Original Research Article

Comparison of thoracic vs lumbar spinal anaesthesia for orthopaedic surgeries

Loveleen Kour*, Mushtaq Ahmed Wani

Department of Anaesthesia, Government Medical College, Jammu, India

*Correspondence:
Dr. Loveleen Kour,
E-mail: loveeenkour@gmail.com

ABSTRACT

Background: Thoracic spinal anaesthesia has emerged as one of the most promising anaesthetic techniques in the recent times. On the other hand, lumbar approach has been the conventional choice for orthopaedic surgeries since the advent of spinal anaesthesia. This study aimed at determining which approach is better suited for orthopaedic surgeries.
Methods: Total 60 patients scheduled for orthopaedic surgeries were divided into two groups : group T and group L. Group T patients were given thoracic spinal anaesthesia at the T9-T10 / T10-T11 interspace using 1.5 ml of hyperbaric bupivacaine 0.5% (5 mg/ml) + 25µg (0.5 ml) of fentanyl. Group L patients received 2.5 ml of hyperbaric bupivacaine 0.5% (5 mg/ml) + 25 µg (0.5 ml) of fentanyl at LI-L2/L2-L3 interspace. Authors evaluated the degree of analgesia and motor block, haemodynamics and neurological complications.
Results: Onset of analgesia was faster in thoracic group - 2min. The duration of sensory and motor block was shorter in thoracic group. There were no significant differences in haemodynamic variables and respiratory parameters between the two groups and no neurological complication in any patient.
Conclusions: Thoracic spinal anaesthesia is preferable to lumbar spinal anaesthesia for orthopaedic surgeries.

Keywords: Lumbar spinal anaesthesia, Orthopaedic surgeries, Thoracic spinal anaesthesia

INTRODUCTION

Spinal anaesthesia has been the preferred modality for orthopaedic surgeries. It provides safe and effective anaesthesia, minimizes airway manipulation, decreases blood loss and also provides post operative analgesia. Conventionally, the term spinal anaesthesia has been synonymous with lumbar spinal anaesthesia. The lumbar approach entails the insertion of the spinal needle below the termination of the cord i.e. below L1.

The introduction of thoracic spinal anaesthesia dates back to 1909 when Thomas Jonnesco proposed puncture of the spinal cord at two segments – T1-T2 and T12-L1.[1] The concern over cervical cord injury during high puncture has been addressed by anatomical studies of the cervical spine which showed that the spinal cord was pushed along the needle forming a tent, and that this tent protected the spinal pia mater during spinal puncture preventing spinal cord injury.[2] Recently the anatomy of thoracic cord was investigated using MRI by Imbelloni et al, and Lee et al.[3-5] It was found that the distance between the thoracic cord and needle tip is increased due to curvature of thoracic spine making thoracic puncture safe. This finding is further cemented by a study where 300 patients were given low thoracic spinal anaesthesia, the incidence of paraesthesia was 6.6% which is half that seen with lumbar puncture - 12%.[6]

The ACC/AHA classify orthopedic surgery as intermediate-risk surgery, which in most cases involves intermediate-risk patients. Orthopaedic surgeries encompass a wide spectrum of surgeries including arthroplasty, joint replacement, arthroscopy and many more. These surgeries pose unique anaesthetic challenges like increased risk of thromboembolism, increased chances of blood loss, fat embolism syndrome and many more. Also, a huge share of patients undergoing orthopaedic procedures constitutes geriatric population. These patients suffer from multiple co morbidities making them a challenge for the anaesthetist. Regional anaesthesia is clearly beneficial for orthopaedic surgeries as it not only decreases the chances of embolism and blood loss but also minimises the stress response which increase its usefulness in geriatric population.

This study aimed at determining which of the two approaches - thoracic or lumbar is more suited for orthopaedic surgeries.

METHODS

This study was performed in the department of anaesthesia, GMC Jammu between September 2018 and December 2018. Approval was obtained from the institutional ethical committee . 60 ASA 1and 2 patients who were scheduled for elective orthopaedic surgery were chosen for the purpose of this study and informed and written consent was obtained from all of them. They were divided randomly by computer generated numbers into two equal groups- group T receiving thoracic spinal anaesthesia and group L receiving lumbar spinal anaesthesia. The non parametric data was compared using Chi-square test and Mann- whitney U test. Parametric data was analysed using student t test using SPSS 16.0 software.

Patients belonging to ASA status 3 and 4, severe cardiovascular/renal disability , coagulation anomaly and allergy to local amide anaesthetics were excluded from the study.

Patients were kept fasting six hours prior to surgery and premedicated with tablet alprax 0.25 mg, pantoprazole 40 mg and domperidone 10 mg on the night prior to surgery.

Every patient received pre-loading with Ringer lactate 10 ml/kg over 30 minutes and premedication with Ondansetron 0.1 mg/kg and Ranitidine Hydrochloride 50 mg intravenously. All routine monitoring namely, non invasive blood pressure (NIBP), pulse oximetry (SpO_2), end tidal Carbon dioxide (ETCO2) and electrocardiogram (ECG) was started. Inj. midazolam 1 mg i.v. was given to the patient just prior to the start of the procedure in order to allay the anxiety and apprehension.

In both the groups: group T and group L, spinal anaesthesia was performed with the patient in the sitting position. In group T spinal needle was administered either at the T9-T10/T10-T11 interspace using 1.5ml of hyperbaric bupivacaine 0.5% (5 mg/ml) + 25µg (0.5 ml) of fentanyl. In case of group L, 2.5 ml of hyperbaric bupivacaine 0.5% (5 mg/ml) + 0.5 ml (25µg) of Fentanyl was injected into the L3-L4/L4-L5 space using 27 gauge pencilpoint whitacre spinal needle and then the spinal needle was removed. Immediately, the patient was turned to the supine position with a 10 -20 degrees head down tilt. Oxygen at four to five litres/minute was given to the patient by the face mask. Diverting type ETCO2 monitoring system was used, using nasal prongs applied inside the face mask.

Onset of sensory block was assessed every 2 minutes bilaterally (upper and lower levels) in midclavicular line till there was no sensation to pinprick with hypodermic needle. Onset of motor block was assessed every two minutes till complete motor block (grade 3) was achieved and graded according to modified Bromage scale.

The time to reach T10 dermatome sensory block, peak sensory block height, the lowest segment blocked and the maximum motor block achieved was recorded before surgery. Once the desired sensory block (minimum block T10 as assessed by pinprick) was achieved, surgery was commenced.

Intraoperative parameters (heart rate, SBP, DBP, MAP, SpO_2, respiratory rate and ETCO2) were recorded in all patients every two minutes for first ten minutes, every five minutes for next fifteen minutes and every ten minutes thereafter till the completion of surgical procedure.

Intraoperative anxiety was treated with Midazolam 1 mg intravenous boluses upto total 5mg ,hypotension (decrease in mean arterial pressure more than 20 % from baseline value) with fluid bolus 10 ml/kg ringer lactate or mephentermine 6 mg boluses upto total 30mg and bradycardia (heart rate below 20% of baseline) with atropine 10 µg /kg intravenously.

Duration of the sensory block was taken as the time from the onset of sensory block at T10 dermatome to the time when the sensory block regresses to T12 dermatome and duration of motor block as the time from the previous recorded motor block till the patient regained the ability to raise extended legs.

The patients were discharged 24 hours after the procedure after excluding post operative complications and neurological sequelae.

RESULTS

Among all 60 patients who were enrolled in the study, no difference was observed between the two groups with respect to gender, age, height and weight (Table 1). The non parametric data was compared using Chi-square test

and Mann- whitney U test. Parametric data was analysed using student t test using SPSS 16.0 software.

Table 1: Demographics.

Demographic variables	Group thoracic	Group lumbar	P value
Age	45.30	46.30	0.704
Weight	74.80	75.81	0.547
ASA (1/2)	19/11	18/12	0.532
Sex (F/M)	17/13	14/16	0.452

The incidence of paraesthesia in group T was 4% whereas in group L the incidence was 6.5%. This difference was statistically significant.

Table 2: Block characteristics.

Block parameters	Group thoracic (T)	Group lumbar (L)	P value
Onset of sensory block (min)	2.07	4.16	<0.0001
Peak block height (T3/T4/T5)	15/12/3	4/10/16	<0.0001
Time to peak block height (min)	4.03	8.05	<0.0001
Max motor block (B1 /B2/B3)	2/9/19	3/7/20	<0.0001
Sensory block duration (min)	150.10	180.03	<0.0001
Motor block duration (min)	170.33	200.10	<0.0001

The onset of analgesia was faster in group T- 2 min. Whereas in group L, the onset was slower- 4min. The peak block height achieved was lower for group L (T4-T5) than for group T (T2 -T4). Time to reach peak block height was lesser in group T (4 min) than in group L (8 min) (Table 2).

Maximum motor block achieved was bromage 3 in 19 patients in group T whereas maximum motor block achieved in group L was bromage 3 in 20 patients (Table 2). There was no significant difference between the two groups.

The duration of motor block was significantly higher with group L (200 min) than with group T (170 min) (Table 2). The duration of sensory block was significantly longer in group L (180 min) than in group T (150 min).

There was significantly lower incidence of bradycardia and hypotension in group T than in group L. In group T, 3 patients had bradycardia whereas in group L, 8 patients

developed bradycardia. Five patients in group T and 10 patients in group L developed hypotension (Table 3). No patient developed nausea, vomiting or pruritis during the surgical procedure.

No patient developed headache. All patients developed spinal anesthesia; there were no patchy blocks and in no case conversion to GA was done. No patient who experienced paresthesia complained of neurological symptoms at follow-up. There were no serious complications such as epidural hematomas, infection, or permanent nerve injuries in any patient.

Table 3: Characteristics in perioperative period.

Peri- operative parameters	Group Thoracic	Group Lumbar	P value
Surgical time (min)	25	27	0.42
Hypotension (%)	16.67%	33.3%	<0.0001
Bradycardia (%)	10%	26.6%	<0.0001
Conversion to GA	nil	nil	-

DISCUSSION

In present study authors showed that the thoracic approach is better suited for orthopaedic surgeries than lumbar approach. Thoracic approach allows adequate anaesthesia, early recovery of sensory and motor function with maximal haemodynamic stability.

Since the advent of regional anaesthesia, spinal anaesthesia has been synonymus with lumbar spinal anaesthesia. This approach was justified by the safety provided to the neural tissue because of the introduction of the needle below the cord termination.

However, recent studies by Lee and Imbelloni et al, have shown thoracic approach to be safe and effective.[3-5] It was found that the distance between the thoracic cord and needle tip is increased due to curvature of thoracic spine making thoracic puncture safe.

As a result of the difference of the growing rhythm between the spinal column and the medulla, there is an increasing distance of the medullary segments from the corresponding vertebrae. So, in the adult, the vertebrae T_{11} and T_{12} correspond to the five lumbar medullary segments.

To know what level the spinous process of the vertebra corresponds to the medullary segment we have the following rule: Between C_2 and T_{10} authors add two to the spinal process of the vertebra to find out the lumbar medullary segment while from T_{11} and T_{12} they correspond to the five lumbar segments. The process of L_1 corresponds to the five sacral segments. The anatomical data described in this paragraph explain that a

puncture at T_{10} is justified because the nerves of the lower limbs derive from the medulla at this level and the lower limbs will be easily blocked.[7]

The incidence of paraesthesias in thoracic group is lower than in lumbar group in our study . This is explained by the anatomy of the thoracic spine where the posterior separation between the cord and duramater is more than at lumbar level. This separation is further increased in the sitting position as shown by Lee et al.[5] Present study results are similar to those of Imbelloni et al.[6] The safety of thoracic puncture is also reflected in the zero incidence of post operative neurological complications in our study.

The onset of analgesia was faster as well as the peak block height achieved was higher in thoracic group. This can be explained by the fact that there is lower amount of CSF in the chest region compared to the lumbar segment.[8] This produces lesser anaesthetic dilution per segment from the site of injection. Lesser dilution means increased concentration and potency of a given dose of drug in CSF. Also, thoracic roots have been shown to be thinner compared to lumbar and cervical roots.[9] This makes them prone to easy and efficient blockade. Our results are similar to other studies comparing thoracic spinal anaesthesia in patients undergoing different laparoscopic surgeries.[10,11]

The fact that thoracic roots are thinner making them prone to efficient blockade and that there is lesser anaesthetic dilution increasing the concentration of the drug also explains the lesser dose required in the thoracic approach than lumbar. Further, thoracic approach allows drug deposition very close to the target dermatomes. This obviously decreases the drug dose required to produce the desired effect. Our study clearly highlights this fact as 1.5ml of drug given via thoracic route produced the same effects as 2.5 ml drug given via lumbar approach. This is in agreement to the findings of Imbelloni et al, who also illustrated that thoracic approach can also be termed as low drug dose approach.[12]

The duration of sensory and motor block with thoracic approach is lesser than with lumbar approach. Present study results are similar to those seen by others.[12,13] The longer duration of sensory and motor block seen with lumbar spinal anaesthesia can be explained by the greater drug dose required in lumbar approach. The longer duration of the block cannot be considered as an advantage as the block extends well beyond the duration of surgery into the post operative period; which is unnecessary considering that patient is unable to move his legs long after the surgery is over.

Present study showed that inspite of a shorter duration of sensory and motor block in thoracic approach , none of the patients required conversion to general anaesthesia. This highlights that the thoracic approach provides adequate block required for orthopaedic surgeries and avoids unnecessary paralysis in the post operative period.

The haemodynamic disturbances like bradycardia and hypotension were significantly less in thoracic group than in the lumbar group. This highlights another advantage of thoracic approach over lumbar. The lesser haemodynamic disturbances can be explained by the lesser drug dose needed in thoracic approach because of the proximity of site of drug deposition to target dermatomes. This minimizes the unnecessary blockade of the higher dermatomes. Lesser segments blocked means lesser sympathectomy which translates into minimal haemodynamic alterations. This is in coherence with Solakovic N, who while studying the haemodynamic effects of isobaric and hyperbaric bupivacaine concluded that more segments blocked means more sympathocoliosis, more vasodilatation and hence more haemodynamic changes.[14]

CONCLUSION

Thoracic spinal anaesthesia is better than lumbar spinal for orthopaedic surgeries. It provides adequate sensory and motor block with minimal haemodynamic disturbances and no post operative neurological complications.

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