence rate is diminished as compared to when done under general anaesthesia.⁶ Patients chosen for this technique need to be evaluated carefully and should be avoided in patients with coagulation disorders and infection at the site of injection.

2. *Drugs:* Amongst the available drugs, isobaric drugs like Levobupivacaine, Ropivacaine, or Chlorprocaine can be used for segmental spinals. Hyperbaric bupivacaine can also be used with good effects. Isobaric drugs are usually preferred as they are less sensitive to position issues and when used in low doses, they have propensity to block sensory nerves in preference to motor ones (labelled as Selective A.) This tends to preserve the muscle tone and power in the legs. Addition of small doses of fentanyl 25mcg, or clonidine 30mcg, or dexmedetomidine 10mcg causes increased intensity of sensory blockade. Other advantages of isobaric drugs are onset is gradual, haemodynamic stability even with high levels of block, motor block time is shorter leading to early ambulation and voiding. There is no difference for time to onset at thoracic levels with isobaric and hyperbaric drugs, while isobaric drugs take little time for onset at lumbar levels. -Chlorprocaine 1% is very short acting, useful for short duration (40 to 60 mins) open or laparoscopic surgeries when used in the dose range of 3.5 to 5 ml. -Ropivacaine 0.75 % and levobupivacaine 0.5 % are comparable, but for intrathecal use ropivacaine is nearly half as potent as levobupivacaine because of less lipid solubility. -Levobupivacaine 0.5 % being nearly isobaric, it is less sensitive to position issues. Low dose technique blocks sensory nerves in preference to motor ones (selective). -Bupivacaine 0.5 % heavy - thoracic segmental spinal anaesthesia can be produced with just half the dose that is used in the lumbar region and onset time is reduced to reach the T3 levels. Study of 140 patients by Imbelloni et al,⁸ showed the values for time to reach T3 levels, duration of motor and sensory block and hypotensive events were significantly lower with low dose hyperbaric bupivacaine at

thoracic levels (7.5mg) as compared to doses at lumbar levels (15mg).⁷

3. *Technique and doses:* Depending on the type and site of surgery, co morbidities of the patient, whether combined with epidural or not, the dose of local anaesthetic agent and the site of injection along the neuraxis can be varied. Tenth thoracic intervertebral space being chosen as lying in the centre of the surgical field for upper abdominal surgeries. For all abdominal surgeries with adequate dose, thoracic spinal above T10 is hardly required. Space between T10 and L1 is usually sufficient for all abdominal surgeries. On an average a dose of 7.5 to 10mg of bupivacaine (either isobaric or hyperbaric) with some additive like fentanyl/clonidine/dexmedetomidine works well for 90 to 120mins. This is exactly half the dose required when spinal given at lumbar levels.⁸

Rough estimate of procedure specific dose and site of injection

1. For superficial chest wall procedures (breast surgeries etc.) or thoracoscopies, spinal needs to be at mid thoracic levels at T5/6/7 with isobaric levobupivacaine (preferred) in a dose range of 1 to 1.5 ml (max) with additive, giving a duration of effects 60 to 70 mins. For prolonged procedures it needs to be combined with epidural rather than increasing the dose to avoid side effects.
2. For intra-abdominal surgeries spinal at T10 to L1 (for upper abdominal and laparoscopic surgeries upper space, for lower abdominal and open surgeries lower space) with a dose of 10mg in females and 12.5mg in males with additives is sufficient.

Positioning of patient for giving segmental spinal

While using isobaric drugs for segmental spinal initial position of the patient for giving spinal does not matter. Either sitting or lateral position (even prone if necessary) can be used. When combined with epidurals spinal can be given before placement of epidural catheter. But if hyperbaric drugs are used for segmental spinal then lateral decubitus position with slight head low tilt (10 to 15 degrees) is better to avoid sacral pulling of drugs and inadequate levels with low dose of drug used. Also the epidural needs to be placed before the spinal to avoid unilateral effects.⁹

Type of spinal needle used

If combined with epidural, then CSE kit is the safest way to give segmental spinal. Either a quincke or pencil point needle both can be used. In a study of 300 patients for giving lower thoracic spinals using either cutting needle or pencil point needle, the incidence of paraesthesia and neurological complications afterwards were evaluated by Imbelloni et al.⁶ Paresthesia occurred in twenty patients, seven patients experienced paresthesia with cut needle compared to thirteen patients with pencil point. All paraesthesias were transient and no neurological complications were observed. Procedure.

After giving spinal with the preferred needle and required dose the patient can be turned to supine position. For lateral position surgeries patient can be kept in same position if isobaric drugs are used for spinal in lateral position with operative side up. If hyperbaric drugs are used, then the tilt of the table can be adjusted according to level achieved and desired. Using isobaric drugs patient can be positioned to operative position once the desired sensory level is set in, without worrying for position dependant spread. Sensory block usually sets in two to three minutes (tested by pin prick). Complete effects can be seen in five to seven minutes. With spinal given at thoracic levels, minor and transient degrees of lower limb motor block is more likely to have been due to minimal physical spread of some drug to lumbosacral roots. Whatever little haemodynamic fluctuations that occur with low dose segmental spinal, they occur within first ten minutes depending on the dose used and condition of patients. But the changes are usually minimal and gradual. Complete recovery of the patient with average dose used (7.5 to 10 mg) is usually complete in 90 to 120 mins. Patients can be completely mobilised within 31/2 to 4 hours.¹⁰

*Advantages and disadvantages***Advantages**

Minimal haemodynamic fluctuations even with high levels of block - minimal motor block, faster sensory recovery - early ambulation and voiding - patients with multiple co-morbidities can be considered for day care surgery under segmental spinal.

Disadvantages

With isobaric drugs the level of block cannot be

modified by any change of position - - drugs need to be placed at precise dermatomes required to be blocked for proposed surgical procedure - - slightly less muscle relaxation, may need higher doses in male muscular patients. - - sacral sparing is common with low doses used at higher spaces, needs to be considered for pelvic manipulations - - time limit as with any low dose spinal technique

Conclusion

Low dose segmental spinal is associated with remarkable cardiovascular stability. It is a useful alternative in select patients for various thoracic and abdominal surgeries. Patients with multiple comorbidities, cardiac and respiratory disease may be considered for day care surgeries. Advantages demonstrated are minimal haemodynamic fluctuations, minimal motor block, faster sensory recovery, early ambulation and voiding. Above all postoperative pulmonary complications are avoided.

Remarks

Patient safety takes precedence over the unnecessary risks to be taken for success of the procedure. This technique is reserved for experienced clinicians working in defined and approved evaluation programmes. Fact that anaesthetic technique is not usual does not mean that it is wrong.

Conflict Of interest: None

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